STORMWATER PUMP STATION DESIGN GUIDELINES

January 2024

City of San Diego Stormwater Department
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THINK BLUE®
City of San Diego
Stormwater Department

Preface

Guidelines For Stormwater Pump Station Design

The *Guidelines for Stormwater Pump Station Design* contain information, criteria, and requirements to assist Design Consultants and Contractors with the design and construction of stormwater pump station facilities to be managed and operated by the City of San Diego's (City) Stormwater Department Operations Division.

This guide summarizes and outlines relevant City policies, applicable codes, engineering design, and operational practices and procedures that have been developed in an effort to establish a cost-effective, reliable, and safe stormwater pumping and discharge system. Also, to be considered and used in conjunction with this design guide are all applicable current standard drawings, specifications, codes, laws, and industry requirements for the planning and design of stormwater infrastructure.

The purpose of these guidelines is to recommend the minimum acceptable design and plan submittal requirements for all stormwater pump stations to be managed by the City's Stormwater Department. Conformance to the recommendations set forth herein will expedite the design, review, and acceptance of plans and ensure uniformity of design concepts, procedures, construction materials, types of equipment, and quality of work products.

These guidelines are not a substitute for good engineering. Sound judgment must be exercised in all applications to provide quality, uniform, cost-efficient, safe, and workable facilities. Under most conditions, this guide should serve as a minimum standard. However, it is not meant to preclude alternative designs when the standards cannot be met or when special or emergency conditions warrant, as long as proper authorization is obtained.

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Acknowledgements

The City of San Diego Stormwater Department's Stormwater Pump Station Design Guidelines was completed with the combined efforts of many staff members who contributed through workshops, interviews, and review. The efforts of this team are acknowledged as follows:

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Chapter 1 Introduction

1.1 GENERAL

The City of San Diego (City) Stormwater Department's (SWD) Stormwater Operations Division (Operations) is responsible for the operation and maintenance of all stormwater pump stations in its respective service areas.

These *Guidelines for Stormwater Pump Station Design* (Guidelines) establish procedures and design requirements to provide a consistent and reasonable standardization of all new stormwater pump station projects throughout the City and significant rehabilitation efforts of an existing stormwater pump station project in the City.

In summary, the Guidelines are intended to:

- Establish SWD general project submittal requirements.
- Establish design guidelines for new pump station projects and for significant rehabilitation of an existing pump station project.
- Identify specific elements to be designed by Design Consultants.
- Provide an acceptable level of quality and uniformity in pump station design.
- Promote consistency in equipment provided and simplicity in operations and maintenance (O&M) requirements.

Additionally, the Guidelines are intended to help pump station facilities meet the following objectives:

- Design pump station capacity for the criteria listed, to protect public safety, and to allow access to and maintain functionality of critical services from the 100-year design storm event.
- Design reliable and accessible pump stations.
- Minimize impact to pump station surroundings and environment.
- Provide O&M guidance for pump stations and their components.

1.2 SCOPE OF DOCUMENT

These Guidelines have been developed for use by Design Consultants to prepare design documents for all new stormwater pump stations to be managed and operated by SWD Operations. Operations staff were consulted in the preparation of these Guidelines and provided input on the design criteria and the desired facility features that incorporate O&M preferences. These Guidelines establish the City's expectations for pump station design.

These Guidelines are intended to assist Design Consultants in providing professionally sound, efficient, uniform, and workable pump station facilities. Not all aspects of design are addressed in

these guidelines. For areas that are not addressed, Design Consultant must rely on good engineering judgment and best practices.

1.3 DISCLAIMER

It is recognized that due to site constraints, the inherent complexity of projects, and unique parameters such as location, area being served, nature of stormwater being pumped, zoning, and other local conditions, certain deviations from these Guidelines are inevitable. Therefore, Design Consultants must exercise caution and professional judgment while using the information provided in this document and consult with the appropriate representatives of Operations. The Guidelines incorporate by reference, wherever appropriate, the applicable building codes and industry standard procedures typically used for the design of similar facilities. Nothing in this document should be construed to allow design of new facilities to a level less than that required by the applicable building codes and industry standards. This document includes references to specific manufacturers to be used for design of pump stations; these manufacturers or products are mentioned by name to establish a level of quality rather than to restrict the procurement to only the named manufacturer(s). If the proposed design deviates from the requirements presented in these Guidelines due to the above-mentioned conditions, the Design Consultant shall propose such deviation with a detailed report and justification to Operations for review and approval by using the format presented in Appendix H – Deviation From Standards (Design Only).

1.4 ORGANIZATION OF THE GUIDELINES

These Guidelines are organized into a series of chapters detailing general requirements, project submittal requirements, recommended design criteria, and guidance for associated disciplines such as civil engineering, architecture, structural engineering, mechanical engineering, and electrical engineering. They also detail instrumentation, control requirements, and pump station facility testing, acceptance, and O&M requirements.

The Guidelines are organized in 14 chapters:

- **Chapter 1: Introduction.** Discusses the purpose and scope of the Guidelines.
- **Chapter 2: General Provisions.** Establishes codes, industry standards, City manuals, applicable environmental clearances and permits, and design submittal requirements.
- **Chapter 3: Drainage Design Requirements.** Provides the basis for flood risk management, stormwater management, and associated design criteria.
- **Chapter 4: Pump Stations.** Presents overall pump station design criteria.
- **Chapter 5: Civil.** Provides design guidelines related to civil infrastructure components of pump stations.
- **Chapter 6: Architectural.** Presents guidelines associated with architectural design of pump stations.
- **Chapter 7: Structural.** Provides structural design codes and standards that apply to pump station design.
- **Chapter 8: Mechanical.** Presents design guidelines for ancillary components of pump stations.

- **Chapter 9: Electrical.** Provides guidelines for the design of electrical equipment and backup power generation.
- **Chapter 10: Instrumentation.** Provides design guidelines for the control system and its operation.
- **Chapter 11: Security Design Criteria.** Presents guidelines for site security and access control.
- **Chapter 12: Pump Station Operation and Testing Requirements.** Provides instruction on performing factory tests, field testing and commissioning, and coordination with existing infrastructure.
- **Chapter 13: Acceptance Procedures.** Presents the facility acceptance procedure at the completion of construction and warranty requirements.
- **Chapter 14: Operation and Maintenance Manuals.** Describes the content required to be included in the Operation and Maintenance Manuals and identifies spare parts that should be maintained in the City's inventory.

Chapter 2 General Provisions

This chapter outlines study area, design code, plan submittal, and permit requirements.

2.1 STUDY AREA

The Design Consultant shall define the pump station's study area and identify the flow capacity, inlet and outflow connection, and discharge point. They shall also coordinate with SWD project manager and seek approval of the study area boundaries. It must address drainage basins as a whole, including existing, proposed, and future tributary areas, pipelines, and pump stations. It shall also verify that a downstream facility has the capacity to accept the flow discharge.

A pre-design report (i.e., basis of design report) of the study area and flow capacity analyses shall be prepared by the pump station Design Consultant and provided to SWD for review prior to development of detailed plans and specifications; Section 2.4.3.1 contains more information on the pre-design report.

2.2 CODES AND INDUSTRY STANDARDS

The pump station shall be designed in accordance with applicable codes and water industry best practice standards. If industry standards and City requirements or regulations conflict, the Design Consultant should discuss the discrepancy with the SWD. In general, the more stringent requirement should govern.

Stormwater pump stations shall be designed to meet City and Hydraulic Institute Standards (HI), as well as other industry-accepted standards for solids-bearing water. Table 2-1 lists industry standards and relevant international and national codes for pump stations. The specific sections of each standard are referenced in the chapters that follow, as applicable. The latest version of these standards shall be used for design.

Table 2-1. Codes and Industry Standards for Pump Stations

Organization	Description
Code and Regulation	
ADA	Americans with Disabilities Act Guidelines for Buildings and Facilities
APCD	Air Pollution Control District
CALGreen	California Green Building Standards Code—Part 11, Title 24, California Code of Regulations
CAL/OSHA	California Division of Occupational Safety and Health Title 8
CARB	California Air Resources Board
CBC	California Building Code
CBC-SD	San Diego Local Amendments to California Building Code
CCR	California Code of Regulations
CEC	California Energy Code
CEQ	Council on Environmental Quality

Organization	Description
CEQA	California Environmental Quality Act
CERS	California Environmental Reporting System
CMC	California Mechanical Code
CFC	California Fire Code
CFR	Code of Federal Regulations
CPC	California Plumbing Code
CWA	Clean Water Act
EPA	Environmental Protection Agency
ESA	Endangered Species Act
LSC	Life Safety Code NFPA 101 Life Safety Code
NEC	National Electric Code Article 701 *Legally Required Standby Systems* Article 702 *Optional Standby Systems* Article 406 *Receptacles, Cord Connections and Attachment Plugs*
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
OSHA	Occupational Safety and Health Administration
SBP	Sustainable Building Policy
SDMC	San Diego Municipal Code
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGBC	U.S. Green Building Council
WIFIA	Water Infrastructure Finance and Innovation Act
ZEMBOP	Zero Emissions Municipal Buildings & Operations Policy
Industry Standards	
AACE	Association for the Advancement of Cost Engineering
ACI	American Concrete Institute 301-16 *Specifications for Structural Concrete* 318-19 *Building Code Requirements for Concrete Structures and Commentary* 350.1-10 *Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary* 350.2R-04 *Concrete Structures for Containment of Hazardous Materials* 350-20 Code *Requirements for Environmental Engineering Concrete Structures* 350.3-20 *Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures*

Organization	Description
AFMBA	Anti-Friction Bearing Manufacturers Association
AIS	American Iron and Steel
AISC	American Institute of Steel Construction 341-16, *Seismic Provisions for Structural Steel Buildings* 360-16, *Specification for Structural Steel Buildings*
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers 7-16 *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers 62 *Ventilation for Acceptable Indoor Air Quality standard* *Standard 105 Standard Methods of Determining, Expressing and Comparing Building Energy Performance and Greenhouse Gas Emissions*
ASME	American Society of Mechanical Engineers 31.3 *Process Piping* B16 *Pipe Flanges and Flanged Fittings*

Organization	Description
ASTM	American Society for Testing and Materials A36 *Standard Specification for Carbon Structural Steel* A53 *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless* A123 *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products* A153 *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware* A193 *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications* A194 *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both* A240 *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure* Vessels and for General Applications A276 *Standard Specification for Stainless Steel Bars and Shapes* A325 *Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength* A500 *Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes* A516 *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service* A615 *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement* A706 *Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement* A786 *Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates* A1064 *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete* *B221Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes* B308 *Specification for Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded* D3034 *Polyvinyl Chloride (PVC) Pipe Material* F593 *Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs* F594 *Standard Specification for Stainless Steel Nuts* F1554 *Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength*
AWS	American Welding Society D1.4 *Structural Welding Code – Steel Reinforcing Bars.* D1.6 *Structural Welding Code – Stainless Steel.* D1.8 *Structural Welding Code – Seismic Supplement.*

Organization	Description
AWWA	American Water Works Association C105 *Polyethylene Encasement for Ductile-Iron Pipe Systems* C111 *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings Ductile-Iron Pipe, Centrifugally Cast* C150 *Thickness Design of Ductile-Iron Pipe* C151 *Ductile-Iron Pipe, Centrifugally Cast* C200 *Welded Steel Pipe* C205 *Cement-Mortar Protective Lining and Coating for Steel Water Pipe* C206 *Resilient-Seated Cast-Iron Eccentric Plug Valves* C210 *Liquid-Epoxy Coatings and Linings for Steel Water Pipe and Fittings* C303 *Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type* C504 *Rubber-Seated Buttery Valves* C509 *Resilient-Seated Gate Valves for Water Supply Service* C517 *Resilient-Seated Cast-Iron Eccentric Plug Valves* C561 *Fabricated Stainless-Steel Slide Gates* C600 *Installation of Ductile-Iron Water Mains and Their Appurtenances* C900 *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings* C906 *Polyethylene (PE) Pressure Pipe and Fittings*
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
FM	Factory Mutual
HI	Hydraulic Institute Standards 9.6.4 *Rotodynamic Pumps for Vibration Measurements and Allowable Value* 9.6.8 *Guideline for Dynamic of Pumping Machinery* 9.8 *Pump Intake Design*
IEEE	Institute of Electrical and Electronics Engineers
IES	Integrated Electrical Services
ISA	Instrument Society of America
ISO	International Organization for Standardization
MSS	Manufacturers Standardization Society, Inc. SP58 *Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation*
NACE	National Association of Corrosion Engineers
NEMA	National Electrical Manufacturers Association

Organization	Description
NFPA	National Fire Protection Association 13 *Standard for the Installation of Sprinkler Systems* 30 *Flammable and Combustible Liquids Code* 70 *National Electrical Code (NEC), with San Diego County and City of San Diego amendments* 101 *Life Safety Code* 90A *Standard for the Installation of Air Conditioning and Ventilating Systems*
SAE	Society of Automotive Engineers
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SSPWC	Standard Specifications for Public Works Construction
TMS	The Masonry Society 402/602, *Building Code Requirements and Specification for Masonry Structures*
UL	Underwriters Laboratory, Inc. 50 *Safety Enclosures for Electrical Equipment* 67 *Safety Panelboards* 891 *Standard for Safety Switchboards*

2.3 CITY-ADOPTED STANDARDS AND MANUALS

Pump stations shall be designed in accordance with the currently adopted version of applicable City codes, regulations, and guidelines. State and City regulations that may be applicable to pump station design are listed below.

2.3.1 STANDARDS

- Codes, Regulations, and Requirements
- Standard Specifications (The "WHITEBOOK" and "GREENBOOK")
- San Diego Standard Drawings
- Regional Standard Drawings
- Consultant Standards for Preparation of PS&E
- City Engineer's Form for Deviation from Standards – CE Deviation Form 201901 (Effective July 1, 2019)

2.3.2 CITYWIDE COMPUTER-AIDED DESIGN AND DRAFTING (CADD)

- CADD Standards and City Standard MicroStation Drafting Files

2.3.3 ACCESS LAWS

- Examples of Curb Ramps

- Detectable Warning Tiles Approved Materials List
- 2010 ADA Standards for Accessible Design
- Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way
- California Building Code (California Code of Regulations, Title 24)
- City Access Memoranda, Policies, and Standards

2.3.4 TRANSPORTATION DESIGN MANUAL

- Street Design Manual

2.3.5 STORMWATER DESIGN MANUALS

- Drainage Design Manual
- Flood Mitigation Plan
- Storm Water Standards
- Urban Runoff Management Plan
- Storm Water Forms and Development Information

2.3.6 DEVELOPMENT SERVICES DEPARTMENT (DSD)

- DSD Technical Bulletins:
  - Approval of Building Product Listing and Evaluation Agencies, **Technical Bulletin BLDG-17-5**
  - Design and Testing Requirements for Smoke Control Systems, **Technical Bulletin BLDG-9-1**
  - Determination of Building Height in the Coastal Height Limitation Overlay Zone, **Technical Bulletin BLDG-5-4**
  - Fire Alarm Wiring, **Technical Bulletin FIRE-9-4**
  - Fire Department Connections, **Technical Bulletin FIRE-9-7**
  - Floor And Wall Finishes In Toilet, Bath, And Shower Spaces, **Technical Bulletin BLDG-12-1**
  - Off-Site Fabrication of Building Components, **Technical Bulletin BLDG-17-3**
  - Requirements for Fire Alarm Control Panels, **Technical Bulletin FIRE-9-2**
  - Requirements for Outdoor Lighting, **Technical Bulletin ENER-5-1**
  - Special Inspection Requirements for Structural Welding, **Technical Bulletin BLDG-17-4**
  - Standpipe System Requirements, **Technical Bulletin FIRE-9-6**

- TESTING AND INSPECTIONS FOR PROOF OF COMPLIANCE, **Technical Bulletin BLDG-17-6**
- Water Heaters, **Technical Bulletin RESD-5-1**

2.3.7 FIRE

- Fire Safety, Codes, Regulations, and Related Information

2.3.8 GEOTECHNICAL

- Guidelines for Geotechnical Reports

2.3.9 LAND SURVEY

- Land Survey
- Monument Perpetuation Video
- The Importance of Datums video
- Information - Survey Monuments on Plan Sets Bulletin 591

2.3.10 LANDSCAPE

- Landscape Plan Review, Regulations, and Standards

2.3.11 PARKS & RECREATION DEPARTMENT

- Consultant's Guide to Park Design and Development

2.3.12 PUBLIC UTILITIES DEPARTMENT

- Clean Water Program Guidelines
- Sewer Design Guidelines, Standards, and Approved Materials List
- Water Design Guidelines, Standards, and Approved Materials List

2.3.13 TRAFFIC

- Caltrans Highway Design Manual
- Traffic Control Forms, Requirements, and Information
- Transportation Development

2.3.14 SUSTAINABILITY

- City Council Policy No. 900-03, Zero Emissions Municipal Buildings and Operations Policy (ZEMBOP)
- Sustainable Buildings Policy

Please note that this is not a complete list, and some items may not be applicable to individual project design. The Design Consultant shall exercise caution and professional judgment while using the information provided and should consult with the appropriate representatives of the City.

2.4 DESIGN DOCUMENT PREPARATION

The design documents shall be used in conjunction with applicable and current standard drawings, specifications, codes, laws, and industry requirements for the planning and design of stormwater infrastructure.

Design documents shall be prepared in accordance with the latest edition of Standard Drawings for Public Works Construction (Standard Drawings). The Standard Drawings shall be used in concert with the latest edition of the City of San Diego Standard Specifications for Engineering and Capital Projects Construction (WHITEBOOK) and the latest edition of GREENBOOK: Standard Specifications for Public Works Construction (GREENBOOK). The Standard Drawings include the San Diego Regional Standard Drawings that have been adopted by the City. The current version of these documents, effective at the time of receipt of notice to proceed with the pump station design shall be used for the design.

2.4.1 DESIGN RESOURCES

Design resources include City Design Standards, Technical and material specifications, and Calculation and Checklists Templates. The City's project management team is responsible for providing the City's General Conditions, General Requirement and Supplemental portions of the specifications. The requirements listed below may not be a comprehensive set for the project.

The latest version of Bentley MicroStation accepted by the City shall be used for the preparation of engineering drawings. The current standards for engineering drawings are available at the following link: CADD Standards and MicroStation Drafting Files.

2.4.2 DESIGN REQUIREMENT

The Design Consultant shall be responsible for completing the following activities:

1. Prepare design drawings from the approved pre-design report and review during each design stage gate. Incorporate refined level of detail in drawings.
2. Participate in discussions with the SWD regarding project scope and cost.
3. Document project meetings.
4. Coordinate and cross-reference documents, such as as-built drawing numbers, easement documents, and others.
5. Conduct conflict checks with adjacent projects and recently paved or planned paving work within the alignment for conformance with City of San Diego Ordinance Number O-19215 (Paving Moratorium Ordinance), which may prohibit trenching within the public right-of-way under certain time constraints. These time constraints are specified in the City's Trench Cut Ordinance and shall be complied with. Identify any additional conflicts (e.g.,

conflicts with other utilities), coordinate with adjacent projects not already addressed in the pre-design report, and perform tasks that are necessary to resolve these problems.

6. Prepare an outline for special provisions (i.e., special project-related specifications) in a manner consistent with the master specifications procedure.
7. Ensure that the specifications and drawings conform to previously established requirements and meet applicable codes and/or specifications.
8. Outline a probable construction document drawing package with numbers and types of drawings enumerated (including all environmental, structural, street lighting, traffic, and other civil design sheets that may be required).
9. Execute the quality management plan for quality assurance and quality control (QA/QC); refer to the Think Blue Infrastructure Program Management, Quality Management Chapter.
10. Complete a City of San Diego Storm Water Requirements Applicability Checklist for determination of state and local stormwater requirements.
11. Update the construction cost estimate at the completion of each design milestone and compare it to the project budget.
12. Prepare structural section of the pavement (when applicable).
13. Perform constructability review.
14. Interface with other design disciplines.
15. Meet structural, streetlight, traffic signal, geometric design, storm drain, and sewer requirements.
16. Provide clarity and organization of construction materials and equipment to be used in terms of sequence of construction, cost, and interface on the job site.
17. Develop basic layout of all design features to ensure design integration, coordination, and adequacy.
18. Finalize design choices in plan, elevation, and cross-section, including intersection design.
19. Address additional requirements from the SWD.
20. Perform special material research in relation to budget and construction schedule.
21. Perform value engineering review/risk analysis.
22. Assess viable alternatives for project features.
23. Conduct community outreach and presentations.
24. Address environmental constraints.

Deliverable documents include (as applicable):

1. Design plans, specifications, and estimates as appropriate to construct the project.
2. Engineering studies, reports, and calculations deemed applicable to the project such as:
    a. Earthwork calculations and reports

b. Drainage studies including limits of the Federal Emergency Management Agency (FEMA)-designated floodplain and determination of whether a conditional letter of map revision (CLOMR) or letter of map revision (LOMR) is needed. The preliminary elevation certificate can be completed (without signature) if the project is located in the designated flood zone.

c. Pump selection

d. Sewer studies

e. Traffic studies

f. Noise studies

g. Dry utility design studies (consult with City Utilities Undergrounding Program team)

h. Geotechnical reports

i. Hazardous materials reports

j. Cost analysis and schedule reports

The requirements provided above may not be a comprehensive set for all projects; the Design Consultant shall tailor them for each contract to suit the individual project requirements.

2.4.3 DESIGN DOCUMENTS

A typical pump station project deliverable document shall include the documents described in this section, as applicable.

2.4.3.1 Pre-Design Report (Basis of Design Report)

The pre-design report (i.e., basis of design report) documents the principles, assumptions, rationale, criteria, and considerations used for calculations and decisions required during design. The pre-design report shall be developed in accordance with the outline listed below. The party responsible for providing the information is shown in brackets.

- Project Purpose [Design Consultant]
- Project Scope of Work [Design Consultant]
- Project Accounting & Finance [City Project Manager]
- Schedule [Milestones by City Project Manager and Detailed Schedule by Design Consultant]
- Prioritization [City Project Manager]
- Preliminary Design [Design Consultant]
  - Pump Station Design Criteria
    - Mechanical Design Criteria
    - Electrical Design Criteria
    - Instrumentation and Control Design Criteria
    - Architectural Design Criteria

        - Structural Design Criteria
        - Site Civil Design Criteria
        - Building Mechanical (Heating, Ventilation, and Air Conditioning [HVAC], Plumbing, and Fire Protection) Design Criteria
        - Equipment and Material Preferences
    - Discharge Pipe Design Criteria
    - Operational Requirements
    - Construction Sequencing
    - Opinion of Probable Construction Cost
- Preliminary Environmental Assessment [Design Consultant/Environmental Specialist]
    - Preliminary Environmental Determination [Design Consultant/Environmental Specialist]
    - Development Permits [Design Consultant/Environmental Specialist]
    - Public Health and Hazardous Sites [Design Consultant/Environmental Specialist]
    - Resource Agency Permits [Design Consultant/Environmental Specialist]
- Project Supporting Documents
    - Appendix A, Project Location [Design Consultant]
    - Appendix B, Project Accounting Information [City Project Manager]
    - Appendix C, Preliminary Cost Estimate [Design Consultant]
    - Appendix D, 10% Design Level – Cash Loaded Schedule Estimate (Primavera) [Design Consultant]
    - Appendix E, Preliminary Environmental Assessment [Design Consultant/Environmental Specialist]
    - Appendix F, Project Intake Form [City Project Manager]
    - Appendix G, Project Preliminary Design Plans [Design Consultant]
    - Appendix H, Prioritization Calculations [City Project Manager]
    - Appendix I, Conflict, Constraints, and Streets Overall Condition Index [OCI] Map [City Project Manager]
    - Appendix J, Coordination Map [City Project Manager]
    - Appendix K, As-Built Drawings [City Project Manager]
    - Appendix L, Project Photos [Design Consultant]
    - Appendix M, Americans with Disabilities Act (ADA) Requirements Memorandum [City Project Manager/ADA Compliance and Accessibility Lead]
    - Appendix N, Response to Comments [Design Consultant]

- Appendix O, Project Key Performance Indices [City Project Manager]
- Appendix P, Pump Station-specific Studies
  - Appendix P.1, Phase I/II Environmental Site Assessment [Design Consultant/Environmental Specialist]
  - Appendix P.2, Hazardous Materials Surveys (Lead-Based Paint, Asbestos, Hazardous Materials) [Design Consultant/Environmental Specialist]
  - Appendix P.3, Geotechnical and Groundwater Investigation [Design Consultant]
  - Appendix P.4, Hydrologic/Hydraulic Studies [Design Consultant]
  - Appendix P.5, Traffic Control Planning Concept [Design Consultant]
  - Appendix P.6, Dry Utility Design Studies [Design Consultant]
  - Appendix P.7, Aesthetic Planning and Neighborhood Strategy [Design Consultant]
  - Appendix P.8, Corrosion Control Study [Design Consultant]
  - Appendix P.9, Sewer Studies (as needed) [Design Consultant]

2.4.3.2 30 Percent Design

The 30% design submittal shall be designed for construction of new facilities and for refurbishment and/or demolition of existing facilities. It shall incorporate information contained in the pre-design report (i.e., basis of design report) and the following, as applicable:

- Obtained environmental clearances.
- Preliminary calculations and hydraulic calculations.
- Geotechnical report.
- Storm Water Requirements Applicability Checklist (Form DS-560).
- Drawings that include at a minimum:
  - Title sheet with general notes, vicinity map, key map, sheet index, legend, and Lambert coordinates.
  - Preliminary list of construction drawings on cover sheet.
  - Locations of existing public and private utilities including undergrounding projects within the project area on plan and profile.
  - Preliminary site plan including construction staging areas, if applicable.
  - Other drawings (civil, architectural, landscaping, structural, mechanical, electrical, instrumentation), as applicable.
  - Preliminary site plan to show FEMA floodplain limits.
  - List of special conditions, if any.
  - Existing topographic and utility information and the plan view (horizontal alignment) within the scope of work.

- Specifications table of contents. Specifications shall follow the GREENBOOK for civil formatting and Construction Specifications Institute (CSI) format for other specifications, including style and content, to the extent possible. In addition, the WHITEBOOK, which supplements the GREENBOOK for the post-award base specifications, shall be included in the contract documents by reference. Refer to Appendix G – Typical Specification Table of Contents.
- Construction cost estimating, which is expected to have an accuracy of +30 to -20% (Association for the Advancement of Cost Engineering [AACE] Manual 18R-97 Class 3).

2.4.3.3 60 Percent Design

The 60% design submittal shall be designed for the construction of new facilities and for refurbishment and/or demolition of existing facilities. It shall update and incorporate information and address review comments on the 30% design submittal by the QA/QC team. The 60% design submittal shall include the following, as applicable:

- Completed and reviewed drainage, structural, and other calculations, and preliminary Title 24 forms.
- Stormwater Quality Management Plan, if applicable.
- The location of construction staging areas, if applicable.
- A written list of permits required for the project identifying permitting agencies and authorities having jurisdiction.
- Drawings that include at a minimum:
    a. Updated plan and profile sheets for the improvements and construction details and notes.
    b. Identification of both special and standard details.
    c. A complete list of reference construction drawings on the cover sheet.
    d. Updated site plan, including construction laydown areas, site grading, landscape and irrigation, and erosion control, if applicable.
    e. Other drawings such as paving, curb ramp installations, guard rails, wet utility relocations (if required), traffic control and staging plans, and preliminary right-of-way drawings, if applicable. Confirm if the street paving is addressed adequately in the previous scope of work, after reviewing the geotechnical report and site visit.
    f. Erosion control plan, stormwater pollution prevention best management practices (BMP), landscaping and irrigation plan, and habitat restoration actions, success criteria, long-term maintenance, and conformance to permits and the Multiple Habitat Planning Area land use adjacency guidelines as applicable.
    g. List of special conditions, if any.
    h. Quantity take-off per plan sheet.
- A complete draft of civil specifications in GREENBOOK format and other specifications in CSI format including the construction cost estimate with an expected accuracy of +20 to -15% (AACE Class 2).

2.4.3.4 100 Percent Design

The 100% design plans are required for City-wide plan check and constructability review and are prepared for construction of new facilities and refurbishment and/or demolition of existing facilities. The include updated and incorporated information and address comments on the 60% design submittal and from a recent site visit. They shall include:

- Completed, reviewed, and bound calculations, which include:
  a. Completed independent structural calculations and other reports, as required.
  b. Updates to engineering reports and studies (e.g., geotechnical, drainage, traffic, foundation).
- Signed Title 24 forms.
- Approved SWD review.
- Permit applications, as necessary.
- Drawings for all disciplines, including but not limited to traffic and staging control plans, landscaping and irrigation plans, improvement and grading plans, street lighting and signal plans, to be approved by the City and California Department of Transportation (Caltrans), if required.
- Necessary documents for right-of-way and/or easement acquisition, if applicable.
- A current written list of permits including environmental permits identifying permitting agencies and authorities having jurisdiction and status and copies of permit approvals.
- Completed civil specifications in GREENBOOK format and other specifications in CSI format.
- Construction cost estimate using the City's Master Bid List with an expected accuracy of +15 percent to -10% (AACE Class 1).

2.4.3.5 Final Design

The final design submittal shall update and incorporate information and comments from the 100% design submittal. It shall include the following as applicable:

- Comments from Citywide permitting agencies, Operations, Field Divisions, and QA/QC plan checks, including a log of comments and responses.
- Final drawings and specifications for the construction of the project plus design calculations stamped and signed by a professional engineer(s).
- A current written list of permits including traffic control, environmental permits identifying all permitting agencies and authorities having jurisdiction, and status and copies of permit approvals.
- Completed specifications in GREENBOOK format and other specifications in CSI format.
- Construction cost estimate using the City's Master Bid List and escalated for market conditions; this shall include equipment escalation to account for inflation and one version in the City's cost estimating format (Master Bid List) with an expected accuracy of +15 to -10% (AACE Class 1). The estimate is intended to serve as the final project cost plan

and shall be used for comparison to the interim budget level cost estimate and analysis of construction bids.

2.5 DOCUMENT SUBMITTAL

In addition to the Design Consultant's design document review processes mentioned in Section 2.4, the design document shall be submitted to Operations staff for design review of the pump stations during each major design milestone (30%, 60%, 100%, and final design). O&M reviews should take place in a workshop setting with the design team and representatives of each Operations discipline.

These workshops should cover proposed equipment, layouts, access, maintenance procedures, and any potential deviations from design standards. Visual aids such as schematic diagrams, three-dimensional (3D) model files, photographs, and other exhibits shall be prepared as needed to illustrate the design intent.

A complete document submittal for Operations review shall be provided and shall include the following:

- Plans and specifications.
- Process flow diagrams that demonstrate the intended flow paths, hydraulic controls, and monitoring points.
- Engineering calculations required per these guidelines.
- Copy of the report with recommendations.
- The manufacturer catalog cut sheets and technical information for the proposed major equipment.

The Design Consultant shall allow 4 weeks for submittal review from the time the complete submittal is received by Operations.

2.6 MINISTERIAL PERMITS

Design contract documents shall include permits required for the construction of stormwater facilities. The Contractor shall be responsible for the permits from the authority having jurisdiction (AHJ). AHJs are governmental or non-governmental entities responsible for enforcing building codes, fire codes, and other regulations in a given jurisdiction.

The Design Consultant shall be responsible for initiating DSD review and incorporating DSD comments into the design documents. The permits include but are not limited to building permits, stormwater discharge permits, CERS (California Environmental Reporting System) permits for aboveground storage tanks, and California Division of Occupational Safety and Health (Cal/OSHA) tank certification, if applicable.

Pump stations will be equipped with a standby generator(s). The following permits are required:

- Fire Permit: The plans need be sent to the City's fire marshal early in the design stage to ensure compliance with fire codes and requirements. The fire marshal may request a submittal for the standby generator system together with the civil and mechanical drawings showing layout and distances.

- Air Pollution Control District (APCD) Permit: The APCD permit requires multiple forms for the standby generator system, to be supplied by the generator system supplier.
- County Hazardous Materials (HAZMAT) Permit: A San Diego County HAZMAT permit is required if a standby generator exceeds the fuel storage limit of liquid hazardous material. Currently this limit is set at containers of more than 55 gallons capacity.

2.7 DISCRETIONARY PERMITS

As defined in the San Diego Municipal Code (SDMC), discretionary permits and processes are required when developments may impact the surrounding area due to a proposed use, design feature, or project location. Discretionary permit reviews could be required for projects modifying a previously conforming use, developments proposing to deviate from zoning requirements, development projects located in Environmentally Sensitive Lands, developments involving historical resources, and developments located in the Coastal Zone. A project's zoning may also dictate if discretionary permit approval is required for a proposed use. Discretionary permits are obtained through the DSD.

Discretionary permits may contain conditions that the applicant must fulfill before and during construction completion and operation of the proposed use. These include but are not limited to the working/operating hours, the need to install/repair sidewalks, and provision of traffic signals.

Additional information on obtaining discretionary permits can be found on DSD's website: https://www.sandiego.gov/development-services/permits/discretionary-permit.

2.8 ENVIRONMENTAL PLANS AND PERMITS

The City is responsible for environmental impact evaluations conducted under the California Environmental Quality Act (CEQA) and SDMC. Projects under the SWD capital improvement program (CIP) programmed to receive federal funds (e.g., Water Infrastructure Finance and Innovation Act funds) must also be assessed for impacts on the environment as set forth by the National Environmental Policy Act (NEPA). The resources needed to assess projects for NEPA compliance can scale with project location, complexity, and the potential environmental impacts of each project or group of similar projects. The level of NEPA compliance required also varies with project stage, which can include, but is not limited to, early conceptual stage prior to funding and design-phase stages (e.g., 30%, 60%, 100% design) and compliance required prior to construction. The following guidance is provided regarding how documentation prepared for CEQA compliance may be utilized to address NEPA requirements.

2.8.1 CALIFORNIA ENVIRONMENTAL QUALITY ACT

The City develops various environmental technical studies to inform the design of CIP projects (including pump stations) and to complete required environmental review under CEQA and the SDMC. These technical studies include biological and cultural resource reports that can be used to address federal environmental consultation requirements.

The CEQA process allows public agencies to disclose the environmental impacts of their projects to decision-makers and the public and assesses ways to avoid or mitigate such impacts when feasible. CEQA uses the term "lead agency" to describe the public agency that has the principal responsibility for carrying out or approving a project that may have a significant effect on the environment. For federally funded projects, the City is the lead agency and is responsible for determining the project-level CEQA coverage pathway.

> Most pump station projects require discretionary actions, often due to required compliance with either the Municipal Code or Land Development Code (e.g., where a deviation from the City's Environmental Sensitive Lands Ordinance or acquisition of additional rights-of-way are required).

For an individual project, the City may determine the project to be exempt from CEQA, covered by a previously adopted CEQA document, or require preparation of one of several types of CEQA documents for public review and adoption/certification; refer to Figure 2-1. Details regarding the City's CEQA process are presented on the following website: https://www.sandiego.gov/planning/work/ceqa. Each potential CEQA document is informed by varying levels of technical analysis to determine the potential for significant environmental effects. These technical analyses may be prepared throughout development of the project, generally when sufficient detail regarding the project design, location, and methodologies are determined. These technical analyses will often include information that can inform the Environmental Protection Agency's (EPA) environmental review.

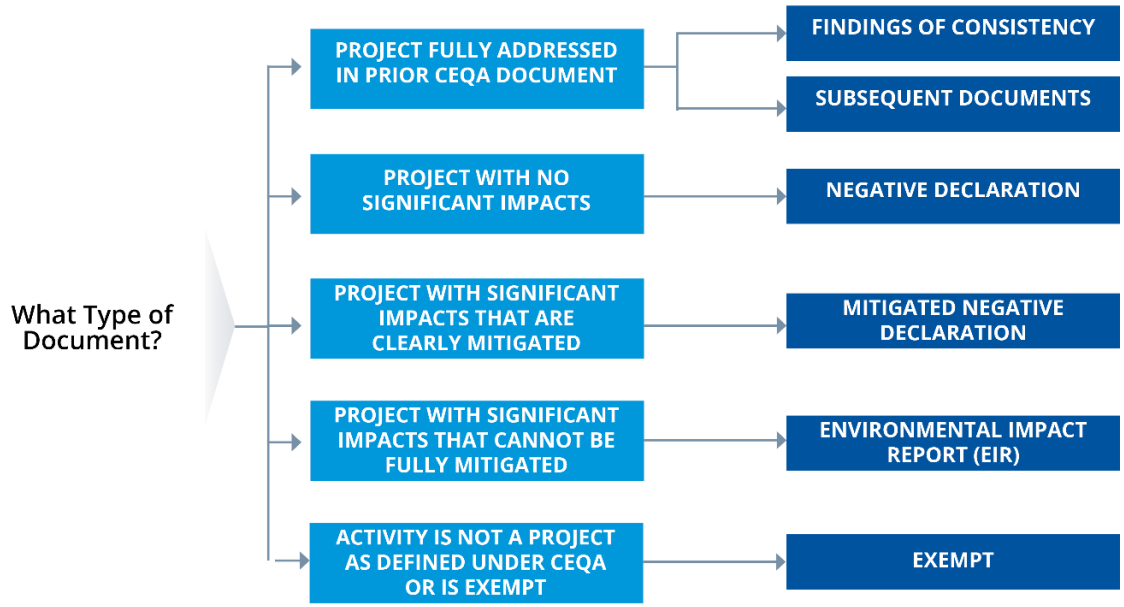

Figure 2-1. Types of CEQA Documents for Different Project Types

2.8.2 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA (42 U.S. Code 4321 et seq.), as implemented by the Council on Environmental Quality (CEQ) regulations (40 Code of Federal Regulations [CFR] 1500–1508), requires that federal agencies include in their decision-making processes appropriate and careful consideration of all environmental effects of proposed actions, analyze potential environmental effects of proposed

actions and their alternatives for public understanding and scrutiny, avoid or minimize adverse effects of proposed actions, and restore and enhance environmental quality to the extent practicable (40 CFR Chapter 1, Subchapter A, Part 6.100). NEPA compliance requirements for federal funding recipients include assessing a suite of potential environmental impacts and, in some cases, includes consultation with resource-specific federal entities to obtain authorization. Similar to CEQA, NEPA requires identification of a lead agency. Since disbursement of federal funding is a discretionary action taken by EPA, federally funded projects require EPA to serve as the lead agency to comply with NEPA. NEPA compliance typically occurs through preparation of a programmatic environmental assessment (PEA), followed by certification of a finding of no significant impact (FONSI). EPA staff prepare the PEA and FONSI based on information provided by the City. However, similar to CEQA, the NEPA process includes categorical exclusions (which are analogous to categorical exemptions under CEQA), environmental assessments (which are analogous to a negative declaration/mitigated negative declaration under CEQA), and environmental impact statements (which are analogous to environmental impact reports under CEQA); refer to Figure 2-2. This guidance document does not include details on the other NEPA compliance documents that could be required.

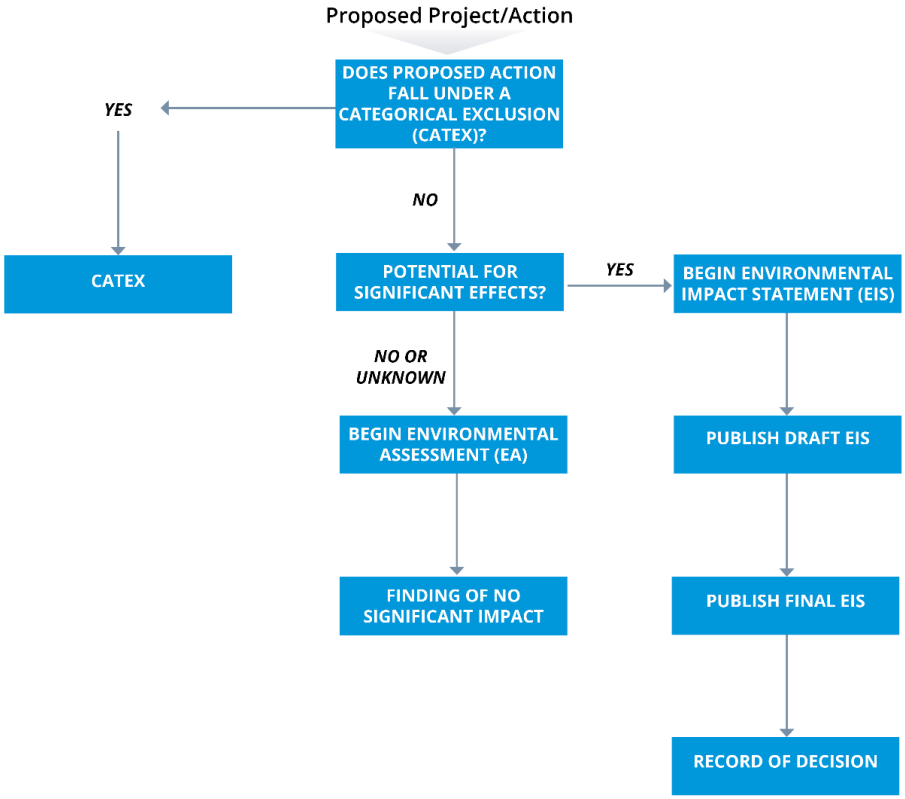

Figure 2-2. NEPA Process

In addition to compliance with NEPA, EPA has several additional federal consultation requirements. For biological resources, federal agencies that authorize, fund, or carry out projects must assess the need to consult with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service under Section 7 of the Endangered Species Act to ensure projects will not jeopardize the continued existence of federally listed species or designated critical habitats. When consultation with USFWS addresses species covered under the City's

Multiple Species Conservation Plan (MSCP), USFWS may request that the City's MSCP staff provide a letter indicating how the projects are designed and will be implemented consistent with the MSCP. For cultural resources, project review by the State Historic Preservation Officer under Section 106 of the National Historic Preservation Act may be required if there is potential to affect historic properties. Additional federal agency authorization and permitting (e.g., Clean Water Act [CWA] Sections 401 and 404 permits) may be required in addition to the Section 7 and Section 106 consultations; however, these authorizations and permits are obtained through a separate process from this initial NEPA checklist and are led by EPA.

2.8.3 LOCAL, STATE, AND FEDERAL PERMITS

Local, state, and federal permits may be required for City projects and may influence the timing of environmental documentation prepared under CEQA and NEPA and/or consultations undertaken by EPA with other federal and state agencies. City projects may require a Site Development Permit and, if located within the City's Coastal Overlay Zone, a Coastal Development Permit. The most typical reasons a Site Development Permit/Coastal Development Permit would be required are project deviations from the City's Environmentally Sensitive Lands Ordinance, such as impacts to wetlands, steep slopes, or floodplains, or compliance with historical resource regulations.

Additional state and federal permits are often required for City projects when those projects result in impacts (e.g., discharge of fill associated with construction) within waters of the state or waters of the United States (e.g., wetlands and/or streambeds). These permits include Section 401 of the federal CWA Water Quality Certification (regulated by the San Diego Regional Water Quality Control Board [SDRWQCB]), Section 404 of the federal CWA (regulated by the U.S. Army Corps of Engineers [USACE]), and/or Section 1600 of the California Fish and Game Code (regulated by the California Department of Fish and Wildlife).

The USACE Section 408 program allows another party, such as the City, to alter a USACE Civil Works project such as a levee. Reasons for alterations could include improvements to the project, relocation of part of the project, or installing utilities or other non-project features. Modifying and replacing a pump station and/or discharge pipe that is located on a levee requires USACE Section 408 permission.

The Section 408 program verifies that changes to authorized USACE Civil Works projects will not be injurious to the public interest and will not impair the usefulness of the project. This requirement was established in Section 14 of the Rivers and Harbors Act of 1899, which has since been amended several times and is codified at 33 U.S. Code 408—the section of U.S. Code that gives the program its name.

It should be noted that USACE, as a separate federal permitting agency, has many of the same federal regulatory requirements as EPA. In most cases, EPA will serve as the lead federal agency and will complete the NEPA process and any required consultations before the City submits an application or notification to USACE for issuance or use of a Section 404 and/or 408 permit. In these cases, USACE will review the consultations completed by EPA and determine their adequacy to address USACE's responsibilities. If the EPA consultations do not fully address USACE's responsibilities to consult, USACE may request that the consultation be reinitiated to address any outstanding issues identified by USACE.

2.9 SUSTAINABILITY

To meet the magnitude of the climate change crisis, the City is setting an ambitious goal to achieve net zero greenhouse gas (GHG) emissions by 2035. the Climate Action Plan (CAP) is the City's policy commitment to set clear goals to reduce GHG emissions and details the strategies and actions to make San Diego a more sustainable, healthy, and thriving city. In support of achieving net zero GHG emissions by 2035, and building assets with sustainability and resiliency in mind, the design, construction, and operation of pump station projects shall comply with City Council policies discussed herein.

2.9.1 ZERO EMISSIONS MUNICIPAL BUILDINGS AND OPERATIONS POLICY

City Council Policy No. 900-03, Zero Emissions Municipal Buildings and Operations Policy (ZEMBOP), establishes an implementing framework to ensure the City leads by example in decarbonizing the municipal building sector and transitioning to a zero-emissions fleet by 2035.

With the adoption of ZEMBOP, new municipal facility construction projects will be required to be all-electric, 10% more efficient than the state code, and designed to include a solar or other renewable energy system plus a battery energy storage system large enough to cover the facility's electricity load. All overnight fleet parking spaces in associated parking lots must be electric vehicle (EV)–ready (i.e., wiring to the spaces), and 50% of staff and public spaces must be EV-capable (i.e., conduit to the spaces) when the number of parking spaces is increased by one or more. The facility must have electric panel capacity for eventual charging stations at all EV spaces.

The policy is triggered by what the policy defines as a major renovation: a project that includes improvements to two or more building systems and/or a parking lot repaving. In those cases, project scopes must be expanded so the facility becomes all-electric, meets current state energy-efficiency standards, and includes solar photovoltaic, battery energy storage, and EV charging infrastructure for fleet spaces installed in any associated parking lot. Although one or more of the provisions of this policy may not apply to stormwater pump stations, the SWD may require stormwater pump stations be designed to meet these requirements. Refer to ZEMBOP for specific applicability and criteria that need to be met for:

- Building Energy Efficiency,
- Zero-Emission Buildings,
- Electrical Vehicle Charging, and
- Greenhouse Gas Reporting.

2.9.2 SUSTAINABLE BUILDING POLICY

The Sustainable Building Policy, Policy No. 900-14, reasserts the City's commitment to green and sustainable building practices and applies to new construction or major renovations that the City owns, occupies, or leases. A major renovation is defined as an alteration or renovation to existing conditioned (air conditioned or heated) spaces that are 5,000 gross square feet or larger in area and require at least two energy building system changes. It is unlikely that a stormwater pump station will meet or exceed this limit because pump station conditioned spaces will be limited to the electrical and instrumentation control room and indoor generator room if so equipped. Areas

of the pump station with ventilation equipment (e.g., exhaust fans) are not considered conditioned spaces. The site boundary for the scope of this policy is the contract limit line of the work included in the major renovation project.

The Sustainable Building Policy requires pump station projects to be designed, constructed, and operated using cost-effective innovative strategies and technologies that seek to achieve the following:

- Avoid permanent adverse impact on the natural state of the air, land, and water.
- Ensure a healthful indoor environmental quality.
- Optimize social and economic benefits to the project and the community.
- Encourage occupant behavior and O&M that maximize conservation opportunities, reduce resource consumption, and minimize wastes.

Refer to the Sustainable Building Policy for specific applicability and criteria that need to be met.

2.9.3 OTHER APPLICABLE COUNCIL POLICIES

Design of pump station projects shall also comply with other City Council policies, where applicable. These include:

- Council Policy 400-15, Comprehensive Policy for a Sustainable Water Supply in San Diego
- Council Policy 900-02, Energy Conservation and Management
- Council Policy 900-06, Solid Waste Recycling

Chapter 3 Drainage Design Requirements

3.1 FLOOD RISK MANAGEMENT REQUIREMENTS

In accordance with City Council Policy 800-04, *Drainage Facilities*, adequate drainage facilities are required to remove stormwater runoff in an efficient, economic, environmentally sound, and aesthetically acceptable manner for the protection of property and life. Various types of drainage facilities are required depending on the situation encountered.

Designs for a stormwater pump station should provide for the effective removal and discharge of stormwater. These functions should be accomplished without causing objectionable backwater, causing excessive or increased velocities, creating damage to downstream ownerships, or unduly affecting the safe operation of traffic on the roadway. The design of stormwater pump stations shall consider the following:

- Providing for the public health and safety.
- Preventing property damage.
- Calculating the quantity and frequency of storm runoff.
- Providing for discharge and other hydraulic controls.
- Accounting for floating trash and debris carried by stormwater.
- Determining the requirements for energy dissipation.
- Analyzing the deleterious effects of corrosive soils and waters on pump station equipment.
- Minimizing scour of receiving waters.
- Comparing and coordinating proposed design with existing structures and systems handling the same flows.
- Coordinating with other agencies on the proposed designs for facilities.
- Providing access for maintenance operations.
- Accounting for removal of subsurface water.

Overall, design efforts shall achieve the most efficient pump stations consistent with good drainage practices and considering economic considerations, environmental considerations, ease, and overall life-cycle costs (including cost-effective O&M), safety, legal obligations, and aesthetics.

3.2 STORMWATER MANAGEMENT REQUIREMENTS

Pursuant to the CWA Section 402(p)(3)(B), National Pollutant Discharge Elimination System (NPDES) permits for stormwater discharges from Municipal Separate Storm Sewer Systems (MS4)

effectively prohibit non-stormwater discharges into MS4s, require controls to reduce the discharge of pollutants in stormwater to the maximum extent practicable (MEP), and require other provisions that the SDRWQCB determines are appropriate to control such pollutants. Order No. R9-2013-0001, as amended by Order Nos. R9-2015-0001 and R9-2015-0100, NPDES No. CAS0109266 prescribes conditions to ensure compliance with CWA requirements for owners and operators of MS4s, including the City of San Diego, to effectively prohibit non-stormwater discharges into the MS4s and require controls to reduce the discharge of pollutants in stormwater from the MS4s to the MEP. Water quality improvement plans (WQIP), developed pursuant to the NPDES permit, guide the City's jurisdictional runoff management programs toward achieving the outcome of improved water quality in MS4 discharges and receiving waters. The goal of the WQIPs is to further the CWA objective to protect, preserve, enhance, and restore the water quality and designated beneficial uses of waters of the state. This goal is accomplished through an adaptive planning and management process that identifies the highest priority water quality conditions within a watershed and implements strategies through the jurisdictional runoff management programs to achieve improvements in the quality of discharges from the MS4s and receiving waters. Capture and treatment or elimination of dry-weather and wet-weather runoff is one strategy being implemented by the City to attain compliance with the City's MS4 permit and protect the health of beaches and waterways. The design of pump stations should consider addressing dry-weather and wet-weather flows if feasible. Refer to Section 3.5 and Appendix F – Low Flow Diversions for planning and design criteria.

3.3 TRASH AMENDMENTS

The SDRWQCB issued Order No. R9-2017-0077 requiring the City to notify the SDRWQCB of its intended compliance approach to prohibit the discharge of trash to receiving waters. The City selected the option to install, operate, and maintain any combination of full-capture systems, multiple-benefit projects, other treatment controls, and/or institutional controls within the jurisdiction of the City.

Trash racks with 1.5- to 3-inch bar spacing are typically installed in pump stations to screen trash and debris before they reach the pumps. These trash racks will prevent some trash from being discharged from the pump station. Pump stations that have relatively small capacities (up to 65 cubic feet per second [cfs]) afford an opportunity to make use of full-capture systems. A full-capture system is a treatment control that traps all particles that are 5 millimeters (mm) or greater and has a design treatment capacity that is either (1) not less than the peak flow rate resulting from the 1-year, 1-hour storm in the subdrainage area or (2) appropriately sized to, and designed to carry, at least the same flows as the corresponding storm drain. Use of a full-capture system has the dual benefit of screening trash before it can foul the pumps and helping the City comply with the Trash Amendments. Refer to Section 4.11 for specific design guidelines.

3.4 DESIGN FLOW

The design flow depends on many variables including but not limited to duration and intensity of rainfall; storm frequency; ground cover; and the size, imperviousness, slope, and shape of the drainage area. Climate change considerations are discussed in Section 3.5.

3.4.1 DESIGN FLOW CALCULATION METHODS

The design flow shall be calculated in accordance with the Drainage Design Manual, which includes:

1. Rational method for watersheds less than 0.5 square mile.
2. Modified rational method for watersheds between 0.5 and 1.0 square miles.
3. Natural Resources Conservation Service (NRCS) method (formally called Soil Conservation Service method) for watersheds greater than 1.0 square miles.
4. USACE Hydrologic Engineering Center's (HEC) computer software for hydrologic engineering and planning analysis procedures.

3.4.2 DESIGN STORM FREQUENCY

The design storm frequency shall be based upon the 100-year frequency storm.

3.4.3 SOIL TYPE

Type D soil shall be used for all areas.

3.5 CLIMATE CHANGE DESIGN CRITERIA

This section provides the draft (as of December 2023) recommended design guidelines and design criteria to incorporate considerations for climate change impacts including extreme precipitation and sea level rise (SLR). The Design Engineer shall consult with City Stormwater Department staff to confirm the latest criteria. The following basis was used for the recommendations:

- Asset criticality
- Precipitation design storm events
- SLR-related design criteria

3.5.1 ASSET CRITICALITY

Pump stations are complex assets comprised of many components. Under this guidance, pump stations are defined as critical assets and shall be designed under the Medium-High risk scenario.

3.5.2 PRECIPITATION DESIGN STORM EVENTS

The rainfall intensity used to calculate the design flow rate (refer to Section 3.4.1) shall be adjusted for the impacts of climate change as described in Table 3-1.

Table 3-1. Design Flow Adjustments to Account for Climate Change

Asset Type	Expected Design Life[1]	Approximate End of Useful Life[4]	Asset Criticality[1]	Required Precipitation Design Storm Event[5]	Intensity, Duration, Frequency (IDF) Adjustment[6]
Initially Installed Pumping System	25 years	2050	Critical	100-year frequency storm	+12%
Pump Station [2, 3] Wet Wells, Manifolds (with adaptive capacity for additional future pumps, if needed), and discharge conveyance	>100 years	>2100			+23%

1 Lifecycle values and asset criticality are referenced from the Watershed Asset Management Plan (WAMP), Version 2.0. See WAMP Table 3-2 for useful life.

2 Conveyance expected lifecycle assumes conveyance is reinforced concrete pipe (RCP). Alterative materials of construction should refer to the Drainage Design Manual.

3 See WAMP Table 3-2 for Pump Stations component useful life assumptions. Pump Stations wet well, manifold, and discharge conveyance capacity should be designed in consideration of a 23% increase in precipitation. Pump Station installed capacity should be designed in consideration of a 12% increase in precipitation. Pump Stations should be evaluated by 2050 to determine needs for installation of additional capacity.

4 End of useful life assumes the asset is constructed by 2025.

5 Required Design Storm Event per City of San Diego Drainage Design Manual.

6 IDF adjustment based on the State of California's Fourth Climate Assessment and CMIP5 data (AghaKouchak et al., 2018).

3.5.3 SEA LEVEL RISE-RELATED DESIGN CRITERIA

SLR shall be factored into pump station design when accounting for tail water effects and the design flood elevation at which electrical, instrumentation, and control equipment shall be placed. SLR projections are based on California Coastal Commission policy guidance. Table 3-2 defines the SLR and storm surge risk scenarios that pump station design shall use. The Total Adjustment to be added to Mean Higher High Water (MHHW) is a comprehensive measurement that encompasses factors contributing to water height at a specific coastal location. The minimum recommended tailwater elevation design criteria shall equate to the Total Adjustment to be added to the MHHW elevation. The corresponding water surface elevation for MHHW to other datums in San Diego is presented in Table 3-3.

Table 3-2. SLR and Storm Surge Projections to be **A**dded to MHHW **E**levation for **T**ailwater **D**esign (San Diego Bay, Mission Bay, San Diego River)

	Medium-High Risk Aversion[1]		
Expected End of Useful Life[2]	**SLR Scenario (ft relative SLR)**	**100-year Coastal Storm Surge**	**Total Adjustment to be added to present MHHW elevation (ft)[5]**
Present	0.0	2.6[3]	2.6
2040	1.30	3.2[4]	4.5
2060	2.70	3.2[4]	5.9
2080	4.60	3.2[4]	7.8
2100	7.0	3.2[4]	10.2

1 Extreme risk aversion scenario should be analyzed to understand and plan for higher rates of SLR and related California Coastal Commission coastal development permit applications; projects do not necessarily need to site or design to the extreme risk aversion scenario.

2 Lifecycle values and asset criticality are referenced from the Watershed Asset Management Plan, Version 2.0. See WAMP Table 3-2 for useful life.

3 Value obtained from NOAA's extreme water level estimate based on historical measurements at San Diego tide station, representing 1% Annual Exceedance Probability (AEP) (100-year water levels).

4 Value obtained from CoSMoS projected 100-year water levels in San Diego and does not reflect wave runup. For open coast areas, wave runup must be added to these values. Note that freeboard is not included in this elevation.

5 To estimate 100-year water elevation for various datums, the adjustment should be added to the values listed in Table 3-3.

Table 3-3. MHHW Elevation in San Diego Relative to Other Datums

Datum	MHHW	MSL	NGVD29	NAVD88	MLLW
Elevation(ft)[1]	+0.0	+2.8	+3.2	+5.3	+5.7

1 Values obtained from NOAA tide and current data for San Diego tide station. (Station no. 9410170), https://tidesandcurrents.noaa.gov/datums.html?id=9410170.

3.5.4 TIPPING POINT

Tipping point in coastal management is the critical juncture where the cumulative effects of rising sea levels, storm events, and other factors lead to sudden and extensive coastal impacts. This point often marks the transition from manageable conditions to widespread coastal flooding and disruption. The concept of water level thresholds is integral to understanding tipping point. Water level thresholds signify the specific total water level at which shoreline overtopping and subsequent flooding commence. When a regional tipping point is reached, it signifies a moment when numerous areas experience significant flooding simultaneously, amplifying the challenge. In the context of pump stations, which play a vital role in managing coastal flooding, rising sea levels introduce a sequence of challenges. Initially, low-lying coastal SWD assets might experience intermittent flooding during storms. However, continued SLR is projected to lead to frequent high tide flooding, ultimately progressing to daily high tide inundation and then permanent submergence. Recognizing and comprehending these points is crucial for the Design

Consultant as they grasp the water levels at which assets will face regular or perpetual inundation. Understanding these dynamics aids in proactive adaptation strategies, ensuring that infrastructure and communities are prepared for the evolving coastal conditions and potential tipping points that lie ahead.

3.5.5 DESIGN FLOOD ELEVATION

Many of the City's pump stations are projected to experience daily high tide flooding between now and 6.6 feet of SLR. Recommended design flood elevations for each of the City's storm drain pump stations shall be calculated using the process shown in Figure 3-1. Note that this methodology does not include combined precipitation – coastal exposure. The Design Consultant should evaluate the risks of site precipitation flooding. If the precipitation flood depth is greater than the coastal flood depth, then precipitation flood depth should be the governing Base Flood Elevation (BFE).

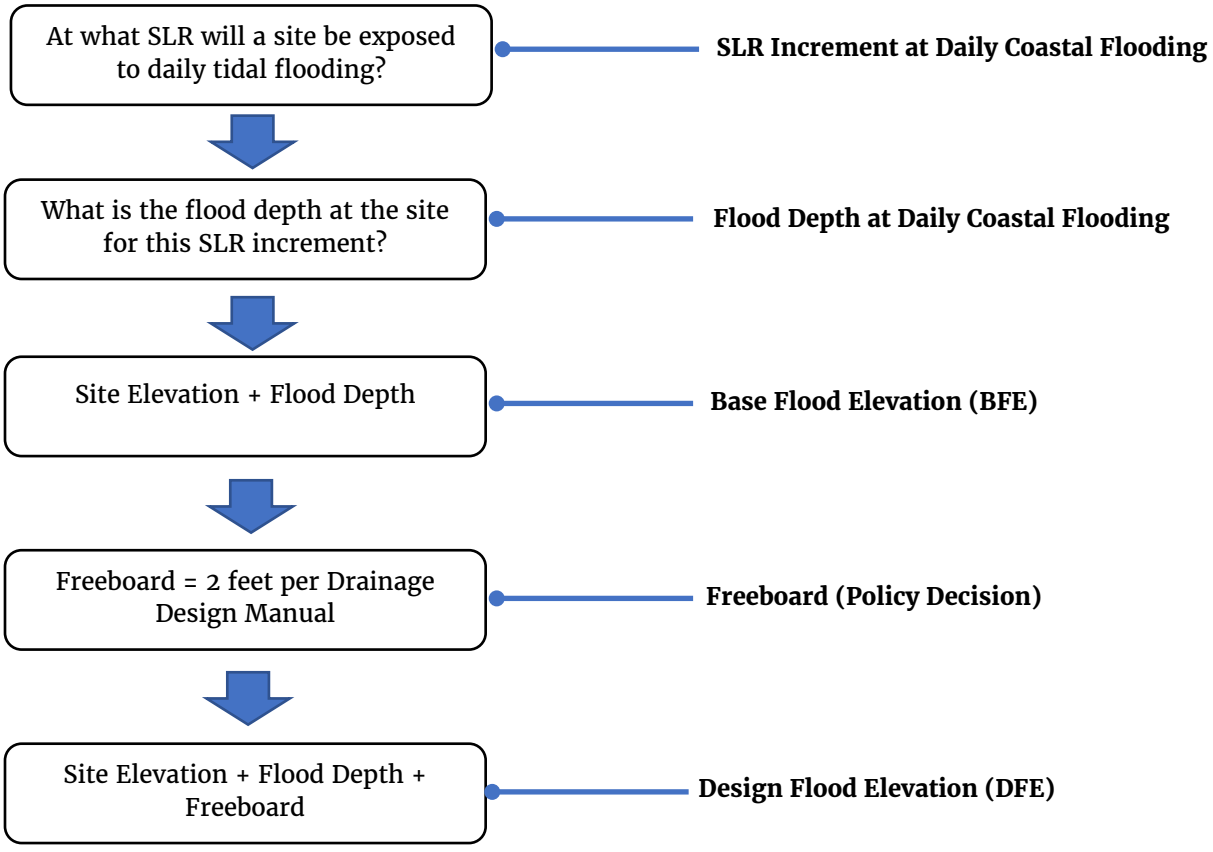

Figure 3-1. Approach to Establish Recommended Minimum Design Flood Elevation

3.5.6 DESIGN FOR RISK REDUCTION, FLOOD RESILIENCY, AND ADAPTATION

The Design Consultant shall consider the following to reduce risks and increase flood resiliency and adaptability.

- Identify opportunities to reduce the probability of pump station flood exposure.
    a. For projects with exposure prior to 6.6 ft of SLR, the Design Consultant should discuss opportunities for alternative siting to reduce the probability of flood risk exposure and document their findings in support of permitting discussions. If projects with near-term exposure cannot be relocated, additional levels of design conservatism are recommended to avoid damage to sensitive, critical components and flooding of fuel storage. Understanding alternative approaches for regional adaptation in these areas will also benefit the project team's planning and design process.
    b. Elevate the site pad to reduce the probability of pump station flooding. Modify site grading to minimize the risk of asset flooding. Consider the effects of modified site drainage on localized flood dynamics to understand and communicate potential community impacts and benefits.
    c. Use features such as flood walls and/or electrical room flood enclosure structures to minimize the probability of critical component flooding. Consider the effects of floodwalls on localized flood dynamics to understand and communicate potential community impacts and benefits.
- Identify opportunities to reduce the probability of component flood exposure. Use more conservative levels of risk aversion (i.e., SLR scenario, coastal storm, additional freeboard) for sensitive equipment, including electrical, instrumentation and controls, and diesel storage and generators.
- Facility hardening to protect against debris flow. Use bollards, floodwalls, or other site protection to reduce the risk of pump station damage due to debris flow, floating cars, and other large hazards that may mobilize in catastrophic flooding conditions.
- Identify opportunities to provide adaptive capacity. It may be cost-effective to design for phased adaptation of pump station assets. Under this approach, the Design Consultant should select an appropriate level of risk aversion for installed components, while including provisions for future asset adaptability. Examples include:
    a. Upsize pads/footprint and flanging to allow for the future installation of additional pumps.
    b. Increase the wet well size to accommodate future increases in precipitation design storms.
    c. Upsize inlet and outlet piping in consideration of future precipitation design storms.
    d. Provide space or features for future installation of closure structures.
    e. Use more extreme coastal storms (e.g., 0.02% AEP (500-year) to establish the DFE for sensitive, critical components and/or incorporate additional freeboard.
    f. Consider the TWL thresholds at which it may be necessary to upsize pumped discharge capacity or convert subsystems to pumped discharge.
    g. Include hydraulic considerations for tidal gates in the associated coastal outfalls.

3.5.7 OTHER REQUIREMENTS

1. Design flows for pump stations shall be based upon build-out of the watershed area in accordance with the land uses shown in the General Plan.
2. Information shall be gathered during the Preliminary Design Phase to determine if the storm drain system upstream of the pump station has the requisite capacity to convey the design flows to the pump station. If the upstream conveyance system is found not to have adequate capacity, the City shall determine if improvements to upstream storm drain system shall be included as part of the pump station design scope of work or be performed under a separate agreement.
3. The City's Floodplain Ordinance, SDMC §143.0101 Environmentally Sensitive Lands Regulations, governs what can and cannot be done in Special Flood Hazard Areas (SFHA). When determining criteria for floodplain management and flood proofing, design runoff within the City shall be based upon existing conditions in accordance with the City Floodplain Management Requirements and FEMA regulations (Title 44 CFR 60.3). All projects in a SFHA or within the levee right-of-way shall demonstrate that the floodplain requirements are met, and the project shall not move forward until its impacts are clear, acceptable, and compliant, as determined by the SWD and/or the DSD.
4. U.S. Code 2011 Title 33 Chapter 9 Subchapter I Section 408 and 33 CFR, § 208.10 (a)(5) govern the designated right-of-way of federally authorized civil works projects. USACE built levees along the San Diego River and Tijuana River that were turned over to the City to monitor and maintain as the designated local sponsor. The Standard Operating Procedures, Administrative Procedures for Floodplain Management, detail the minimum actions required for the intake, review, acceptance, and recordkeeping of all new and substantially improved projects, as well as all repairs due to substantial damage when proposed in an SFHA and/or near a levee.
5. The finished first-floor elevation of any building is a minimum of 2 feet above the 100-year-frequency flood elevation.
6. Discharge from the pump station shall be made into an existing storm drain pipe wherever possible. Discharge into the street is permissible by Stormwater Department approval only.

3.6 DRY-WEATHER FLOW

Dry-weather flow (i.e., non-stormwater flow) consists of discharges to and from an MS4 that do not originate from precipitation events. The quantity and quality of dry-weather flow that enters pump stations needs to be understood so that it can be effectively managed and inform the design of the appropriate pumping equipment (e.g., pump sizing and material). The following sections provide guidance on collecting this information.

3.6.1 CALCULATION AND EVALUATION OF DRY-WEATHER WATER QUANTITY

The quantity of dry-weather flow entering existing pump stations can be measured using past time series data (where available) or by using a water level logger (e.g., HOBO U20L or equivalent) that records the changes in water level collected in the pump station wet well. A level logger

records the increase in pressure exerted on the device as the water level rises in the wet well. The daily flow rate is calculated by multiplying the level increase over time by the surface area of the wet well, which can be measured directly or calculated using as-builts. The low-flow sump pump water level setpoints can be increased or the low-flow sump pump turned off to increase the water depth in the wet well to allow for measurement during the testing period. Data obtained during and after a rain event (i.e., point in time when the data indicate stormwater flow has ceased) should be removed from the analysis to determine the dry-weather flow rate. The recorded data from the level loggers can be plotted to show the rise in water level (pressure) vs. time. The following equation can be used to calculate the daily average flow rate:

$$Q = \frac{(SA)(2.31\Delta P)(7.481)}{\Delta t}$$

Where:

Q – Volumetric flow rate (gallons per minute [gpm])

SA – Surface area, square feet

ΔP – Change in pressure (pounds per square inch [psi])

Δt – Change in time (minutes)

2.31 – Conversion for water pressure to unit of head in feet

7.481 – Conversion from cubic feet to gallons

Data should be collected over a sufficient period of time to account for temporal changes (hourly, daily, and seasonal). Data should be analyzed and summarized to report minimum flow rate, maximum flow rate, average daily flow rate, and 95th percentile flow rate. Any anomalies observed during the monitoring period should be noted and examined. In some cases, monitoring periods with extreme anomalies may be excluded from the evaluation. It is recommended that the 95th percentile flow rate be used to size the low-flow pump.

For locations where there is no historical data to estimate dry-weather quantity, the estimated flow should be measured in situ with a flow meter to account for the temporal changes discussed above. Two excellent flow measurement resources are the U.S. Department of the Interior Bureau of Reclamation *Water Measurement Manual* and the Teledyne ISCO *Open Channel Flow Measurement Handbook*.

3.6.2 WATER QUALITY

The existing characteristics of the urban watershed influence dry-weather flow pollutants. The pollutant loading in dry-weather flow can include a wide variety of constituents and concentrations. Additionally, the proximity of some watersheds to the coastal/marine environment can also introduce saltwater intrusion into the storm drainage system.

The water quality concentrations of dry-weather flow should be analyzed. At minimum, dry-weather flow should be analyzed for local limit constituents if there is intention to divert dry-weather flows to the sanitary collection system. Local limits are presented on the following website: https://www.sandiego.gov/public-utilities/permits-construction/industrial-user-permits/other. Based on the findings of initial monitoring, additional monitoring efforts may be required.

Corrosion and erosion may be detrimental to the life of pumps, valves, and piping. The effects of corrosion and erosion should always be considered when dealing with fluids. Corrosion is an undesirable degradation of material resulting from a chemical or physical reaction with the environment. Erosion is the deterioration of metals buffeted by the linings and entrained solids in a corrosive medium. The corrosive or erosive potential of a service will dictate the materials of construction, hardness and ductility of material, and any requirement for special coatings and liners, such as rubber or hardened materials. Refer to Section 4.13 for guidance on material selection.

Brackish water (chloride ≥ 1,000 milligrams per liter [mg/L]) requires a minimum of type 316 stainless steel, duplex to super-duplex stainless-steel, or non-metallic materials depending on corrosivity. Salinity of water and temperature determines the type of material that is compatible with the service. Dry-weather flow should be analyzed to determine the salinity and concentration of chlorides.

Chapter 4 Pump Stations

This section provides the general design criteria for stormwater pump station facilities. The Design Consultant shall be responsible for determining the pump station design requirements, pump station type and design of other subsystems.

4.1 PUMP STATION DESIGN

The pump station shall be designed for the maximum flow based upon the 100-year frequency storm and to remain in operation during a 100-year flood event, refer to the requirements in Section 3.4, Design Flow.

The site grading shall be designed with finished grade elevation 2 feet above the 100-year flood level. The ground floor of buildings, entry doors to basements, and outdoor equipment pads shall be at least 4 inches above the surrounding finished grade. Sites must be graded sloping away from the buildings to ensure that surface waters drain away from hatches, doors, and other openings.

When a facility requires installation within the 100-year flood zone, special provisions shall be incorporated into the site and facility design to allow the facility to operate when flooded. These special provisions may include one or more of the following:

- Provide equipment that can be continuously operated while submerged—for instance, vertical pumps with motors located above flood level, close-coupled submersible pumps, motors, power cables, and connections. Use of motors unable to be continuously submerged, such as immersible motors, shall not be acceptable.
- Design all access roads at elevation above the 100-year flood elevation, where feasible.
- Locate building floors and equipment pads 2 feet above the 100-year flood elevation.
- Raise access and equipment hatches above the 100-year flood elevation.

The following features shall also be included in pump station design.

- Design for the low-flow diversion system. Please note that low-flow diversion may not be applicable to every pump station design. Low-flow diversion may only be installed if approved by the Public Utilities District (PUD) to accept the water. See Appendix F – Low Flow Diversion.
- Design trash removal system, refer to the requirements in Section 3.3, Trash Amendments.
- Design permanent physical separation between the wet well and equipment room.
- Design permanent access to the wet well and equipment room.

4.2 ELECTRICAL

Pump station electrical systems shall be designed using the following general design criteria:

- Design the permanent electrical room at finished grade and electrical room equipment 4 inches above the finished grade on the ground level.
- Design the electrical equipment (motor control center [MCC] and controls) room to be separate from the pump room.
- Provide a standby power system and/or backup generator that can fully power the pump station.

4.3 REDUNDANCY

Pump station redundancy shall be designed using the following general design criteria:

- Provide N+1 standby pumps, (N is the number of duty pump units for the firm design capacity plus one standby having the largest pumping unit in the station).
- Provide a standby power system sized for full design capacity.
- For wet well level gauges, provide primary level transmitter and backup with hard-wired level float switches.

4.4 FEDERAL REQUIREMENTS

Pump stations shall be designed to meet the following requirements when federally funded:

- The project shall meet the federal requirement of American Iron and Steel (AIS).
- The AIS Step Certification Process shall be used to ensure that producers adhere to the EPA AIS requirements, which can be found at: https://www.epa.gov/cwsrf/state-revolving-fund-american-iron-and-steel-ais-requirement

4.5 PREFABRICATED PACKAGE PUMP STATIONS

Prefabricated package pump stations are not acceptable. Custom-built or built-in-place stations are required.

4.6 PUMP SYSTEM DESIGN LIFE

The Design Consultant shall use sound engineering judgment in the design, selection, and specification of pump system equipment and structure to last or exceed the pump station's design life.

The design life is defined as the period of time for which equipment/structures are expected to perform as intended/designed. Once past their design life, the structures may still continue to function but not as efficiently. The design life serves as an important benchmark for indicating when the pump station or components may need to be rehabilitated or replaced.

The design life of components is affected by ambient conditions, wear and tear during O&M practices, and environmental factors such as:

- Location in a coastal area, salty moisture, high humidity, and rain.

- Solids commonly found in water runoff from roads and highways such as sand, grit, trash, and petroleum products.
- Solar radiation.
- Temperature and temperature fluctuations.
- Other environmental-related factors.

The design of a pump station's structures and equipment should have the anticipated design life given in Table 4-1.

Table 4-1. Design Life for Stormwater Pump Station Elements

Elements	Type	Design Life (years)
Structural	Buildings (aboveground)	100
	Below-grade concrete structures	100
	Ancillary structural elements such as equipment pads, pipe supports, and access equipment (e.g., ladders)	30
	Roof	30
Mechanical	Above-grade pumps	30
	Dry pit pumps	30
	Submersible pumps >25 brake horsepower	15–25
	Submersible pumps <25 brake horsepower	10
	Piping within pump station	25
	Valves	25
Electrical	Motors (time between each rewinding for repair of damaged coils in a motor)	15
	Starter and motor control systems	20
Instruments	Magmeters	20
	Ultrasonic level sensors	5
	Pressure switches	3–5
	Hydrostatic level sensors	5–15

4.7 HYDRAULICS

This section provides the basic criteria for determining the required size, flow capacity, and hydraulic design requirements of pump station facilities. The Design Consultant shall be responsible for determining the required pump station size, capacity, and design of other subsystems not addressed here. The design shall consider the full range of conditions that will be expected of the pumping facility.

Hydraulic design criteria for pump stations vary depending on the service area and location. In addition, the design must consider that some stations receive discharge from other pump stations or other assets and the potential consequences of an increase in flow rate and fluctuations.

Hydraulic grade line (HGL) or hydraulic profiles shall be developed during design. HGL elevation shall consist of the pipe's elevation (relative to a datum) plus the pressure head. HGL elevation at any point along a pressurized discharge pipe is the water surface that would be attained in a conveyance pipeline connected to a pressure measuring device.

Pump station hydraulic and pump sizing shall meet the requirements mentioned in Section 3.4, Design Flow, and shall be based upon the 100-year frequency storm, which is determined by the rational method per the City's *Drainage Design Manual*.

4.8 PUMP STATION TYPE

4.8.1 PUMP STATION SIZE AND NUMBER OF UNITS

When the design capacity of a pump station has been established, the Design Consultant shall determine if the capacity can be delivered by the number of pumping units. Several factors influence the appropriate number of pumping units such as pumping range, peak flow, capacity of available pumps to cover the operation range, and wet well sizing.

All installed pumps for the main stormwater drainage shall be of the same size, to minimize spare parts inventory. If the minimum flow rate is outside the safe operating area of one pump, smaller (jockey) pumps can be provided as an exception to this rule.

The pump station type is classified based on the design configuration into three types: submersible pump wet well (SPWW), submersible pump dry pit (SPDP), and vertically suspended pump dry setting (VSPD). The sizing is determined by the pump or motor size; this criterion allows for the design of equipment handling and access for equipment installation and removal.

4.8.2 SUBMERSIBLE PUMP WET WELL PUMP STATION DESIGN REQUIREMENTS

A SPWW (Figure 4-1) is suitable for a pump station with a flow capacity less than 5,000 gpm with a maximum of three installed pumps (two duty plus one standby) and each pump motor weighing less than 2,000 pounds.

- The pumps are submersible pumps inside a wet well.
- Equipment or pump removal occur using a davit crane or City pickup-truck-mounted mobile hoist.
- Guide rails shall be provided for each pump.
- Design is below-ground with a rectangular or circular structure wet well.
- Trash capture device shall be provided at the upstream portion of the wet well.
- Valve vault structure shall be provided for the pump discharge piping.
- Aboveground MCC and standby diesel generator buildings shall be provided.

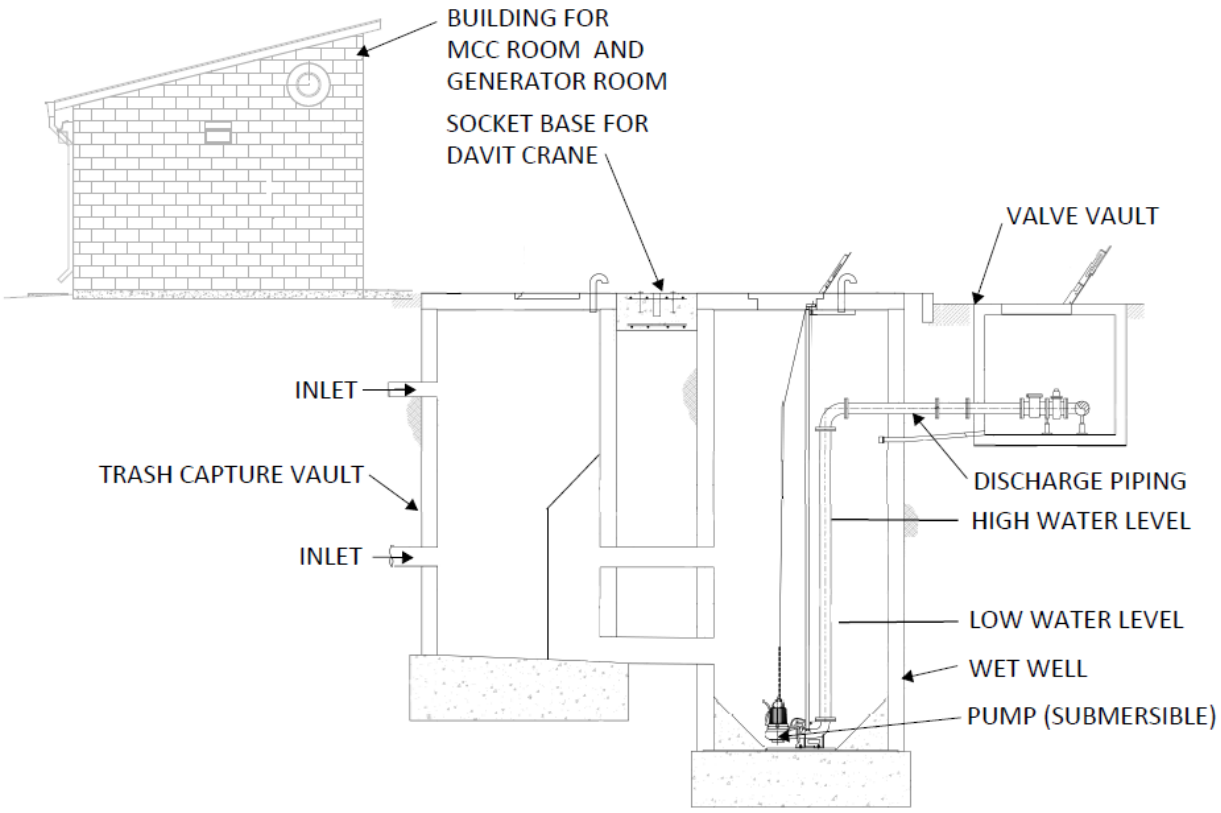

Figure 4-1. Example of Submersible Pump Wet Well Pump Station

4.8.3 SUBMERSIBLE PUMP DRY PIT PUMP STATION DESIGN REQUIREMENTS

An SPDP (Figure 4-2) is suitable for a pump station with a flow capacity range of 5,000 to 20,000 gpm and with a maximum of N+1 number of pumps (N duty plus one standby).

- Submersible type pumps shall be installed inside a dry pit.
- Equipment or pump removal shall occur with a building bridge crane or via skylight with an external mobile boom truck,
- A dry pit shall be designed adjoining a wet well.
- Mechanical trash capture devices shall be provided.
- An aboveground mechanical room shall be provided.
- An aboveground MCC and standby diesel generator building shall be provided.

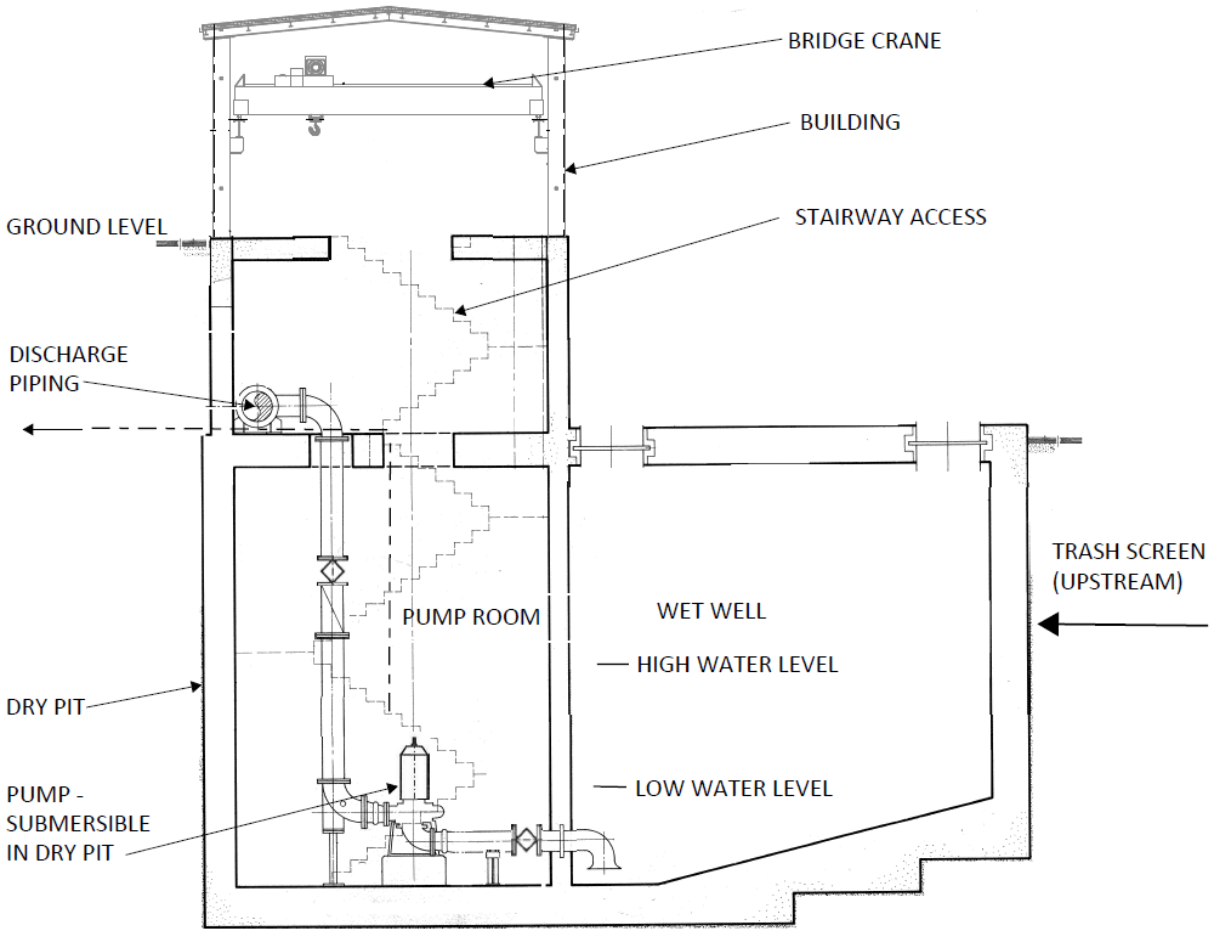

Figure 4-2. Example of Submersible Pump Dry Pit Pump Station

4.8.4 VERTICALLY SUSPENDED PUMP DRY SETTING PUMP STATION DESIGN REQUIREMENTS

A VSPD (Figure 4-3) is suitable for pump stations with a large flow capacity of more than 20,000 gpm and a minimum of two installed pumps (one duty and one standby) to N+1 number of pumps (N duty plus one standby).

- Vertical suspended pump shall be installed at the top slab of the wet well.
- Equipment or pump removal shall use a building bridge crane or via skylight with an external mobile boom truck.
- Mechanical trash capture devices shall be provided.
- Aboveground mechanical and motor room shall be provided.
- Aboveground MCC and standby diesel generator buildings shall be provided.

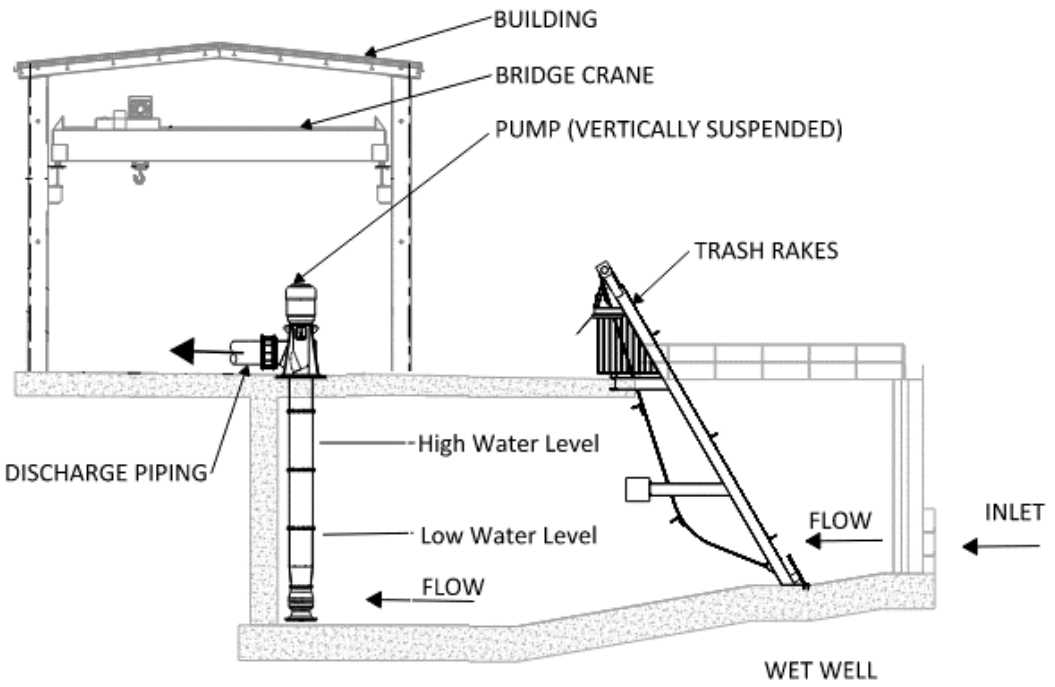

Figure 4-3. Example of Vertically Suspended Pump Dry Setting Pump Station

4.8.5 PUMP STATION CLASSIFICATION BY CAPACITY WITH PUMP AND ACCESS REQUIREMENTS

Table 4-2 summarizes pump station classifications by capacity and access requirements.

Table 4-2. Pump Station Classification by Capacity and Access Requirement

Classification	Pumping Capacity	Pump Driver Weight	Access and Equipment Handling
SPWW Pump Station	< 5,000 gpm	< 2,000 pounds	Minimum 2 parking stalls
Minimum of TWO units installed (1 duty + 1 standby) and maximum THREE (2 duty + 1 standby)			Sufficient for vehicles, crane, boom truck, and vactor truck
SPDP Pump Station	5,000 to 20,000 gpm	Any weight	2–4 parking stalls
Minimum of TWO units installed (1 duty + 1 standby) and maximum N+1 (N duty + 1 standby)			Sufficient for vehicles, crane, boom truck, and vactor truck
VSPD Pump Station	>20,000 gpm	Any weight	Minimum 4 parking stalls
Minimum of TWO units installed (1 duty + 1 standby) and maximum N+1 (N duty + 1 standby)			Sufficient for vehicles, crane, boom truck, and vactor truck

4.8.6 PIPE DESIGN VELOCITY

The minimum and maximum velocities allowed through pump inlet (suction) and discharge pipes shall meet those shown in Table 4-3.

Table 4-3. Velocities for Pump Piping for Individual Pump

Location	Minimum Velocity (feet per second)	Maximum Velocity (feet per second)
Inlet piping	2	8
Discharge piping	2	8

4.8.6.1 Minimum Velocities

For force mains conveying stormwater, minimum velocity must be 2 feet per second (fps) during initial operation. For stations subject to above-average solids in the influent, higher minimum velocities (up to 5 fps) may be required.

4.8.6.2 Maximum Velocities

The maximum velocity in a force main is 8 fps to maintain head losses at reasonable values. Higher velocities up to 10 fps on a case-by-case basis may be allowed for shorter piping less than 500 feet.

4.8.6.3 Design of Pump Discharge Piping

Criteria for the design of force mains include various friction factors, velocity considerations, surge issues, and piping characteristics as discussed below.

- RCP (preferred pipe material) – The Hazen-Williams equation with C = 100 or the Manning's equation with n = 0.013 should be used for all pipe materials and size. A condition with a pipeline value of C = 145 should be evaluated to verify that the system can operate at all intermediate conditions between two scenarios (old and new pipe).
- Cement mortar–lined (CML) pipe: The Hazen-Williams equation with C = 100 or the Manning's equation with n = 0.013 should be used for all pipe materials and size. A condition with a pipeline value of C = 145 should be evaluated to verify that the system can operate at all intermediate conditions between two scenarios (old and new pipe).
- High-density polyethylene pipe (HDPE): The Hazen-Williams equation with C = 130 to 150 or the Manning's equation with n = 0.013 with smooth interior should be used. A condition with a pipeline value of C = 140 should be evaluated to verify that the system can operate at all intermediate conditions.

4.9 PUMP SELECTION

The Design Consultant shall prepare combined system head and pump operating curves showing all pumps operating under the full range of projected system hydraulic conditions. The pumps shall be selected considering the following items:

- Design point of the pump is at or near the best efficiency point of the pump curve.
- Operation should be within the preferred operating region (POR) for the most continuous flow rates and within the allowable operating region (AOR) for intermittent flow rates. Refer to Hydraulic Institute Standard 9.6.1 – *Guideline for Operating Regions*.
- The pump head capacity curve should have a continuously rising performance curve toward the shutoff head. Pumps with dips or reverse slope or flat curve are not allowed.
- System head and pumping operation curves shall be included on Specifications.

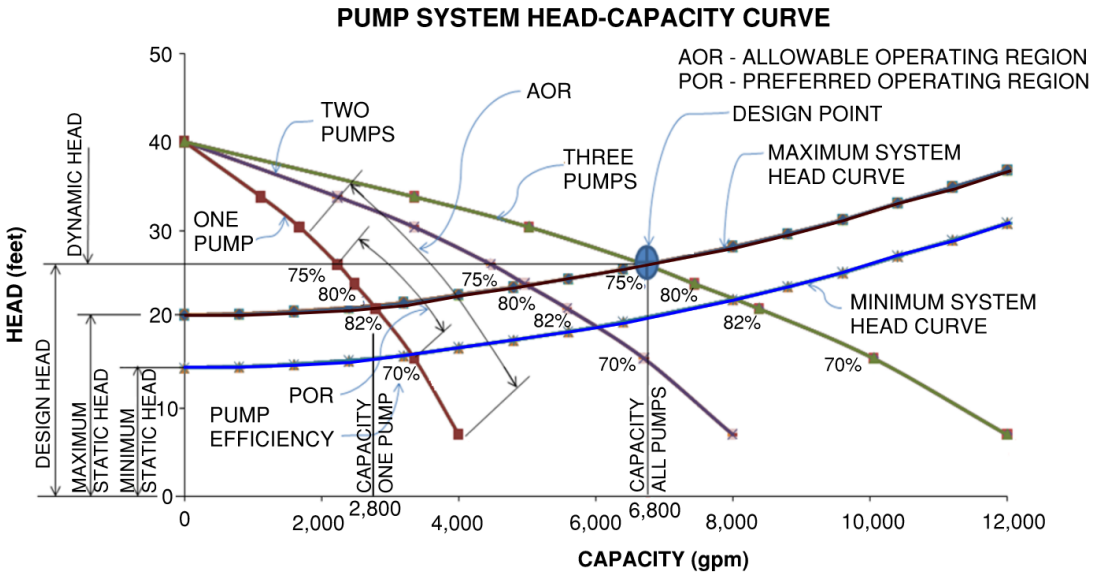

Figure 4-4. Typical System Head-Capacity Schematic of System Head Curve

4.9.1 PUMP TYPE

Pump selection is determined by the pump station type defined in section above (SPWW, SPDP, or VSPD). The following are examples of pump construction for stormwater service:

- Submersible pumps (Figure 4-5): These pumps consist of a volute casing close coupled to a submersible electric motor. They can be used in two different configurations: dry pit/wet well or submersible (wet well).

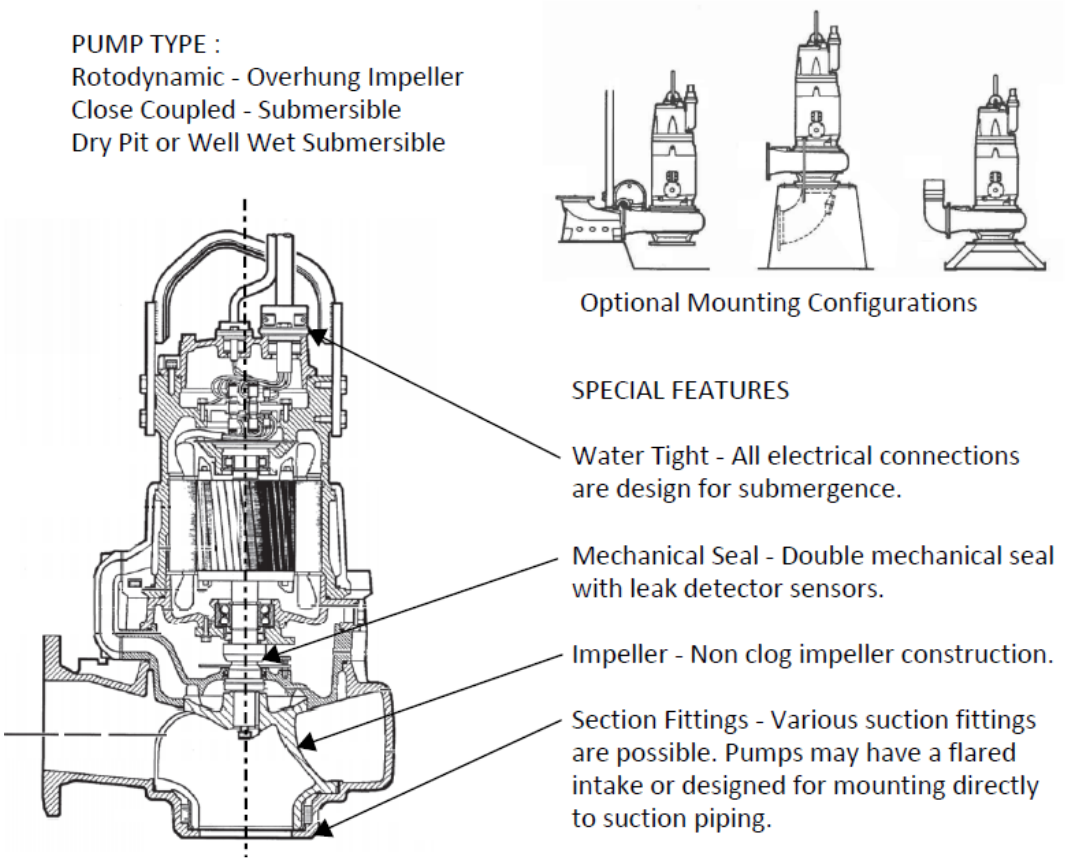

Figure 4-5. Submersible Non-Clog Pump

- Vertically suspended pumps (Figure 4-6): These pumps have a vertical shaft and impeller, connected to the driver having a vertical shaft arrangement.

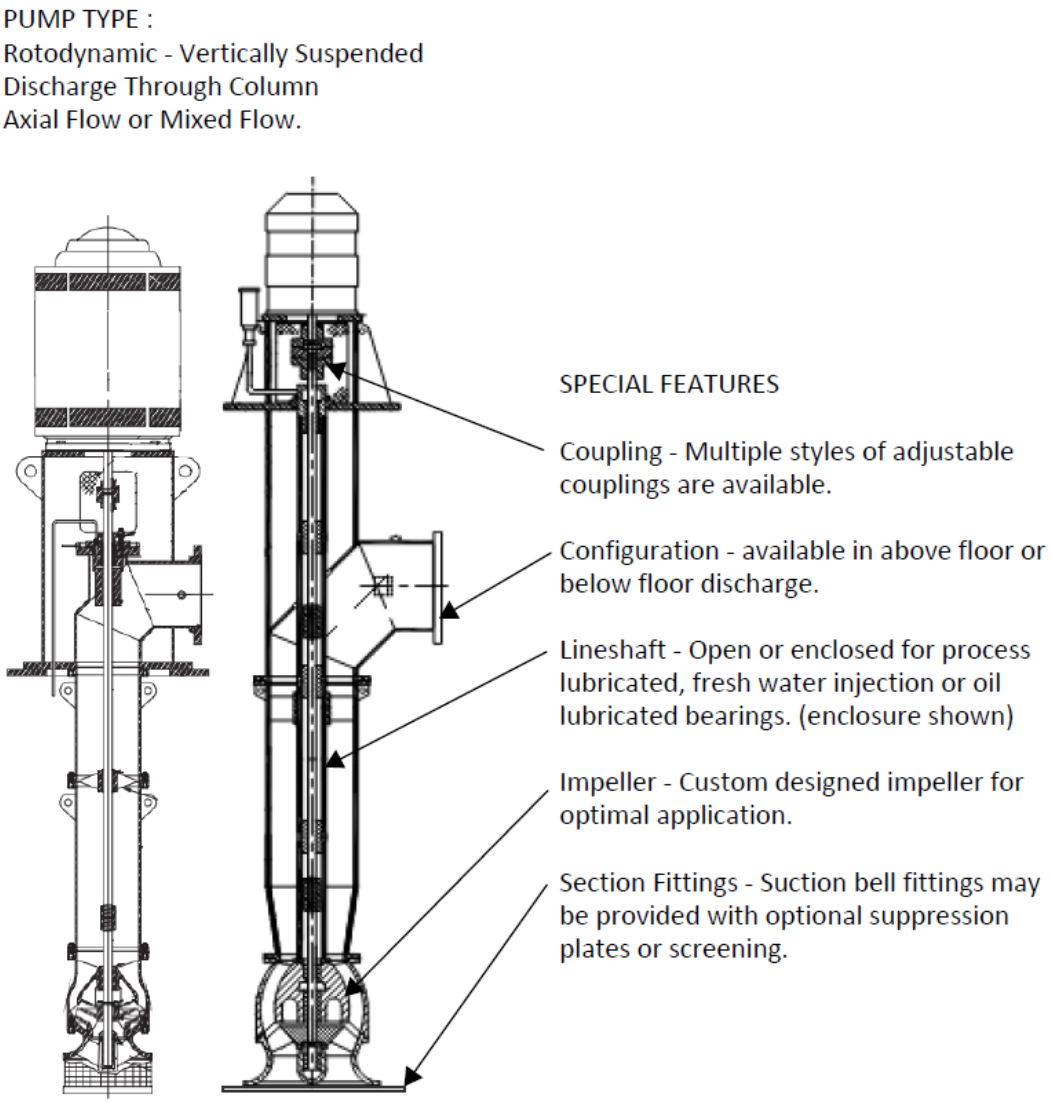

Figure 4-6. Vertically Suspended Pump

4.9.2 SUBMERSIBLE PUMPS

Submersible pumps shall be provided with the following features:

- Moisture-sensing probes and motor bearing high-temperature switch.
- Positive oil-circulating cooling of the motor or product water cooling of the motor; motor cooling jacket shall be equipped with pressurized flushing connection.
- Design for continuous running in a dry-well installation without damage.
- A Factory Mutual (FM) or Underwriters Laboratories (UL) explosion-proof rating. All power and control cables to the pump below the MCC level shall be National Electrical Manufacturers Association NEMA 6P rated so that the pumps can continue operating if the pump room is flooded.

4.9.3 VERTICALLY SUSPENDED PUMPS

Vertically suspended pumps shall include the following features:

- Material: bowl, impeller column, and shaft should be suitable for coastal areas with salty groundwater intrusion.
- Non-clog type impeller, balanced to operate within the acceptable field of vibration limits.
- Bearing: heavy-duty, grease-lubricated, and bronze with minimum L-10 bearing life.
- Oil-lubricated pumps with enclosure shaft.

4.9.4 SUMP PUMPS

A sump pump is a pump that is installed in the sump of wet wells and dry pit stations. It is used to pump out the water remaining in the sump after the water level has dropped and all the main pumps are no longer pumping. The City's Interceptor Pump Stations (IPSs) are examples of where wet well sump pumps are being used.

A specifically designed sump pump may be used to remove accumulated solids, such as silt, sand, and debris that build up gradually at the bottom of the wet well. Sump pumps shall be equipped with guide rails to aid in the removal of the pump.

4.9.5 PUMP PROTECTION FEATURES

The following pump protection features shall be provided.

- Pump Reverse Rotation Protection: A reverse rotation protection should be included for the pump and its driver.
- Backflow Prevention: A backflow prevention device shall be provided in the pump discharge pipe. A backflow prevention device does not substitute for the need to have reverse rotation protection.
- Motor or Bearing Temperature Monitoring: Pump units with a discharge nozzle larger than 12-inch diameter should be provided with resistance temperature detectors (RTD) for the pump or motor bearings.
- Vibration Monitoring: Pump units with a motor larger than 150 horsepower (hp) shall be provided with vibration monitoring devices. The vibration monitoring requirement is described in Section 12.11.2, Pump and Motor Vibration Monitoring and in American National Standards Institute/Hydraulic Institute (ANSI/HI) 9.6.5, *Rotodynamic Pumps – Guideline for Condition Monitoring.*

4.10 WET WELL

4.10.1 STORAGE VOLUME

The storage volume for all incoming stormwater flow conditions shall be determined and consider the following:

- For upstream available storage volume, total available storage volume up to 500 feet upstream of the wet well at the minimum and maximum wet well water setting levels shall be tabulated. The minimum level is where all pumps call to stop, and maximum level is where all pumps are running. This data will be used for pump control setting.
- Capacity in the collection system can be used for wet well storage volume. The available volume of a collection system that can be used for emergency storage should be determined case by case depending on system geometry, pipe routing, backwater effects, and criticality of operation.
- The balance of the storage volume shall be met by either increasing the pump station wet well volume or incorporating separate dedicated detention basins.
- In large pump stations, primary stormwater pumps shall be designed to handle large storm events and smaller base flow pumps can be installed to handle smaller rainfall, groundwater intrusion, and runoff events or for low-flow diversion purposes. This practice is common for stormwater pump station design since the inflow rate can vary greatly.

4.10.2 WET WELL INLET

The wet well inlet invert should be above the normal high water operating level and with no free-fall discharge into the wet well under operating conditions. In addition, the influent pipe shall not discharge directly on top of the suction elbow of a pump. The wet well configuration shall be designed in accordance with ANSI/HI 9.8, *Pump Intake Design*.

4.10.3 WET WELL OPERATING VOLUME

The wet well operating volume and pump(s) sequencing start/stop call levels shall be configured to meet minimum inflow conditions. The wet well shall be large enough to provide adequate pump running time at minimum flow to prevent overheating of the electric motor and controls.

4.10.4 SIZE AND CAPACITY DETERMINATION

The determination of wet well capacity requires close coordination with the entire design of the pump station. ANSI/HI 9.8, Appendix B provides an extensive discussion of the required wet well volume.

The minimum water surface elevation in the wet well is determined by the hydraulic pump submergence requirements and economic considerations as a larger and deeper wet well have higher construction cost.

P – pump discharge capacity, L/s (ft3/s)

Q = inflow to wet well, L/S (ft3/s), variable

T – total cycle time, s

V = active wet well volume to be determined

Time to fill wet well = $T1 = V/Q$

Time to empty wet well = $T2 = V/(P-Q)$

Time (T) for a complete pumping cycle is then:

$T = T1 + T2 = V/Q + V/(P-Q) = VP/Q(P-Q)$ where:

The minimum cycle time occurs when Q = P/2. Rearranging the equation,

$$T_{min} = 4V/P$$

and

$$V_{req} = T_{min} * P/4$$

The pump shall have its suction inlet submerged at all times and meet the minimum submergence requirement. The minimum submergence for pumps should be provided by the manufacturer.

4.10.5 PUMP CYCLE TIMES

The pump station design should include a determination of the water volume between maximum and minimum operating elevations.

- The water volume includes the capacity of the wet well, trash rack chamber, interconnecting piping, and upstream storage holding ponds if available.
- An inflow rate equal to one-half of the pumping rate of the pump should be assumed, as this inflow will cause the most frequent number of repeated starts and stops of the pump.
- The required operating volume of the wet well, V, or the volume between the start level and the stop level of the pump, depends upon such factors as the cycle time for the pump (T), the pump capacity (P), and the rate of the inflow (Q). For variable inflow rate, the shortest cycle time occurs if Q = P/2, which gives the minimum required volume of the wet well.
- The minimum cycle time is determined by the number of pump starts with regard to the temperature rise in the motor. To minimize the required wet well volume, the first pump to start should be the first to stop and the last pump to start should be the last pump to stop (first on and first off operation). The first on pump should always alternate.
- A typical range of minimum operating cycles is 15 to 20 minutes for wet-pit pumps with motor size up to and including 100 hp and 30 minutes between starts for pumps over 100 hp. These values all need to be confirmed with the pump and motor manufacturer. Pumping units over 200 hp should be started and cycled according to data furnished by the motor manufacturer.

4.10.6 PHYSICAL MODEL STUDIES OF INTAKE STRUCTURES

Additional engineering studies and/or physical modeling may be required when circumstances prevent proper wet well design such as constrained station siting. The volume, shape, and geometry of the wet well can be determined and refined through the intake model test. In some

cases, wet well volume must be designed to obtain acceptable pump cycling times. Remedial measures to correct poor wet well design can be costly and time consuming. See ANSI/HI 9.8, Appendix A, for a discussion of these measures.

ANSI/HI 9.8 recommends a physical hydraulic model study with one or more of the following features noted below. The bulleted list below provides some of the features from ANSI/HI 9.8, 2018 edition:

- A suction intake arrangement with elevation relative to water level that does not provide the minimum submergence requirement, irrespective of the pump manufacturer's stated submergence values.
- The intake design is not a standard intake design or the geometry deviates from the standard.
- Circular stations with four or more pumps or with flows exceeding 5000 gpm per pump.
- The pumps have flows greater than 40,000 gpm per pump or the total station flow with all pumps running would be greater than 100,000 gpm.

4.10.7 OTHER CONSIDERATIONS

4.10.7.1 Trench Well Stations

Trench well stations should only be used where space and real estate constraints preclude the use of conventional pump stations. Trench well stations have flow entering from the side of the station perpendicular to the pumps. See ANSI/HI 9.8 Appendices C and D, for more extensive discussion of these station types.

4.10.7.2 Multiple Pump Sizes

Designs using multiple pump sizes is not recommended if there is an excessive number of pumps or complicated control systems. Pump stations equipped with multiple pump sizes can result in excessive costs and decreased reliability.

4.10.7.3 Bypass Pumping

There are three different types of bypass systems. These include open systems, closed systems, and combination systems. An open system involves taking suction from sources open to the air and pumping to areas that are also open to the air such as pumping from one manhole to another manhole. A closed system is the opposite of an open system and involves pumping from a closed source into another closed area. Both are usually under pressure, like pumping from a pressurized line to another pressurized line such as a force main. Finally, a combination system involves taking suction from an open system and pumping into a closed system. This ensures that back pressure is experienced at the end of the system's discharge line. Bypass pumping shall be designed in conformance with the following guidelines:

- Bypass pumping systems shall be designed and assembled to handle maximum flow capacity.
- Bypass systems shall be designed to convey flow at a specified rate pressure. For gravity applications, the system needs to be able to pump the upstream flow and discharge it to a manhole downstream.

- A hydraulic check valve shall be provided if high wet well water level can rise above the discharge inlet elevation without backup/flooding in the inlet line.
- Where bypass requires an external temporary pump system, the piping from the temporary pump system shall accommodate the pumped discharge flow.
- Temporary bypass pumping during construction requirements is addressed in Section 12.12. 2

4.11 TRASH CAPTURE DEVICES

This section provides information for the selection of trash capture devices. The types of trash capture devices used depend on the size of the pump station, frequency of operation, type and size of the pumps, and type of inflow conditions such as pipe, open ditch, or others.

Selection of trash capture devices should be based on the amount and characteristics of the debris, station configuration, safety, and engineering judgment. The two basic types of trash capture devices are hydrodynamic separator (Figures 4-7 and 4-8) and mechanical raking (Figures 4-9 and 4-10).

- SPWW pump stations: trash hydrodynamic separator.
- SPDP pump stations: trash hydrodynamic separator or mechanical raking.
- VSPD pump stations: mechanical raking.

4.11.1 TRASH HYDRODYNAMIC SEPARATOR

Hydrodynamic separator devices shall be provided using the following general design criteria:

- A self-cleaning device that uses hydrodynamic separator swirl concentration and continuous defective separation to screen, separate, and trap trash, debris, and sediment.
- Typical for removing floatable and neutrally buoyant material debris $^{3}/_{16}$ inch or larger.
- Traps trash, debris, and sediment settled inside trash collection structure and is cleaned with a vactor truck.
- Access and maintenance: Accumulated debris inside the trash collection structure should be removed to prevent restricted flow into the pump intake wet well.

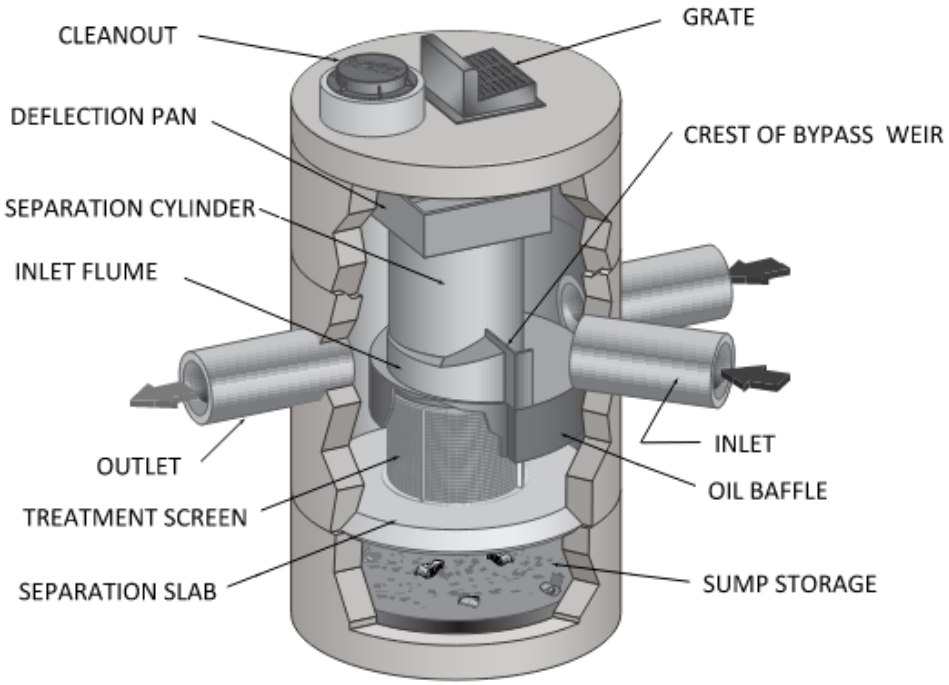

Figure 4-7. Example of Trash Hydrodynamic Separator

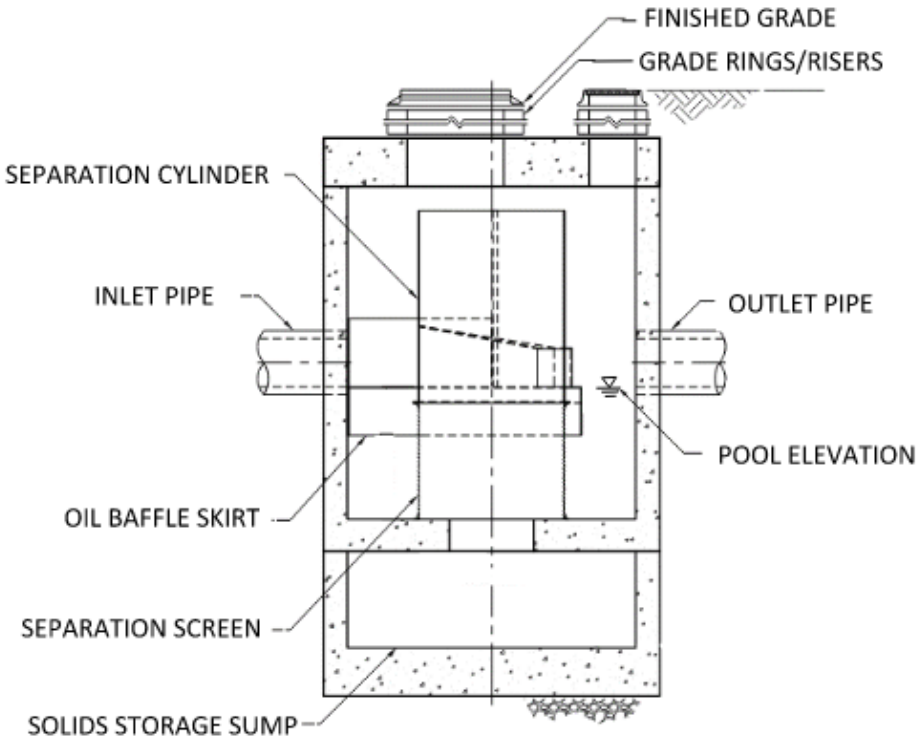

Figure 4-8. Trash Hydrodynamic Separator Typical Section

4.11.2 MECHANICAL TRASH RAKES

Mechanical trash rakes shall be designed using the following general design criteria:

- Self-cleaning and mechanically driven with chains, levers, or arms, hydraulic cylinders, and gears to move the rake up and down to remove the trash from the rack.
- Access and Maintenance: Accumulated debris in front of the racks should be removed to prevent structural damage or prevent restricted flow into the wet well. Trash racks must be accessible for cleaning and removable for repair and maintenance.

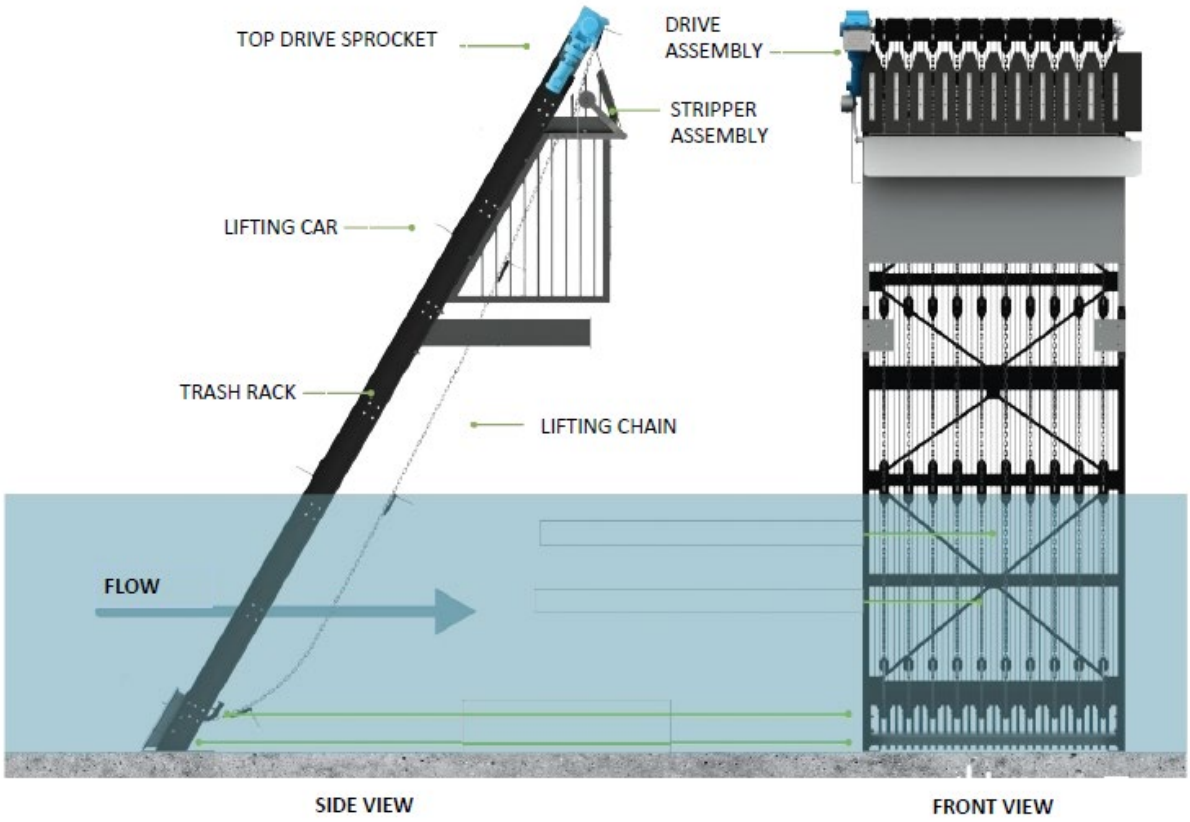

Figure 4-9. Example of Mechanical Trash Rakes

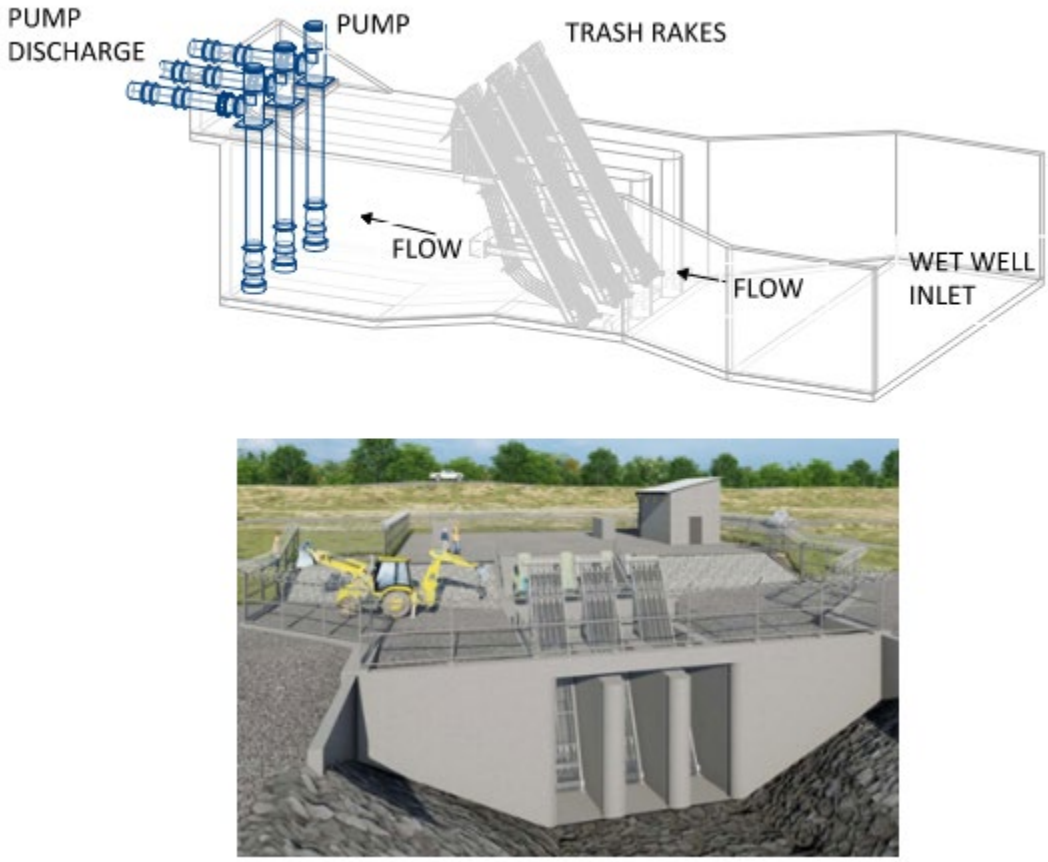

Figure 4-10. Mechanical Trash Rakes Upstream of Pump Station

4.12 GENERAL ACCESS AND CONFINED SPACE ENTRY

General access and confined space entry shall be provided in conformance with this section. Access and confined space entry procedures shall be detailed in the Operation and Maintenance Manual; refer to Chapter 14.

4.12.1 GENERAL ACCESS

Table 4-4 summarizes access requirements. Site access shall be provided to allow a boom truck to reach major equipment, such as pumps, motors, and valves, and remove these items completely from the pump station. If site constraints prohibit equipment lifting by boom truck, fixed equipment lifting hoists and other suitable equipment-handling systems must be provided. Both the wet well and dry pit should be equipped with a large hatch located over major equipment for equipment installation and removal.

Access shall be provided for a vactor truck to reach the wet well or screen area. This includes a clear path from the wet well access hatch to the bottom of the well. Working platforms located directly below the hatch shall include hinged or removable grating panels.

Access via stainless steel or fiberglass stairways should be provided to serve as a primary method of egress into confined spaces if feasible and practical. If infeasible, hatches for personnel access shall provide enough space for a retrieval tripod to be set up over the opening or for the hatch to be equipped with a removable davit arm.

Table 4-4. Equipment Access

Elements	Equipment Access	Acceptable
Pump/motor room above-grade	Pump room on grade and a roll-up door provided to move equipment in and out	7-foot-high, 6-foot-wide double door
Pump/motor room below-grade	Stairwell	Ladder, one per 10-foot vertical drop if total vertical distance is greater than 15 feet
Hatch access for lifting equipment and cleaning	Minimum 36 inches × 48 inches	Minimum on all sides, overall minimum of 36 inches by 36 inches, double door opening for hatch 6 feet wide and greater Fall protection such as handrails shall be provided around hatch accesses where feasible
Lifting mechanism	Boom truck preferred, then crane hoist	Crane hoist or overhead traveling crane
Clearance	8-foot minimum under lifting hoist, subject to overall equipment size	Largest equipment dimension in hoisting orientation, plus 2 feet between bottom of equipment and any other equipment in the station that must be crossed over, plus rigging height

4.12.2 CONFINED SPACE ENTRY

The confined space entry procedures shall comply with all the Cal/OSHA general requirements, which can be found at: https://www.dir.ca.gov/dosh/dosh_publications/confspa.pdf or Confined Space Guide for General Industry (ca.gov).

An operating manual shall be provided to inform the SWD with the preferred methodology for wet well cleaning and various pump operation procedures for each station.

During maintenance work or inspection when the wet well or vaults must be entered, safety or other protective warning devices should be placed around the opening. It is a requirement that all wet well areas be ventilated before any personnel enter.

After each rainy season and at periodic inspections, the pump stations and wet wells should be thoroughly cleaned and the equipment completely inspected, oiled, and greased. The pump system should be inspected for cracks, damage, or looseness on the fasteners. The post-rainy season inspection and maintenance procedures and frequency shall be covered in detail in the operating manual.

A log of pump station operation should be furnished by Operations following each major storm event and associated post-rain inspection. It is advisable that a log of operations be also submitted for all trial operations of each pump station to be certain that all inspections and operations are conducted and that a complete record of the operations is available for future reference.

4.12.3 SAFETY DEVICES AND PRECAUTIONS

The following safety devices and precautions shall be provided.

- Warning and safety signs:
  a. Adequate warning and safety signs shall be provided and placed near energized or other hazardous equipment; signs shall be maintained in good condition.
  b. Adequate warning and safety signs shall be provided for road closures and drop gates as applicable.
- A guardrail shall be designed around the entry point.
- Permanent stainless-steel ladders shall be located in the wet well with a grab bar in the wall above.
- Fire extinguishers shall be provided in aboveground structures.
- Positive ventilation system that provides a minimum of 20 air changes per hour based on the total volume of an empty wet well shall be provided.

4.12.4 CONFINED SPACE ENTRY PROCEDURES

Safe confined space entry operation requires the following at a minimum:

- Be sure that all motor starter switches are in "OFF" position and locked before closing the unfused disconnect switches.
- An adequate mechanical exhaust ventilation rate of 20 air changes per hour.
- Enclosed spaces shall be evaluated for contaminants and periodic check tests shall be made to assure an acceptable atmospheric condition.
- Protective clothing and respiratory protection shall not be used as a substitute for cleaning and ventilating of spaces.
- Persons working in confined or enclosed spaces shall have a safety harness and lifeline with an attendant if the atmosphere has oxygen deficiency or contamination sufficient to require respiratory protection. The attendant shall be full time attending and assigned no other duties. A signal system shall be established.
- There shall be sufficient connection points and retrieval locations for the number of personnel required to be in the space for the worst-case maintenance activities.

4.13 MATERIAL SELECTION

This section outlines the main exposures to materials anticipated at stormwater pump stations serving coastal area marine environment and high groundwater water table with high concentrations of chlorides.

- Soil Exposure - wet soil environments are corrosive to buried metal structures.
- Surfaces Exposed to Service Fluids - corrosive stormwater from surrounding serving areas with salty groundwater intrusion.
- Atmospheric Exposure - marine environment with airborne salts.

Table 4-5 lists the recommended materials found to be suitable for stormwater pump station applications.

Table 4-5. Acceptable Materials—Supplemental Information

Item	Acceptable Materials of Construction
Buried Pipe	
Pipeline	RCP, DIP[1,2,8], SCRW, CMLTCMC steel[1], CMLC steel[1], and PVC
Pipe Fittings	Steel[1,4,5] and ductile iron[1,2,8]
Exposed Pipe	DIP[9], Steel[9], PVC[10]
Valves	
Body	Cast-iron[7], ductile iron[7], stainless steel[7]
Stem and Trim	Bronze and stainless steel[6]
Pumps	
Body	Cast-iron, ductile iron, stainless steel
Impeller	Bronze, cast-iron, ductile iron, stainless steel
Shaft	Stainless steel[6]
Culverts	Reinforced concrete pipe
Structural Concrete	Type V cement
Structural Metal	Stainless steel, galvanized steel
Ladders	
Dry	Aluminum, stainless steel, and fiberglass
Submerged	Stainless steel
Handrail	Aluminum or stainless steel

1. Provide cathodic protection in immersion services and buried condition.
2. Cement mortar lined with dielectric coating.
3. Not used in aggressive soils.
4. Cement mortar lined and coated.
5. Cement mortar lined, tape wrapped, and mortar coated for corrosive soils.
6. Use type 316 stainless steel in corrosive atmospheric exposures.
7. Epoxy coated and wrapped in petrolatum/wax tape for buried service.
8. Polyethylene encasement.
9. Cement-lined, aliphatic acrylic polyurethane coated.
10. Acrylic latex coated.

Key:
CMLC = Cement Mortar Lined and Coated
CMLTCMC = Cement Mortar Lined, Tape and Cement Mortar Coated
DIP = Ductile Iron Pipe
PVC = Polyvinyl Chloride
RCP – Reinforced Concrete Pipe
SCRW = Steel Cylinder Rod Wrapped

4.14 NOISE CONTROL

Designs shall result in an operating pump station that complies with all local, state, and federal noise regulations (Table 4-6). Facility noise predictions are developed during the engineering design phase to predict the pump station noise levels, facility boundary line noise levels, and community noise levels. The sound pressure levels of completed facilities during operation shall be within permissible limits.

Table 4-6. Applicable Noise Limits

Land Use	Time of Day	One-Hour Average Sound Level (decibels)
1. Single-Family Residential	7 a.m. to 7 p.m.	50
	7 p.m. to 10 p.m.	45
	10 p.m. to 7 a.m.	40
2. Multi-Family Residential (up to a maximum density of 1/2,000)	7 a.m. to 7 p.m.	55
	7 p.m. to 10 p.m.	50
	10 p.m. to 7 a.m.	45
3. All Other Residential	7 a.m. to 7 p.m.	60
	7 p.m. to 10 p.m.	55
	10 p.m. to 7 a.m.	50
4. Commercial	7 a.m. to 7 p.m.	65
	7 p.m. to 10 p.m.	60
	10 p.m. to 7 a.m.	60
5. Industrial or Agricultural	Any time	75

Following are additional design considerations to control noise:

- Provide the design, specification and implementation of noise control measures and devices so that maintenance and safety issues are addressed.
- Pump Station facility exterior noise shall not exceed the City standards in SDMC Chapter 5, Article 9.5, *Noise Abatement and Control* (edition 12-2019) or the latest amendment.
- It shall be unlawful for any person to cause noise by any means to the extent that the 1-hour average sound level exceeds the applicable limit listed in Table 4-6 at any location in the City on or beyond the boundaries of the property on which the noise is produced. The noise subject to these limits is that part of the total noise at the specified location that is due solely to the action of said person.

- The sound level limit at a location on a boundary between two zoning districts is the arithmetic mean of the respective limits for the two districts.
- Fixed-location public utility distribution or transmission facilities located on or adjacent to a property line shall be subject to the noise level limits listed in Table 4-6 measured at or beyond 6 feet from the boundary of the easement upon which the equipment is located.

4.15 ODOR CONTROL

California Health and Safety Code Section 41700 states that no person can discharge air contaminants that cause injury, nuisance, or annoyance to any considerable number of persons or the public, or discharge air contaminants that endanger the comfort, health, or safety of such persons. If a business violates this prohibition or any other air quality requirement, the APCD may issue a notice of violation to the business. If a notice of violation is issued, the business must take action to correct the violation and pay a monetary penalty to the APCD. Penalties are determined in accordance with Health and Safety Code Sections 42400 through 42403.

A project that is not an agricultural, commercial, or industrial activity subject to San Deigo County APCD standards, as a result of implementation will either generate objectionable odors or place sensitive receptors next to existing objectionable odors, which will affect a considerable number of persons or the public. APCD Rule 51 (Public Nuisance) and California Health & Safety Code, Division 26, Part 4, Chapter 3, Section §41700 prohibit the emission of any material that causes nuisance to a considerable number of persons or endangers the comfort, health, or safety of the public. Projects required to obtain permits from the APCD, typically industrial and some commercial projects, are evaluated by APCD staff for potential odor nuisance, and conditions may be applied (or control equipment required) where necessary to prevent occurrence of public nuisance. Odor issues are very subjective by the nature of odors themselves and their measurements are difficult to quantify. As a result, this guideline is qualitative, and each project will be reviewed on an individual basis, focusing on the existing and potential surrounding uses and location of sensitive receptors.

Currently, the San Diego County APCD has no specific quantitative thresholds for odor control requirements for stormwater pump stations. If an odor complaint were to be filed, necessary investigation, evaluation, and action should be taken to manage the odor. However, the following clause is excerpted from the County of San Diego's Guidelines for Determining Significance and Report Format and Content Requirements for Air Quality, Section 4.5, Odor Impacts: "Odor issues are very subjective by the nature of odors themselves and their measurements are difficult to quantify. As a result, this guideline is qualitative and each project will be reviewed on an individual basis, focusing on the existing and potential surrounding uses and location of sensitive receptors." Refer to Section 4.5, Odor Impacts of the County of San Diego of the *Guidelines for Determining Significance and Report Format and Content Requirements for Air Quality*, available at: https://www.sandiegocounty.gov/content/dam/sdc/pds/ProjectPlanning/docs/AQ-Guidelines.pdf.

Chapter 5 Civil

Civil parameters generally include demolition, grading, paving, access, site layout, and underground wet utilities. The civil design shall consider existing and future uses and needs as well as interim measures needed during construction such as flow bypassing, temporary support of existing facilities, and so on.

The following are general civil design requirements:

- Improvements at existing pump station sites shall be designed to the same horizontal and vertical coordinate system determined by the City. Where this is not feasible due to lack of available or common benchmarks, existing features slated to remain should have locations and elevations clearly indicated for future reference.
- Improvements and construction work areas shall be limited to within existing City rights-of-way and easements. Should additional property acquisition or easements be required for improvements, City staff shall be notified to initiate discussions for resolution.
- A water service with a meter and backflow shall be provided for each pump station. The service shall be used for onsite hose bibs and sinks.
- Fire hydrants with dedicated supplies shall be provided to satisfy requirements of the California Fire Code Appendix C. When a sprinkler system is required for fire protection, a dedicated fire service with a reduced pressure detection assembly will be provided to serve fire hydrants and sprinkler systems.
- For new potable water services, coordination with the City shall be undertaken to determine available flow and pressure at connection points. Should insufficient flow and/or pressure be available, City staff shall be notified to initiate discussions for resolution.
- Potholing, ground-penetrating radar, and other buried utility investigation shall be provided where improvements cross or interface with existing buried utilities.
- Project classification (standard development project vs. priority development project) shall be determined to inform permanent BMP requirements for stormwater runoff.
- Services for domestic water, fire water, stormwater, sewer, gas, telecommunication, and electricity shall be confirmed as accounted for as required by the pump station facilities.

5.1 DEMOLITION

The civil demolition design shall consider equipment, structures, piping, and site features to be demolished and which of these elements may contain hazardous materials. Items to be salvaged, what phasing requirements apply to the demolition/salvage work, and the custody requirements for disposal or recycling of potentially hazardous materials. The design shall also consider the following:

- Extents of demolition shall be clearly defined on drawings. The use of record drawings and field photographs to depict items to be demolished is encouraged.

- Items to be salvaged shall be indicated as such with additional information for where the item should be relinquished.
- Lead, asbestos, and other potentially hazardous materials shall be surveyed for prior to commencement of demolition work. Any hazardous materials discovered shall be marked and disposed of by qualified Contractors at appropriate disposal facilities. The City's Environmental Services Department (Disposal and Environmental Protection Division) should be notified early in the design process to provide the "Lead/Asbestos Containing Materials Abatement Specification" in the contract documents.
- All items to be demolished shall be approved by the City.

5.2 GRADING

Grading shall be designed using the following design criteria:

- Sites shall be prepared per site-specific geotechnical requirements including clearing, grubbing, over-excavation, and so on.
- Sites shall be graded to avoid ponding and convey rainfall runoff to catch basins or offsite.
- Maximum grade slopes shall be limited to 10% where possible. Grades shall not be without slope in any circumstance.
- Short- and long-term erosion control measures shall be considered for inclusion in the design.
- Rainfall runoff collected in new and existing catch basins shall be conveyed to the storm drain pump station wet well using gravity piping in accordance with these Guidelines. If BMPs are required by the project classification, runoff shall be routed to the BMPs before it enters the wet well.
- Refer to Chapter 11, Security Design Criteria, for information on perimeter barriers, fencing, walls, gates, and other security features.

5.3 BURIED PIPING

Buried piping for wet utilities (i.e., sewer, water, storm drain, recycled water) shall be designed using the following design criteria:

- All buried pipes conveying liquids shall be designed for H-20 traffic loads with a minimum of 4 feet of cover.
- Trench section and backfill shall follow City standards including relevant references from the GREENBOOK, WHITEBOOK, and site-specific geotechnical parameters.
- Flexibility shall be provided at structure interfaces to accommodate anticipated settlement based on site-specific geotechnical information via rocker joints, harnessed couplings, or other means acceptable to the City.
- In accordance with the State Water Resources Control Board, Division of Drinking Water criteria, a minimum 10-foot edge-to-edge horizontal separation and a minimum 1-foot edge-to-edge vertical separation shall be maintained between potable water and sewer,

storm drain, and recycled water lines where feasible. Potable water shall always cross above sewer, storm drain, and recycled water lines. Where the 10-foot horizontal separation is not feasible, 4-foot minimum horizontal separation and 1-foot vertical separation shall be maintained, and additional protective measures for the potable water line shall be implemented. Additional protective measures include using welded joints for the potable water line, concrete encasement of either of the pipes, or sleeving of either of the pipes. Review and written approval by the State Water Resources Control Board's Division of Drinking Water shall be obtained for separation deviations between water, sewer, or reclaimed water.

5.3.1 PRESSURE PIPING

Pressure piping shall be designed using the following design criteria:

- Pressure piping shall be American Water Works Association (AWWA) C200 welded steel pipe in accordance with AWWA C206 or AWWA C150/C151 ductile iron pipe.
- Pressure piping shall be designed to minimize changes in slope direction. Air release assemblies shall be provided at local high points and blowoff assemblies at local low points.
- Flow velocity shall be a maximum of 8 fps with a regular minimum velocity of 2 fps to prevent sedimentation of solids.
- Thrust restraint shall be provided via thrust blocks (San Diego Regional Standard Drawing SDW-151), restrained joints, or a combination of restrained joints and thrust blocks. Restraint of upward thrust shall be provided using restrained joints, not concrete blocks.
- Connections to existing pressure piping shall be made using restrained joints.
- Connections to existing active pressure piping shall be made using service saddles or tapping sleeves. Direct tapping is not permitted.

5.3.2 GRAVITY PIPING

Gravity piping shall be designed using the following design criteria:

- Gravity piping shall be AWWA C906 HDPE pipe or American Society for Testing and Materials (ASTM) D3034 polyvinyl chloride (PVC) pipe material. See Section 8.10, Plumbing sections for details on plumbing pipe materials.
- Gravity piping slope shall be a minimum 0.5% and designed to convey anticipated peak flows without exceeding 70% flow depth by diameter.
- Connections to existing gravity piping shall be made using restrained joints and without affecting the existing pipe capacity through changes in slope or diameter.

5.3.3 CORROSION CONTROL

Corrosion is an undesirable degradation of material resulting from a chemical or physical reaction with the environment. Corrosion control shall be designed using the following design criteria:

- Exterior coatings of buried metallic piping shall be cement mortar per AWWA C205 or asphaltic material.
- Pressurized stormwater and sewer piping shall be lined with epoxy.
- Buried metallic piping shall be encased in polyethylene sheeting per AWWA C105.
- Connections between pipes of dissimilar metals shall be avoided where practical. Where not possible, insulating joints shall be provided to avoid direct contact between the dissimilar metals.
- Buried steel piping shall be equipped with passive galvanic cathodic protection systems using sacrificial anodes.

5.4 GAS SERVICE

To meet the magnitude of the climate change crisis, the City is setting an ambitious goal to achieve net zero greenhouse gas (GHG) emissions by 2035. The Climate Action Plan (CAP) is the City's policy commitment to set clear goals to reduce GHG emissions. Accordingly, natural gas shall not be permitted as source of energy to power stormwater pump stations.

5.5 ELECTRICAL SERVICE

Electrical service to pump stations shall be coordinated with San Diego Gas & Electric and in accordance with their latest version of the Service Standards & Guide.

5.6 COMMUNICATIONS

Communication cables such as fiber optics and those used for security shall be designed in accordance with Chapters 10 and 11 of these Guidelines.

5.7 BUILDINGS AND ENCLOSURES

Buildings consist of structures with a roof and walls, whereas an enclosure is an area that is sealed off with a natural or artificial barrier. Buildings and enclosures shall be designed using the following design criteria:

- The finished floor for new buildings shall be set at a minimum of 4 inches above surrounding grade or as required to avoid settlement-related drainage issues based on site-specific geotechnical information.
- Under City requirements, the minimum elevation of the finished first floor of any building is 2 feet above the 100-year frequency flood elevation.
- Expansions to existing buildings shall match the existing building finish floor where practical. If the existing building finished floor is below the 100-year flood elevation, the floor should be raised, or other mitigation measures should be put in place to prevent flooding or minimize flooding impacts.

- Where new buildings replace existing buildings, the new building finished floor shall meet the previously stated requirement of being at least 2 feet above the 100-year frequency flood elevation.

5.8 ACCESS AND PARKING

Site access and parking shall be designed using the following design criteria:

- Sites shall include a 26-foot minimum width paved asphalt access road to provide adequate access for staff vehicles, including crane trucks and vactor trucks. Where existing site access roads are less than 26-foot wide and there is no opportunity to widen, an exception can be considered. However, minimum access shall comply with FPB Policy A-14-1, Fire Access Roadways.
- Access roads shall be provided to all stormwater management appurtenances (maintenance holes, cleanouts, outfalls, etc.).
- Pump station sites shall be arranged to allow a boom truck to lift major equipment such as pumps and motors completely out of the pump station. The availability of adequate flat firm ground for boom trucks shall be verified.
- The site shall allow for vactor truck access to the wet well. This shall include a clear path from the wet well access hatch to the bottom of the well. The hatch shall be located such that a standard City vactor truck boom arm can adequately reach the hatch and perform required cleanings.
- At large pump stations (refer to Table 4-2), sufficient parking shall be provided for two 3-ton maintenance trucks and a 10-ton boom truck or a space for a truck-mounted crane sized for the heaviest equipment in the pump station.
- At small pump stations, sufficient parking shall be provided for one 3-ton maintenance truck.
- Access roads and parking shall not be located above inlet or discharge piping penetrations to pump station walls.
- Layouts shall provide sufficient emergency vehicle access per California Fire Code (CFC) Section 503 and comply with FPB Policy A-14-1, Fire Access Roadways. This Policy clarifies San Diego Fire Rescue Department's fire apparatus access roadway requirements as outlined in CFC Section 503 including minimum roadway width, vertical and horizontal clearances, distance from buildings, maximum grades, pavement design loads, turning radius, red curbs, and signage. Sufficient access for maintenance vehicles shall also be provided.
- Coordination with architectural and City staff shall be undertaken for signage and striping requirements, including fire lane delineation.

5.9 PAVEMENT

Pavement shall be designed using the following design criteria:

- The majority of site paving shall be asphaltic concrete with a structural section designed in accordance with the site-specific geotechnical parameters. Structural sections of asphalt concrete pavement shall be designed to accommodate the heaviest vehicles anticipated over the pavement lifetime, including cranes, vactor trucks, and construction equipment.
- Portland cement concrete for sidewalks, driveways, and equipment pads shall be minimum 3,000 psi compressive strength. Concrete shall meet the requirements of City Standard Drawings SDG-159 (560-C-3250). Pavement sections shall be designed by a civil or geotechnical engineer.
- Special areas where heavy loading is anticipated such as crane pads shall be paved with Portland cement concrete with a structural section and mix design sufficient for the anticipated loading.

Chapter 6 Architectural

This section provides a general basis for the approach to architectural design of pump stations. The following guidelines and criteria are provided to ensure a consistent and thorough design process for each pump station.

6.1 ARCHITECTURAL DESIGN REQUIREMENTS

The architectural design of the building and all its components shall comply with applicable state, local, and federal codes and standards.

6.1.1 CODES AND STANDARDS

- California Building Code 2022 (CBC) plus San Diego local amendments.
- California Fire Code 2022 (CFC) plus San Diego local amendments.
- California Energy Code 2022 (International Energy Conservation Code) plus San Diego local amendments.
- Life Safety Code (National Fire Protection Association [NFPA] 101).
- Occupational Safety and Health Administration (OSHA).
- Americans with Disabilities Act Accessibility Guidelines (ADAAG).
- Accessible and Usable Buildings and Facilities International Code Council (ICC) A117.1-2009.
- City Council Policy 900-03, ZEMBOP.

6.1.2 CODES EVALUATION

Pump station design shall be compliant with the following:

- Pump stations are exempt from ADA based on 2010 *ADA Standards for Accessible Design*, Section 203.5: "General Exceptions; Machinery Spaces: Spaces frequented only by service personnel for maintenance, repair or occasional monitoring of equipment shall not be required to comply with these requirements or to be on an accessible route. Machinery spaces include, but are not limited to…, water or sewage treatment pump rooms and stations; electrical substations and transformer vaults; and highway and tunnel utility facilities."

  Except for regular monitoring and maintenance of equipment, pump station buildings are not intended for human occupancy for extended periods of time. The primary purpose of a pump station building is to house processing equipment for water conveyance.
- The building shall have a sufficient number and location of emergency exits, fire detection and suppression system, design of zones of safety, horizontal and vertical clearances, and other personal safety, acoustic, and lighting safety provisions.

- Thermal performance of building elements such as walls, windows, and doors shall comply with the requirements of the energy code.
- The buildings shall comply with the building code regarding its occupancy classification, construction type, allowable area, and height.

6.2 ARCHITECTURAL DESIGN APPEARANCE GUIDELINES

Pump station design shall comply with the following architectural appearance guidelines:

- In cases where pump stations are located aboveground, the Design Consultant shall provide architectural design for the pump station structures taking into consideration functional requirements with considerations to aesthetics.
- Functionality of the pump station and health and safety requirements shall always take precedence over aesthetics.
- The proposed design should blend with surroundings and reflect local culture and heritage wherever possible. Material selection shall prioritize ease of maintenance, durability, and longevity. Preference shall be given to environmentally friendly and locally produced and sourced materials.

The criteria for the appearance and physical performance of the structural system and building envelope shall meet the City's requirements. The architectural design shall be developed in character, style, form, color, and materials to harmonize effectively with its surrounding environment. Suggested design parameters to assist in these aspects of the design of pump stations include:

- **Height of Structures.** The facilities are kept as low in profile as is functionally possible. Where appropriate, the design should de-emphasize verticality and encourage the grounding of planar elements of the facility into the natural landscape.
- **Reflective Finishes.** Visible and highly reflective materials and surface finishes should be avoided on the exterior of the facility.
- **Exterior Walls**. Low-maintenance indigenous materials such as masonry and concrete shall be used for the exterior walls of the facility. Concrete masonry units exposed to the exterior shall receive a spray-applied, clear penetrating sealer with anti-graffiti control system. All exterior walls shall be fully grouted and reinforced as required by the code and/or contract documents. If insulation is required per the energy code, rigid insulation shall be installed on the inside face of the exterior walls with z-furring channels and covered with $^{5}/_{8}$-inch type-x gypsum boards.
- **Roof.** The design of roof systems should be carefully developed to harmonize with the visual context of the facility. Pitched roofs are desired, and consideration is given to selecting pitch, materials, and coloration to harmonize with the surroundings. Highly reflective roof surfaces shall not be visible from adjacent properties. Securable skylights or access hatch shall be provided for ease of equipment removal using a mobile crane. The roof system shall meet UL Class A rating and satisfy wind uplift requirements for the area. The insulation shall conform to the energy code requirements.
- **Windows.** Where windows are appropriate to the design, they should be selected for energy efficiency, acoustic characteristics, and security. Glazing systems are designed to

avoid light leakage to adjacent properties as direct glare or reflected glare from sunlight. Glass tinting and window frame colors should be chosen for their consistency with the palette of materials and colors selected for the facility.

- **Insets, Grills, Trim, and Accents.** Insets, grills, trim material, and accents should be employed judiciously and only where necessary or appropriate for compatibility with adjacent structures. Insets, grills, trim, and accents shall be consistent with the color palette chosen for the facility and should avoid bold, strong, or reflective colors.
- **Doors and Frames.** Door and frame colors shall be compatible with the wall surface in which they are located. Exterior doors and their frames shall be flush hollow metal steel. Overhead coiling doors will be manual or motor-operated, insulated steel doors with weather-stripping. Six-inch-diameter, concrete-filled, painted bollards shall be provided to protect service entries and any other mounted equipment.
- **Finish Hardware.** All doors shall have heavy-duty steel locksets, latches, privacy sets, and passage sets as required. The function of such hardware shall be appropriate for the door's use. Stainless steel panic hardware shall be used where required by code. Finish hardware specified shall be reviewed by the City in compliance with its standards during design. Louvers with painted aluminum finish shall be provided.
- **Interior Finishes.** Interior finishes in the building shall be as follows: flooring shall be concrete slab with a steel trowel finish and sealed. There shall be no wall base. Walls shall be painted concrete masonry units and painted gypsum board, if any. Exposed structural ceilings shall receive a painted coating.
- **Lighting.** Lighting should satisfy functional and security needs while not creating light pollution in the form of point sources of direct glare visible from a distance. Lighting should be sensitive to the privacy of adjacent land uses. Fixtures should be selected for efficiency, cut-off, consistent lamp coloration throughout the project, and effectiveness in delivering only the light necessary for the task. Natural lighting of the interior of the building shall be in the form of skylights. See Chapter 9, Electrical, and section 11.6.1, Exterior Lighting, for additional lighting requirements.
- **Materials and Safety.** Materials used in the construction of the facility shall conform in composition and application to all applicable regulations, including those concerning volatile organic content, lead, mercury, chlorofluorocarbons, and asbestos.
- **Moisture Protection.** Building insulation shall be provided for roofs and exterior walls and conform to the energy code requirements. A vapor barrier shall be provided along the inside face of the insulation. Caulking, sealing, and moisture protection shall be provided for weather-tight construction for all buildings. A plastic vapor retarder shall be placed over the backfill and under any new concrete floor slabs.
- **Trench Drains.** Trench drains shall be provided in the pump room with a floor sloped toward the trench drain to allow for collection of water in the pump room.
- **Specialties**. Fire protection shall be provided per the appropriate authorities, agencies, and building code.
- **Equipment Pads.** The electrical room floor shall be raised to prevent water from migrating to the room. A minimum of 4-inch housekeeping pads shall be provided underneath all electrical cabinets and equipment

- **Signage for Room Type, Area, or Special identifications.** Restrictive/caution and hazard identification signages shall be provided per the appropriate authorities, agencies, and building code for applicable areas.
- **Signage for the Pump Station.** Signage for the pump station shall be provided on the front entry wall and on the entry gate of the facility.
  - The signs shall be high-performance fiberglass, constructed of a printed polyester film permanently bonded to a rigid fiberglass panel and over-laminated with a total thickness of 0.10-inch minimum.
  - Signs shall be suitable for interior or exterior use, and resist ultraviolet light, dirt, and harsh chemicals.
  - Signs shall be 24 inches wide by 16 inches tall, with rounded corners.
  - Signage shall be provided to match the sample shown on Figure 6-1, with the following information: SWD logo, capitalized stormwater pump station letter, address, and emergency contact number.

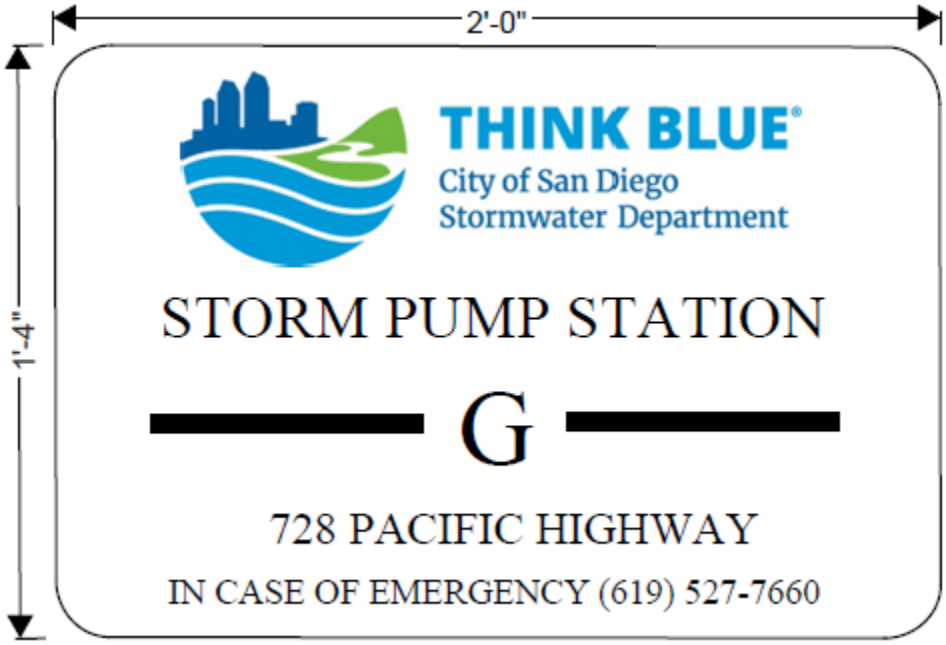

Figure 6-1. Example of Stormwater Pump Station Signage

Signage for Area Subject to Potential Localized Flooding. Flashing warning signs and/or drop gates shall be provided for areas where there is potential localized flooding (e.g., pumped roadway under crossings). Signs shall be activated when wet well water levels surcharge to the roadway.

Chapter 7 Structural

The structural design requirements apply to the design of concrete, masonry, and steel structures. The structures anticipated for all pump stations include portions of underground reinforced concrete, above-grade masonry buildings with steel-framed roofs with metal deck, and concrete mat foundations. Structural review shall be performed by the DSD, Building and Safety Plan Review. New building regulations are adopted under the SDMC on a regular basis. The structural design criteria shall comply with the current 2022 CBC and standards referenced in the 2022 CBC with the San Diego local amendments to the CBC.

7.1 STRUCTURAL DESIGN CODES AND STANDARDS

The following codes, specifications, and standards shall apply to the structural design for all pump stations. Unless specifically stated otherwise, the edition of all codes enforceable as of April 1, 2023, shall apply.

- SDMC Chapter 14, *General Regulations.*
- 2022 *California Building Code*.
- San Diego local amendments to the 2022 CBC.
- ASCE 7-16, *Minimum Design Loads for Buildings and Other Structures and Supplemental No. 3.*
- American Concrete Institute (ACI) 318-19 (22), *Building Code Requirements for Concrete Structures and Commentary* (reapproved 2022).
- ACI 350-20, *Code Requirements for Environmental Engineering Concrete Structures.*
- ACI 350.3-20, *Code Requirements for Seismic Analysis and Design of Liquid-Containing Concrete Structures.*
- American Institute of Steel Construction (AISC) 341-16, *Seismic Provisions for Structural Steel Buildings.*
- AISC 360-16, *Specification for Structural Steel Buildings.*
- American Welding Society (AWS) D1.1-2015, *Structural Welding Code – Steel.*
- AWS D1.4-2018, *Structural Welding Code – Steel Reinforcing Bars.*
- AWS D1.6-2017, *Structural Welding Code – Stainless Steel.*
- AWS D1.8-2016, *Structural Welding Code – Seismic Supplement.*
- The Masonry Society (TMS) 402 /602–2016, *Building Code Requirements and Specification for Masonry Structures.*
- ACI 350.1-10, *Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary*.
- ACI 301-16, *Specifications for Structural Concrete*.
- ACI 350.2R-04, *Concrete Structures for Containment of Hazardous Materials*.
- Concrete Reinforcing Steel Institute (CRSI) Handbook.
- AISC *Steel Construction Manual,* 15th Edition.

7.2 GENERAL DESIGN REQUIREMENTS

7.2.1 FOUNDATION DESIGN

The structural design of all foundations shall be based upon geotechnical investigations. As a minimum, this shall include recommendations for:

- Foundation type (e.g., spread footings, mat foundations, vaults, minimum width, and depths).
- Soil stabilization or removal and replacement.
- Allowable soil bearing pressure.
- Passive pressure.
- Frictional capacity.
- Compaction requirements.
- Temporary cut slope requirements.
- Shoring recommendations.
- Lateral loads due to surcharge.
- Lateral loads due to hydrostatic pressure if any.
- Soil corrosion potential.
- Deep foundations as necessary to resist gravity and seismic loads.
- Lateral earth pressures, active pressures, and at-rest pressures including seismically induced earth pressures.
- Short- and long-term settlement.
- Potential for liquefaction and soil strength loss, consequences, and mitigation measures.
- Controlled low-strength material.

7.2.2 DEAD LOADS

Dead loads shall consist of the weight of all permanent construction, including walls; floors; roofs; ceilings; stairways; fixed mechanical equipment; HVAC ducting and piping; mechanical distribution systems; and electrical distribution systems. In estimating dead loads for purposes of design, the actual weights of materials and construction shall be used. Dead loads shall consider the following:

- Weight of structure, including tank operating weights.
- Weight of pipe and valves, including the weight of contents.
- Weight of mechanical and electrical equipment.
- Weights of mechanical and electrical distribution systems.

7.2.3 LIVE LOADS

Live loads are those loads produced by the use and occupancy of a building or structure and do not include environmental loads such as wind load, snow load, rain load, earthquake load, or dead load. Live loads on a roof are those produced (1) during maintenance by workers, equipment, and materials, and (2) during the life of the structure by people and by movable objects such as planters. Live loads shall consider the following:

- The live loads assumed in the design of the building and other structures are the maximum loads likely to be produced by the intended use. Live loads are in no case less than the minimum uniform or concentrated loads required by the 2022 CBC Table 1607.1.
- Unless otherwise indicated, the following minimum live loads are used:
  - Mechanical and operating forces and reactions.
  - Reactions due to hydraulic thrusts.
  - Pump station floor slab: 300 pounds per square foot (psf).
  - Roofs that require vehicular access for maintenance: H-20 traffic loads.
  - Walkways, platforms, and stairs: 100 psf uniform load.
  - Concentrated live load of 2,000 pounds minimum on any floor span supporting a tributary area greater than 200 square feet.

7.2.4 VEHICLE LOADS

All new underground structures subject to traffic loading shall be designed to withstand standard H-20 vehicle loading as defined in Caltrans *Bridge Design Specifications* Section 3. Construction vehicle loading that exceeds the standard Caltrans H-20 loading shall be considered individually for each case. Impact loading shall be calculated as outlined by Caltrans *Bridge Design Specifications* Section 3.

7.2.5 WIND LOADS

Wind loads shall be determined and applied in accordance with the ASCE 7 and CBC, or with the requirements of local code, whichever is more stringent. The design is governed by maximum wind or maximum seismic load, whichever is greater.

7.2.6 FLOOD LOADS

The flood loads shall be applied per Section 1603.1.7 of 2022 CBC as needed by the final geotechnical investigation report.

7.2.7 TSUNAMIC LOADS

Tsunamic loads shall be considered for design per DSD recommendation, Tsunami Loads, ASCE 7 Chapter 16. Tsunami risk category III shall be assumed for the design if the structure is located in the tsunami zones defined in the Tsunami Design Geodatabase.

7.2.8 SEISMIC LOADS

Seismic forces shall be verified with site-specific geotechnical reports commissioned by the Design Consultant as part of detailed design. Assume Risk Category III when determining importance factors in accordance with the 2022 CBC (ASCE 7-16) or ACI 350.3 as applicable, which equates to I_e = 1.25. The site-specific seismic parameters shall be determined by the geotechnical engineer.

7.2.9 HYDRAULIC STRUCTURES

Design shall be based on ACI 350-06, Code Requirements for Environmental Engineering Concrete Structures, and ACI 350.3-06, Seismic Design of Liquid-Containing Concrete Structures.

7.2.10 EQUIPMENT ANCHORAGE

Anchorage of equipment shall be based on 2022 CBC criteria, which in general reference the requirements in ASCE 7-16 Chapter 13. Cast-in-place anchors shall be used whenever possible. Adhesive anchors, specifically Hilti HIT-RE 500 Adhesive, shall be used in accordance with the requirements listed under Section 7.3.5, Structural Bolts. No cinch anchors, expansion anchors, or chemical anchors are acceptable for equipment anchorage.

For all equipment weighing 400 pounds (181 kilograms) or more with the center of mass located 4 feet or more above the adjacent floor level, the minimum anchor bolt (including adhesive anchor rods) diameter is 0.5-inch with minimum 5-inch embedment. The minimum anchor rod diameter for all other equipment is $^3/_8$ inch with minimum 3-inch embedment.

7.2.11 FALL ARREST DAVITS OR TIE-OFF POINT ANCHORAGE

Anchorage for the fall arrest davits or tie-off points shall be designed to resist at least 5,000 pounds for each attached line, in any direction (including safety factor for shock loads), per OSHA and CBC 2022.

7.3 STRUCTURAL MATERIALS

Structural materials shall meet the following design criteria:

7.3.1 CONCRETE

Concrete shall have an f'c = 4,500 psi minimum for all, except the following:

- f'c = 3,000 psi: Curb and gutter, drainage structures, sidewalks, pavements, fence and guard post embedment, and underground pipe encasement.
- f'c = 2,000 psi: Reinforced thrust blocks and concrete fill for structural foundations.
- f'c = 5,000 psi: Precast concrete.
- f'c = 1,700 psi: Electrical duct bank red concrete encasements.

7.3.2 REINFORCEMENT

Reinforcement shall meet the following design criteria:

- Reinforcing steel bars shall be ASTM A615 Grade 60 with fy = 60 (ksi).
- Welded wire fabrics shall be ASTM A1064 with fy = 70 ksi.
- Reinforcing steel bars where welding is required shall be ASTM A706 Grade 60.

7.3.3 STRUCTURAL STEEL

Structural steel shall meet the following design criteria:

- "W" Shapes: ASTM A992 with a specified yield strength of 50 ksi.
- Other shapes, bars, and plates: ASTM A36 with a specified yield strength of 36 ksi.
- Pipe: ASTM A53, Grade B, with a specified yield strength of 35 ksi.
- Tubing: ASTM A500, Grade B, with a specified yield strength of 42 ksi.

7.3.4 MASONRY

Masonry shall meet the following design criteria:

- All masonry shall be 8-inch nominal (or larger) concrete masonry unit block wall construction with all cells fully grouted.
- All masonry joints shall be shown on the plan or wall details.
- f'm = 2,000 psi with type M or S mortar.

7.3.5 STRUCTURAL BOLTS

Structural bolts shall conform to ASTM A325 Type 3 bolts with threads included in the shear plane.

7.3.6 CONCRETE ANCHORS

Concrete anchors shall be designed using the following design criteria:

- Anchors in normally dry environments shall conform to ASTM F1554, Grade 36, galvanized in accordance with ASTM A153, and shall be designed in accordance with ACI 318-19, Chapter 17. Anchors immersed in water, intermittently or continuously, or in a moist environment shall be stainless steel type 316.
- Post-installed anchors (adhesive or expansion) have current ICC Evaluation Service or IAPMO Uniform Evaluation Service Reports.
- Adhesive for anchorage and doweling into hardened concrete shall be two-component and insensitive to moisture. Adhesive anchors immersed in water, intermittently or continuously, or in a moist environment shall be stainless steel straight-threaded anchor bolts complying with ASTM F593, American Iron and Steel Institute (AISI) Type 316,

Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts shall be provided.

- Expansion anchors shall only be used for the installation of light metal accessories. Expansion anchors in normally dry environments shall be hot-dip galvanized or stainless steel. Expansion anchors immersed in water, intermittently or continuously, or in a moist environment shall be stainless steel. All components of expansion anchors shall be stainless steel type 304 or 316. Expansion anchors shall not be used in applications that are subjected to vibrations or impact loads. Drop-in anchors shall not be used in applications to resist seismic or wind loading.

7.3.7 WELDING

Welding shall use AWS A5.1 or A5.5 E70XX electrodes.

7.3.8 ALUMINUM

Aluminum structural shapes shall conform to ASTM B308, Alloy 6061-T6. Aluminum plates shall conform to ASTM B221, Alloys 6061-T6511 or Alloy 6063-T52.

7.3.9 STAINLESS STEEL

Stainless steel shall meet the following design criteria:

- Plates: ASTM A240, Type 304 or 316.
- Plates: ASTM A240, Type 304L or 316L where welding is required.
- Plates: ASTM A240, Type 316 or 316L used in water or moist environments.
- Shapes: ASTM A276, Type 304 or 316.
- Shapes: ASTM A276, Type 304L or 316L where welding is required.
- Shapes: ASTM A276, Type 316 or 316L used in water or moist environments.

7.4 STRUCTURAL DESIGN METHODS AND ASSUMPTIONS

Structural designs shall be prepared in accordance with recognized engineering principles and accepted practices established by building codes and the codes/standards published by various professional institutions.

7.4.1 REINFORCED CONCRETE DESIGN

Reinforced concrete shall be designed using the following design criteria:

- Non-hydraulic/Water Bearing Structures: Strength design method in accordance with CBC Chapter 19 and ACI 318-19.
- Hydraulic: Design shall be based on ACI 350-06 and ACI 350.3-06.
- Testing Reinforced Concrete Hydraulic/Water Bearing Structures: Shall be based on ACI 350.1-10.

- Underground reinforced concrete structures subjected to traffic loading shall be per Caltrans *Bridge Design Specifications* Section 3.

7.4.2 STRUCTURAL STEEL DESIGN

Structural steel shall be designed using the following design criteria:

- All structural steel shall be designed per the AISC *Manual of Steel Construction* 15th edition and per the AISC *Seismic Design Manual* 3rd edition.
- All steel framing for platforms, stairways, hatches, or steel exposed to earth or weather shall be hot-dip galvanized in accordance with ASTM A123.
- Cold-formed steel structural designs shall be in accordance with the provisions of the AISI Specifications (AISI S100-16 w/ S2-20, AISI S202-20, and AISI S204-20).
- AISC *Structural Design Guide 01* 2nd edition by AISC Steel Design Guide shall be used for base plate and anchor rod design.
- AISC *Structural Design Guide 24* by AISC Steel Design Guide shall be used for hollow structural section connections.

7.4.3 MASONRY WALL DESIGN

Masonry walls shall be designed using the following design criteria:

- All masonry designs shall be designed per TMS 402/602-16, *Building Code Requirements and Specification for Masonry Structures*.
- The plan or wall elevations shall show all necessary masonry control joints per the code.

7.4.4 GRATING DESIGN

Grating shall be designed using the following design criteria:

- Weight of grating or plate segment shall be limited to 80 pounds maximum.
- Steel bar grating shall be welded, type W-19, designed for a uniform distributed live load of 100 psf or the actual applied loads, whichever are greater, and a deflection of $^{1}/_{240}$ of the span or ¼-inch maximum. All grating shall be galvanized in accordance with ASTM A123.
- Fiberglass reinforced plastic (FRP) grating shall be vinyl ester fire retardant (VEFR) pultruded fiberglass grating wherever possible and one piece-molded construction at all other locations that require a slip-resistant surface. Resin for FRP grating shall be vinyl ester to provide maximum corrosion resistance. FRP grating shall be used for all platforms or walkways.

7.4.5 STEEL PLATE DESIGN

Steel floor plates shall be designed to conform to ASTM A36 steel and shall be designed for a uniform live load of 100 psf or the actual applied loads, whichever are greater, and a deflection of $^{1}/_{240}$ of the span or ¼-inch maximum. Steel floor plate shall have a raised pattern in accordance with ASTM A786 Pattern No. 4 or No. 5. Floor plates shall be galvanized in accordance with ASTM A123. Plates immersed in water, intermittently or continuously, or in a moist environment shall be stainless steel type 316.

Chapter 8 Mechanical

8.1 CODE REQUIREMENTS AND INDUSTRY STANDARDS

Stormwater pump stations and ancillary facilities shall conform to the latest editions of all applicable local, state, and federal regulations and industry standards.

The building mechanical design shall be in accordance with applicable industry codes and standards. The following is a list of applicable codes that will be followed in the mechanical design. Unless specifically stated otherwise, the latest editions of all codes will apply.

- CBC with San Diego County and City of San Diego amendments.
- California Fire Code with San Diego County and City of San Diego amendments.
- California Mechanical Code with San Diego County and City of San Diego amendments.
- California Plumbing Code with San Diego County and City of San Diego amendments.
- *ASHRAE Fundamentals Handbook.*
- California Energy Conservation Standards Title 24.
- Cal/OSHA standards.
- NFPA 70, National Electrical Code (NEC), with San Diego County and City of San Diego amendments.
- NFPA 13, *Standard for the Installation of Sprinkler Systems*.
- NFPA 30, *Flammable and Combustible Liquids Code*.
- NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems.*
- NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities.*
- SMACNA duct construction standards.
- City Council Policy 900-03, ZEMBOP.

The design of pump stations will follow the industry standards published by the following organizations. For any specific pump station design, not every standard published by the following organizations will apply. It is the Design Consultant's responsibility to identify the publications relevant to the specific pump station design. Unless specifically stated otherwise, the latest editions of all standards will be followed.

- ANSI/HI standards.
- Anti-Friction Bearing Manufacturers Association (AFMBA) Standards.
- ASME standards.
- ASTM standards.
- AWWA standards.
- Foundation for Cross-Connection Control and Hydraulic Research (FCCCHR) standards.

8.2 ENERGY EFFICIENT DESIGNS

Pump stations shall be designed for energy efficiency including, but not limited to, designing the pump station with all-electric mechanical equipment that is required to pump stormwater out of the pump station; to operate, drive, and control the pumps; and to provide ventilation and cooling. Pumps shall be designed and specified to operate within the pump's preferred operating range as defined by the pump manufacturer, and the design operating condition should be within 10 to 15% of the best efficiency point as defined by the pump manufacturer. The design shall be coordinated with San Diego Gas and Electric Company (SDG&E) and its contracted agencies to implement design features that receive all available energy-saving incentives and grants that apply.

8.3 EQUIPMENT

The design of a pump station shall include all mechanical equipment required to pump stormwater out of the pump station; to operate, drive, and control the pumps; to access and remove the pumps from the wet well; to screen and remove debris and trash in the incoming water source before it enters the pump station wet well; to provide ventilation and cooling; and to provide utility water and drainage.

The requirements for the following major design components are provided in other sections of this document. Refer to the section noted below:

- Pumps: Chapter 4, Pump Station.
- Motors: Section 9.1, Motors.
- Trash capture devices: Section 4.11, Trash Capture Devices.

Requirements for additional mechanical equipment are given in this chapter.

All equipment shall be designed to be properly installed, anchored, and restrained. Working clearance shall be provided around all equipment equal to a minimum of 36 inches. All equipment shall be provided with corrosion-resistant coatings on the exterior and in interior wetted parts that are suitable for the service and location the equipment is intended for.

8.4 EQUIPMENT AND DEVICES IDENTIFICATION

Equipment and devices shall be identified in accordance with the following design criteria:

- Identification labels are required for all pipes using color bands, lettering, flow direction arrows, and related permanent identification devices, and all appurtenant work. The Contractor shall submit the manufacturer, color, description, and the quantity of markers and include these items in the Operations Manual.
- Pumps, valves, and other appurtenant work shall have identification tags with equipment tag numbers as identified in the design. Tags for equipment shall be provided on material that will not discolor or erode from corrosion.
- See Appendix B – Design Checklist for additional identification requirements for equipment, valves, and piping.

8.5 PIPING

Piping shall be designed using the following design criteria:

8.5.1 PIPE SIZE

Pipe sizes shall be selected to maintain the fluid velocities within the minimum and maximum velocities indicated in Section 4.8.6 Pipe Design Velocity.

8.5.2 PIPE MATERIAL REQUIREMENTS

The piping material shall be selected in accordance with the current issue of the City of San Diego Public Utilities Department Approved Materials List. Piping materials currently used by the City should be used unless specific design requirements require another material. Currently approved materials that are allowed for use for stormwater pump stations are:

- Ductile iron (DI)
- Steel (STL)
- Reinforced Concrete Pipe (RCP)
- Polyvinyl Chloride (PVC)
- High Density Polyethylene (HDPE)

Exposed piping shall be flanged or connected by restrained flexible couplings. Pump discharge piping material shall be either ductile iron or steel.

8.5.3 DUCTILE IRON PIPE

Pipe shall conform to AWWA C-150 and C-151. Pipe thickness design shall be per AWWA C-150. Flanges shall be a minimum of 125-pound pressure class. Rubber-gasket joints shall conform to AWWA C-111. The installation of ductile iron pipe and its appurtenances shall conform to AWWA C-600.

8.5.4 STEEL PIPE

Steel pipe shall be designed using the following design criteria:

- Steel pipe 6 inches and larger shall conform to the AWWA C200 standard. Exposed steel piping inside stations shall be flanged or connected by flexible coupling. Flanges shall be a minimum of Class D.
- Steel pipe smaller than 6 inches shall conform to ASTM A53, Schedule 40. Exposed steel piping inside stations shall be flanged or connected by flexible coupling. Flanges shall be a minimum ASME B16.5 Class 150.

8.5.5 REINFORCED CONCRETE PIPE

RCP is preferred. The selection of pipe material shall consider factors such as strength of the conduit under maximum or minimum cover, bedding and backfill conditions, anticipated loading,

length of sections, ease of installation, corrosive action of surrounding soils, expected deflection, and cost of maintenance. Where field conditions indicate the use of one pipe material in preference to others (for instance, corrosive soil conditions, presence of a groundwater table, or a seawater outfall), the reasons shall be clearly presented in the plans and specifications. Pipe shall be designed in accordance with the Drainage Design Manual.

8.5.6 POLYVINYL CHLORIDE PIPE

Polyvinyl chloride pipe shall be designed using the following design criteria:

- Buried Pipe: PVC pipe 4 inches through 60 inches in diameter shall conform to AWWA C-900. The dimension ratio for PVC pressure pipe shall not exceed 18. Bell and spigot pipe or gasketed couplings shall be used. Pipe-to-fitting connections shall be mechanical joint only.
- Exposed Pipe: PVC Schedule 80 with solvent cement or flange joints. PVC pipe is only allowed for ancillary services at pump stations. The discharge piping from the stormwater pumps shall not be PVC.

8.5.7 HIGH-DENSITY POLYETHYLENE

HDPE pipe shall conform to AWWA C-906 with material conforming to pipe material designation code PE 4710. The pipe dimension ratio shall not exceed 17. HDPE piping may provide some advantages at specific locations where corrosion and significant settlement are expected. The feasibility of using HDPE as an alternative to other materials shall be evaluated during the design phase.

8.5.8 LININGS AND COATINGS

The term “linings” describes materials applied to the pipe interior for corrosion protection. The term “coatings” refers to materials applied to the exterior of the pipe including tape coatings for corrosion protection. The lining and coating materials shall be capable of performing the desired function in a safe and economical manner, and the materials shall operate satisfactorily over the design life of the facility. Linings and coatings shall be designed using the following design criteria:

- All discharge pipes shall be lined on the inside with a smooth epoxy material. The lining for ductile iron and steel pipes shall be factory-applied PROTECTO 401 ceramic epoxy or approved equal. The minimum dry film thickness will be 16 mils.
- The Design Consultant shall refer to geotechnical reports for the pump station location and select a coating that is appropriate given the soil conditions, soil corrosivity, and groundwater levels. At a minimum, buried pipe shall be provided with an outer protective coating of cement, epoxy, or coal-tar coating and if warranted combined with a tape wrapping. Buried ductile iron pipe, fittings, and couplings shall be wrapped with polyethylene film in tube form.
- Linings and coatings shall be shop-applied to the maximum extent possible due to the higher quality control achieved with a shop application. Epoxy lining and coating on steel pipes shall be per the requirements of AWWA C210.

- Linings and coatings requirements are described in more detail in the City of San Diego *Water Facility Design Guidelines*, Chapter 7: Corrosion Control Design Criteria.

8.6 VALVES

The following valves shall be provided for flow control and shutoff, equipment isolation, and instrument isolation purposes.

- Wet well inlet isolation: gate valves are preferred by the City and allowed on wet well inlet piping sized 24 inches and smaller. Slide gate valves should be used for inlets larger than 24 inches.
- Pump suction piping isolation: plug valves are the preferred type; gate valves or knife gate valves may be considered if there are space limitations. This requirement does not apply to SPWW and VSPD arrangements.
- Pump discharge piping isolation: plug valves are the preferred type; gate valves or knife gate valves may be allowed; butterfly valves may only be considered for pipe with diameter larger than 24 inches. One isolation valve shall be installed on the discharge piping from each pump, upstream of the point where individual pump discharge lines combine into a common header.
- Pump discharge backflow prevention: one check valve shall be installed on the discharge piping from each pump.
- Instrument and appurtenance isolation: a ball isolation valve shall be installed on the branch of utility water lines at each pressure gauge, switch, transmitter, air valve, or any other appurtenance.

8.6.1 VALVE REQUIREMENTS

Valve size shall be chosen so that flow velocities meet the maximum velocity criteria for pump suction and discharge piping given in Chapter 4. Design criteria for each individual valve type are as follows.

8.6.1.1 Slide Gates

Slide gates shall only be used at inlets to wet wells and partition walls between wet wells. Slide gates shall meet the requirements of AWWA C561, *Stainless Steel Slide Gates*, be of a self-contained design, and be constructed of type 316 stainless steel with ultra-high-molecular-weight polyethylene (UHMWPE) side and top seals.

8.6.1.2 Plug Valves

Plug valves are the preferred valve type for any stormwater pipeline isolation and should be used unless site constraints or other factor limit the use of plug valves. Plug valves for stormwater service shall conform to AWWA C517, *Resilient-Seated Cast-Iron Eccentric Plug Valves*. The valves shall be non-lubricated, eccentric plug design.

- The plugs shall be totally encapsulated with a resilient material best suited for the service.
- Valves up to and including 20-inches in size shall have an unobstructed port area of not less than 80 percent of full pipe area, and not less than 70 percent for larger valves.

- The stem seal shall consist of field adjustable packing, replaceable without removal of the actuator, or of self-adjusting U-cup packing

8.6.1.3 Knife Gate Valves

Knife gates shall be limited to isolated applications where the maximum hydraulic head is less than 20 feet and space is restricted. When used, knife gates shall have a resilient seated design and cast 316 stainless-steel construction.

8.6.1.4 Gate Valves

Gate valves can be used as manually or electrically operated isolation valves in horizontal lines with valve stems oriented vertically upward to 45 degrees.

- Resilient seated gate valves, 3- to 12-inch diameter: use an outside stem and yoke (OS&Y) gate valve in exposed locations. Use a non-rising stem gate valve in buried locations. Gate valves shall be full port, with a cast-iron valve body and gate with styrene butadiene rubber resilient seats. Gate valves shall comply with AWWA C509, *Resilient-Seated Gate Valves for Water Supply Service*.
- Resilient seated gate valves, 14- to 36-inch diameter: use a non-rising stem, full port, ductile iron valve with bonded styrene butadiene rubber ductile iron gate and Buna-N stem seals. Valves shall comply with AWWA C509, *Resilient-Seated Gate Valves for Water Supply Service*.

8.6.1.5 Butterfly Valves

Butterfly valves may be used on discharge piping for locations sized 16 inches and larger. Valves shall be rubber-seated butterfly valves, with flanged ends. Valves shall comply with AWWA C504, *Rubber-Seated Butterfly Valves*.

8.6.1.6 Swing Check Valves

Swing check valves shall have an air-cushioned, counterbalanced swing arm. The valves shall be of either cast-iron or steel with a replaceable bronze or Buna-N seat ring. Swing check valves shall be mounted in horizontal piping only. They shall be located outside the wet well.

8.6.2 VALVE AND GATE ACTUATORS

Valve and gate actuators shall be designed using the following design criteria:

- Gates with an actuator extension shall be provided with a 2-inch square nut accessible at grade. Extension guides shall be provided at a maximum of 10-foot spacing.
- Buried valves shall be minimized in pump station applications and located in an accessible vault wherever possible. Buried valves in pipelines shall have a 2-inch square nut with extension stem as required for the nut to be accessible at grade. A cast-iron or plastic valve box shall be installed around the extension stem of a valve when it is not feasible to provide a vault that allows for full accessibility to the valve.
- Handwheels shall be provided for manually operated gate valves and butterfly valves. Gear operators will be required for gate valves 20 inches and larger. Chain actuators are required for valves 6 feet or higher from the finished floor to valve centerline.

- Where required, electric motor actuators shall be specifically designed for valve operator service. For large actuators (pipe sizes greater than 6 inches) they shall have a 480-volt/60Hz/3-phase totally enclosed non-ventilated motor with Class F insulation designed for Class B temperature rise, thermal overload protection, a manual handwheel, a positive clutch mechanism to engage or disengage the handwheel, 120-volts alternating current (VAC) space heaters, torque limit switches, and a control station that includes open/close pushbuttons, indicating lights, and remote/local switch. For small actuators (pipe sizes 6 inches or less) shall have a 120-volt/60Hz/1-phase.
- Valve Access Requirements: all valves shall be installed using sound ergonomic principles. Designs must comply with all OSHA and Cal/OSHA applicable ergonomic rules in effect at the time of engineering, specifically:
    a. Valves must be easily accessible, with adequate clearances so that operators can work with and around them.
    b. Installation of valves that require operation with chain operators shall be minimized. In general, valves shall not be more than 5 feet above ground.

8.7 SUPPORTS AND RESTRAINT

All equipment supports, anchors, and restraints shall be adequately designed for static, dynamic, wind, and seismic loads.

Piping systems and pipe connections to equipment shall be properly anchored and supported to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, and forces applied during construction as well as stresses on piping, equipment, and structures.

8.7.1 PIPE SUPPORTS

Pipe supports shall be designed using the following design criteria:

- The spacing of pipe supports depends on the beam strength and rigidity of the pipe material and on bearing considerations at the supports. Supports must be designed to provide anchorage and axial movement, as required by pipeline construction.
- Piping supports shall be provided for the suction and discharge lines. Piping supports shall be designed to support the piping runs both vertically and horizontally. Pipe bracing shall be provided to resist the maximum expected pressure transient forces.
- Pipe supports and parts shall conform to the requirements of ASME B31.3, *Process Piping*, Chapter 2, Part 5 - *Flexibility and Support*. Design of the pipe supporting elements shall be in accordance with the rules of Manufacturers Standardization Society (MSS) SP-58, *Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation*.
- Pipe that connects to mechanical equipment such as pumps shall be supported by pipe supports connected to the surrounding structure and not by the pump itself.

8.7.2 PUMP BASES

Pump bases shall be designed using the following design criteria:

- Pump concrete support bases shall be monolithically constructed with the dry-well floor concrete pour. Edges of the pump concrete bases shall be chamfered (1 inch minimum). Anchor bolts shall be cast-in-place only and constructed with type 316 stainless steel.
- The pump foundation shall be designed to have a mass five times the mass of the pump, driver, and base plate combined.
- The pump support shall be designed for easy maintenance access. The design shall incorporate a sole plate on top of the pump pedestal that allows the pump to be accurately leveled and eases pump removal and maintenance. The sole plate shall be properly grouted into place to provide firm contact between the pump and the pedestal.
- Pump bases are unique for submersible pumps installed in wet wells and shall be designed to meet the pump manufacturer's recommendation.

8.8 EQUIPMENT ACCESS AND REMOVAL

Access hatches, doors, skylights for each pump, and major mechanical equipment shall be provided. Access shall allow personnel to access, maintain, and remove equipment. Major mechanical equipment is defined as any equipment heavier than 100 pounds. Lifting devices such as a crane or hoist shall be provided, or provision shall be made for use of mobile lifting devices such as davit cranes or truck-mounted cranes for each pump and other major mechanical equipment. Specific requirements for each type of location in the pump station are given in this section.

8.8.1 CLEARANCE REQUIREMENTS

Building dimensions and traveling crane hoists shall be laid out so that all major equipment is under within the range of travel of the crane. The vertical clearance between overhead crane hoists and installed equipment shall be sufficient to lift equipment above other equipment and move it over the other equipment when the crane is in a raised position.

Davit mounting locations for portable davit cranes shall be located so that the distance between the mounting location and the lifting location is 42 inches or less. Where a single davit base is installed to lift more than one piece of equipment, the base shall be located so the lift point for each piece of equipment is within a 42-inch radius of the mounting base.

8.8.2 PUMP ROOM AND DRY PIT

The following requirements apply to SPDP and VSPD pump station arrangements, as defined in Chapter 4, Pump Stations:

- Overhead bridge crane or monorail with motorized hoist and trolley shall be provided in the pump room for lifting and moving equipment across the pump room to a position accessible for equipment maintenance or removal by an external mobile crane.

- If the hoist system installation cannot be accommodated due to space or piping limitations, a wall-mounted, rotating jib crane shall be provided between each pair of installed pumps. This crane shall be equipped with hand chain hoists and shall allow lifting and moving of pumps between the pump base and the floor.
- Lifting eyebolts shall be provided in the ceiling between each installed pump and adjacent wall-mounted eyebolts. Eyebolts shall be mechanically connected to the reinforcing bar with a structural insert. These will be used for installation of hand chain hoists for lifting and moving pumps vertically or horizontally between the pump base and the floor.
- Embedded eyebolts shall be provided on dry pit ceilings to assist in valve or meter removal. Lifting eyes shall be attached directly above the valves and equipment weighing more than 100 pounds in locations where access by bridge crane or monorail is not possible due to the pump station arrangement.
- A heavy-duty rolling ladder shall be stored in the pump room for installation and movement of the mechanical chain hoists.

8.8.3 SUBMERSIBLE PUMP IN WET WELL

The following requirements apply to the SPWW pump station arrangements, as defined in Chapter 4, Pump Stations:

- A crane system type shall be selected to suit the pump's physical size and weight.
- For wet wells without an aboveground superstructure, access hatches shall be provided into the wet well above the pumps. The access hatches shall be sized so that all pumps can be removed through an access hatch when lifted directly upward out of the wet well. A davit crane or jib crane system shall be provided with manual or electric hoists.
- For wet wells with an aboveground superstructure, access hatches shall be provided in the floor of the superstructure that allow the pumps to be removed when lifted directly upward. Where the height of the aboveground structure is not sufficient to allow clearance to fully lift the pump out of the wet well and to a clear area for maintenance and storage, roof access hatches or operable skylights shall be provided above each pump for removal of pumps and motors using mobile cranes or boom trucks. An operable skylight or roof hatch shall be provided above the clear area inside the aboveground structure designated for pump placement after removal.

8.8.4 EQUIPMENT HATCHES

Equipment hatches shall be designed using the following design criteria:

- Both wet wells and dry pits shall be equipped with a large hatch located over all major equipment for equipment installation and removal. Hatches shall be spring balanced requiring a maximum force of 40 pounds to open unless there are specific security concerns that require otherwise. Design Consultant shall consult with the Stormwater Department Operations team.
- Outdoor access floor doors shall be H-20 load rated, single-leaf type fitted with end chains, stainless steel hinges, stainless steel vertical spring in a closed tube. A secondary safety grating shall be provided underneath the primary hatch door. Hatches are to be

Bilco, Inc. or an approved equivalent. For locations where hatches will be larger than 48 inches by 48 inches, double leaf shall be used for easy lifting.

- Hatches shall be airport-rated (extra heavy duty) when located within the vehicular path of travel.

8.8.5 GENERATOR ROOM

The engine-generator room shall be equipped with monorails with trolley hoists for routine maintenance functions. Doors or louvers shall be sized for generator removal. Removal of generators and engines shall be accomplished by portable equipment provided by others. Provisions shall be included for access hatches, lifting hooks, hoisting systems, roll-up doors, and other means to provide maintenance.

8.9 HEATING, VENTILATION, AND AIR CONDITIONING

All HVAC equipment shall be designed to meet the minimum efficiency levels required by code, designed to use only electricity, and installed in accordance with the latest rules, regulations, and codes requirements. HVAC equipment shall be designed using the following design criteria:

- The use of natural gas systems shall not be allowed in new construction.
- A ventilation system using outside fresh air shall be provided for the enclosed spaces in the pump station facility.
- If the pump station structure is determined to have no significant sensible cooling load, ventilation shall be provided only at a rate of six air changes per hour or 1.5 cfm/sf, whichever is greater. Where air conditioning is required, the ASHRAE-recommended outdoor air requirements for ventilation shall be met.
- The requirements of NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*, apply to all pump stations. Ventilation shall be provided in dry pits and aboveground pump house structures to declassify the space. Typically, this requires six air changes per hour.

8.9.1 OUTDOOR AND INDOOR CONDITIONS

Outdoor design conditions shall be per the *ASHRAE Fundamentals Handbook* climate design data. Any cooling for pump rooms and electrical buildings shall be designed for process heat loads. Sensible heat load calculations shall account for process heat load requirement and envelope requirements. Internal loads shall account for motors, electrical equipment, occupancy, lighting, and miscellaneous heat-generating equipment.

8.9.2 DRY PIT AND PUMP ROOM VENTILATION

A ventilation system for dry pits and above ground pump and motor rooms is required to meet the ventilation requirements given by NFPA 820 to declassify the space. The ventilation shall be no less than six continuous air changes per hour plus additional requirements for motor cooling, as determined by building heat loads. Ventilation shall be achieved by a powered supply and exhaust

system. Ventilation equipment shall be installed so that it is located a minimum of 2 feet above the 100-year flood level. Fan control switches shall be installed at accessible locations above the 100-year flood level.

8.9.3 WET WELL VENTILATION

A dedicated wet well ventilation system shall be provided that will be used when personnel enter the wet well for operation and maintenance. This ventilation system will not operate continuously. Wet well ventilation fans will operate by manual timer switch with a selector dial for up to 4 hours of operation. The ventilation rate for the wet well shall be 20 air changes per hour to meet standard practice for ventilation in confined spaces. The minimum water level in the wet well shall be used to determine the wet well volume when calculating the airflow rate required to provide 20 air changes per hour.

8.9.4 DEDICATED VENTILATION SYSTEMS

Separate ventilation systems shall be provided for the wet well and dry pit. Interconnections between the dry pit and wet well ventilation systems shall not be allowed.

8.9.5 AIR CONDITIONING AND COOLING SYSTEM

Air conditioning and cooling systems shall be designed using the following design criteria:

- For electrical rooms and generator spaces, cooling shall be provided to limit room temperature to no more than 85 degrees Fahrenheit (°F).
- In the pump or motor room, cooling should be considered only if it is required for motor heat rejection and operator comfort. Maximum room temperature should be 100°F. Heat loads should consider heat generated by equipment when all equipment is operating.
- Where required for specialized electronic equipment, a dedicated panel air filtration and/or air conditioning unit that treats the panel ventilation air shall be provided. Panels will be provided with filters and prefilters. Pre-filters shall be the washable type.

8.9.6 DUCTWORK

Ductwork shall be designed using the following design criteria:

- Duct sizing and airflow velocity: ducts should be a minimum of 6 inches in diameter, sized for a nominal airflow velocity of 1,500 feet per minute (ft/min); the maximum allowable velocity in any duct is 2,000 ft/min.
- Ductwork in dry areas shall be aluminum with PVC coating/lining or type 316 stainless steel construction and with type 316 stainless-steel anchor bolts and fasteners.
- Ductwork in wet wells shall be FRP with type 316 stainless-steel anchor bolts and fasteners.
- Replaceable dust filters shall be provided on inlet wall louvers and supply air fans. A label at the filter access location shall alert operating personnel of the need to check or replace filters at specified intervals or as measured by a differential pressure gauge.

- Moisture removal filters shall be provided on the suction side of supply air intakes for pump stations with exposure to salt-bearing marine air. This type of filter uses a combination of stainless-steel mesh and other filtration media to remove salty and corrosive moisture from the supply air stream.
- Insect and pest screening: stainless-steel mesh screening or wall louvers shall be provided on all louvers and equipment cabinet and enclosure vents, both intake and outlets, to prevent entrance of birds, rodents, and other small animals. Maximum mesh size shall be 8x8 mesh.

8.9.7 NOISE ATTENUATION

Noise attenuation shall be designed using the following design criteria:

- The ventilation system shall be designed for noise levels as described in Section 4.14, Noise Control. This noise limit includes the sum of fan intake, fan discharge, motor, and casing rotation noise. Ventilation systems shall specify the use of low noise fans. The maximum fan noise load at 1-meter distance is 85 dBA.
- Acoustic doors and louvers, and inlet and outlet baffles or silencers shall be installed. Fans shall be located away from the inlets and outlets or other features of the station as required. The generator room shall be installed with acoustic panels on the walls and ceiling.

8.10 PLUMBING

The plumbing system design shall include:

- Backflow prevention devices to protect potable water from cross contamination.
- Medium-duty hose bibbs and hydrants for interior and exterior wash-down.
- Floor trenches, floor drains, floor sinks, and hub drains.
- Perimeter drains pumped up and discharged to grade if required.

8.10.1 PLUMBING WATER SUPPLY

Plumbing water supply shall be designed using the following design criteria:

- A 2-inch-diameter main potable water line supply shall be provided onsite for cleaning, wash-down, and flushing of dry pits and wet wells.
- The potable water supply system shall be protected with a reduced pressure backflow preventer in accordance with local code requirements and as approved by the FCCCHR. The source of the domestic water line shall be coordinated with the City.
    a. Provide 2-inch fire hose bibbs outside, adjacent to the wet well.
    b. Provide 5/8-inch hose bibbs within the pump room and wet well for cleaning and washing.

8.10.2 RESTROOM

A restroom facility shall be provided if requested by the SWD for the specific pump station. Restroom facilities may be either unisex or separated for men and women, but in either case shall meet current building and plumbing code requirements, including OSHA and ADA provisions.

If the station includes a restroom facility, an additional 2-inch reduced pressure backflow device shall be provided at the hose bibb located next to the wet well. This reduced pressure backflow device shall protect the upstream connection to the restroom from potential contamination from the hose bibb.

8.10.3 PLUMBING DRAINAGE

Plumbing drainage shall be designed using the following design criteria:

- Provide a drainage system for the pump station. The drainage system shall include floor trenches, floor drains, hub drains, drainpipes, holding sump, and sump pumps. The drainage system shall be designed for handling drainage from the wash-down, pump seals, air release valves, and housekeeping.
- Sump pump system shall be duplex-type submersible pump types, complete with lifting chain, discharge valve, check valve, piping, starter, level controls, and automatic alternator. High-water-level alarms that are connected to the main pump station control shall be provided.
- The wet well shall have adequate volume to prevent the pump from cycling more times per hour than recommended by the pump or motor manufacturer. The wet well shall be covered with aluminum grating.
- The drainage system shall be discharged to a municipal sewer system. The Design Consultant shall consult with the local governing authority to design the drainage system to meet all applicable codes, including cases where a nearby municipal sewer is not available.
- Building drain and vent piping materials shall comply with Sections 701.0 and 903.0 of the California Plumbing Code. All sanitary system materials used shall be listed by an approved agency listing.
- Where sanitary vents are required, the sanitary vent piping shall extend a minimum of 6 inches above the 100-year flood level elevation before offsetting horizontally or before being connected to any other vent.

8.11 FIRE PROTECTION

Fire protection shall be designed using the following design criteria:

- Fire protection requirements for the pump station facility design shall be coordinated with the local AHJ.
- Fire extinguishers rated for Class A, B, and C fires shall be provided in the pump room, motor room, MCC room, and standby generator room. Where required, fire sprinkler

systems shall be a wet pipe system. Unless noted otherwise, the fire sprinkler system shall be designed for Ordinary Hazard Group 1.

- Unless required by the AHJ, a fire sprinkler system for pump rooms, motor rooms, dry pits, and wet wells shall not be provided.
- When an emergency backup power generator is installed in a building and diesel fuel is stored with the generator, fire protection must be provided as required by NFPA 30, *Flammable and Combustible Liquids Code.*

Chapter 9 Electrical

The Design Consultant shall prepare the technical specifications section necessary to assemble a complete electrical design package and develop the electrical drawings for stormwater pump stations necessary to construct a complete electrical design package. Electrical systems shall be designed using the following design criteria:

- The stormwater pump station electrical system must comply with the requirements of the NEC, the SDMC, California Electrical Code, ANSI, UL, NEMA, Integrated Electrical Services (IES), and Institute of Electrical and Electronics Engineers (IEEE), as applicable. Building design shall comply with the regulations and standards associated with the current adopted San Diego codes, including the California Electrical Code (Part 3), City Council Policy 900-03, ZEMBOP; City Council Policy 900-14, Sustainable Building Policy; and the California Energy Code (Part 6) of the 2022 CBC Title 24.
- All electrical equipment and devices in a wet well, including pumps and sensors, shall comply with the requirements for Class I Division 2 of NFPA 820, *Standard for Fire Protection in Wastewater Treatment and Collection Facilities*. All electrical devices and components shall be watertight, assuming submergence of the entire well. Conduits passing between wet and dry pits shall be mechanically sealed. Mechanical seals used shall be suitable for use in a corrosive environment.
- The facility shall coordinate with the local utility, SDG&E, for electrical service. The preferred voltage should be 480/277 VAC. An application for service upgrade or a new service request may be required. A one-line diagram, load calculation, and site plan shall be provided to the utility company. The electric power service equipment, such as the pole-mounted transformer and pad-mounted transformer, shall be owned by the electric utility company for the life of the project. Figure 9-1 shows a one-line diagram for an SDG&E pad-mounted transformer. The electric service equipment shall be located in a place that is accessible to the utility company for maintenance and repair.

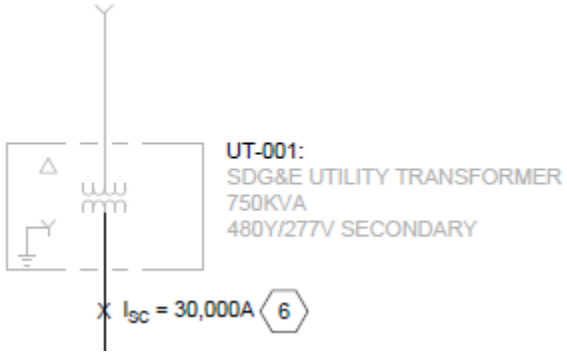

Figure 9-1. Example of One-Line Diagram (Pad-Mounted Transformer)

- All electrical devices in a dry pit, including sump pumps, sensors, and lighting, shall comply with the requirements of Class I Division 2 of NFPA 820, *Standard for Fire Protection*

in Wastewater Treatment and Collection Facilities. All electrical devices and components located in the dry pit shall be watertight, assuming submergence of the entire well.

- A separate electrical room is preferred for new pump stations, and significant rehabilitation efforts should be incorporated during the design phase where possible. Exception to this shall be confirmed by the City. In addition, the electrical room shall be elevated at least 4 inches above the finished floor to provide positive drainage in the event of a pipe failure.
- All empty conduits shall be capped on both ends after the wiring work has been performed. A minimum of one spare power, control, and instrumentation conduit shall be provided from each area through any intermediate junction boxes to the final termination point. Spare conduits shall include pull ropes and be capped.

9.1 MOTOR

Motors shall be designed using the following design criteria:

- Motors with adjustable frequency drives shall comply with NEMA MG-1, Part 31 and shall be clearly identified as inverter duty. The motor enclosure shall be NEMA B, open drip-proof (ODP) 1.15 safety factor (SF), or Totally enclosed fan-cooled (TEFC) (1.15 SF).
- Motors must be heavy-duty, with 100,000-hour-rated bearings. Oil-lubricated motors are equipped with a visual oil level indicator. Locked rotors must comply with NEMA Code F or a higher standard.
- Motors for water pumps shall be solid shaft types, to facilitate adjustment of the impeller by adjusting a nut at the top of the impeller. The Contractor will be required to submit details showing how adjustment of the pump impeller would occur using the upper end of the motor for City approval.
- Motors higher than 50 hp installed outdoors, in unheated areas, or elsewhere as indicated shall be provided with 120-VAC space heaters wired to a terminal strip in a low-voltage motor junction box.
- Pumping units larger than 24 inches in diameter shall be provided with RTDs to determine the temperature of each motor bearing (top and bottom). RTDs shall also be provided for line shaft bearings on pumps greater than 48 inches in diameter. When indicated or specified, winding thermostats shall be snap action, bi-metallic, temperature-actuated switches. Thermostats shall be provided with one normally closed contact. The thermostat switch point shall be pre-calibrated by the manufacturer. All inverter-duty motors shall be provided with winding thermostats, unless RTDs are specified. All explosion-proof motors shall be provided with winding thermostats.
- Motors require shaft grounding rings with a braided copper band from the motor frame to a grounding electrode pigtail stubbed out of the slab. Rings shall be factory installed by Aegis or an equal alternative. The pigtail shall be connected to the grounding electrode system.
- For motors at or greater than 150 hp (vibration monitoring), an accelerometer-type sensor shall be placed near the upper pump motor near the packing gland housing at the discharge head.

- For submersible pump motors, a water leakage sensor shall be provided to detect the presence of water in the stator chamber. In addition, a moisture and temperature detection relay shall be implemented to shut down the submersible pump motors if needed.
- If utilized with a variable frequency drive (VFD), the motor shall be an inverter-duty type. Shaft grounding with insulated bearing shall be provided.

9.2 POWER, CONTROL, AND INSTRUMENTATION CABLES

Power, control, and instrumentation cables shall be designed using the following design criteria:

- The power cable shall be selected based on the latest NEC Article 310, *Conductors for General Wiring*. Wire rated for 600 volts used in ducts or conduits for power shall be single conductor, Class B-type XHHW-2 cross-linked polyethylene conforming to UL-44 standards.
- Low-voltage control wire in ducts or conduits shall be No. 14 AWG. Control wires inside the panels and cabinets shall be machine tool–grade type MTW, UL-approved, and rated for 90 degrees Celsius (°C) at dry locations.
- The instrumentation cable shall be rated at 300 volts at minimum, and individual conductors shall be No. 16 AWG stranded, tinned copper. Single-pair, No. 16 AWG twisted, shielded cable shall be Belden Part No. 9719, or equal.

9.3 MOTOR CONTROL CENTER, SWITCHBOARDS, AND PANELBOARDS

Motor control center, switchboards, and panelboards shall be designed using the following design criteria:

- Low-voltage MCC assemblies must conform to the UL and ANSI standards for NEMA Class 2, type B wiring. All breaker handle mechanisms shall have padlocking devices for the off position. All indicator lights mounted on the MCC shall be the push-to-test type and comply with NEC machine-indicating light and icon standards. MCC bussing equipment shall have manufacturer label of voltage, amperage, and short-circuit ratings.
- The MCCs shall be the end product of one manufacturer to standardize appearance, operation, maintenance, spare parts, and service. The manufacturer of the low-voltage MCC shall manufacture molded case circuit breakers, up to and including 225-ampere frame size, disconnect switches, magnetic motor starters, reduced-voltage soft starter, control and timing relay, pushbuttons, lights, selector switches, including remote mounted control stations, and meters, including ammeter, voltmeter, and solid-state metering devices.
- Indoor MCC enclosures shall be NEMA 1 or 12, and outdoor MCC enclosures shall be NEMA 3R. Stainless-steel enclosures shall be used for corrosive environments. Compartment doors shall be interlocked with compartment circuit breakers, fitted with a maintenance override. Latches for panelboard compartments shall have butterfly heads or another hand-operable method that does not require tools.

- Each MCC section shall be nominally 90 inches tall by at least 20 inches deep. Equipment within the MCC may be rearranged at the discretion of the manufacturer, providing that the MCC includes spare parts, space, and future provisions as indicated and that panelboards are either at the top of their sections or the bottoms are at least 36 inches above the housekeeping pad. Switches and circuit breakers used as switches shall be located such that the center of the grip of the operating handle for the switch or circuit breaker, when in its highest position, shall be less than 6 feet and 7 inches above the floor, including the height of the concrete pad.
- The MCC shall provide a continuous copper ground bus along the full width of the MCC line-up. The main horizontal bus shall be of tin-plated copper and located in an isolated compartment. The bus shall be rated for 600 amperes at minimum, but in no case shall it be less than the main lug or main breaker frame size. The vertical bus in each section shall consist of a single tin-plated copper conductor per phase, with a current capacity of not less than 300 amperes. The vertical bus shall be completely isolated and insulated and shall extend along the full height of the section wherever possible. Power buses shall be braced to withstand 65,000 amperes at minimum.
- The switchboard (Figure 9-2) shall be freestanding NEMA 1 or 3R, metal-enclosed type, consisting of front removable panels. It shall bear the label of UL 891. A hinged panel section shall allow access to all of the sub-panel mounted control equipment. Each section shall be designed to permit future additions without distributing the initial installation. The switchboard shall be constructed of formed sections of smooth, rolled sheet steel, bolted together and reinforced where necessary with structural steel members. Doors and interior panels shall be constructed of 12-gauge minimum formed sheet steel. Hinges shall be concealed and allow the doors to swing through no less than 105 degrees from the closed position. Each door shall be furnished with a locking latch with keys removable in both the locked and unlocked position. All locks shall be keyed alike.

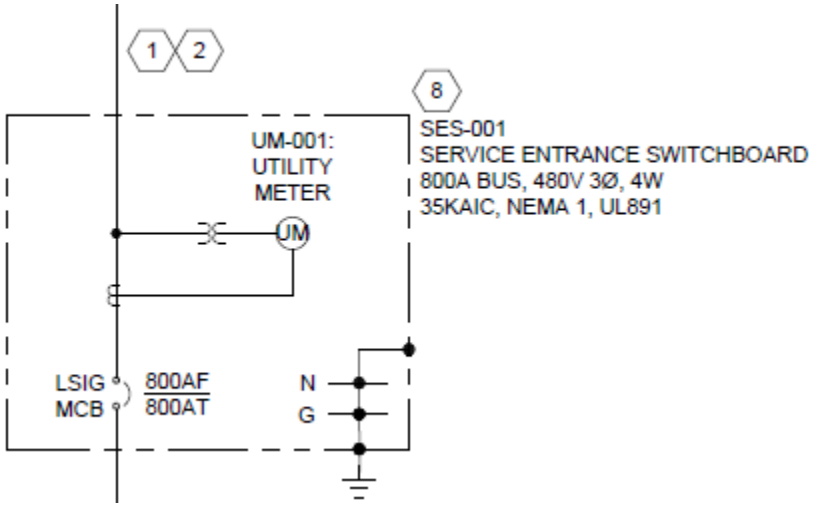

Figure 9-2. An Example of Switchboard on One-Line Diagram

- Panelboards shall be dead-front factory assembled. They shall comply with NEMA PB-1 panelboards standards and the provisions of UL 50, *Safety Enclosures for Electrical Equipment*, and UL 67, *Safety Panelboards*. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208 volts, three-phase

operation or 120/240 volts for single-phase operation as indicated. Power panelboards shall be rated for 480 volts, three-phase, three-wire operation, unless indicated otherwise.

9.4 VARIABLE FREQUENCY DRIVES

Variable frequency drives shall be designed using the following design criteria:

- A VFD shall be provided for variable-speed motors. The VFD can be standalone or located in the MCC. AC cooling shall be provided for the VFD if necessary, in accordance with Section 8.9.5 of these *Guidelines*. The VFD shall be one size above the motor horsepower rating. Both the AV voltage and frequency shall be varied simultaneously to operate the motor at required speeds. The minimum VFD inverter efficiency shall be 95% at 100% speed and load and 85% at 50% speed and load. The VFD shall shut down in an orderly manner when a power outage occurs on one or more phase. Upon restoration of power and a START signal, the motor shall restart and run at the speed corresponding to the current process input signal.
- The VFD shall be provided with inrush current adjustment between 50% and 110% of the motor full load current (factory set at 100%), overload capability at 110%for 60 seconds for variable torque loads and 150% for constant torque loads, and input and output signal of 4 to 20 milliampere (mA). The VFD shall operate at a preset speed upon loss of input signal. Ethernet I/O communications is preferrable and shall be used to transmit VFD data to/from a plant Programmable Logic Controller (PLC)–based control system. If Ethernet I/O communications is not possible, then Modbus protocol shall be used.
- An 18-pulse VFD is required for motors greater than 50 hp. For motors that are 50 hp or less, the Design Consultant shall consider adding a line reactor. A dV/dT filter device shall be provided at the VFD output per the manufacturer's recommendation. Harmonic analysis shall be performed in accordance with IEEE 519 standards for harmonic control and reactive compensation of static power converters at unit full load. The provided VFD power cable shall be three conductor stranded copper, PVC-jacketed shielded type, tray cable rated 600 volts with three symmetrical ground conductors. The individual conductors shall be UL listed as Type XHHW-2 or RWH-2 rated for 90°C at wet and dry locations, with XLPE insulation.

9.5 EMERGENCY POWER GENERATORS

Emergency power generators shall be designed in accordance with the following sections:

9.5.1 STANDBY GENERATOR

Standby generators shall be designed using the following design criteria:

- Diesel engine generator units shall be provided and coordinated with the City project manager in conjunction with the SWD. The need for emergency power is established in the pre-design report or the basis-of-design report. Sizing the generator shall be based on full capacity. Refer to NEC Article 701 for required standby generators and Article 702 for optional standby generators.

- A standby generator with a manufacturer-provided enclosure should be an objective in design of new pump stations and significant rehabilitation efforts (wherever this is possible). Exceptions to this may be dictated by available space, sound requirements, architectural/esthetic needs, or other site-specific design requirements.
- A standby generator with automatic transfer switch (ATS) is required for all pump stations. Figure 9-3 shows an example of an ATS on a one-line diagram. The ATS should be located within the electrical room. Generators above 60 kilowatts (kW) shall be provided with a permanent load bank or a portable load bank with adequate quick-disconnect SO cord and connections. Four-pole automatic closed-transition transfer switches shall be provided when ground fault tripping is required at above 1,000 amperes. Modbus transmission control protocol (TCP) shall be provided from the generator control panel to the PLC.

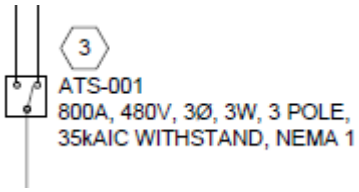

Figure 9-3. An Example of Automatic Transfer Switch on One-Line Diagram

- The generator size shall be adequate to provide power for the pump motor starting current, limited by VFD to 125% of running current, and for control, lighting, ventilation, and other auxiliary equipment necessary for safe and proper operation of the pump station. The air compressor shall be excluded from the sizing of the generator. The ATS shall not power the air compressor, or a control scheme shall be employed to disconnect the air compressor during power outages. For generators of 60 kW and below, the compressor shall be connected in a manner that allows it to be used as a load bank for testing. Calculations on generator sizing shall be provided.
- Standby generators shall have a remote or skid-mounted base fuel tank with secondary containment adequate for minimum 24-hour continuous operation. Underground fuel storage tanks and piping are not allowed. Aboveground storage tanks shall comply with all fire department requirements. Fuel tanks located outdoors shall be provided with noncombustible rain canopy and secondary containment.
- Emergency generators shall minimize discharge of gaseous pollutants and comply with the discharge limitations of the San Diego County APCD. The APCD permit to operate shall be acquired and transferred to the SWD prior to acceptance for maintenance. Diesel engine–powered electric generator set in an indoor or outdoor waterproof and sound-attenuated enclosure shall be provided.
- Generators shall also be equipped with two 120-volt, thermostatically controlled jacket water heaters. Power shall be derived from a suitably rated dry-type transformer and panelboard, also provided as part of the generating system and including facilities to provide power to the battery charger, fuel oil transfer pumps if required, and other generator-related facilities.

9.5.2 PORTABLE GENERATOR

In stations without an alternative backup power source, a manual transfer switch and CAM-LOCK power connection shall be installed to the stormwater pump station for use with a portable generator.

9.6 RECEPTACLES

Receptacles shall be designed using the following design criteria:

- Receptacles shall be of the polarized three-wire type for use with a three-wire cord with grounded lead. One designated stud shall be permanently grounded to the conduit system in accordance with NEC Article 406.4.
- Receptacles for damp/wet locations shall be ground-fault circuit-interrupting (GFCI) type and weather-resistant with extra duty, in-use listed covers in accordance with NEC Article 406.8
- GFCIs shall be installed at the indicated locations and as required by the NEC standards. GFCIs shall be duplex receptacles, of specification grade, and tripping at 5 mA. The GFCI rating shall be 125 volts, 20 amperes, NEMA WD-1, Configuration 5-20R, and capable of interrupting 5,000 amperes without damage. GFCIs shall be weather resistant-listed in accordance with NEC Article 406.8.
- Receptacles for hazardous locations shall be of the single-gang type with a spring door. They shall be provided with a factory-sealed chamber and a delayed action feature requiring the plug to be inserted into the receptacle and rotated before the electrical connection is made. Receptacles shall not work with non-hazardous rated plugs. One plug shall be rated for 20 amperes at 125 VAC.

Chapter 10 Instrumentation

This section documents instrumentation and controls system requirements related to stormwater pump stations, standardized by the City. The Design Consultant shall review, incorporate, and implement the requirements listed herein while adhering to industry codes and meeting project specific objectives.

10.1 CONTROL SYSTEM GENERAL

The City stormwater Supervisory Control and Data Acquisition (SCADA) system is standardized on the HMS Netbiter Argos cloud-based platform, allowing real-time remote monitoring, control, and trending of remote site operations through a web-based application portal. Siemens WinCC Open Architecture is a secondary platform that is currently in development. Consequently, all new and upgraded pump stations shall be designed to seamlessly integrate into the existing Argos Netbiter platform but this is subject to change; reference Appendix A – Preferred Equipment /Vendors/Manufacturers Lists for the latest information.

New or upgraded pump stations shall be controlled and monitored by a dedicated PLC, local to the site, serving as the primary control system. The control system shall be solely based on the Siemens line of controllers listed in Appendix A, while a secondary hard-wired control system, independent of the PLC system, shall serve as a backup.

10.1.1 PRIMARY CONTROL SYSTEM

The primary control system shall include a PLC-based automatic liquid level control for pumps based on redundant non-homogeneous continuous level measuring technologies. Specifically, a non-contact radar sensor and a submersible hydrostatic pressure transducer shall serve as the primary control elements. All associated software pump start/stop level setpoints shall be made adjustable from SCADA.

10.1.2 BACKUP CONTROL

The backup control arrangement shall utilize wet well, low-low and high-high floats directly hardwire interlocked with the pump controller/small PLC/motor starter/drive trip circuit/relay logic. Utilizing a pump controller or small PLC is preferred to manage the backup system. The standard backup control system shall function in the instance where the PLC or level instrument fails to start/stop the pumps. The backup floats shall be set at different levels from the primary control setpoints.

10.1.3 PROGRAMMABLE LOGIC CONTROLLER

Programmable Logic Controllers shall be designed using the following design criteria:

- PLCs shall be interconnected with field instrumentation/equipment, motor starters, VFDs, and packaged control systems to gather process information and execute control strategies.

- The system integrator shall prepare detailed drawings and catalog cutsheets and, depending on agreements with the City, shall also fabricate and install PLCs for the project.
- The PLC shall include the manufacturer-recommended power supplies to provide intrinsically safe ratings of sensors.
- The PLCs shall have the appropriate processing and memory capacity and shall have redundant power supplies. The PLC shall have 120 VAC discrete inputs and outputs. Analog signal inputs and outputs shall be 4 to 20 mA DC.
- The PLCs shall have the ability to run autonomously independent of operator interface terminal (OIT)/human machine interface (HMI) workstations; however, their operation may be dependent on information (such as flow rates and levels) passed to them from other PLCs. The passing of information between PLCs required for automatic operation is not desired and shall be avoided where possible.
- The PLC programming shall be per the City standard program requirements. The system integrator shall consult with the City's Telemetry/Control group regarding PLC programming requirements and shall arrange and support the installation and testing of PLC programming.
- Redundant PLCs are not required.
- The PLCs shall be as per Appendix A – Preferred Equipment /Vendors/Manufacturers Lists, which contains model/manufacture details.
- All legacy non-Siemens PLCs shall be decommissioned and removed.

10.1.4 CONTROL PANEL REQUIREMENTS

Control panels shall be designed using the following design criteria:

- All control panel enclosures shall preferentially be in climate-controlled, non-hazardous environments with thermostatically controlled fans/heaters (as required) and remote temperature monitoring.
- Outdoor panels or panels located in corrosive areas indoors shall be rated NEMA 4X, type 316 stainless steel, whereas indoor panels located in non-corrosive process/dry pit areas shall be rated NEMA 4, painted steel.
- Outdoor panels shall include a lockable dead-front.
- Where a facility requires installation within the 100-year flood zone, control panels shall be located 2 feet above the 100-year flood elevation, in close proximity/line-of-sight of the pump station.
- PLC enclosures shall be standalone or part of the MCC enclosure where there are space constraints.
- Enclosures shall be sized to allow for future expansion and facilitate easy maintenance and operation. Free-standing enclosures shall be installed on a dedicated housekeeping pad. Enclosures shall be designed to meet the enclosed equipment manufacturer's

recommended operating environment. Instrument enclosures shall not be used as a pull box or junction box.

- The PLC control panel shall house the following major equipment as a minimum. Refer to Appendix A – Preferred Equipment /Vendors/Manufacturers Lists, for model/manufacture details.
  a. PLC with redundant power supply and IO.
  b. Backup SITOP uninterrupted power source (UPS).
  c. Cellular gateway.
  d. OIT.
  e. Intrinsically safe relays.
  f. Siemens selector switches, pushbuttons, and light-emitting diode (LED) modules.
  g. Saginaw enclosure with sub-panel.
  h. Phoenix power outlets.
  i. Siemens terminal blocks.
  j. Fiber patch panel.
- Wiring markers shall be provided to identify each conductor at panel terminals and in intermediate junction boxes. Wiring numbering shall be included in as-built information.

10.1.5 FIELD OPERATOR INTERFACE TERMINAL

The field operator interface terminal shall be designed using the following design criteria:

- A processor-based, panel-mounted, UL-listed OIT suitable for browser-based applications and terminal server client access using the Windows CE operating system shall be provided. The NEMA 4X, 24 volts direct current (VDC) panel-mounted unit shall be equipped with (at minimum):
  a. Minimum 9-inch (800 × 480) integrated touchscreen.
  b. Membrane keypad.
  c. Two USB 2.0 ports.
  d. Two USB-C ports.
  e. Two Secure Digital (SD) card slots.
  f. Two 10/100-BaseT RJ-45 ethernet ports.
- Field OIT shall communicate via Modbus TCP protocol.
- The unit shall be designed to operate in 32 to 131°F temperature range at up to 95% humidity, non-condensing.
- Each panel-mounted operator interface unit shall be as per Appendix A – Preferred Equipment /Vendors/Manufacturers Lists, which contains model/manufacture details, programmed using the latest software, or equal.

10.1.6 HUMAN MACHINE INTERFACE (WORKSTATIONS)

The HMI workstations shall be provided at the central control room for operators to monitor and control the facilities. New graphic displays shall be developed to show each process's status, provide control of the equipment, and display alarms matching the existing graphical standards at SCADA.

10.2 COMMUNICATION MEDIUM

The communication medium shall be designed using the following design criteria:

- The communication network at each facility shall be developed on a case-by-case basis but in general shall consist of communication channels and protocols, along with transmitting and receiving hardware.
- Fiber optic shall be the preferred communication approach at new facilities (where available). The Design Engineer shall review the City's existing fiber network to determine the feasibility of leveraging existing City fiber infrastructure. City standards for fiber requirements are still to be defined.
- Cellular communication should be used wherever fiber optic use is infeasible.
- Cellular based communications: Based on the location, a cellular carrier shall be selected from the following providers with coordination from the City for contracts and subscriber identity module (SIM) cards:
    a. AT&T Wireless.
    b. Verizon Wireless.
    c. T-Mobile.
- A wireless router shall be furnished per Appendix A – Preferred Equipment /Vendors/Manufacturers Lists.
- A Federal Communications Commission license is not required but a monthly service fee is charged for the service. Given the monthly fee, the City will furnish and install the SIM card within the Contractor-furnished cellular gateway.
- Where both fiber and cellular communication is infeasible, there needs to be coordination directly with the City to explore alternative options.

10.3 REMOTE ALARMING

Each pump station shall be equipped with a separate cellular-based remote alarming system, dialing out pre-defined critical alarms to the operator. An Alarm Agent Wireless Remote Terminal Unit (WRTU) alarm system and working touch-tone telephone line shall be provided with single touch-tone instrument and jack for Alarm Agent. The latest Alarm Agent WRTU model shall be used.

The following are the minimum alarms to be configured for remote alarming:

a. Wet well low-low level alarm (from primary and backup float system).

b. Wet well high-high level (from primary and backup float system).
c. Dry pit or valve vault flood alarm.
d. Utility power fail (from ATS).
e. Generator running.
f. Generator low fuel level.

10.4 CONTROL PHILOSOPHY

The pump station control philosophy shall be designed in accordance with the following sections:

10.4.1 CONTROL MODES

The facility shall be designed for unattended operation using a PLC-based control system with remote monitoring and control. The control system shall be automated to achieve maximum efficiency without providing undue complexity to O&M personnel. Four levels of control shall be provided (where appropriate). The process equipment shall operate in one or more of the control modes described in the following subsections:

a. Local Manual Control.
b. Remote Manual Control.
c. Remote Automatic Control.
d. Emergency Shutdown.

10.4.1.1 Local Manual Control

Local manual control (field selected) shall only be at the equipment control station. The control station shall be conveniently located at or near the equipment. A hand-off-auto (HOA) selector switch, start/stop pushbuttons, and run/fault pilot lights shall be used on the control stations for local operation.

Local manual control is engaged when the HOA selector switch is placed in the “Hand” position. While in the Hand position, all control from the PLC is inhibited. All local type controls shall be hardwired and shall not go through the PLC. For equipment with adjustable speed, a manual speed control potentiometer shall be provided.

This mode of operation, although available in most cases, will be restricted to maintenance activities except where specifically noted otherwise.

10.4.1.2 Remote Manual Control Mode

Remote control is engaged when the HOA selector switch is placed in the “Auto” position at the equipment control panel. This mode of control refers to operator-initiated control functions available via the panel mounted OIT or SCADA but executed via the PLC control logic (i.e., all PLC process interlocks and safety functions remain engaged).

10.4.1.3 Remote Auto Control

Remote control is engaged when the HOA selector switch is placed in the "Auto" position at the equipment control station. Once in Auto mode, to go into remote automatic, the OIT/SCADA application needs to be accessed and the "Manual-Automatic" graphical switch needs to be placed in "Automatic."

In Remote Auto control, the ability to adjust pre-set operating level setpoints and prioritize pump stations to mitigate potential flood scenarios based on local rain gauges and National Oceanic and Atmospheric Administration (NOAA) weather data shall be considered.

10.4.1.4 Emergency Shutdown

Emergency pushbuttons shall be located next to every piece of moving equipment. The E-stop pushbutton shall remove power and shut down the equipment. The equipment shall only become available once the E-stop pushbutton has been disengaged.

10.4.2 PUMP STATION CONTROL PHILOSOPHY OVERVIEW

Refer to Appendix D – Typical Pump Station Control Philosophy for additional information regarding stormwater pump station operation.

The basic premise of a pump station is to start the pumps based on an inlet or wet well water level. As the water level continues to rise, additional pumps are started. As the water level drops, the pumps are turned off. A pump will stop at a lower water level than was present when it was started.

A common configuration is lead-lag operation. The "lead" pump starts first and if it cannot keep up with the inflow, a lag pump is started. The system can contain multiple lag pumps. The last pump started is usually the first to turn off. When an "alternator" function is added, the controller changes the lead pump, so the run hours are distributed across all of the pumps in the system.

The level in a wet well shall be monitored by redundant level instruments with backup wet well low-low and high-high level detection float switches serving as override pump protection and backup start control.

In auto mode, the PLC shall control the pumps to automatically operate based on operator pre-set level setpoints based on the primary instrument wet well level measurement. Once initiated in auto, the pump station shall continue to operate until a low-low level condition is encountered or an operator initiates a system stop command. Following a low-low level shutdown, the pump station shall be placed in standby mode. Once the pump station wet well level recovers greater than a pre-set start permissive setpoint for longer than a pre-set timer period, active pump station level control shall be re-initiated. In the event of primary level instrument failure, the secondary level instrument may be automatically employed in the level control strategy. The pumping arrangement shall include a standby pump, and the PLC control logic shall be designed to continuously rotate pump start positions in an effort to automatically balance runtimes. Should the control system determine that a required pump is "Not Ready" to start or becomes unavailable during operation, the standby pump shall be immediately called to start. Level setpoints shall be remotely adjustable from SCADA.

An example of level setpoints in a wet well is provided below.:

a. **L7 High-high Overflow Level (rising level)**: Alarm (Backup Hardwired Override Start All Pumps, Float).
b. **L6 Start All Pumps (rising level)**: All Pumps On (Primary Control, PLC level setpoints).
c. **L5 Lag1 Pump Start (rising level)**: Lag1 Pump On (Primary Control, PLC level setpoints).
d. **L4 Pump Start (rising level)**: Lead/Duty Pump On (Primary Control, PLC level setpoints).
e. **L3 Lag1 Pump Stop (falling level)**: Lag1 Pump Off (Primary Control, PLC level setpoints).
f. **L2 Lead/Duty Pump (falling level)**: Lead/Duty Pump Off (Primary Control, PLC level setpoints).
g. **L2 Stop All Pumps (falling level)**: All Pumps Stop (Primary Control, PLC level setpoints).
h. **L1 Low-Low Level (falling level)**: Alarm (Backup hardwired Interlock/Shutdown, Float).

Additional level setpoints may be necessary for larger pump stations with more than two pumps. All levels shall be shown on the wet well elevation view on the plan drawings. All PLC level setpoints shall be adjustable from SCADA.

The status of the pumps (including current draw) shall be monitored by the SCADA. Each pump shall be equipped with a motor temperature monitor and a leak detection monitor directly interlocked with each pump's VFD/starter. Auto shutdown and pump lockout shall be initiated if any fault condition is detected for greater than a pre-set time delay.

For low flow diversion to sanitary sewer, there shall be a flow measurement to verify the flow rate and account for totalized flow volume discharge to the sanitary sewer. A modulated valve can be used to provide the required control. See appendix F, Low Flow Diversion for more information

10.4.3 REMOTE MONITORING AND CONTROL PARAMETERS

Listed below are the status and control signals that shall be included at the SCADA HMI typical for pump station facilities. The list should not include building security alarms as they will be managed by a separate system.

1. Pumps
   a. Pump running
   b. In Auto
   c. Start Command
   d. Stop Command
   e. Start Command Fail
   f. Stop Command Fail
   g. Motor high temperature

h. Motor Fault Trip
i. VFD Failure (VFD only)
j. Speed Feedback (VFD only)
k. Speed Command (VFD only)
l. High Discharge Pressure (if applicable)
m. Seal Fail (if applicable)
n. Missing Pump High Vibration Alarm (on pumps 150 hp or above)
o. Transducer output
p. Disable alarms
q. Check valve failed to open
r. Check valve failed to close

2. Remote termina unit (RTU)/PLC Panel
   a. Control Power Failure
   b. RTU/PLC Enclosure Intrusion Alarm
   c. Communication Failure/Failsafe/Loss of Echo
   d. Pump Station Flow Rates
   e. 24 VDC Power Supply Failure
   f. 120 VAC Power Supply Failure
   g. Redundancy Module Failure
   h. Network Switch Major Alarm Failure (if applicable)
   i. Cabinet High Temperature Alarm
   j. UPS
      i. DC Battery Discharge
      ii. DC Battery Fail
      iii. DC Battery OK/Loss of DC Power
   k. Surge Protection
   l. Float Mode Activated
   m. Underpass Overflow
   n. Level Control Switch
   o. Water Pressure Loss
   p. Rain Sensor
   q. Tide Sensor
   r. Station Shutdown

s. Loss of Air
t. Remote Alarm Reset
u. Bypass Mode

3. Valve
   a. In Auto
   b. In Hand
   c. Open Command
   d. Close Command
   e. Closed Command Fail
   f. Open Position
   g. Closed Position
   h. Failed to Open
   i. Failed to Close
   j. Open Torque High
   k. Close Torque High
   l. Actuator Motor Overload
4. Generator
   a. Generator Run Status and Failure
   b. Main Power Phase Unbalance/Failure
   c. Fuel Status
   d. DEF Levels
   e. Oil Pressure
5. Wet Well
   a. Wet Well Level
   b. Wet Well Level Low-Low
   c. Wet Well Level Low
   d. Wet Well Level High
   e. Wet Well Level High-High
   f. Ventilator Fan Failure, etc.
   g. Pump Station Ambient Temperature
6. Dry Pit
   a. Dry Pit Flooded
7. Automatic Transfer Switch (ATS)

a. Transfer Status

10.5 SYSTEM INTEGRATION

System integration shall be performed in accordance with the following sections:

10.5.1 SCADA SYSTEM

The SCADA System shall be designed using the following design criteria:

- A third-party system integrator shall configure the SCADA system. Configuration of the SCADA system includes historian workstations as well as system databases and reports.
- The system integrator shall be responsible for developing HMI graphic display screens.
- The PLC programming shall be per the City's standard program requirements. The system integrator shall consult with the City regarding PLC programming requirements and shall arrange and support installation and testing.

10.5.2 VENDOR-PACKAGED CONTROL SYSTEMS (IF APPLIABLE)

Vendor packaged systems are not typical for pump stations but should reference the following requirements where applicable:

- All vendor-packaged control systems shall be designed by the consultant in conjunction with the vendor. Design Consultant shall be responsible for providing a control process narrative and performance specification for the equipment, and the vendor shall be responsible for providing detailed drawings and specifications to fabricate the equipment panels. The vendor shall program the vendor equipment PLCs.
- Packaged systems shall be required to provide alarming and/or process data to the local pump station PLC. If a vendor packaged control system necessitates a dedicated PLC network using Modbus TCP (or optionally hardwired analog or discrete signals), the signal interface requirements shall be as defined in the packaged system specifications.
- All vendor control panels shall be furnished with redundant 24 VDC power supplies and have a UPS with relay-card interface.

10.6 PROCESS REQUIREMENTS AND DESIGN CRITERIA

Process requirements and design criteria shall be performed in accordance with the following sections:

10.6.1 INSTRUMENTATION DESIGN CRITERIA

Instrumentation shall be designed in accordance with the following criteria:

- Instruments shall be designed with the appropriate environmental considerations.
- Magnetic flow meters shall be the preferred flow measurement instrument for process flows where applicable.

- Rain gauge instruments shall help detect and alarm SCADA in the event of heavy rainfall.
- Preferred location of all instruments shall be indoors.
- Outdoor analog signals shall have surge suppressors.
- Input/Output (I/O) depicted on the P&ID drawings for each process area shall be displayed on the HMI/OIT control screens. All analog data (as well as alarms and status points) shall be historically collected, recorded, and trended. HMI control screens shall be consistent in presentation, quality, color usage, symbol usage, and navigation. Options shall be developed through meetings with the City.

10.6.2 INSTRUMENT SELECTION

Instrumentation shall be selected in accordance with the following criteria:

- Instruments shall communicate via hardwire interface using 4 to 20 mA and/or highway addressable remote transducer (HART) protocol for instruments that are capable.
- Local power disconnects shall be provided next to each instrument requiring 120 VAC.
- Refer to Appendix A – Preferred Equipment /Vendors/Manufacturers.
- Instrumentation signal standards shall meet the following requirements:
  a. Redundant level sensors shall be used for critical process measurements, including wet well continuous level monitoring.
  b. Discrete input signals shall utilize 24 VDC signals to the PLCs.
  c. All discrete output signals shall be 24 VDC type and provided with interposing relays for isolation.
  d. Monitoring of the VFD shall be via hardwire for critical status and control and Modbus TCP communication to the PLCs for secondary information.
- Analog inputs – conventional two wire and HART intelligent transmitters:
  a. Signal level to the PLC shall be an isolated 4 to 20 mA DC.
  b. All instrument shields shall be terminated at the PLC control panels.
  c. For instruments wired directly to the PLC, the 24 VDC loop power (redundant) shall be from the PLC control panel.
  d. Lightning surge arrestors shall be provided for all outdoor instruments.
- Analog inputs – four wire transmitters:
  a. Signal level to the PLC shall be an isolated 4 to 20 mA DC at 24 VDC (with surge suppressors).
  b. Transmitter power supply shall be from an external power source.
- Analog inputs – two wire transmitters:
  a. Signal level to the PLC shall be an isolated 4 to 20 mA DC at 24 VDC (with surge suppressors).

b. Transmitter power supply shall be from the controller.

- Analog outputs:
  a. Signal from the PLC shall be an isolated 4 to 20 mA DC at 24 VDC.
  b. Signal power supply shall be from the PLC.

10.6.3 CALIBRATION SCHEDULE

A control device calibration range schedule shall be provided on the design plans for reference during installation and adjustment of the control devices.

10.6.4 PROCESS INSTRUMENTATION AND CONTROL DIAGRAM

Process instrumentation and control diagrams shall be shown in the design drawings. All pump station process components shall be shown for clarity.

10.6.5 "FAIL-SAFE" DESIGN ALARM RELAYS

Alarm relays shall be designed using the following design criteria:

- Alarm relays shall be designed to be normally energized during normal pump station operation. Relay "fail-safe" design shall thus alert operators through the telemetry system should an alarm condition occur that de-energizes the alarm relay as designed or should an alarm relay fail and de-energize.
- Where electro-mechanical relays are installed, standard relays shall be provided with octal base mounting to simplify replacement of defective units.
- Adequately sized (minimum of 30 minutes at full load) UPS system shall be provided for maintaining seal-in of relays during ATS operation.

10.6.6 EMERGENCY MOTOR CONTROLS

Emergency motor controls shall be designed using the following design criteria:

- Motor winding imbedded "motor high temperature switch" pump interlock.
- Pedestal-mounted emergency stop pushbutton (NEMA 6P submergence rated) at pump unit shall be provided.
- For protection of below-grade MCC/control panel locations in event of flooding, a "dry pit flood" float switch shall disconnect the main breaker and emergency generator breaker shunt.
- There shall be an emergency stop of the generator upon explosive gas alarm by closure of the fuel valve with normally closed solenoid valve located outside the generator room on the fuel line. The solenoid shall be operated from DC power generator or battery. Hazardous gas alarm warning light and audible alarm shall be provided at the panel.

10.6.7 MOTOR STARTER CIRCUIT HAND OPERATION

This circuit shall be designed so that in hand position, the circuit interlocks, including the motor over-temperature and motor starter overload contacts, shall be "hard relay wired" outside the PLC to allow operation of this circuit in hand should failure of the PLC occur. The control circuit shall be designed for H-O-A switch selection to “off” or “manual hand” operation or lockout of circuit breaker does not result in alarm.

10.6.8 EMERGENCY STOP

Pump emergency stop pushbutton switch controls shall be provided adjacent to each pump installation. This control shall include a lock-out feature, which will disable remote operation until unlocked for safety reasons. The switch shall be NEMA 6P submergence rated, Gianini Inc., or approved equivalent.

10.6.9 PUMP STATUS INDICATOR LIGHTS

For each pump, the following indicator lights shall be provided: pump running (green); pump off (red); and pump failure (amber).

10.6.10 PUMP RUN TIME

An externally non-resettable elapsed time meter shall be provided for each pump in service. The run time meter for each pump shall be located at the motor controller.

10.6.11 PANEL INDICATOR LIGHT BULB

All indicating lights and alarm annunciator lights shall be of the “push-to-test” type.

10.6.12 ALARM AND CONTROL RELAY RESETS

Alarm and control relay resets shall be designed using the following design criteria:

- Alarm display relays shall require a manual reset actuation (i.e., reset of alarm indication shall not occur automatically after an alarm condition clears).
- Motor trips shall require a manual reset and shall not occur automatically after a trip/alarm condition clears.
- A master alarm with buzzer and acknowledge (silence) function shall be provided. The buzzer shall be loud enough to be heard near the pump station door, but not so loud as to result in complaints from neighborhood homeowners.

10.6.13 ENCLOSURE REQUIREMENTS/AREA CLASSIFICATIONS

The Design Engineer shall request applicable code-related information from the Uniform Fire Code and requirements of the local fire department that serves the project site. Pump stations shall meet NFPA 820, *Fire Protection for Wastewater Treatment and Collection Facilities*. Refer to Chapter 9, Electrical for detailed design guidelines of enclosure requirements and area classifications.

10.7 INSTRUMENTATION AND CONTROLS PREFERENCES

Instrumentation and controls preferences shall be designed using the following design criteria:

- The Design Consultant shall specify/select instruments and devices required for the project per Appendix A– Preferred Equipment /Vendors/Manufacturers.
- The Design Engineer shall specify the range of measurement for each of the instruments and devices.
- Instruments shall meet the requirements of American Iron and Steel (AIS) where applicable.

10.7.1 LEVEL INSTRUMENTATION

Level instrumentation shall be designed using the following design criteria:

- The primary method of online level measurement shall be non-contact radar level instruments. A hydrostatic type of level instrument shall be the second primary method of online level measurement.
- Level switches such as floats shall be used in select locations to serve as backup secondary control and alarms. A typical level switch is a float-type switch (specify without mercury). The switch shall be designed and manufactured for Class 1 Division 1, Hazardous Conditions.

10.7.2 FLOW INSTRUMENTATION

Flow instrumentation shall be designed using the following design criteria:

- Flow instruments are not typically required with stormwater pump stations. Electromagnetic flow meters are preferred where required.
- Magnetic type flow meters shall be used for full pipe flows to the pipe.
- Magnetic type flow meters shall have a 25:1 flow range with ±1% accuracy.
- Typically, the flow meter is installed between straight pipe sections with minimum length of 5D (5 pipe diameter) upstream and 2D downstream.
- Flow instrumentation shall be provided for low flow diversions. Refer to Appendix F.

10.7.3 PRESSURE INSTRUMENTATION

Pressure instrumentation shall be designed using the following design criteria:

- Pressure gauges and transmitters shall be provided for monitoring and to provide equipment protection only where applicable.
- All pressure gauges and transmitters shall be fitted with diaphragm seals to prevent accumulation of materials and blockage of the sensing system.

10.7.4 ANCILLARY EQUIPMENT

Ancillary equipment shall be designed in accordance with the following sections:

10.7.4.1 Power Monitors

Power monitors shall be designed using the following design criteria:

- Multifunction digital meters shall be provided for all switchgear, switchboard, and MCC mains. In non-process buildings, meters may be connected to a centralized power monitoring system or computer to track energy usage and establish trending.
- Power monitoring equipment shall be interfaced to the SCADA network and directly polled by the software over Modbus TCP.

10.7.4.2 Submersible Pump Protection

Submersible pumps shall be equipped with a motor stator moisture/leak detection switch and motor bearing high temperature switch. Both motor high temperature and leak switches shall be wired to a monitoring relay module, with dry contact outputs directly hardwired to the pump motor control shutdown logic. The monitoring relay module shall be manufactured by Flygt MiniCAS or approved equivalent.

10.7.4.3 Gas Detectors

Gas detectors shall be designed using the following design criteria:

- Methane/explosive gas, hydrogen sulfide, low oxygen, and carbon monoxide (CO) detectors shall be installed in the dry pit.
- Methane/explosive gas and carbon monoxide detectors shall be installed in the power plant room.
- Methane sensors shall be infrared types, which do not require periodic calibration.
- Gas detection equipment shall be as per Appendix A – Preferred Equipment /Vendors/Manufacturers, which contains model/manufacture details, for standardization of this safety equipment with other pump stations.
- The gas detectors shall be calibrated to alarm at the following setpoint gas concentrations: Combustible gas - 10% Lower Explosive Limit (LEL); hydrogen sulfide - 10 parts per million; oxygen high - 23%; CO - 35 parts per million.
- Per NFPA 820, gas detectors shall be designed to be failsafe and activate warning lights and beacons at ingress and egress points of the monitored space.

10.8 TAGGING CONVENTION

Tagging shall be performed in accordance with the following sections:

10.8.1 DEVICE TAG NUMBERS AND INSTRUMENT LOOP NUMBERS

Device tag numbers and instrument loop numbers shall be designed using the following criteria:

- The major equipment for each process shall be assigned an equipment tag number in accordance with the City's standard tagging scheme as detailed on the P&ID legend sheets.
- There shall be area numbers assigned for process units. There shall be loop numbers assigned for panel devices and instruments.
- An instrument loop consists of one or more elements or functions associated with an equipment piece or single process variable (such as flow, level, temperature, analysis, etc.). The initial measurement is made by the primary element. All the instruments and functions in a loop shall use the same base loop number as the primary element. For example, a flow loop senses flow in one pipe or channel; level, temperature, pressure, or any other variable for that channel shall each have a different loop number.
- Tag numbers shall be constructed by adding the Instrument Society of America (ISA) Standard S5.1 device mnemonic.
- If an instrument loop has two or more parallel devices that measure or manipulate the same variable, the transmitters shall have the same loop number, but they shall be suffixed by A, B, C, etc. (e.g., LIT-100A, LIT-100B, LIT-100C). This is a common arrangement with critical redundant wet well level measurements, as an example. Refer to the Instrument Tag Appendix E – Use of Suffix detail included.

10.8.2 INSTRUMENT TAG NUMBERS AND IDENTIFICATION

Instrument tag numbers and identification shall be designed in accordance with Figure 10-1.

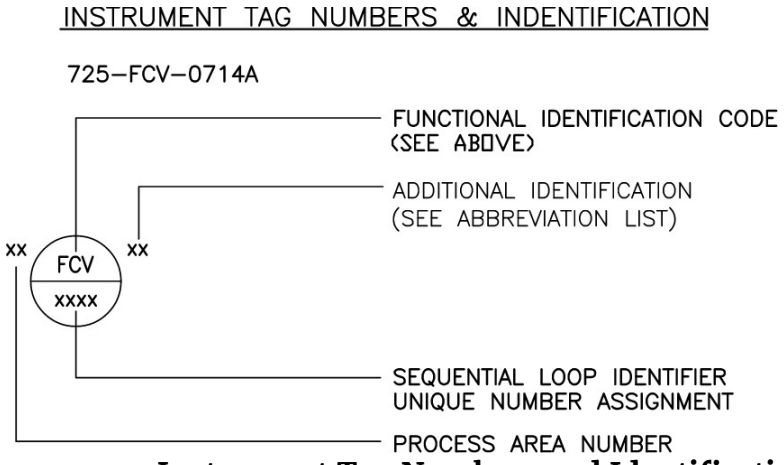

Figure 10-1. Instrument Tag Numbers and Identification

10.8.3 INSTRUMENT ABBREVIATIONS

Instrumentation abbreviations shall be in accordance with Appendix E – Instrument Abbreviations and Identifications.

10.8.4 ISA LOOP DRAWING SUBMITTALS

The Contractor shall submit loop drawings to be prepared in accordance with ISA Standard S 5.4, latest edition. These submittals shall satisfy the following requirements:

- Be 11 × 17 inches in size.
- Provide separate drawings for each instrument loop.
- Limit loop diagram to hardwired components only.
- Conform to standard conventions (naming, tagging, and symbols).

10.9 FIRE ALARM SYSTEM

A fire alarm system shall be provided in areas where required by applicable codes and by the local fire marshal. The SCADA system shall receive a discrete failure alarm output from the fire alarm system.

Chapter 11 Security Design Criteria

11.1 GENERAL

This chapter outlines the design requirements of the security systems for stormwater pump station facilities. This Standard Security Specification shall be used in accordance with the most currently approved edition of the GREENBOOK and WHITEBOOK, as adopted by the City.

11.2 SECURING ELECTRONIC EQUIPMENT

The security system shall be separated from the pump station operation and SCADA system. All security system components, such as control panels, switches, and other apparatus shall be installed in a secure, accessible location within a protected space. All onsite electronic security equipment shall be mounted in locations designated or approved by the Security and Emergency Planning Section. Any electronic equipment installed outside of a building shall be installed in an all-weather enclosure equipped with tamper-proof latches, alarms, and/or card readers.

11.3 WIRING FOR ELECTRONIC SECURITY

Wiring for electronic security shall be designed using the following design criteria:

- All wiring must be concealed and installed in an electrical conduit, unless otherwise specified. Any exposed conduit of 1-inch diameter or greater, or conduit from hand holes to poles, or other above-grade equipment, shall be threaded galvanized steel. If wiring conduits are installed inside a secured facility, wiring shall be protected using rigid or flexible conduits. Other suitable forms of protective covering may be considered if design requires explosive proofing.
- All wiring and field connections shall be weather-tight and secured for the length of the conduit from the device to the enclosure along the walls or structures.
- The grounding/bonding conductor shall be green-PVC-jacketed stranded copper soft conductor, unless otherwise noted.
- Where rolling gate and power operators are used, sufficient conduit shall be provided between the electrical room and gate operator for power, remote operation from future electrical room provisions—whether discrete or ethernet—and additional conduit for gathering card or key, driver-side entry and exit stations and additional conduit for in-driveway loop sensors on both sides of the gate.
- Cameras relatively close to the video network controller may be powered by CAT6 PoE communications. Cameras at distances greater than 100 feet from the video network controller require conduit for fiber or unpowered ethernet and a separate conduit for 120 VAC power from a dedicated video power terminal cabinet.

11.4 CYBERSECURITY

SCADA networks shall be designed with a defense-in-depth strategy for SCADA networks. Defense-in-depth is an approach to cybersecurity in which a series of defensive mechanisms are layered to protect valuable data and information. As of July 2019, it is the recommended security strategy by the U.S. Department of Homeland Security (https://www.us-cert.gov/ics/Recommended-Practices). The following lists cybersecurity measure inherent to the Netbiter Argos platform:

- Wireless general packet radio services [GPRS])
    a. Ensuring wireless GPRS is secure, SIM cards can only be used exclusively together with the Netbiter solution. This also means that it is not possible to ping or try to gain access to the remote site except through the Netbiter Argos data center and therefore does not consume unnecessary and costly GPRS traffic.
- User authentication (two-step)
    a. All access to the online system at www.netbiter.net requires password authentication.
    b. Several user levels shall be established, providing permissions to access different functions.
    c. Two-step verification shall be configured per user. This provides greater security by requiring a user to enter an extra one-time login security code sent to the user's mobile phone. This is in addition to the standard login procedure required for all logins.
- Separate user data from others
    a. A built-in mechanism manages authenticated users and ensures they have access only to data they are responsible for.
    b. All communications are secure using Secure Socket Layer (SSL) encryption.

AWWA has developed some essential planning resources to start water utilities on the path to cyber resilience. They are designed to help clarify a utility's exposure to cyber risks, set priorities, and execute an appropriate and proactive cybersecurity strategy:

- *Water Sector Cybersecurity Risk Management Guidance*. Practical, step-by-step guidance from AWWA for protecting process control systems used by the water sector from cyber attacks.
- Assessment Tool. This interactive tool asks utilities to examine how they are using various technologies. Based on responses, the tool generates a customized, prioritized list of controls that are most applicable to the utility's technology applications. Utilities can use this output to determine the implementation status of critical controls designed to mitigate cybersecurity vulnerabilities.
- Small Systems Guidance. A getting-started guide to help small rural utilities improve their cybersecurity practices. This is for water utilities serving fewer than 10,000 people and especially those serving fewer than 3,300 people.

The following steps are recommended be performed to minimize the risk of an industrial cyber attack:

1. Complete all control system software backups as recommended, according to schedules provided by manufacturers.
2. Install and properly configure firewalls.
3. Secure open network ports
4. Install intrusion detection devices on RTU panels.
5. Train employees on industrial control system security, including the importance of password controls and awareness of social engineering attacks; the percentage of policy violations and security incidents detected should be automatically tracked.
6. Have an automatic method that points to the source of a cyber threat; this may include connections between the corporate information technology (IT) network and the industrial process control network.

This section documents instrumentation and controls system requirements related to stormwater pump stations, standardized by the City. The Design Consultant shall review, incorporate, and implement the requirements listed herein while adhering to industry codes and meeting project specific objectives.

11.5 COMMUNICATIONS

The City uses two primary methods of communication for access control information: (1) detection systems and (2) streaming video surveillance footage from the SWD's facilities to the Security Operations Center. The operational requirements for each facility must be evaluated to determine a suitable communication path during the design phase. SanNet (the City's proprietary communication network) and SecNet (Security and Emergency Management's proprietary communication network) are both used depending on the site's conditions and availability. The operational requirements for each facility must be evaluated to determine which communication path is most suitable. The City will conduct a feasibility study for the communication path for each site. Fiber or microwave are the preferred methods of communication. SecNet and SanNet are the preferred destinations for the communication signal that will communicate back to the servers at the Chollas Security Operations Center.

SecNet is a wireless microwave network that is designed to create a point-to-point link. When designing a microwave link, the required bandwidth and travel distance shall be considered. Transmissions carrying a larger amount of data over a longer distance may have to use a licensed link and may require a repeater. A licensed link may require additional licensing from the Federal Communications Commission.

11.6 CONSTRUCTION SPECIFICATIONS

Construction specifications shall be prepared in accordance with the following sections:

11.6.1 EXTERIOR LIGHTING

Outdoor lighting shall be designed using the following design criteria:

- Outdoor lighting shall not exceed nominal 4,000-Kelvin Color Correlated Temperature, per SDMC Chapter 14, Article 2, Division 7, Part 4.
- Exterior lighting is expected to produce the least amount of glare over the surveillance area.
- White-light LED light sources shall be installed to provide accurate color images in secured sensitive areas such as entrances and exits.
- LED lighting shall be installed for general lighting and anywhere light pollution may affect the operational efficiency or image quality of the closed-circuit television (CCTV) system.
- Infrared (IR) illuminators shall be installed in secured sensitive areas where light pollution must be avoided.

11.6.2 PERIMETER BARRIERS

Perimeter barriers shall consist of fences, walls, gates, and other devices necessary to control or limit access to the facility. The perimeter barriers shall be uniform and shall protect the entire facility without interruption, unless otherwise specified. The Security and Emergency Planning Section shall be consulted to assess the site and determine the need for additional secured perimeters within the facility through security vulnerability and risk assessments.

11.6.2.1 Fencing

Fencing shall be designed using the following design criteria:

- Safety, effectiveness, and aesthetics shall be considered to determine the ideal fence type. Acceptable fence types are wrought-iron and chain-link. Wrought-iron style requires a fence height minimum of 9 feet and a maximum of 10 feet. For chain-link fences, the fence height shall be a minimum of 8 feet and shall require a top guard (barbed wire/concertina coils), bringing the total fence height to a maximum of 10 feet.
- All accessible valves, vaults, water fixtures, and irrigation system fixtures shall be located inside the security fence. Specific fencing height and materials must be determined on a case-by-case basis. An intrusion alarm should be considered at the front gate as may be required by the City. The security fence is placed, wherever possible, on or immediately adjacent to the property line.
- Architectural wrought-iron style is an option for fencing with the top ends clipped/sheared to form a point or with cast points inserted into the end of the tubing. The vertical post shall be a minimum of 4-inch-square 10-gauge tubing. Horizontal posts shall be 2-inch 11-gauge tubing. Additionally, the individual pickets at the top of the wrought-iron-style fence will be radiused out toward the threat a minimum of 12 inches, with 1-inch 12-gauge squared tubing. The finished height for wrought-iron style shall be no less than 10 feet.

11.6.2.2 Chain-Link Fence

Chain-link Fence shall be designed using the following design criteria:

- In high-security areas, where the risk of cutting through standard chain-link is probable, no-cut no-climb fencing shall be installed with approval from a representative of the Security and Emergency Planning Section. Specifications for no-cut no-climb fencing shall be established by the Design Consultant and approved by the Security and Emergency Planning Section on a case-by-case basis.
- Standard chain-link fencing shall be galvanized steel with black PVC vinyl coating and a minimum of 9-gauge wire mesh. The mesh openings shall be no greater than 2 inches per side and no less than 1 inch.
- Chain-link fencing posts, rails, and braces shall have a galvanized coating. The top and bottom edge of the fence fabric shall be secured using tension wire or hog rings every 12 to 18 inches. Posts, rails, bracings, and tension wire of these components shall be installed on the secure side. The bottom edge of the fabric shall have a 2-inch gap or smaller from fabric to hard ground. Fabric shall be mounted to galvanized steel posts with additional bracing at corners, end posts, and gate openings. The horizontal bottom rails, tension wires, and concrete curbs, sills, sheet piling, piping, or other materials shall be installed such that the fence fabric is prevented from being lifted by hand more than 5 inches in height.
- The preferred climbing deterrents are barbed wire with stainless steel concertina wire (i.e., razor wire). The double barbed wire shall be designed with a "Y" style outrigger; double concertina will be coiled inside. Outriggers (support arms) shall be installed at 45-degree angles in a double-arm design. These double-arm outriggers shall consist of 18-inch arms, each having three strands of barbed wire at regular intervals along the top of the fence. Outriggers must be permanently affixed to vertical fence posts with threaded fasteners or by spot welding. All field welds shall have cold galvanizing spray applied to prevent corrosion. Fasteners used to affix outriggers to vertical posts shall be tamperproof by design or by spot welding. Outriggers arms shall be coated to match adjacent posts and fabric.

11.6.2.3 Reinforced Concrete/Concrete Masonry Unit Walls

Reinforced concrete or concrete masonry unit wall shall meet the minimum height of 8 feet, excluding the top guard. The top guard shall be designed by the Design Consultant and shall be approved by a representative of the Security and Emergency Planning Section before being installed.

11.6.2.4 Gates

Gates shall be designed as follows:

Personnel

- Gates used for personnel shall be either single-swing or full-height turnstiles. These gates shall have access control card readers installed on both the secure and unsecure sides. Electronic pin/pass code lock system shall be provided as a backup for the card reader.

- The single-swing gates shall match the fence fabric material, height, and climbing deterrent of the adjacent fence. Gate hinges shall be pressed steel or malleable iron having a minimum zinc coating of 1.2 ounces per square foot and allow the gate to open and close without binding. Hinges shall be designed to permit a gate swing of 180 degrees. A hydraulic gate closure shall be installed on the secure side of the gate.

Vehicular

- The height of vehicular gates shall match the adjacent security fencing and, when feasible, the gate opening shall be as wide as the roadway approaching the gate. Acceptable gate types are single-wheel, rolling (v-groove) slide gates or single-swing gates. The operational and space requirements for the gate must be evaluated to determine which gate type is most suitable.
- Powered gate operators and photo eye sensors are required for all vehicular gates. Product type, horsepower, voltage, and phases will be determined by anticipated traffic flow and access control procedures. To avoid degradation over time, ground safety loops (gate trigger/metal detector) shall be installed, and all points shall be completely sealed.
- For single-wheel-supported (v-groove) sliding gates, the wheels shall be hardened steel and tack welded. The v-track for these gates shall be one galvanized steel piece with no welds, to avoid cracks and rust.
- All single-swing vehicular gates shall be designed to swing inward toward the secured area at either 90 or 180 degrees. The hinges of these gates shall be secured to the gate post and the gate frame by tack welding to prevent twisting or turning. Bolts and all other hardware associated with the hinges shall be welded or peened to prevent removal by hand tools.

11.7 ACCESS CONTROL SYSTEM

Software House Ccure 9000 software running on a Ccure server is the PUD standard for an access control system. To maintain compatibility with the PUD's existing standard systems, substitutions or equivalent products will not be accepted per SDMC 22.3007 and 22.3008. The access control system shall be a networked system, which can operate independently as a standalone system. Therefore, if the network connectivity is lost, the access control panels shall continue operating independently without degradation in the operation of the system.

Card readers and electric locking devices shall be installed at all designated entry doors to the protected space, including stairwell doors at points of public access. Elevators directly accessing protected spaces shall have card access to control the movement of the elevator on a floor-by-floor basis. All doors equipped with a card reader or electric locking device shall have door contacts and a request-to-exit motion sensor connected to the access control system. All readers are to be installed 46 inches above the finished floor unless otherwise noted. The access control system shall be a networked system but shall be capable of operating independently as a standalone system. If network connectivity is lost, the access control panels shall continue operating independently without degradation in the operation of the system.

11.8 SYSTEM INTERFACE REQUIREMENTS

The access control panels, I-star, shall be connected to a dedicated 120 VAC power source through an external power supply. All access control panels shall be grounded to prevent electrostatic charges and other transient electrical surges from damaging the panel.

In the event of an AC power failure, the external power supplies shall send an alarm to report a "Power Failure" alert to the City's access control system server and the end user/operator. For power outages, access control panels shall have replaceable batteries for panel memory backup, enabling the panel to retain the downloaded database and configuration.

The software for card readers shall be Software House model (SWH-4100) or equivalent. The reader shall have a minimum life expectancy of 1 million reads and shall be equipped with three visual indicators (LED) and an audible tone. All readers shall be capable of normal operation indoors, outdoors, and within a temperature range of 40°C and ± 75°C. For outdoor applications, an optional weather hood shall be installed. See Table 11-1 for a list of the color scheme standard for card readers.

Table 11-1. Color Scheme Standard for Card Readers

Red LED	Green LED	Yellow LED	Indication
ON	ON	ON	Online-Door Locked
Flashes	OFF	OFF	Invalid Card Read; Access Not Granted
OFF	Flashes	OFF	Valid Card Read; Access Granted
OFF	OFF	Flashes	Offline or Device Issue
Flashing	Flashing	Flashing	Alarm: Door Forced or Held Open

11.9 CLOSED CIRCUIT TELEVISION SYSTEM

Milestone Xprotect Corporate is the City's standard for CCTV systems; it runs on a centralized management server and may not be substituted. To maintain compatibility with PUD's existing standard systems, substitutions or equivalent products will not be accepted per SDMC 22.3007 and 22.3008. The CCTV system shall monitor entrances, restricted areas, critical asset areas, alarm conditions, access points, parking lots, building perimeters, and interior areas. These CCTV systems shall be operated from a centralized workstation or the City's Security Operations Center.

11.9.1 CAMERAS

All components of the CCTV system shall be compatible with the standard City CCTV system and integrated with all security subsystems (e.g., Access Control, two-way speaker system) to ensure a full operational system. Unless otherwise stated, a device license and at least 1 year of care plus coverage should be purchased for all new installed cameras. The following camera manufacturers are acceptable: Samsung, Bosch, Canon, Axis, Pelco, Flir, or equivalent. Other manufacturers may be considered if they complete a proof-of-concept with approval of a representative of the Security and Emergency Planning Section.

The type of cameras to be installed are fixed, pan tilt zoom (PTZ), and multi-sensor multi-directional. Fixed cameras shall be the primary type to surveil designated access control and monitoring points. PTZ cameras shall be used for site perimeter and exterior building areas to support the fixed cameras. The multi-sensor multi-directional cameras shall be used in large, unobstructed areas and multi-entrance rooms. The following features should be included:

- Device license with 1 year of care plus coverage.
- Latest secured version of firmware/software.
- Internet protocol.
- Resolution of 1920 × 1080 p.
- 3.0 megapixel.
- Wide dynamic range.
- Low-light capabilities.
- Electronic image stabilization.
- Open network video interface forum compliant.
- Powered over ethernet.
- IP-66 weatherproof housing and IK-10 vandal-proof housing (applicable to outdoor cameras).

Cameras shall be installed on approved mounting surfaces structured for weight, wind load, and extreme weather conditions. External poles for cameras shall be constructed of metal with a concrete base, installed and grounded in accordance with the NEC, and be weather resistant.

When mounting cameras, the camera shall be oriented so that equipment may swivel inward for maintenance. Camera conduits shall be a minimum of 8 feet above the highest climbing aide (steps, stem wall, caisson). Cameras shall not be installed behind, next to, or on any natural/artificial object that may restrict the field of view, cause signal loss, or cause camera malfunction.

11.9.2 NETWORK VIDEO RECORDER

The network video recorder (NVR) shall be installed on a Windows PC and shall have no storage restrictions (RAID, NAS, etc.). The NVR shall be capable of recording in the following formats: H.264, MPEG-4, and M-JPEG. The NVR shall perform simultaneous recordings at a minimum frame rate of 30 frames per second, 24 hours per day, for a minimum of 90 days.

Chapter 12 Pump Station Operation and Testing Requirements

Facility operation and testing requirements are typically beyond the scope of the Design Consultant's responsibilities but shall be considered and specified in the design contract documents. Close coordination is required among the Contractor, Owner (i.e., Engineering and Capital Projects' Construction Management & Engineering Field Division and the SWD Pump Station Operations Team), and Design Consultant to ensure that design and construction requirement have been adequately met. The Design Consultant shall provide specific information in the contract documents to describe pump station operation and testing requirements. The following describes the general responsibilities of the Design Consultant and the Contractor.

12.1 DESIGN CONSULTANT RESPONSIBILITIES

The Specifications shall include a Summary of Master Test Plan, which describes the type of testing, the phases of testing, sequence, and requirements in the contract documents to accomplishing the testing requirement.

The Summary of Master Test Plan shall include a detailed listing in tabular form of all the specific test procedures to be accomplished by the Contractor for each type and each phase of the testing and testing sequence. The section also shall include a schedule of operational tests that will demonstrate the proper operation of all equipment at the station. The proper operation of all pump station mechanical equipment, electrical controls, emergency power operations, and control warning displays shall be demonstrated by the Contractor.

The Design Consultant shall provide a general note in the contract documents specifying that the Contractor is responsible for all costs including power, fuel, potable water, testing/training specialists, and other testing costs associated with the factory and facility tests until such time that the station is accepted by the City.

12.2 CONTRACTOR RESPONSIBILITIES

The Contractor shall have the following responsibilities during operation and testing:

- The Contractor shall implement the requirements in compliance with the specification, including demonstration and testing of all equipment as described in the operational test procedures, preparation and completion of required equipment test report forms, test procedures verification checklists, and other documentation to be provided by the Contractor.

- The Contractor shall be responsible for compilation of all facility and equipment testing requirements. This shall be coordinated with specific equipment testing requirements specified in the equipment specification sections.
- The Contractor shall designate a test coordinator responsible for accomplishing the required testing. All testing work shall be accomplished by a skilled team of specialists under the direction of the test coordinator.
- The Contractor shall schedule and coordinate all phases of the facility tests and demonstrations with City representatives.
- The Contractor shall prepare a Master Test Plan per specification requirements for approval by the City prior to the start of testing. This plan shall be a bound, step-by-step compilation of the specific tests to be performed in the facility test sequence and the sample forms to be submitted documenting the results of the tests and test information. During the step-by-step testing, these forms will require signing off by the City representative prior to continuation of the test sequence. No test sequence shall commence or continue until all preceding tests have been successfully completed and signed off by the City.

12.3 OWNER RESPONSIBILITY

Similar to the Contractor, the Owner shall also designate a test coordinator. The Owner's test coordinator is responsible for witnessing and accepting the required testing performed by the Contractor.

12.4 CONSTRUCTION MANAGEMENT

The City shall provide a Construction Manager (CM) who represents the City's interest and oversees the entire project directly for the owner. The CM collaborates with all parties to deliver the project on time, at or under budget, and to the owner's expected standard of quality, scope, and function.

12.5 MATRIX OF RESPONSIBILITY

The responsibility matrix with a Responsible, Accountable, Consulted, and Informed (RACI) chart shall be provided for the pump station construction, testing, startup, commissioning, permit, and facility acceptance as a key part in establishing the initial human resources planning for the construction. These designations are defined below:

- Responsible: The party responsible for the task, deliverable, developing the deliverable, or completing the activity.
- Accountable: The party accountable for ensuring the work or task is complete and suitable.
- Consulted: The party from whom feedback and input should be consulted or solicited.
- Informed: The party that should be in the loop for awareness of subjects, decisions, and progress.

For a traditional construction project with design-bid-build (DBB) delivery method, construction does not begin until the design process is complete, and a bid accepted, and the Owner has its own CM (Construction Management) service and retains the Design Consultant for Engineering Service During Construction (ESDC). Table 12-1 is a typical matrix of responsibility for each party.

Table 12-1. Responsibility Matrix

Description	Owner	Design Consultant	Contractor	CM
Specification of Master Test Plan requirements	C	R	I	I
Schedule and Implement Master Test Plan	C	C	R	A
Approved CM Assignment	R	I	I	A
Approved ESDC Design Consultant Assignment	R	A	I	C
Facility Construction	C	A	R	A
Site system and yard piping - CIVIL	C	C	R	A
Building System - Structural	C	C	R	A
Building System - Architectural	C	C	R	A
Building System - Electrical and Instrumentation	C	C	R	A
Building System - Mechanical	C	C	R	A
Pump Station System	C	C	R	A
Shop Drawing submittal	C	A	R	A
Factory Acceptance Test	C	C	R	A
Pipe Testing (Gravity & Pressurized)	C	C	R	A
Installation Check	C	C	R	A
Equipment installation verification by supplier	C	C	R	A
Field Equipment Tests by manufacturer	C	C	R	A
System installation test and check	C	C	R	A
System Demonstration Test	C	C	R	A
Commissioning Tests	C	C	R	A
Specialty Test	C	C	R	A
Field Performance Verification	C	C	R	A
Operational Checklist	C	C	R	A
Asset Input	C	C	R	A
Punch List	C	C	R	A
As-Build Drawing	C	A	R	C
Approved Submittals Verification	C	A	R	C
Pump System Training by Design Consultant	C	R	C	C
Equipment O&M Training by Manufacturer	C	C	R	C
Station Cleanup	C	C	R	A
Final Signoff	A	A	R	A
Final acceptance	A	A	R	A

Key:
A = Accountable
C = Consulted
CM (Constriction Management) as Owner Agent
DBB project (Design Bid Build)
ESDC (Engineering Service During Construction)
ESDC with the Design Consultant
I = Informed
R = Responsible

12.6 FACTORY TESTS

Factory testing shall be performed in accordance with the following sections:

12.6.1 FACTORY TESTING

Factory testing shall be required on the following major equipment and other equipment as required:

- Pumps and drives.
- Switchgears.
- Standby generators.

12.6.2 PUMP CERTIFIED FACTORY TEST

Pump certified factory test shall be performed in accordance with the following:

- Performance testing should be conducted for all centrifugal pumps with drives up to and including 125 hp in accordance with the ANSI/HI 14.6, *Rotodynamic Pumps for Hydraulic Performance Acceptance*. Such tests shall include hydrostatic tests and performance tests documenting head, flow, motor horsepower and vibrations.
- For pumps with drives 15 hp and larger, the pumps shall meet hydraulic acceptance criteria Grade 1U unless otherwise indicated.
- For pumps with drives smaller than 15 hp, sump pumps, and sample pumps, pumps shall meet hydraulic acceptance criteria Grade 2U.

12.6.3 PUMP CERTIFIED FACTORY TEST AND WITNESSED BY DESIGN CONSULTANT AND OWNER

Pump certified factory tests shall be witnessed by the Design Consultant and City for the following:

- Perform factory witnessed tests on centrifugal pumps with drives 150 hp and larger in accordance with the certified factory test procedure indicated above for 15 hp to 125 hp pumps with the exception that the tests shall be witnessed by the Owner and Design Consultant.

- Mechanical tests shall be conducted in accordance with ANSI/HI 14.6, Appendix E, *Mechanical Test*. Such tests shall, at a minimum, consist of the following:
  a. Measure and record overall motor winding temperature.
  b. Measure and record motor and pump bearing temperatures.
  c. Measure and record motor and pump vibration.
- Acceptance criteria and mechanical test records shall be in accordance with ANSI/HI 14.6, Appendix E, *Mechanical Test*.
- The pump manufacturer should guarantee pump performance at the flow, head, brake hp, and efficiency specified. Pump curves developed during the factory test should be certified to guarantee performance.

12.7 FUNCTIONAL CHECK AND INSTALLATION CERTIFICATION

Functional check and installation certification shall be performed in accordance with the following requirements:

- After all construction is completed, the Contractor shall submit a completed Manufacturer's Installation Certification form for each major equipment item certifying by the manufacturer's authorized representative that the equipment has been professionally installed, aligned, and functionally checked out and is ready for operation testing.
- Certification forms shall be submitted for all pumps, motors, extended drive shafts, variable speed drives, emergency generators, electrical switchgear, HVAC equipment, and control fans. Forms demonstrating successful testing of the switchgear, MCC, conductor installation, grounding system resistance, control system loops, circuit breakers, and motor starters also shall be submitted.
- Documentation demonstrating proper installation of diesel fuel system shall be submitted.

12.8 PUMP STATION FIELD TESTS

Pump station field tests consist of pump performance and the hydraulic design of the pumping facility. Field testing allows evaluation of pump intake design, force main hydraulics, pump and piping installation, and pump field performance and shall be performed in accordance with the following requirements.

- Gravity flow pipes flowing to the wet well shall be tested for exfiltration or infiltration leakage; pump discharge pipes shall be hydrostatic pressure tested.
- The initial field test of a pump system shall be performed with the pump manufacturer's representative present. The pump system tests shall be performed to demonstrate the design flow and head conditions. Testing should be documented and signed off by the Contractor, Vendor, Design Consultant, and Owner CM.

- Due to the limitations of available field setting and instrumentation on the field testing as opposed to factory testing, certain special care must be taken to obtain a reasonable level of accuracy during field testing. Field test performance shall be per ANSI/HI 14.7 – Guidelines for Field Performance Tests. Field data should be recorded and compared to factory testing data to verify pump performance.
- On large pump station installations, specifications may require an independent company to do vibration testing to ensure the vibration limits meet the contract specification requirements. If pump or motor vibration levels exceed specified values per specification requirements or ANSI/HI 9.6.4, *Rotodynamic Pumps for Vibration Measurements and Allowable Values*, the root cause of the vibration should be identified and corrected.
- Field testing results and information collected during the test shall be recorded and shall serve as baseline condition for maintenance purposes to verify change in performance during future testing.
- All pump station supporting systems such as mechanical, electrical, instrumentation, and others shall be tested, and acceptable certified performance test results shall be submitted prior to acceptance of the station.

12.9 COMMISSIONING TESTS

Commissioning tests shall be performed in accordance with the following requirements:

- Operational Test: After the Contractor has completed the pre-operational testing, the operational testing shall be scheduled.
- The test shall demonstrate pump station operation on automatic control without equipment or control failure. The pump station mechanical equipment, electrical/control systems, and emergency power equipment shall operate without failure during the operational test.
- The Contractor shall operate and monitor the station for five consecutive days. If any failure or function outside the design parameter occurs, the Contractor shall correct the deficiencies and the operational test shall be repeated.
- Commissioning: After all the operational testing and required Master Test Plan documentation is completed and approved by the City, the Contractor shall make final adjustments to all equipment to ensure proper operation. The City will then accept operational responsibility for the facility. Following completion of all punch-list items, facility acceptance by the City and filing of the notice of completion can be initiated.

12.10 OPERATION TEST CHECKLIST

The following checklist shall be included in the contract document specifications of all proposed stormwater pump stations.

12.10.1 PRE-OPERATIONAL CHECKLIST

A pre-operational checklist is a tool for all parties to ensure that the pumping system has been correctly installed, checked by the Contractor, Vendor, and Owner's representative, and is ready for operation. It should be completed by the CM for the Owner.

12.10.2 INITIAL OPERATIONAL CHECKLIST

The initial operational checklist compares actual pump performance to its advertised factory performance. The certified pump curve should be used for this comparison. During the test, pressures and flows at different operating points are plotted over the certified performance curve. These values should be checked to make sure they are within design tolerances. This checklist is also used to ensure that auxiliary systems that support pumping operation are operating effectively at their designed setpoints.

12.10.3 POST-OPERATIONAL TEST CHECKLIST

Once the pumping system is put into operation and has operated for a test period (typically seven days), a post-operational test is done. This test should ensure that flow rates have not been compromised and no detrimental grout cracking or vibration have occurred.

12.10.4 PRE-COMMISSIONING TEST CHECKLIST

Demonstration testing of the station shall be overseen by the Design Consultant and performed by the Contractor and/or equipment manufacturer representatives in the presence of Operations staff.

Following demonstration testing, the CM shall prepare a summary report. The summary report shall include signoff forms, tabulated testing results, performance requirements, and a signed statement by the Design Consultant that all requirements have been met. The report shall also include a notarized written report/statement from each equipment manufacturer, or its authorized representative, certifying the following:

- The equipment has been professionally installed, connected, aligned, and lubricated under an authorized representative's supervision.
- An authorized representative has inspected and adjusted the equipment during the operational demonstration tests, and the equipment was free from any undue stress imposed by connecting piping or anchor bolts, and has been satisfactorily operated under the design load conditions.

12.11 SPECIALTY TESTS FOR LARGE PUMP STATIONS

The Contractor shall provide the following tests or analyses per contract specification requirements.

12.11.1 ROTODYNAMICS AND STRUCTURAL ANALYSES

The Contractor shall perform and submit torsional, lateral, and structural analyses in reference to the latest edition of ANSI/HI 9.6.8, *Guideline for Dynamic of Pumping Machinery* and as required by the Specification for the following pumps:

- Pumps with constant speed drives of 500 hp and greater.
- Pumps with variable speed drives of 100 hp and greater.
- Pumps with engine drives, gear drives, and extended shafts with universal joints.

An experienced specialist from the manufacturer or a highly qualified third-party engineer approved in writing by the Design Consultant shall perform a complete torsional, lateral and structural vibration analysis for each distinct motor, driven equipment, and VFD system.

12.11.2 PUMP AND MOTOR VIBRATION MONITORING

The motor for each pump above 150 hp should be monitored for vibration. The vibration monitors should be specified to be manufactured by PMC/BETA Corporation, or equal. Each vibration monitor shall have the following features:

- Two limit switches for each pump, one for alarm and one for pump shutdown; each limit should be independently adjustable.
- A display to show the current status of the velocity level and a static display to show the maximum velocity measured.
- Manual reset button to reset the monitor and relays to the non-alarm state.
- Test button for each channel to trip the alarm for testing with and without pump shutdown.
- Time delay for each limit to be independently adjustable from 2 to 15 seconds.

The Contractor is required to provide a vibration analysis test report for the installed pumps.

12.12 COORDINATION OF NEW CONSTRUCTION WITH EXISTING FACILITY

The Contractor shall coordinate the construction of the new pump station with the existing facility. This includes but is not limited to the requirements specified in the following sections.

12.12.1 SALVAGE NOTE ON DRAWINGS

The Contractor shall remove equipment to be salvaged and deliver it to the location specified by the Owner. The Contractor shall list the items to be salvaged when determined by the Owner.

12.12.2 TEMPORARY BYPASS PUMPING

The Contractor shall install and operate a temporary bypass pumping system as required to maintain pumping operations at existing facilities during construction of the new station. This system shall include an automated telemetry system to dial out to the Contractor for repair

response, and to the City in the event of failure conditions. The Contractor shall submit to the City for approval a complete Bypass Plan, including detailed drawings and pump curves, and operation and response plan.

12.12.3 SEQUENCE OF CONSTRUCTION

Where bypass pumping of the existing station and/or for tie-in connection of new facilities is required, the Design Consultant shall provide a general recommended sequence of construction on the plans and in the General Provisions to describe the required construction sequence, including bypass pumping.

Chapter 13 Acceptance Procedures

The requirement of the facility inspection and acceptance procedure shall be clearly specified in the contract documents. Prior to acceptance for maintenance by SWD Maintenance Division, the following items must be satisfactorily completed:

- All required permits necessary to operate equipment shall be obtained by Contractor and transferred to the SWD. Proof that all necessary operating permits have been acquired and are paid through the date of transfer shall also be provided.
- The station shall be inspected and found satisfactorily completed by Construction Inspector and the City for compliance with building, plumbing, mechanical, and electrical codes and the approved plans and specifications.
- As-built plans for the pump station and pipeline main. Plans must accurately show actual depth, horizontal and vertical location of underground raceways, cables, pipes, conduits, utilities, and appurtenances.
- Detailed as-built wiring diagrams of all electrical systems and special equipment, including all conductor wiring numbers.
- Detailed shop drawings supplied by the manufacturers and corrected to comply with as-built conditions of all mechanical equipment.
- Digital photographic history of pump station construction. Photographs shall focus primarily on excavations, reinforcing, buried structures/pipes/conduits, and other non-visible improvement.
- A certified report on required noise testing.
- Summary report on factory, installed, preoperational, and functional testing of piping, coatings, wet well leak test, instrumentation, electrical, and mechanical equipment. Testing and performance requirements shall be included by the Design Consultant in the plans or specifications and shall require the signoff by Contractor/equipment manufacturer representative and City construction inspector. The summary report shall be prepared and signed by the Design Consultant certifying compliance with design requirements.
- Demonstration testing plan and signoff forms. The Design Consultant together with the Contractor and equipment manufacturer representatives shall provide a demonstration testing plan and signoff forms to the satisfaction of the SWD. This information should be forwarded to SWD well in advance of proposed demonstration testing to ensure there are no delays.
- Testing procedures shall be designed to duplicate, as much as possible, all conditions of operation and shall at a minimum include all testing required in Appendix B – Design Checklist. Signoff forms shall be provided for each item of mechanical, electrical, and

instrumentation equipment provided or installed and shall contain provisions for recording relevant testing parameters and performance data for original testing and not less than three retests.

- The inspection and testing forms shall be provided for signoff by the Design Consultant, Contractor, equipment manufacturer representative, City inspector, and SWD.
- Equipment that requires testing or final signoff.
- "Equipment Sign Off Form".

13.1 FACILITY ACCEPTANCE

Facility acceptance shall be performed in accordance with the following process:

- Recommendation for Acceptance by Owner: After completion of the operational testing and commissioning, the substantial completion of all inspection punch-list items, and receipt of all required submittals including the O&M Manuals and as-built drawings. The construction inspector will submit a written memorandum to the CM recommending that the City issue a Notice of Completion for the station.
- Transfer of Utility Billings: The Contractor shall submit the SDG&E utility billing and other utility billings to SWD to transfer billings to the City. The effective date of the transfer shall be the date of the memorandum from the Department recommending acceptance. The Design Consultant shall provide a general note on the design drawings discussing this timing for transfer of utility billings.
- Acceptance of Operational Responsibility: Following commissioning of the facility, the SWD will accept operational responsibility for the station.
- City Standard Locks: Following City acceptance, The Contractor shall provide facility locks with the City standard SPA-1 lock manufactured by Best Inc. Also, the Contractor shall provide the SDG&E standard lock, where required.
- Number of Key Sets: The Contractor shall provide five sets of keys to all locked doors, enclosures, and equipment in the station at acceptance of the station by the City.

13.2 PERFORMANCE AND WARRANTY AND EXTENDED WARRANTY

Performance and warranty requirements shall be specified as follows:

- Start of Warranty: Warranty dates shall commence on the date of the memorandum recommending acceptance in Subsection 13.1 Facility Acceptance by the City.
- One-Year Warranty (for overall facility): The facility improvements overall shall have a 1-year full parts and service warranty period.
- Two-Year Warranty (for major equipment): Major equipment including motors, pumps, VFD units (if installed) and the emergency generator shall be provided with a 2-year manufacturer's warranty.

- Extended Warranty: The City may request an extended warranty under certain conditions for the facility or equipment after the facility is constructed but conditions are not feasible for it to be immediately placed in service due to specific reasons as directed by the City. For example, full--scale performance testing on pumps onsite may not be feasible due to lack of water or storage. The facility's overall 1-year warranty period shall commence when substantial testing has been performed and accepted by the City. Until such time, after commissioning, the City shall regularly inspect and maintain the facility. However, the Contactor shall be responsible for repair of any vandalism and warranty repairs until the end of the extended warranty period.
- Warranty Service:
    a. The Contractor and/or equipment vendor (manufacturer's warranty) shall respond to City inquiries for warranty repairs within 24 hours of notification by the City.
    b. The Contractor and/or equipment vendor (manufacturer's warranty) shall commence the required warranty repairs within a reasonable duration after notification by the City.
    c. Vendors for all major critical equipment (pumps, motors, MCCs, VFDs, control panels, hazard warning systems, emergency generators, automatic transfer switches) shall have the capability of arriving onsite with equipment and personnel for emergency repairs within 24 hours of notification by the City.
    d. Warranty Ownership: Manufacturer's warranty documentation shall name both the Contractor and the City of San Diego as the holder of the warranty.

Chapter 14 Operation and Maintenance Manuals

The Operation and Maintenance (O&M) of pump stations involves frequent inspection, monitoring, and maintenance. The following O&M manuals and trainings shall be specified in the pump station design contract documents and be provided by the Design Consultant and the Contractor or equipment vendors.

14.1 OPERATION AND MAINTENANCE MANUALS BY THE DESIGN CONSULTANT

The following sections describe the responsibilities of the Design Consult as it relates to the preparation of the Operation and Maintenance Manual.

14.1.1 PUMP OPERATION

The operation manual shall emphasize the pump station design and operation requirements specific to the site and hydraulic conditions. The manual shall include site hydraulic conditions and limitations, intake design, piping layout, pump system curves and operation region, and controls.

14.1.2 AUTOMATIC CONTROLS SUMMARY

The automatic controls summary shall provide a description of the operation of pump station automatic controls and instrument requirements.

14.2 OPERATION AND MAINTENANCE MANUALS BY THE CONTRACTOR OR EQUIPMENT VENDOR

Contract specifications shall require that the Contractor submit O&M manuals in both printed and electronic format. Manuals shall require electronic submittals for review, comment, revision, and final approval before delivery of the final versions in print and electronic format. Manuals for each piece of major equipment shall include a table of contents and shall be indexed by system and piece of equipment. Contract documents shall also require the Contractor to provide a storage cabinet onsite at the pump station for the storage of print versions.

The O&M manual for the operation, maintenance, and repair of the pump and equipment as published by the manufacturer shall be provided. The manual shall be organized in the following manner and subdivided first by specification section number; second, by equipment item; and last, by category. The following categories shall be addressed (if applicable).

14.2.1 CATEGORY 1: EQUIPMENT SUMMARY

- **Summary**: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.
- **Equipment Data Sheet**: A data sheet shall be provided for each item of mechanical apparatus with relevant information regarding electrical systems and instrumentation.

14.2.2 CATEGORY 2: OPERATIONAL PROCEDURES

Manufacturer-recommended procedures on the following shall be included:

- Installation, adjustment, and startup.
- Controls, equipment required, or related instrumentation needed for operation.
- Operation procedures.
- Load changes and calibration.
- Shutdown.
- Troubleshooting.
- Disassembly, reassembly, and realignment.
- Tabulation of proper settings for all mechanical, electrical and instrumentation devices.
- List of all electrical relay settings including alarm and contact settings.

14.2.3 CATEGORY 3: PREVENTIVE MAINTENANCE PROCEDURES

A consolidated summary of required routine scheduled maintenance for each piece of equipment shall be provided along with references to the location within the manual where detailed information may be found.

Procedures: Preventative maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component and by maintaining the equipment in place. Inspection and maintenance procedures such as wet well cleaning methodology, wet well cleaning frequency and any other required maintenance shall be described.

Schedules: A schedule listing the preventative maintenance and inspection frequency shall be maintained for each station. Preventative maintenance activities for pump stations include routine inspection of the following: pump, valve, and major equipment exercise frequency and requirement, lubrication schedules, including lubricant SAE grade, type, and temperature ranges.

14.2.4 CATEGORY 4: PARTS LIST

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

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

14.2.5 CATEGORY 5: WIRING DIAGRAMS

Diagrams: Complete internal and connection wiring diagrams shall be provided for electrical equipment items.

14.2.6 CATEGORY 6: SHOP DRAWINGS

Certified Test Documents: Factory-certified pump test curve for the actual pumping and motor units installed at the station shall be provided.

Drawings: Includes approved shop or fabrication drawings with Design Consultant comments and corrections incorporated, complete with dimensions. The Design Consultant shall review/check for accuracy the Contractor -submitted electrical/control system as-built drawings and diagrams.

14.2.7 CATEGORY 7: SAFETY

Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it, including access and confined space entry procedures

14.2.8 CATEGORY 8: DOCUMENTATION

Equipment warranties and Address: The City Internal Order Number and the name/address of the pump station shall be noted in the manuals.

Equipment certifications, calibrations, factory test results, and others required by the Technical Specifications shall be placed in this category.

14.3 OPERATION AND MAINTENANCE MANUAL SUBMITTAL REQUIREMENTS

14.3.1 HARD COPY

The Design Engineer shall prepare Specifications that require the Contractor to provide:

- Four sets of O&M binders shall be provided to the SWD.
- The manual shall fit in standard-size three-ring hardcover binders, labeled on the spine and cover with the project name, Owner's project number, specification section number, equipment name, and equipment identification number.
- The binder shall contain its own detailed table of contents at the front, plus a summary-level table of contents information for the other binders in a multi-binder set.
- Documents in binders shall be three-hole punched, with no text punched out, and pages larger than 8.5 by 11 shall be folded to 8.5 by 11.

14.3.2 ELECTRONIC COPY

The Specifications shall also require the Contractor to provide:

- Electronic files in searchable PDF format shall be provided for each set of major equipment.
- Files' content shall be similar to the hard copy mentioned above.

14.4 OPERATION AND MAINTENANCE TRAINING

Operation and maintenance training is critical for the long-term performance of the pump station. Operations and maintenance training shall be provided by the Design Consultant and Contractor/Vendor as presented in the following sections.

14.4.1 O&M TRAINING BY THE DESIGN CONSULTANT

The Design Consultant shall provide a minimum of 4 hours of training related to the pump station system design, and operation of the station. The training shall emphasize the pump system design, operation, site hydraulics, and controls.

14.4.2 O&M TRAINING BY THE CONTRACTOR/VENDOR

The Contractor shall provide, by factory-trained representatives, a minimum of 16 hours of training in the O&M of the major equipment. This training shall emphasize theory of operation and maintenance of electrical controls, pumps, motors, generators, and other major equipment. The training shall specifically cover the following elements:

- Electrical panels, specifically MCC panels.
- Mechanical equipment, including as a minimum, pumps, valves, and auxiliary system.
- Instrumentation, including PLC and SCADA operation.
- Emergency power generator.
- HVAC systems.
- Security system.
- Cranes and hoists.
- Confined Space and Safety Features.

14.5 PREFERRED EQUIPMENT/VENDOR LIST

See Appendix A – Preferred Equipment/Vendor/Manufacturers Lists, for the manufacturer preferences for stormwater pump station projects. When possible, manufacturers with local service centers and parts warehouses shall be used. If pumps with long-lead or unique spare parts are required, Operations staff shall be consulted to identify which spare parts should be procured.

The PUD Approved Materials List shall also be used. Refer to https://www.sandiego.gov/public-utilities/permits-construction/construction-and-development/sewer.

14.6 SPARE PARTS

The following spare parts shall be provided for each pump installed:

- Pump (for each pump with motor larger than 15 brake horsepower).
- Impeller.
- Wear ring set.
- Bearing set.
- Couplings.
- Mechanical seal.
- Set of gaskets and O-rings.
- Complete set of any special tools required for dismantling the pump.

Appendix A

Preferred Equipment /Vendors/Manufacturers Lists

Appendix A Preferred Equipment / Vendors / Manufacturers list

A.1 PREFERRED VENDORS/MANUFACTURERS

The Stormwater Department Operations utilizes specific manufacturers of equipment and accessories common throughout their systems. Therefore, specific standard equipment (make and model) may be requested by Operations. The list provided below covers some equipment categories.

A.2 FEDERAL REQUIREMENTS.

The project shall meet the requirement of American Iron and Steel (AIS) if federally funded.

The AIS Step Certification Process shall be used to ensure that producers adhere to the AIS requirements. The AIS Step Certification Process shall comply with all the US EPA AIS requirements, which can be found at: https://www.epa.gov/cwsrf/state-revolving-fund-american-iron-and-steel-ais-requirement.

A.3 MECHANICAL EQUIPMENT (VENDOR DATA AND INFORMATION WILL BE PROVIDED LATER)

Equipment	Type	Manufacturer	Addition Requirement
Pumps	Submersible Solids Handling	Fairbanks Morse/Fairbanks Nijhuis Wilo Little Giant Zoeller	Or Pre-approved by SWD
Pumps	Dry Pit Submersible Solids Handling	Fairbanks Morse/Fairbanks Nijhuis Wilo Gorman-Rupp Aurora	Or Pre-approved by SWD
Pumps	Vertical Mixed Flow	Fairbanks Morse/Fairbanks Nijhuis Cascade Pump Peerless	Or Pre-approved by SWD
Trash Capture Devices	Trash Rack Self-Cleaning Type	Duperon -Self Cleaning	Or Pre-approved by SWD
Isolation Valves	AWWA C17- Resilient-Seated Cast-Iron Eccentric Plug Valves AWWA C509 Resilient Seated Gate Valves AWWA C520 Knife Gate Valve	Mueller/Pratt DeZurik	Or Pre-approved by SWD
Check Valves	AWWA C508 Swing-Check Valves	Mueller DeZurik	Or Pre-approved by SWD
Actuators	Linear Actuator Rotary Actuator	Beck Industries	Or Pre-approved by SWD

A.4 ELECTRICAL

Equipment	Manufacturer
Motor	• U.S. Motor/Nidec • Baldor • WEG
Power Cable	• Okonite • General Cable • Southwire
Control Cable	• American • General Cable
MCC	• Eaton • Siemens
Switchboard	• Eaton • Siemens
Panelboard	• Eaton • Siemens
VFD	• Siemens • Eaton
Generator	• Caterpillar • Cummins

A.5 INSTRUMENTATION & CONTROL

Equipment	Type	Manufacturer	Addition Requirement
PLC Equipment			
PLC	Controller	Siemens Simatic S7-1500	
OIT	Touchscreen Display HMI	Siemens Simatic HMI TP900 Comfort	Latest WinCC software
UPS	Uninterruptible Power supply Unit	Eaton 5PX UPS Series	Or Pre-approved by SWD
Process Transmitters			
Liquid Flow	Magnetic Flowmeter	Endress Hauser Promag W 400	4-20mA Hart
Air/Gas Flow	Thermal Mass Flowmeter	FCI ST98	Integral, 4-20mA Hart
Level	Radar Level Meter	Primary selection- Siemens LR Series radar instruments. Secondary- Endress Hauser Micropilot FMR5x Series, Rosemount 5408 Series	4-20mA, Hart
Level	Hydrostatic Submersible Level Transducer	KPSI 720 Series	P/N 720S14B0A-0165
Gas Detectors	Electrochemical sensor	Ultima X series gas sensors.	Or Pre-approved by SWD
Gas Detectors	Infrared Sensor	Crowcom Corporation Cirrus Model	Or Pre-approved by SWD
Process Switches			
Flow	Thermal Dispersion Flow Switch	FCI FTL93S	
Level	Vibration Point Level Switch	Endress Hauser Liquiphant M FTL51	
Level	Float Level Switch	Magnetrol T10, Conery 2900 Series	
Level	Pressure Switch	Ashcroft B Series Type 400	
Process Switches			
Flow	Rotameter	Brooks GT130x Series	
Level	Sight Glass	Barksdale LevelSite Series	
Pressure	Bourdon Tube	Ashcroft 1279	
Security			
Access Control System	Server	C-Cure 9000 Siteserver	

Equipment	Type	Manufacturer	Addition Requirement
Access Control System	Card Reader	Software House SWH-4100	Or Pre-approved by SWD
Closed Circuit Television System	Cameras	Samsung, Bosch, Canon, Axis, Pelco, Flir	Or Pre-approved by SWD
Telemetry			
Wireless Router	Cellular Gateway	HMS EWON Netbiter 360	Carrier choice to be coordinated directly with SWD
Controller			
Backup System	Pump Controller	Red Lion PXU	Or Pre-approved by SWD

Appendix B

Design Checklist

EXAMPLE - CHECKLIST AND CONTENT
TO BE REVISED BY DESIGN CONSULTANT
TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
GENERAL & CAD

Notes: The Design Checklist is intended to aid the Design Engineer. It is not intended to replace the City's QC Checklist. Not all content or drawings apply to all projects, some drawings may be combined, but should still show applicable content.
***S** = Started: Work has begun, typical limited to sketches, outlines or similar levels of early development.*
***O** = Ongoing: Work is progress to an intermediate level for internal review and approval as appropriate*
***D** = Defined: Work is advanced, deliverables is near complete for internal review and approval as appropriate*

		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents	
						50% to 70% Completion	70% to 100% completion
GENERAL							
1		**Process Design Requirements**	**S**	**O**	**O**	**D**	**D**
2		Design Criteria and Data: - Design Requirements - Site Conditions - Design Constraints Evaluation	☐	☐	☐	☐	☐
3		Existing Data study and verification		☐	☐	☐	☐
4		New criteria (expansion, modification, etc.)		☐	☐	☐	☐
5		Basis of design criteria: - Flows, stormwater characteristics, etc…		☐	☐	☐	☐
6		Design criteria of major processes and process equipment		☐	☐	☐	☐
7		Design criteria of supporting equipment		☐	☐	☐	☐
8		Major Equipment Data		☐	☐	☐	☐
9		Piping and conveyance system		☐	☐	☐	☐
10		**CAD Standards**	**S**	**O**	**O**	**D**	**D**
11		Existing data from pursuit phase and contract requirements	☐	☐	☐	☐	☐
12		Filing system setup	☐	☐	☐	☐	☐
13		Drawing production standards set and distributed		☐	☐	☐	☐
14		Area/Facility numbering set		☐	☐	☐	☐
SPECIFICATIONS							
1		**Specifications**	**S**	**O**	**O**	**D**	**D**
2		Specifications status list & TOC (standard template)	☐	☐	☐	☐	☐
3		Status and responsibility assigned		☐	☐	☐	☐
4		Specifications status list & TOC updated as needed			☐	☐	☐
DRAWINGS							
1		**All Drawings**		**S**	**O**	**D**	**D**
2		Standard border (on all drawing except the cover sheet)		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number and Drawing number (provided via DSDDrawingNumberReq@sandiego.gov)		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)		☐	☐	☐	☐
9		Revision box information		☐	☐	☐	☐
10		License seal & signature		☐	☐	☐	☐
11		**Cover/Title Sheet**		**S**	**D**	**D**	**D**
12		Standard cover sheet cell		☐	☐	☐	☐
13		City SWD and logo		☐	☐	☐	☐
14		Project name		☐	☐	☐	☐
15		Deliverable title		☐	☐	☐	☐
16		Submittal name and date		☐	☐	☐	☐
17		Revision Block		☐	☐	☐	☐
18		**Location and Vicinity Map**		**S**	**D**	**D**	**D**
19		Location map		☐	☐	☐	☐
20		Vicinity map		☐	☐	☐	☐
21		North arrow		☐	☐	☐	☐
22		Annotation		☐	☐	☐	☐
23		**List of Drawings**		**S**	**O**	**D**	**D**
24		Off-line drawing list, status, and revisions		☐	☐	☐	☐
25		Current drawing list imported into CAD file		☐	☐	☐	☐
26		**Building / Location / Area Key Plan**		**S**	**O**	**D**	**D**
27		Existing site plan		☐	☐	☐	☐
28		New buildings/structures		☐	☐	☐	☐
29		Major features labeled (e.g. roads, creek crossings)		☐	☐	☐	☐
30		Existing and new buildings/structures labeled		☐	☐	☐	☐
31		Area designation key		☐	☐	☐	☐
32		North arrow		☐	☐	☐	☐

EXAMPLE - CHECKLIST AND CONTENT
TO BE REVISED BY DESIGN CONSULTANT
TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
GENERAL & CAD

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents	
						50% to 70% Completion	70% to 100% completion
33		Annotation			☐	☐	☐
34		**Pipeline Key Plan**		S	O	D	D
35		Base map		☐	☐	☐	☐
36		Pipe alignment		☐	☐	☐	☐
37		Major features labeled (e.g. roads, creek crossings)		☐	☐	☐	☐
38		North arrow (north should point up)		☐	☐	☐	☐
39		Drawing boundaries for each sheet		☐	☐	☐	☐
40		Sheet numbers for drawing boundaries		☐	☐	☐	☐
41		Annotation			☐	☐	☐
42		**General Symbol Sheets**		S	O	D	D
43		Standard symbol sheet cells		☐	☐	☐	☐
44		Project specific symbols added		☐	☐	☐	☐
45		**Abbreviation Sheet**		S	D	D	D
46		Standard abbreviation sheet cell		☐	☐	☐	☐
47		Project specific abbreviations added			☐	☐	☐
48		Abbreviations finalized				☐	☐
49		**Process Flow Schematics**	S	O	D	D	D
50		Major and auxiliary unit processes shown	☐	☐	☐	☐	☐
51		Major equipment and piping shown		☐	☐	☐	☐
52		Processes and fluid abbreviations shown		☐	☐	☐	☐
53		Annotation			☐	☐	☐
54		**Design Criteria Drawing**		S	D	D	D
55		Design criteria		☐	☐	☐	☐
56		**Hydraulic Profile - Plants**		S	O	D	D
57		Vertical scale shown		☐	☐	☐	☐
58		Major unit process shown at correct elevations		☐	☐	☐	☐
59		Water surface shown and labeled at: - design flow		☐	☐	☐	☐
60		Elevation of all hydraulic control points labeled		☐	☐	☐	☐
61		Overflow elevation at all overflow points labeled		☐	☐	☐	☐
62		Annotation			☐	☐	☐
63		**Hydraulic Gradeline - Pipelines**		S	O	D	D
64		Vertical and horizontal scale: elevation and station markers		☐	☐	☐	☐
65		Existing gradeline		☐	☐	☐	☐
66		Pipe invert		☐	☐	☐	☐
67		Hydraulic gradeline		☐	☐	☐	☐
68		Major features labeled (e.g. roads, creek crossings)		☐	☐	☐	☐
69		Annotation			☐	☐	☐
70		**Piping Schedule**		S	O	D	D
71		Pipe schedule		☐	☐	☐	☐
72		Desired piping material(s) for each fluid selected			☐	☐	☐
73		Appropriate test pressures for fluid piping checked and corrected			☐	☐	☐
74		**Equipment Schedules**			S	D	D
75		Major equipment schedules			☐	☐	☐
SUSTAINABILITY CRITERIA							
1		**All Drawings and Specifications**	S	O	O	D	D
2		Identify feasible sustainability requirements	☐	☐	☐	☐	☐
3		Assigned Sustainability SME Design Lead and coordinate with Design Disciplines		☐	☐	☐	☐
4		Confirm feasible sustainability requirements		☐	☐	☐	☐
5		Clearly identify design criteria that demonstrates compliance with applicable sustainability requirements			☐	☐	☐
LEED CRITERIA (When required by Sustainable Building Policy [i.e., conditioned space ≥ 5,000 square feet])							
1		**All Drawings and Specifications**	S	O	O	D	D
2		Identify feasibile LEED credits	☐	☐	☐	☐	☐
3		Assign LEED SME to coordinate with design disciplines		☐	☐	☐	☐
4		Confirm feasible LEED credits		☐	☐	☐	☐
5		Clearly identify design criteria that demonstrates compliance with applicable LEED credits			☐	☐	☐

THINK BLUE SAN DIEGO

EXAMPLE - CHECKLIST AND CONTENT
TO BE REVISED BY DESIGN CONSULTANT
TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
CIVIL

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SPECIFICATIONS							
	Civil Specifications		**S**	**O**	**O**	**D**	**D**
1		Specifications status list is up to date for Civil	☐	☐	☐	☐	☐
2		Draft specifications for major civil items			☐	☐	☐
3		Specifications for CIVIL Divisions edited and finalized				☐	☐
OTHER							
1	**Civil Design Criteria**		**S**	**O**	**O**	**D**	**D**
2		Existing technical data from pursuit phase	☐	☐	☐	☐	☐
3		Permit requirements		☐	☐	☐	☐
4		City SWD standards and preferences		☐	☐	☐	☐
5		Local and national standards researched and identified		☐	☐	☐	☐
6		Criteria for roadways (width, type, cross-section)		☐	☐	☐	☐
7		Criteria for fencing, guardrail, gates, security and access control (location, type, etc.)		☐	☐	☐	☐
8		Existing facilities researched (yard piping, utilities, etc…)			☐	☐	☐
9		Conditions assessment of existing facilities			☐	☐	☐
10		Criteria for pavement design			☐	☐	☐
11	**Geotechnical Exploration**			**S**	**O**	**D**	**D**
12		Preliminary subsurface investigation locations		☐	☐	☐	☐
13		Potholing		☐	☐	☐	☐
14		Final subsurface geotechnical investigation locations with coordinates and notes as appropriate.			☐	☐	☐
15		Final geotechnical report			☐	☐	☐
DRAWINGS							
1	**All Drawings**			**S**	**O**	**D**	**D**
2		Standard border		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number (no leading zero)		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)				☐	☐
9		Revision box information					☐
10		License seal & signature					☐
11	**Civil General Notes and Symbols**			**S**	**O**	**D**	**D**
12		General Civil notes and symbols		☐	☐	☐	☐
13		General notes tailored for project			☐	☐	☐
14		General and project specific notes finalized				☐	☐
15	**Civil Standard Details**			**S**	**O**	**D**	**D**
16		City Standard detail index			☐	☐	☐
17		City SWD standard details			☐	☐	☐
18		City Standard details edited and finalized					☐
19	**Project Specific Standard Details**				**S**	**O**	**D**
20		Owner, agency, building department, government, etc... standard details shown			☐	☐	☐
21		Project-specific standard details developed and shown			☐	☐	☐
22		Project specific details finalized and annotated					☐
23	**Minor Civil Structures**				**S**	**D**	**D**
24		Initial structure plans			☐	☐	☐
25		North arrows			☐	☐	☐
26		Draft section and details			☐	☐	☐
27		Plans finalized and annotated				☐	☐
28		Details finalized and annotated				☐	☐
29	**Existing Site Plan**			**S**	**O**	**D**	**D**
30		Existing base map		☐	☐	☐	☐
31		North arrow		☐	☐	☐	☐
32		Basis of bearing and datum note		☐	☐	☐	☐
33		Site boundary labeled		☐	☐	☐	☐

EXAMPLE - CHECKLIST AND CONTENT
TO BE REVISED BY DESIGN CONSULTANT
TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
CIVIL

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34		Environmentally sensitive areas indicated		☐	☐	☐	☐
35		Updated from record drawings or field investigations			☐	☐	☐
36		Remaining annotation			☐	☐	☐
37	**Demolition Drawings**				S	D	D
38		Existing base map			☐	☐	☐
39		North arrow			☐	☐	☐
40		Individual items for demolition identified with keynote bubbles (hexagons and keyed to the notes			☐	☐	☐
41		Large areas for demolition identified with hatched lines and notes			☐	☐	☐
42		Items to be protected (that are in close proximity to demolition work) identified with numbers in circles keyed to the notes			☐	☐	☐
43		Remaining annotation				☐	☐
44	**Site Key Plan**			S	D	D	D
45		Existing base map		☐	☐	☐	☐
46		New buildings/structures		☐	☐	☐	☐
47		Major features labeled (e.g. roads, creek crossings)		☐	☐	☐	☐
48		Existing and new buildings/structures labeled		☐	☐	☐	☐
49		Area designation key		☐	☐	☐	☐
50		North arrow		☐	☐	☐	☐
51		Remaining annotation			☐	☐	☐
52	**Construction Staging Area Plan and Notes**				S	D	D
53		Existing base map			☐	☐	☐
54		New buildings/structures			☐	☐	☐
55		Major features labeled (e.g. roads, creek crossings)			☐	☐	☐
56		Existing and new buildings/structures labeled			☐	☐	☐
57		Limit of construction/site disturbance indicated			☐	☐	☐
58		North arrow			☐	☐	☐
59		Remaining annotation				☐	☐
60	**Civil Site Plan**			S	O	D	D
61		Existing base map (referenced and screened) showing all existing improvements, easements, site and project boundaries with major features labeled (e.g. roads, creeks, crossings)		☐	☐	☐	☐
62		North arrow (shall be the same on all plans)		☐	☐	☐	☐
63		Conceptual layout of new structures, roads, and piping (labeled)		☐	☐	☐	☐
64		New improvements (vaults, boxes, inlets, etc...) shown		☐	☐	☐	☐
65		Site and project boundaries shown		☐	☐	☐	☐
66		Benchmark reference (with the appropriate symbol) shown		☐	☐	☐	☐
67		Preliminary major circulation/parking concept shown		☐	☐	☐	☐
68		Major utility corridors		☐	☐	☐	☐
69		Site and project boundaries labeled with distances and coordinates			☐	☐	☐
70		Horizontal and vertical survey control			☐	☐	☐
71		Site layout for building and structures finalized			☐	☐	☐
72		Roadway layout and vehicle access shown			☐	☐	☐
73		Walkway layout and personnel access			☐	☐	☐
74		Staging areas, borrow pits and spoils piles shown (when not using a separate drawing)			☐	☐	☐
75		Site access control, fencing and security shown			☐	☐	☐
76		Other items, including road layout, grading and drainage finalized				☐	☐
77		Label individual structures and process units				☐	☐
78		Sequencing shown for the enlarged plans				☐	☐
79		Ties to the state plane coordinate system				☐	☐
80		Reference to location of the notes to the contractor				☐	☐
81		Horizontal location of major structures and buildings labeled				☐	☐
82		Remaining annotation					☐
83	**Horizontal Control and Paving Plans**			S	O	D	D
84		Existing base map (referenced and screened) showing all existing improvements, easements, site and project boundaries with major features labeled (e.g. roads, creeks, crossings)		☐	☐	☐	☐
85		New facilities and improvements including catch basins, maintenance holes etc...(referenced and solid)		☐	☐	☐	☐

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86		Boundary and easement lines		☐	☐	☐	☐
87		North arrow		☐	☐	☐	☐
88		Key plan with hatching/shading to indicate location		☐	☐	☐	☐
89		Road layout and access to major buildings and structures		☐	☐	☐	☐
90		Road layout and access to major and minor buildings and structures			☐	☐	☐
91		Walkway layout and personnel access			☐	☐	☐
92		Coordinates of structures, roads, and all surface improvements. (minimum of two coordinates along a common wall is used to locate each structure)			☐	☐	☐
93		Matchlines shown with annotation			☐	☐	☐
94		Civil sitework including: - Curbs and gutters - Paved swales - Driveways and access ramps - Structure exterior doorways or access points - Equipment enclosures and pads - Planting areas				☐	☐
95		Fencing, walls, guardrail, gates, security and access control finalized				☐	☐
96		Roadway alignments finalized				☐	☐
97		Types of paving indicated with clearly distinguishable patterns, to separate them from each other				☐	☐
98		Site signage				☐	☐
99		Roadway annotation including: - Centerlines - Point of intersection (pi) - Curve data - Road dimensions - Stationing				☐	☐
100		Callouts for sections and details associated with paving and surface improvements				☐	☐
101		Parking, striping, and pavement markings with sufficient dimensions or coordinates.				☐	☐
102		Remaining annotation				☐	☐
103	**Grading and Drainage Plans**			**S**	**O**	**D**	**D**
104		Existing base map showing all existing improvements, easements, site and project boundaries with major features labeled (e.g. roads, creeks, crossings)		☐	☐	☐	☐
105		New facilities and improvements including catch basins, maintenance holes etc…		☐	☐	☐	☐
106		North arrow		☐	☐	☐	☐
107		Key plan with hatching/shading to indicate location		☐	☐	☐	☐
108		Overall drainage concept		☐	☐	☐	☐
109		Preliminary size of major drainage facilities		☐	☐	☐	☐
110		Approximate finish grade around structures		☐	☐	☐	☐
111		Matchlines shown with annotation			☐	☐	☐
112		Road and walkway layout			☐	☐	☐
113		Flow lines, grade break lines, and ridge lines shown and labeled			☐	☐	☐
114		Top and toe of slopes (for slope greater than 5:1)			☐	☐	☐
115		Preliminary grading			☐	☐	☐
116		Transitions clearly labeled.			☐	☐	☐
117		Requirements for temporary erosion and/or drainage control			☐	☐	☐
118		Stormwater control concepts for ditches, swales, cub and gutter, inlets, etc.			☐	☐	☐
119		Site access control, fencing and security shown			☐	☐	☐
120		Building and structure elevations			☐	☐	☐
121		Underdrains (if required)			☐	☐	☐
122		Site section references			☐	☐	☐
123		Structural/retaining walls			☐	☐	☐
124		Rip-rap			☐	☐	☐

EXAMPLE - CHECKLIST AND CONTENT
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CIVIL

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125		Civil sitework including: - Curbs and gutters - Paved swales - Driveways and access ramps - Handicap access - Structure exterior doorways or access points - Equipment enclosures and pads - Utility trenches - Planting areas				☐	☐
126		Final grading and spot elevations, walkway, door pads and floor elevations shown				☐	☐
127		Slope benching				☐	☐
128		Daylight lines (join lines)				☐	☐
129		Slopes				☐	☐
130		Drainage system based on final grading				☐	☐
131		Culverts				☐	☐
132		Drainage channels				☐	☐
133		Maintenance holes				☐	☐
134		Storm drain lines				☐	☐
135		Swales				☐	☐
136		Landscaping and other walls				☐	☐
137		Inlet and maintenance hole schedules				☐	☐
138		Remaining annotation including: - Control Points - Coordinates - Dimensions - Callouts for sections and details associated with grading				☐	☐
139		**Large Yard Piping Plans - 12" diameter and larger**		**S**	**O**	**D**	**D**
140		Existing base map showing all existing improvements, piping and structures with major features labeled (e.g. roads, creeks, crossings)		☐	☐	☐	☐
141		New facilities and improvements including catch basins, maintenance holes etc…		☐	☐	☐	☐
142		North arrow		☐	☐	☐	☐
143		Key plan with hatching/shading to indicate location		☐	☐	☐	☐
144		Conceptual layout of new piping and utilities		☐	☐	☐	☐
145		Electrical duct banks locations. (Civil to determine horizontal and vertical alignment with input and guidance from electrical.)			☐	☐	☐
146		Piping layout finalized and connection points to process piping shown (Alignment reports needed on drawings for all proposed alignments)			☐	☐	☐
147		Connection points and layout of fire protection piping shown			☐	☐	☐
148		Vertical alignment of utilities and drainage (gravity)			☐	☐	☐
149		Vertical alignment of utilities (non-gravity)				☐	☐
150		New piping annotation showing: - Coordinates - Sizes - Material - Fluid service				☐	☐
151		Cross-referencing to profiles, sections, and details associated with yard piping.				☐	☐
152		Temporary piping needed to maintain plant operations during construction.				☐	☐
153		Work by others that affects the yard piping.				☐	☐
154		Remaining annotation					☐
155		**Small Piping Plans - less than 12" diameter**				**D**	**D**
156		Existing base map showing all existing improvements, piping and structures with major features labeled (e.g. roads, creeks, crossings)				☐	☐
157		New facilities and improvements including catch basins, maintenance holes etc…				☐	☐
158		North arrow				☐	☐
159		Key plan with hatching/shading to indicate location				☐	☐
160		Connection points and layout of plumbing piping and utilities				☐	☐
161		Connection points and layout of sanitary sewer and plant drain piping an utilities				☐	☐
162		Vertical alignment of utilities				☐	☐

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163		Invert elevations on small gravity lines less than 12 inches which do not have a profile.				☐	☐
164		Work by others that affects the yard piping.					☐
165		Remaining annotation					☐
166		**Site Sections**			S	D	D
167		Existing ground lines and structures shown			☐	☐	☐
168		Finished grade lines and structure (solid)				☐	☐
169		Extent and thickness of special materials such as select fill				☐	☐
170		Subsurface drains, utilities, etc…				☐	☐
171		Space limitations and other unusual constraints				☐	☐
172		Benching and keying requirements per geotechnical report				☐	☐
173		Boundary lines, if encountered				☐	☐
174		Civil sitework including: - Roads - Curbs and gutters - Walkways - Pavements - Swales				☐	☐
175		Vaults, catch basins, etc…				☐	☐
176		Remaining annotation				☐	☐
177		**Yard Piping Profiles**		S	O	D	D
178		Existing grade line (dashed or screened)		☐	☐	☐	☐
179		New Finished grade line (solid line)		☐	☐	☐	☐
180		New pipe invert, crown, and maintenance holes (gravity pipe).		☐	☐	☐	☐
181		New pipe invert, soffit , and appurtenances such as meters, couplings, valves, etc (pressure pipeline).		☐	☐	☐	☐
182		Stations called out at all pipe angle points, maintenance holes, structures, appurtenances, inlets, outlets, and any other items necessary for fabrication and installation.		☐	☐	☐	☐
183		Pipe crossings (new and existing)		☐	☐	☐	☐
184		Concrete encasements		☐	☐	☐	☐
185		Casings including casing data		☐	☐	☐	☐
186		Special pipe supports		☐	☐	☐	☐
187		Callouts and references specific to the construction of pipe		☐	☐	☐	☐
188		Slopes			☐	☐	☐
189		Bedding conditions			☐	☐	☐
190		Underground interference's (new and existing)			☐	☐	☐
191		Matchline and matchline data			☐	☐	☐
192		Pipe material including classifications			☐	☐	☐
193		Storm drains: - Year event (for a 100 year event) - Hydraulic grade for each reach			☐	☐	☐
194		Remaining annotation				☐	☐

EXAMPLE - CHECKLIST AND CONTENT
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CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
PIPELINE (PLAN AND PROFILE)

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SPECIFICATIONS							
1		**Pipeline Specifications**	**S**	**O**	**O**	**D**	**D**
2		Specifications status list is up to date for Pipeline	☐	☐	☐	☐	☐
3		Draft specifications for major piping items			☐	☐	☐
4		Specifications for Piping Divisions edited and finalized				☐	☐
OTHER							
1		**Pipeline Design Criteria**	**S**	**O**	**D**	**D**	**D**
2		Assumed information: - Pipeline length - Pipe diameter - Material - Wall thickness - Coatings - Geotechnical data - Potholing Data		☐	☐	☐	☐
3		Right of way characterization (width, topography, open, developed, roadway, etc.); include anticipated length of each row situation	☐	☐	☐	☐	☐
4		Minimum pipe depth/cover	☐	☐	☐	☐	☐
5		Criteria for crossings, tunnels, etc. (where required, type)		☐	☐	☐	☐
6		Assumed information: - Trench cross-section (bedding, backfill, etc.) - Pipe joint details		☐	☐	☐	☐
7		Preliminary information: - Geotechnical Investigation - Pipe diameter - Material - Wall thickness - Coating		☐	☐	☐	☐
8		Preliminary details for appurtenances (meters, valves, air valves, blowoffs, couplings, etc.)		☐	☐	☐	☐
9		Finalized information: - Pipe diameter - Material - Wall thickness - Coating - Pipe joint details - Trench cross-section (bedding, backfill, etc…) - Details for appurtenances - Geotechnical Final Report			☐	☐	☐
DRAWINGS							
1		**All Drawings**		**S**	**O**	**D**	**D**
2		Standard border		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number (no leading zero)		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)				☐	☐
9		Revision box information					☐
10		License seal & signature					☐
11		**Plan and Profile - Plan View**		**S**	**O**	**D**	**D**
12		Base map showing existing topographic features - existing roads, structures and surface features		☐	☐	☐	☐
13		Existing sub-surface piping and structures (dashed lines)		☐	☐	☐	☐
14		Major features labeled (roads, creeks, rivers etc.)		☐	☐	☐	☐
15		New piping (solid lines)		☐	☐	☐	☐
16		New piping labeled with coordinates and sizes		☐	☐	☐	☐
17		Stationing and tick marks laid out parallel to the pipeline		☐	☐	☐	☐
18		Pipe bend information to angle point callouts		☐	☐	☐	☐
19		Survey control points (may be entirely separate drawing)			☐	☐	☐
20		Geotechnical bore hole/test pipe locations			☐	☐	☐
21		New improvements (solid lines)			☐	☐	☐

EXAMPLE - CHECKLIST AND CONTENT
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TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
PIPELINE (PLAN AND PROFILE)

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents 50% to 70% Completion	Construction Documents 70% to 100% completion
22		Any work by others which affects the pipeline			☐	☐	☐
23		Cross-referencing to details.			☐	☐	☐
24		Individual sheets cut				☐	☐
25		Plan and profile panel borders				☐	☐
26		North arrow				☐	☐
27		Matchlines				☐	☐
28		Corrosion control concept shown				☐	☐
29		**Plan and Profile - Profile View**		**S**	**O**	**D**	**D**
30		Existing ground line (dashed line.)		☐	☐	☐	☐
31		New pipe showing invert, crown and maintenance holes (gravity pipe)		☐	☐	☐	☐
32		New pipe showing pipe invert and crown (pressure pipe)			☐	☐	☐
33		Appurtenances such as meters, couplings, valves, blowoffs, etc…			☐	☐	☐
34		New finished grade (solid line)			☐	☐	☐
35		Stations at all pipe angle points, appurtenances, inlets, outlets, and any other items necessary for fabrication and installation			☐	☐	☐
36		Casings including casing data			☐	☐	☐
37		Pipe crossings both new and existing			☐	☐	☐
38		Pipe slopes			☐	☐	☐
39		Pipe material classifications including size, service and material callouts.			☐	☐	☐
40		Underground interference's (gravity pipe)			☐	☐	☐
41		Individual sheets cut				☐	☐
42		Plan and profile panel borders				☐	☐
43		Profile grid				☐	☐
44		Matchline and matchline data.				☐	☐
45		Underground interference's (pressure pipe)				☐	☐
46		Sizes for appurtenances such as air valves and blowoffs, etc…				☐	☐
47		Special bedding conditions.				☐	☐
48		Concrete encasement or special pipe supports				☐	☐
49		Detail references specific to the construction of the pipe.				☐	☐
50		Surface restoration requirements				☐	☐

EXAMPLE - CHECKLIST AND CONTENT
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CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
ARCHITECTUAL

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents	
						50% to 70% Completion	70% to 100% completion
SPECIFICATIONS							
		Architectural Specifications	**S**	**O**	**O**	**D**	**D**
1		Specifications status list is up to date for Architectural	☐	☐	☐	☐	☐
2		Draft specifications for major architectural items			☐	☐	☐
3		Specifications for Architectural Divisions edited and finalized				☐	☐
OTHER							
1		**Architectural Design Criteria**	**S**	**O**	**O**	**D**	**D**
2		Define building requirements: - Use - Approximate square footage - Class of construction (block, tilt-up panel, etc.)	☐	☐	☐	☐	☐
3		Existing technical data from pursuit phase	☐	☐	☐	☐	☐
4		Local and national standards researched and identified		☐	☐	☐	☐
5		City SWD standards and preferences		☐	☐	☐	☐
6		Existing facilities researched		☐	☐	☐	☐
7		Conditions assessment of existing		☐	☐	☐	☐
8		Permit requirements		☐	☐	☐	☐
9		**Renderings**		**S**	**O**	**D**	**D**
10		Preliminary 3D model developed. (if in the scope of work) minimal detail, a basic mass model with preliminary fenestrations, and material assignments.		☐	☐	☐	☐
11		3D model refined - Detail added - Materials refined - Lighting set - Surrounding terrain, vegetation, sky, photomontage etc…			☐	☐	☐
12		**Material Boards**				**D**	**D**
13		Exterior materials sample/color board(s)				☐	☐
14		Interior materials sample/color board(s)				☐	☐
DRAWINGS							
1		**All Drawings**		**S**	**O**	**D**	**D**
2		Standard border		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)				☐	☐
9		Revision box information					☐
10		License seal & signature					☐
11		**Architectural General Notes & Symbols**		**S**	**O**	**D**	**D**
12		General Architectural notes and symbols		☐	☐	☐	☐
13		General notes tailored for project			☐	☐	☐
14		General and project specific notes finalized				☐	☐
15		**Architectural Standard Details**		**S**	**O**	**D**	**D**
16		City Standard detail index		☐	☐	☐	☐
17		City SWD standard details			☐	☐	☐
18		City Standard details edited and finalized				☐	☐
19		**Project Specific Standard Details**			**S**	**D**	**D**
20		Owner, agency, building department, government, etc... standard details shown			☐	☐	☐
21		Project-specific standard details developed and shown			☐	☐	☐
22		Project specific details finalized and annotated					☐
23		**ADA Standards (NA where projects are exempt)**			**S**	**D**	**D**
24		Standard ADA standards			☐	☐	☐
25		Updated to regional and local regulations			☐	☐	☐
26		Final annotation added					☐
27		**Wall & Partition Types**			**S**	**D**	**D**
28		Wall and Partition Types			☐	☐	☐
29		Non-applicable types removed			☐	☐	☐

EXAMPLE - CHECKLIST AND CONTENT
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TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
ARCHITECTUAL

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents	
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30		Project specific types added				☐	☐
31		Final annotation added				☐	☐
32		**Schedules**			S	D	D
33		Standard / blank schedule cells - Room finish schedule - Door and hardware schedule - Window schedule - Toilet accessories schedule			☐	☐	☐
34		Door types tailored to project, and data entered into schedule for general door and frame info			☐	☐	☐
35		Window types tailored to project			☐	☐	☐
36		Room finish schedule tailored to project			☐	☐	☐
37		Toilet accessories tailored to project and info added to schedule				☐	☐
38		Room finish schedule info added				☐	☐
39		Window schedule info added				☐	☐
40		Schedules finalized				☐	☐
41		**Architectural Key Plans**		S	D	D	D
42		Existing floor plan background		☐	☐	☐	☐
43		New floor plan background		☐	☐	☐	☐
44		Basic annotation: - Gridlines and north arrow - Area/sheet boundaries and labels - Room names		☐	☐	☐	☐
45		Final annotation: - Dimensions and notes - Section cut references			☐	☐	☐
46		**Demolition Drawings - Plans, Sections & Details**		S	O	D	D
47		Existing backgrounds		☐	☐	☐	☐
48		Basic annotation: - Gridlines, keyplan, and north arrow - Room names		☐	☐	☐	☐
49		Items to be demolished identified (hatched)		☐	☐	☐	☐
50		Items for demolition identified with key notes			☐	☐	☐
51		Detailed annotation: - Sheet notes - Pertinent dimensions - Reference to other discipline drawings for utility demolition requirements			☐	☐	☐
52		Known hazardous materials noted (asbestos, lead, etc…)				☐	
53		Final annotations				☐	
54		**Architectural Building Code Data**		S	O	D	D
55		Standard/blank building code cell		☐	☐	☐	☐
56		Client specific design criteria added		☐	☐	☐	☐
57		Basic code data fields completed		☐	☐	☐	☐
58		Remaining code data completed			☐	☐	☐
59		Code data finalized				☐	☐
60		**Life Safety Plans**			S	D	D
61		Existing floor plan background			☐	☐	☐
62		New floor plan background			☐	☐	☐
63		Basic annotation: - Gridlines, keyplan, and north arrow - Room names - Notes			☐	☐	☐
64		Emergency egress pathways and direction of travel			☐	☐	☐
65		Primary area & room designations			☐	☐	☐
66		Occupancy loads			☐	☐	☐
67		Occupancy types			☐	☐	☐
68		Life safety plans & notes finalized				☐	
69		**Floor Plan(s)**		S	O	D	D
70		Existing floor plan background		☐	☐	☐	☐
71		New floor plan background		☐	☐	☐	☐
72		Discipline backgrounds for structural, mechanical, electrical, etc.		☐	☐	☐	☐

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		Description	Project Phase / (Estimate Class)				
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73		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Room and area names - Primary dimension (overall building and gridlines)		☐	☐	☐	☐
74		Wall, partition, and associated component fire assemblies			☐	☐	☐
75		Trenches, pits, pedestals, housekeeping pads, curbs, door landings			☐	☐	☐
76		Changes in floor material			☐	☐	☐
77		Recessed components; recessed floor mats, shower stalls, etc... Coordinated with Structural			☐	☐	☐
78		Toilet & plumbing fixtures, floor drains etc... Coordinated with Plumbing			☐	☐	☐
79		Downspouts, rainwater leaders, splash blocks			☐	☐	☐
80		Wall section callouts for those that are not extracted from the building sections			☐	☐	☐
81		Additional annotation: - Door tag #s and window types - Room and area numbers - Floor elevations - Building section callouts, notes, and legends - Chemical tanks labeled with name and volume - Secondary dimensions (wall openings, ladders etc…)			☐	☐	☐
82		Louvers and mechanical wall and floor openings				☐	☐
83		Special door threshold embedment requirements; i.e., overhead door threshold, called out and coordinated with Structural				☐	☐
84		Chase walls, plenums, etc.				☐	☐
85		Critical horizontal clearances shown and coordinated				☐	☐
86		Additional annotation: - Interior elevation callouts - Wall type callouts - Criteria for acoustical wall panels - Additional dimensions				☐	☐
87		Fire extinguishers and cabinets				☐	☐
88		Acoustical wall panel locations				☐	☐
89		Final annotation: - Enlarged plan callouts - Fire extinguishers and cabinets - Detail callouts - Additional annotation as needed				☐	☐
90	**Roof Plan**			**S**	**O**	**D**	**D**
91		Existing roof plan background		☐	☐	☐	☐
92		New roof plan background		☐	☐	☐	☐
93		Building line below		☐	☐	☐	☐
94		Discipline backgrounds for structural, mechanical, electrical, etc.		☐	☐	☐	☐
95		Roof drains and scuppers		☐	☐	☐	☐
96		Roof ridges. valleys, slope directions and pitches		☐	☐	☐	☐
97		Basic annotation: - Gridlines, north arrow, keyplan, and matchlines - Primary dimension (overall building and gridlines)		☐	☐	☐	☐
98		Gutters and downspouts			☐	☐	☐
99		Roof material systems			☐	☐	☐
100		Additional annotation: - Roof material system - Drainage - Building section callouts - Secondary dimensions and notes (openings etc…)			☐	☐	☐
101		Roof openings; skylights, roof access hatches, equipment hatches, and associated curbs				☐	☐
102		Roof penetrations; vents, stacks, etc.				☐	☐
103		Roof walkways				☐	☐
104		Roof access and parapet ladders				☐	☐
105		Roof equipment screens				☐	☐
106		Roof mounted building mechanical equipment; air handling units exhaust fans, etc., and associated curbs.				☐	☐

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107		Final annotation: - Enlarged plan callouts - Detail callouts - Additional annotation as needed				☐	☐
108		**Reflected Ceiling Plans**		S	O	D	D
109		Existing reflected ceiling plan background		☐	☐	☐	☐
110		New reflected ceiling plan background		☐	☐	☐	☐
111		Discipline backgrounds for structural, mechanical, electrical, etc.		☐	☐	☐	☐
112		Basic annotation: - Gridlines, north arrow, keyplan, and matchlines - Primary dimension (overall building and gridlines)		☐	☐	☐	☐
113		Ceiling grid system, or ceiling materials		☐	☐	☐	☐
114		Soffits			☐	☐	☐
115		Additional annotation: - Ceiling materials - Building section callouts - Notes			☐	☐	☐
116		Folding partitions, sliding partitions, etc. coordinated with Structural				☐	☐
117		Additional annotation: - Detail callouts - Enlarged plan callouts				☐	☐
118		Electrical systems; lights, sensors, exit signs, etc. coordinated with Electrical				☐	☐
119		Building mechanical systems; diffusers, access panels				☐	☐
120		Final annotation: - Final notes - Additional annotation as needed				☐	☐
121		**Furnishings Plan & Schedule**				D	D
122		Existing floor and furnishing plan background				☐	☐
123		New floor plan background				☐	☐
124		Discipline backgrounds for structural, mechanical, electrical, etc.				☐	☐
125		Furnishings laid out				☐	☐
126		Annotation - Gridlines, north arrow, keyplan, and matchlines - Room and area names - Sheet notes and schedule - Primary dimension (overall building and gridlines)				☐	☐
127		**Enlarged Plans**				D	D
128		Existing plan				☐	☐
129		New plan model				☐	☐
130		Discipline backgrounds for structural, mechanical, electrical, etc				☐	☐
131		Annotation - Gridlines, north arrow, keyplan, and matchlines - Room and area names - Title cross-referenced back to overall floor plans) - Primary dimension (overall and gridlines) - All pertinent components - Interior elevation callouts				☐	☐
132		Toilet accessories				☐	☐
133		Cabinets and counters				☐	☐
134		Equipment				☐	☐
135		Final annotation: - Sheet notes defining toilet accessories - Laboratory cabinets, counters etc… referenced to schedule - Dimensions, notes, and detail callouts - Materials and equipment - Critical clearances, ADA compliance etc... - Additional annotation as needed				☐	☐
136		**Exterior Building Elevations**		S	O	D	D
137		Existing elevation backgrounds		☐	☐	☐	☐
138		New elevation backgrounds		☐	☐	☐	☐
139		Basic annotation - Gridlines - Title and cross-reference		☐	☐	☐	☐
140		Primary wall openings; doors, windows, louvers		☐	☐	☐	☐

EXAMPLE - CHECKLIST AND CONTENT
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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents 50% to 70% Completion	Construction Documents 70% to 100% completion
141		Wall systems, materials, and colors, if multiple		☐	☐	☐	☐
142		Scuppers, downspouts, rain water leaders, and splash blocks			☐	☐	☐
143		Annotation - Vertical elevations and dimensions - Openings, drains, wall systems etc... - Building section callouts - Window type callouts			☐	☐	☐
144		Secondary wall openings; removable wall sections, miscellaneous mechanical wall openings and penetrations				☐	☐
145		Structural control joints and secondary architectural callouts				☐	☐
146		Electrical fixtures				☐	☐
147		Final annotation: - Lights - Detail callout					☐
148	**Interior Elevations**				**S**	**D**	**D**
149		Existing elevation backgrounds			☐	☐	☐
150		New elevation backgrounds			☐	☐	☐
151		Basic annotation - Gridlines - Title and cross-reference - Critical vertical dimensions			☐	☐	☐
152		Pertinent components			☐	☐	☐
153		Materials and systems			☐	☐	☐
154		Toilet Accessories					☐
155		Annotation - Notes identifying toilet accessories (reference to schedule) - Detail callouts - Critical clearances					☐
156	**Building Sections**			**S**	**O**	**D**	**D**
157		Existing section backgrounds		☐	☐	☐	☐
158		New section backgrounds		☐	☐	☐	☐
159		Architectural roofing system and roof pitch		☐	☐	☐	☐
160		Finish grade lines		☐	☐	☐	☐
161		Basic annotation - Gridlines - Title and cross-reference - Room names		☐	☐	☐	☐
162		Architectural building components			☐	☐	☐
163		Major or pertinent structural systems; trusses, joists, slabs, etc.			☐	☐	☐
164		Interior floor assemblies, platforms, etc.			☐	☐	☐
165		Key process mechanical equipment			☐	☐	☐
166		Additional annotation - Room numbers - Wall section callouts			☐	☐	☐
167		Skylights, light wells, and roof equipment hatches				☐	☐
168		Bridge cranes, monorails, jib cranes, etc.				☐	☐
169		Additional annotation - Critical headroom clearances, at stairwells and elsewhere - Major vertical elevations and dimensions				☐	☐
170		Building mechanical equipment, roof and interior mounted				☐	☐
171		Acoustical wall and/or ceiling panel system				☐	☐
172		Final annotation - Equipment - Crane requirements (quantity, location, capacity) - Detail Callouts				☐	☐
173	**Wall Sections**				**S**	**D**	**D**
174		Existing section backgrounds			☐	☐	☐
175		New section backgrounds			☐	☐	☐
176		Architectural roofing system and roof pitch			☐	☐	☐
177		Finish grade lines			☐	☐	☐
178		Basic annotation - Gridlines - Title and cross-reference - Room names				☐	☐

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents	
						50% to 70% Completion	70% to 100% completion
179		Acoustical wall and/or roof panels					☐
180		Final annotation - Vertical dimensions and elevations - Detail callouts					☐
181		**Details & Sections**			S	D	D
182		Existing backgrounds			☐	☐	☐
183		New background			☐	☐	☐
184		Flashing				☐	☐
185		Detail components (coordinated with all disciplines)				☐	☐
186		Annotation - Gridlines - Title and cross-reference - Room names - Flashing - Notes and dimensions to all components				☐	☐

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		Description	Project Phase / (Estimate Class)				
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SPECIFICATIONS							
1		**Structural Specifications**	**S**	**O**	**O**	**D**	**D**
2		Specifications status list is up to date for Structural	☐	☐	☐	☐	☐
3		Draft specifications for major structural building materials			☐	☐	☐
4		Specifications for Structural Divisions edited and finalized				☐	☐
OTHER							
1		**Structural Design Criteria**	**S**	**O**	**O**	**D**	**D**
2		Existing technical data from pursuit phase	☐	☐	☐	☐	☐
3		City SWD standards and preferences		☐	☐	☐	☐
4		Local and national standards researched and identified		☐	☐	☐	☐
5		Permit requirements		☐	☐	☐	☐
6		Existing facilities researched		☐	☐	☐	☐
7		Conditions assessment of existing facilities		☐	☐	☐	☐
8		Equipment weights from equipment list			☐	☐	☐
9		Identify miscellaneous minor structures that are cast-in-place and that will require structural calculations and detailing (civil, landscaping, electrical, etc…)			☐	☐	☐
10		**Geotechnical Input**		**S**	**O**	**D**	**D**
11		Input to Geotechnical Scope from lead structural		☐	☐	☐	☐
12		Coordinate with the geotech to complete prelim calcs to determine the type and prelim sizes of piles and general pile layout		☐	☐	☐	☐
13		Established need and preliminary criteria for soil improvement		☐	☐	☐	☐
14		Finalized criteria for any soil improvement			☐	☐	☐
15		Preliminary geotech report reviewed			☐	☐	☐
16		Final geotech report reviewed				☐	☐
DRAWINGS							
1		**All Drawings**		**S**	**O**	**D**	**D**
2		Standard border		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number (no leading zero)		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)				☐	☐
9		Revision box information					☐
10		License seal & signature					☐
11		**Structural Notes and Standard Details**				**D**	**D**
12		General Structural notes				☐	☐
13		General notes tailored for project				☐	☐
14		General and project specific notes finalized					☐
15		**Structural Standard Details**			**D**	**D**	**D**
16		City Standard detail index			☐	☐	☐
17		City SWD standard details				☐	☐
18		City Standard details edited and finalized				☐	☐
19		**Project Specific Standard Details**				**D**	**D**
20		Owner, agency, building department, government, etc... standard details shown				☐	☐
21		Project-specific standard details developed and shown				☐	☐
22		Project specific details finalized and annotated				☐	☐
23		**Minor Structures - Plans, Sections & Details**			**S**	**D**	**D**
24		New Structure backgrounds			☐	☐	☐
25		Rebar factors for each type of structural elements			☐	☐	☐
26		Basic annotation: - North arrow, Section cuts - Preliminary dimensions including slab and wall thickness			☐	☐	☐
27		Main reinforcement shown and called out				☐	☐
28		Miscellaneous items such as ladders, hatches, plate, etc… shown and called out				☐	☐
29		Final dimensions				☐	☐

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents 50% to 70% Completion	Construction Documents 70% to 100% completion
30		Reinforcement for details such as openings etc…				☐	☐
31		Final detailing and annotation				☐	☐
32		**Structural Key Plans**			S	D	D
33		Existing floor plan background			☐	☐	☐
34		New floor plan background			☐	☐	☐
35		Basic annotation: - Gridlines and north arrow - Area/sheet boundaries and labels - Room names			☐	☐	☐
36		Final annotation: - Dimensions and notes - Section cut references				☐	☐
37		**Demolition Drawings - Plans, Sections & Details**			S	D	D
38		Existing backgrounds			☐	☐	☐
39		Basic annotation: - Gridlines, keyplan, and north arrow - Room names			☐	☐	☐
40		Items to be demolished identified (hatched)			☐	☐	☐
41		Items for demolition identified with key notes				☐	☐
42		Detailed annotation: - Sheet notes - Pertinent dimensions - Construction notes				☐	☐
43		**Pile Plan**		S	O	D	D
44		Existing foundation/pile plan backgrounds		☐	☐	☐	☐
45		New pile plan backgrounds			☐	☐	☐
46		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Primary dimension (overall building and gridlines)			☐	☐	☐
47		Rebar factors for each type of structural elements			☐	☐	☐
48		Reinforcement				☐	☐
49		Annotation: - Reinforcing - Sheet and Construction Notes - Dimensions				☐	☐
50		**Foundation, Floor, Intermediate, and Top Deck Plans**		S	O	D	D
51		Existing plan backgrounds		☐	☐	☐	☐
52		New plan backgrounds			☐	☐	☐
53		Main structural systems			☐	☐	☐
54		Discipline backgrounds for architectural, mechanical, electrical, HVAC, etc…			☐	☐	☐
55		Control and expansion joints			☐	☐	☐
56		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Primary dimension (overall building and gridlines) - Preliminary dimensions of footings, slabs, walls, etc… - Section callouts			☐	☐	☐
57		Rebar factors for each type of structural elements			☐	☐	☐
58		Stairs, doors, windows, etc…				☐	☐
59		Equipment supports, pipe supports, etc…				☐	☐
60		Grating, platforms, railings, guardrails, hatches, ladders, etc…				☐	☐
61		Construction joints				☐	☐
62		Major equipment/pads (HVAC, Elec, Mech etc…)				☐	☐
63		Annotation: - Final dimensions of footings, slabs, walls, etc… - Locations of openings, hatches, stairs, sumps, etc… - Enlarged/partial plan callouts				☐	☐
64		Sumps, floor drains, floor sinks, etc…				☐	☐
65		Floor slopes				☐	☐
66		Final annotation: - Final dimensions - Sheet notes - Detail callouts				☐	☐
67		**Roof Framing Plans**		S	O	D	D

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents 50% to 70% Completion	Construction Documents 70% to 100% completion
68		Existing framing plan backgrounds		☐	☐	☐	☐
69		New roof framing plan backgrounds			☐	☐	☐
70		Main structural systems			☐	☐	☐
71		Discipline backgrounds for architectural, mechanical, electrical, HVAC, etc…			☐	☐	☐
72		Control and expansion joints			☐	☐	☐
73		Preliminary structural framing layout for main members			☐	☐	☐
74		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Primary dimension (overall building and gridlines) - Preliminary sizes of main structural framing - Section callouts			☐	☐	☐
75		Final structural framing layout for main members				☐	☐
76		Openings, hatches, and major equipment and supports				☐	☐
77		Roof drains				☐	☐
78		Metal/plywood decking orientation				☐	☐
79		Annotation: - Dimensions to hatches, supports, openings etc.. - Final size of main structural framing				☐	☐
80		Finalized structural faming layout				☐	☐
81		Final annotation: - Final dimensions - Sheet notes - Detail callouts				☐	☐
82	**Enlarged/Partial Plans**				**S**	**D**	**D**
83		Enlarged plans follow same content as normal plans			☐	☐	☐
84	**Main Sections**				**S**	**D**	**D**
85		Existing section backgrounds			☐	☐	☐
86		New section backgrounds			☐	☐	☐
87		Main structural systems			☐	☐	☐
88		Other discipline's backgrounds as required			☐	☐	☐
89		Control and expansion joints			☐	☐	☐
90		If required, provide rebar factors for each type of structural elements			☐	☐	☐
91		Basic annotation - Gridlines - Title and cross-reference - Room names			☐	☐	☐
92		Structural features: - Stairs, doors, windows - Openings, hatches - Equipment and pipe supports, curbs, pads - Trenches, sumps, floor sinks - Grating, platforms, railings, guardrails, ladders				☐	☐
93		Detailing around openings				☐	☐
94		Main reinforcement (minimum scale: 3/8" = 1'-0")				☐	☐
95		Finish grade lines				☐	☐
96		Annotation: - Dimensions and elevations - Sizes and locations of structural features - Detail callouts - Reinforcing sizes				☐	☐
97		Floor drains				☐	☐
98		Major equipment/supports (elec, HVAC, mech)				☐	☐
99		HVAC duct openings				☐	☐
100		Detailed reinforcement including additional around openings				☐	☐
101		Final annotation - Detailed dimensions and notes - Final reinforcing - Detail callouts - Sheet notes				☐	☐
102	**Partial Sections**					**D**	**D**
103		Existing section backgrounds				☐	☐
104		New section backgrounds (referenced)				☐	☐

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105		Main structural systems				☐	☐
106		Other discipline's backgrounds as required (referenced)				☐	☐
107		Control and expansion joints				☐	☐
108		If required, provide rebar factors for each type of structural elements				☐	☐
109		Main Structural features: - Stairs, doors, windows - Openings, hatches - Trenches - Grating, platforms, railings, guardrails, ladders				☐	☐
110		Annotation - Gridlines - Title and cross-reference - Room names - Dimensions and elevations - Sizes of main structural features				☐	☐
111		Minor structural features: - Minor openings - Equipment and pipe supports, curbs, pads - Floor drains, sumps, floor sinks - Grating, platforms, railings, guardrails, ladders				☐	☐
112		Detailed reinforcement including additional around openings				☐	☐
113		Annotation: - Dimensions and elevations - Sizes and locations of structural features - Detail callouts - Reinforcing sizes				☐	☐
114		**Structural Steel Frame Elevations and Details**			S	D	D
115		Existing framing elevations (referenced and screened)			☐	☐	☐
116		New framing elevations			☐	☐	☐
117		Preliminary framing details and sizing			☐	☐	☐
118		Basic Annotation - Gridlines - Title and cross-reference - Overall dimensions - Preliminary sizes of main structural framing			☐	☐	☐
119		Final framing detail components with sizing				☐	☐
120		Annotation - Weld symbols - Dimensions and elevations - Final sizes of main structural framing				☐	☐
121		Finalized elevations with minor framing and connections				☐	☐
122		Final Annotation - Detail callouts - Sheet notes - Remaining dimensions and annotation				☐	☐
123		**Details**				D	D
124		Existing backgrounds				☐	☐
125		New backgrounds				☐	☐
126		Main reinforcement (minimum scale: 3/8" = 1'-0")				☐	☐
127		Main structural elements, connections, etc…				☐	☐
128		Basic Annotation - Gridlines - Title and cross-reference - Overall dimensions - Preliminary sizes of main structural elements				☐	☐
129		Remaining reinforcement				☐	☐
130		Remaining structural elements				☐	☐
131		Final Annotation - Final sizes of structural elements - Detail and section callouts - Sheet notes - Remaining dimensions and annotation				☐	☐

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SPECIFICATIONS							
1		**Mechanical Specifications**	S	O	O	D	D
2		Specifications status list is up to date for Mechanical	☐	☐	☐	☐	☐
3		Draft specifications for major equipment items.			☐	☐	☐
4		Specifications for Mechanical and Piping Division edited and finalized				☐	☐
5		Input to other disciplines Specification Divisions.				☐	☐
6		Input to specification for Protective Coatings				☐	☐
7		Input to Division 01 (construction and schedule constraints, demolition and reconstruction, testing and disinfection, testing and startup etc…)				☐	☐
8		System head and pumping operation curves				☐	☐
OTHER							
1		**Mechanical Discipline Criteria**	S	O	O	D	D
2		Existing technical data from pursuit phase	☐	☐	☐	☐	☐
3		Permit requirements		☐	☐	☐	☐
4		City SWD standards and preferences		☐	☐	☐	☐
5		Local and national standards researched and identified		☐	☐	☐	☐
6		Existing facilities and equipment researched		☐	☐	☐	☐
7		Conditions assessment of existing equipment and facilities		☐	☐	☐	☐
8		**BIM and 3D Modeling**	S	O	O	D	D
9		Confirm design calculation are developed and updated		☐	☐	☐	☐
10		All major equipment has been identified and sized		☐	☐	☐	☐
11		BIM Execution Plan is developed by the project team	☐	☐	☐	☐	☐
12		Refer the BIM Execution Plan to confirm the plan is being implemented as intended		☐	☐	☐	☐
DRAWINGS							
1		**All Drawings**		S	O	D	D
2		Standard border		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)				☐	☐
9		Revision box information					☐
10		License seal & signature					☐
11		**Mechanical Standard Details**			S	D	D
12		City Standard detail index			☐	☐	☐
13		City SWD standard details				☐	☐
14		City Standard details edited and finalized				☐	☐
15		**Project Specific Standard Details**				D	D
16		Project-specific standard details developed and shown				☐	☐
17		Project specific details finalized and annotated				☐	☐
18		**Mechanical Key Plans**		S	O	D	D
19		Existing floor plan background		☐	☐	☐	☐
20		New floor plan background		☐	☐	☐	☐
21		Basic annotation: - Gridlines and north arrow - Area/sheet boundaries and labels - Room names, etc…			☐	☐	☐
22		Final annotation: - Dimensions and notes - Section cut references				☐	☐
23		**Demolition Drawings**		S	O	D	D
24		Existing backgrounds		☐	☐	☐	☐
25		Basic annotation: - Gridlines, keyplan, and north arrow - Room names, etc…		☐	☐	☐	☐
26		Items, equipment, appurtenances etc... to be demolished identified (hatched)		☐	☐	☐	☐
27		Items to be relocated or salvaged			☐	☐	☐

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28		Items for demolition identified with key notes			☐	☐	☐
29		Detailed annotation: - Sheet and construction notes - Pertinent dimensions				☐	☐
30		**Mechanical Floor Plans**		**S**	**O**	**D**	**D**
31		Existing plan backgrounds		☐	☐	☐	☐
32		New plan backgrounds		☐	☐	☐	☐
33		Large piping and valves		☐	☐	☐	☐
34		Preliminary equipment, pumps, valves, gates, tanks, and instrumentation devices shown (from prelim schedules and P&IDs)		☐	☐	☐	☐
35		Structural backgrounds with wall thicknesses,		☐	☐	☐	☐
36		Basic annotation: - Gridlines, key plan, matchlines, and north arrow - Primary dimension (overall building, gridlines, etc...) - Tag numbers for prelim equipment, pumps etc... - Callout major piping and valves, etc…		☐	☐	☐	☐
37		Section callouts		☐	☐	☐	☐
38		Piping and valves			☐	☐	☐
39		Space allocation for items not shown such as small piping, HVAC ducts, control panels, and lighting panels			☐	☐	☐
40		Major electrical equipment such as switchgear and motor control centers estimated by electrical.			☐	☐	☐
41		Annotation: - Additional dimensions - Location and sizes of major electrical equipment - Callout piping and valves			☐	☐	☐
42		Final structural backgrounds			☐	☐	☐
43		Finalize equipment, pumps, valves, gates, tanks, and instrumentation devices shown			☐	☐	☐
44		Auxiliary equipment and appurtenances that support process equipment.			☐	☐	☐
45		All piping and valves.			☐	☐	☐
46		Motor, hydraulic, and pneumatic actuators for applicable gates and valves.			☐	☐	☐
47		Pipe couplings for dismantling, isolation or expansion			☐	☐	☐
48		Pipe supports			☐	☐	☐
49		Show equipment pads			☐	☐	☐
50		HVAC equipment and ductwork			☐	☐	☐
51		Electrical equipment such as switchgear, motor control centers, control panels, and lighting panels			☐	☐	☐
52		Annotation: - Callout all piping and valves - Callout type and location of piping penetrations - Callout pipe supports - Callout equipment, valves, gates, tanks etc… - Dimensions to equipment, openings, clearances etc…			☐	☐	☐
53		Detail and standard detail callouts			☐	☐	☐
54		Access for foot traffic and loading docks, chemical fill station etc.			☐	☐	☐
55		Emergency access for fire and emergency personnel shown			☐	☐	☐
56		Clearances necessary to maintain and remove equipment, space to pull shafts, and head room clearances below cranes and doorways.			☐	☐	☐
57		Door, window, louver, hatch, etc... openings shown			☐	☐	☐
58		Grating, platforms, railings, ladders, and stairs			☐	☐	☐
59		Curbs, ramps, trenches, recesses, etc...			☐	☐	☐
60		Floor drains and floor sinks			☐	☐	☐
61		Final annotation - All equipment tags - All piping tags - Final dimensions - Notes and sheet notes - Any additional annotation				☐	☐
62		**Mechanical Sections**		**S**	**O**	**D**	**D**
63		Existing section backgrounds		☐	☐	☐	☐
64		New section backgrounds		☐	☐	☐	☐
65		Large piping and valves		☐	☐	☐	☐

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66		Preliminary equipment, pumps, valves, gates, tanks, and instrumentation devices shown (from prelim schedules and P&IDs)		☐	☐	☐	☐
67		Structural backgrounds with wall thicknesses		☐	☐	☐	☐
68		Basic annotation: - Gridlines and matchlines - Primary dimension (overall building, gridlines, etc...) - Tag numbers for prelim equipment, pumps etc... - Callout major piping and valves - Section title cross-referenced to plan		☐	☐	☐	☐
69		Piping and valves			☐	☐	☐
70		Space allocation for items not shown such as small piping, HVAC ducts, control panels, and lighting panels			☐	☐	☐
71		Major electrical equipment such as switchgear and motor control centers estimated by electrical.			☐	☐	☐
72		Annotation: - Additional dimensions - Location and sizes of major electrical equipment - Callout piping and valves			☐	☐	☐
73		Finalize equipment, pumps, valves, gates, tanks, and instrumentation devices				☐	☐
74		Auxiliary equipment and appurtenances that support process equipment.				☐	☐
75		All piping and valves.				☐	☐
76		Motor, hydraulic, and pneumatic actuators for applicable gates and valves.				☐	☐
77		Pipe couplings for dismantling, isolation or expansion				☐	☐
78		Pipe supports				☐	☐
79		Show equipment pads				☐	☐
80		HVAC equipment and ductwork				☐	☐
81		Electrical equipment such as switchgear, MCCs, control panels, and lighting panels				☐	☐
82		Annotation: - Callout all piping and valves - Callout type and location of piping penetrations - Callout pipe supports - Callout equipment, valves, gates, tanks etc… - Dimensions to equipment, openings, etc…				☐	☐
83		Final structural backgrounds (structural referenced and mechanical versions deleted)				☐	☐
84		Detail and standard detail callouts				☐	☐
85		Door, window, louver, hatch, etc... openings shown				☐	☐
86		Grating, platforms, railings, ladders, and stairs				☐	☐
87		Curbs, ramps, trenches, recesses, etc...				☐	☐
88		Floor drains, floor sinks, and vents				☐	☐
89		Clearances necessary to maintain and remove equipment, space to pull shafts, and head room clearances below cranes and doorways.			☐	☐	☐
90		Final annotation - All equipment tags - All piping tags - Final dimensions including clearances - Notes and sheet notes - Any additional annotation				☐	☐
91		**Mechanical Details**			O	D	D
92		Existing backgrounds			☐	☐	☐
93		New backgrounds (reference)			☐	☐	☐
94		Isometrics views (where applicable)			☐	☐	☐
95		Basic Annotation - Gridlines - Title and cross-reference - Overall dimensions - Preliminary sizes			☐	☐	☐
96		Final Annotation - Final sizes - Detail and section callouts - Sheet notes - Remaining dimensions and annotation				☐	☐

EXAMPLE - CHECKLIST AND CONTENT
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CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
MECHANICAL

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						50% to 70% Completion	70% to 100% completion
97		System head and pumping operation curves			☐	☐	☐

THINK BLUE SAN DIEGO

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CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
ELECTRICAL

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		Description	Project Phase / (Estimate Class)				
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SPECIFICATIONS							
1		**Electrical Specifications**	S	O	O	D	D
2		Specifications status list is up to date for Electrical	☐	☐	☐	☐	☐
3		Draft specifications for major equipment items - 18 pulse VFD's, large custom motors, standby generator systems, etc		☐	☐	☐	☐
4		Specifications for Electrical Division edited and finalized				☐	☐
OTHER							
1		**Electrical Design Criteria**		O	O	D	D
2		Coordinate with all necessary utilities		☐	☐	☐	☐
3		Permit requirements		☐	☐	☐	☐
4		City SWD standards and preferences		☐	☐	☐	☐
5		Local and national standards researched and identified		☐	☐	☐	☐
6		Site history researched (existing electrical facilities, existing duct bank information, etc)		☐	☐	☐	☐
7		Conditions assessment of existing equipment, conduit, and electrical loads conducted		☐	☐	☐	☐
8		Preliminary electrical load list developed from equipment list		☐	☐	☐	☐
9		Preliminary electrical room space requirements developed		☐	☐	☐	☐
10		Need and criteria for back-up power supply systems		☐	☐	☐	☐
11		Lighting criteria (foot-candles, etc.) for all interior and exterior areas.			☐	☐	☐
DRAWINGS							
1		**All Drawings**		S	O	D	D
2		Standard border		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)				☐	☐
9		Revision box information					☐
10		License seal & signature					☐
11		**Electrical Standard Symbols, Notes and Abbreviation**		S	O	D	D
12		General Electrical notes, abbreviations, and symbols		☐	☐	☐	☐
13		General notes tailored for project				☐	☐
14		General and project specific notes finalized					☐
15		**Electrical Standard Details**			S	D	D
16		City Standard detail index			☐	☐	☐
17		City SWD standard details				☐	☐
18		City Standard details edited and finalized					☐
19		**Project Specific Standard Details**				D	D
20		Owner, agency, building department, government, etc... standard details shown				☐	☐
21		Project-specific standard details developed and shown				☐	☐
22		Project specific details finalized and annotated					☐
23		**Area Classification Key Plans**			S	D	D
24		Existing base map			☐	☐	☐
25		New buildings/structures			☐	☐	☐
26		Major features labeled (e.g. roads, creek crossings)			☐	☐	☐
27		Existing and new buildings/structures labeled			☐	☐	☐
28		North arrow			☐	☐	☐
29		Cross reference sheet numbers to equipment location plans				☐	☐
30		Hazardous areas located and called out				☐	☐
31		Sheet notes to detail classified areas				☐	☐
32		Remaining annotation					☐
33		**Electrical Site Plans**		S	O	D	D
34		Existing base map (referenced and screened) showing all existing improvements, easements, site and project boundaries with major features labeled (e.g. roads, creeks, crossings)		☐	☐	☐	☐
35		North arrow (shall be the same on all plans)		☐	☐	☐	☐
36		Conceptual layout of new structures, roads, and piping (labeled)		☐	☐	☐	☐

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DESIGN CHECKLIST
ELECTRICAL

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents 50% to 70% Completion	Construction Documents 70% to 100% completion
37		Area designation key (if required)		☐	☐	☐	☐
38		Major electrical equipment (MCCs, switchgear, etc.)			☐	☐	☐
39		Manholes, pull boxes and duct banks			☐	☐	☐
40		Street and area lighting			☐	☐	☐
41		Determine duct bank sections and routing			☐	☐	☐
42		Label individual structures and process units				☐	☐
43		Remaining annotation					☐
44		**Duct Bank Schedules**			S	D	D
45		Duct bank section arrangement			☐	☐	☐
46		Blank duct bank schedule				☐	☐
47		Schedule data entered showing duct number, duct size, wire fill, from and to locations					☐
48		Detailed sheet notes and additional annotation					☐
49		**Manhole, Hand hole and Pull Box Schedules**				D	D
50		Blank manholes, pull boxes and duct banks schedule				☐	☐
51		Schedule data entered showing box number, inside dimensions, cover rating, and remarks (i.e. hi voltage, control, signal etc…)				☐	☐
52		Detailed sheet notes and additional annotation					☐
53		**Single Line Diagrams**		S	O	D	D
54		Point of connection for power service and revenue meter		☐	☐	☐	☐
55		Panels, MCCs, feeders, sub feeders, branch circuit conductors, transformers, panelboards, switchgear, and major loads shown		☐	☐	☐	☐
56		Electrical component ratings, i.e. breaker sizes, (circuit breakers show frame and trip ratings for thermal magnetic, and show continuous and trip ratings for map's), etc.		☐	☐	☐	☐
57		Circuit compartments shown in the same order as the equipment elevations.		☐	☐	☐	☐
58		motor loads complete with their corresponding horsepower sizes, branch circuit breakers/fused or non-fused disconnect switches, motor starters, miscellaneous devices/components such as local disconnecting means, speed controllers, power factor correcting shown		☐	☐	☐	☐
59		Annotation and key notes		☐	☐	☐	☐
60		Miscellaneous electrical loads complete with their corresponding circuit breakers, starters, contactors, disconnects, etc. shown			☐	☐	☐
61		MCC or panel annotation showing bus ampacity, voltage, number of phases, number of wires, bus bracing, circuit numbers, and future loads.			☐	☐	☐
62		Substation transformers complete with all necessary protective equipment, i.e. circuit breakers, disconnect switches, surge arrestors, grounding resistors, protective relays, etc.			☐	☐	☐
63		Electrical interlocks.				☐	☐
64		Electrical equipment metering and protective relaying.				☐	☐
65		All additional annotation including detailed sheet notes				☐	☐
66		**Electrical Equipment Elevations**		S	O	D	D
67		Blank equipment elevations		☐	☐	☐	☐
68		Input to plant building programming		☐	☐	☐	☐
69		Compartments arranged in accordance with the single line		☐	☐	☐	☐
70		Each individual compartment identified		☐	☐	☐	☐
71		Empty compartments for future assigned equipment identified		☐	☐	☐	☐
72		Pull sections and transition sections identified		☐	☐	☐	☐
73		Basic annotation: - Titles and equipment numbers - Structural detail for housekeeping pad		☐	☐	☐	☐
74		Dimensions of electrical equipment enclosure			☐	☐	☐
75		Enclosure types and NEMA designations, including materials, if required to be shown on the drawings labeled			☐	☐	☐
76		Additional annotation and detailed sheet notes				☐	☐
77		**Schematic Diagrams**			S	D	D
78		Blank ladder schedules with rung numbers			☐	☐	☐
79		locate connection of electrical protective devices			☐	☐	☐
80		locate control power sources			☐	☐	☐
81		show all interlocks between equipment controls			☐	☐	☐
82		Usage tables with equipment name and tag numbers for multiple pieces of the same equipment			☐	☐	☐

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CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
ELECTRICAL

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83		Basic annotation: - Titles			☐	☐	☐
84		Blank location legend inserted and modified per schematic requirements				☐	☐
85		Control components				☐	☐
86		Ladder rung numbers labeled to cross reference coils and associated contacts. (rung numbers should be underlined for normally closed contacts and unchanged for normally open contacts)				☐	☐
87		Additional annotation and detailed sheet notes				☐	☐
88	**Lighting Fixture Schedule**					D	D
89		Blank lighting fixture schedule				☐	☐
90		Schedule data entered: - Luminare type - Lamp type - Lamp wattage and number per fixture - Voltage - Description - Manufacturer - Model/catalog number - Detailed description, mfr, and model number of pole (for pole mounted)				☐	☐
91		Additional annotation and detailed sheet notes					☐
92	**Panel Schedule**					D	D
93		Blank Excel spreadsheet for panel schedule				☐	☐
94		List of electrical loads for circuit identification gathered				☐	☐
95		Number of circuits required to feed all electrical loads determined				☐	☐
96		Loads located on automated panel schedules				☐	☐
97		Spreadsheet data entered: - Panel identification - Panel location - Mounting type - Voltage - Number of phases - Number of wires - Circuit identification - Load identification - KVA per circuit - Bus amperes - Main breaker amperes - Total KVA - Total amperes				☐	☐
98		Panel board spreadsheet imported into CAD file				☐	☐
99		Panelboard title				☐	☐
100		Additional annotation and detailed sheet notes					☐
101	**Riser Diagrams for Telephone Systems**				S	D	D
102		Existing conditions and communication tie-in point shown			☐	☐	☐
103		New telephone cabinets to be used for the new facilities				☐	☐
104		Intermediate hand holes or pull boxes between telephone equipment				☐	☐
105		Conduit and wire shown				☐	☐
106		Annotation: Cross reference sheet numbers to help identify telephone equipment location on plan drawings				☐	☐
107		Conduit and wire tags between telephone equipment					☐
108		Additional annotation and detailed sheet notes					☐
109	**Riser Diagrams for Fire Alarm Systems**				S	D	D
110		Fire alarm control panels and all associated audio and visual fire alarms			☐	☐	☐
111		Intermediate hand holes or pull boxes between fire alarm equipment			☐	☐	☐
112		Conduit and wire shown				☐	☐
113		Annotation: Cross reference sheet numbers to help identify fire alarm equipment location on plan drawings				☐	☐
114		Conduit and wire tags between fire alarm equipment					☐
115		Additional annotation and detailed sheet notes					☐
116	**Conduit Development**				S	D	D

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		Description	Project Phase / (Estimate Class)				
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117		Block diagrams showing electrical devices (switchgears, MCCs, panelboards, motors, junction boxes, disconnect switches, instruments, control stations, plc's etc.)			☐	☐	☐
118		Power conduits (exposed=solid, encased=dashed)			☐	☐	☐
119		Control/signal conduits (exposed=solid, encased=dashed)				☐	☐
120		Tag numbers for each conduit				☐	☐
121		Tag numbers for each piece of equipment				☐	☐
122		Annotation: - conduit size - Wire fill - From and to locations - Special remarks for each conduit				☐	☐
123		Additional annotation and detailed sheet notes					☐
124	**Conduit Schedule**					**D**	**D**
125		Blank Excel spreadsheet for conduit schedule				☐	☐
126		Information from conduit development entered into spreadsheet				☐	☐
127		Conduit schedule spreadsheet imported into CAD file				☐	☐
128		Additional annotation and detailed sheet notes					☐
129	**Demolition Drawings - Plans, Sections & Details**			**S**	**C**	**D**	**D**
130		Existing backgrounds (referenced and screened)		☐	☐	☐	☐
131		Basic annotation: - Gridlines, keyplan, and north arrow - Room names - etc…		☐	☐	☐	☐
132		Items to be demolished identified (hatched)		☐	☐	☐	☐
133		Items for demolition identified with key notes			☐	☐	☐
134		Detailed annotation: - Sheet notes - Pertinent dimensions - Construction notes			☐	☐	☐
135	**Electrical Equipment Location Plans**				**S**	**D**	**D**
136		Existing floor plan background			☐	☐	☐
137		New floor plan background			☐	☐	☐
138		Discipline backgrounds for structural, mechanical, architectural, HVAC, etc… (reference as they become available, screened if new site without existing)			☐	☐	☐
139		Major electrical equipment (MCCs, switchgear, panelboards, fad's, etc)			☐	☐	☐
140		Special routing of feeder and duct bank conduits, if required			☐	☐	☐
141		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Room and area names - Primary dimension (overall building and gridlines) - etc…			☐	☐	☐
142		Plant building programming input				☐	☐
143		Special routing of other conduits, if required				☐	☐
144		Electrical components such as disconnect switches, local control panels, local control stations, process instrumentation, special control devices, etc				☐	☐
145		If conduit development is not used, power, control and instrumentation/signal conduit runs are shown				☐	☐
146		Annotation: - Plan title - Tag numbers				☐	☐
147		If conduit development is not used, each conduit on the plan drawing is identified					☐
148		Standard detail callouts					☐
149		Additional annotation and detailed sheet notes					☐
150	**Lighting and Receptacle Plans**					**D**	**D**
151		Existing floor plan background				☐	☐
152		New floor plan background				☐	☐
153		Discipline backgrounds for structural, mechanical, architectural, etc…				☐	☐
154		Plant building programming input				☐	☐
155		Light fixtures and receptacles				☐	☐
156		Lighting control switches				☐	☐

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ELECTRICAL

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157		Circuit identification and switching identification				☐	☐
158		Special receptacle (generator receptacle, 480v welding receptacle, etc) shown and identified				☐	☐
159		Lighting and receptacle panels				☐	☐
160		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Room and area names - Callout lighting control switches - Mounting heights of receptacles - Weatherproof or GFCI ratings - Panels - etc…				☐	☐
161		Fixtures called out with circuit identification, wattage and mounting heights				☐	☐
162		Standard detail callouts				☐	☐
163		Special junction/splice boxes if required					☐
164		Additional annotation and detailed sheet notes					☐
165	**Lightning and Grounding Plans**					**D**	**D**
166		Existing background				☐	☐
167		New background				☐	☐
168		Discipline backgrounds for structural, mechanical, architectural, etc…				☐	☐
169		Grounding system components (ground rods, ground test wells, etc…)				☐	☐
170		Lightning system components (lightning rods, risers, etc…)				☐	☐
171		Wire sizes of grounding system called out				☐	☐
172		Wire sizes of lightning system called out				☐	☐
173		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Room and area names - Wire sizes for grounding and lightning systems - Detailed sheet notes - etc…				☐	☐
174		Standard detail callouts					☐
175		Additional annotation and detailed sheet notes					☐
176	**Miscellaneous Systems Plans**				**S**	**D**	**D**
177		Existing background			☐	☐	☐
178		New background			☐	☐	☐
179		Discipline backgrounds for structural, mechanical, architectural, etc… (reference as they become available, screened if new site without existing)			☐	☐	☐
180		Riser diagrams identifying systems components and all associated appurtenances			☐	☐	☐
181		Basic annotation: - Gridlines, keyplan, matchlines, and north arrow - Room and area names - etc…			☐	☐	☐
182		Intermediate hand holes or pull boxes between system components if applicable				☐	☐
183		Cross referenced sheet numbers (to help identify system component location on plan drawings)				☐	☐
184		Conduit and wire tags between system components labeled					☐
185		Additional annotation and detailed sheet notes					☐

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CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
INSTRUMENTATION

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			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents 50% to 70% Completion	Construction Documents 70% to 100% completion
SPECIFICATIONS							
1		**Instrument Specifications and Control Strategies**	**S**	**O**	**O**	**D**	**D**
2		Specifications status list is up to date for Instrumentation	☐	☐	☐	☐	☐
3		Draft specifications for instruments with NTS edited			☐	☐	☐
4		Draft specifications for control strategies				☐	☐
5		Final instrument specifications edited and finalized				☐	☐
6		Final control strategies				☐	☐
7		Reviewed, coordinated and commented on specifications for valve actuators and package control systems.				☐	☐
OTHER							
1		**Prepare Instrument and I/O Lists**			**S**	**D**	**D**
2		Draft instrument data sheets with data manually added in attribute columns			☐	☐	☐
3		Draft SCADA system I/O list with data manually added in attribute columns			☐	☐	☐
4		Finalized instrument list.				☐	☐
5		Finalized SCADA system I/O list				☐	☐
6		**Instrumentation Design Criteria**	**S**	**O**	**O**	**D**	**D**
7		Existing technical data from pursuit phase	☐	☐	☐	☐	☐
8		City SWD standards and preferences		☐	☐	☐	☐
9		Permit requirements		☐	☐	☐	☐
10		Local and national standards researched and identified		☐	☐	☐	☐
11		Existing facilities researched (instruments, SCADA, etc…)			☐	☐	☐
12		Conditions assessment of existing equipment			☐	☐	☐
13		Control system criteria including: - Number and location of workstations - Remote I/O needed - Number and location of all new SCADA field panels - Type of communications media(s) to be used			☐	☐	☐
14		Communication system criteria including: - Subsystems to be brought into SCADA panels - Type of communications media(s)			☐	☐	☐
15		Security system criteria including: - Equipment required (CCTV, intrusion switches, infrared sensors, motion detectors, keycard readers, etc…) - Location for equipment - Tie-in to existing systems			☐	☐	☐
DRAWINGS							
1		**All Drawings**		**S**	**O**	**D**	**D**
2		Standard border		☐	☐	☐	☐
3		Drawing title		☐	☐	☐	☐
4		Sheet number (no leading zero)		☐	☐	☐	☐
5		Drawn by (initial and last name)		☐	☐	☐	☐
6		Designed by (initial and last name)		☐	☐	☐	☐
7		Scale		☐	☐	☐	☐
8		Checked by (initial and last name)				☐	☐
9		Revision box information					☐
10		License seal & signature					☐
11		**Instrumentation General Symbols, Notes, and Nomenclature Drawings**		**S**	**O**	**D**	**D**
12		General Instrumentation symbols, notes, and nomenclature		☐	☐	☐	☐
13		General notes tailored for project			☐	☐	☐
14		Additional definitions added			☐	☐	☐
15		General and project specific notes finalized				☐	☐
16		**Instrumentation Standard Details**		**S**	**O**	**D**	**D**
17		City Standard detail index		☐	☐	☐	☐
18		City SWD standard details			☐	☐	☐
19		City Standard details edited and finalized				☐	☐
20		**Project Specific Standard Details**			**S**	**D**	**D**
21		Owner, agency, building department, government, etc... standard details shown			☐	☐	☐

EXAMPLE - CHECKLIST AND CONTENT
TO BE REVISED BY DESIGN CONSULTANT
TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
INSTRUMENTATION

Notes: The Design Checklist is intended to aid the Design Engineer. It is not intended to replace the City's QC Checklist. Not all content or drawings apply to all projects, some drawings may be combined, but should still show applicable content.
***S** = Started: Work has begun, typical limited to sketches, outlines or similar levels of early development.*
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***D** = Defined: Work is advanced, deliverables is near complete for internal review and approval as appropriate*

		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents	
						50% to 70% Completion	70% to 100% completion
22		Project-specific standard details developed and shown			☐	☐	☐
23		Project specific details finalized and annotated					☐
24		**Block Diagrams (Control, Communication, and Security)**		**S**	**O**	**D**	**D**
25		Existing equipment, networks, locations, workstations, etc...		☐	☐	☐	☐
26		Preliminary block diagram showing: - Communications networks - SCADA panel locations - Workstation locations - Auxiliary interface requirements - Communications media type		☐	☐	☐	☐
27		Annotation including keynote symbols and keynotes		☐	☐	☐	☐
28		Finalized block diagram			☐	☐	☐
29		Remaining annotation			☐	☐	☐
30		**Logic Diagrams**				**D**	**D**
31		Logic diagrams are generally shown in the Electrical drawings.				☐	☐
32		**Panel Layout Drawings**			**S**	**D**	**D**
33		Control Panel including: - Instruments within and on the face of the panel - Layout of the equipment in the enclosure - Faceplate arrangement - Legends, switch and indicator locations - Front panel mounted instruments - Panel interior layout details			☐	☐	☐
34		Control Panel and internal mounting panel dimensions including: - Panel height - Panel width - Panel depth - Height above floor			☐	☐	☐
35		Location of field panels called out			☐	☐	☐
36		Panel installation details				☐	☐
37		Schedule for legends, labels, and panel equipment bill of materials				☐	☐
38		Notes and other annotation				☐	☐
39		**Loop Drawings (if required)**				**D**	**D**
40		Separate drawing for each instrument loop				☐	☐
41		Loop number and instrument components operated within the loop				☐	☐
42		Power supply				☐	☐
43		Scaling				☐	☐
44		Component function				☐	☐
45		Wiring associated with the loop				☐	☐
46		Terminal blocks associated with the loop					☐
47		Junction boxes					☐
48		Annotation including: - Wire numbers - Conduit numbers					☐
49		**Control Room Plan and Elevations**			**S**	**D**	**D**
50		Existing room plan, equipment, etc…			☐	☐	☐
51		New room plan, equipment etc…			☐	☐	☐
52		Keyplan hatched with the control room location			☐	☐	☐
53		North arrow			☐	☐	☐
54		Workstation, console, and computer equipment shown in the room with basic dimensions			☐	☐	☐
55		Workstation/Console layout (plan, elev, sections) including: - Equipment and its physical arrangement on the console - Doors, panels, shelves, drawers, etc… - Lights, power outlets, network, phone, etc… connections - Vents, controls, monitor arms, etc…			☐	☐	☐
56		Annotation including: - Dimensions of console/workstations - Equipment labeled - Detailed annotation				☐	☐
57		Schedule for legends, labels, and panel equipment bill of materials.				☐	☐
58		Installation details				☐	☐

EXAMPLE - CHECKLIST AND CONTENT
TO BE REVISED BY DESIGN CONSULTANT
TO SUIT PROJECT NEEDS

CITY OF SAN DIEGO STORMWATER DEPARTMENT
DESIGN CHECKLIST
INSTRUMENTATION

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		Description	Project Phase / (Estimate Class)				
			Project Initiation	Preliminary Design	Design Development 30% completion	Construction Documents	
						50% to 70% Completion	70% to 100% completion
59		**P&IDs - Process and Instrumentation Diagrams**		**S**	**O**	**D**	**D**
60		Existing necessary process shown including equipment, piping and instruments (and labeled)		☐	☐	☐	☐
61		Existing process units/structures shown and labeled		☐	☐	☐	☐
62		New process units/structures shown and labeled		☐	☐	☐	☐
63		New equipment, pumps, valves, gates, tanks and primary instruments shown and labeled		☐	☐	☐	☐
64		New piping shown and identified including material, size, and process identification		☐	☐	☐	☐
65		Motor drive types identified (Variable speed vs. constant speed)		☐	☐	☐	☐
66		Valve and gate actuator types identified (motorized, hydraulic, pneumatic, etc…) and type of duty (open/close or modulating)		☐	☐	☐	☐
67		New instruments drawn and labeled		☐	☐	☐	☐
68		Future equipment, piping, and instruments shown and identified)		☐	☐	☐	☐
69		Heat tracing on primary and secondary piping		☐	☐	☐	☐
70		Monitored or controlled HVAC equipment		☐	☐	☐	☐
71		Monitored or controlled electrical equipment		☐	☐	☐	☐
72		Signals between the I&C components/instruments and control panels		☐	☐	☐	☐
73		Major package control system components, local control panels and instruments		☐	☐	☐	☐
74		Control concepts ("local", "remote" and "automatic") labeled along with equipment monitoring and alarm requirements.		☐	☐	☐	☐
75		Annotation callouts between P&IDs including: - Cross references - Drawing process connectors - Signal connectors		☐	☐	☐	☐
76		Pipe routing finalized and coordinated with Civil and Mechanical			☐	☐	☐
77		Input & outputs from the equipment, local control panels and instruments to and from the SCADA system shown			☐	☐	☐
78		Tag numbers for all equipment			☐	☐	☐
79		Instruments have tag numbers and loop numbers			☐	☐	☐
80		Final annotation including: - Pipe size - Process abbreviations - Pipe type - Pipe segment numbers			☐	☐	☐

Appendix C

Pump Data Sheet

PUMP DATA SHEET

NO	BY	DATE	REVISION

CITY OF SAN DIEGO
STORMWATER DEPARTMENT

STORMWATER PUMP STATION - NAME

PROJECT DATA	
PROJECT NAME	
PROJECT NUMBER	
ISSUE STATUS	

PROCESS BASELINE

FLUID SERVICE

FLUID NAME	STORMWATER			
	UNITS	MIN	MAX	AVG
FLUID TEMP	°F			
% of SOLID	%			
CHLORIDES CONCENTRATION	ppm			

OPERATING ENVIRONMENT

	UNITS	MIN	MAX	AVE
AMBIENT TEMP	°F			
MAX. SPHERE TO PASS (dia)	IN			
NPSH, AVAILABLE (FT)	FT			

PUMP TYPE	NOTE
☐ VERTICAL AXIAL	
☐ VERTICAL MIXED FLOW	
☐ VERTICAL TURBINE	
☐ VERTICAL SOLID HANDLING	
☐ SUBMERSIBLE	
☐ SUBMERSIBLE DRYPIT	
☐ OTHERS, SEE NOT (1)	

☐ INDOOR	☐ CONFINED SPACE
☐ OUTDOOR	☐ SUBJECT TO FLOODING
☐ EXPOSED TO SUNLIGHT	☐ CORROSIVE AREA
NEC AREA CLASSIFICATION	☐ CONTINUOUS OPERATION
☐ UNCLASSIFIED	☐ INTERMITTENT OPERATION
☐ CLASS 1 DIV 1	☐ OTHER, SEE NOTE (1b)
☐ CLASS 1 DIV 2	

NOTE (1a) : Note 1a

NOTE (1b) : Note 1b

EQUIPMENT BASELINE

EQUIPMENT TAG NO	
EQUIPMENT NAME	
ASSET NO	
PROCESS LINE NO	
P&ID DWG NO	
MECHANICAL DWG NO	
SPECIFICATION SECTION	
OPERATING WEIGHT (LB)	
INSTALLED BY	
INSTALLED DATE	

EQUIPMENT IDENTIFICATIONS

EQUIPMENT NAME	TAG NUMBER	MODEL NO	MANUFACTURER	NOTE (2)

NOTE (2) :

DESIGN AND PERFORMANCE REQUIREMENTS

MECHANICAL

PERFORMANCE REQUIREMENT AT MAXIMUM SPEED	UNITS	
DESIGN FLOW CAPACITY	gpm	
DESIGN FLOW BOWL TOTAL DYNAMIC HEAD (TDH)	ft	
DESIGN FLOW MINIMUM BOWL EFFICIENCY	%	
MAXIMUM FLOW CAPACITY AT MAXIMUM SPEED	gpm	
MAXIMUM FLOW BOWL TOTAL DYNAMIC HEAD (± 5%)	ft	
MAXIMUM FLOW MINIMUM BOWL EFFICIENCY	%	
MAXIMUM FLOW NPSH AVAILABLE (ABSOLUTE)	ft	
MINIMUM FLOW CAPACITY AT MAXIMUM SPEED	gpm	
MINIMUM FLOW BOWL TOTAL DYNAMIC HEAD (± 5 %)	ft	
MINIMUM FLOW MINIMUM BOWL EFFICIENCY	%	
MAXIMUM PUMP SPEED (rotations per minute)	rpm	
SHUT OFF HEAD	ft	

VARIABLE SPEED DRIVE ☐ VFD

PERFORMANCE REQUIREMENT AT MINIMUM SPEED		
FLOW CAPACITY	gpm	
PUMP TOTAL DYNAMIC HEAD	ft	
MINIMUM PUMP SPEED	rpm	

Mechanical Note:

ELECTRICAL

POWER SUPPLY	☐ ELECTRIC	☐ STANDBY POWER	
DRIVER	☐ ELECTRIC MOTOR		
TYPE	☐ INDUCTION	☐ SYNCHRONOUS	
SPEED	☐ CONSTANT	☐ VARIABLE	
ENCLOSURE	☐ ODP	☐ WP-1	☐ WP-2
	☐ TEFC	☐ TEFC-XP	☐ TENV ☐ SUBMERSIBLE
EFFICIENCY	☐ NEMA PREMIUM	☐ NEMA HIGH	

MOTOR RATING	UNITS	
RATED POWER	hp	
RATED SPEED	rpm	
VOLTAGE/PHASE/HZ	VAC	

Electrical Note:

SPARE PARTS

1	SUCTION BELL BEARING ASSEMBLY	qty	
2	SET OF BOWL AND DISCHARGE CASE BEARINGS	qty	
3	SET OF IMPELLERS	qty	
4	SET OF WEAR RINGS	qty	
5	SET OF PUMP SHAFT BEARINGS	qty	
6	PACKING ASSEMBLY OR MECHANICAL SEAL	qty	
7	SET OF GASKETS AND O-RINGS	qty	
8		qty	
9		qty	
10		qty	

NOTES

1. TESTING REQUIREMENTS AND MATERIALS OF CONSTRUCTION ARE NOTED WITHIN THE SPECIFICATIONS
2.
3.
4.
5.

Appendix D

Typical Pump Station Control Philosophy

Appendix D Typical Pump Station Control Philosophy

This template provides the Design Consultant with a standard reference for preparing a detailed stormwater pump station control philosophy of consistent content and format.

PART 1 – GENERAL

D.1 SCADA HMI CONTROL FUNCTIONS

A. General: SCADA HMI (Supervisory Control and Data Acquisition/Human Machine Interface) requirements are as listed in the sub-sections below and are generally applicable to Vendor developed PLC/IO (Programmable Logic Controller/Input Output) control packages except where specifically noted as "Not Applicable to Vendor Packages." SCADA HMI refers to screens at workstations in control room, local OIT refers to screens at local touchscreen panels.

B. Development Overview and Access: The SCADA HMI shall display the status or value of all PLC controller input and output points described in this section, detailed in the I/O (Input/Output) schedule, and shown on the P&ID drawings. In addition, the SCADA HMI shall serve as a parallel interface point for all networked vendor package controllers, displaying the status or value of all shared I/O points as well as providing access to vendor package control points and setpoint entries.

C. Access to the SCADA HMI (and vendor control package IOs) will be password restricted to authorized personnel only with increasing authority required to effect system changes. Access rights shall be established at the Domain level. In general, SCADA HMI base access groups will be defined as follows:

1. Maintenance Group – view access to specific equipment usage / performance summary screens (with pre-defined historical and real-time trend pop-ups), alarm screens and Viewpoint Navigation screen. No other view, write or control access rights. Alarm acknowledgement will also be restricted.
2. Operations Group – typically granted equipment and process control rights but limited access to process control configuration / tuning parameters. Specific operator adjustable values shall be as defined in the detailed control descriptions. Access to generated (but read-only versions) of system reports and predefined trends shall be supported as well as creation of temporary ad-hoc trends and print screen access.
3. Supervisory Group – typically granted administrative level rights within the control system software environment but only limited (if any) access to the operating system. Supervisors shall have access to all operator adjustable values as well as process control configuration / tuning parameters and alarm configuration. Specific supervisor tunable values shall be as defined in the detailed control descriptions. Ability to create new

trends, modify existing trends, create reports, and modify existing report templates shall be supported.

4. Administrator / Developer – full application and operating system level administrative access rights.

D. Controller Setpoint Handling:

1. Operator entered setpoints shall be constrained to match PLC programmed setpoint ranges. If a value lower than the setpoint range is entered, the PLC program defaults to the lowest possible range value. If a value higher than the setpoint range is entered, the PLC program defaults to the highest possible range value. The PLC shall prohibit entry of setpoint values beyond the operational range of a system or process. In general, confirmed PLC setpoint entries become the default program values. All system setpoints are to be made adjustable at the HMI by authorized users as detailed in the individual control philosophy sections.
2. Should a PLC reboot occur, through purpose or uncontrolled event, the PLC program shall be automatically restored with last setpoint entries. No operator intervention shall be necessary to bring a freshly rebooted controller online and operational.

E. Controller Run Output handling: In general, a PLC issued motor run command signal shall be propagated as a maintained contact. However, the PLC run command output signal must be disabled under the following conditions:

1. Equipment stop issued (by the PLC, operator, or Local Auto logic).
2. Equipment fail detected.
3. Equipment placed in local control at the equipment, outside of PLC control.
4. Power-loss (black-out) condition detected.
5. If separate START and STOP (or Open and Close) outputs have been allowed for, once initiated, the PLC shall maintain the selected output for no less than 3 seconds to allow the local logic sufficient time to latch in the PLC issued command signal.

F. Significant Digit Usage: All HMI display values will be configured to show a minimum of 1 significant digit except in the following cases where 2 significant digits are required:

1. Flow readings (where the primary reading is scaled to 3 digits or less)
2. Analytical readings

G. Control Mode Definitions – as a function of defining system control logic, it is necessary to define the manner and extent of control available at the major control access layers. Typical access layer control definitions are provided here as reference.

1. Local Control Mode (Field Selected): This mode of control refers to the first line of operator-initiated control functions available at the equipment and/or drive/starter and by definition PLC independent. This mode of operation, although available in most cases, will be generally restricted to maintenance activities except where specifically noted otherwise.
2. Local Safety Interlocks: This level of control is not selectable and is always active. It specifically refers to protection logic integral to the equipment or equipment package

that is directly interlocked with the equipment controls, and which automatically executes regardless of the current method of operation.

3. Controller Programmed Safety Interlocks: This level of control is not selectable and is always active unless parameter bypass selection is required to be HMI accessible and then invoked by a Supervisor. It specifically refers to protection logic programmed at the PLC with an output that is directly hardwire interlocked with the equipment controls and which automatically executes regardless of the current method of operation. Note: The output will be wired fail-safe such that in the event of controller failure, the equipment will be forced to stop.
4. Local Auto Control Mode (HMI or Field Selected – subject to package configuration): This mode of control refers to independent operational logic integral to the equipment or equipment package that is responsible for the proper operation of the equipment. The operational logic may execute based on remote command triggers (e.g., start/stop, open/close, etc.) or field inputs (e.g., flow, pressure, level, temperature, etc.). Local auto mode may be bypassed through selection of local control mode (if available).
5. Remote Manual Control Mode (HMI Selected): This mode of control refers to operator-initiated control functions available via the control system local OIT, SCADA HMI or LCP but executed via the PLC control logic (i.e., all PLC process interlocks, and safety functions remain engaged).
6. Remote Auto Control Mode (HMI Selected): This mode of control refers to PLC initiated control functions which are automatically executed and managed by the PLC logic, operator independent.

H. Historical Data Collection and Display: The control system shall historically collect, trend and record, in the historical database, all analog input and output data represented on the Contract Drawings and I/O Schedule. In addition, the HMI shall:

1. Log (daily and lifetime) runtimes to the historical database for all monitored equipment.
2. Log the number of starts to the historical database for all monitored equipment.
3. Calculate and log daily (and other Part 3 required) flow totals for all measured flows.
    1) Note: daily flow totals will be summed and recorded over a 24-hr period from 12am to 12am with allowance for daylight savings time (DST) annual time shift.

I. Trending Format – General: As a minimum, trends shall display the process variable, the transmitter tag, a clear description, and the units for both axes. For variables which are controlled by the PLC, both the setpoint and the controlled process variable shall be displayed on the same trend. Where multiple variables are displayed, separate and distinct colors shall be used for each variable along with a color key with clear descriptions defining each variable. A 3rd Party System Integrator shall be responsible for providing PLC programming to support the above log points. All logic required to develop the above I/O for historical collection at the HMI shall be provided by the 3rd Party System Integrator.

J. Alarm Terminology: The following alarm terms will be used throughout this document.

1. Permissive: PLC tracked Input, status, interlock and/or process variable value required to allow start of a piece of equipment or a process to proceed. Although lack of

permissive will inhibit start, loss of permissive will not necessarily generate a fault once the equipment or process is operational.

2. Warning or System Alert (displayed as per project graphics standards): PLC generated low priority alarm intended to alert Operators to process or equipment operation drift outside of norm. Typically, the gap between "warning" and "alarm" is sufficient to allow Operator response to avoid an alarm/trip condition.

    1) Note 1: System alerts are also utilized at specific field equipment locations to alert area personnel to imminent start of rotating equipment. System alerts (typically in the form of beacons and/or horns) are only used in areas of potentially unsecured (i.e., exposed and/or approachable) rotating equipment which may start unexpectedly.

3. Alarm or Trip (displayed as per project graphics standards) PLC generated high priority alarm or interlock intended to alert Operations to PLC execution of equipment or process protective measures OR imminent fault condition requiring operator intervention / action.

K. Alarm History: The entire system alarm history (inclusive of system warnings, alarms, and advisories) shall be made accessible at the HMI to all authorized users. The Alarm History shall be established as read-only from the moment of system field initialization. An alarm configuration screen at the HMI shall allow a Supervisor to enable or disable any HMI warning or alarm notification without the need to access the control system software back-office tools. Other related requirements:

1. Warnings / Alarms related to HMI displayed field equipment and facilities shall be displayed on the related system control screen as well as recorded in the historical alarm summary.

2. Warnings / Alarms may be assigned to one of four (maximum) sub-groups. The alarm sub-groups shall be as defined at the conclusion of the project Graphics Meetings.

L. Fault Detection / Handling:

1. Unresponsive Equipment: In addition to monitoring fail contacts for controlled equipment, if at any point a device fails to start, stop, open or close as commanded by the PLC, a "Fail to Respond" condition shall be generated by the PLC and displayed at the HMI. PLC generated "Fail to Respond" fault, as well as any other logically generated fail condition identified in the detailed control philosophy sections, shall be resettable at the HMI unless specifically noted otherwise. The HMI reset function shall be in the form of a screen button made visible to the Operator at the interlock or control faceplate when a PLC generated fault condition is detected for the associated equipment. "Fail to Respond" specifics shall be as follows:

    a) When a drive or starter is being called to run, default "Fail to Respond" fault delay shall be 10sec. If a drive or starter is called to start and run status is not received before expiration of the fault timer (Supervisor adjustable), the controller shall generate a "Fail-to-Respond" alarm and lock-out the equipment.

        i. In general, the "Fail to Respond" time delay timers (for stop commands in particular) will take into account the drive configured spin-down timer.

b) When a drive or starter is in operation, if the run status is lost for longer than 3secs (Supervisor adjustable), the controller shall generate a "Fail-to-Respond" alarm and lock-out the equipment.

c) In both cases, only an HMI reset will be required to allow the equipment to be restarted.

2. Analogue Inputs: The PLC shall generate an instrument or signal fault (Out of Range or PV_Bad) alarm if the analog input from a given field instrument or device is detected to be equal to or less than 3.8mA or equal to or greater than 20.5mA for longer than 10 seconds. The alarm time delay assigned to each signal shall be a Supervisor adjustable value.

a) Note: When an instrument is detected to be in fault, system control response to the signal and all associated alarms (e.g., LAHH, LALL, etc.) shall be suspended. Other system response specifics shall be as defined in the Part 3 control detailed control descriptions.

3. Discrete Instrument Warning / Alarm Contacts: The PLC shall process a discrete warning / alarm contact if the contact is detected to be active for longer than a preset (supervisor adjustable) time delay. The default settings shall be 2 seconds unless specifically noted otherwise in the Part 3 detailed control descriptions.

a) Note: discrete signals arriving via drive, starter, actuator, LCP, or other device which have already confirmed authenticity of the alarm shall be immediately processed by the PLC without time delay unless specifically noted otherwise in the Part 3 detailed control descriptions

M. Event Logging: An event log, separate from the alarm history, shall be made accessible at the HMI (read-only from the moment of system field initialization) to all authorized users. The event log shall date/time stamp and record any discrete change in status of the equipment monitored by the PLC (e.g., Auto/Manual, Local/Remote, Run/Off, Open/Close, Forward-Off-Reverse, Intrusion, Start Sequence Change, Alarm Enable/Disable, etc.). Important notes:

1. HMI adjustable setpoint values shall be historically collected and trended against the associated process variable or performance parameter.

2. Events may be assigned to one of four (maximum) sub-groups. The event sub-groups shall be as defined at the conclusion of the project Graphics Meetings.

N. Loop tuning parameters: The SCADA HMI shall be configured to allow supervisory level users to access all loop tuning parameters from the HMI for any control loop. Changing loop tuning parameters shall not require reconfiguring, reprogramming, or reloading of the PLC program.

O. Equipment READY Logic: The term "READY" (used throughout this document) shall be interpreted as "being available for PLC control." The following conditions, as applicable, must be satisfied to achieve "READY" status:

1. Field equipment is Available (powered) AND is currently in Remote and/or Auto mode at the starter/drive/actuator (as applicable) i.e., not in Local Control Mode.

2. No fail (interlock) conditions pending (including field E-Stop).

3. No run inhibit (permissive) conditions exist.
    a) Equipment start via the PLC cannot be achieved without the associated equipment satisfying the above "READY" definition. With initiation via the PLC and run status confirmation, the equipment shall be noted to be in REM AUTO RUN or REM MAN RUN mode depending upon HMI operating mode selection.
        (1) Note: if the equipment has been started at the starter/drive control interface, the equipment shall be noted to be in LOCAL RUN mode with PLC confirmation of run status
4. Unless specifically stated otherwise in the detailed control descriptions, it will not be necessary to display a "Not Ready" status if the above conditions are not satisfied. However, fail conditions, run inhibit conditions, local control status and run status should be clearly displayed.

P. Local Control Station (LCS) Handling Reference: Where shown on the contract drawings, a local control station shall be provided at the field equipment. Each station shall include one push-pull E-Stop button fail-safe hardwired directly to the starter or drive, and which may be engaged with effect regardless of the current operating mode of the equipment or communication means (hardware or fieldbus). Once pressed, the equipment will be immediately disabled at the starter / drive local control level and an alarm generated at the HMI. Release of the LCS E-stop button and reset of the alarm condition at the drive and the HMI will cancel the emergency stop.

Q. Process Control Deviation: Throughout the various plant processes, the PLC will be required to control and manipulate equipment designed to maintain a preset flow, level, temperature, pressure, or other water quality parameter. In general, should the control system fail to maintain the identified process parameter within the operator or system specified deadband for longer than a preset time period (Supervisor adjustable default shall be as nominated within the specific control section and/or the project alarm table), a process warning shall be generated by the PLC and displayed at the HMI. In specific instances (as defined in the Part 3 detailed control descriptions), should the condition persist beyond a second preset time delay, a critical process alarm shall be generated. Additional system response shall be as defined in the specific control section.

R. VFD Control Coordination: In general, VFD operating parameters critical to proper drive operation will be established at the drive. The PLC control program will be developed to support this arrangement.

1. Where a start delay timer has been set at the pump VFD, the PLC shall be programmed to account for pump start delay in the re-start logic (and fail-to-respond logic) following issue of pump stop command or unexpected pump stop. Where possible the start delay timer shall be displayed at the HMI.
2. It should be anticipated that the VFD of any given pump may include a custom configuration that does not necessarily support operation over the entire speed range. The PLC speed control signal (as generated by logic controller or operator entered setpoint) shall be ranged 0 to 100% of maximum and output proportionally from 4-20 mA. The VFD will manage the received signal over its actual configured operating range.

3. For all VFDs, the ramp rate (starting and stopping) shall be as set at the VFD. The PLC PID controller (as applicable) will be tuned to take into account the final VFD ramp rate.

S. Auto Rotation Logic: Where referenced in the detailed controls section, the start sequence for a system of pumps or other equipment may be automatically established by the PLC or manually established by an authorized Operator.

1. PLC Auto Sequencing: In auto sequencing mode, the equipment start sequence will be automatically rotated by the PLC based on runtime values. Pump runtimes will be continuously compared. Should two or more runtime meters register runtime hours within a +/- 1hr deadband (Supervisor adjustable), the runtimes will be considered equal, and the auto start sequence will default to the numerical order of the equipment in question (i.e., Pump No.1 will be selected to precede Pump No.2 under this runtime comparison scenario). When pump runtimes exceed the deadband limit, the start sequence will be automatically updated. However, pump operation will not normally be impacted by a start sequence change (in Auto or Manual sequencing mode): pump start/stop re-order will be applied as a normal function of pump Cascade start/stop operation unless specifically noted otherwise in the Part 3 detailed control descriptions. Auto PLC rotation may also be suspended by an authorized Operator via the HMI and the pump start sequence manually selected by the operator by means of an HMI pump start selection matrix.

a) Override Auto Sequencing Runtime Comparator: An override sequencing runtime comparator will be provided and made adjustable by authorized Operator (default = 72hrs). Under auto sequencing mode, should the pump(s) remain in continuous operation for a period greater than the preset runtime comparator, the controller logic will auto cycle the pumps to match the current pending start sequence. For forced rotation, the new pump will always be started and confirmed running prior to shutdown of the current in-operation pump (unless specifically noted otherwise in the Part 3 detailed control descriptions).

b) Operator Manual Sequencing: An authorized operator may manually establish the start sequence for a system of equipment by means of a matrix selection chart at the associated system HMI control screen. For manual start sequence entry, the operator will be required to enter a start position next to each equipment number. The selection interface will be programmed with a means of directing the PLC to accept or cancel the entered start sequence. Once the Operator has completed the start sequence, the PLC must be directed to accept the sequence in order for the entries to be written to the appropriate active PLC registers. Directing the PLC to cancel will clear all proposed entries. Submitted start sequences containing duplicate and/or invalid entries will be automatically rejected and not written to the active PLC registers (thereby retaining the original start sequence). Until the start sequence modifications are accepted, the PLC will ignore all unaccepted start sequence modifications and continue to operate equipment based on the current start sequence.

T. Bumpless Remote Auto to Remote Manual Transition: Changing the HMI control status of PLC controlled equipment from Remote Auto to Remote Manual shall be a bumpless operation. Therefore, a VFD operating in Auto mode at 78% of maximum speed shall maintain that speed and remain in operation when switched from Auto to Manual control at

the HMI. A similar adjustment to a modulating valve actuator should display identical behavior.

U. Flow Signal Dampening: Various flow meters are used to measure the rate of flow of water, air, and chemicals throughout the facility. The PLC shall be programmed to dampen the incoming analog signal. This shall be accomplished by calculating a running average of the flow signal over 5-second periods (nominal setpoint) using a data sample rate of 0.5 seconds. The means for a supervisor to enable/disable this function and adjust the sampling period (fixed options of 5-sec, 10-sec and 15-sec) at the HMI shall be provided. Refer to individual process control sections (listed in the Appendices) for specific application.

V. Out of Service: The control system shall have the capability to assign an "Out-of-Service" tag to equipment monitored by the control system. During extended periods of maintenance and/or repair, an operator may make such an assignment so as to suppress associated alarms and inhibit HMI/DCS control functions.

    1. Note: normal "lockout / tag-out / check-out" procedures will need to be followed with the field equipment and associated electrical feeds.

W. Control System Historian: The 3rd Party System Integrator shall register the redundant SCADA Servers (as identified on the Control Network Architecture Drawings) with the site Historian and configure the server to historically collect the analog, event and alarm data collected at the active SCADA Server. With loss of communication to the active SCADA server, the Historian shall automatically engage the redundant server pending auto fail-over active status promotion. In the event of communication loss with both SCADA Servers, the Historian shall automatically backfill the historical database, in chronological order once communications are re-established with an active SCADA Server.

    1. Once the Historian server is installed and configured, the 3rd Party System Integrator shall be responsible for verification of communication connection stability/reliability, confirmation of required data backfill and collection and complete test of the data collection redundancy scheme with the Engineer and Owner representatives as witness.

X. Control Philosophy Refinement: It shall be understood that some refinement and/or minor modification of the control philosophy will be necessary over the course of the project as part of the control system configuration and programming work. Forums for informal discussions and clarifications have been provided in these documents. They include the Pre-submittal Conference, Graphics/Reports Development Workshops, Factory Testing, Field Development Phase and Startup. Note: All timer, level, position, analysis, pressure, temperature, and flow rate values noted within the control philosophy sections are provided for reference only and are subject to refinement based on system testing and final construction.

PART 2 - EXECUTION

D.2 DETAILED CONTROL PHILOSOPHY SECTIONS

A. STORMWATER PUMP STATION

The basic premise of a pump station is to start the pumps based on an inlet or sump water level. As the water level continues to rise, additional pumps are started. As the water level drops, the pumps are turned off. A pump will stop at a lower water level than when it is started.

A common configuration is lead-lag operation. The "lead" pump starts first and if it cannot keep up with the inflow, a lag pump is started. The system can contain multiple lag pumps. The last pump started is usually the first to turn off. When an "alternator" function is added, the controller changes the lead pump, so the run hours are distributed across all of the pumps in the system.

The level in a wet well shall be monitored by redundant level instruments with backup wet well low-low and high-high level detection float switches serving as override pump protection and backup start control.

In auto mode, the PLC shall control the pumps to automatically operate based on operator pre-set level setpoints based on the primary instrument wet well level measurement. Once initiated in auto, the pump station shall continue to operate until a low-low level condition is encountered, or an operator initiates a system stop command. Following a low-low level shutdown, the pump station shall be placed in standby mode. Once the pump station wet well level recovers greater than a preset start permissive setpoint for longer than a preset timer period, active pump station level control shall be re-initiated. In the event of primary level instrument failure, the secondary level instrument may be automatically employed in the level control strategy. The pumping arrangement shall include a standby pump and the PLC control logic shall be designed as using run time strategy to continuously rotate pump start positions in an effort to automatically balance runtimes. Should the control system determine that a required pump is "Not Ready" to start or becomes unavailable during operation, the standby pump shall be immediately called to start. Level setpoints shall be remotely adjustable from SCADA.

EQUIPMENT DESCRIPTION

The PLC control logic is designed to avoid excessive pump cycling. The start/stop cycles per hour are within the motor manufacturers specifications. The PLC program allows the operator to perform level set points and timer adjustments remotely on the HMI through the local operator interface on the control panel. The timers are intended to delay the start/stop of pumps upon detection of level set points.

The wet well operational area and distance between the lead pump start and stop elevations shall be sized to allow manufacturer recommended time between successive starts.

OPERATIONAL OVERVIEW

Stormwater pump stations use pumps to transfer stormwater runoff from one location to another. Stormwater pump stations help to prevent flooding by moving stormwater runoff to a location where it can be safely discharged.

Stormwater pump stations typically have a number of components, including Wetwell basins that collects stormwater runoff, pumps to move stormwater runoff from the sump to a discharge point where the stormwater runoff is released.

Level control is the most common method for controlling stormwater pumps. This philosophy involves controlling a pump based on the free water surface elevation in the wet well. There are 2 pumps normally of the same size with solid-state soft start motor starters and bypass contactors. These pumps are configured as N+1 redundancy. As flow enters the wet well, the water surface elevation rises and drops in proportion to the flow being pumped out of the wet well to discharge.

For larger pump stations, multiple pumps may need to run simultaneously. At a predetermined level set point, the first pump energizes and immediately operates at full speed. If the water surface elevation drops to a preset level, the pump eventually turns off. However, if the free water surface continues to rise to the next set level, the next available pump turns on.

When the level drops, the pumps will be controlled to stop in the reverse order according to the start sequence. An automatic alternator program will sequence the pumps start/stop sequence so that the last pump to start would be the last pump to stop in order to make the cycle time of the pumps longer and distribute the running hours more evenly.

LOCAL CONTROL MODE

With the starter HOR switch in Hand mode, a pump may be operated at the starter by means of the Start/Stop pushbuttons. The pump shall run continuously once started until called to Stop by the Operator or upon fault detection. With the HOR switch in Off mode, the pump shall be isolated from all command signals. The local control mode of operation is not a supported operating mode and should be used for starter or pump maintenance purposes only.

LOCAL SAFETY INTERLOCKS

A pump shall be immediately called to stop, and an alarm generated if any of the conditions listed below are detected. A physical reset will be required at the starter before the pump will be available to operate.

- Motor Winding High Temperature
- Moisture Intrusion
- Motor Overload

CONTROLLER PROGRAMMED SAFETY INTERLOCKS

A pump override-stop output shall be triggered, run inhibited and an HMI equipment alarm generated if any of the conditions listed below are detected by the Plant PLC.

- Wetwell low-low level detected.

LOCAL AUTO CONTROL MODE

Not applicable.

REMOTE MANUAL CONTROL MODE (Plant PLC)

The Plant PLC shall monitor equipment status and alarms as shown on the referenced P&ID drawings. An overview control station shall be developed for the plant pump station at the HMI. The overview station shall provide the following as a minimum:

- Per Pump, a pop-up control palette to access:
  - Status (Run, Ready, E-stop and all Fail Conditions)
  - Manual S/S controls (only accessible if pump station placed in Remote Manual Control Mode)
  - Current draw
  - Runtime (daily and lifetime)
  - Duty assignment
    - Wetwell level reading
    - Wetwell level instrument fault detect.
    - Wetwell LAHH (overflow imminent)
    - Wetwell LALL override shutdown.
    - Pump Station A/M status

The control station shall also include a separate pop-up Supervisor level control palette to support the following control and monitoring functions:

- Pump Station A/M control selection (a single common A/M control selection shall be used to dictate the control status of all Pumps)
- pump start sequence select A/M
- pump start sequence manual select.
- Tabular representation of:
  - Lead pump start setpoint with delay timer (entry and display). Default entries % level TBD, 10 second delay.
  - Lag pump start setpoint with delay timer (entry and display). Default entries % level TBD, 10 second delay.
  - LAL pump station stop setpoint with delay timer (entry and display) Default entries % level TBD, 3 second delay.
  - Wetwell LAHH delay timer (default = 2 seconds)
  - Wetwell LALL override shutdown delay timer (default = 2 seconds)

With the starter exhibiting a Ready status at the HMI and the pump station HMI common control station A/M switch in Manual (i.e., Remote Manual Control Mode) the associated pump may be manually controlled by an authorized operator at the HMI using the S/S controls previously described provided a wet well low-low level alarm condition is not detected.

- **Note**: Valid wet well level signal need not be available for Remote Manual start of the pumps.

REMOTE AUTO CONTROL MODE (Plant PLC)

With the pump station HMI common control station in Auto mode, all pump starters exhibiting a Ready status at the HMI will be made available to the PLC auto control logic. (Note: no additional Operator confirmation will be necessary to initiate the pump station.)

The ability to adjust pre-set operating level setpoints and prioritize pump stations to mitigate potential flood scenarios based on local rain gauges and National Oceanic and Atmospheric Administration (NOAA) weather data shall be considered.

Pump station auto start will be subject to the following permissives:

- Valid level signal available
- Low level alarm condition not detected.
- Level start / stop and timer setpoints populated.
- Start sequence populated.
- At least one pump is Ready to operate.
- Pump station Auto operating mode selected.

The Plant PLC shall call the lead pump to start based on the current level readings in the pump station wet well (as shown in the table below). If the lead pump Fails, Fails to Start, or becomes otherwise unavailable while not in operation (i.e., Not Ready), the lag pump shall immediately be called to start.

Plant Pump Station Level Control Logic		
P.S. Wetwell Level	**Demand Falling**	**Demand Rising**
• Longer than 2 seconds • LAHH float switch trip detected		Generate Overflow Flood Alarm Override start lead and lag pumps *
• Longer than 3 seconds • Wetwell level equal to or greater than pump station High-high level stop setpoint @ SCADA		Start all pumps.
• Longer than 10 seconds • P.S. in Auto Mode • Wetwell level equal to or greater than lead pump start setpoint @SCADA		Start lead pump
• Longer than 10 seconds • Lead pump called to run in Auto. • Wetwell level equal to or greater than lag pump start setpoint @ SCADA		Start lag pump
• Longer than 10 seconds • Lead pump called to run in Auto. • Wetwell level equal to or greater than lag pump stop setpoint @ SCADA	Stop Lag Pump	

Plant Pump Station Level Control Logic		
P.S. Wetwell Level	**Demand Falling**	**Demand Rising**
• Longer than 10 seconds • Lead pump called to run in Auto. • Wetwell level equal to or greater than Lead pump start setpoint @ SCADA (TBD)	Stop Lead Pump	
• Longer than 3 seconds • Wetwell level equal to or less than pump station Low-Low level stop setpoint (TBD)	Stop all pumps.	
• Longer than 2 seconds • LALL float switch trip detected	Stop all pumps and inhibit start until LALL condition clears. (Note: trip will not be dependent upon current status of the LAL pump station stop timer.)	

Note 1: All level setpoints and timers shall be adjustable at the Plant HMI at the Supervisory level.

Note 2: A Wetwell LALL condition detected for longer than 2 seconds will result in immediate pump shutdown and inhibit of pump start until the LALL condition is lost for longer than 60 seconds.

Note 3: Wetwell LAHH condition will override start all pumps currently indicating a Ready status (in Remote Auto or Remote Cascade Mode).

Note 4: Pump response to the LALL and LAHH floats shall always override the sump level signal (i.e., a LAHH condition will override start the pumps and a LALL condition will override trip the pumps regardless of level reading or pump station Remote operating mode – Auto or Manual). In the event of level signal fault during operation, the pumps will continue to run until LALL condition is encountered. Auto restart of the pumps in Remote Cascade mode will be prohibited (except if LAHH condition encountered); however, restart of the pumps in Remote Manual mode will be permitted.

B. MBSIS/LFDS OPERATION STRATEGIES

The purpose of the MBSIS/LFDS is to divert dry weather run-off to the sewer system to prevent water contamination at local beaches, bays, and creeks. When the Diversion Valves (DV) are open, dry weather run-off will gravity flow into the sewer system, and the Interceptor Pump Stations (IPS) will pump into the sewer system.

Please note that LFD may not be applicable to every Pump Station Design. LFD may only be installed if required by the waterboard and Approved by PUD to accept the water. See Appendix F Low Flow Diversion.

EQUIPMENT DESCRIPTION

There are six (6) strategically placed optical rain sensors, one (1) tide sensor, and two (2) trunk sewer sensors sending signals to their assigned stations. These signals prevent rainwater and and tidally influenced seawater from entering and overwhelming the sewer system. For detection of

hazards such as hydrocarbon gas leaks, there shall be VOC/LEL sensors for the low flow diversion structures.

There shall be a flow measurement instrument to verify the flow rate and account for totalized flow volume that is discharged to the sanitary sewer. A modulated valve can provide control, as necessary.

OPERATIONAL OVERVIEW

Dry Weather - The DVs are open, and IPSs pump into the sewer system to divert dry weather run-off.

Non-Operational Stations - When IPS or DV stations are non-operational during a rain event, crews will shut down or close stations manually. If a DV actuator cannot be closed manually, a plug will be inserted before the rain event and removed after the rain event.

Emergency Operation - In case of an emergency, crews can bypass the auto function and/or operate the station manually.

LOCAL CONTROL MODE

Not applicable.

LOCAL SAFETY INTERLOCKS

Not applicable.

CONTROLLER PROGRAMMED SAFETY INTERLOCKS

Not applicable.

LOCAL AUTO CONTROL MODE

Not applicable.

REMOTE AUTO CONTROL MODE (Plant PLC)

All PLC program logic is site-specific designed due to various site conditions. All five (5) modes of operation described below are applied in AUTO MODE.

There are five (5) shutdown modes of operation for the DV/IPS systems with telemetry notification:

1. **Rain** – When a 0.25 inch of rain is detected, the optical rain sensor assigned station will start a 20-minute flush, followed by a 3-hour shutdown (20-minute flush is to remove as much contaminates from entering the bay/beaches from the first initial rainfall). Once the 3-hour timer expires, the DV/IPS will reset to dry weather pumping/diversion operation.
2. **High Tide** – DV/IPS systems may introduce seawater when tides are high due to flapper or check valve malfunction. The local PLC program will receive tide levels to shut down the IPS or close the DV. Once acceptable levels are resumed, the DV/IPS will reset to dry weather operation.
3. **Wastewater Collections (WWC Sewer Pump Stations)** - Specific SPS will send a high flow signal to only the IPS control system to override the local PLC program to shut down when high-wet well levels are reached. Once acceptable levels are resumed, the DV/IPS will reset to dry weather operation.

4. **Trunk Sewer** – When a high flow sewer signal is reached at LJ-PB TS, and OB TS all sensor assigned stations will shut down to help prevent high-high flow. Once acceptable levels are resumed, the DV/IPS will reset to dry weather pumping/diversion operation.
5. **Abnormal Flow** - Infrequently, the stations may receive a high flow of run-off water (e.g., water main break, local construction project, etc.) or extended pump runtime. If this were to occur, only the local IPS has a PLC program strategy to determine if a high flow situation has occurred; if so, a 3-hour shutdown will proceed. Once the 3-hour timer expires, only the IPS will reset to dry weather pumping/diversion operation. A rain event however shall supersede this mode.

Appendix E

Instrument Abbreviations and Identification

Appendix E Instrument Abbreviations and Identifications

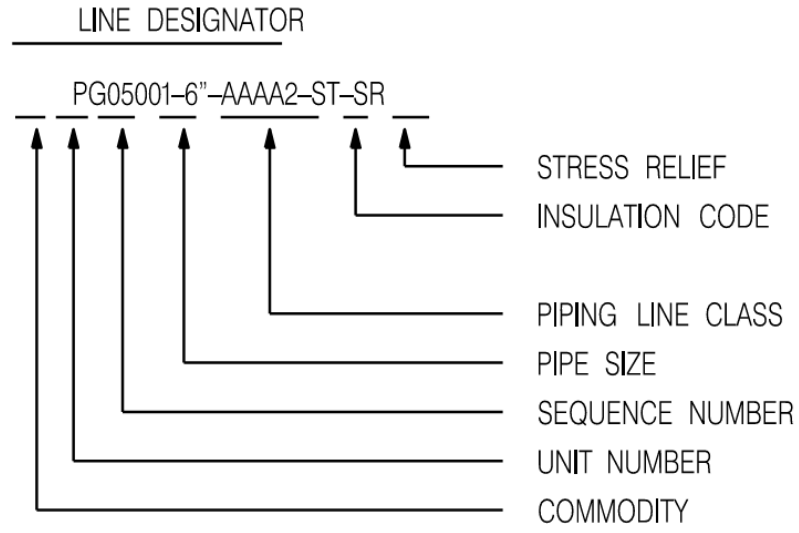
E.1 INSTRUMENTATION ABBREVIATIONS

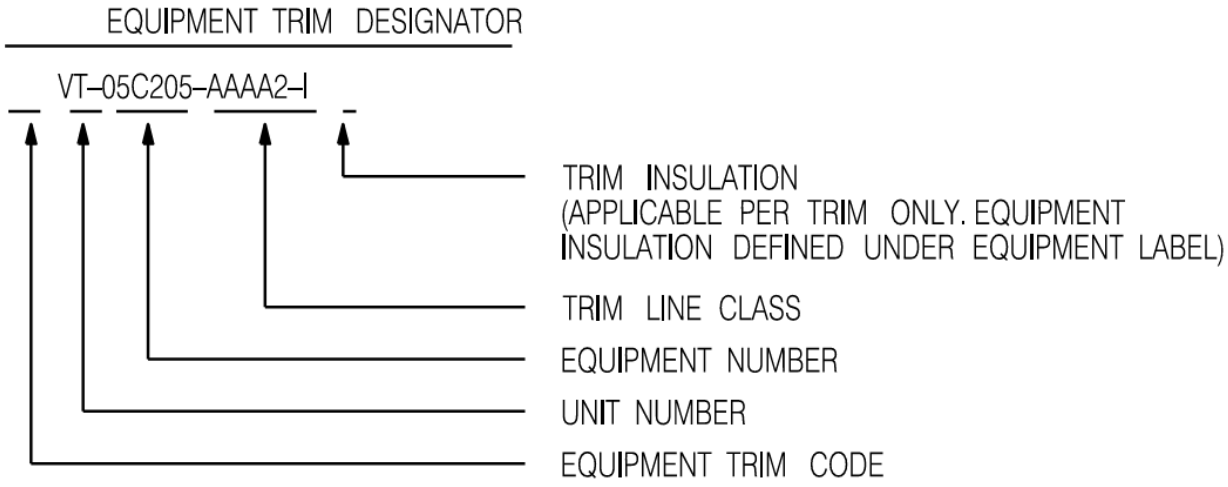
ACK	ACKNOWLEDGE	L	LOW
ACP	AREA CONTROL PANEL	LL	LOW LOW
A/S	AIR SUPPLY	LCP	LOCAL CONTROL PANEL
BRG	BEARING	LEL	LOWER EXPLOSIVE LIMIT
CT	CURRENT TRANSFORMER	LOR	LOCAL/OFF/REMOTE
CL2	CHLORINE	M/A	MANUAL/AUTO
COMB	COMBUSTIBLE	O2	OXYGEN
DIFF	DIFFERENTIAL	OBD	OUTBOARD
DISCH	DISCHARGE	O/C	OPEN/CLOSE
DO	DISSOLVED OXYGEN	O/L	OVERLOAD
D/P	DIFFERENTIAL PRESSURE	O/O	ON/OFF
ESD	EMERGENCY STOP DEVICE	ORP	OXYGEN REDUCTION POTENTIAL
ETM	ELAPSED TIME METER	PAR	PROCESS ALARM RELAY
FC	FAIL CLOSED	PLC	PROGRAMMABLE LOGIC CONTROL
FO	FAIL OPEN	RESET	RESET
H	HIGH	RIO	REMOTE INPUT/OUTPUT
HH	HIGH HIGH	SO2	SULPHUR DIOXIDE
HMI	HUMAN MACHINE INTERFACE	SP	SET POINT
HOA	HAND/OFF/AUTO	SW	SELECTOR SWITCH
HORN	ANNUNCIATOR HORN	S/S	STOP/START
HOR	HAND/OFF/REMOTE	TURB	TURBIDITY
H2S	HYDROGEN SULPHIDE	UPS	UNINTERRUPTABLE POWER SUPPLY
IBD	INBOARD	VCP	VENDOR CONTROL PANEL
I/I	CURRENT/CURRENT ISOLATION	VIB	VIBRATION
I/P	CURRENT TO PNEUMATIC	WDG	WINDING

E.2 ISA IDENTIFICATION LETTERS

ISA TABLE (MODIFIED)					
	FIRST LETTER		SUCCEEDING LETTER(S)		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION				
C	CONDUCTIVITY			CONTROL	CLOSED
D	DENSITY	DIFFERENTIAL			
E	VOLTAGE		SENSOR (PRIMARY ELEMENT)		
F	FLOWRATE	RATIO (FRACTION)			FORWARD
G			GAUGE, GLASS, VIEWING DEVICE		
H	HAND				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER	SCAN			
K	TIME, TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT		LOW
M	MOISTURE	MOMENTARY			MIDDLE, INTERMEDIATE
N	TORQUE		ISOLATE	ISOLATOR	
O			ORIFICE, RESTRICTION		OPEN
P	PRESSURE, VACUUM		POINT (TEST) CONNECTION		
Q	QUANTITY	INTEGRATE, TOTALIZE			
R	RADIATION		RECORD		REVERSE
S	SPEED, FREQUENCY	SAFETY		SWITCH	
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	MULTIFUNCTION
V	VIBRATION, MECHANICAL ANALYSIS			VALVE, DAMPER, LOUVER	
W	WEIGHT,FORCE		WELL		
X	INTRUSION	XAXIS			
Y	EVENT, STATE, OR PRESENCE	YAXIS		COMPUTE, CONVERT	
Z	POSITION, DIMENSION	ZAXIS		DRIVER, ACTUATOR, FINAL CONTROL ELEMENT	

E.3 EQUIPMENT AND LINE DESIGNATORS





Appendix F

Low Flow Diversions

Appendix F Low Flow Diversions

F.1 DRY WEATHER FLOW

Non-stormwater (i.e., dry weather flow) includes illicit discharges and NPDES permitted discharges. Non-stormwater discharges from the MS4s are not considered stormwater discharges and therefore are not subject to the MEP standard of CWA section 402(p)(3)(B)(iii), which is explicitly for "Municipal Stormwater Discharges (emphasis added)" from the MS4s. Pursuant to CWA 402(p)(3)(B)(ii), non-stormwater discharges into the MS4s must be effectively prohibited.

Dry weather flow can be generated from many sources such as:

- Irrigation system drainage and landscape overspray or overapplication
- Car washing
- Infiltration of groundwater into the storm drainage system
- Natural springs, groundwater, foundation drainage, footing drainage
- Fire hydrant and fire prevention or response system flushing
- Potable water related to the operation, maintenance, or testing of potable water systems
- Drinking fountain water and atmospheric condensate including refrigeration, air conditioning, and compressor condensate
- Seawater infiltration where the seawater is discharged back into the source
- Incidental windblown mist from cooling towers that collect on rooftops or adjacent portions of facilities

F.2 LOW FLOW DIVERSION CONFIGURATIONS

A Low Flow Diversion (LFD) is a structural system that diverts dry weather or integrated dry weather/wet weather flow from the storm drain system to the sanitary collection system to achieve WQIP pollutant load reduction requirements, and where the diverted flow can be treated by the Pure Water Program to augment water supply. LFDs can have several different configurations including:

- LFD integrated with stormwater pump stations; refer to Figure F.1a and Figure F.1.b
- Diversion Valve (DV) LFD; refer to Figure F.2
- Interceptor Pump Station (IPS) LFD; refer to Figure F.3

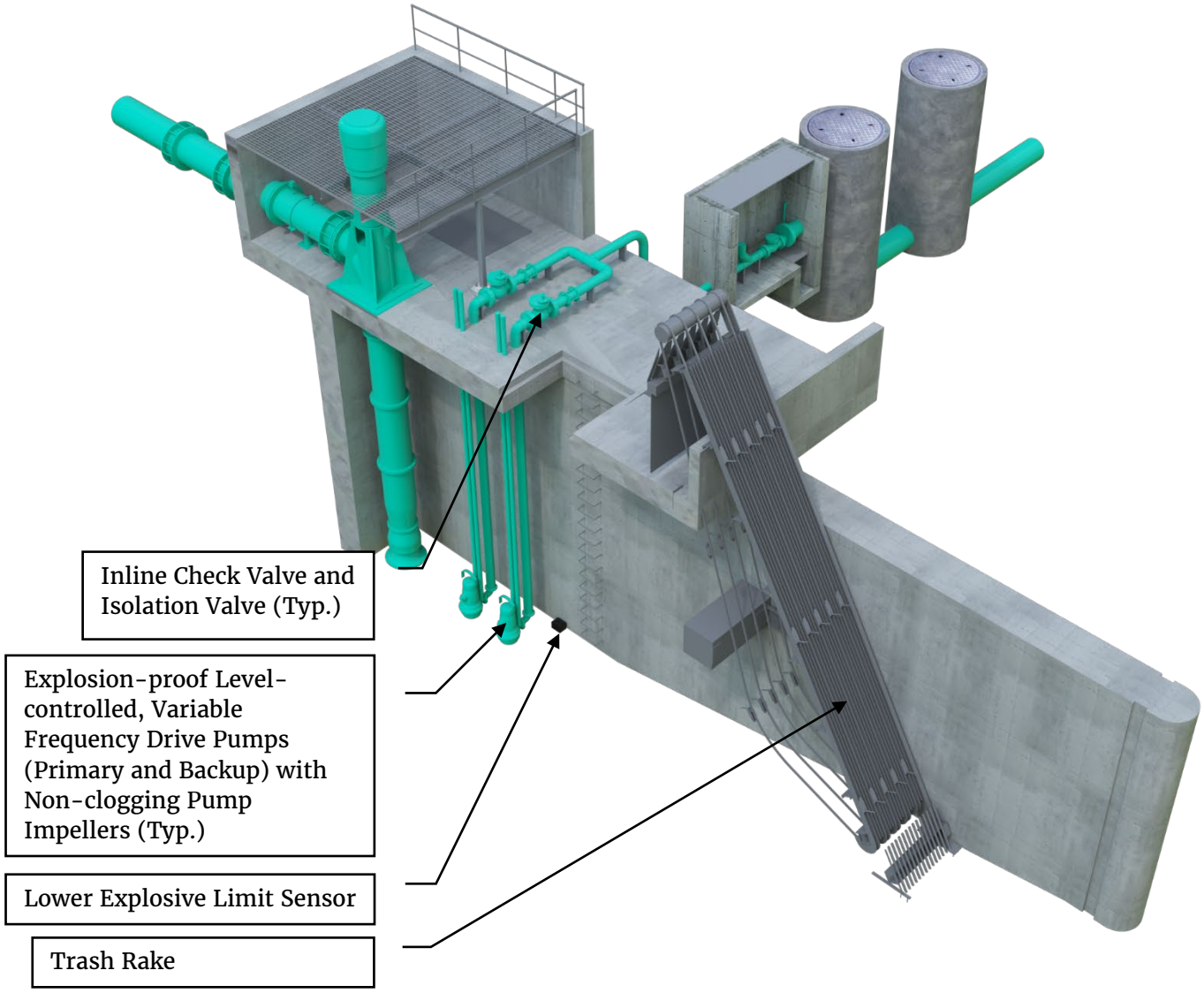


Figure F.1.a. Low Flow Diversion within Stormwater Pump Station

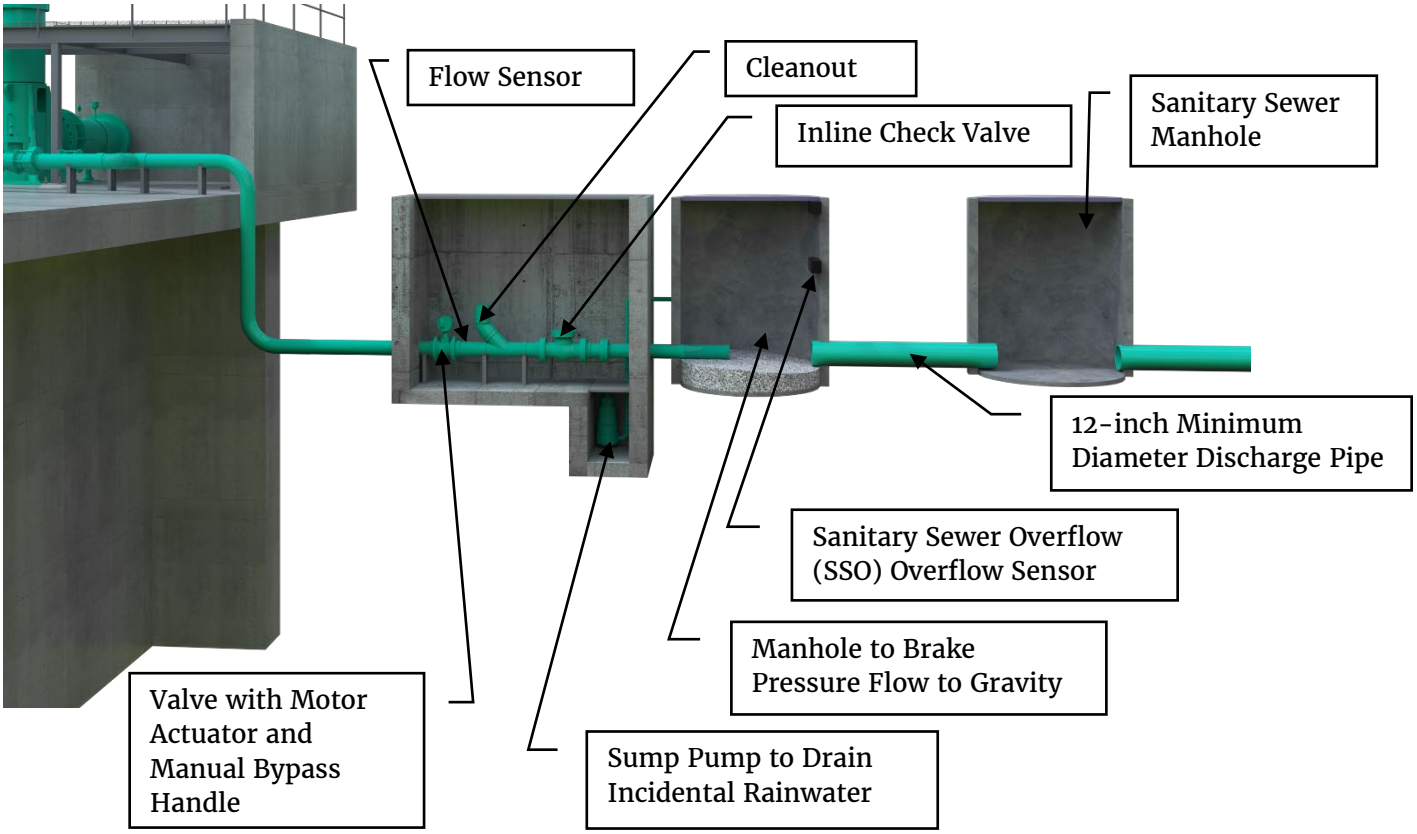


Figure F.1.b. Low Flow Diversion within Stormwater Pump Station Details

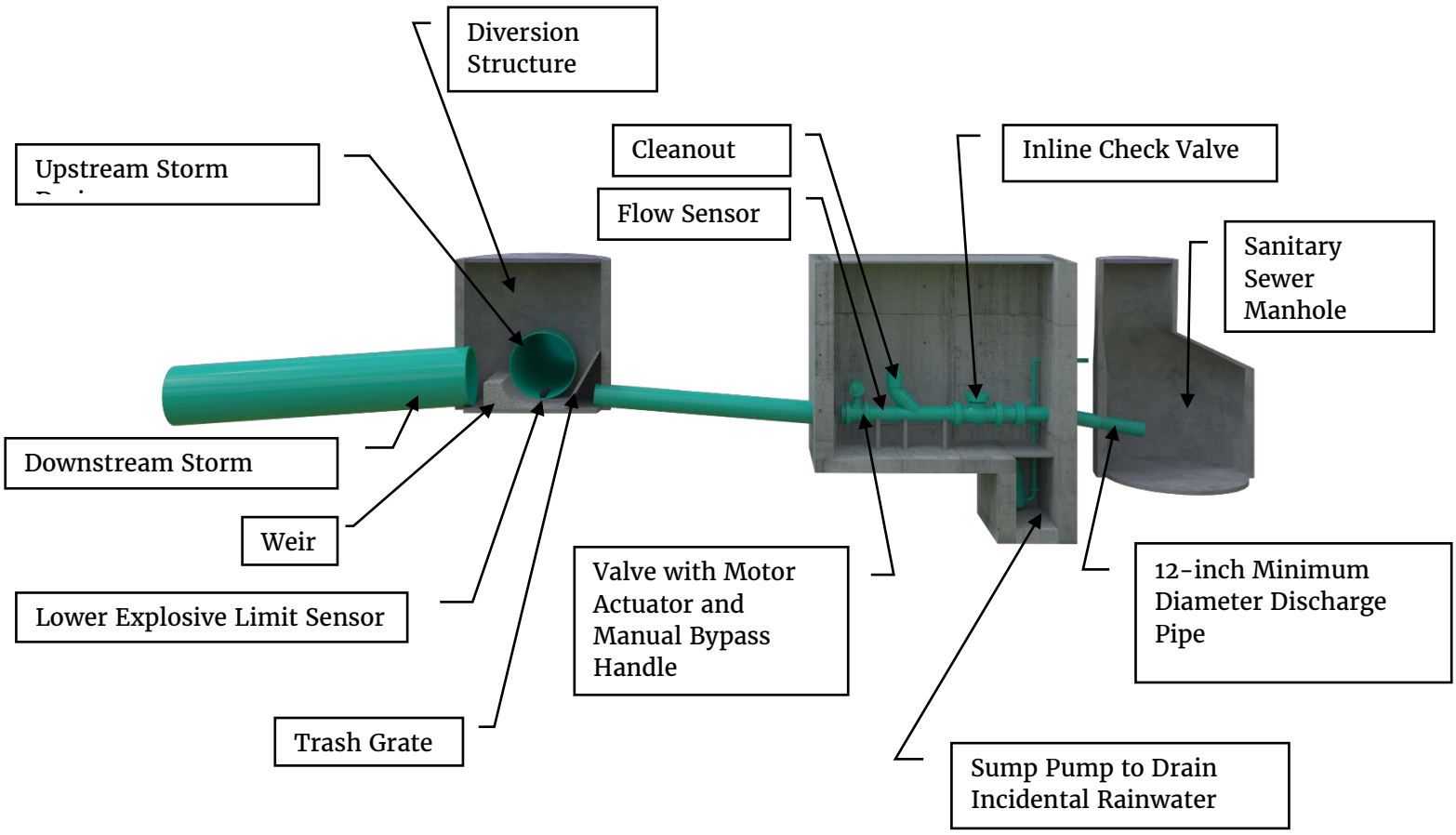


Figure F.2. Diversion Valve Low Flow Diversion

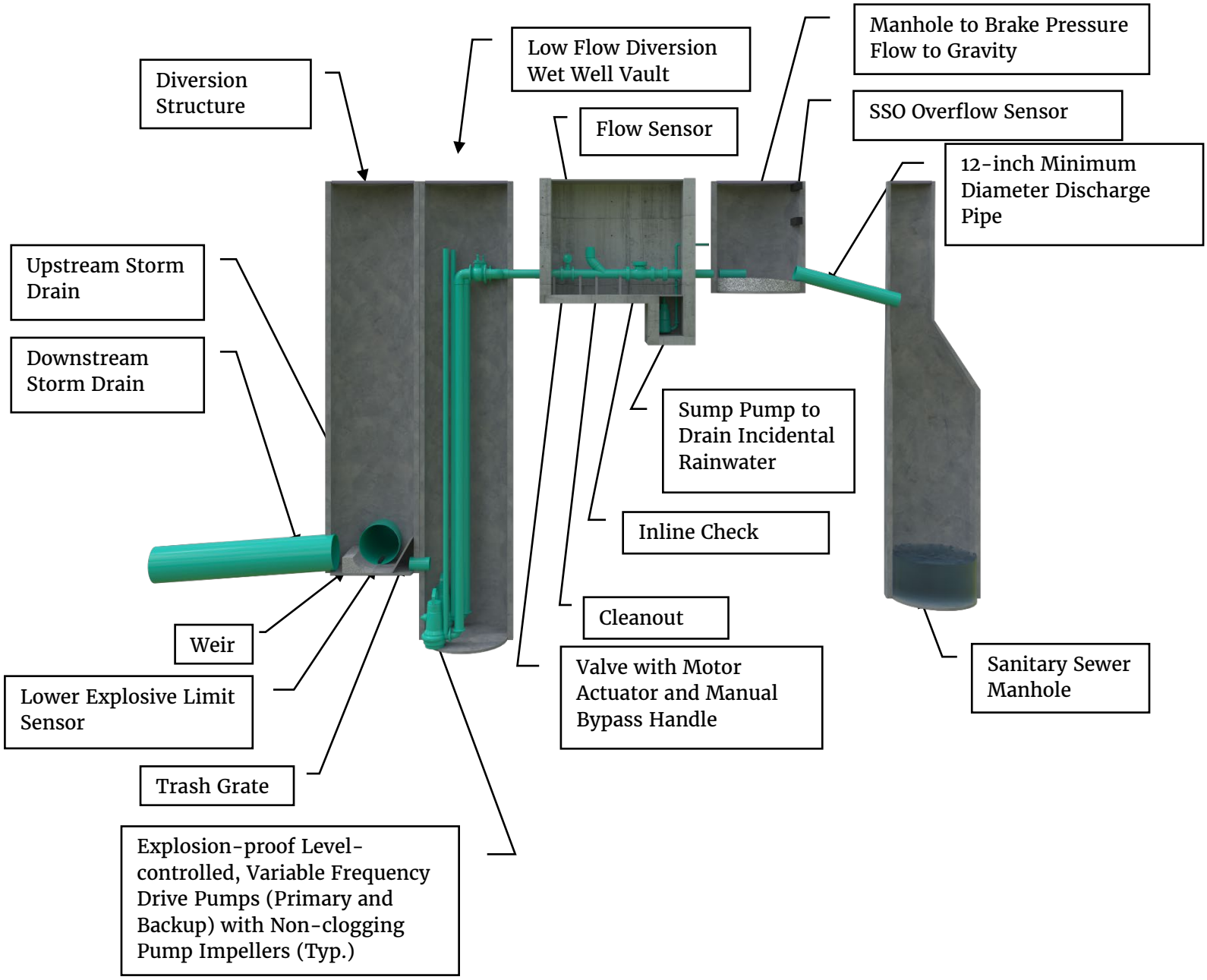


Figure F.3. Interceptor Pump Station Low Flow Diversion

Implementation of LFDs requires thoughtful consideration and compliance with:

1. Regulatory and policy requirements,
2. Planning considerations, and
3. Design, construction, operation, and maintenance criteria.

The following sections summarize these requirements.

F.3 REGULATORY AND POLICY ASSESSMENT

An LFD is subject to several regulatory and policy requirements. These requirements are driven by permits and policies that are applicable to the Stormwater Department (SWD) and Public Utilities Department (PUD).

The initial consideration for an LFD is whether or not it will support the City in compliance with its MS4 permit by way of pollutant load reduction to receiving waters. Ideally, this should be the case, with the co-benefit of augmenting the City's water supply. In many instances integrating LFDs in stormwater pump stations will meet this criterion. For other situations, it may be more convenient and cost-effective to locate the LFD in a receiving water where dry weather and wet weather flows concentrate from multiple drainage systems. However, these LFDs, which are diverting water from a Water of the US would be classified as an in-stream treatment system by the SDRWQCB; refer to MS4 Permit Finding 7 below. As a result, the LFD would not serve as a Best Management Practice (BMP) that treats runoff prior to discharge to a receiving water. The resulting consequence would be the requirement for the SWD to implement additional measures to effectively eliminate the discharge prior to entering the receiving water.

MS4 Permit Finding 7: In-Stream Treatment Systems. Pursuant to federal regulations (40 CFR 131.10(a)), in no case shall a state adopt waste transport or waste assimilation as a designated use for any waters of the U.S. Authorizing the construction of a runoff treatment facility within a water of the U.S., or using the water body itself as a treatment system or for conveyance to a treatment system, would be tantamount to accepting waste assimilation as an appropriate use for that water body. Runoff treatment must occur prior to the discharge of runoff into receiving waters. Treatment control best management practices (BMPs) must not be constructed in waters of the U.S. Construction, operation, and maintenance of a pollution control facility in a water body can negatively impact the physical, chemical, and biological integrity, as well as the beneficial uses, of the water body.

Discharge of dry weather flow or integrated dry weather/wet weather flow to the sanitary sewer system requires close coordination, collaboration, and approval by PUD. This is essential so that the resulting diverted discharge is compliant with PUD's NPDES Permit and City Municipal Code, does not cause a sanitary sewer overflow, and does not upset wastewater and Pure Water Program treatment processes. Currently, only dry weather flow diversion to the sanitary sewer will be considered and deemed acceptable by PUD. Figure F.4 presents the process that should be followed during the regulatory and policy assessment phase of the LFD project. It may be necessary to incorporate engineering controls and treatment processes to meet the regulatory and policy criteria presented in Figure F.4.

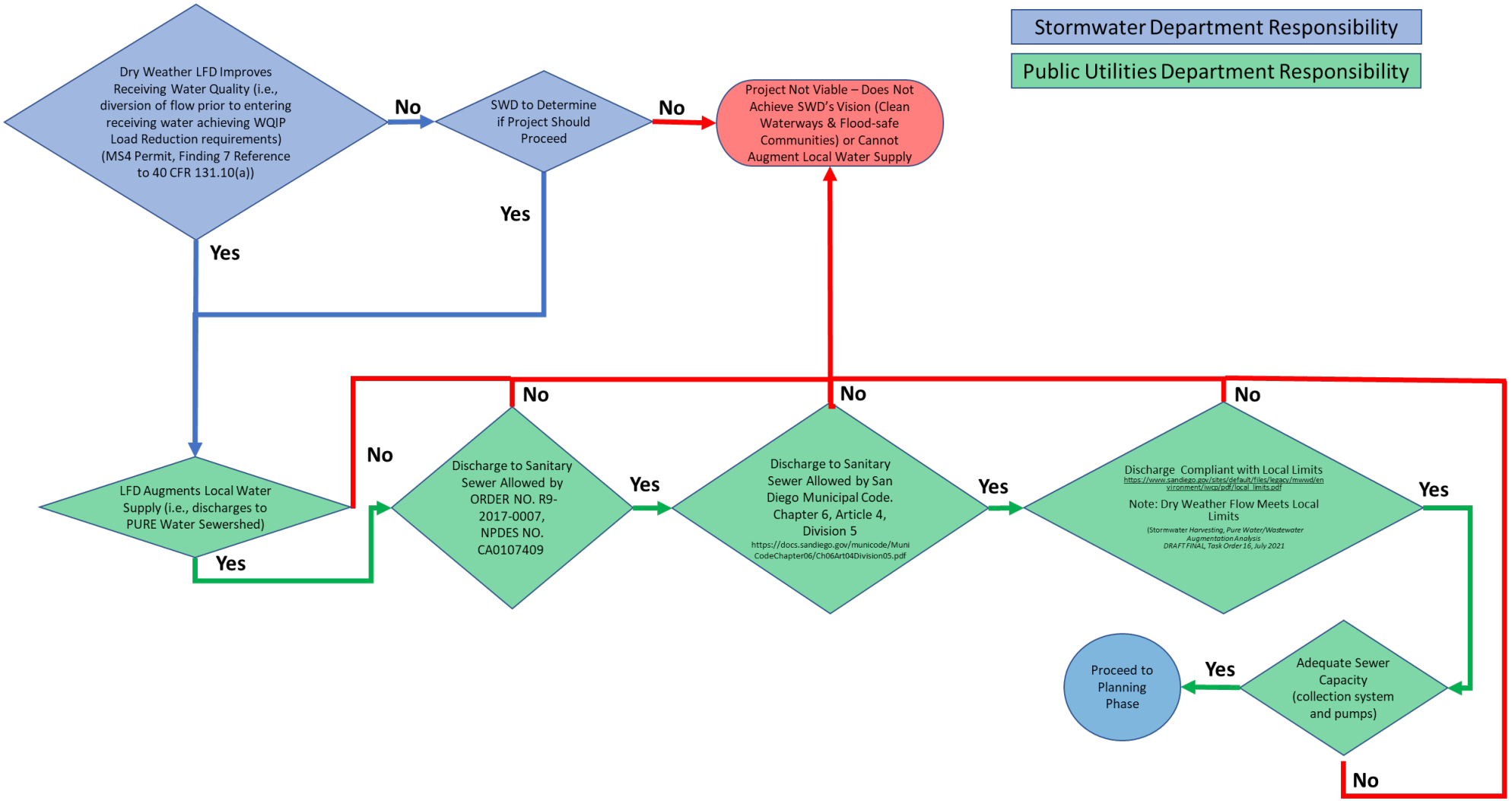


Figure F.4. Dry Weather Low Flow Diversion Regulatory and Policy Assessment Phase Process

F.3.1 PLANNING CONSIDERATIONS

If the LFD was deemed viable during the Regulatory and Policy Assessment Phase, then the Planning Phase commences. Specific planning considerations for the project include:

- Confirming the LFD is located within the City's jurisdiction.
- Verifying there is sufficient dry weather flow whereby it is cost effective to implement the LFD (i.e., flows ≥ 100 gpm). From a high-level planning exercise, drainage areas that are between 100 acres, but less than 15 square miles should be considered.
- The LFD must be situated on a parcel that has a slope of <15 percent.
- Adequate space must be provided to attenuate flows prior to discharge to sanitary sewer. Detention should be sized to attenuate and meter wet weather flows into the sanitary sewer such that the maximum design flow specified by PUD is not exceeded.
- The LFD must be located at least 10 feet away from buildings/structures except for being placed in the pump station wet well.
- Sanitary sewer should be located within 200 feet of the LFD unless otherwise approved by the SWD to be further away.
- There are no impacts to biological or cultural resources in the downstream receiving water.
- The LFD is collocated with other planned projects.
- The project is deemed cost-effective using triple-bottom-line cost/benefit analysis.

Figure F.5 presents the process that should be followed during the planning phase of the LFD project.

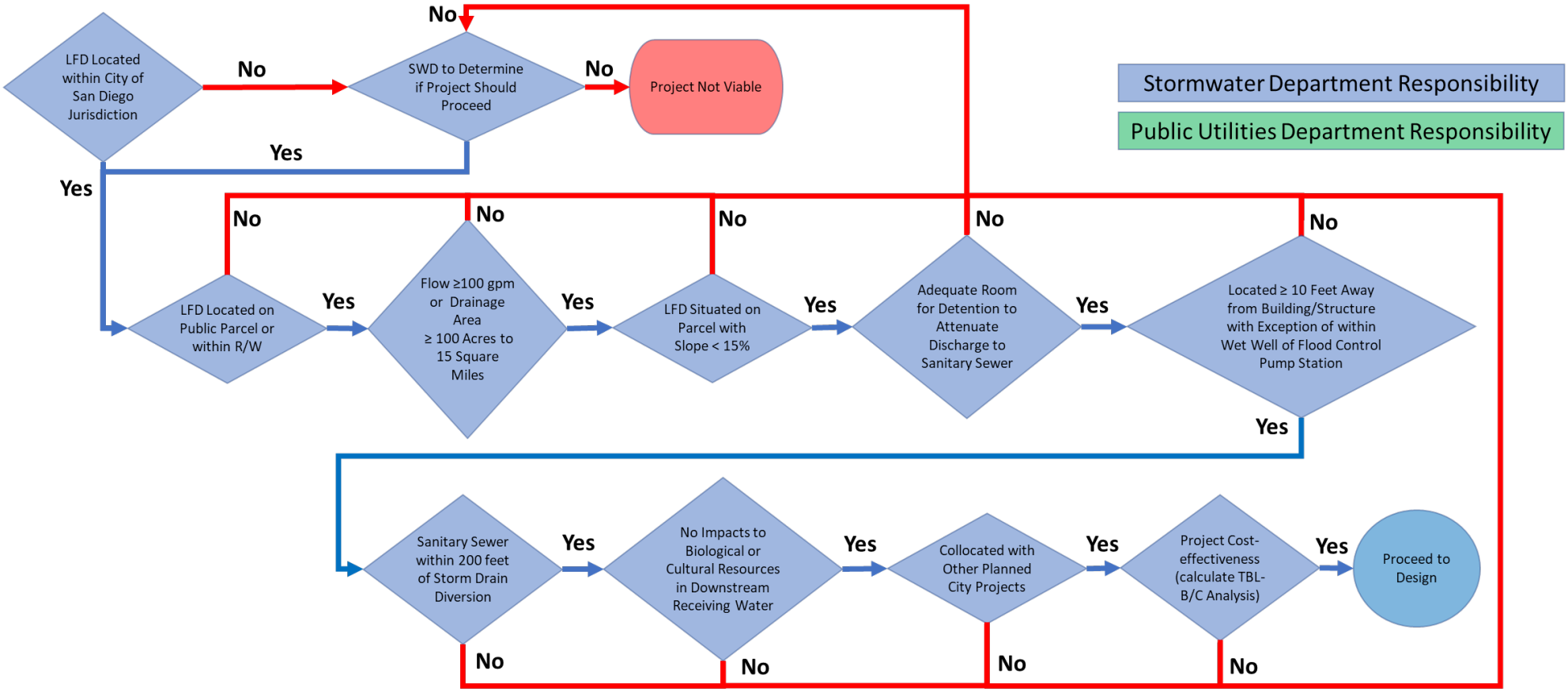


Figure F.5. Low Flow Diversion Planning Phase Process

F.3.2 DESIGN, CONSTRUCTION, AND OPERATION & MAINTENANCE CRITERIA

Design, construction, and O&M criteria are discussed in the subsections below.

F.3.2.1 Design, Construction, and Operation & Maintenance Criteria

Concepts for typical LFDs are shown in Figures F.1.a, F.1.b, F.2, and F.3. The figures call attention to key attributes that need to be incorporated into the design. These include:

- Locating electrical and instrumentation and control equipment above the design flood elevation, which accounts for sea level rise; refer to Section 3.5.5.
- Designing the diversion structure to divert the maximum flow rate of dry weather flow (refer to Section 3.6.1) or the maximum allowed to be discharged to the sanitary sewer by PUD. The PUD's maximum allowable discharge will govern. The diversion shall not result in hydraulic jumps or losses that cannot be contained by the system.
- Trash interceptor to screen trash before being discharged to the sanitary sewer. Full capture devices should be used that trap particles that are 5 mm or greater.
- A valve with an electric motor actuator and manual bypass handle to stop the diversion of flow to the sanitary sewer. The valve shall be capable of being controlled remotely.
- Explosion-proof pumps (primary and backup) with non-clogging pump impeller. A backup pump shall be included to satisfy the California Coastal Commission.
- Level controlled variable frequency driven (VFD) pumps modulate electric motor speed by varying the frequency and voltage of its power supply. The VFD also has the capacity to control ramp-up and ramp-down of the motor during start or stop, respectively.
- Lower Explosive Limit sensor capable of triggering the electric motor actuator to close in the event hydrocarbons enter the diversion structure.
- Flow sensor and meter to rate flow rates and totalize flow entering the sanitary collection system. The flow sensor shall also be used to modulate the valve to control flows such that the flow rate does not exceed that maximum diversion rate.
- SCADA for gathering and analyzing real-time data to monitor and control equipment including onsite rain gauge, sensors in all manholes to control overflow, backflow, and pump shutoff.
- A structure that breaks pumped (pressurized) flow to gravity before discharge to the sanitary sewer.
- Vault access cover sized for HS-20 traffic loading.
- Cleanouts.
- Pump discharge piping with Inline check and isolation valves to prevent backflow of sanitary sewer flows.
- 12-inch diameter minimum discharge pipe to sanitary sewer.

F.3.2.2 Construction

The following criteria should be followed during construction:

- Construction to take place to minimize impacts during nesting and breeding seasons, and to avoid unintended flooding.
- Public access and traffic control shall be implemented.
- Staging and storage areas shall be identified on project plans.
- Disruption to the sanitary sewer shall be minimized.
- Environmental mitigation requirements shall be satisfied.

F.3.2.3 Operation & Maintenance

The following O&M criteria should be followed:

- Access to LFD components including but not limited to the diversion structure and trash interceptor shall be accessible by maintenance staff. Access shall be sufficient to make use of vactor equipment.
- Discharge to the sanitary sewer is not allowed until there is a 7-day antecedent dry period following appreciable rainfall (≥ 0.1 inch).
- Permits shall be obtained to maintain LFDs located in Waters of the U.S.
- Monitoring shall be performed to confirm local limits are met. PUD shall determine the necessary monitoring requirements and verify local limits are met.
- Diverted flows to the sanitary sewer shall not exceed the maximum allowable discharge rate and shall be consistent as practicable.
- The SWD is responsible for O&M of the LFD. When requested, the SWD shall provide PUD access.

Appendix G

Typical Specification Table of Contents

Appendix G Typical Specification Table of Contents

SAN DIEGO STORM WATER PUMP STATION

The pump stations contract specification document shall be provided in accordance with the currently adopted version of Standard Specifications (The "WHITEBOOK" and "GREENBOOK").

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Supplementary specification shall be added if some specific project requirements are not addressed well in the Standard Specification. The supplementary specifications are organized according to the Construction Specifications Institute's (CSI) Master-Format. The supplementary specifications shall be used in concert and incorporate into the contract specification. .

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Appendix H

Deviation from Standards (Design Only)

THINK BLUE SAN DIEGO	DEVIATION FROM STANDARDS (DESIGN ONLY)	SWD ENGINEER
DRAWING NUMBER(S):	DSD PROJECT NUMBER:	WBS OR IO NUMBER(S):
PROJECT TITLE/DESCRIPTION: PROJECT LOCATION(S):		PLACE RCE STAMP OF EOR HERE
ENGINEER OF RECORD: _____ (EOR) (Print Name) _____ (Signature) _____ (RCE NUMBER) _____ (Date)		
STANDARDS DEVIATING FROM (e.g. 2018 Greenbook Section; 2018 Standard Drawing SDG-133 Curb Ramps Type A and B): LOCATIONS OF DEVIATION(S) (Street names/intersections or facility locations):		
DESCRIPTION OF DEVIATION(S):		

THINK BLUE SAN DIEGO	DEVIATION FROM STANDARDS (DESIGN ONLY)	CITY ENGINEER

REASON(S) FOR DEVIATION(S):

MITIGATION MEASURES FOR DEVIATION:

SEE ATTACHED SHEETS (e.g. D sheets, photos or sketches) PROVIDE SHEET NUMBERS WITH DESCRIPTIONS.:

REVIEWED BY:
DESIGN/PLAN CHECK ENGINEER:_____
(Print Name)

_____ _____
(Signature) (Date)

APPROVED BY:
SWD ENGINEER: _____
(Print Name)

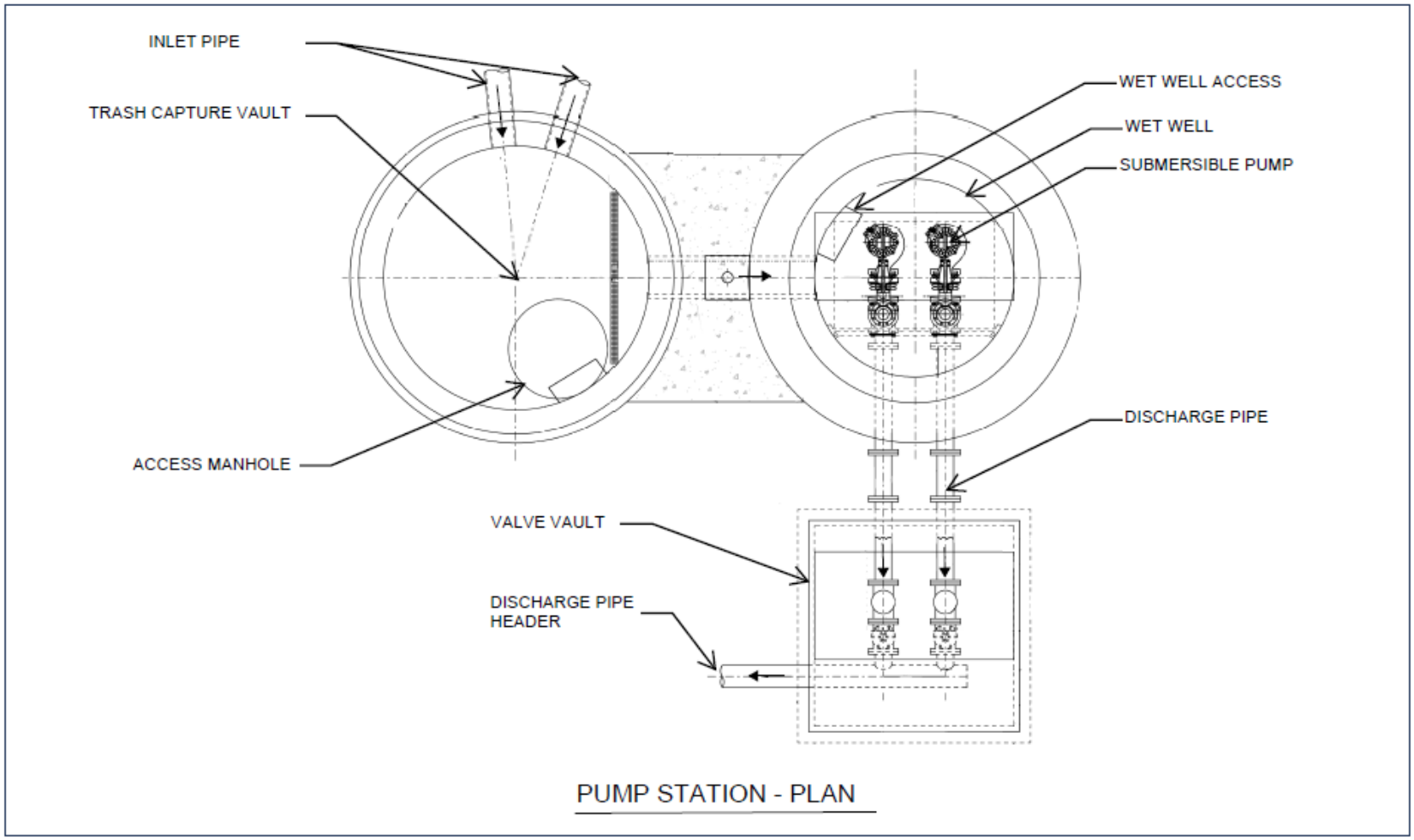
_____ _____
(Signature) (Date)

Appendix I

Example Pump Station Layouts

SAN DIEGO STORM WATER PUMP STATION

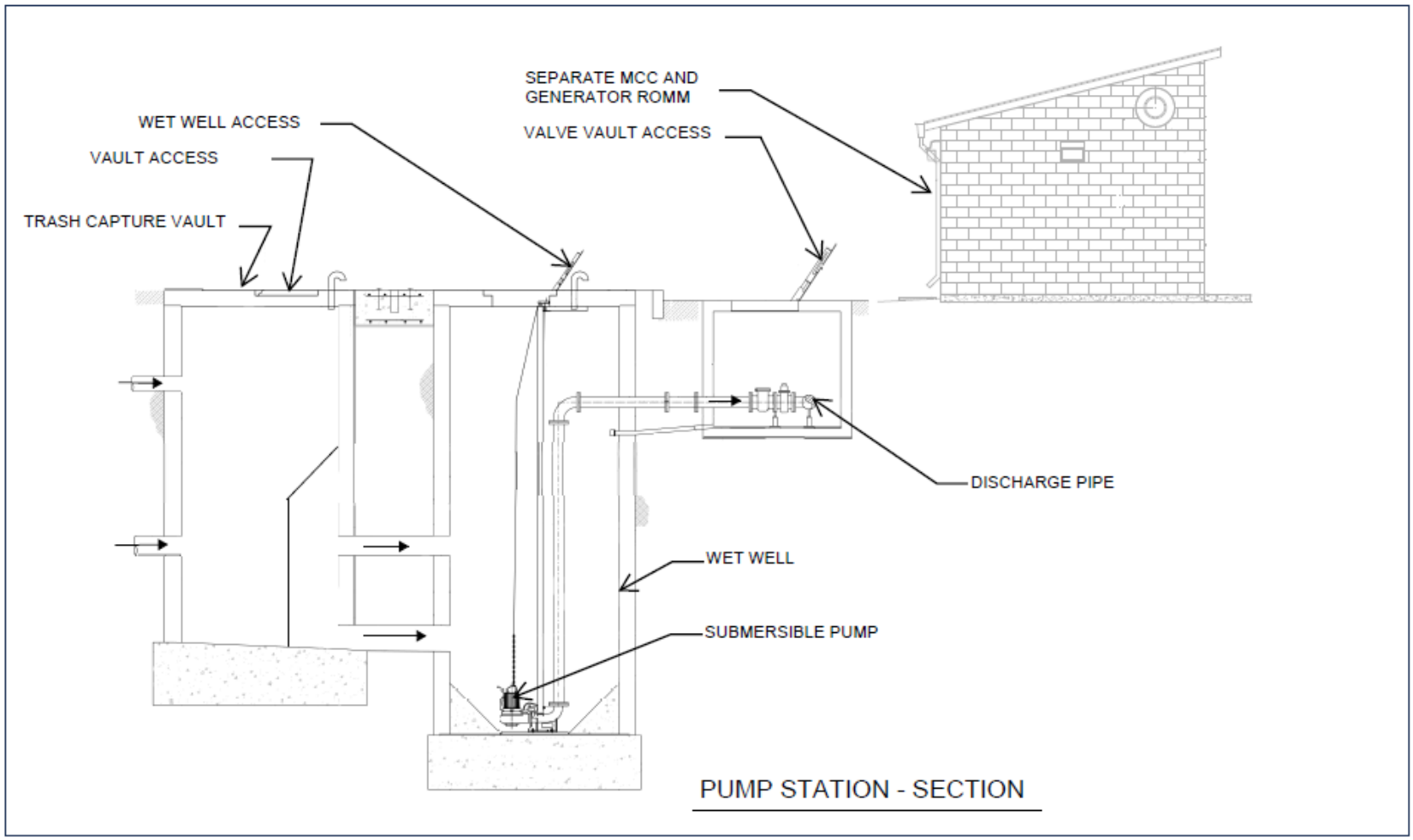
Example of Pump Station Layout – Submersible Pumps In Wet Well Configuration -Plan



NOTE: Example layout shown is for illustration purposes only, layout shall be suitable to suit design needs and site conditions.

SAN DIEGO STORM WATER PUMP STATION

Example of Pump Station Layout - Submersible Pumps In Wet Well Configuration -Section



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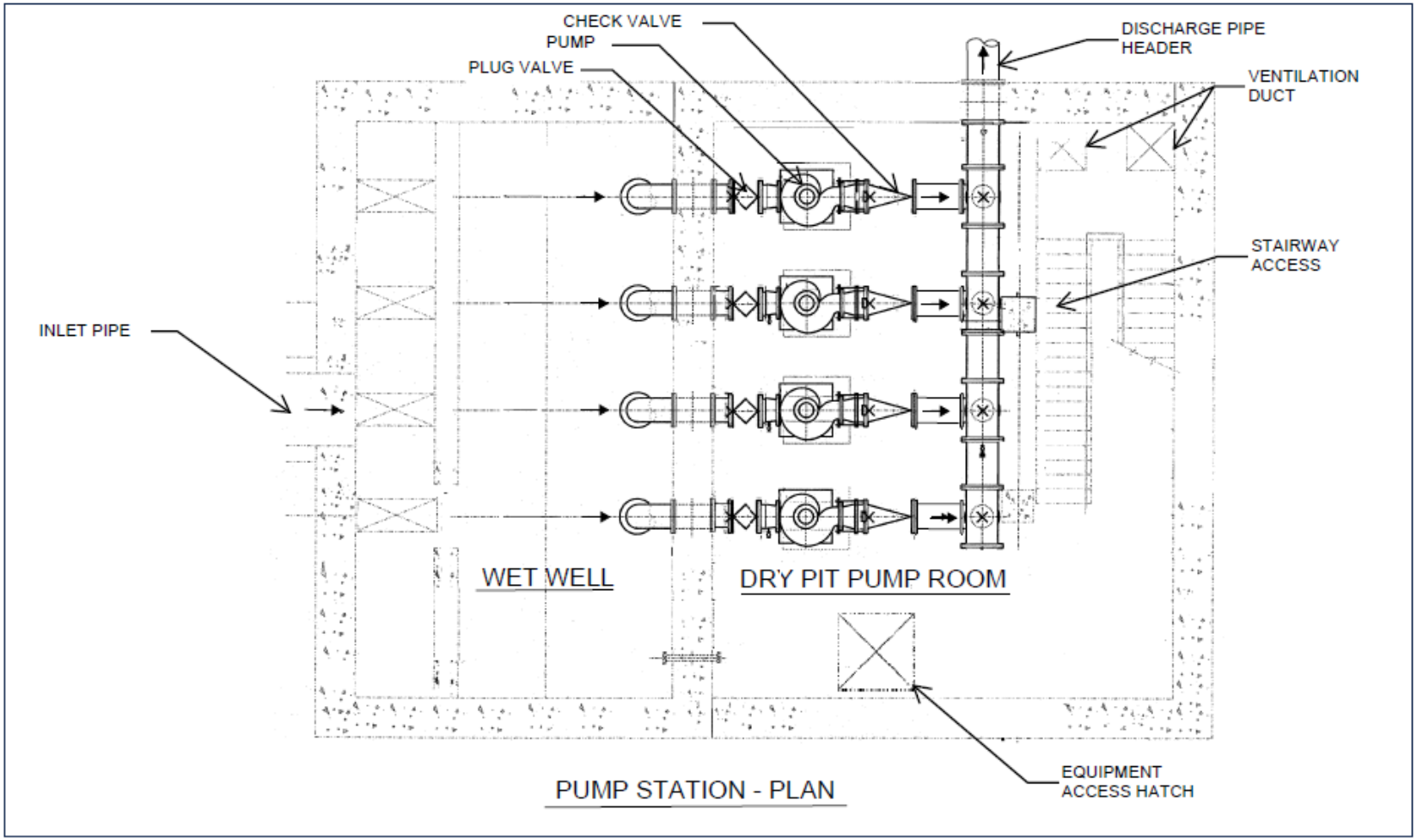
SAN DIEGO STORM WATER PUMP STATION

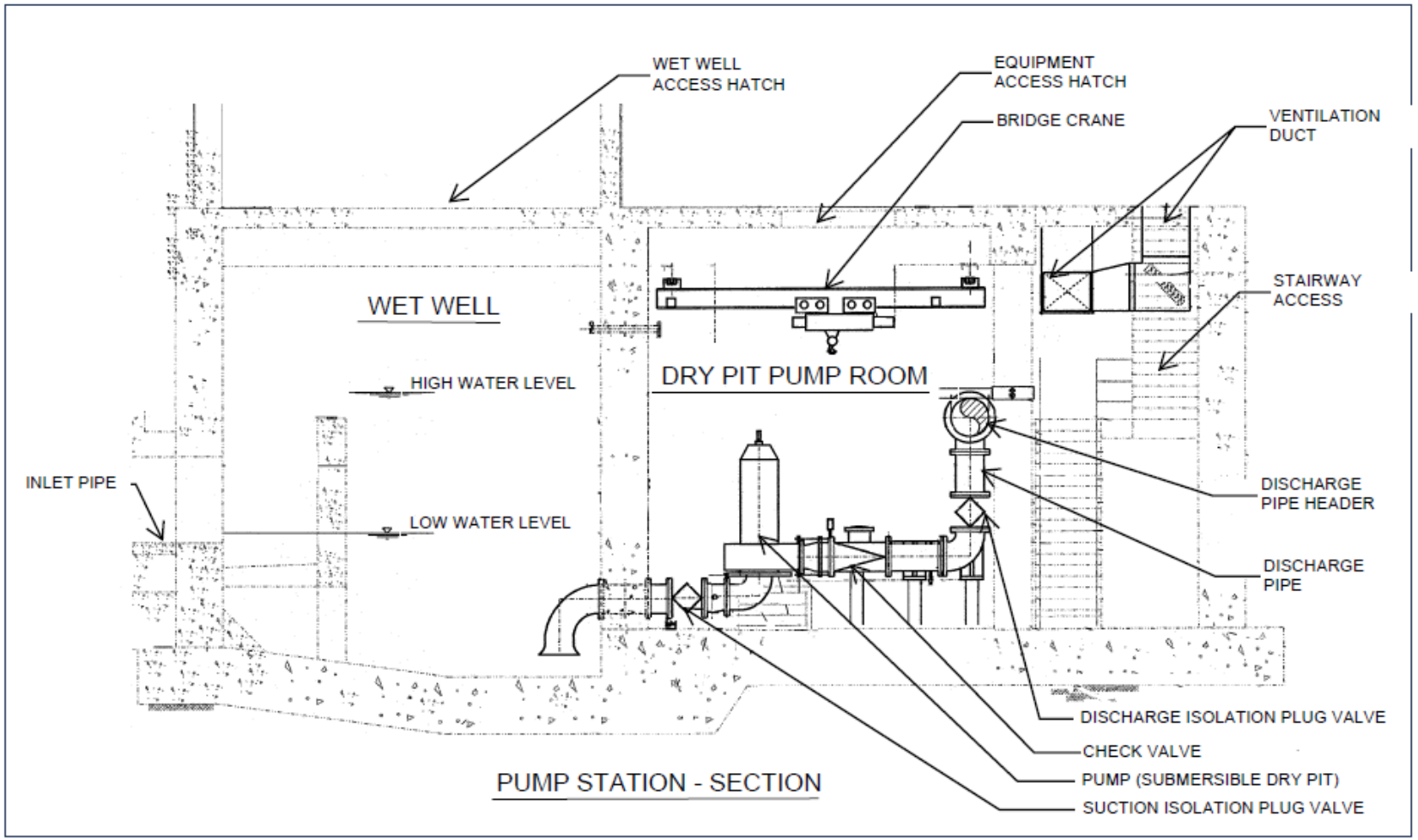
Example of Pump Station Layout - Submersible Pumps In Dry Pit Configuration -Plan



NOTE: Example layout shown is for illustration purposes only, layout shall be suitable to suit design needs and site conditions.

SAN DIEGO STORM WATER PUMP STATION

Example of Pump Station Layout - Submersible Pumps In Dry Pit Configuration -Section



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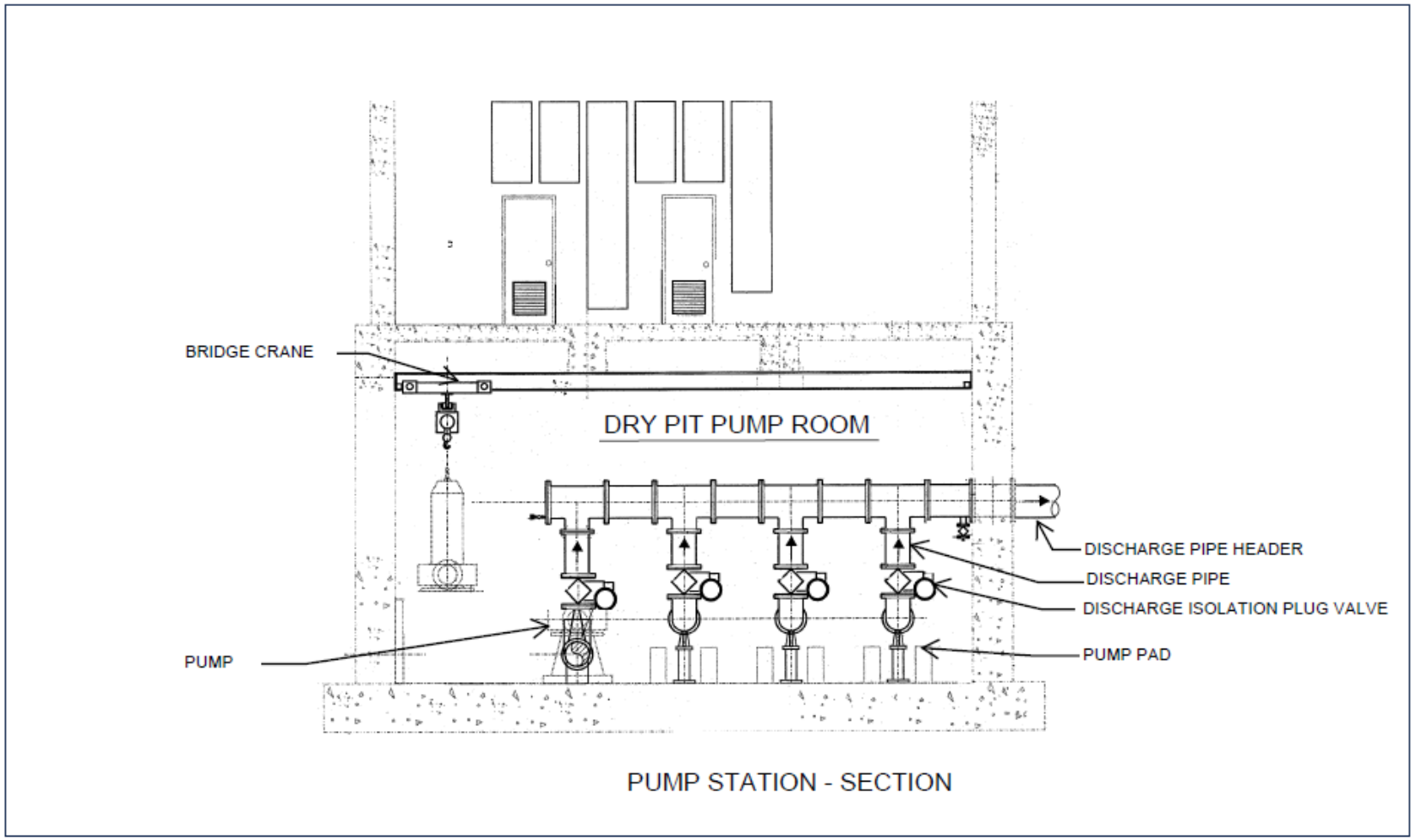
Example of Pump Station Layout - Submersible Pumps In Dry Pit Configuration -Section



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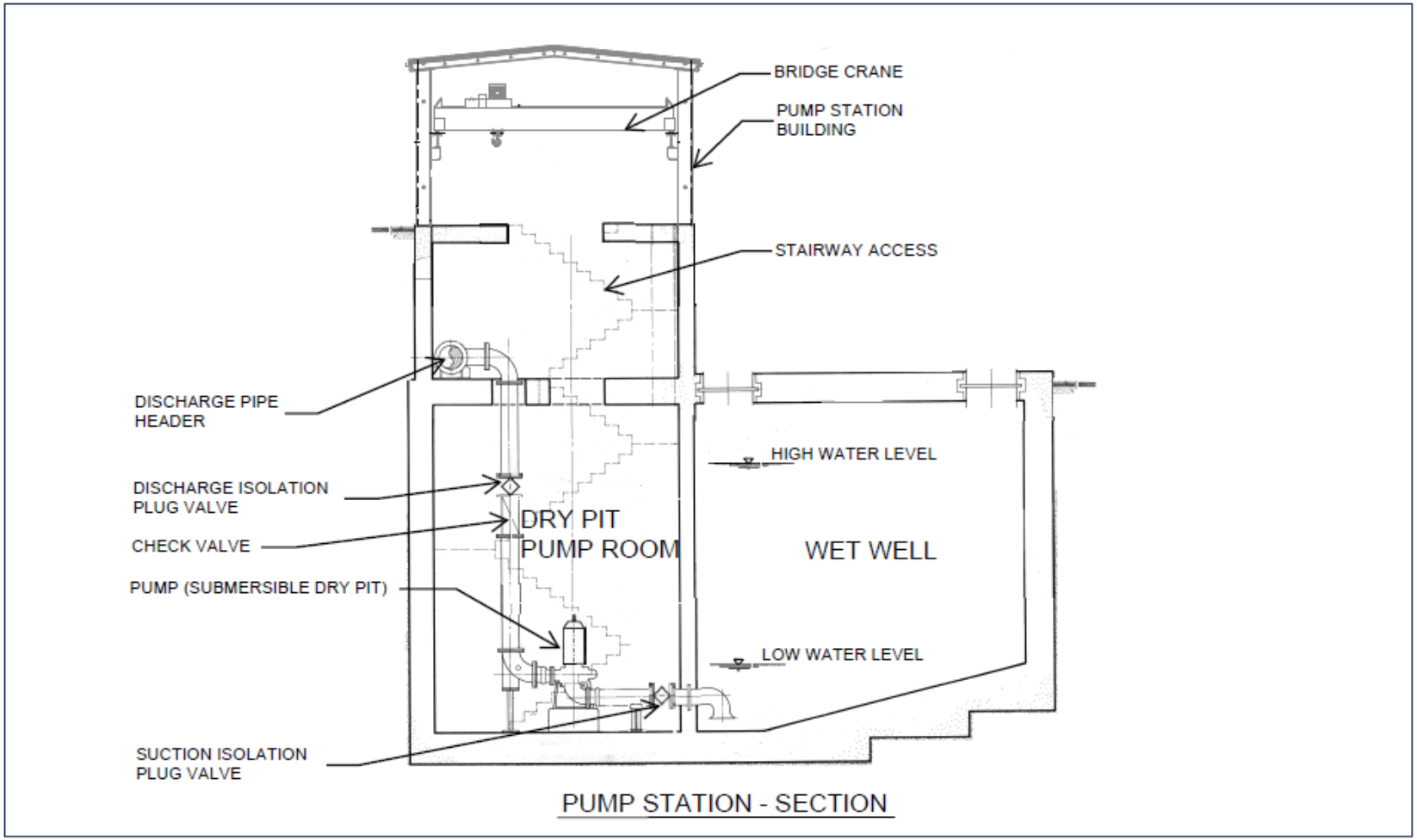
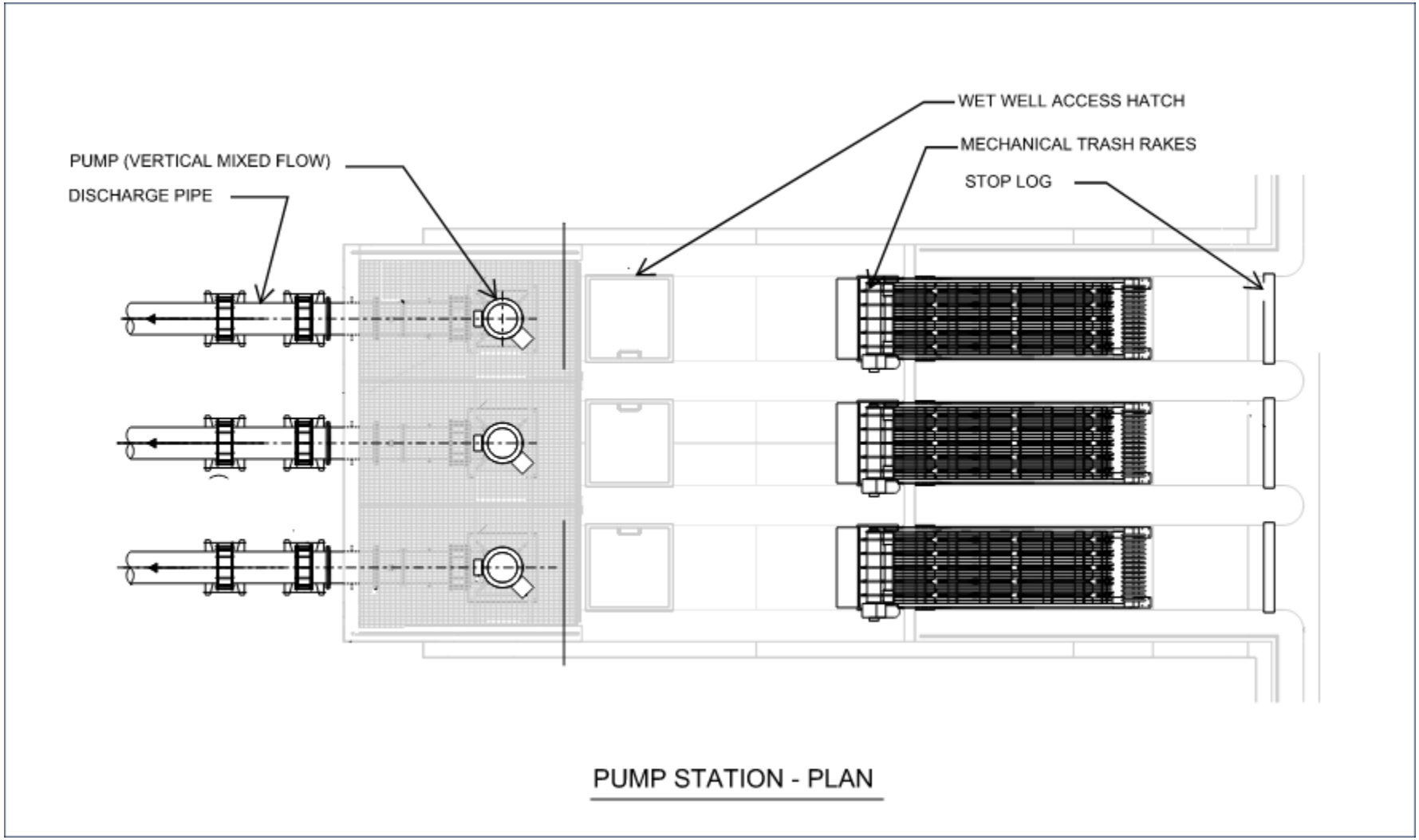
Example of Pump Station Layout - Submersible Pumps In Dry Pit Configuration -Section



NOTE: Example layout shown is for illustration purposes only, layout shall be suitable to suit design needs and site conditions.

SAN DIEGO STORM WATER PUMP STATION

Example of Pump Station Layout - Vertically Suspended Pumps – Above Ground Configuration -Plan



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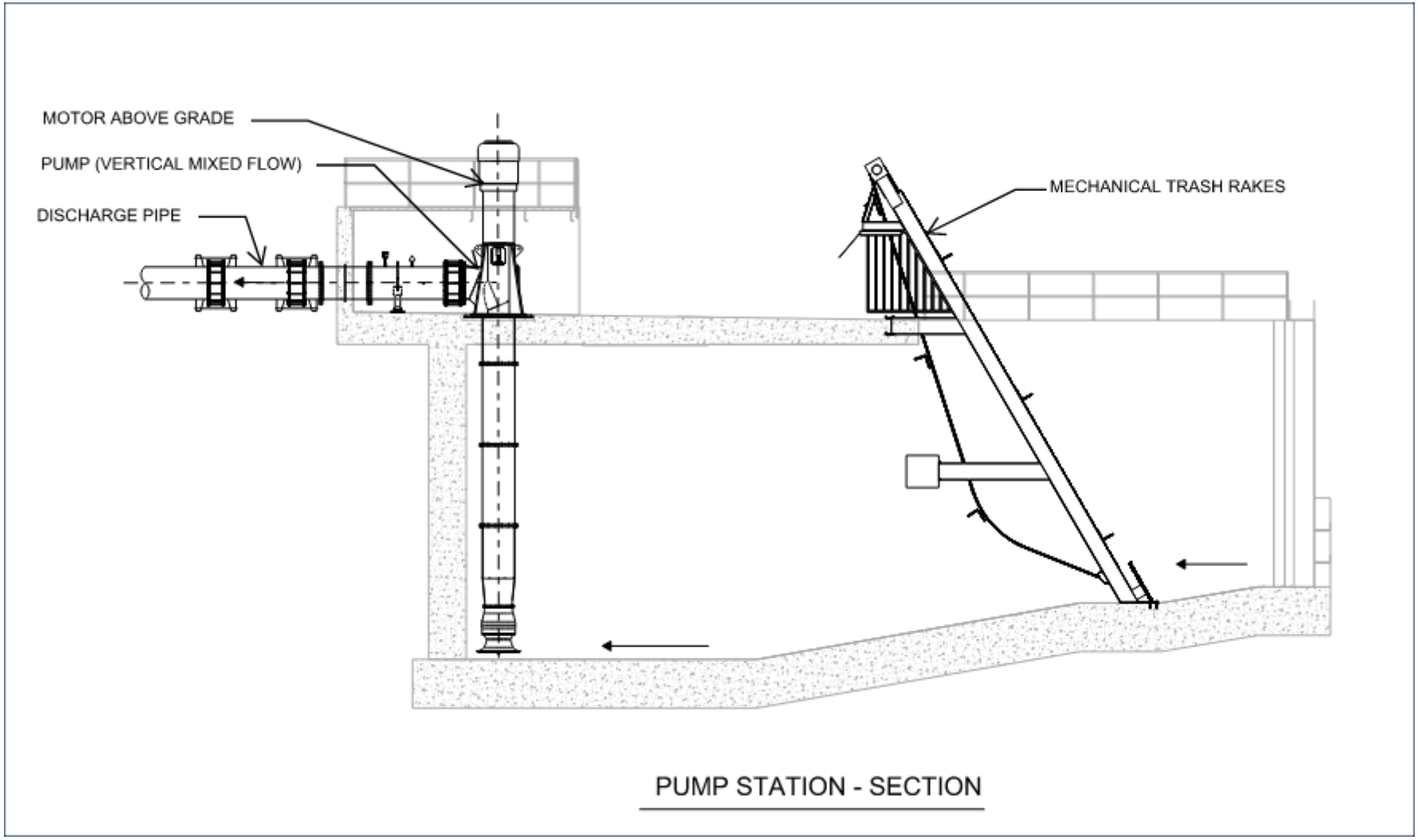
SAN DIEGO STORM WATER PUMP STATION

Example of Pump Station Layout - Vertically Suspended Pumps – Above Ground Configuration -Section



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