

October 27, 2023

**EASTERN MUNICIPAL WATER DISTRICT
POTABLE WATER
BOOSTER PUMPING STATION
SUBMITTAL AND DESIGN GUIDELINES**

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Appendix A - Typical Booster Station Construction Drawing Index

Appendix B - Typical Booster Station Mechanical Plan and Mechanical Sections

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UPDATE LOG		
Date	Item(s) Changed	Page #
10/27/23	Updated generator room requirements including evaporative cooler, portable access platform, etc.	V-7, V-8, V-18, V-19, V-20, V-21, V-22
12/14/21	Clarified design Risk Category.	III-2, VI-1
	Updated control strategy requirements.	II-6
11/04/21	Revised various electrical provisions throughout	
	Deleted skylight provisions throughout	
08/12/21	Revised minimum capacity under Section V.G.	V-18
	Revised DPF system requirements under Section V.G.7.	V-19
	Revised minimum capacity under Section V.G.14.	V-21
	Added article 15 under Section V.G.	V-21
09/27/16	Entire section revised	
03/01/10	Original	

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**POTABLE WATER
BOOSTER PUMPING STATION
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CHAPTER I INTRODUCTION

This document in conjunction with the District's Water System Planning and Design Guidelines provides guidance to Developers and their Engineers through the process of planning and designing potable water booster stations.

District's existing domestic water distribution system consists of transmission pipelines, booster stations, and storage tanks. Distribution system pressures are based on pressure zones established by the elevation of the water storage tanks. Domestic water system facilities for new developments shall be consistent with the District's existing water distribution system and master planned facilities. Domestic water systems for new developments shall utilize storage tanks open to the atmosphere (reservoirs) to provide the required capacity to serve the pressure zone, or combination of pressure zones. Water storage tanks shall be filled utilizing booster stations or well pumping plants.

Each booster station shall be reviewed and approved by the District from concept through design, construction, and start-up. Preparation of engineering analyses, design calculations, and construction drawings and specifications shall be performed by engineers licensed in the State of California with experience in water system and booster station design. Developer is responsible for the design and construction of all water system facilities within and adjacent to their development which are necessary to serve their development, including extensions of lines to properties that may be served in the future. The District reserves the right to modify and supplement these guidelines and to require additional facilities, depending upon the specific project location, limitations, and changes in government regulations and standards.

CHAPTER II SUBMITTAL PROCEDURES

Procedures required for District approval of a potable water booster station are as follows:

- A. The Developer and the Developer's Engineer (Engineer) shall acquire and review the latest revision of the Potable Water System Evaluation and Facilities Planning Criteria, as well as these guidelines.
- B. All required submittals shall be prepared in accordance with the District's published design criteria and guidelines, and as directed by District staff. Incomplete or unorganized submittals shall be returned to the Developer or Developer's Engineer without review. All submittal documents, including, but not limited to, reports, evaluations, drawings, and specifications, shall be provided in an appropriate electronic format (i.e., searchable PDF, MS Word, CAD, GIS, jpg, tif).
- C. The Developer shall pay all District costs for the following:
 - Review and approval of the Plan of Service for the proposed development.
 - Plan checking of booster station construction drawings and specifications, including all associated engineering submittals required herein.
 - Inspection and construction engineering costs associated with the construction of booster stations.

Planning, plan checking, and inspection/construction engineering fees shall be determined by the District.

The Developer is advised to review these guidelines, including the typical construction drawing index provided in Appendix A herein, to understand the full scope of the submittal and review process for booster stations. The Developer is also advised to consult with the District's Development Services Department to obtain an estimate of the planning, plan checking, and inspection/construction engineering deposits and fees for the proposed booster station. The Developer's actual fees for these services will be dependent upon the competence and diligence of the Developer's Engineer and Contractor.

The Developer will be required to deposit funds for Plan of Service review and approval, prior to District Staff commencing any effort on the project. The Developer will be required to deposit funds for plan check services prior to District Staff, or District's representative commencing review of any engineering or construction drawing submittals required herein. Prior to District approval of the booster station construction drawings, Developer shall pay all remaining plan check fees. Likewise, the Developer will be required to deposit funds for inspection/construction engineering services prior to scheduling the preconstruction conference and initiating any construction activities. Prior to

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District acceptance of the completed booster station, Developer shall pay all remaining inspection/construction engineering fees.

- D. Following District approval of the Plan of Service for the proposed development, the Engineer shall request a preliminary planning/concept meeting with District staff to discuss the design of the required potable water conveyance facilities. At least two (2) weeks prior to the meeting, the Engineer shall submit four (4) copies of the following:
1. Development information, including preliminary tentative tract map(s), dwelling unit densities, demand quantities (average, maximum, and peak hour demands, and fire flow), conceptual sizing and layout of in-tract water system, conceptual sizing and alignment of any transmission pipelines, and point(s) of connection to the District's existing system.
 2. District's existing and master planned facilities in the vicinity of the development.
 3. Source(s) of water supply for the proposed development, including suction zone high water level (HWL) and low water level (LWL) elevation, and available system pressure during all ranges of operation at the proposed connection points to the existing system. If possible, two sources of water supply shall be provided to the proposed booster station. If necessary, District staff will utilize the existing distribution system InfoWater network computer model to determine the system pressures at connection points to the existing system under various operating conditions.
 4. Identify concepts for serving the proposed development and adjacent areas (if applicable) using either existing or new elevated water storage tanks (reservoirs). If a new reservoir is required, identify minimum and maximum reservoir elevations required to meet District static pressure requirements per EMWD Reservoir and Reservoir Site Submittal and Design Guidelines. Compare reservoir elevations to existing District pressure zones in the vicinity of the development and establish a preliminary pressure zone elevation conforming to the District's Water Facilities Master Plan (WFMP).
 5. Identify concepts for reservoir site(s) if a new reservoir is required.
 6. Identify booster station capacity, including initial and ultimate capacities per the District's WFMP.
 7. Identify concepts for booster station site(s).

At the preliminary planning/concept meeting, the Engineer shall present the above information to District staff. District staff and Engineer shall jointly establish the water system alternatives to be further evaluated by the Engineer. If necessary, a

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second concept meeting will be scheduled to refine the water system alternatives.

- E. Engineer shall evaluate the water system alternatives established during the concept meeting(s). At a minimum, the evaluation process shall consist of the following preliminary engineering:
1. Provide a land use study, delineating the geographic extent of the proposed pressure zone necessitated by the project. The land use study shall also include the water demand for future development in this area, which will require future infrastructure.
 2. Determine the demands within the pressure zone (initial and ultimate).
 3. Determine the booster station and reservoir capacities necessary to serve the proposed development. For required new reservoir(s), determine HWL and LWL for each reservoir.
 4. Based on the initial booster station capacity, determine minimum and maximum operating pressures for the booster station pumping units. Provide preliminary pump selection (number and size) based on rough estimate of system head loss.
 5. Identify the booster station and reservoir capacities necessary to serve the ultimate pressure zone per the District's WFMP.
 6. Prepare preliminary scaled map(s) showing existing roads, dwellings, ground surface topography, existing and proposed water system facilities (pipelines, booster stations, and reservoirs), and pressure zone boundary.

Engineer shall document the evaluation results in a preliminary design report (PDR), and shall submit the PDR to the District for review and comment. In addition to the above evaluation requirements, the PDR shall contain the following:

- Tentative tract map(s) for the proposed development.
 - Conceptual service plan
 - Sub-area master plan
 - Project site map showing proposed water system facilities
 - All other maps or drawings as may be required by the District
- F. Following the District's review and approval of the PDR, Engineer shall proceed with the design of the booster station and associated facilities in accordance with the District's published guidelines for these facilities.

Prior to commencing detailed design, a Preliminary Booster Station Site Plan shall

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be submitted that includes the following:

1. Proposed property to be deeded to the District. This shall include all fee/easement requirements for Items 2 through 7 of this section.
2. Location of booster station facilities, including equipment building, pumping units, suction and discharge piping, chemical conditioning equipment and appurtenances (chemicals, if any, to be determined by the District), electrical panels, standby generator, chemical addition equipment, and surge tank (if required).
3. Location of future facilities, including additional pumping units, associated suction and discharge piping, electrical panels, standby generator, and equipment building expansion (if necessary).
4. Access road and/or driveway.
5. Location of site fencing or walls and access gates.
6. Site drainage facilities, including discharge to offsite improvements and/or drainage courses.
7. Location of any cut or fill slopes adjacent to the booster station site.

Note: The Preliminary Booster Station Site Plan shall clearly demonstrate the intent and method to control/contain discharge of storm water runoff to eliminate or mitigate any downstream impacts to public or private property.

- G. Submit design calculations, construction drawings, and specifications for District approval as follows:

All submittals required by these guidelines shall be provided to the District electronically in conformance with the District's Electronic Submittal Guidelines unless otherwise directed by the District.

1. Preliminary design (30% complete construction drawings) including booster station capacity calculations, system hydraulics, pump selection, drainage hydrology and hydraulic calculations, slope stability calculations, surge analysis, standby generator sizing calculations, building HVAC calculations, noise study, geotechnical report, preliminary site layout and grading plan, preliminary equipment building mechanical layout, and a list of selected equipment and materials. Preliminary site layout and grading plan shall depict all property requirements identified in Section E above. Depending upon the site location, the District will determine whether the site will need special considerations and improvements such as masonry block perimeter walls in lieu of chain link fence, concrete paving in lieu of asphalt pavement,

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additional site lighting, additional access points, etc. District will provide specialty technical specifications to be utilized if necessary and available.

2. Submit 60% complete booster station construction drawings and specifications. Construction drawings shall incorporate District review comments from the 30% submittal. Submit legal description and plat for all identified booster station property. Property requirements, title reports, and related title documents shall be submitted with the legal description and plat. Construction drawings shall include references to all associated property and easement documents, including, but not limited to, the following: title reports, legal descriptions/plats, parcel maps, records of survey, and easements. In addition, submit plans for associated street improvements, water pipelines, storm drains, and access roads.
3. Submit 90% complete booster station construction drawings, specifications, and final engineering design calculations. Construction drawings and specifications shall incorporate District review comments from the 60% submittal.
4. Submit final design calculations and 100% complete construction drawings and specifications. Construction drawing set shall include general, civil, mechanical, architectural, structural, and electrical drawings showing all schedules, plans, sections, and details necessary for construction of the booster station facilities. A typical booster station construction drawing index is provided in Appendix A, herein. The title sheet shall include a summary of project specific requirements and data, such as booster station capacity, number of pumping units (duty and standby), and required pumping unit performance including minimum shut-off head, minimum motor size, discharge capacity, maximum net positive suction head required, total dynamic head and efficiency for at least three conditions with one being the design condition.

H. Submit Original Construction Drawings for Signature

After all plan checks are completed and the booster station construction drawings and specifications are acceptable to the District, the original drawings shall be submitted to the District for signature. Prior to the District approval of the booster station construction drawings, final legal descriptions and plats shall have been received, reviewed by the District for conformance with the approved plans, and approved for use in property conveyance documents. In addition, Developer shall pay all remaining plan checking fees.

I. Provide the District with Drawings and Specifications

When the drawings have been fully approved by all agencies, the Developer shall provide the District with a clean set of photo mylars, three sets of full-size prints,

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three sets of half-size prints, one loose master Specification, and computer CD/DVD or USB drive containing the drawing files in AutoCAD/Microstation and PDF formats, and Specification files in MS Word and smart (searchable) PDF formats. All files shall be compatible with the District's latest software versions.

J. Prepare and Present the Control Strategy

At the completion of the design phase and prior to facility commissioning during the construction phase, the Engineer shall prepare a presentation (PowerPoint) and review workshop to discuss the proposed operational strategy. The strategy shall address the following key aspects at a minimum:

- Purpose of workshop and presentation
- Facility and system overview
- Project features and components
- Anticipated operating conditions
- Initial set point recommendations
- Energy saving initiatives and District energy use optimization
- Other items of interest
- Programming and SCADA coordination during construction and startup
- Meeting and presentation at end of design and prior to startup with District's Operations and Maintenance staff to review procedure and schedule

Engineer shall summarize the results of the workshop into a technical manual (detailed PowerPoint) and submit eight (8) copies for District review. District comments on the Draft manual shall be incorporated into a Final manual for future reference. The Engineer may submit to the District eight (8) copies of the Final manual, including an electronic copy (smart PDF) and original files.

**CHAPTER III
DESIGN REQUIREMENTS**

A. General

1. Guidelines, Standards, Codes and Regulations

- a. Potable water booster stations shall be designed and constructed in accordance with the District guidelines contained herein and other District published standards (drawings and specifications).
- b. Where not specifically addressed or modified by the District guidelines and standards, the most current edition of the following codes and regulations shall be complied with: Riverside County Department of Environmental Health and California Department of Public Health, District Detailed Provisions, Standard Specifications for Public Works Construction, California Building Code, National Electric Code, California Fire Code, American Water Works Association, and all other applicable government codes and regulations.

2. Construction Drawings

- a. Booster station construction drawings shall be prepared by an engineer licensed in the State of California experienced in the design of similar facilities.
- b. Drawings shall be clear, concise, and meet all District guidelines and standards contained herein.
- c. Drawings shall be on D size mylar sheets (24" x 36") with an Eastern Municipal Water District approved title block.
- d. The Drawings shall be professional quality drawings specifically prepared as Booster Station Construction Drawings for the proposed project.
- e. Work shall be of standard engineering practice and shall be legible and present the proposed construction without confusion.

3. Construction Specifications

- a. The project Construction Specifications shall include the District's General Requirements, Detailed Provisions, District Standard Drawings, District Approved Materials List, and Geotechnical Report for the booster station site.

- b. District's Detailed Provisions shall be utilized wherever applicable. District's Detailed Provisions do not cover all equipment and material required for booster station construction. Engineer shall provide Detailed Provisions for all equipment and material not addressed by District's Detailed Provisions.

4. Geotechnical Investigation

- a. A Geotechnical Investigation shall be performed for the selected booster station site and a report shall be prepared presenting the findings and design recommendations for the proposed booster station facilities.
- b. As a minimum, the geotechnical report shall contain site preparation requirements, allowable soil bearing loads, lateral soil loads for below grade or soil retaining structures, seismic design parameters, soil corrosion potential, pipe backfill recommendations, foundation design recommendations, and pavement design recommendations. All recommendations contained therein shall be adhered to during design and construction of booster station facilities. Seismic design parameters shall conform to Risk Category IV for "essential facilities" in accordance with Chapter VI of these guidelines.

B. Site Selection

A number of factors shall be considered when selecting the booster station site, including, but not limited to:

- 1. Conformance with all state and local subdivision and zoning regulations.
- 2. Proximity to existing distribution system transmission lines for the pressure zone supplying the station.
- 3. Providing the required elevation to receive water from the supplying transmission lines.
- 4. Adequate property for the proposed booster station facilities, including adequate space around the facilities to accommodate maintenance, service, and safety vehicles, such as crane trucks and fire trucks.

Minimum lot size shall be 200' by 200'.

- 5. Adequate property for future booster station facilities (as determined by the District) adjacent to the proposed facilities, such as future pumping units, pipelines, and associated components.

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6. Access from public roads.
7. Minimizing noise and visual impacts on the surrounding neighborhoods.
8. Proximity to existing drainage facilities that can accommodate site discharge flows due to storm runoff.

The booster station site and associated access road and/or driveways shall be located a minimum of 2' above the 100-year floodplain, and outside of any areas designated as wetlands or critical habitat for endangered species. In addition, locations vulnerable to overland drainage and erosion shall be avoided.

The booster station site shall be located such that existing or proposed offsite drainage facilities are available whenever possible; however, should offsite facilities not be available or construction of same is impracticable, downstream impact shall be evaluated and if necessary, facilities to mitigate same shall be designed and constructed.

A separate access road/driveway shall be provided to the booster station site. The access road/driveway may not serve as a multi-purpose access, such as being coupled with access to facilities of other public agencies or with a private driveway. The access road/driveway shall commence at a public road and terminate at the booster station site.

The Engineer shall design the proposed booster station facilities to comply with all applicable city or county noise ordinances. To ensure that the facilities to be constructed will comply with said ordinances, the District may require the Engineer to perform a sound study that provides the theoretical sound levels from the proposed equipment as measured at the booster station property lines and at adjacent property (if applicable). The construction drawings and specifications shall include all sound attenuating measures necessary to comply with the applicable noise ordinances.

C. Property Acquisition

The property required for the booster station shall be owned by the District in fee title. Booster station access roads/driveways, suction and discharge pipelines, and storm drains shall be constructed on District property, District right-of-way, or within public right-of-way whenever possible. Easements for access roads/driveways and pipelines will only be considered under special conditions.

Submit legal descriptions, plats, and current title reports for the proposed booster station property, and easements (if applicable) for the proposed access roads/driveways, and pipelines. Legal descriptions and plats shall conform to District Standards. Contact District's Rights-of-Way Department for details. **Note,**

final plans will not be signed until all legal descriptions, plats, title reports, and easements have been received and reviewed for conformance with the approved site plan. Before construction can commence, all property Grant Deeds and easement deeds shall be conveyed to the District and recorded by the County of Riverside.

A street address for the booster station site shall be obtained from the City or County.

D. Booster Station Capacity and Pumping Unit Selection

1. Booster Station Capacity

The minimum required booster station capacity shall be the Maximum Day Demand (MDD) for the area to be served. When requested by the District, additional booster station capacity may be required to reduce pumping unit energy costs by utilizing a time-of-use (TOU) rate schedule from Electrical Utility Provider. Where TOU pumping is desired by the District, Engineer shall evaluate the physical and economic impact of the TOU rate selected by the District on the booster station facilities (e.g., suction and discharge piping, pump suction cans, pump selection and horsepower, electrical switchgear, standby generator, and equipment building). If higher pressure zones exist above the booster station discharge pressure zone, the booster station capacity shall also include the pump-through demands for the higher-pressure zones.

Where service area demands are expected to increase incrementally over a long period of time, the District may allow an intermediate booster station capacity that will be less than the capacity required to serve the entire area (i.e., ultimate booster station capacity). If allowed, only certain station components will be sized for the intermediate capacity, while the majority of components will be sized for the ultimate capacity. For example, pumping units would be sized for the intermediate capacity, but pump suction cans would be sized for the ultimate capacity. Specific requirements for equipment sizing are provided hereinafter.

2. Pumping Unit Selection

Pumping units shall be selected to supply the booster station ultimate design flow rate to the distribution system. If it is impractical, as determined by the District, for the initial pumping units to be sized for the ultimate design

flow rate, an intermediate design flow rate may be required. If so, pumping units shall be selected for both conditions, intermediate and ultimate.

a. Pumping Unit Type

Pumps for use in potable water booster stations shall generally be vertical turbine type with enclosed impellers, electric motor driven, constant speed (variable speed if required due to varying system hydraulic conditions). Only in specific cases, as approved by the District, may alternate types of pumps be used.

b. Number of Pumping Units

A minimum of one standby pump shall be provided and shall be available for service at all times. The standby pump shall be the same size as the largest duty pump. The number of duty pumps will be dependent upon the booster station design flow rate(s) and system curve. Unless special conditions dictate otherwise, multiple duty pumps shall be the same size. The booster station design flow rate shall be achieved with all duty pumps operating. The following table is a general guide for determining the required number of pumping units:

Booster Station Design Flow Rate (gpm)	No. of Duty Pumps	No. of Standby Pumps
Below 1,000	1	1
1,000 - 4,000	2	1
4,000 - 10,000	3	1

c. Hydraulic Design Criteria

A complete hydraulic analysis of the piping network on the supply and discharge side of the booster station shall be made to determine system curves for maximum, minimum, and average operating conditions. Systems curves shall be developed based on the Hazen-Williams formula for C-factors of 120 and 150, and shall include minor losses for fittings, valves, etc. Computer modeling software may be utilized to develop the system curves. InfoWater is the District's preferred hydraulic modeling software. As a minimum, system curves shall be provided for the following operating conditions:

- 1) High Head Condition - Minimum demand on discharge side of booster station (or no demand), lowest hydraulic gradient on suction side (suction side reservoirs at low water level), and

highest hydraulic gradient on discharge side (discharge side reservoirs at high water level).

- 2) Low Head Condition - Maximum demand on discharge side of booster station (maximum peak hour demand), highest hydraulic gradient on suction side (suction reservoirs at high water level), and lowest hydraulic gradient on discharge side (discharge side reservoirs at low water level).
- 3) Average Head Condition (Normal Operation Condition) - Average demand on discharge side of booster station (ADD), and average hydraulic gradient on suction and discharge sides (suction and discharge side reservoirs at 50% level).

Pump curves (including TDH, flow rate, and efficiency) from each of the selected manufacturers shall be plotted on the system curves. The manufacturer's published limits of continuous pump operation shall be delineated on the pump curves. For booster stations with multiple parallel pumps, combined pump head/capacity curves shall be plotted for each duty pump combination. For the booster stations with variable speed pumps, pump curves for both the high and low end of the proposed pump speed shall be plotted on the system curves. The point of intersection of the combined pump curve (all duty pumps operating at full speed) with the system curve for the high head condition and C-value closest to the actual C-value for the transmission system shall match the booster station design capacity. Wherever possible, the pump design point shall correspond to the peak pump efficiency. Under every design condition, the selected pumping unit(s) shall operate within their normal operating range as established by the manufacturer. The net positive suction head required (NPSHR) for the selected pumping unit(s) shall be less than the net positive suction head available from the lowest suction pressure condition with a minimum safety factor of 10 feet.

E. Waterhammer and Pressure Surges

Engineer shall evaluate waterhammer and pressure surges in the transmission pipelines as a result of starting and stopping pumping units, check valve closure, or loss of power to pumps. Under surge conditions, the maximum allowable pressure for steel piping shall be limited to the pipe pressure rating plus a 33 percent surge allowance. The maximum allowable pressure for PVC piping shall be limited to the pipe pressure rating only (no surge allowance). Where surge analyses indicate damaging surge pressures or formation of vapor cavities in the piping, surge protection measures shall be recommended. Protection measures may include installation of vacuum relief valves on the pipeline, installation of pressure relief/surge relief valves on the system, and installation of a pressurized

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surge tank equipped with a compressed air system.

If required, surge tanks shall be designed and constructed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Surge tanks with volumes of 500 gallons or less may be horizontal or vertical vessels. Surge tanks with volumes greater than 500 gallons shall be horizontal vessels. All tank connections 3" diameter and larger shall be flanged. All tank connections smaller than 3" diameter shall be threaded 3,000 lb. full or half couplings.

Surge tanks shall be provided with the following minimum appurtenances: one inlet/outlet nozzle, one air inlet connection, two manways (one elliptical 14" x 18" minimum, and one round 24" diameter minimum), one 4" diameter drain outlet, and two stilling well connections. An 8" diameter (minimum) external stilling well shall be provided for mounting level monitoring probes and a sight glass. Level monitoring probes shall be conductance type or capacitance type. Stilling well connections to the tank shall be provided with isolation valves. Stilling well shall be provided with a bottom drain and drain valve.

Whenever possible, avoid the use of surge tanks, as these are a maintenance and re-certification issue. If the surge analysis provided during design indicates the need for a surge tank, the recommendation will be evaluated by the District's Engineering and Operations and Maintenance staff. The decision to use or not use a surge tank for the proposed booster station will be documented as part of the preliminary design report.

F. Leadership in Energy and Environmental Design

Engineer shall evaluate green design initiatives for the proposed booster station in accordance with the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. The LEED evaluation shall include site development, storm water system, site lighting, landscaping, energy usage, material supply, building materials, building ventilation, and building lighting. Implementation of LEED initiatives shall be at the discretion of the District.

The equipment building design shall, at a minimum, incorporate a roof-mounted tubular daylighting system and/or integrated translucent wall paneling system in order to transmit sufficient natural light to the building interior so as to not require use of building lighting during daytime hours.

CHAPTER IV CIVIL DESIGN

The following design criteria shall be utilized in preparing construction drawings for the proposed booster station site.

A. Site Layout

The site shall be designed to accommodate the proposed booster station, as well as other facilities as directed by the District. The site shall be designed to accommodate maintenance, service, and safety vehicles, such as crane trucks, chemical delivery trucks, and fire trucks. Adequate space shall be provided around the booster station facilities for vehicle ingress/egress and access to related facilities. A vehicle turn movement analysis is required. As a minimum, space and turning radius requirements for truck cranes shall be according to the State of California Department of Transportation, Highway Design Manual for California Legal Design Vehicle with 50' radius per Figure 404.5D. Space and turning radius requirements for fire trucks shall be according to the local agency having jurisdiction over the proposed site. Site layouts requiring vehicles to exit the site by backing out into street right-of-way will not be acceptable.

The site shall be designed to accommodate all booster station ancillary facilities, including vehicle access to said facilities. The height of surge tanks (if required) shall be minimized. Masonry block walls and landscaping may be required to conceal the tank(s) from view. A minimum 100' setback from booster station equipment to residential dwelling units is preferred to minimize noise, visual, and lighting impacts. The site setback from public road right-of-way shall be sufficient to provide a minimum of 30' between the roadway sidewalk and the front of the site.

B. Site Plans

The booster station site plans (e.g., general site plan, site plan, site grading plan, site piping plan, and site electrical plan) shall be drawn at a scale of not greater than 1" = 10' and shall show all proposed above-grade and below grade facilities. Existing improvements/features shall be shown up to 30' (minimum) beyond the booster station site. The site plan shall clearly show the location of all proposed facilities with sufficient information to perform construction staking for same.

As a minimum, the following components shall be located on the Site Plan(s):

- Site piping and appurtenances
- Equipment building
- Surge tank(s) (if necessary)
- Electrical Utility Provider electrical service transformer and service panel

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- Fencing and/or masonry block walls
- Access road/driveway
- Site drainage improvements

The Electrical Utility Provider service transformer and panel (meter and main circuit breaker) shall be located in a separate fenced enclosure at the front of the site and adjacent to the street right-of-way. The Electrical Utility Provider area shall be provided with a separate driveway, completely independent of the booster station driveway(s). Development of the Electrical Utility Provider service plan shall be coordinated with the booster station site plan.

Horizontal and vertical survey control information shall be provided on the title sheet, including "Basis of Bearings" and "Benchmark". The "Benchmark" shall be based on the North American Datum of 1983 (NAD 83).

C. Access Road/Driveway

Each site shall be provided with a paved access road and/or driveway from a public road to the booster station site. A minimum of one (1) driveway, of at least 30' length, shall be provided between the public road sidewalk (existing or future) and the front of the site for vehicle staging prior to site entry.

1. The access road between public road right-of-way and booster station driveway(s) shall adhere to the following design criteria:
 - a. Minimum Width: 20' (curb face to curb face)
 - b. Maximum Slope: 15%
 - c. Minimum Cross Slope: 2%
 - d. Maximum Cross Slope: 8%
 - e. Minimum Radius: 100' (to centerline of road)
 - f. The access road shall be paved with a minimum of 4" of asphalt concrete (A.C.) pavement over 6" of Class II base, or as recommended in the geotechnical report (if greater).
 - g. A 6" high concrete curb with an 18" wide gutter shall be constructed along both edges of the booster station access road.
 - h. At approximately 200' intervals, openings shall be provided in the concrete curb to convey storm flows off of the access road. Concrete swales shall be constructed down the fill slopes to protect the slopes

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from erosion damage. Concrete swales shall terminate into flow energy dissipaters.

- i. At natural drainage course crossings, culverts with headwalls shall be constructed to convey storm flows under the access road.
 - j. If required by the District, an access road barrier shall be provided approximately 30' from the beginning of the access road to keep unauthorized vehicles from using the road.
2. Booster station driveway(s) shall adhere to the following design criteria:
- a. A minimum of one (1) driveway, of at least 30' length, shall be provided between the public road sidewalk (existing or future) and the front of the site for vehicle staging prior to site entry.
 - b. Minimum Width: 20'
 - c. Maximum Slope: 8%
 - d. Maximum Cross Slope: 2%
 - e. The driveway(s) shall be paved with minimum of 6" of reinforced concrete over 6" of Class II base, or as recommended in the geotechnical report (if greater).

D. Site Grading

The booster station site grading plan shall be drawn at a scale of not greater than 1" = 10' and shall show all proposed above grade facilities. Existing contours and improvements/features shall be shown up to 30' (minimum) beyond the booster station site. The site grading plan shall show existing and proposed ground surface contours at 1' contour intervals.

Grades for paved areas within the booster station site shall be designed to prevent local ponding, and to provide positive drainage away from structures and facilities. Pavement slope within the booster station site shall be 1.5% minimum and 5% maximum. The maximum step height from asphalt paving to concrete slabs shall be 8".

Grading of land outside the booster station fence shall have a maximum slope of 3:1. Retaining walls adjacent to the booster station shall be avoided. Drainage facilities (above-grade or below grade) shall be provided to convey surface runoff from the booster station site to offsite drainage courses and improvements. Drainage facilities shall be adequately sized to convey runoff from a 100-year storm event and shall be designed to require minimal maintenance.

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E. Site Paving

The entire booster station site shall be paved with a minimum of 4" of A.C. pavement over 6" of Class II base, or as recommended in the geotechnical report (if greater). The Class II base and 12" of subgrade beneath the base shall be compacted to 95% relative compaction, minimum. A.C. pavement shall be furnished and installed in two lifts in accordance with District Standards and Detailed Provisions.

F. Site Fencing

As a minimum, the entire booster station site shall be secured by a commercial grade 8' high chainlink fence with 3-strand barbed wire or a 8' high masonry block wall. Access gates shall include a minimum 20' wide double gate for vehicles and a 4' wide single gate for District personnel. The Electrical Utility Provider service transformer and electrical service panel shall be located in a separate fenced enclosure at the front of the site and adjacent to the street right-of-way. A minimum 16' wide double gate shall be provided for Electrical Utility Provider vehicles and a 4' wide single gate shall be provided for District personnel at the rear of the Electrical Utility Provider fenced enclosure. Chainlink fencing and gates shall be provided in accordance with District Detailed Provisions and District Standard Drawing D-672.

Where masonry block walls are selected for site security, construction plans shall show the top of wall elevation and top of concrete footing elevation for each wall segment. Walls shall be constructed level. Walls shall step as required to provide a minimum of 8'-0" height from outside finished grade. Drawings shall include masonry block wall and concrete footing construction details showing all dimensions, reinforcing steel, block type, and grouting requirements.

If site fence or masonry block wall is not located along the property line, 2' high permanent markers shall be placed at property corners and along property lines at maximum 200' intervals. Marker type shall be approved by District prior to installation.

Conduit shall be installed between each access gate and the RTU for future installation of gate switches by District staff. Conduit shall be stubbed up adjacent to each gate post. Conduit shall be provided with end caps and pull ropes.

G. Site Lighting

Booster station site shall be provided with a lighting system designed to minimize offsite impacts while maintaining functionality for maintenance personnel working on outdoor booster station components. As a minimum, each site shall be provided with a pole mounted exterior work light and area light. The work light shall be one

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LED outdoor fixture mounted on top of a 4" square aluminum pole. The area light shall be one LED outdoor fixture with built-in photocell mounted 5' below the work light and 180° apart. Unless directed otherwise by District, work light shall be 20'± above finished grade. Concrete support foundation for light pole shall extend 3' above grade to protect pole from vehicles. A 120V duplex receptacle with ground fault interrupter and weatherproof gasketed cover shall be provided at the bottom of the light pole. The receptacle opening shall be integrated in the pole construction; external boxes are not allowed. The work light shall be activated by a standard light switch located in the equipment building.

H. Landscaping

In general, site fencing shall be constructed along the property lines for the booster station site. Landscaping beyond the booster station site fencing, including design, construction, and maintenance of same, shall be the responsibility of the Developer, Homeowner's Association, or a public entity other than the District (e.g., City or County Special District). Prior to District acceptance of booster station facilities and placement of same into operation, the Responsible Party shall provide District with a copy of the executed agreement with the entity responsible for maintenance of landscaping adjacent to the booster station site.

In specific cases where the District requests landscaping within the limits of the booster station property, the following requirements shall apply:

1. All areas to receive landscaping shall be located outside the booster station site fencing or block wall. Landscaping areas shall be a minimum of 5' wide and shall be bordered by continuous 2" x 6" (all heart) redwood headers per District Standard Drawing.
2. Landscaping shall consist of shrubs and/or trees. The use of vines or vine-like plants is prohibited. Plants shall not be supported by or climb booster station fencing.
3. Landscaping plants shall be California-friendly plants only. Plants shall be aesthetically pleasing and require minimal maintenance (fertilizing, trimming, etc.)
4. Plants shall be selected and located to provide a year-round screen around the booster station site.
5. Plants shall require minimal watering. Plants and irrigation system shall comply with the District's Water Conservation Ordinances.
6. Recycled water shall be utilized for landscape irrigation where available. Recycled water irrigation system design shall comply with the District's "Procedural Guide and General Design Requirements for Construction of

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Recycled Water Facilities". Where recycled water is not available, potable water shall be utilized for landscape irrigation. The connection for irrigation supply shall be from the discharge side of the booster station. A reduced pressure backflow assembly per District Standards shall be provided prior to any irrigation facilities.

7. Landscape planting plans shall be prepared showing the planting arrangement of the shrubs and trees, identifying each type of plant by both genetic and common names, specifying plant size, and providing installation details.
8. Landscape irrigation plans shall be prepared showing type, size, and location of all irrigation piping, valves, heads, controllers, and appurtenances. Plans shall show water flow rates and pressures for each irrigation zone. Drip or other water conserving heads are recommended wherever appropriate. Irrigation systems shall be automatic and shall be furnished with programmable controllers.

CHAPTER V MECHANICAL DESIGN

The following design criteria shall be utilized in preparing construction drawings and specifications for booster station equipment, piping, valves, and appurtenances.

A. General

Booster station facilities shall be designed with the following capabilities and features:

1. Deliver potable water to the distribution system at the required flow rates and pressures.
2. Provided with the necessary redundant equipment to maintain reliable station operation.
3. Equipment and materials selected to provide long-term trouble-free operation.
4. Equipment selected to provide required performance and minimize energy consumption.
5. All equipment and systems shall be capable of continuous operation.
6. All equipment and systems shall be capable of manual and automatic operation.
7. Provided with control and monitoring safeguards to protect equipment and facilities from damage.
8. Provided with adequate access and space for maintenance.
9. Provided with unobstructed access to all equipment.
10. Provided with protective features to maintain personnel safety.
11. Provided with equipment and materials to minimize noise impacts to operations personnel and adjacent property.
12. Secure from trespass and vandalism.

Packaged or pre-manufactured booster stations are not acceptable. The Engineer shall be responsible for the design of the booster station facilities, including all pumping units, ancillary equipment, appurtenances, controls, and instrumentation.

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All equipment, piping, materials, and appurtenances that can come into contact with water intended for use in the District's domestic water supply shall meet the applicable NSF International/American National Standards Institute (ANSI) standards for drinking water additives and shall be compatible with chlorine concentrations up to 5 mg/l. District's primary method of maintaining chlorine residual throughout the distribution system is via chloramination.

B. Mechanical Layout

All mechanical and electrical equipment shall be located within a masonry block building (as described hereinafter), except for the Electrical Utility Provider meter panel and surge tank(s) (if necessary). The layout of booster station mechanical facilities shall take into account: access space for maintenance, ease of removal/replacement, personnel safety, and noise control. Confined spaces shall be avoided. Facilities requiring access shall be located above grade. For reference, drawings showing a mechanical plan and mechanical sections for a typical booster station are provided in Appendix B, herein.

1. Equipment

Equipment arrangements and layouts shall satisfy the requirements of applicable local, state, and national codes, including state and federal OSHA requirements. Equipment layouts shall comply with the following requirements:

- a. Equipment shall be located to provide easy access for service, repair, removal, and replacement.
- b. Crane truck access shall be provided opposite of the above grade discharge piping and valves.
- c. Electrical panels (including main control panel) shall face the pumping units unless electrical panels are located in a separate room.
- d. Equipment components requiring routine maintenance shall be located at a convenient height above the floor or be provided with a permanent platform for access. Maintenance access requirements will be assessed by the District on a case-by-case basis.
- e. Equipment shall be located so that access for repair does not require removal or disassembly of adjacent equipment.

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- f. A minimum of 36" of clearance shall be provided between pump foundations, and 60" minimum distance between pump centerlines, whichever is greater.
- g. A minimum of 36" of clearance shall be provided adjacent to mechanical and electrical components that need periodic adjustment or service (e.g., pump seals, valves, instrumentation, grease fittings, and oil reservoirs).
- h. Walking areas shall be free of tripping hazards and overhead obstructions to a minimum height of 7'.
- i. Chemical storage facilities shall be located to provide easy access for chemical delivery trucks.
- j. For future pumping units, the following facilities shall be installed during initial construction:
 - 1) Pump suction cans
 - 2) Suction piping and isolation valve between the suction header and suction can
 - 3) Discharge piping from the discharge header to above grade and terminated with a blind flange.
- k. A minimum of 48" clearance shall be provided in front of all electrical equipment.

2. Piping and Valves

Piping and valves shall be located to provide easy access for service, repair, removal, and replacement. Piping and valve layouts shall comply with the following requirements:

- a. Piping shall be provided with strategically placed break-out joints, such as flexible couplings or grooved couplings (e.g., Victaulic), to permit the easy removal of pumps, valves, meters, etc.
- b. Below grade suction and discharge piping shall be designed to minimize high points where air may accumulate. Air release valves shall be provided at high points.
- c. All suction piping shall be below grade.
- d. Suction header shall be located outside the equipment building.

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- e. Branch connection from header to pump suction piping shall be a horizontal tee or wye fitting. Each branch connection to the header shall be equipped with a below grade isolation valve (see Chapter V, Section E.3.a for valve requirements).
- f. Minimum cover over below grade piping shall be 36".
- g. A minimum of 24" clearance shall be provided between the bottom of the building footing and top of suction piping to pump cans.
- h. Discharge piping from each pumping unit shall be a minimum of 30" and a maximum of 36" above the equipment building floor (distance from top of floor to centerline of piping).
- i. Centerline of pumping unit discharge head shall match centerline of discharge piping.
- j. Discharge header shall be below grade and shall be located outside the equipment building.
- k. Discharge and suction headers shall be provided with bypass connections that allow the entire booster station to be bypassed with portable pumping unit(s). Bypass connections shall be extended above grade and shall be equipped with isolation valves and blind flanges. Bypass connections shall be placed in a convenient location for staging portable pump(s) and shall not interfere with vehicle access to station facilities.
- l. Discharge piping from each pumping unit shall be equipped with a flow meter, combination air valve, pressure gauge, check valve, and isolation valve (see Chapter V, Sections E.3 and E.4 for valve and appurtenance requirements).
- m. Each flow meter shall be provided with the appropriate length of straight piping on the upstream and downstream sides of the meter. As a minimum, provide 5 pipe diameters of straight piping upstream and 2 pipe diameters downstream of each flow meter.
- n. Provide one spare pipe spool with the same end connections, diameter, and length as the flow meter for use as a replacement when the meter is removed for repair.
- o. Provide two (2) 1" corp stops in the pipe spool upstream of the flow meter tube, approximately 6" from the tube. One corp stop shall be

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located at the top of the piping with the other corp stop located 45° above the pipe springline.

- p. Provide one (1) 1" corp stop at the top of the pump discharge piping just prior to the downturn to the discharge header.
- q. An above grade hydraulic operated pressure relief valve (PRV) shall be provided between the booster station discharge header and suction header. Isolation valves and short pipe spools equipped with combination air valves shall be provided on each side of the PRV. One pipe spool shall be provided with a grooved coupling (e.g., Victaulic) located to facilitate PRV removal/replacement.
- r. A combination air release and vacuum valve, along with a pressure transmitter, shall be provided on each pump suction can.
- s. Pressure transmitters shall be provided on both suction and discharge header piping. Minimum 3/4" pressure sensing lines shall be provided from the suction and discharge pipe headers to inside the equipment building for connection to suction and discharge pressure transmitters. Pressure sensing line shall be constructed of Schedule 40 red brass or Type K copper.

Each pressure transmitter shall be equipped with an isolation ball valve, pressure gauge, and manual bleed valve.

- t. Provide a minimum 1 1/2" connection to the discharge header for supplying water to booster station hose bibs and restroom facilities (if required). Provide a 1 1/2" reduced pressure backflow assembly per District Standards prior to any water using fixtures.
- u. Provide conveniently located hose bibs adjacent to areas or equipment requiring wash down, such as the pump room, chemical feed equipment room, chemical delivery area, air cooling units, and surge tank.
- v. Pipe supports shall be located to eliminate transfer of pipe loads to equipment, to minimize piping removal when removing connected valves and appurtenances, and to minimize pipe stresses.
- w. Each pumping unit shall be provided with a 2" drainpipe directly adjacent to the pump foundation. A seal water drain line shall be provided between the pump discharge head drain connection and the 2" drainpipe.

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- x. A minimum 3/4" water quality sample line shall be provided from the suction piping. In addition, a minimum 3/4" water quality sample line shall be provided from upstream of the chemical injection points on the discharge header.

Sample lines shall be connected to smooth-nosed, chrome plated water sampling taps located above grade adjacent to the pressure transmitters. Each sample tap shall be provided with a nameplate designating the location of the sample point.

- y. Provide a drain line with funnel strainer adjacent to the chlorine residual analyzer and ammonia analyzer (if required).

3. Building

An equipment building designed to house booster station equipment, systems, and components shall be provided, unless the Engineer demonstrates, to the satisfaction of the District, that certain equipment items may be located outdoors.

As a minimum, an equipment building shall be provided to house the pumping units, electrical panels, emergency standby generator, chemical system components (storage tanks, generation equipment, feed equipment, and ancillary equipment), and surge tank air compressor/receiver (if necessary).

The following layout requirements pertain to an equipment building housing all potential equipment systems, including pumping units, electrical panels, standby generator, surge tank air system, and chemical addition facilities. Therefore, certain requirements will not apply to booster stations containing only some of these equipment systems.

- a. A separate room shall be provided to house the pumping units (initial and ultimate), pumping unit flow meters, pressure relief valve, and electrical panels (except Electrical Utility Provider service panel).

A roof hatch shall be provided over each pumping unit for pump removal/replacement by a crane truck parked outside the building. Roof hatches shall be sized for the ultimate pumping units with a minimum of 12" of clearance on all sides.

The pump/electrical room shall be provided with a double door or roll-up door, 6' wide by 8' high, minimum.

The pump/electrical room shall be provided with evaporative cooling. Wall mounted louvers shall exhaust air from the room. Air supply

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diffusers and exhaust louvers shall be located to maximize air flow across the pumping units and electrical panels.

- b. A separate room shall be provided to house the electrical panels if variable frequency drives are required. The electrical room shall be located next to the pump room.

The electrical room shall be air conditioned. The air conditioner shall be located on the roof with bottom entry supply and return ductwork into the electrical room.

The electrical room shall be provided with a double door, 6' wide by 8' high minimum. A single door, 3' wide by 7' high (minimum) shall be provided between the electrical room and the pump room.

- c. A separate room shall be provided to house the emergency standby generator and surge tank air compressor/receiver.

The generator room shall be provided with a sound attenuated double door, roll-up door, or easily removable wall panel(s), sized to allow removal/replacement of the generator unit. The door/opening shall be sized for the ultimate generator unit with a minimum of 12" of clearance on all sides. Allow a minimum of 6" for placement of rollers beneath the generator unit skid.

The generator room shall be provided with forced air ventilation. Outside air supply to the room shall be through wall mounted louvers. Roof mounted fan(s) shall exhaust air from the room. The air supply louvers shall be sized for the roof exhaust fans and the generator unit radiator fan. The radiator fan shall exhaust through a wall mounted louver. A sheet metal shroud and flex connector shall be provided between the radiator housing and the wall exhaust louver. For noise control, the exhaust louver shall face away from adjacent property with existing or potential future residential or commercial buildings.

In addition to the forced air ventilation system described above, the generator room shall be provided with a dedicated evaporative cooling unit, including any necessary ducting, controlled by a spring-loaded type timer switch. The generator room evaporative cooling unit shall be sized to provide cooling for staff (not sized based on equipment heat loads), but not less than 3,000 CFM.

- d. A separate room shall be provided to house the chemical addition equipment. Where on-site chlorine generation is required, a separate room shall be provided for sodium chloride salt storage.

The chlorine/ammonia equipment room shall be provided with a double door, 6' wide by 7' high, minimum. The salt storage room shall be provided with a roll-up door, 8' wide by 8' high, minimum.

Both rooms shall be provided with forced air ventilation. The supply air shall be provided by wall mounted louvers or wall mounted supply fans. Air shall be exhausted from the room through wall or roof mounted exhaust fans.

- e. Floor drains shall be provided for wash down within the equipment building where appropriate. Additional drains are required adjacent to the following: each pumping unit to convey seal water drainage, the surge tank compressed air receiver to convey receiver tank condensate, air release and vacuum valves to convey nuisance water, water sampling station to convey sample waste, chemical analyzers to convey analyzer drainage and generator room to convey washdown waste. Each drain shall be routed/contained and equipped with oil/water separator(s) as necessary to handle anticipated drain wastes. Each drain shall be provided with an appropriate weight-rated cover.

C. Pumping Units and Pump Suction Cans

1. Pumping Unit Construction

Pumping units shall be provided in accordance with the District's Detailed Provisions Section 11936, Vertical Turbine Pumps. Pumping units shall be vertical turbine, close coupled open line shaft type with above ground flanged discharge.

Pumping units shall comply with the following requirements.

- a. Pump Speed - Speed shall not exceed 1,800 RPM.
- b. Pump Bowls - Bowls shall be lined with vitreous porcelain enamel or fusion bonded epoxy.
- c. Pump Impellers - Impellers shall be enclosed type. Impellers in multi-stage pumps shall all have the same diameter and trim.
- d. Suction Bell Assembly - A suction bell of the same material and diameter as the bowl assembly shall be provided at the pump inlet. The suction bell shall be equipped with a stainless steel strainer with cross vanes designed for vortex suppression. The strainer shall have a net inlet area of at least four times the column pipe area.

- e. Flow Vanes - Pumping units with capacities greater than 3,000 gpm shall be equipped with two vertical flow vanes attached to the pump bowls and column. Since larger pumps may be installed in the future, vertical vanes attached to the inside of the suction can are not acceptable.
- f. Discharge Head - Pump discharge head shall be constructed of fabricated steel with AWWA Class E base and discharge flanges. Discharge flange size shall match discharge piping. Base flange shall be provided with at least one 1" diameter threaded tap for suction can air release. Discharge head shall be provided with a mechanical seal assembly. Discharge head shall accommodate a two (2) piece top shaft with coupling. The discharge head assembly shall be capable of withstanding 1-1/2 times the pump shut-off head pressure (zero discharge) or the discharge piping hydrostatic test pressure, whichever is greater.
- g. Line Shaft - Pump line shaft shall be open type (water lubricated). Pump line shaft sections shall not exceed 10' in length. Top shaft shall be two (2) pieces with coupling within discharge head.
- h. Motor - Motor horsepower shall be selected such that no point on the pump performance curve exceeds the motor nameplate horsepower.
- i. Safety Guards - Pump discharge head shall be provided with removable safety guards around the pump shaft.

2. Pump Suction Cans

Pump suction cans shall be designed and constructed for the ultimate pumping units. Pump suction cans shall comply with the following:

- a. Designed to withstand 1-1/2 times the maximum suction side operating pressure or the suction piping hydrostatic test pressure, whichever is greater.
- b. Constructed of minimum 1/4" thick steel.
- c. Provided with 10 mil thick (minimum) holiday free epoxy lining. Steel shall receive a near-white sandblast prior to application of the epoxy coating.
- d. Provided with AWWA Class E top flange drilled and tapped to mate with pump discharge head.

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- e. Encased in reinforced concrete, minimum 6" thick. Encasement shall extend up to the bottom of the pump can top flange. Set elevation of pump can top flange such that pump discharge head outlet flange shall be 30" to 36" above the floor slab (distance from center of flange to floor).
- f. Can shall be of sufficient length to provide column piping of 4' minimum length, and a minimum clearance of 12" or the suction bell diameter (whichever is greater) between the bottom of the pump suction bell/strainer assembly and bottom of can.
- g. Minimum distance between the bottom of pump suction bell and the centerline of the suction piping inlet shall be 200% of the pump can diameter. Suction piping inlet shall be located to provide 36" minimum cover over piping. Provide a minimum of 24" clearance between bottom of building footing and top of pump can suction piping.
- h. The net inside diameter (including lining thickness) shall be sized so that the velocity of water passing between the can and the largest cross-sectional area of the pump/column assembly, including suction bell, is no greater than 2 fps at the maximum flow rate for the ultimate pumping unit. The maximum flow rate shall be determined from the low head condition system curve with $C=150$ and one pump operating.

D. Surge Tank and Compressed Air System (if required)

1. Surge Tank

Surge tank shall be constructed of steel. Tank shall be designed and constructed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, be ASME and National Board stamped and approved, and be OSHA certified. The tank design working pressure shall be the maximum expected distribution system working pressure plus 30% or the maximum surge pressure, whichever is greater. The minimum tank design working pressure shall be 150 psi. Metal thickness shall include at least 1/8-inch corrosion allowance.

Surge tank shall not contain a rubber bladder. Tanks with volumes of 500 gallons or less may be horizontal or vertical vessels. Tanks with volumes greater than 500 gallons shall be horizontal vessels. Tanks shall be located above the site ground surface. All tank connections 3" diameter and larger shall be flanged. All tank connections smaller than 3" diameter shall be threaded 3,000 lb. full or half couplings.

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Tanks shall be provided with the following minimum appurtenances:

- a. One (1) inlet/outlet nozzle, 150 lb. flanged, at bottom of tank.
- b. One (1) air inlet connection, threaded, top mounted.
- c. One (1) pressure relief valve connection, threaded, top mounted.
- d. Two (2) manways (one elliptical 14" x 18" minimum, side mounted, and one round 24" diameter minimum, hinged, end mounted)
- e. One (1) 4" diameter drain outlet, 150 lb. flanged, at bottom of tank.
- f. One (1) air release valve and silencer connection, threaded, top mounted.
- g. Two (1) stilling well connections, threaded, end mounted.
- h. One (1) 8" diameter (minimum) external stilling well for mounting level monitoring probes and a sight glass.
- i. One (1) sight glass with stainless steel upper and lower isolation valves and four guard rods.
- j. One (1) pressure gauge connection, threaded, end mounted near stilling well.
- k. Two (2) lifting lugs on top.

A tank mounted pressure relief valve shall be provided in accordance with ASME and OSHA requirements. Isolation valves shall be provided for the following appurtenances: air inlet/outlet connections, drain outlet, pressure gauge connection, and stilling well connections. The stilling well and sight glass shall be provided with valves to allow independent drainage of each. In addition, tank inlet/outlet connection shall be provided with an isolation valve to allow operation of the pumping units without the tank. Level monitoring probes shall be conductance type or capacitance type. Adequate clearance shall be provided around the stilling well for access to the level monitoring probes for removal and installation, including space for ladders and portable platform lifts.

2. Compressed Air System

The compressed air system shall be designed to maintain the surge tank air volume. The compressed air system shall be provided with all necessary appurtenances to provide clean, oil free air to the surge tank. Compressed

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air system shall consist of one air compressor, an air receiver, control panel, and appurtenances.

The air compressor shall be air cooled, two stage, reciprocating type. Oil shall be suitable for use in a drinking water system. The compressor shall be equipped with an air filter suitable for removing 99.9% of 5-micron particles and oil aerosols and shall be sized for the compressor rate with a maximum pressure drop of 4 psig over the element life. The filter shall be piped into the system with bypass piping for changing the filter element without shutting the air system down. As a minimum, the compressor shall be capable of delivering 1.0 cfm per 1,000 gallons of surge tank capacity at the design pressure of the tank.

The air receiver shall be a minimum of 60 gallons. The air receiver shall be ASME and National Board stamped and approved and shall be OSHA certified. The receiver shall be equipped with a pressure gauge, pressure relief safety valve before the first isolation valve, and a solenoid type automatic drain trap. The air compressor shall be mounted on the receiver tank. The receiver tank shall be provided with vibration isolators.

All controls necessary to start and stop the compressor at the appropriate air pressures shall be provided in a unit mounted control panel. The unit mounted control panel shall consist of a combination starter for the compressor motor, HOA switch, elapsed time meter, low air pressure switch, control voltage transformer, and a NEMA 12 enclosure with hinged door and padlocking hasp.

E. Piping, Valves, and Appurtenances

Piping, valves, and appurtenances shall be provided in accordance with the District's Detailed Provisions, and shall comply with the following requirements:

1. Design Criteria

- a. Flow Rate - Below grade suction and discharge piping shall be sized for ultimate design flow rates. Above grade discharge piping shall be sized for the initial flow rates, unless requested otherwise by the District.
- b. Velocity - Maximum velocity in suction piping shall be 3 ft/sec. Maximum velocity in discharge piping shall be 6 ft/sec.
- c. Pressure - Suction piping and valves shall be capable of withstanding 1 1/2 times the maximum suction operating pressure or the suction piping hydrostatic test pressure, whichever is greater. Discharge piping and valves shall be capable of withstanding 1 1/2 times the

pump shut-off head pressure (zero discharge) or the discharge piping hydrostatic test pressure, whichever is greater. In no case shall the station piping or valves be rated for less than 150 psi working pressure.

2. Piping Materials

All piping materials shall be provided in accordance with the District's Detailed Provisions and shall comply with the following requirements. Pipe and fitting pressure class and thickness specified herein are minimum requirements. These requirements shall be increased as necessary for working pressures and test pressures that exceed these minimum ratings.

a. Suction Piping

All suction piping shall be buried. Suction piping shall be constructed of schedule steel pipe, or fabricated steel pipe. Suction piping beneath the equipment building shall be schedule steel pipe with minimum thickness of 3/8" and shall be concrete encased (6" min. thickness). All suction piping shall be constructed with restrained joints. Acceptable restrained joints consist of welded joints, flanged joints, mechanical joints with restraining glands, and flexible couplings with restraining harnesses. Grooved couplings (e.g., Victaulic) are not acceptable since they are not desired in below-grade applications.

b. Discharge Piping

Above grade discharge piping shall be constructed of schedule steel pipe with smooth bend fittings. Mitered fabricated steel fittings are not acceptable above grade. Above grade piping shall be constructed with restrained joints. Acceptable above grade restrained joints consist of welded joints, flanged joints, grooved couplings (e.g, Victaulic), and flexible coupling with restraining harnesses.

If above grade discharge piping is 12" diameter or greater, check valves shall be located outside the building, as illustrated in Appendix B. If above grade discharge piping is less than 12" diameter, all above grade piping may be enclosed within the building, subject to additional accessibility analysis and District approval.

Below grade discharge piping shall be constructed of schedule steel pipe, or fabricated steel pipe. Below grade discharge piping shall be constructed with restrained joints. Acceptable below grade restrained joints consist of welded joints, flanged joints, mechanical

joints with restraining glands, and flexible coupling with restraining harnesses. Grooved couplings (e.g., Victaulic) are not acceptable since they are not desired in below grade applications.

c. Schedule Steel Pipe

Schedule steel pipe shall be ASTM A53 or A105, electric – resistance welded or seamless, and Grade B (35,000 psi minimum yield strength). Pipe dimensions and wall thickness shall be standard weight (minimum) per ASME B36.10. Pipe fittings shall be ASTM A234, Grade B with dimensions conforming to ASME B16.9 and shall be standard weight (minimum).

Pipe joints for piping 4" and larger shall be welded, flanged, grooved (e.g., Victaulic) (above grade only), or flexible couplings with restraining harnesses. Pipe joints for piping smaller than 4" shall be welded or coupled.

Flanged pipe and fittings shall be provided with fully welded slip-on or weld-neck flanges conforming to ASTM A105 and ANSI B16.5. Plain end pipe with flanged adaptors is not acceptable.

All schedule steel pipe and fittings shall be cement mortar lined per Detailed Provision Section 15061. Below grade pipe and fittings shall be cement mortar coated per Detailed Provision Section 15061.

d. Fabricated Steel Pipe (Below grade Only)

Fabricated steel pipe and fittings shall be Class 150 (minimum) and shall be provided in accordance with District Detailed Provision Section 15061, Steel Cylinder Water Pipe. The inside diameter of fabricated steel pipe shall match the inside diameter of associated fittings.

Pipe joints shall be welded, flanged, or flexible couplings with restraining harnesses.

All fabricated steel piping and fittings shall be cement mortar lined and coated per Detailed Provision Section 15061.

3. Valves

Valves shall be provided in accordance with the District's Detailed Provisions and Approved Materials List and shall comply with the following requirements. Engineer shall obtain current copies of the District's Detailed Provisions and Approved Materials List from the District's website

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(<http://www.emwd.org>). Engineer shall consult with District staff for confirmation of the applicable Detailed Provision Sections. All valves shall be rated for a working pressure of not less than 150 psi. Valves rated for higher working pressures shall be provided where system working pressures may exceed 150 psi. In addition, the pressure rating of valves connected to station discharge piping shall exceed the maximum pump shut-off head pressure (zero discharge).

a. Isolation Valves

Below grade isolation valves shall be flanged resilient seated gate valves per AWWA C509 with non-rising stems and 2" square nut.

Above grade isolation valves 12" and smaller shall be flanged resilient seated gate valves. Above grade isolation valves greater than 12" shall be flanged butterfly valves. Resilient seated gate valves shall conform to AWWA C509 with non-rising stem, and 2" square nut. Butterfly valves shall conform to AWWA C504 with rubber seats, worm gear operators, and 2" square nuts. Electric valve actuators shall be 120V and Modbus-capable.

b. Check Valves

Valves shall be flanged single disc, swing type, check valves per AWWA C508, with outside lever and spring. Check valves shall be "clear waterway" type, where the disc in the full-open position swings clear of the waterway.

c. Pressure Relief Valves

Valves shall be flanged diaphragm type globe valves as manufactured Cla-Val Company, no substitutes. Pressure relief valves shall be provided with stainless steel trim and shall be equipped with a limit switch which activates when the valve opens.

d. Air Valves

All air release valves shall be combination air/vacuum and air release type valves.

Each air valve assembly shall include an isolation ball valve, pressure gauge, and manual bleed valve. Pipe and fittings for the air valve assembly shall be Schedule 40 red brass, NPT. Pipe outlets for air valves shall be 3000 lb welded half couplings.

4. Appurtenances

Booster station appurtenances shall be provided in accordance with the District's Detailed Provisions and Approved Materials List and shall comply with the following requirements. Appurtenances shall be located to provide easy access for service, repair, removal, and replacement.

a. Flow Meters

Flow meters shall be propeller type or magnetic type as determined by the District for each specific project.

Propeller type flow meters shall be manufactured by McCrometer for uniformity with existing District equipment. Flow meter tubes shall be constructed of carbon steel with grooved (e.g., Victaulic) end connections and be suitable for a working pressure of 150 psi (minimum). Each flow meter shall be equipped with a direct mounted register and 4-20 ma signal transmitter. The meter register shall display the flow rate in "gpm" and total flow in "acre feet".

Magnetic type flow meters shall be manufactured by Endress+Hauser, ABB or Siemens (no substitutes). Flow meter tubes shall be constructed of carbon steel with flanged end connections and be suitable for a working pressure of 150 psi (minimum). Each flow meter shall be equipped with a local readout/totalizer and a remote signal transmitter (4-20 ma). The meter shall be Modbus-capable. The meter shall display the flow rate in "gpm" and total flow in "acre feet".

b. Pressure Gauges

Pressure gauges shall be liquid filled, weatherproof, and provided with 4-1/2" dials, 1/4" threaded connections, epoxy coated aluminum cases with safety glass windows, and 316 stainless steel needle valves. Pressure gauge range shall be selected such that the normal operating pressure is near the middle of the range. Pressure gauge accuracy shall be $\pm 1\%$.

c. Pressure Transmitters

Pressure transmitters shall be electronic two wire devices with adjustable span, integral display scaled in engineering units, solid state circuitry, and HART communication. Process connection shall be 1/2" NPT and shall be provided with a 316 stainless steel isolation ball valve. Transmitter housing shall be epoxy coated low copper

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aluminum alloy and rated NEMA 4X. Pressure transmitters shall be as manufactured by Foxboro, no substitutes.

d. Pipe Supports

All piping and valves shall be adequately supported. Pipe supports shall consist of cast iron or fabricated steel saddles with adjustable stanchions and fully welded floor mounting plates. Pipe supports shall be provided with hot-dipped galvanized coating.

F. Building Mechanical

Booster station mechanical equipment shall comply with the following requirements.

1. Heating, Ventilation, and Air Conditioning (HVAC)

HVAC system design shall be in accordance with the guidelines and standards of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) and the Air Movement Control Association (AMCA). HVAC system components, including louvers, ductwork, registers, ventilators, and air conditioners shall be sized and selected to provide the required performance and minimize room noise levels. Noise generated by HVAC system components shall not exceed levels recommended for light industrial/commercial occupancy. HVAC ductwork shall not be routed over electrical equipment unless an appropriate pan and drain system is provided per ASHRAE guidelines and standards.

a. Wall Louvers

Louvers shall be supply or exhaust with a blade width of 4" and sized to fit the wall opening. Louvers shall be fixed, adjustable, automatic gravity, or acoustical type depending upon the application. Louvers shall be constructed of heavy gauge galvanized steel and shall be provided with 1/4" galvanized mesh insect screens.

b. Roof Mounted Exhaust Ventilators

Roof exhaust ventilators shall be sized to remove heat generated by the housed equipment operating at full capacity. A maximum temperature differential of 10 degrees-F above the outdoor ambient temperature shall be used when determining the required air flow for the ventilators. Air flow determined for heat removal shall not be less than that required to provide 12 room volume air changes per hour.

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Roof exhaust ventilators shall be low profile, centrifugal, belt-driven, or direct drive type, with aluminum hoods. A single stage (or two stage if two speed ventilator) cooling thermostat shall be provided for automatic operation.

c. Roof Mounted or Ground Mounted Air Conditioning Unit

Air conditioners shall be sized to remove heat generated by the housed equipment operating at full capacity plus radiated heat from an outdoor ambient temperature of 110°F, minimum. The air conditioning unit shall be capable of maintaining an indoor temperature of 72°F.

Air conditioners shall be packaged units with easily replaceable air filter elements and roof curb or concrete slab on grade for unit support. A weatherproof power disconnect with convenience receptacle shall be provided adjacent to each air conditioning unit.

d. Evaporative Cooling Unit

Evaporative cooling units shall be 100 percent outside air, direct evaporative cooling, and the constant volume type. Evaporative cooling units shall be sized according to maximum ambient temperature, relative humidity, room volume and dimensions, heat loads, desired indoor temperature, and/or air exchanges as appropriate.

The evaporative cooling unit shall be controlled by a thermostat except in generator room applications, in which the units shall be controlled by spring-loaded type timer switch.

All cooling units shall be outdoor rated and of weatherproof construction.

2. Roof Hatches

a. Pump Hatches

Pump hatches shall be constructed of aluminum with single or double door leafs. Door leafs shall be provided with automatic hold open arms, padlockable latch, and compression springs sized for easy opening and to retard downward motion when closing.

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b. Roof Access Hatches

Roof access hatches shall be constructed of galvanized steel with single door leaf. Door leaf shall be provided with automatic hold open arm, padlockable latch, and compression springs sized for easy opening and to retard downward motion when closing.

G. Emergency Standby Power Generator

An emergency standby power generator shall be provided for all pumping facilities, unless otherwise specified by the District, in accordance with the District's Detailed Provisions. The emergency standby power generator shall be provided with sufficient capacity to start and operate all booster station motor loads and low voltage transformer loads (except the standby pumping unit) for a minimum of 24 hours during an Electrical Utility Provider power outage. Sizing of the standby generator to accommodate future and ultimate equipment loads shall be evaluated on a case-by-case basis by the Engineer. At a minimum, standby generator structures (e.g., building rooms, isolated foundation, etc.) shall be sized to accommodate future equipment and ultimate equipment loads. Large equipment loads may be step started under emergency power, provided the appropriate time delays are incorporated into the station controls.

The emergency standby power generator (generator set) shall comply with the following requirements:

1. Manufacturer(s) shall be in accordance with the District's Detailed Provisions
2. The maximum allowable instantaneous voltage dip shall be 20%.
3. The generator set shall be rated 277/480 (reconnectable), 3-phase, 4 wire, 60 hz.
4. The engine shall be naturally aspirated or turbocharged and after-cooled diesel, 4 cycle, 1800 RPM (maximum), and water cooled. Two cycle engines are not acceptable.
5. Generator set components shall be mounted to a heavy-duty steel base (skid) to maintain alignment between components.
6. The generator set shall be equipped with an engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full rated load and 110 degrees F ambient air entering the generator room.

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7. Generator sets shall be “pre-certified”/“pre-approved” by South Coast Air Quality Management District (SCAQMD) for emergency standby power service and shall be equipped with all necessary components to meet current SCAQMD air emission regulations for the operation of a diesel emergency standby generator. Generator sets shall have the highest available Tier certification. If equipped with a diesel particulate filter (DPF) to meet the requirements of SCAQMD Rule 1470, the Engineer shall evaluate site-specific operational parameters and electrical loading characteristics in order to specify one of the following ancillary equipment alternatives:

- Passive DPF System; or
- Passive DPF System + Permanent Load Bank.

For a passive DPF system to be specified without a permanent load bank, site electrical loads must be sufficient during all routine testing and standby operations scenarios to provide adequate engine exhaust gas temperatures and ensure passive DPF regeneration.

When a passive DPF system is specified with a permanent load bank, the load bank must include an integral ‘active control’ panel that can sense the facility loads and automatically regulate the load applied to the generator by the load bank.

Engineer shall submit all DPF technical data and supporting calculations for District’s review and acceptance.

The DPF shall be located in an area that is readily accessible for maintenance.

8. The generator shall be a single bearing, self-ventilated, drip-proof design in accordance with NEMA MG1. Insulation material shall meet NEMA standards for Class H insulation. Temperature rise of the rotor and stator shall not exceed NEMA Class F (130°C rise by resistance over 40°C ambient at unit full load rating). Excitation power shall be via a permanent magnetic generator (PMG). An automatic voltage regulator shall be provided to maintain output voltage with 1% for any constant load between no load and full load. Generator shall be provided with a 120-volt space heater to prevent condensation when the unit is not operating.
9. A generator set mounted control panel shall be provided for complete control and monitoring of the engine and generator functions. Alarm and status indicating lamps for protection and diagnostics shall be provided in accordance with NFPA 110, Level 1. The control panel shall be mounted at a height that provides suitable access from floor level or platform without obstruction.

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10. An engine mounted, thermostatically controlled, UL listed, circulation type water jacket heater shall be provided to maintain jacket water temperature at 90 degrees F. Power to the jacket water heater shall be supplied by a dedicated GFI-type circuit breaker. Circuit breaker shall be 110V for heater wattages up to 3000 W. For heater wattages of 3000 W or greater, circuit breaker shall be 220/240 V, single phase
11. Engine shall be provided with a critical or hospital grade silencer which shall be constructed of stainless steel. Engine exhaust piping and fittings shall be constructed of 316 stainless steel. Engine exhaust system inside the generator room or outdoor enclosure shall be insulated with removable silica/glass mat insulation and silicone coated silica fabric.
12. Heavy-duty diesel starting type lead-acid batteries shall be provided. A UL listed, current limiting battery charger shall be furnished to automatically recharge the batteries.
13. Generator set shall be provided with a main circuit breaker equipped with a thermal magnetic trip unit and DC shunt trip. Circuit breaker shall be housed in a NEMA 1 enclosure mounted on the generator set and shall be provided with a dead front panel and a padlockable handle with an extension arm for the breaker. The circuit breaker shall be mounted at a height that provides suitable access from floor level or platform without obstruction.
14. The generator set shall be provided with a UL listed double walled, sub-base fuel storage tank, constructed of corrosion resistant aluminized steel. The sub-base tank shall be provided with over-fill protection, tank rupture and low fuel level alarms, venting, and any other required accessories. Fuel tank shall have sufficient capacity to allow continuous operation of the generator set for a minimum of 24 hours at 100% rated load. Aggregate indoor fuel storage capacity shall not exceed 660 gallons as set forth in the California Fire Code. In the case where the calculated fuel storage volume is in excess of 660 gallons, the required storage shall be met by outdoor storage or a combination of indoor and outdoor storage. Where a remote fuel tank is required, fuel piping between the remote fuel tank and the generator shall be designed in such a way to avoid tripping hazard.
15. Adequate and safe clearance shall be provided around the generator set for access such as ladders and portable platform lifts. Generator set frame shall be elevated above finished floor elevation via isolation pads or concrete housekeeping pad subject to District approval and generator set manufacturer acceptance. Generator set housekeeping pad, where provided, shall be designed to provide appropriate clearance free of tripping hazards or stepped surfaces.

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16. A portable Cal/OSHA-compliant platform dedicated for the generator shall be provided. The portable platform shall meet the following requirements:
 - Minimum 800-pound load rating
 - 36- by 48-inch top deck
 - Maximum 50-degree stairway with serrated treads
 - The height of the platform shall provide suitable access to the engine
 - 2-rail handrail system with 42-inch-high full-handrails, 21-inch-high mid-rails, and toeboards all around the exterior of the platform
 - One side of the top deck shall have two removable chains to allow for full access to the generator set
 - The platform shall have a single chain at the top of the stairway
 - The platform shall be provided with a rolling locking mechanism

H. Chemical Addition

If required by the District, chemical addition facilities shall be incorporated into the booster station design. Unless directed otherwise, these facilities shall inject chlorine and ammonia into station discharge piping. All chemical storage tanks and feed pumps shall be mounted on concrete housekeeping pads, 3" minimum height.

1. Chlorine System

The chlorine system shall utilize an on-site sodium hypochlorite generator manufactured by ClorTec. The chlorine system shall include the following items:

- a. Water softener system
- b. Salt storage pallets
- c. Brine storage tank and appurtenances
- d. Sodium hypochlorite generator (sized to provide 2.5 mg/l of chlorine at the booster station design flow rate)
- e. Control panel with PLC
- f. Rectifier
- g. Sodium hypochlorite storage tank and appurtenances
- h. Sodium hypochlorite dosing pumps with variable frequency drives
- i. Chlorine analyzers (total chlorine)
- j. Chlorine residual recorder
- k. Solution injector
- l. Emergency shower and eyewash station

Any devices or equipment in the salt storage room shall be protected from salt dust during salt deliveries.

2. Ammonia System

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The ammonia system shall utilize commercial aqueous ammonia. The ammonia system shall include the following items:

- a. Chiller-less (pressurized) aqueous ammonia storage tank and appurtenances (Snyder Ultratainer, or equal).
- b. Aqueous ammonia dosing pumps with variable frequency drives.
- c. Solution injector.

CHAPTER VI STRUCTURAL/ARCHITECTURAL DESIGN

The following design criteria shall be utilized in preparing construction drawings and specifications for the booster station equipment building.

A. Equipment Building

The equipment building shall be designed to house booster station equipment, systems, and components. Layout requirements for the equipment building are addressed in Chapter V of these guidelines. The equipment building shall comply with the following structural and architectural requirements.

1. Building shall be designed in accordance with the California Building Code (CBC), latest edition. Seismic design parameters shall be established by the geotechnical investigation for the booster station site. Risk Category IV (CBC Table 1604.5 "essential facilities") shall be used for the design of buildings and other structures, and for the design of equipment and other nonstructural components, and their supports and attachments. Buildings housing well pumping and other ancillary equipment shall also be designed in conformance with these requirements.
2. Building shall be constructed of masonry block, solid grouted. Masonry block type and color shall match landscaping features and walls within the Development or surrounding area.
3. Building shall be designed to be vandal-resistant. Under no circumstances shall exterior windows be provided. All doors shall be constructed of steel and shall be equipped with panic bars. Vandal-resistant door hardware in accordance with the District's Detailed Provisions shall be used, including heavy duty locksets with deadbolts and tamper-proof door hinges with non-removable pins. Roof access ladders shall be located inside the building.
4. Building shall be provided with a roof parapet. Roof parapet shall be of adequate height to conceal the roof mounted equipment including engine exhaust silencers, roof hatches, ventilation fans, and air conditioners.
5. Building shall be provided with metal roof decking covered by built-up roofing. The built-up roof system shall be warrantied for 20 years, minimum (full value, non-prorated, no dollar limit guarantee). Metal roof decking shall be supported by structural steel roof framing. Steel roof framing shall be supported by the masonry walls. No interior columns will be allowed. Bottom of roof framing shall be at least 24" above the top of any electrical or mechanical equipment, including MCC and pumping units.

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6. A roof hatch shall be provided over each pumping unit for pump removal/replacement. Each roof hatch shall be provided with a retraceable safety net beneath the hatch for fall protection when the hatch door(s) is open. The safety net shall comply with Cal/OSHA, General Industry Safety Orders, Section 3212 for roof opening covers.
7. An interior wall mounted ladder and roof hatch shall be provided for access to roof equipment. The ladder shall be provided with a safety climb assembly, RailBloc Model AC101A or DBI Sala 1 Lad-Safe Flexible Cable Ladder Safety System Model 6116502.
8. Building roof shall drain to wall mounted roof scuppers or to roof drains. Parapet shall be provided with roof overflow openings near the scuppers or roof drains.
9. Floors shall be constructed of reinforced concrete, 6" minimum thickness, with a light broom finish to provide a slip-resistant surface. Floors shall be sloped a minimum of 1% to floor drains. Floor drains shall be cast iron with 8" diameter (minimum) bronze strainers and p-traps, or channel drains with cast iron channel grates and p-traps, where appropriate.
10. Roof and floor drains shall be provided with clean-outs. Below grade drain piping shall be constructed of Schedule 40 CPVC. The building drain system shall be connected to the District's sewer system or drywell seepage pit if no sewer connection is available.
11. Pump foundations shall be of adequate mass and rigidity to absorb vibration from the pumping units as recommended by the Hydraulic Institute Standards.
12. Building rooms shall be well lighted by 4' or 8' long energy efficient LED fixtures. Lighting fixtures shall be suitable for damp locations, and shall be fully gasketed, totally enclosed and provided with acrylic diffusers attached with pivot latches. Light fixtures shall be located for easy access by ladder for changing bulbs.
13. A wall mounted LED exterior light fixture with integral photocell shall be provided on each side of the building. The exterior lights shall be activated by photocell or by a wall mounted light switch located inside the building.
14. Convenience receptacles shall be provided on at least two (2) walls in every room. All convenience receptacles shall be GFI type and waterproofed.

CHAPTER VII ELECTRICAL DESIGN

A. General

Electrical design and components shall be in strict accordance with all applicable national, state, and local codes (e.g., NEC, NEMA, IEEE), Electrical Utility Provider requirements, or the latest revision of the District's electrical standards and details.

Wherever practical, electrical equipment and components shall be sized for the ultimate conditions and loads. These items may include panels, bussing, short circuit protective devices, motor starters, motor control center (MCC) buckets, transformers, lighting panels, conduit, and conductors. As a minimum, panel/bucket sizes and conduit sizes shall be selected for ultimate conditions and loads.

Electrical equipment specifications shall include requirements for performance of an Arc Flash Hazard Study to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and required personal protective equipment (PPE) for all energized electrical equipment, and arc flash and shock hazard warning labels. The study shall include all electrical equipment from the normal power source or sources to and including all electrical panels with voltage greater than 24 volts. Electrical equipment shall be provided with warning labels in accordance with study recommendations. The Arc Flash Hazard Study and equipment labeling shall be performed in accordance with the District's latest Detailed Provisions for same. The study shall be completed utilizing SKM software and submitted to the District. A Protective Device Coordination Study shall also be completed in accordance with the District's latest Detailed Provisions to determine proper settings of protective devices to assure that the protective devices operate as an integrated system.

B. Normal Power

Three-phase, 480-volt, 60-hertz power is required from the Electrical Utility Provider. The Engineer shall contact Electrical Utility Provider to confirm the availability of 480-volt power and establish requirements for providing 480-volt power to the booster station site. The Engineer is responsible for preparation of all Electrical Utility Provider applications, furnishing all pertinent drawings and data, obtaining all Electrical Utility Provider design requirements for the booster station electrical service, and obtaining the Electrical Utility Provider Electrical Service Plan. The Electrical Utility Provider Electrical Service Plan shall be incorporated into the Specifications. The booster station electrical plans shall include all Electrical Utility Provider related facilities required to be constructed by the applicant (Developer), such as conduit and pull boxes for primary and secondary conductors, transformer pad, electrical service panel, grounding system(s), and

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protective guard posts. All electrical service equipment, materials and components shall conform to Electrical Utility Provider requirements, including the electrical service plan document, and comply with the following:

1. The Electrical Utility Provider service transformer and electrical service panel (pull section, metering section, and main disconnect) shall be located in a separate fenced enclosure at the front of the site and adjacent to the street right-of-way.
2. The electrical service panel shall face north or east.
3. Pedestal type electrical service panel rated for 200A (minimum) on 480-volt, 3-phase power shall be provided for booster stations with total connected loads of 200A or less. The electrical service pedestal shall be UL listed with a short circuit current rating of 42 KAIC (minimum) and be provided with a NEMA 3R enclosure. Pedestal shall include a separate, barriered-off, utility metering compartment with sealable door and padlock hasp as approved by Electrical Utility Provider. Electrical service pedestals shall be as manufactured by Milbank Manufacturing Co., or Cooper B-Line; no substitutes.
4. Booster station total connected load shall be 25 KVA or greater. Connected loads less than 25 KVA will not qualify for 3-phase, 480-volt service from Electrical Utility Provider.
5. Full height (90" high), 480 volt, 3-phase, electrical service panel with current rating higher than the booster station total connected load, or 400A (whichever is greater) shall be provided for loads in excess of 200A. The electrical service panel shall have a short circuit current rating of 65 KAIC (minimum) and be provided in a NEMA 1 enclosure with a NEMA 3R wrapper and padlockable door handles. Panel shall include a separate, barriered-off, utility metering compartment with hinged sealable door as approved by Electrical Utility Provider.
6. Main disconnect shall be a molded case circuit breaker with inverse time and instantaneous tripping characteristics, and ground fault protection system. Main circuit breaker shall have a minimum interrupting capacity matching the service panel rating. Circuit breaker shall be provided with adjustable continuous current and thermal-magnetic trip units, an Arc Flash reduction mode switch with blue indicator light, and a padlockable door mounted operator mechanism.

C. Emergency Power

If required by the District, emergency standby power facilities shall be incorporated into the booster station design. These facilities shall be capable of automatically

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providing power for full booster station operating capacity during an Electrical Utility Provider power outage. Emergency power facilities shall consist of an emergency standby power generator (reference Chapter V of these guidelines for requirements) and an automatic transfer switch (ATS). The ATS shall automatically transfer electrical current from multiple sources to the load. The ATS shall be capable of the following operations:

1. Supply normal (Electrical Utility Provider) power to the MCC when normal power is available. Supply standby power from the emergency standby power generator set to the MCC when normal power fails or is disconnected.
2. Detect the sustained loss of normal power (power failure), signal the emergency standby generator to start and run when normal power fails, and when standby power from the generator is within proper limits of voltage and frequency, transfer to supply standby power to the MCC.
3. Detect the sustained restoration of normal power within proper limits of voltage and frequency, and then retransfer to supply normal power to the MCC.

The ATS shall be mounted in the MCC. The ATS and accessories shall be UL listed, labeled, and tested per UL Standard 1008 and comply with applicable NEMA and NFPA standards. The ATS shall be rated for continuous duty and shall be "open" transition type. The ATS continuous and short circuit current ratings shall match the electrical service panel ratings. The ATS shall be as manufactured by ASCO, Olympian, Russelectric, or equal.

D. Transient Voltage Surge Suppressor (TVSS)

A TVSS shall be provided on the load side of the ATS (or load side of the main circuit breaker if emergency power is not required) and shall be mounted in the MCC. The TVSS shall be provided with an integral disconnect switch which has been tested to the surge current rating of the TVSS. The TVSS shall be UL tested and labeled as a complete system to a symmetrical fault current rating of 200 KA, minimum. The TVSS shall provide protection for L-L and L-G modes, and each mode shall be fused and incorporate a thermal cutout device. The minimum surge current capability of the TVSS shall be 150 KA per mode and 300 KA per phase. The TVSS shall be provided with status indicating lights, surge counter, and dry contacts for remote monitoring.

E. Motor Control Center (MCC)

All electrical switchgear and controls for pumping units, and ancillary equipment such as building ventilation equipment, chemical addition equipment, and surge tank air compressor, shall be housed in an MCC. MCC shall be rated for 600 volts

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and shall be suitable for operation on a 3-phase, 60 hertz system. MCC shall be sized based on ultimate equipment requirements and shall include all sections and compartments required for any future equipment; however, internal switchgear and components for future equipment is not necessary. MCC manufacturers shall be as specified in the District's standard detailed provisions; no substitutes.

The MCC line-up shall include a full height section to house the District furnished remote telemetry unit (RTU). The RTU section shall be a minimum of 24" deep and 36" wide by 30" high. The RTU section shall not be bussed and shall be provided with a full height back panel. The RTU door shall be equipped with filtered and louvered openings at the top and bottom, and a 120V thermostatically controlled supply air fan at the bottom.

1. Construction

MCC structures shall be totally enclosed dead front, free-standing assemblies, 90± inches high and minimum 21± inches deep. Each section shall be minimum 20± inches wide, and wider where required for housing specified components.

Each structure shall contain a main horizontal copper tin plated or copper silver plated bus with a minimum ampacity rating of 400A or matching the electrical service panel rating (whichever is greater). All MCC disconnect switches, circuit breakers, and motor circuit protectors shall be provided with external padlockable "on/off" handles.

MCC enclosures shall be suitable for the proposed location. As a minimum, MCC enclosures shall be rated NEMA 1 and shall be fully gasketed. MCCs installed outdoors shall be provided with NEMA 3R wrappers. As a minimum, each outdoor MCC enclosure section shall be furnished with a convenience receptacle, overhead fluorescent light in wrapper vestibule, inside mounted light switch, and padlockable door handles. Outdoor MCCs shall be positioned on the site to face north or east.

2. Motor Controllers (Motor Starters)

Equipment with motor horsepower ratings of 100 or less shall be provided with full voltage combination starters. Equipment with motor horsepower ratings greater than 100 shall be provided with solid-state reduced voltage starters. Motor controllers shall be sized for the motor horsepower of the initial equipment; however, MCC controller bucket space shall be sized for the ultimate equipment motor starter. Each pumping unit shall be provided with a power monitor.

a. Combination Starters

Combination starters shall consist of motor circuit protectors and motor starters with overload relays. Combination starter units shall be full voltage, non-reversing, rated for 42 KAIC (minimum). Current overload protection shall consist of thermal bimetallic ambient compensated type overloads. Overloads shall be sized based on characteristics of the actual furnished motors. Combination starters shall be provided with phase loss protection, which shall consist of a DLM series phase loss relay as manufactured by SSAC; no substitutes.

b. Solid-State Reduced Voltage (SSRV) Starters

SSRV starters shall consist of input circuit breaker and solid-state motor controller (SSMC). SSMC units shall be integrated, solid state systems, designed to energize electric motor drivers. SSMC units shall provide a smooth and stepless acceleration ramp on startup and a deceleration ramp on shutdown to reduce inrush current and hydraulic surges. Power semiconductor assemblies shall contain MOVs and resistor capacitors to protect the semiconductors from line voltage transients. Each SSMC shall be provided with current overload protection, power unit overtemperature protection, input line fuses, and phase loss and undervoltage protection. Each SSMC unit shall be equipped with internal shunting contactors, which shall engage when the motor reaches full speed. SSRV starters shall be in accordance with District Detailed Provision Section 16480. SSRV starters shall be capable of Modbus RTU communication.

c. Controls

Each starter shall be equipped with control relays, timers, selector switches, indicating lights, elapsed time meter, and auxiliary contacts as required to provide manual and automatic equipment operation. As a minimum, each starter shall be provided with a Hand-Off-Auto switch, elapsed time meter, and the following status and alarm lights. Status lights shall be provided for "Control Power On" and "Run". Three lights shall be provided: Power on (white), Running (green), and Fail (red). Alarm conditions shall open the respective motor starter and activate a corresponding alarm light, which shall be latched "on". Alarm conditions shall require a manual reset to clear. Warning lights shall be latched "on" and require a manual reset to deactivate the light but shall not open the motor starter. All status and alarm lights shall be push-to-test type LED and shall be heavy duty, oil tight (NEMA 13). All control power shall be 120-volt, single phase.

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d. Variable Frequency Drives (VFDs)

VFDs, where required, shall be front end active drive type and shall be equipped with Modbus RTU communications. VFDs shall be in accordance with District Detailed Provision Section 16160.

3. Lighting Panel

The MCC shall include a step-down transformer and lighting panel for low voltage single phase loads such as lights, controls, convenience receptacles, and miscellaneous small equipment. The transformer shall be dry type 480 volt/120-240 volt and shall be adequately sized for ultimate loads and future equipment. Circuit breakers shall be provided for future equipment. As a minimum, six (6) spare 20A, 120-volt circuit breakers shall be provided.

4. Ventilation and Heating

Ventilation and heating shall be as designed by the MCC manufacturer and shall comply with the following requirements.

- a. All electrical equipment and components shall be capable of operation under any combination of the following conditions without mechanical or electrical damage.

Ambient Temperature:	15°F to 120°F
Relative Humidity:	10% to 90%

- b. Ventilation openings (if necessary), including fan openings, shall be provided with washable aluminum mesh air filters.
- c. Forced air ventilation (if necessary) shall be provided by supply air fans with cooling thermostats.
- d. Each MCC section (except section with low voltage lighting panel transformer) shall be provided with thermostatically controlled space heaters to prevent condensation.
- e. Power for forced air ventilation and space heaters shall be provided from dedicated circuit breakers in the lighting panel.

F. Motors

All electric motors shall be high efficiency and shall be provided with a minimum service factor of 1.15. Motor horsepower, not including motor service factor, shall

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equal or exceed the horsepower requirements of the driven equipment over its full range of operation.

Pumping unit electric motors shall be provided in accordance with the District's Detailed Provisions and comply with the following requirements.

1. Motors shall be vertical hollow shaft type and shall be Design B, high thrust, squirrel cage with NEMA weather protected Type I enclosures.
2. Motors shall be nameplate rated, 3 phase, 60 hertz, 460 volts.
3. Motors shall have a no-load speed of 1800 rpm or less.
4. Motors shall be rated premium efficiency.
5. Motors shall be equipped with anti-friction type thrust and guide bearings. Bearings shall be of sufficient capacity to carry all static and dynamic up and down thrust loads, both momentary and continuous, imposed by the pump. Bearings shall provide a minimum 5-year B10 life (40,000 hours) based on continuous design thrust load or minimum 1-year B10 life (8770 hours) based on pump shut-off thrust load, whichever is greater. Bearings shall also provide for minimum momentary upthrust equal to 30% of rated downthrust. Motor thrust bearings shall be oil lubricated; however, motor guide bearings shall be grease lubricated.
6. Motors greater than 50 hp shall be equipped with 120-volt thermal sensors, one for each phase, affixed to or embedded in the motor windings, set to open the motor control circuit at 135 degrees C. Thermal sensor leads shall terminate in the motor terminal box.
7. Motors greater than 25 hp shall be equipped with 120-volt single phase belt type space heaters capable of raising motor temperature 10 degrees C above ambient temperature to prevent condensation. Space heater leads shall terminate in the motor terminal box.
8. Motors shall be equipped with non-reverse mechanisms which shall limit reversal to within 10 degrees of rotation.
9. Motors shall be equipped with extra large heavy duty split type conduit boxes. Motor terminal boxes shall be located 90 degrees from the pump discharge.

G. Conduit and Conductors

Conduit shall be of adequate size to carry conductors required for ultimate electrical loads. Conduit without conductors shall be provided from the MCC to all

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future equipment locations. Spare conduit shall be provided to all locations requested by the District. Pull ropes shall be installed in all future or spare conduits.

1. **Conduit**

- a. Exposed conduit shall be minimum 3/4". Below grade conduit shall be minimum 1".
- b. Below grade conduit shall be PVC, Schedule 40, UL listed, and sunlight resistant.
- c. Above grade conduit shall be Schedule 40 rigid steel, finished inside and out by hot-dip galvanizing (HDG), and shall be UL listed.
- d. Below grade conduit shall be installed with a minimum of 24" cover. Below grade conduit shall be encased in red colored concrete per District Detailed Provisions.
- e. Transition from below grade PVC conduit to above grade HDG conduit shall be made at the horizontal leg of the below grade conduit bend. Conduit bend and riser shall be PVC-coated rigid HDG to 3" above finished floor.
- f. HDG rigid steel conduit in direct contact with the ground or concrete shall be PVC-coated.
- g. Above grade conduit shall be run exposed.
- h. Exposed conduit in the Chemical Room shall be PVC coated rigid steel conduit as manufactured by Ocal, Robroy, or equal.
- i. Connection from junction box or conduit to motor or equipment terminal box shall be with PVC coated liquid-tight flexible metallic conduit.

2. **Conductors**

- a. All conductors below grade shall be stranded copper with 75 degrees C XHHW-2 insulation from the source to the device.
- b. Minimum power conductor size shall be #12 AWG. Minimum control conductor size shall be #14 AWG.
- c. Provide three (3) conductor #16 AWG shielded Belden cable for all 4-20 ma analog signals unless special cable is required by the instrument manufacturer.

H. Grounding

All grounding shall be in accordance with the National Electrical Code, latest edition. Under no circumstances shall electrical grounding systems utilize booster station piping.

I. Controls, Security, and Telemetry

1. General

Controls for manual and automatic equipment operation shall be located in the MCC compartment containing switchgear for the respective equipment. Minimum requirements for equipment control are described herein under the section entitled "Motor Control Center (MCC)".

Pumping units operating in the "auto" mode shall receive the start/stop signal from the District's Telemetry System. The District will furnish the telemetry equipment for the booster station, including internal components for the remote telemetry unit (RTU). However, the enclosure for the RTU shall be furnished and installed by the contractor. The RTU will transmit alarm and status signals from the booster station to the existing Telemetry System and will receive control signals for pumping unit operation. All booster station alarm, status, and control signals shall be terminated on a terminal block within the RTU panel. The RTU section of the MCC and terminal block shall be furnished and installed by the contractor. The RTU internal components shall be mounted by the District on the MCC back panel supplied by the contractor.

If the RTU fails, the only mode of pump operation will be manual via the pump H-O-A switch.

2. Security

Each booster station shall be provided with a security system, which shall be connected to the RTU for alarming District security personnel via the District's Telemetry System. Specific security system components will be determined by the District depending upon facility location.

For booster stations with equipment buildings, the minimum-security system components shall include site access gate limit switches and building motion sensors. As described above, Construction Drawings shall show conduit from the RTU to the hinge side of each access gate and corresponding junction boxes. In addition, conduit shall be shown between the RTU and each building door. Conduit shall terminate at a LB conduit over each door leaf or along the side of each roll-up door.

Additional security system components may include outdoor security cameras and motion detectors, card readers for automatic rolling access gates, card readers for equipment building doors, and motion detectors inside the equipment building. Where any of these components are required by the District, Construction Drawings shall show conduit and junction boxes between the RTU and/or security system cabinet (if applicable) and the respective device.

3. Remote Telemetry Unit (RTU)

The District furnished RTU will contain a programmable logic controller. The programmable logic controller (PLC) will receive all booster station alarm and status signals, and all analog signals from field instrumentation. In addition, the PLC will provide output signals to the respective MCC pump starter which will start/ stop pumping units and cause pumping unit shutdown under various alarm conditions (e.g., low flow rate, high discharge pressure, low discharge pressure, and low suction pressure). All input/output signals to the RTU shall be connected to a common RTU terminal strip located in the RTU. The contractor will be required to provide the interconnection wiring between the respective MCC terminal strip and the RTU.

As a minimum, the following alarm, status and control signals shall be provided:

Discrete Input

- Pump in Auto mode
- Pump in Hand mode
- Pump Running
- Pump Fail (motor overload, or phase loss)
- Pump Warning (motor high temp)
- High Water Level in Surge Tank
- Low Water Level in Surge Tank
- Add Air Solenoid Valve Opened
- Low Compressor Air
- PRV Opened
- Generator Run
- Generator Fail
- Building Door Intrusion Alarm or RTU Door Intrusion Alarm (if no equipment building)
- Gate Intrusion Alarm
- Eyewash Alarm
- Low Chlorine Level Alarm
- Low Ammonia Level Alarm

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Discrete Output

Start/Stop Lead Pump
Start/Stop Lag 1 Pump
Start/Stop Lag 2 Pump
Start/Stop Lag Etc. Pump
Stop Lead Pump on Low Flow Rate
Stop Lag 1 Pump on Low Flow Rate
Stop Lag 2 Pump on Low Flow Rate
Stop Lag Etc. Pump on Low Flow Rate
Stop All Pumps on Low Suction Pressure
Stop All Pumps on Low Discharge Pressure
Stop All Pumps on High Discharge Pressure

Analog Input

Suction Header Pressure
Discharge Header Pressure
Lead Pump Flow Rate
Lag 1 Pump Flow Rate
Lag 2 Pump Flow Rate
Lag Etc. Pump Flow Rate

**APPENDIX A
TYPICAL BOOSTER STATION
CONSTRUCTION DRAWING INDEX**

TABLE 1

**EASTERN MUNICIPAL WATER DISTRICT
POTABLE WATER BOOSTER STATION SUBMITTAL AND DESIGN GUIDELINES**

TYPICAL BOOSTER STATION CONSTRUCTION DRAWING INDEX

<u>NO.</u>	<u>SHT. NO.</u>	<u>SHEET TITLE</u>
1	G-1	TITLE SHEET
2	G-2	CONSTRUCTION NOTES
3	G-3	LEGENDS, SYMBOLS, AND ABBREVIATIONS
4	G-4	SCHEDULES AND PIPE DUTY DESIGNATIONS
5	C-1	GENERAL SITE PLAN
6	C-2	SITE GRADING PLAN
7	C-3	SITE PIPING AND ELECTRICAL PLAN
8	C-4	CIVIL SECTIONS AND DETAILS
9	C-5	CIVIL DETAILS
10	M-1	EQUIPMENT BUILDING MECHANICAL PLAN
11	M-2	EQUIPMENT BUILDING MECHANICAL PLAN AND SECTIONS
12	M-3	EQUIPMENT BUILDING MECHANICAL SECTIONS
13	M-4	EQUIPMENT BUILDING MECHANICAL SECTION AND DETAILS
14	M-5	SURGE ARRESTOR AND MISCELLANEOUS DETAILS
15	M-6	MISCELLANEOUS DETAILS
16	M-7	MISCELLANEOUS DETAILS
17	A-1	EQUIPMENT BUILDING FLOOR PLAN
18	A-2	EQUIPMENT BUILDING ELEVATIONS AND FINISH SCHEDULE
19	A-3	EQUIPMENT BUILDING ROOF PLAN

TABLE 1

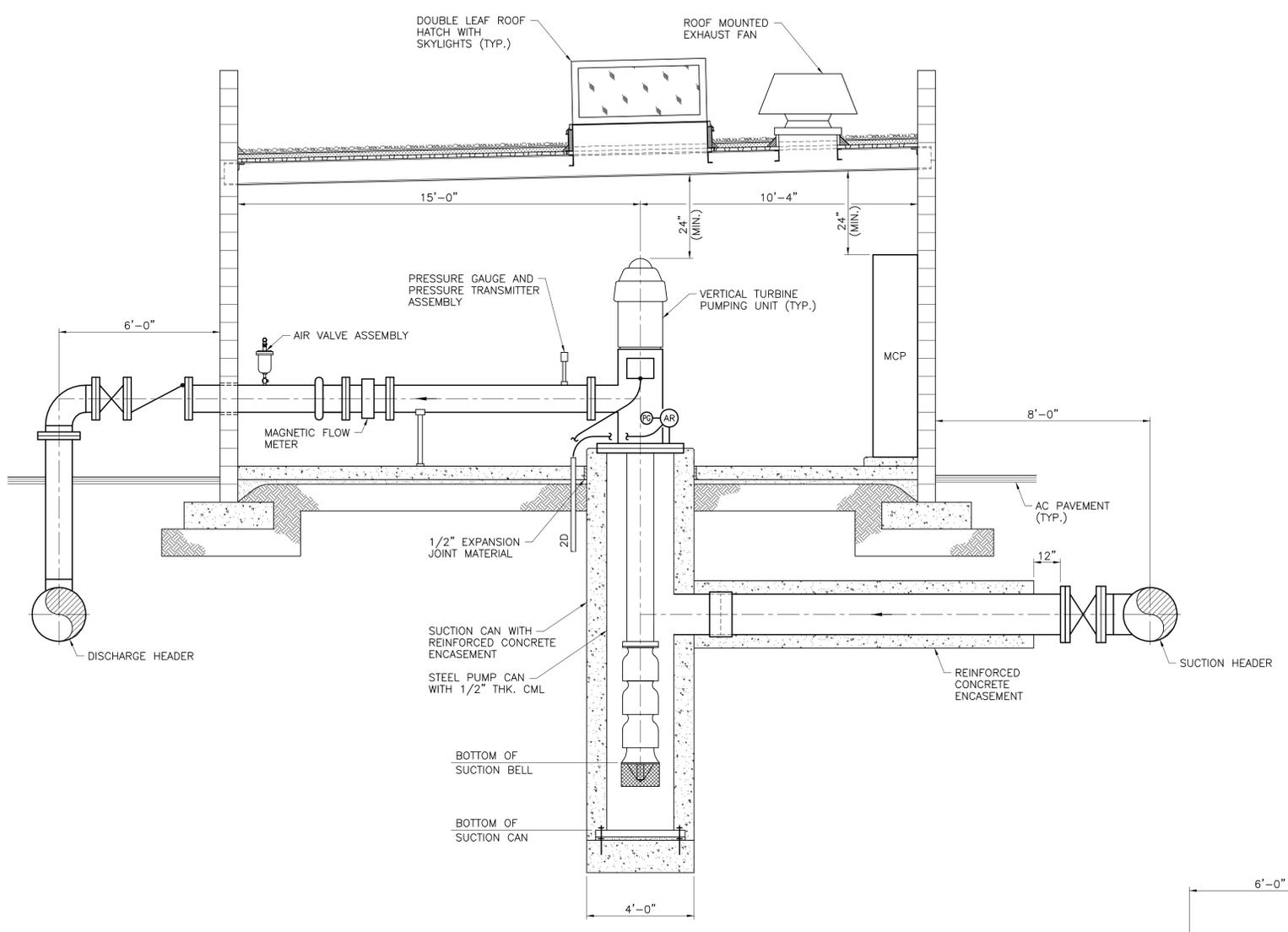
**EASTERN MUNICIPAL WATER DISTRICT
POTABLE WATER BOOSTER STATION SUBMITTAL AND DESIGN GUIDELINES**

TYPICAL BOOSTER STATION CONSTRUCTION DRAWING INDEX

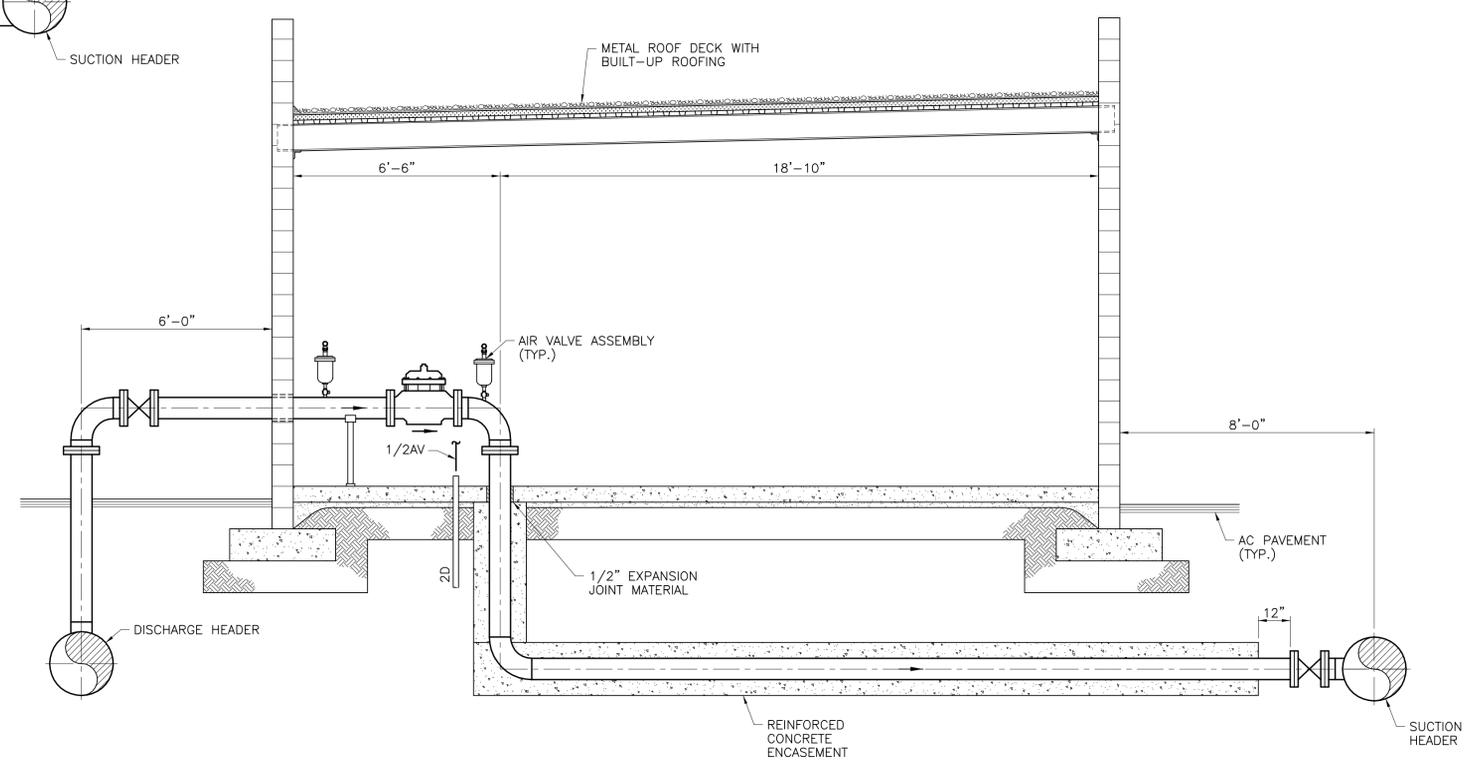
<u>NO.</u>	<u>SHT. NO.</u>	<u>SHEET TITLE</u>
20	A-4	EQUIPMENT BUILDING SECTION AND DETAILS
21	S-1	STANDARD STRUCTURAL DETAILS
22	S-2	EQUIPMENT BUILDING FOUNDATION AND FLOOR PLAN
23	S-3	EQUIPMENT BUILDING ROOF FRAMING AND ROOF DRAINAGE PLANS
24	S-4	EQUIPMENT BUILDING SECTIONS
25	S-5	EQUIPMENT BUILDING STRUCTURAL DETAILS
26	S-6	EQUIPMENT BUILDING STRUCTURAL DETAILS
27	E-1	ELECTRICAL NOTES, SYMBOLS, AND ABBREVIATIONS
28	E-2	ELECTRICAL SINGLE LINE DIAGRAM, CONDUIT SCHEDULE, AND PANEL ELEVATIONS
29	E-4	EQUIPMENT BUILDING ELECTRICAL POWER PLAN AND LIGHTING PLAN
30	E-5	ELECTRICAL CONTROL DIAGRAMS
31	E-6	ELECTRICAL CONTROL DIAGRAMS AND RTU INTERCONNECT DIAGRAMS

**APPENDIX B
TYPICAL BOOSTER STATION
MECHANICAL PLAN AND MECHANICAL SECTIONS**

DWG. NO.: 491-40-22m2bFILE NO.: 491.40.22_UPDATE BY: TMM PROJ. ENG.: PES_PLOT DATE: 02/16/10_PLOT TIME: 10:57AM_PLOT SCALE: 1=1



PUMP SECTION A
SCALE: 3/8"=1'-0" M-1



PRESSURE RELIEF VALVE SECTION B
SCALE: 3/8"=1'-0" M-1

Underground Service Alert
Call: TOLL FREE 1-800-227-2600
TWO WORKING DAYS BEFORE YOU DIG

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY
HORZ./VERT. DATUM
HORZ. =
VERT. =

REVISIONS				
NO.	DATE	INITIAL	DESCRIPTION	APP'D/DATE

APPROVED BY _____
REGISTERED ENGINEER No. _____ DATE _____

REFERENCES

APPROVALS

PROJECT ENGR.		
INSPECTION		
WTR. OPERATIONS		
MAINTENANCE		

EASTERN MUNICIPAL WATER DISTRICT

PROJECT MANAGER		DATE	
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		DATE
DESIGNED	WGH	8/28/07
DRAWN	TMW	8/28/07
TRACED	N/A	
CHECKED	PES	8/28/07
SUBMITTED	PES	8/28/07

SCALE: AS NOTED

EASTERN MUNICIPAL WATER DISTRICT
RIVERSIDE COUNTY, CALIFORNIA

EQUIPMENT BUILDING MECHANICAL SECTIONS

SPEC. No. _____

I.D.	
S.A.	
W.O.	
C.O.	
COORD.	
SHT. OF 	
D-	
M-2	