DRAFT

PREPARED FOR THE CITY OF MORRO BAY

WATER RECLAMATION FACILITY MASTER PLAN

B&V PROJECT NO. 189276 | NOVEMBER 2016

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BLACK & VEATCH
Building a world of difference.

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City of Morro Bay

9 NOVEMBER 2016

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CITY OF MORRO BAY
INCORPORATED JULY 17, 1964

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Water Reclamation Facility Master Plan
Project No. 189276

Facility Master Plan
November 2016

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Abbreviations and Acronyms

The following abbreviations and acronyms are used in this report:

AA	annual average
AACE	American Association of Cost Engineers
AADF	average annual daily flow
ac/hr	air changes per hour
ACoE	U.S. Army Corps of Engineers
ADC	alternative daily cover
ADMMF	average day maximum month flow
ADWF	average dry weather flow
AOB	ammonia oxidizing bacteria
AOP	advanced oxidation process
APCD	Air Pollution Control District
AS	activated sludge
ASTM	American Society for Testing and Materials
ATW	advanced treated water
ATWP	advanced treated water plant
AWP	advanced water purification
AWT	advanced water treatment
AX	anoxic
B&V	Black & Veatch Corporation
BAF	biological aerated filter
BFP	belt filter press
BMPs	best management practices
BNR	biological nutrient removal
BOD	biochemical oxygen demand
C	degrees Centigrade
$CACO_3$	calcium carbonate
Caltrans	California Department of Transportation
CAM	California Title – 22 Metals
CCC	California Coastal Commission
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDP	Coastal Development Permit
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CIP	Capital Improvement Program
CIP	clean-in-place
City	City of Morro Bay
CIWMB	California Integrated Waste Management Board
CO_2	carbon dioxide
COD	chemical oxygen demand
COLMR	Conditional Letter of Map Revision
County	County of San Luis Obispo
CPVC	chlorinated polyvinyl chloride

CSD	Cayucos Sanitary District
CT	contact time
CTR	California Toxic Rule
CWA	Clean Water Act
cy	cubic yards
DAFT	dissolved air flotation thickening
DDW	California Division of Drinking Water
DNB	denitrifying bacteria
DO	dissolved oxygen
DPR	direct potable reuse
DPR – ATW	DPR with advanced treated wastewater
DPR – FW	DPR with finished water
EAAS	extended aeration activated sludge
EBPR	enhanced biological phosphorus removal
EIR	Environmental Impact Report
EPA	United States Environmental Protection Agency
EQ	exceptional quality
ESA	Environmental Site Assessment
F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FF	fixed film
FMP	Facility Master Plan
FOG	fats, oil, and grease
fps	feet per second
FRP	fiber reinforced plastic
FSEs	food service establishments
ft	feet
ft_2	square feet
ft/sec	feet per second
gal	gallons
gal/ft3	gallons per cubic foot
gfd	gallons per square foot per day
GHG	greenhouse gas
GIS	Geographical Information System
gpcd	gallons per capita per day
gph	gallons per hour
gpm	gallons per minute
gpm/ft_2	gallons per minute per square foot
GTW	grease trap waste
GWR	Groundwater Rule
H_2O_2	hydrogen peroxide
HCH	hexachlorcyclohexane
HDD	horizontal directional drilling
HDPE	high density polyethylene
HSW	high-strength waste
hp	horsepower

HRT	hydraulic retention time
I&I	inflow and infiltration
IFAS	integrated fixed film activated sludge
IPR	indirect potable reuse
ISC	Influent Scrubber Complex
IVCs	in-vessel composting systems
IWMA	Integrated Waste Management Authority
kW	kilowatt
kW-hr	kilowatt hour
lb/d	pounds per day
lb/gal	pounds per gallon
lbs	pounds
LF	linear feet
LOMR	Letter of Map Revision
MBBR	moving bed bioreactor
MBCSD	Morro Bay – Cayucos Sanitary District
MBR	membrane bioreactor
MCC	motor control center
MCL	maximum contaminant level
MDF	maximum day factor
MF	microfiltration
MF/RO	microfiltration/reverse osmosis
MF/UF	microfiltration/ultrafiltration
mgd	million gallons per day
MG/KG	milligrams per kilogram
mg/L	milligrams per liter
mg N/L	milligrams of nitrogen per
min/D	minimum day
ml/L	milliliters per liter
MLE	modified Lutzak-Ettinger
MLSS	mixed liquor suspended solids
MM	maximum month flow
mm	millimeters
MPN	most probable number
N/A	not available, not applicable
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
NTU	nephelometric turbidity unit
O&M	operations and maintenance
PC	primary clarifier
PC	processing cavity
PD	peak day
PDF	peak day flow
PF	peaking factor
PFDs	process flow diagrams
PFRP	Process to Further Reduce Pathogens

PHF	peak hour flow
PLC	programmable logic controller
PSDWF	peak seasonal dry weather flow
PSRP	Process to Significantly Reduce Pathogens
PU	process unit
RBCs	rotating biological contactors
RO	reverse osmosis
RV	recreational vehicle
RWQCB	Regional Water Quality Control Board
SAR	sodium adsorption rate
SBR	sequencing batch reactor
SCADA	Supervisory Control and Data Acquisition System
scf/lb	standard cubic feet per pound
scfd	standard cubic feet per day
scfm	standard cubic feet per minute
SCSMPU	Sewer Collection System Master Plan Update
SLO	San Luis Obispo
SLOCOG	San Luis Obispo Council of Governments
SRT	solids retention time
SSC	Solids Scrubber Complex
SSMP	sanitary sewer master plan
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TDH	total dynamic head
TDS	total dissolved solids
TF	trickling filter
THMs	trihalomethanes
Title 22	Title 22 of the California Code of Regulations
TKN	Total Kjehdahl Nitrogen
TM	technical memorandum
TMs	technical memoranda
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TS	total solids
TSS	total suspended solids
TUc	toxicity units chronic
UF	ultrafiltration
ug/L	micrograms per liter
UL	Underwriters Laboratory
um	micrograms per liter
UPS	uninterruptible power supply
USCB	United States Census Bureau
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UV	ultraviolet light
UV/AOP	UV-mediated advanced oxidation

VFDs	variable frequency drive
VOCs	volatile organic compounds
VS	volatile solids
VSR/VSr	volatile solids reduction
WAS	waste activated sludge
WDR	waste discharge requirements
WEF	Water Environment Foundation
WRF	Proposed City of Morro Bay Water Reclamation Facility
WRFCAC	Water Reclamation Facility Citizens Advisory Committee
WRR	Whale Rock Reservoir
WTP	water treatment plant
WWTP	wastewater treatment plant

1.0 Introduction

1.0 Introduction

1.1 OVERVIEW

The City of Morro Bay (City) is in the planning stages of a major capital improvement project to replace the 60-year-old Morro Bay-Cayucos Wastewater Treatment Plant (WWTP). This need to replace the WWTP has provided the City an opportunity to build a new Water Reclamation Facility (WRF) that will turn the City's wastewater into a new, sustainable water source.

There are many potential opportunities to beneficially use the reclaimed water that the WRF will provide, all of which are being considered by the City. These opportunities range from general irrigation uses for parks or golf courses and irrigation of agriculture such as avocado orchards, all of which offset the use of drinking water supplies; to uses that directly augment the City's drinking water supply through Indirect Potable Reuse, and possibly in the future Direct Potable Reuse. In so doing, the City will be improving its water supply reliability through expanding its water supply portfolio, and thereby become less reliant on expensive imported water.

1.2 CITY COUNCIL GOALS

This WRF Facility Master Plan (FMP) provides detailed planning of the new WRF, setting the stage for its design and construction. It provides a roadmap for a new, cost-effective facility, with a specific focus on developing a plan that meets the forward looking goals set forth by the Morro Bay City Council for the project. These include:

Table 1-1 City Council Goals and FMP Results

CITY COUNCIL GOAL	RESULT PRESENTED IN FMP
Produce tertiary disinfected wastewater	FMP develops two treatment process train alternatives, both of which are capable of providing tertiary disinfected wastewater.
Design for cost effective reuse	FMP develops process train alternatives which are flexible to deliver a wide range of product water quality to serve the potential end uses that are being studied in the Master Water Reclamation Plan.
Implement the facility to be operational within 5 years	FMP defines a WRF that can be constructed and made operational within five years.
Design to treat for contaminants of emerging concern	Selection of unit processes and process train alternatives addressed desired capability to treat for contaminants of emerging concern.

CITY COUNCIL GOAL	RESULT PRESENTED IN FMP
Ensure compatibility with neighboring land uses	Final site selection, preliminary site layout, WRF features such as odor control, and preliminary architectural style all seek to provide compatibility with neighboring land uses.
Consider other municipal uses	FMP provides space planning for relocation of Public Works functions and offices to the WRF site.
Consider design for energy recovery	FMP provides capital and life cycle cost analyses to assess opportunities to provide energy recovery. It was determined that energy recovery will not be cost effective at this facility.
Consider onsite composting	FMP analyzes costs for handling and disposing residual solids from the treatment process, including onsite composting. It was determined that onsite composting is not cost effective.

All of the City Council's goals are addressed in this FMP and included in the project plan where feasible.

1.3 ADDITIONAL BACKGROUND

The existing Morro Bay – Cayucos WWTP serves the City and the Cayucos Sanitary District (CSD).

The Environmental Protection Agency and the California State Water Resources Control Board regulate municipal wastewater discharges into the Pacific Ocean under regulations defined within the National Pollutant Discharge Elimination System (NPDES). Permit requirements are developed in accordance with Section 402 of the Federal Clean Water Act (CWA). The existing WWTP operates under a 301(h) modified NPDES permit, which waives full secondary treatment requirements for biochemical oxygen demand and total suspended solids. Based on an agreement with the RWQCB, the City and Cayucos Sanitary District had previously pursued bringing the existing facility to full secondary treatment in place of continued requests for a 301(h) modified discharge permit. The agreement allowed the City and District to pursue secondary treatment on a schedule that was mutually agreed upon by both agencies and the RWQCB.

As part of permitting for an upgraded wastewater treatment facility at its existing location, a Coastal Development Permit (CDP) is required from the California Coastal Commission (CCC). At a meeting on January 10, 2013, the CCC voted to deny the CDP for construction of the upgraded plant. The basis for denial included the CCC's assessment that the new facilities would be inconsistent with the Local Coastal Plan's zoning provisions, failed to avoid coastal hazards, failed to include a sizable reclaimed water component, and that the project location was within an LCP-designated sensitive view area.

Denial of the CDP caused the City to pursue alternative locations for siting of a new upgraded wastewater treatment plant. The City also realized that it has an opportunity to take advantage of this situation to design and construct a WRF to enhance the City's water supply portfolio.

The Cayucos Sanitary District is pursuing its future options through its own studies, and at this point the efforts of the two agencies are independent of one another.

1.4 PURPOSE AND SCOPE OF THE FMP

The City has retained Black & Veatch Corporation (B&V) to prepare the FMP. The overall goals of the FMP include:

- Assessing treatment technologies that are feasible and applicable to the project needs.
- Assessing conveyance alternatives to deliver the City's wastewater to the new WRF site for treatment.
- Provide specific preliminary design criteria for the various project facilities, setting the stage for preliminary and detailed design and construction.
- Establish planning criteria for both current and future system needs such as indirect potable reuse (IPR) and direct potable reuse (DPR).
- Develop preliminary site layout for the proposed facilities.
- Develop architectural styles for the new WRF.
- Determine budgetary cost opinions for the WRF and conveyance facilities to support the City's budgeting and funding process.

The Scope of Work for the FMP was organized into seven task groups as follows:

- Task Group 100: Project Management and Meetings
- Task Group 200: Preliminary Investigations and Site Survey
- Task Group 300: WRF Support Facilities
- Task Group 400: Waste Characteristics, Flow, and Load Projections
- Task Group 500: Development and Evaluation of Treatment Alternatives
- Task Group 600: Water Reclamation Facility Master Plan
- Task Group 700: Evaluated Potential Facility Needs to Implement Direct Potable Reuse in the Future, and Evaluated Feasibility of Implementing Additional Organic Waste Treatment at the WRF

The Group 100 tasks include a proactive outreach program with public meetings throughout the project. Meetings were held with the Water Reclamation Facility Citizens Advisory Committee (WRFCAC), other community advisory bodies, the Morro Bay City Council and other stakeholders. In addition, public forums provided opportunities for input from the general public, contractors, or equipment suppliers that could be considered in the FMP or other parts of the program.

The Group 200 – 500 tasks include technical investigations and evaluations to define the ultimate WRF FMP (Task Group 600). Table 1-1 outlines the subtasks comprised by Group 200 – 500 tasks and lists the FMP chapter(s) where these topics are discussed. Table 1-1 also identifies associated deliverables, including technical memoranda (TMs), workshops, and other items. TMs prepared during development of the FMP can be found on the City's website.

Table 1-2 Scope of Work for Task Group 200 – 500 Tasks

SUBTASK	DESCRIPTION	FMP LOCATION
201: Preliminary Investigations	Obtain and review existing data pertinent to the evaluation and design of the new WRF and the decommissioning of the WWTP.	• TM 1: Summary of Existing Documents Reviewed • Chapter 1: Introduction • Appendix A
301: Onsite Support Facilities	Work with the City to determine specific requirements for designated support facilities, including preparation of site plans, visual simulations, and architectural concepts.	• TM 4: Onsite Support Facilities Requirements • Workshop • Chapter 7: WRF Site Development
302: Offsite Support Facilities	Work with City to develop design criteria and concept level arrangement for new pump station. Evaluate options for offsite wastewater collection and conveyance to the new WRF.	• TM-5: Offsite Facilities • Chapter 9: Collection System Facilities
303: Morro Bay WWTP Decommissioning	Evaluate requirements for decommissioning WWTP and prepare site for a variety of potential future uses. Identify regulatory hurdles and develop conceptual costs for the work.	• TM 3: MBCSD WWTP Decommissioning • Chapter 10: Existing WWTP Decommissioning
401: Influent Waste Characterization	Analyze recent and historical wastewater data to develop a waste strength for the new WRF. Recommend a sampling program to be implemented by the City to support future project phases.	• TM-2: Influent Waste Characterization, Flow Projections, and Effluent Discharge Requirements • Chapter 3: Plant Flow and Loading Analysis
402: Flow and Loading Projections	Establish long-term growth trends for flows and loads at new WRF over 30-year planning period. Address potential impacts of water conservation.	• TM-2 • Chapter 3: Plant Flow and Loading Analysis
403: Effluent Discharge Requirements	Summarize effluent discharge quality requirements for varying types of scenarios. Evaluate current and future regulations that may dictate level of treatment required at the new WRF.	• TM-2 • Chapter 3: Plant Flow and Loading Analysis
501: Liquid Treatment Technology Alternatives	Evaluate liquid treatment process alternatives based on several alternative scenarios. Identify top-ranked process alternatives and review with public at draft and final workshops.	• TM 7: Liquid Treatment Evaluation • Chapter 4: Liquid Treatment Technologies Evaluation • Chapter 6: Overall Treatment Process Alternatives

SUBTASK	DESCRIPTION	FMP LOCATION
502: Future Potable Reuse Analysis	Development requirements for future potable reuse facilities.	• TM 8: Future Potable Reuse Evaluation • Chapter 9: Analysis of Potential Potable Reuse Options
503: Biosolids Treatment and Disposal Alternatives	Evaluate options for treatment and disposal of biosolids including an analysis of composting and onsite generation and recovery.	• TM 6: Biosolids Treatment Evaluation • Chapter 6: Solids Management/Treatment Alternatives Evaluation
504: Workshops	Conduct workshops with City technical staff to develop visual simulations of the proposed WRF and other potential City facilities at the site.	• Visual Simulations of Facilities
505: Cost Estimating	Prepare engineer's preliminary opinion of probable cost and projected operational costs for the two top ranked process train alternatives. Evaluate cost for potential project alternative that includes Cayucos Sanitary District.	• Chapter 11: Preliminary Opinion of Probable Costs

Task 600 brings together the results of all the prior tasks and resulting technical memoranda in the form of this FMP. This task included development of a preliminary site plan, as well as a series of 3-D visualizations to show how the WRF might appear after construction.

1.5 PROJECT LOCATION

Figure 1-1 shows the general location of the project facilities. The Council preferred WRF site is located north of the northern terminus off South Bay Boulevard. Property acquisition will occur once the final EIR is certified and, if challenged, once there is a final resolution.

The proposed lift station site is located nearby to the existing WWTP since all of the City's wastewater is currently conveyed to that location. The site of the new lift station is the City's Corporation Yard on Atascadero Road. This site was selected because it is at the lowest elevation of the City's existing sewer collection system. To do otherwise would result in the need for additional and ultimately more expensive infrastructure to convey the City's wastewater to the new WRF. The selected location provides the most efficient design. California Coastal Commission staff have indicated that such a location is potentially supportable.

The proposed pipeline corridor generally follows Highway 1 and Quintana Road.

Figure 1-1 Overall Location of Project Facilities

1.6 MASTER PLAN ORGANIZATION

This document consists of twelve chapters that provide background information; regulatory and permitting requirements; evaluations of liquid treatment and solids management/ treatment technologies; the results of alternatives screening developed with City technical staff to establish the preferred process and siting alternatives; analyses for future potable reuse, both IPR and DPR; and WRF site development and preliminary architectural treatment. Preliminary master planning is also provided for collection system facilities and decommissioning of the existing WWTP. A preliminary opinion of probable cost is also presented.

To guide preparation of the FMP, several technical memoranda (TMs) were prepared. These documents are summarized in Table 1-3. Copies of the TMs are included and can be found on the City's website.

Table 1-3 List of Technical Memoranda

TECHNICAL MEMORANDUM	OBJECTIVE
TM-1: Summary of Existing Documents Reviewed	Summarize salient information from existing data and documentation provided by the City, some of which provided the basis for planning criteria and assumptions applied during FMP development.
TM-2: Influent Waste Characterization, Flow Projections, and Effluent Discharge Requirements	Provide flow and load projections to support preliminary facility planning for the WRF. Review historical population and population projections; evaluate historical influent flows; evaluate influent loads; develop influent flow and load projections; assess effluent quality requirements; and provide influent sampling program recommendations.
TM-3: Morro Bay-Cayucos WWTP Decommissioning	Evaluate the requirements and costs associated with decommissioning the existing WWTP.
TM-4: Onsite Support Facilities	Describe onsite support facilities required, or that could be accommodated, in addition to the WRF process facilities, including operations, office, and maintenance buildings; corporation yard and storage; site solar farm; water resources education center; electrical feed and stand-by power; hazardous materials containment and handling; possible co-location of the City's water treatment plant; and other facilities.
TM-5: Offsite Facilities	Review the existing collection system and evaluate offsite facility options for the collection and conveyance of wastewater flows to the new WRF site; identify and evaluate lift station site alternatives; and evaluate preferred sites.
TM-6: Biosolids Treatment Evaluation	Evaluate biosolids regulations; assess biosolids treatment technologies; review biosolids disposal and reuse options; review energy recovery options; and develop recommended treatment alternatives.

TECHNICAL MEMORANDUM	OBJECTIVE
TM-7: Liquid Treatment Evaluation	Evaluate options for liquid treatment processes that can be employed at the WRF to provide water of sufficient quality to serve a range of potential end uses and to meet regulatory requirements.
TM-8: Future Potable Reuse Evaluation	Evaluate issues surrounding development of a regulatory framework and appropriateness of advanced treatment technologies for a future direct potable reuse (DPR) project and develop and evaluate four conceptual level DPR alternatives.
TM-9: Organic Waste Feasibility Study	Evaluate potential benefits of accepting hauled waste streams at the WRF including fats-oil-grease (FOG), septic waste, recreational vehicle (RV) waste, and green waste (yard waste).

1.7 MASTER PLAN DEVELOPMENT PROCESS

The development process for the FMP included a wide range of meetings and workshops with City technical staff. It also included a robust public information campaign conducted through many public workshops to discuss the progress of the master planning efforts. Early and continuing stakeholder engagement was provided by the City's Program Management team to ensure current and accurate information consistent was disseminated to the City Council, the City's Water Reclamation Facility Citizen's Advisory Committee (WRFCAC), and the community.

1.8 REFERENCES

Several studies have been conducted for the City to support the development of the entire water reclamation program. Much of that work is applicable to the proposed WRF project and was used during the development of the FMP. Appendix A, Summary of Existing Documents Reviewed, presents salient information from the existing data and documentation provided by the City, some of which served as the basis for planning criteria and assumptions applied in the FMP.

2.0 Regulatory Requirements

2.0 Regulatory Requirements

2.1 OVERVIEW

Several permitting and regulatory requirements affect the development and operation of the new WRF. Here, the focus is on those regulations and permits relevant to effluent use and quality and biosolids disposal. These are summarized in Table 2-1 and described in more detail in the sections that follow.

Table 2-1 Overview of Relevant Permit and Other Regulatory Requirements which Impact Effluent and Biosolids Quality and Use

PROJECT ELEMENT	DESCRIPTION	OBJECTIVE OF PERMIT OR REGULATION
Applicable Permits		
NPDES	Issued by California Regional Water Quality Board, Central Coast Region.	• Water quality standard for ocean discharge. • Sets forth requirements for selected pollutants.
Applicable Regulations		
Effluent Quality	The regulations which govern the target water quality standards for the end-use opportunities currently envisioned for the new WRF are summarized in Section 2.2.1.	• Provides requirements for ocean discharge, percolation ponds, agricultural reuse, and unrestricted reuse.
Non-Potable Reuse	Reuse of recycled water in California is regulated by Title 22 of the California Code of Regulations (Title 22).	• Regulations are relevant to reuse applications. • Four treatment levels are defined in the Title 22 regulations depending on the end-use option(s).
Potable Reuse	Potable reuse can be divided into two categories: Indirect Potable Reuse (IPR) and Direct Potable Reuse (DPR).	• IPR through groundwater replenishment is regulated by the State Water Resources Control Board within the Title-22 regulation, Division 4, Article 5.2. • Regulations have not been specifically developed for DPR projects at either the State or Federal level and DPR is not legal in California at this time.
Biosolids Treatment and Disposal	Key regulations are described in the EPA Sewage Sludge Regulations, Federal Register, 40 CFR Part 503 in addition to State and Local Regulations.	• Mitigate potential public health and environmental impacts associated with land application or surface disposal of biosolids.

2.2 EFFLUENT QUALITY REQUIREMENTS

2.2.1 Background

The regulations which govern the target water quality standards for the end-use opportunities currently envisioned for the new WRF are listed in Table 2-2. In addition to key water quality requirements, the anticipated timing of the implementation of these end-uses is listed. The timing of each option is germane to technology recommendations, and phasing. The City's Program Management team is currently developing a Master Water Reclamation Plan which will provide details related to the specific end-use/reuse opportunities available to the City.

Table 2-2 Water Quality Standards for Target End-Use Opportunities

CONSTITUENTS	OCEAN DISCHARGE	GROUNDWATER RECHARGE	AG. REUSE (AVOCADO)	UNRESTRICTED REUSE
Anticipated timing	Immediate	≤5 years		
Governing Permits	NPDES	Waste Discharge Requirements (State Water Resource Control Board)		
Governing regulation(s)	Ocean Plan Basin Plan[1] Thermal Plan	Basin Plan[1] Title 22		

Notes:

1. Basin Plan Objectives have been developed by the State Water Resource Control Board for the Chorro Creek Basin, but not currently developed for the Morro Basin

In addition to the governing regulations noted in Table 2-2, several future regulatory actions may affect permit requirements for some of the discharge/reuse options. A summary of new policies being considered and the potential regulatory impacts are presented in Table 2-3. Although specific effluent requirements cannot be assigned to these future regulatory impacts, the potential for more stringent regulations needs to be considered. Process flexibility to adapt to tighter regulations will be a consideration for technology selection in this FMP.

Table 2-3 Potential Future Regulatory Impacts

REGULATORY POLICY	IMPACT
Toxicity and Control Policy	New toxicity water quality objectives
Bacteria Policy	Enterococci limits for marine and fresh water discharges and E. coli limits for fresh water discharges
Revised USEPA Human Health Criteria	Updated criteria for 94 chemical pollutants

2.3 NPDES PERMIT

The existing WWTP currently operates under NPDES Permit No. CA0047881 issued by the California Regional Water Quality Control Board (RWQCB), Central Coast Region, under Order No. R3-2008-0065. The water quality standard for ocean discharge is currently regulated by the Permit and Order Number listed above. The Order Number expired on February 28, 2014. The City applied for renewal of the NPDES permit in August 2013 and as of this FMP, the RWQCB is expected to issue a new NPDES permit in 2017. Discharge requirements from the existing NPDES permit (effective March 1, 2009) are noted in Table 2-2. It is anticipated that the requirements for ocean discharge will be more stringent in the future.

Table 2-4 NPDES Permit CA004781 Effluent Discharge Requirements for Selected Pollutants

PARAMETER	UNITS*	EFFLUENT LIMITATIONS					
		AVERAGE MONTHLY	AVERAGE WEEKLY	MAXIMUM DAILY	INSTANT. MINIMUM	INSTANT. MAXIMUM	6-MONTH MEDIAN
5-day Biochemical Oxygen Demand (BOD_5)	mg/L	120				180	
	lb/d	2,062				3,092	
	% removal	30%					
Suspended Solids	mg/L	70				105	
	lb/d	1,203				1,804	
	% removal	75%					
Grease and Oil	mg/L	25	40			75	
	lb/d	430	687			1,288	
Settleable Solids	ml/L	1.0	1.5			3.0	
Turbidity	NTU	75	100			225	
pH	S.U	6.0 – 9.0					
Ammonia	mg-N/L			322		804	80.4
Total Residual Chlorine	ug/L lb/d			1.07		8.04	0.27
Chronic Toxicity	TUc						

*mg/L – milligrams per liter; lb/d – pounds per day; ml/L - milliliters per liter;
NTU – nephelometric turbidity unit; TUc - Chronic Toxicity Unit

In addition to the limits noted above, NPDES permit CA004781 includes limits for metals, cyanide, phenolic compounds, endosulfan, endrin, hexachlorocyclohexane (HCH) and radioactivity for the protection of marine aquatic life. Carcinogens and non-carcinogens, regulated for the protection of human health are also specified in the NPDES permit.

2.4 NON-POTABLE REUSE REGULATIONS

Reuse of recycled water in California is regulated by Title 22 of the California Code of Regulations (Title 22). For the proposed WRF, these regulations are relevant to unrestricted reuse applications including avocado orchard/agricultural irrigation and groundwater recharge for IPR. Four treatment levels are defined in the Title 22 regulations depending on the non-potable end-use option(s). These four recycled water types are (in order of increasingly stringent water quality requirements): undisinfected secondary, disinfected secondary-23, disinfected secondary-2.2, and disinfected tertiary. Specific water quality requirements for these four levels are provided in Table 2-5. And, a more detailed discussion on Title 22 requirements is provided in Appendix B.

Table 2-5 Title 22 Recycled Water Types and Allowable Irrigation Uses (Adapted from California Code of Regulations [CCR])[7]

EXAMPLES OF END USE OPTIONS	RECYCLED WATER TYPE	REQUIRED TREATMENT	MEDIAN TOTAL COLIFORM (MPN/ 100 ML)[1]	MAXIMUM TOTAL COLIFORM (MPN/ 100 ML)[2]
Irrigation for: • Food crops where recycled water contacts edible portion; • Parks and playgrounds; • Schoolyards; • Unrestricted access golf courses; **Supply for Impoundments:** • **Non-restricted** recreational impoundments, with supplemental monitoring for pathogenic organisms	Disinfected Tertiary	Oxidized[8], Coagulated[3], Filtered[5], Disinfected[6]	2.2	23[4]
Irrigation for: • Food crops – surface irrigated (e.g., drip) - where above-ground edible portion DOES NOT contact recycled water; **Supply for Impoundments:** • **Restricted** recreational impoundments and publicly accessible fish hatcheries • Landscape impoundments without decorative	Disinfected Secondary-2.2	Oxidized[8], Disinfected[6]	2.2	23
Irrigation for: • Cemeteries; • Freeway landscaping; • Restricted access golf courses; • Ornamental nursery stock and sod farms; • Pasture for milk animals (for human consumption); • Non-edible vegetation (with access control to PREVENT use as a park, playground, etc.); **Supply for Impoundments:** • Landscape impoundments **without** decorative	Disinfected Secondary-23	Oxidized[8], Disinfected[6]	23	240

EXAMPLES OF END USE OPTIONS	RECYCLED WATER TYPE	REQUIRED TREATMENT	MEDIAN TOTAL COLIFORM (MPN/ 100 ML)[1]	MAXIMUM TOTAL COLIFORM (MPN/ 100 ML)[2]
Irrigation for: • Orchards with no contact between edible portion and recycled water; • Vineyards with no contact between edible portion and recycled water; • Nonfood-bearing trees, not irrigated less than 14 days before harvest • Fodder and fiber crops and pasture for animals NOT producing milk for human consumption • Ornamental nursery stock, sod farms not irrigated less than 14 days before harvest	Undisinfected Secondary	Oxidized[8]	N/A	N/A

Notes:

1. Based on bacteriological results of the last 7 days for which analyses were completed.
2. Does not exceed in more than one sample in any 30 day period
3. Coagulation is not typically required if membrane filtration is used and/or turbidity requirements are met.
4. No sample shall exceed 240 MPN/100 mL.
5. “Filtered” means an oxidized wastewater that satisfied (a) or (b) below:
   a. Has been coagulated and passed through natural undisturbed soils or filter media with a specified maximum flux rate depending on the type of filtration system and does not exceed:
      i. An average of 2 NTU within a 24-hour period,
      ii. 5 NTU more than 5 percent of the time within a 24-hour period, and
      iii. 10 NTU at any time.
   b. Has been passed through a microfiltration, ultrafiltration, nanofiltration, or reverse osmosis membrane so that the turbidity does not exceed:
      i. 0.2 NTU more than 5 percent of the time within a 24-hour period, and
      ii. 0.5 NTU at any time.
6. “Disinfected” by either:
   a. A chlorine process with a continuous concentration contact time (CT) 450 mg-mins/L with a modal contact time ≥ 90 minutes (based on peak dry weather design flow).
   b. A process combined with filtration that inactivates and/or removes 99.999% of F- specific bacteriophage MS-2, or polio virus.
7. Reference: California Code of Regulations, Title 22, Division 4, June 2014 Edition
8. "*Oxidized wastewater*" means wastewater in which the organic matter has been stabilized, is nonputrescible, and contains dissolved oxygen.

2.5 POTABLE REUSE REGULATIONS

2.5.1 Indirect Potable Reuse

Indirect potable reuse (IPR) is the augmentation of groundwater or surface water supplies using recycled water. In IPR applications, the groundwater or surface water systems are considered environmental buffers, where the recycled water blends with naturally occurring water, which along with adequate retention time allows for natural mechanisms of contaminant attenuation and/or dilution. In addition, the travel time in the natural environment provides an opportunity to detect and respond to any water quality concerns prior to treatment at a water treatment plant. Collectively, these environmental buffers are considered as providing enhanced public health protection benefits. IPR through groundwater replenishment is regulated by the State Water Resources Control Board (SWRCB) within the Title-22 regulation, Division 4, Article 5.2.

Advanced water purification (AWP) using reverse osmosis (RO) and oxidation (i.e., *Full Advanced Treatment*) is mandatory for groundwater replenishment using recycled water. Details related to the RO system requirements are provided within Article 5.2, §60320.201. A critical component related to design and operation of the WRF and AWP to implement groundwater recharge is meeting the regulatory requirements related to pathogenic microorganisms (Table 2-6). The WRF-AWP treatment must consist of a minimum of three unit operations. A single unit operation can only be credited with a maximum of 6-log pathogen reduction and at least three unit operations much have a minimum log-reduction credit of 1.0. Additional requirements related to IPR are provided in Appendix B.

Table 2-6 Pollutant Concentration Limits

PATHOGEN	LOG REMOVAL REQUIRED
Enteric Virus	12
Giardia	10
Cryptosporidium	10

2.5.2 Direct Potable Reuse

Direct potable reuse (DPR) is the planned introduction of recycled water into the public water system or into the raw water supply upstream of a water treatment plant. Importantly, DPR involves use of recycled water to supplant existing potable water uses without the use of an environmental buffer. For DPR to become legal in California, it will be necessary to compensate for the lack of an environmental barrier. This will entail providing a robust combination of technologies to address a broad variety of pathogens and contaminants, incorporating resiliency to make rapid adjustments to correct or restore plant performance, and providing system redundancy through use of multiple unit processes to address common wastewater constituents.

Regulations have not been specifically developed for DPR projects at either the State or Federal level. California Water Code Section 13560-13569, which was enacted in February 2009, directed the SWRCB's Division of Drinking Water (DDW) to take several steps to investigate and report to the legislature on the feasibility of developing uniform water recycling criteria for direct and indirect potable reuse. To guide this effort, the law required DDW to convene and administer an **Expert Panel** to provide an independent review, identify knowledge gaps, and make recommendations based on the current state-of-the-science. The Expert Panel was tasked with:

- advising DDW on public health issues and scientific and technical matters regarding the feasibility of developing of uniform water recycling criteria for DPR;
- identifying any additional research needed on DPR; and
- recommending an approach for accomplishing any additional needed research regarding uniform criteria for DPR.

In addition, the SWRCB convened an **Advisory Group** consisting of representatives from water and wastewater agencies, environmental organizations, environmental justice organizations, public health specialists, ratepayer advocate organizations, business interests, local public health officers, USEPA and SWB staff. The Advisory Group was tasked with advising the Expert Panel and making recommendations to the SWRCB related to practical considerations relevant to developing uniform water recycling criteria.

A draft report (SWRCB, 2016) was posted for public comment by the SWRCB on September 8, 2016. This report includes the expert panel and advisory group and final reports. It is anticipated that the SWRCB will submit the final report to the legislature by December 31, 2016 and subsequently work on developing uniform criteria and regulations for implementation of DPR in California.

It is unclear when DPR implementation regulations will be finalized. The SWRCB will want to be conservative in assuring that public health is protected when DPR is ultimately implemented, it is anticipated that the SWRCB will enact stringent regulations. As a result, it is anticipated that the testing and redundancy requirements for DPR will be cost prohibitive for facilities like the WRF for the foreseeable future.

2.6 REGULATIONS GOVERNING BIOSOLIDS DISPOSAL

Regulations that govern the classification and land application of biosolids include the treatment plant owner's Waste Discharge Requirements (WDR) issued by the SWRCB, the EPA's Sewage Sludge Regulations (Federal Register 40 CFR Part 503), the SWRCB Water Quality Order No. 2004-0012 - DWQ (General Order), and any biosolids ordinance from the county where the biosolids are land applied. Any offsite facility that would receive biosolids must be permitted by the RWQCB through either the General Order or a site-specific permit.

2.6.1 Federal Biosolids Regulations

EPA requires the processing of biosolids prior to land application or surface disposal such that adverse effects to public health or the environment are mitigated. Biosolids are classified into the three categories as described in Table 2-7: Class A; Class B; and sub-Class B. Class A biosolids are more highly processed sludges that meet higher pathogen and vector reduction goals. These biosolids are typically land applied or surface disposed. Class B biosolids must meet one of three pathogen reduction alternatives to demonstrate significant reduction of pathogens. Biosolids that do not meet Class B requirements (sub-class B) must be further processed prior to land application and/or surface disposal.

EPA requires the processing of biosolids prior to land application or surface disposal such that adverse effects to public health or the environment are mitigated. A brief summary of the Federal Standards that biosolids must meet in order to comply with the 40 CFR 503 Regulations is provided below.

Table 2-7 EPA Classification of Biosolids

	LOG REMOVAL REQUIRED
Class A	More highly processed sludges that meet higher pathogen and vector reduction goals. These biosolids are typically land applied or surface disposed.
Class B	Biosolids must meet one of three pathogen reduction alternatives to demonstrate significant reduction of pathogens.
Sub-class B	Biosolids that do not meet Class B requirements (sub-class B) must be further processed prior to land application and/or surface disposal.

Exceptional Quality Biosolids

The designation of "exceptional quality" (EQ) refers to biosolids that meet both the Class A requirements and the maximum pollutant levels of Part 503 relating to concentrations of various metals.

Metals Limitations

The maximum allowable concentrations of regulated metals for any biosolids to be land applied are found in 40 CFR 503.13, Table 1. Biosolids with pollutants greater than the limits defined in Table 1 cannot be applied to land. Biosolids with pollutants below the Table 1 ceiling limits, but above the Table 3 limits, can be applied to land, but are subject to annual and cumulative pollutant loading limits. Biosolids below the Table 3 limits can be applied to land without regard to the annual or cumulative loading limits. Currently, metal pollutant concentrations for biosolids produced at the City's existing WWTP are below the Table 3 limits. The Table 1 and Table 3 metals limits are listed in Table 2-8 below.

Table 2-8 Pollutant Concentration Limits

POLLUTANT	CEILING CONCENTRATION LIMITS FOR ALL BIOSOLIDS APPLIED TO LAND (MG/KG)[A]	POLLUTANT CONCENTRATION LIMITS FOR EQ AND PC BIOSOLIDS (MG/KG)[A]
Arsenic	75	41
Cadmium	85	39
Chromium	3,000	1,200
Copper	4,300	1,500
Lead	840	300

POLLUTANT	CEILING CONCENTRATION LIMITS FOR ALL BIOSOLIDS APPLIED TO LAND (MG/KG)[A]	POLLUTANT CONCENTRATION LIMITS FOR EQ AND PC BIOSOLIDS (MG/KG)[A]
Mercury	57	17
Molybdenum [B]	75	--
Nickel	420	420
Selenium	100	36
Zinc	7,500	2,800

Applies to:	All biosolids that are land applied	Bulk biosolids and bagged biosolids[C]
From Part 503	Table 1, Section 503.13	Table 3 Section 503.13

[A]Dry-weight basis

[B]As a result of the February 25, 1994, Amendment to the rule, the limits for molybdenum were deleted from the Part 503 rule pending EPA reconsideration.

[C]Bagged biosolids are sold or given away in a bag or other container.

Pathogen Reduction

The goal of Class A biosolids is to reduce pathogens to below detectable limits. In contrast, Class B biosolids may contain some pathogens. Because of this, the Part 503 Rule contains restrictions associated with the application of Class B biosolids for the harvesting of crops and turf, for the grazing of animals, and for public contact until environmental conditions have further reduced the pathogens. The Class A and Class B pathogen reduction requirements are provided in Figure 2-1 below.

Vector Attraction Reduction

The pathogens in biosolids present a health risk when they are brought into contact with humans. Vectors, which include flies, rodents, and birds, can transmit these pathogens to humans through contact or by biologically supporting the pathogen. Reducing the attractiveness of biosolids to vectors reduces the potential of disease transmission. Regulation 40 CFR 503 specifies ten alternatives for meeting the vector attraction reduction requirements. One alternative must be met in order for biosolids to be land applied. These alternatives are provided in Table 2-9. The vector attraction reduction requirement for the existing WWTP biosolids is currently achieved by satisfying Option 1. The mass of volatile solids in the sludge is reduced by a minimum of 38 percent during the sludge treatment process using anaerobic digestion (Carollo Engineers, 2007).

Table 2-9 Class A and B Pathogen Reduction Requirements (40 CFR 503.32)

CLASS A	CLASS B
In addition to meeting the requirements in one of the six alternatives listed below, fecal coliform or *Salmonella* sp. Bacteria levels must meet specific density requirements at the time of biosolids use or disposal or when prepared for sale or give-away. ***Alternative 1: Thermally Treated Biosolids.*** Use one of four time-temperature regimens. ***Alternative 2: Biosolids Treated in a High pH-High Temperature Process.*** Specifies pH, temperature, and air drying requirements. ***Alternative 3: For Biosolids Treated in Other Processes.*** Demonstrate that the process can reduce enteric viruses and viable helminth ova. Maintain operative conditions used in the demonstration. ***Alternative 4: Biosolids Treated in Unknown Processes*** Demonstration of the process is unnecessary. Instead, test for pathogens – Salmonella sp. or fecal coliform bacteria, enteric viruses, and viable helminth ova – at the time the biosolids are used or disposed of or are prepared for sale or give away. ***Alternative 5: Use of PFRP.*** Biosolids are treated in one of the processes to Further Reduce Pathogens (PFRP) (see Table 5-4). ***Alternative 6: Use of a Process Equivalent to PFRP.*** Biosolids are treated in a process equivalent to one of the PFRPs, as determined by the permitting authority.	The requirements in one of the three alternative below must be met. ***Alternative 1: Monitoring of Indicator Organisms.*** *Test for fecal coliform density as an indicator for all pathogens at the time of biosolids use or disposal.* ***Alternative 2: Use of PSRP.*** Biosolids are treated in one of the Processes to Significantly Reduce Pathogens (PSRP). ***Alternative 3: Use of Processes Equivalent to PSRP.*** Biosolids are treated in a process equivalent to one of the PSRPs, as determined by the permitting agency.

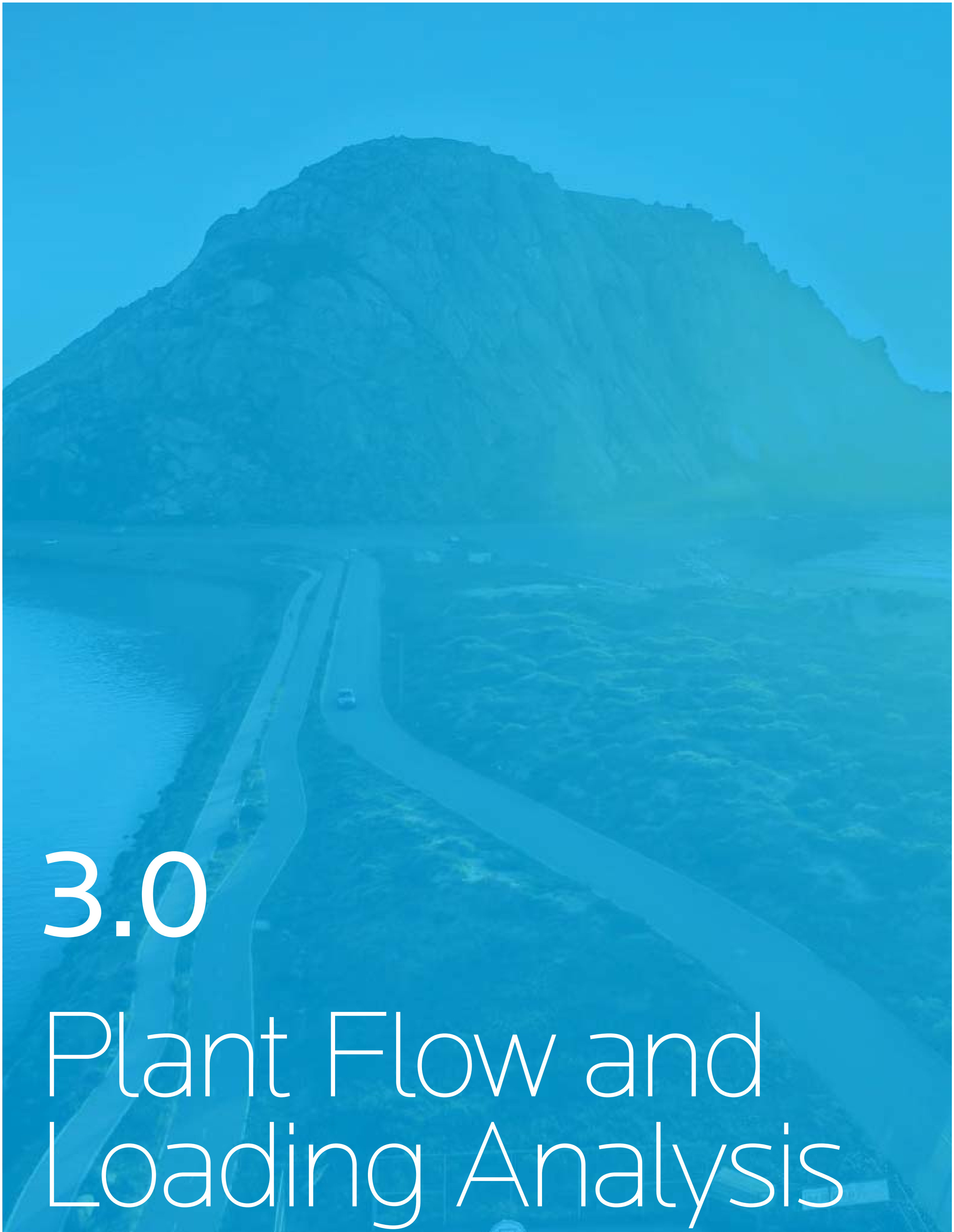
Table 2-10 Summary of Vector Attraction Reduction Options

Requirements in one of the following options must be met:
Option 1: Reduce the mass of the volatile solids by a minimum of 38 percent
Option 2: Demonstrate vector attraction reduction with additional anaerobic digestion in a bench-scale unit
Option 3: Demonstrate vector attraction reduction with additional aerobic digestion in a bench-scale unit
Option 4: Meet a specific oxygen uptake rate for aerobically treated biosolids
Option 5: Use aerobic processes at greater than 40°C (average temperatures 45°C) for 14 days or longer (e.g., during biosolids compositing)
Option 6: Add alkaline materials to raise the pH under specified conditions
Option 7: Reduce moisture content of biosolids that do not contain unstabilized solids from other than primary treatment to at least 75 percent solids.
Option 8: Reduce moisture content of biosolids with unstabilized solids to at least 90 percent
Option 9: Inject biosolids beneath the soil surface within a specified time, depending on the level of pathogen treatment
Option 10: Incorporate biosolids applied to or placed on the land surface within specified time periods after application to or placement on the land surface.

2.6.2 State and Local Biosolids Regulations

In 2004, the SWRCB adopted general WDR for the discharge of biosolids as a soil amendment. These requirements exceed the requirements of the Part 503 Rule. The WDR is contained in Water Quality Order No. 2004 - 0012 - DWQ (General Order) and is intended to streamline the regulatory process for land application sites statewide.

In addition, application of biosolids is governed by the ordinances in the county where the biosolids are land applied. Only EQ Class A biosolids can be used on agricultural land within the limits established by the San Luis Obispo County Biosolids Ordinance. This ordinance limits the annual amount of land application of treated biosolids to 1,500 cubic yards (cy) until March 2018 and is an extension of the original 48-month moratorium (Ordinance No. 3080). This extension is intended to allow time for additional studies to evaluate impacts to food crops, issues related to emerging contaminants of concern, and other concerns related to widespread use of biosolids. Composted biosolids are currently exempt from the County's application limits.



3.0 Plant Flow and Loading Analysis

3.0 Plant Flow and Loading Analysis

3.1 OVERVIEW

The primary purpose of this chapter is to establish the predicted wastewater flows for the new WRF as well as the influent water quality characteristics at the associated flow conditions. This is typically called the "flows and loads" information. This information is used to determine the size of the new WRF and its various components to be able to hydraulically manage the flows, as well as to determine how best to treat the wastewater based on the flows and influent water quality loading.

To develop the flows and loads, past studies, historical population, and flow and water quality data at the existing WWTP were used to provide baseline information in addition to further analysis to confirm the numbers. The flows developed in this Chapter do not consider flows from the Cayucos Sanitary District.

Historical wastewater data provided by the City was reviewed, along with previous studies and planning work, to confirm design characteristics are consistent with previous estimates. Long-term growth trends for Morro Bay were developed by City staff as part of its current General Plan and Local Coastal Permit update process, in collaboration with the consultants supporting that effort as well as the WRF consultant team. The planning period is 25 years. Both the General Plan and Local Coastal Plan are currently in the process of being updated. Design flows and loads were developed for the average wet weather daily flow, peak month dry weather flow, peak month wet weather flow, peak day wet weather flow, and peak hour wet weather flow.

Table 3-1 presents an overview of the discussion in this chapter.

Table 3-1 Overview of Plant Flow and Loading Analysis

PLANT FLOW AND LOADING ANALYSIS	
TOPIC	**DESCRIPTION**
Population	Historical population information for the City from two previous reports is summarized, and population projections are described as a baseline for flow and load projections.
Evaluation of Existing Plant Flows	Key information from past studies is summarized. Further analyses to confirm important design factors are described as are factors identified to provide baseline information on the existing plant flows.
Evaluation of Existing Plant Influent Loads	Key information from past studies is summarized. Further analyses of important design constituents are described to provide baseline information on the existing plant loads.
Influent Flow and Load Projections	Basis of design values for flow and load are identified and the methodology described.

3.2 POPULATION

Historical population information for the City has been summarized as part of two previous planning efforts. The 2007 Wastewater Treatment Plant Facility Master Plan Report (2007 FMP) and the 2010 Wastewater Treatment Plant Upgrade Project Facility Master Plan Draft Amendment No. 2 (2010 FMP) were reviewed to leverage information already prepared for previous flow and load projections.

3.2.1 Historical Population

In addition to the previous studies, historical population data for Morro Bay was obtained from the United States Census Bureau (USCB) and California's Department of Finance.

Table 3-2 and Figure 3-1 summarize the City's historical population. The population generally increases during summer months due to seasonal tourism. It should be noted that the population for Morro Bay has generally remained constant over the past fifteen years.

Table 3-2 Morro Bay Historical Population

MORRO BAY					
YEAR	HISTORICAL POPULATION	YEAR	HISTORICAL POPULATION	YEAR	HISTORICAL POPULATION
1995	9,749	2002	10,432	2009	10,239
1996	9,843	2003	10,389	2010	10,234
1997	9,975	2004	10,390	2011	10,291
1998	10,097	2005	10,343	2012	10,187
1999	10,168	2006	10,265	2013	10,235
2000	10,350	2007	10,207	2014	10,254
2001	10,384	2008	10,217	2015	10,284

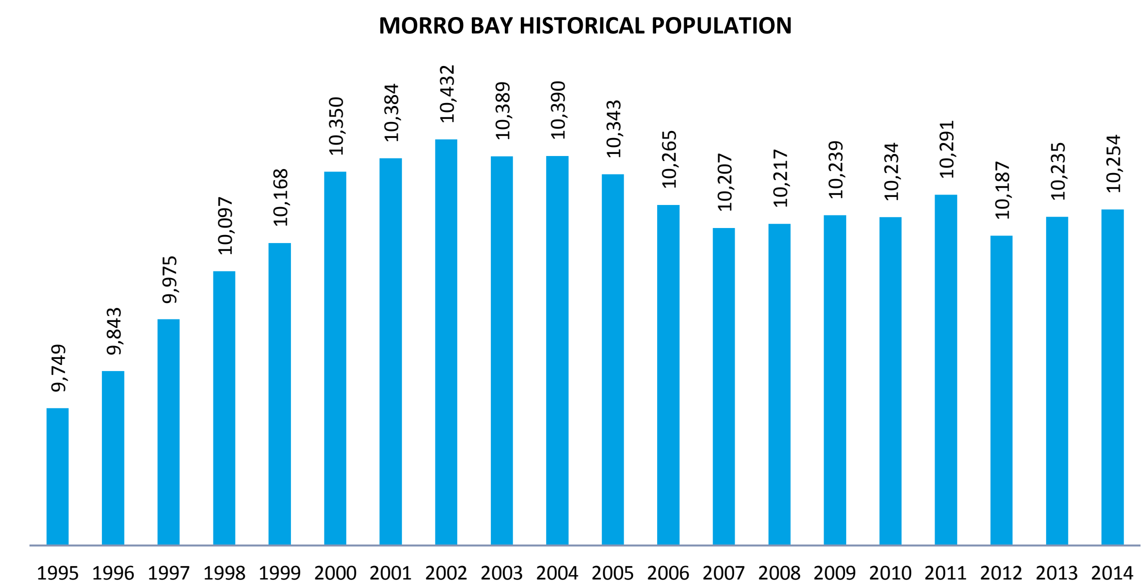


Figure 3-1 Morro Bay Historical Population

3.2.2 Population Projections

In 1984, the City passed Measure F (Ordinance 266), which established an ultimate population cap of 12,200. The City's average annual growth from 1980 to 2015 was 0.36 percent. The San Luis Obispo Council of Governments (SLOCOG) projects an annual growth rate through 2040 of 0.41 percent, which would result in a population of 11,381 in 2040.

The City is currently embarking on a process to update its General Plan, which will also evaluate future population for the City. The City's preliminary analysis provided a build-out population of 12,000 in the year 2040, higher than the SLOCOG projections. This estimate provides a conservative basis for the population projection and is consistent with Measure F. City staff confirmed that a population of 12,000 should be used as the basis for the analysis of flows and loads. This results in an annual growth rate of 0.62 percent for the years 2016 to 2040. An increase in population of 1,716 equates to approximately 828 new homes using the City's 2015 average household size of 2.07 people per household.

City staff indicated in August 2015 that the City, at that time, currently had a total of 6,378 residential units, but had a high vacancy rate of 23.2 percent. This suggests that many of these homes are not continuously occupied. They are instead likely vacation rentals or only seasonally occupied. Despite this, it is important to note that the inconsistent occupancy of these homes is accounted for in the population projections. In addition to private vacation rentals, City staff also indicated in August 2015 that Morro Bay, at that time, currently had 872 hotel rooms. Based upon conversations with City staff, the City's projected growth rate associated with tourism is expected to be greater than the population growth rate, and for this report is estimated to be approximately one percent. This would result in a total of 1,118 hotel rooms in 2040, or about 246 more rooms. Using a typical occupancy rate of 2 people per room, this would equate to 500 additional people during peak seasonal months at build-out, assuming full occupancy. It should be noted, however, that the current population per capita wastewater flow rates, and peaking factors already account for tourism at its current level. Therefore the difference in population growth rate (0.62 percent) and tourism growth rate (1 percent) results in a potential tourism population increase of under 250 people, assuming full occupancy. This is only 2 percent of the projected maximum population of 12,000, which is within the level of accuracy of the calculations. Therefore, no special provision to separately account for the projected tourism increase was provided in the calculations.

Table 3-3 presents the population projections for Morro Bay based on the 0.62 percent projected growth rate as estimated by City staff in August 2015. The City's current (2015) population is 10,284 reaching a population of 12,000 at build-out. These population projections were used to project future wastewater flows and are generally consistent with the population projections generated for Morro Bay in the previous studies.

Since the City is currently updating its Local Coastal Plan and its General Plan, all of which will be supported by development of an EIR, note that the population projections could change in the near future. The population projections included herein are accurate to the extent practical based on current data, and are conservative.

Table 3-3 Morro Bay Population Projection

YEAR	POPULATION*
2015	10,284
2020	10,606
2025	10,939
2030	11,282
2035	11,636
2040	12,000
Build-Out	12,000
*Annual growth rate 0.62%	

3.3 EVALUATION OF EXISTING PLANT FLOWS

3.3.1 Summary of Influent Flow Basis of Design from Previous FMPs

The evaluation of existing plant flows comprised historical influent flows, average annual daily flow (ADDF), average day maximum month flow (MMF), the peak seasonal flow factor, and a combination of factors. The influent flow to the existing MBCSD WWTP has previously been evaluated and summarized as part of the 2007 FMP and 2010 FMP. Historical flows from the 2007 FMP and 2010 FMP are summarized in Tables 3-4 and 3-5, respectively. Flows are presented in million gallons per day (mgd).

Differences between the flow calculations presented in the 2007 FMP and the 2010 FMP occurred due to dissimilarities in the selection of historical data and methodologies employed in the analysis. The 2007 FMP evaluated annual historical flows from 2002-2006 separately for Morro Bay and the Cayucos Sanitary District (CSD) (Table 3-5). Flow data for the WWTP was available from 1995; however, a significant decrease in flowrate was observed after 2002, reflecting a change in the flow measuring strategy. In 2001, a Palmer-Bowles flume was installed to measure the influent flow, replacing the effluent propeller flow meter. The 2007 FMP limited the analysis to flow measurements collected by the Palmer-Bowles flume. The 2010 FMP identified the years 2002-2006 as dry years; therefore, a larger data set, including flow data from 1995-2009, was analyzed (Table 3-5). A correction factor was applied to the effluent propeller flow meter readings to account for the discrepancy between the flume and propeller meter measurements.

The peak hour flow (PHF) of the 2007 FMP was reported as 5.49 mgd for both Morro Bay and CSD, based on the maximum hourly flowrate of the 2002-2006 peak rain event. The analysis disregarded abnormally high flow readings that exceeded the measurement range of the flume and were considered to result from a back-up in the headworks. The 2010 FMP selected a PHF from heavy rain events occurring prior to flume installation. Flows surpassing the range of the propeller meter were reported as the highest value within calibration, so rather than relying on flow data, hydraulic capacity and historical operation of the influent pumps, primary clarifiers, and outfall were used to approximate the PHF at 8 mgd (for both Morro Bay and CSD).

Several flow conditions were included for the analysis including the AADF, the peak seasonal dry weather flow (PSDWF), the MMF, and the PHF. The PSDWF condition is the greatest average monthly flow between the months of July and August and was chosen because it encompasses the traditional peak tourist season for the service area.

Table 3-4 Historical Flows for 2002-2006 as Provided by the 2007 FMP

	UNIT	2002	2003	2004	2005	2006	5 YR AVG TOTAL
AADF	mgd	0.90/0.26	0.79/0.27	0.81/0.28	0.94/0.32	0.85/0.33	1.15
MMF	mgd	1.20/0.37	0.88/0.33	0.89/0.35	1.11/0.42	0.95/0.42	1.38
PSDWF, Average Day	mgd	0.83/0.37	0.88/0.33	0.82/0.35	0.96/0.39	0.92/0.40	1.25
Note: The first number listed is for Morro Bay, and the second for CSD							

Table 3-5 Historical Flows for 1995-2009 as Provided by the 2010 FMP

	UNIT	1995-2009
ADF	mgd	1.25
MMF	mgd	2.66
Annual Peak 30-Day Flow	mgd	3.55
PDF	mgd	5.42
PSDWF, Average Day	mgd	1.32
PSDWF, Peak Month	mgd	1.70
PSDWF, Peak 30 Day	mgd	1.71
PSDWF, Peak Day	mgd	2.49

3.3.2 Evaluation of 2002-2014 Annual Average Daily Flow

Table 3-6 presents the AADF in mgd and the corresponding population for each year. The AADF was divided by the corresponding population to establish wastewater generation on a per capita basis. The AADF factor is in gallons per capita per day (gpcd). Figure 3-2 presents a graph of AADF for each year, values ranging from 70 to 91 gpcd, resulting in an average value of 81 gpcd. An AADF factor of 81 gpcd was used to project the future AADF for the City. This value is consistent with both the 2007 FMP and the 2010 FMP.

Table 3-6 Morro Bay Historical Annual Average Daily Flow 2002-2014

MORRO BAY ANNUAL AVERAGE DAILY FLOW			
YEAR	AADF (MGD)	POPULATION	AADF FACTOR (GPCD)
2002	0.89	10,432	85
2003	0.79	10,389	76
2004	0.81	10,390	78
2005	0.94	10,343	91
2006	0.86	10,265	84
2007	0.82	10,207	80
2008	0.82	10,217	81
2009	0.83	10,239	81
2010	0.88	10,234	86
2011	0.94	10,291	91
2012	0.85	10,187	83
2013	0.73	10,235	71
2014	0.72	10,254	70
Average	0.84		81

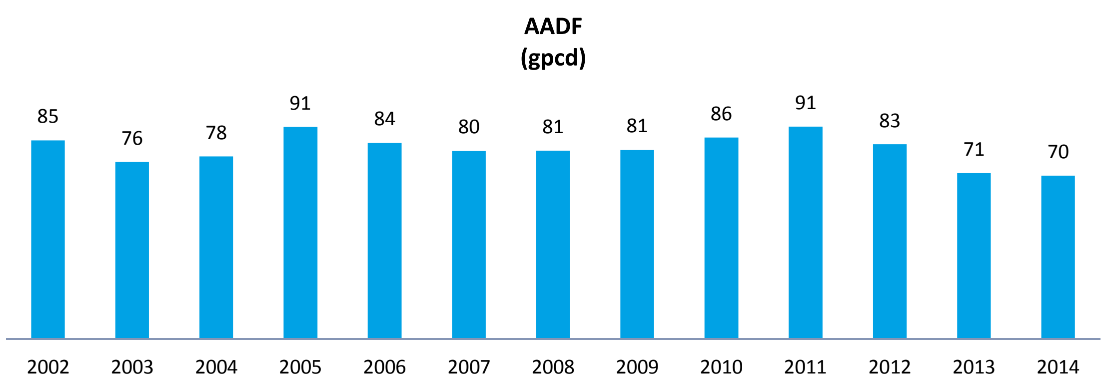


Figure 3-2 Morro Bay Historical Annual Average Daily Flow Factor 2002-2014

3.3.3 Evaluation of 1995-2014 Maximum Month Flow

Total monthly flows were compared for each year from 1995 to 2014 and are presented in Table 3-7. Average daily flows were calculated for the month with the maximum flow in a given year, providing the MMF for each year. For example, for year 2014 July had an average daily flow of 0.82 mgd. The AADF for 2014 was 0.72 mgd. Dividing 0.82 mgd by 0.72 mgd (MMF/AADF) resulted in a peaking factor of 1.15 for 2014.

Table 3-7 Morro Bay Average Max Month Daily Flow 1995-2014

MORRO BAY AVERAGE MAX MONTH DAILY FLOW					
YEAR	ADMM (MONTH)	MAX MONTH FLOW (MGD)	MMF (MGD)	AADF (MGD)	MMF (PEAKING FACTOR)
1995	Mar-95	52.83	1.70	1.18	1.44
1996	Dec-96	43.80	1.41	1.23	1.15
1997	Jan-97	54.27	1.75	1.34	1.31
1998	Feb-98	62.60	2.24	1.58	1.41
1999	Aug-99	48.80	1.57	1.40	1.13
2000	Jul-00	51.93	1.68	1.50	1.12
2001	Mar-01	43.73	1.41	1.21	1.17
2002	Jan-02	36.08	1.16	0.89	1.31
2003	Jul-03	27.41	0.88	0.79	1.12
2004	Dec-04	27.54	0.89	0.81	1.10
2005	Jan-05	34.50	1.11	0.94	1.19
2006	Mar-06	29.49	0.95	0.86	1.10
2007	Jul-07	28.38	0.92	0.82	1.11
2008	Aug-08	27.93	0.90	0.82	1.09
2009	Jul-09	29.54	0.95	0.83	1.15
2010	Jan-10	31.00	1.00	0.88	1.13
2011	Mar-11	34.12	1.10	0.94	1.18
2012	Jul-12	37.16	1.20	0.85	1.41
2013	Jul-13	24.32	0.78	0.73	1.08
2014	Jul-14	25.53	0.82	0.72	1.15
20 Year Average					1.19

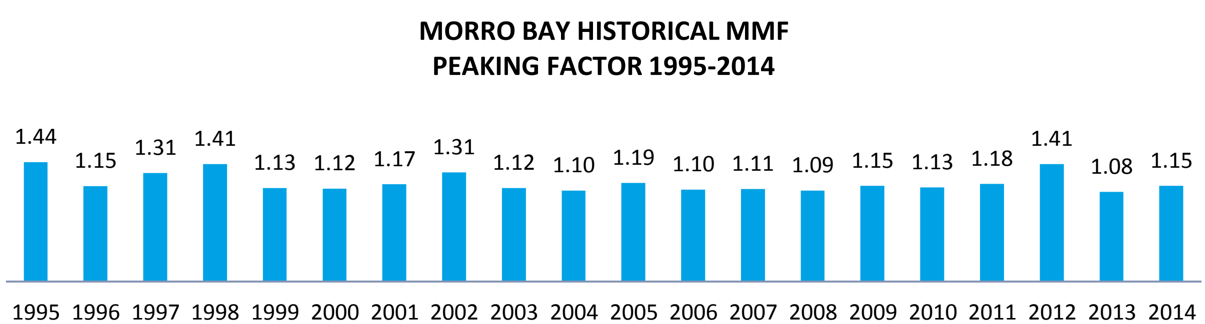


Figure 3-3 Morro Bay Historical Average Day Max Month Peaking Factor 1995-2014

MMF peaking factors were calculated for each year and are shown in Figure 3-3 with values ranging from 1.08 to 1.44. The average value of these factors was 1.19. The MMF factor of 1.19 was used to project future MMF for the City, which is consistent with previous FMP studies completed in 2007 and 2010.

3.3.4 Evaluation of Dry Season Flow

3.3.4.1 1995-2014 Peak Dry Season Flow

The Peak Season Dry Weather Flow (PSDWF) condition is the highest average monthly flow between the months of July and August, and was calculated because it encompasses the traditional peak tourist season for the City. Flow data for July and August of each year were averaged over the period of the two months (i.e., 62 days), resulting in PSDWF for each year. In 2014, the total flow for July and August was 47.36 MG, resulting in an average daily flow of 0.76 mgd. The AADF for 2014 was 0.72 mgd. Dividing 0.76 mgd by 0.72 mgd (PSDWF/AADF) resulted in a peaking factor of 1.07 for 2014 as shown in Table 3-8.

Table 3-8 Morro Bay Peak Seasonal Dry Weather Flow 1995-2014

MORRO BAY AVERAGE MAX MONTH DAILY FLOW					
YEAR	PSDWF (MONTH)	TOTAL JULY AND AUGUST FLOW (MG)	PSDWF (MGD)	AADF (MGD)	PSDWF (FACTOR)
1995	July and August	72.61	1.17	1.18	0.99
1996	July and August	78.09	1.26	1.23	1.02
1997	July and August	85.26	1.38	1.34	1.03
1998	July and August	102.89	1.66	1.58	1.05
1999	July and August	95.64	1.54	1.40	1.10
2000	July and August	102.25	1.65	1.50	1.10
2001	July and August	69.63	1.12	1.21	0.93
2002	July and August	46.88	0.76	0.89	0.85
2003	July and August	54.15	0.87	0.79	1.11
2004	July and August	50.79	0.82	0.81	1.01
2005	July and August	58.32	0.94	0.94	1.00
2006	July and August	55.29	0.89	0.86	1.04
2007	July and August	55.70	0.90	0.82	1.09
2008	July and August	55.40	0.89	0.82	1.09
2009	July and August	56.37	0.91	0.83	1.10
2010	July and August	57.86	0.93	0.88	1.06
2011	July and August	61.91	1.00	0.94	1.07
2012	July and August	63.31	1.02	0.85	1.20
2013	July and August	47.01	0.76	0.73	1.04
2014	July and August	47.36	0.76	0.72	1.07
20 Year Average					1.05

PSDWF peaking factors were calculated for each year and are shown in Figure 3-4 with values ranging from 0.85 to 1.20. The average value of these factors was 1.05. The PSDWF factor of 1.05 was used to project future PSDWF for the City.

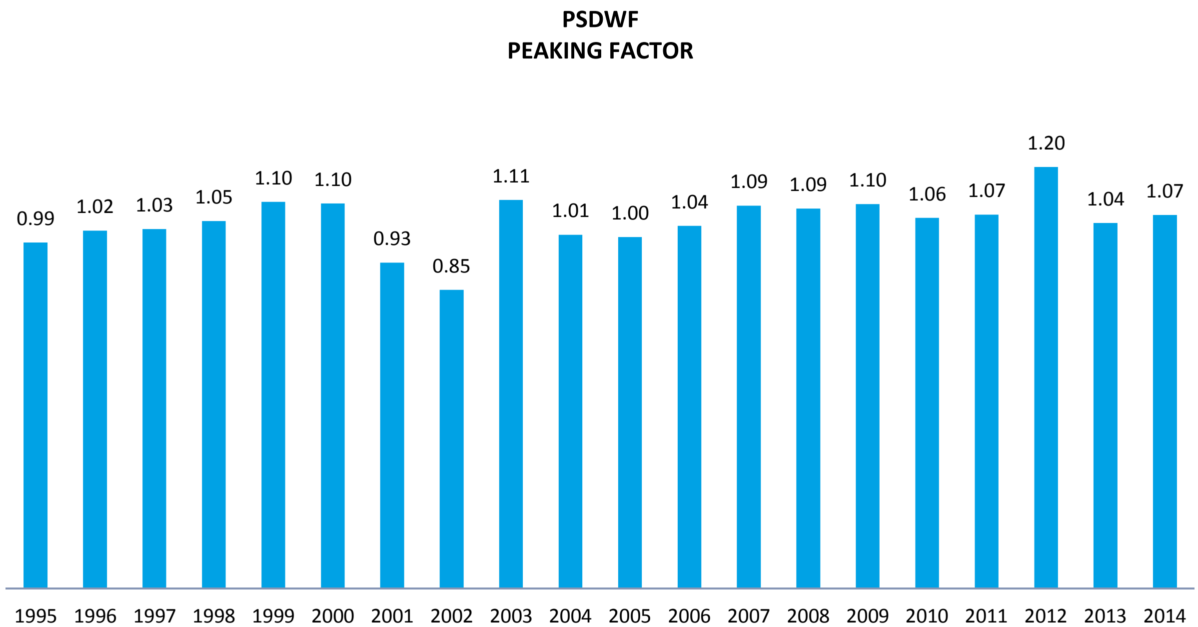


Figure 3-4 Morro Bay Peak Seasonal Dry Weather Flow 1995-2014

3.3.4.2 2010 – 2014 Dry Weather Diurnal Analysis

The influent diurnal flow (2010-2014) was analyzed and compared with the daily rainfall data to evaluate the proposed WRF dry weather diurnal patterns. Figure 3-5 presents the typical dry weather diurnal pattern for these five years. Note that for the purposes of this analysis, dry weather days were considered days with no recorded precipitation for that day and the two preceding days as well. This criterion was used in consideration of the anecdotal evidence that the Morro Bay collection system receives a significant amount of infiltration and inflow and the effects of rain events persist over several days (i.e., high autocorrelation in the daily flow data). The following basis of design criteria for dry weather conditions were established using this diurnal analysis:

- Dry weather peak hourly flow peaking factor, DWPHF-PF = 1.63. The DWPHF-PF was in the range of 1.61 and 1.67 for these five years.
- Dry weather minimum 2-hour flow peaking factor, DWM2HF-PF = 0.35. The DWPHF-PF was in the range of 0.32 and 0.34 for this five year period. As shown in Figure 3-5, the minimum two hours occurred consistently between the hours of 4 - 6 am. The DWM2HF is assumed to correspond to the overall minimum 2-hour flow.

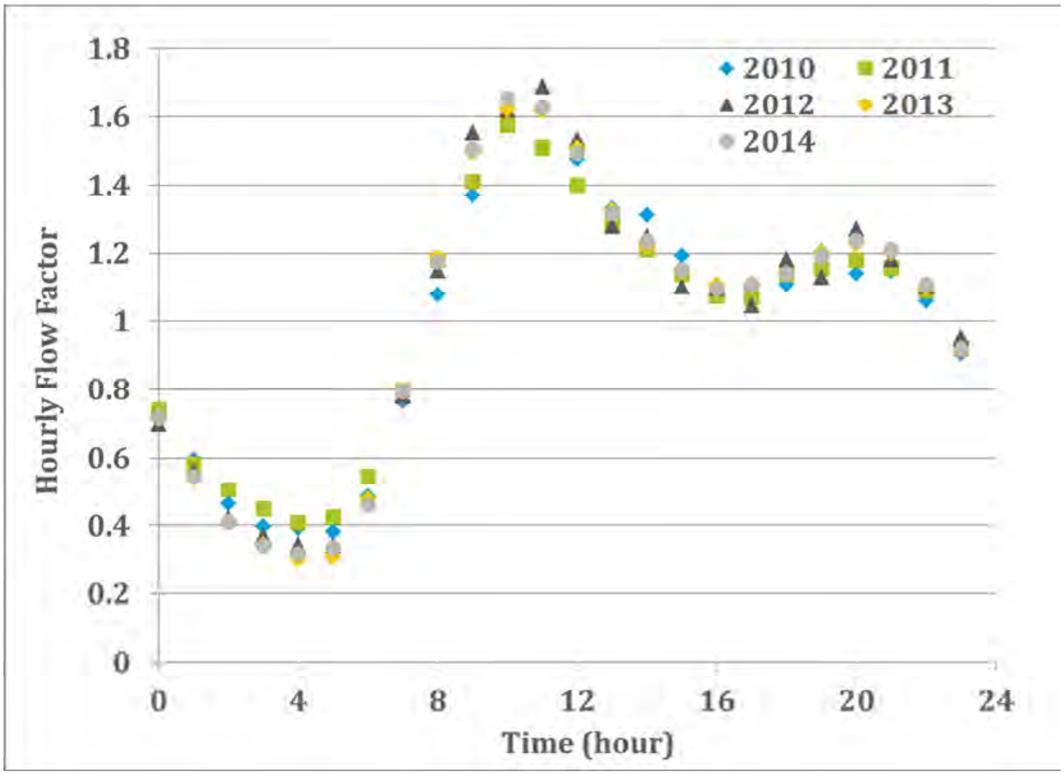


Figure 3-5 Typical Dry Weather Diurnal Flow Pattern for Existing Morro Bay WWTP (2010-2014)

3.3.5 Evaluation of 2002-2014 Peak Day Flow

The Peak Day Flow (PDF) is used to establish the maximum solids load into the plant while the PHF is used to size pipelines and other critical hydraulic appurtenances to assure all potential flow rates can be conveyed to the WRF, protecting against potential flooding or overflow during high flow events. The 2007 FMP did not present a PDF. The 2010 FMP utilized a PDF factor of 1.8.

Data from 2010-2014 was reviewed to calculate the PDF as shown in Table 3-9. From this data set, the Peak Day flow occurred on December 18, 2010, and correlates to a peaking factor of 2.75.

Table 3-9 Peak Day Peaking Factor

YEAR	DATE	PEAK DAY (MGD)	ANNUAL AVERAGE (MGD)	PEAK DAY PF
2010	18-Dec-10	3.27	1.19	2.75
2011	2-Jan-11	3.14	1.24	2.52
2012	4-Jul-12	2.00	1.10	1.82
2013	4-Jul-13	1.52	0.97	1.57
2014	11-Dec-14	1.78	0.94	1.90

The City has reported that the existing WWTP influent flume becomes surcharged during high flow events or during unusual operational situations and as a result does not provide accurate measurements during those periods. This is also reflected in the 2007 and 2010 FMPs. As a result, it is problematic to screen out anomalous data from the City's flow records to determine peak day flows and peaking factors with a high degree of numerical confidence. For purposes of this FMP, a PDF factor of 2.75 was utilized.

3.3.6 Evaluation of 2003 – 2014 Peak Hour Flow

The 2007 FMP calculated the peak hour flow to be 5.49 mgd for flow data captured on December 31, 2004, after adjusting the data for abnormally high readings likely due to a back-up in the plant bar screens or headworks wet well facility. Compared to an AADF of 1.25 mgd, the ratio of PHF to AADF was 4.39 and, therefore, the 2007 FMP used a peak hour flow factor of 4.5.

The 2010 FMP established the PHF at 8.0 mgd based on the following considerations:

- Reduction of effluent propeller meter flows by the correction factor would reduce the "unseen" flow rate that is above the upper calibration limit of 6.5 mgd (corrected), but the magnitude of the corrected peak flow above 6.5 mgd is still unknown.
- The effective maximum pumping capacity of the influent pump station during the period of record for flow evaluation has likely been on the order of 8.0 mgd.
- The effective hydraulic capacity of the primary clarifiers before surcharging is expected to be 6.6 mgd or higher.
- The manual operation of the existing influent pumps during large wet weather events to prevent the primary clarifiers from surcharging reduces the peak flow reaching the plant by attenuation in the collection system.

In order to establish the PHF peaking factors for this FMP, hourly flow data to the existing MBCSD WWTP was analyzed from 2003 to 2014. Using this data, a PHF peaking factor of 7.25 is recommended. This corresponds to the 99.98th percentile of the hourly flow/AADF ratios originating from analyzed data between 2003 and 2014 (Figure 3-6). Details of this analysis are included in Appendix C. Note that since November 2015, the City has been regularly collecting flow measurements in the collection system to help establish the City's wet weather PHF. Precipitation was light over the winter and spring months and the peak flows captured were not significant compared to previous years. The City will continue to collect flow data and the PHF analysis may be need to be updated during subsequent phases of planning and design.

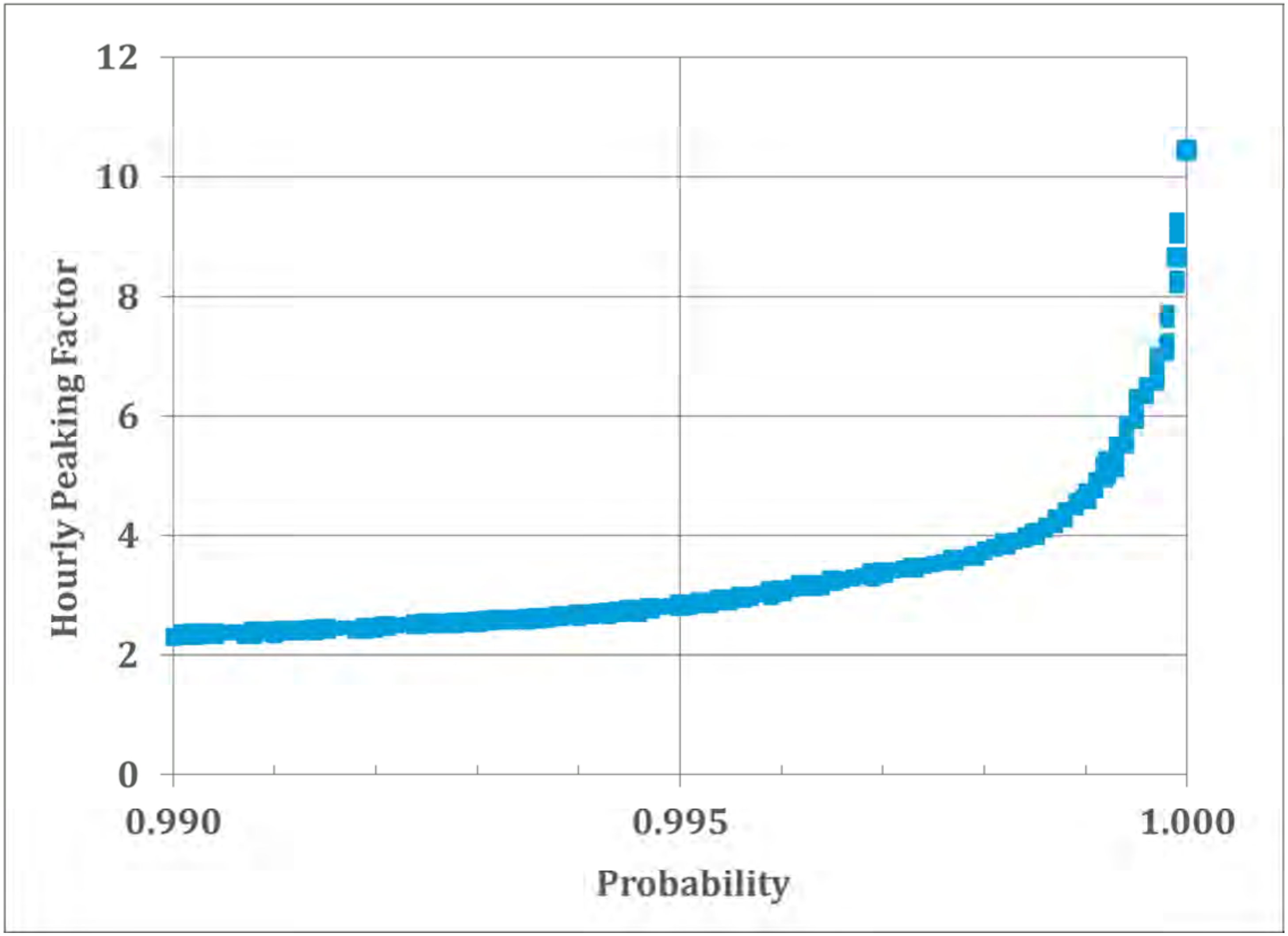


Figure 3-6 Hourly Peaking Factor Probability

3.3.7 Evaluation of 2010 – 2014 Minimum Day Flow

A minimum day flow peaking factor (i.e., the ratio of the minimum day flow to average daily flow) of 0.74 was established for the FMP (Table 3-10) considering the historical data from 2010-2014.

Table 3-10 Minimum Day Flow Peaking Factor

YEAR	DATE	MIN. DAY (MGD)	ANNUAL AVERAGE (MGD)	MIN. DAY PEAKING FACTOR
2010	**05-Nov-10**	0.66	1.19	0.56
2011	**14-Dec-11**	0.84	1.24	0.68
2012	**02-Oct-12**	0.75	1.10	0.68
2013	**12-Nov-13**	0.78	0.97	0.80
2014	**29-Oct-14**	0.69	0.94	0.74
5 YR AVG				**0.74**

3.4 EVALUATION OF EXISTING PLANT INFLUENT LOADS

The evaluation of existing plant influent loads reviewed biochemical oxygen demand (BOD), total suspended solids (TSS), and nutrient loads, as well as temperature and pH.

3.4.1 Summary of Previous Load Analyses

Annual average BOD and TSS influent concentrations and loads for the years 2002-2006, as reported in the 2007 FMP, are provided in Table 3-11. The 2010 FMP evaluated the annual average, peak rolling 30-day average and peak month BOD and TSS loads for 2002-2009 as shown in Table 3-12.

Table 3-11 Historical Influent BOD and TSS Loads as Reported in the 2007 FMP

YEAR	ANNUAL AVERAGE BOD		ANNUAL AVERAGE TSS	
	CONCENTRATION (MG/L)	LOAD (LB/DAY)	CONCENTRATION (MG/L)	LOAD (LB/DAY)
2002	386	3,711	492	4,707
2003	306	2,702	340	3,458
2004	336	3,074	418	3,929
2005	303	3,171	406	4,562
2006	291	2,852	366	3,728
5 YR	**324**	**3,102**	**404**	**4,077**

Table 3-12 Historical Influent Loads for BOD and TSS as Reported in the 2010 FMP

PARAMETER	UNIT	2002-2009
BOD		
Annual Average	lb/day	3,000
Annual Peak Rolling 30-Day Average	lb/day	4,090
Annual Peak Day	lb/day	5,540
TSS		
Annual Average	lb/day	3,260
Annual Peak Rolling 30-Day Average	lb/day	4,560
Annual Peak Day	lb/day	6,090

3.4.2 Analysis of BOD Loads

Table 3-13 provides the BOD load analysis for years 2010-2014. Note that the influent BOD concentration was measured from 24-hour composite samples taken approximately once every eight days, resulting in 46-58 samples for each year. In 2010 and 2012, samples were collected for 3 to 4 consecutive days over with the holidays of Memorial Day, Fourth of July, and Labor Day. These sampling campaigns, although infrequent, may influence the analyses as the loads tended to be above average during these holidays. The BOD load analysis presented here is based on daily BOD load values, which were calculated by multiplying the reported BOD concentration for a given day by the corresponding daily flow. The annual average influent BOD load for the five year period of analysis ranged from 2,600 to 3,600 lb/d. The annual maximum month and peak day loads ranged from 3,200 – 4,300 lb/d and 4,600 - 6,300 lb/d, respectively.

Table 3-13 BOD Load Summary (2010-2014)

YEAR	ANN. AVG. (LB/DAY)[1,2]	MINIMUM DAY		ANNUAL MAX. MONTH		ANNUAL MAX. DAY	
		LOAD (LB/DAY)[1]	PEAKING FACTOR	LOAD (LB/DAY)[1,2]	PEAKING FACTOR	LOAD (LB/DAY)[1,2]	PEAKING FACTOR
2010	3,600 (55)	2,500	0.69	4,300 (6)	1.18	6,300 (55)	1.68
2011	3,200 (46)	2,300	0.71	4,300 (4)	1.32	4,900 (46)	1.52
2012	3,100 (58)	1,450	0.47	4,100 (7)	1.33	4,700 (58)	1.52
2013	2,600 (51)	1,600	0.62	3,400 (5)	1.28	4,700 (51)	1.79
2014	2,700 (53)	1,750	0.64	3,200 (5)	1.17	4,600 (53)	1.68
5-YR	**3,100**		**0.63**	**4,300[3]**	-	**6,300**	-

Notes:
1. All values are rounded to the nearest hundred pounds.
2. Values in parentheses indicate number of data points.
3. This value represents the maximum average load for a calendar month over the 5-year period. The maximum 30-d rolling average for the 5 years was 4,500 lb/day- note that this average, where n=6, included an event with 3 consecutive days of BOD sampling.

The influent BOD concentration measurements from January 2010 – July 2015 are shown on Figure 3-7. Our analysis suggests that the 2014 BOD data set is different from the 2013 data set (Mann Whitney test, $\alpha = 0.05$). Furthermore, the annual average BOD load has been generally decreasing over the five year period evaluated, as shown in Figure 3-8. This is likely a result of decreased influent flow, as discussed in Section 3.3.1. The BOD loads of 2013 and 2014 experienced a narrower distribution than in previous years (see Figure 3-8). The difference between the 75th percentile and 25th percentile of the data (i.e., the interquartile range – IQR) for 2013 and 2014 data is ~600 lb/d compared to ~1,000 lb/d for previous years. The primary implication, if this trend continues (i.e., if the differences between the low and high loads remain relatively small), is that the process design must be robust enough to operate under the higher load conditions, which are likely to occur for a greater proportion of the year.

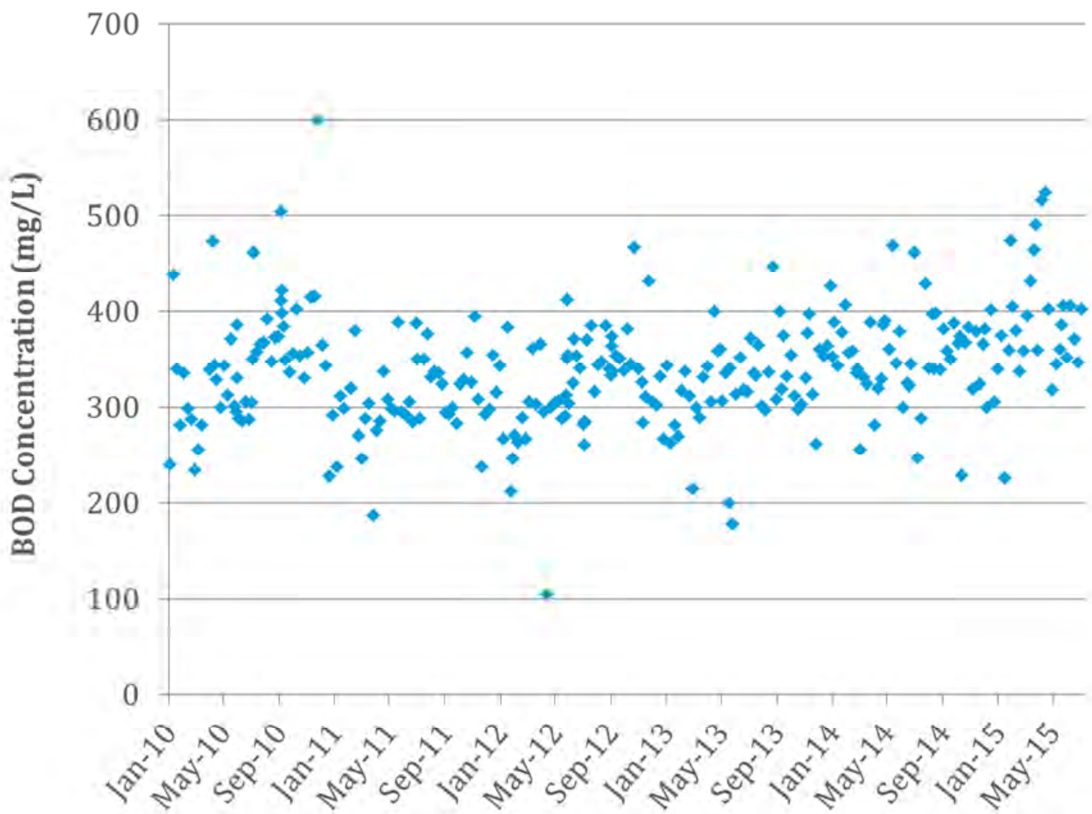


Figure 3-7 Historical Influent BOD Concentration from 2010 - 2015

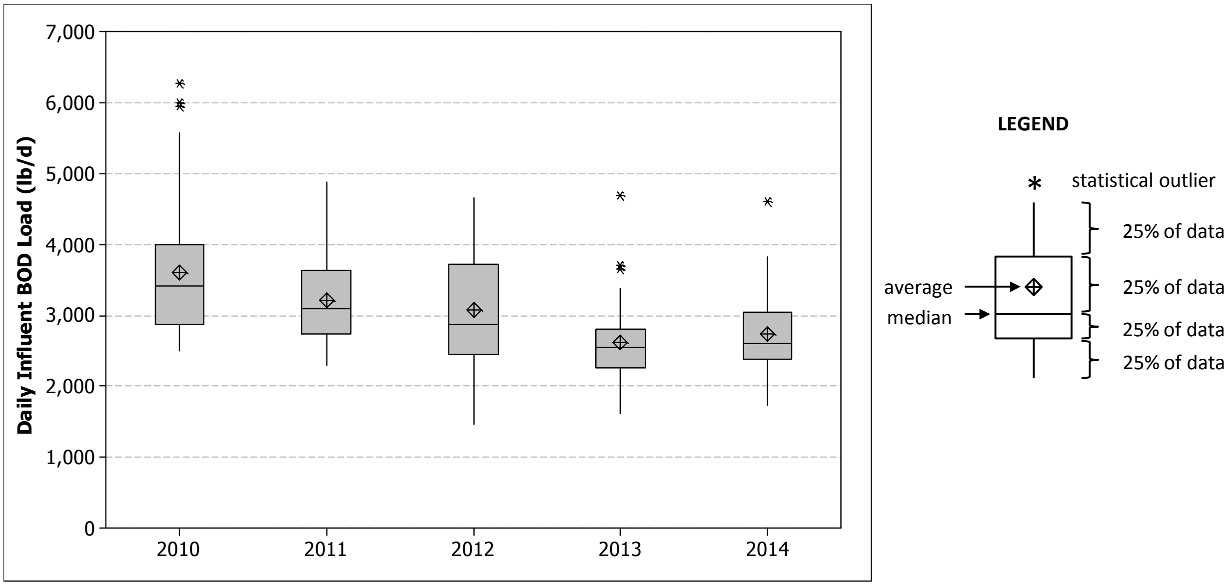


Figure 3-8 Boxplot Indicating Distribution of Daily Influent BOD Load for 2010 – 2014

3.4.3 Analysis of TSS Loads

Table 3-14 provides the TSS load analysis for years 2010-2014. The average influent TSS concentration from 2010-2014 ranged from 2,800-4,000 lb/d. Similar to BOD, TSS was analyzed typically once every 8 days, resulting in between 46-55 samples for each year. In 2010 and 2012, samples were collected for 3-4 consecutive days coinciding with the holidays of Memorial Day, Fourth of July, and Labor Day. These sampling campaigns, although infrequent, may influence the analyses as the loads tended to be above average during these holidays. The load analysis was based on daily TSS load values, which were calculated by multiplying the TSS concentration for a 24-hour composite sample by the corresponding daily average flow. The influent TSS concentration in Figure 3-9 showed no trends from year to year, though average TSS loads for 2013 and 2014 were noticeably less than those in 2010-2012 (Figure 3-10) due to lower flows.

Table 3-14 TSS Loads Summary (2010-2014)

YEAR	ANNUAL AVERAGE (LB/DAY)[1,2]	MINIMUM DAY		ANNUAL MAX. MONTH		ANNUAL MAX. DAY	
		LOAD (LB/DAY)[1]	PEAKING FACTOR	LOAD (LB/DAY)[1,2]	PEAKING FACTOR	LOAD (LB/DAY)[1,2]	PEAKING FACTOR
2010	4,000 (55)	2,100	0.53	5,400 (6)	1.36	9,700 (55)	2.46
2011	3,500 (48)	1,500	0.43	4,500 (4)	1.28	5,500 (48)	1.57
2012	3,700 (58)	2,000	0.54	5,100 (7)	1.40	7,000 (58)	1.90
2013	2,800 (52)	1,150	0.41	4,000 (5)	1.42	4,900 (52)	1.73
2014	2,900 (53)	1,100	0.37	3,500 (5)	1.18	5,400 (53)	1.84
5-YR	**3,400**		**0.46**	**5,400[3]**	**-**	**9,700**	**-**

Notes:
1. All values are rounded to the nearest hundred pounds.
2. Values in parentheses indicate number of data points.
3. This value represents the maximum average load for a calendar month. The maximum 30-d rolling average for the 5 years was 6,100 lb/day- note that this average, where n=6, included an event with 3 consecutive days of TSS sampling.

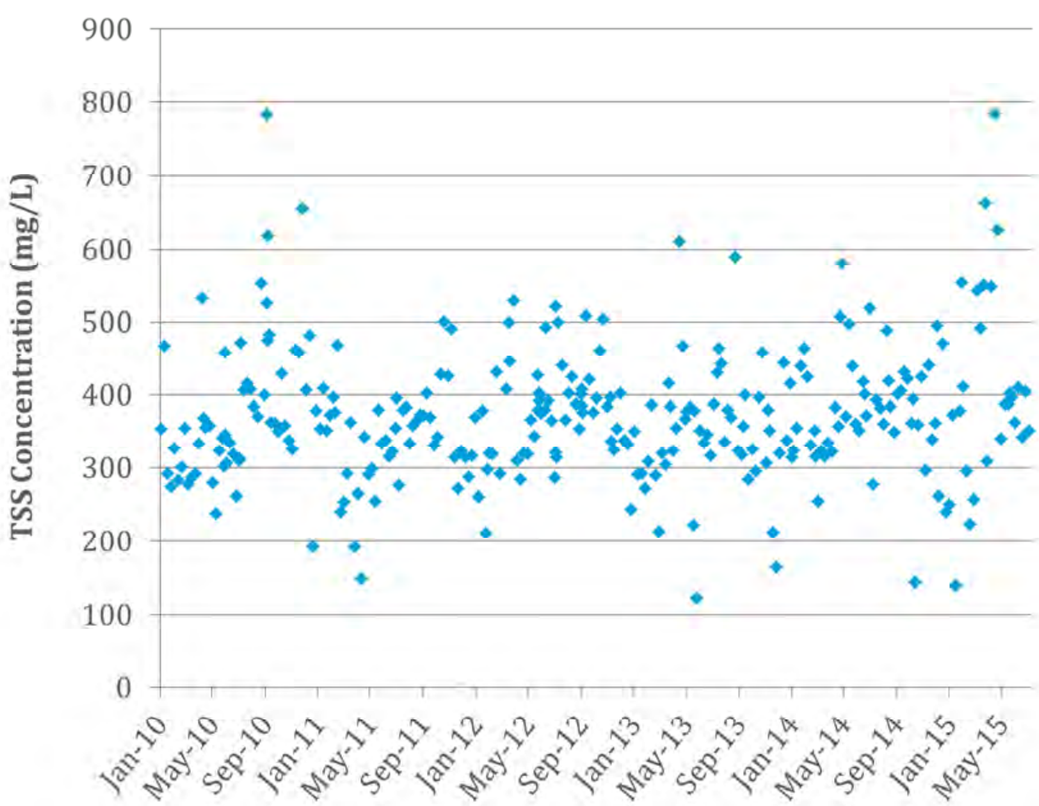


Figure 3-9 Historical Influent TSS Concentration from 2010-2015

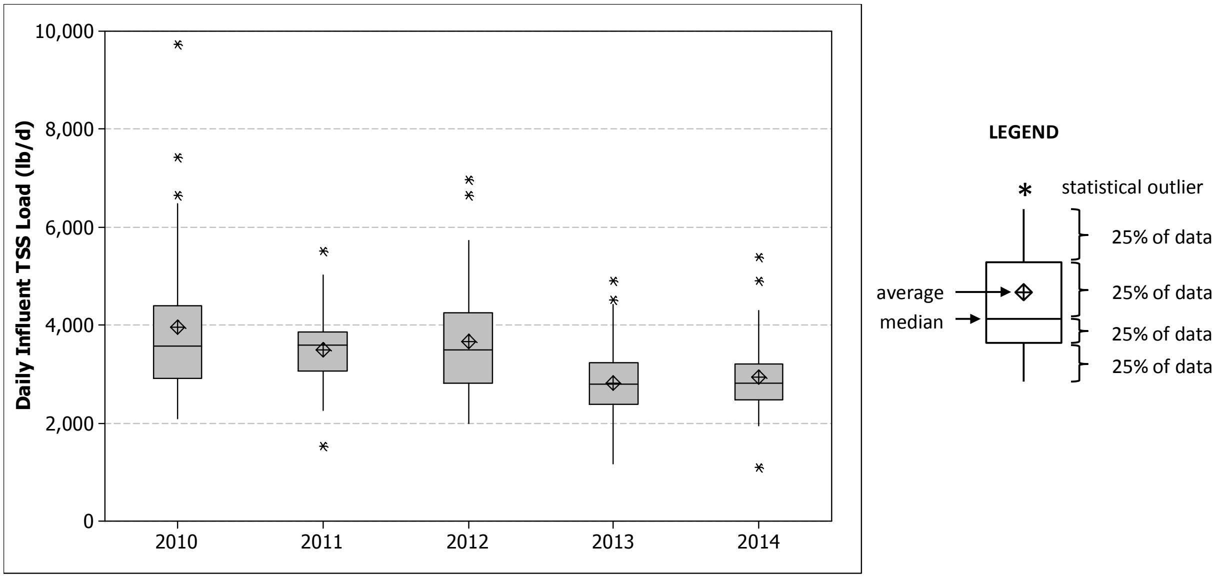


Figure 3-10 Boxplot Indicating Distribution of Daily Influent TSS Load for 2010 – 2014

3.4.4 Analysis of Nutrient Loads

There are currently no NPDES permit requirements related to nitrogen species in the existing WWTP influent. The influent nitrogen load is nonetheless an important consideration in the current planning effort of the future WRF. Therefore, we have estimated the influent Total Kjehdahl Nitrogen (TKN) load using the effluent ammonia concentration provided by plant personnel and the assumptions noted below:

- The existing WWTP operating conditions are such that nitrogen removal is exclusively linked to assimilation by heterotrophic biomass engaged in BOD oxidation;
- The representative formula for biomass is $C_5H_7O_2N$, so percent nitrogen by weight is 14g N/113g biomass, and the biomass use ammonia as the sole nitrogen source for growth;
- The yield of heterotrophic biomass is 0.67 g $BOD_{biomass}$/g $BOD_{soluble}$;
- Based on stoichiometry, the ratio of BOD mass to biomass is 1.42;
- Effluent organic nitrogen is negligible (i.e., effluent ammonia ≅ effluent TKN);

The ammonia concentration in the effluent was typically measured monthly, whereas the influent and effluent BOD were, in general, measured weekly. Therefore, the influent TKN load was estimated using the annual average BOD removal for each year. The resulting influent TKN:BOD ratio of 0.16 compares favorably with that used previously in the 2007 FMP (0.17). Table 3-15 summarizes the nitrogen loads from 2010-2014.

Table 3-15 Nitrogen Loads Summary (2010-2014)

YEAR	ANNUAL AVERAGE (LB/DAY)	MINIMUM DAY		ANNUAL MAX. MONTH		ANNUAL MAX. DAY	
		LOAD (LB/DAY) [1]	PEAKING FACTOR	LOAD (LB/DAY) [1,2]	PEAKING FACTOR	LOAD (LB/DAY) [1,2]	PEAKING FACTOR
2010	580 (55)	400	0.69	680 (6)	1.20	960 (55)	1.68
2011	510 (46)	370	0.71	680 (4)	1.32	780 (46)	1.52
2012	490 (58)	235	0.47	650 (7)	1.33	740 (58)	1.52
2013	420 (51)	260	0.62	540 (5)	1.28	750 (51)	1.79
2014	440 (53)	280	0.64	510 (5)	1.17	740 (53)	1.68
5-YR	**490**		**0.63**	**680[3]**	**-**	**960**	**-**

Notes:
1. All values are rounded to the nearest ten pounds.
2. Values in parentheses indicate number of data points. Here, the number of points equates to BOD, not nitrogen, sampling events; the TKN:BOD ratio is applied to the BOD data to estimate nitrogen loads.
3. This value represents the maximum average load for a calendar month. The maximum 30-d rolling average for the 5 years was 730 lb/day- note that this average, where n=6, included an event with 3 consecutive days of BOD sampling.

3.4.5 Evaluation of Diurnal Variation of Pollutant Load

No information was available on the diurnal variation of influent pollutant concentrations at the time of development of the FMP. Therefore it was assumed that for each pollutant the diurnal load variation is a result of the diurnal flow variation. Evaluation of the minimum day and minimum 2-hr loads for years 2010-2014 with the design peaking factors are shown in Table 3-16.

Table 3-16 Minimum 2-Hour Load Peaking Factors

YEAR	TSS			BOD			TKN		
	ANNUAL AVG. (LB/DAY)	MIN. 2-HR (LB/DAY)	MIN. 2-HR PF	ANNUAL AVG. (LB/DAY)	MIN. 2-HR (LB/DAY)	MIN. 2-HR PF	ANNUAL AVG. (LB/DAY)	MIN. 2-HR (LB/DAY)	MIN. 2-HR PF
2010	3,950	1,200	0.31	3,600	1,450	0.40	575	235	0.40
2011	3,500	750	0.21	3,200	1,150	0.35	515	180	0.35
2012	3,650	900	0.25	3,050	650	0.22	490	105	0.22
2013	2,800	450	0.16	2,600	650	0.24	420	105	0.24
2014	2,950	500	0.18	2,750	820	0.30	435	130	0.30
5 YR AVG			0.22			0.30			0.30

3.4.6 Analysis of Temperature and pH

While neither a flow nor load, temperature and pH are important considerations when characterizing the influent. The effluent water temperatures from 2010-2015 are shown in Figure 3-11. The temperature varied between 13-24 degrees Centigrade (°C) with the hottest annual temperatures experienced in July, August, and September and the coldest annual temperatures experienced in December, January, and February. The pH of the influent ranged from 6.7-8.8 with 99 percent of the values falling within the range of 7.5-8.5, as presented in Figure 3-12. The influent pH exhibited no significant correlation with season or time.

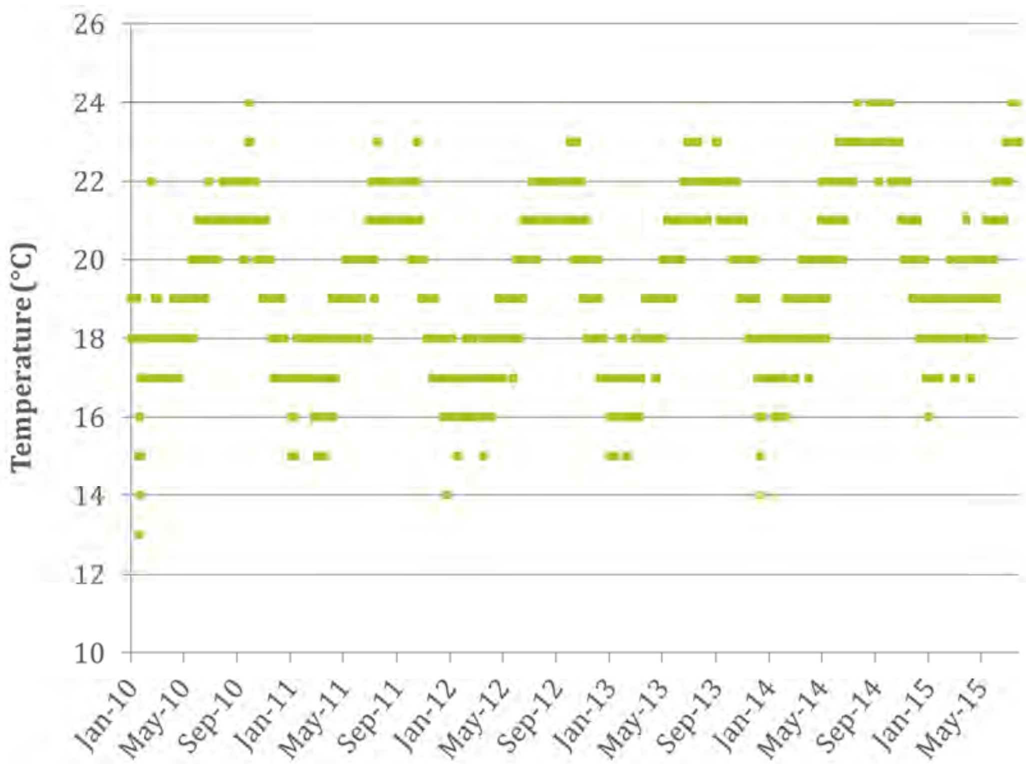


Figure 3-11 Historical Effluent Temperature from January 2010 – July 2015

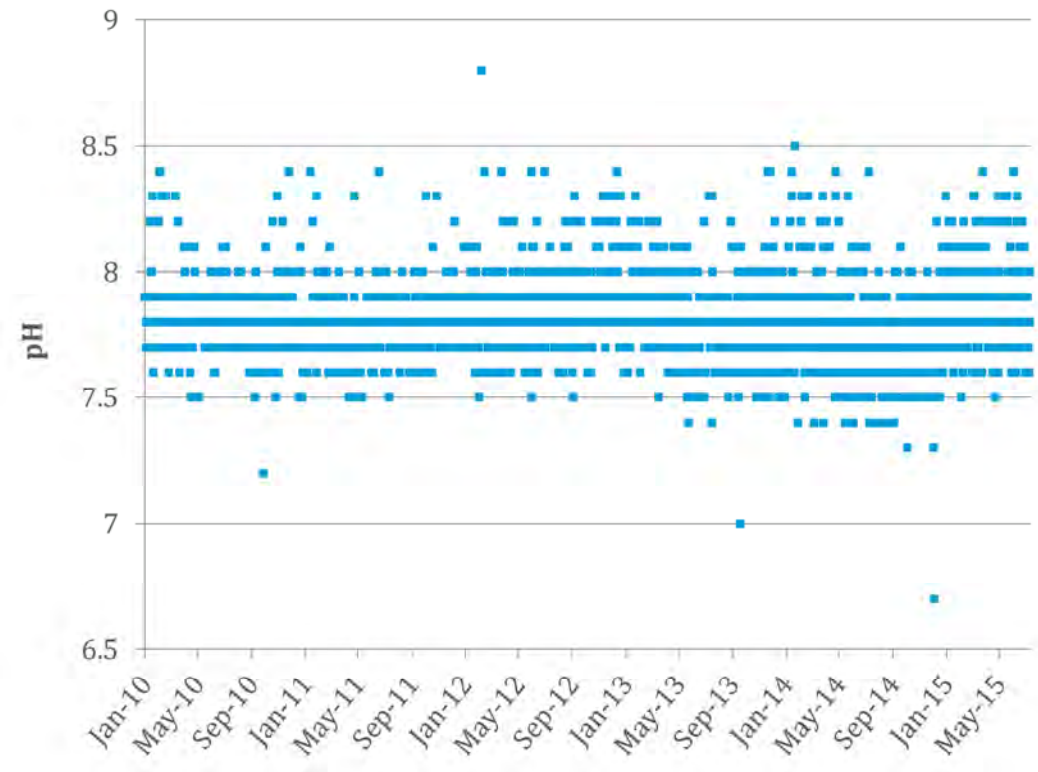


Figure 3-12 Historical Influent pH from January 2010 to July 2015

3.5 INFLUENT FLOW AND LOAD PROJECTIONS

Table 3-17 shows the recommended basis of design values for flow and load based on the analyses presented in this FMP. Flow estimates were determined based on the population projections described in Section 3.2. The annual average, maximum month and peak day pollutant loads are calculated as described in Equations 1-7.

Determination of Design Annual Average Pollutant Load and Concentration Estimates:

Design Ann. Avg. Pollutant Load	=	*Ann. Avg. per Capita Load [lb/person-d] (from 2010-2014 data set)*	x	*Build Out Population Estimate [people] (from population projection)*	*(1)*

$$\text{Design Ann. Avg. Pollutant Conc.} = \frac{\text{Design Ann. Avg. Pollutant Load [lb/d]}}{\text{Design Ann. Avg. Daily Flow [mil. gal./d]}} \times \frac{0.12\ \text{[mg][mil. gal.]}}{\text{[lb][L]}} \quad (2)$$

Determination of Design Minimum 2-hour Pollutant Load and Concentration Estimates:

Design Min.2H Pollutant Load	=	*Design Ann. Avg. Pollutant Load [lb/d] (from Equation 2)*	x	*Minimum 2h Load Peaking Factor [-] (from Peaking Factor Analysis)*	*(3)*

Determination of Design Minimum Day Pollutant Load and Concentration Estimates:

Design Min.Day Pollutant Load	=	*Design Ann. Avg. Pollutant Load [lb/d] (from Equation 2)*	*x*	*Minimum Day Load Peaking Factor [-] (from Peaking Factor Analysis)*	*(4)*

Determination of Design Maximum Month Pollutant Load and Concentration Estimates:

Design Max. Month Pollutant Load	=	*Design Ann. Avg. Pollutant Load [lb/d] (from Equation 2)*	*x*	*Max. Month Load Peaking Factor [-] (from Peaking Factor Analysis)*	*(5)*

$$\text{Design Max. Month Pollutant Conc.} = \frac{\text{Design Max. Month Pollutant Load [lb/d]}}{\text{Design Max. Month Flow [mgd]}} \times \frac{0.12\ \text{[mg][mil. gal.]}}{\text{[lb][L]}} \quad (6)$$

Determination of Design Peak day Pollutant Load and Concentration Estimates:

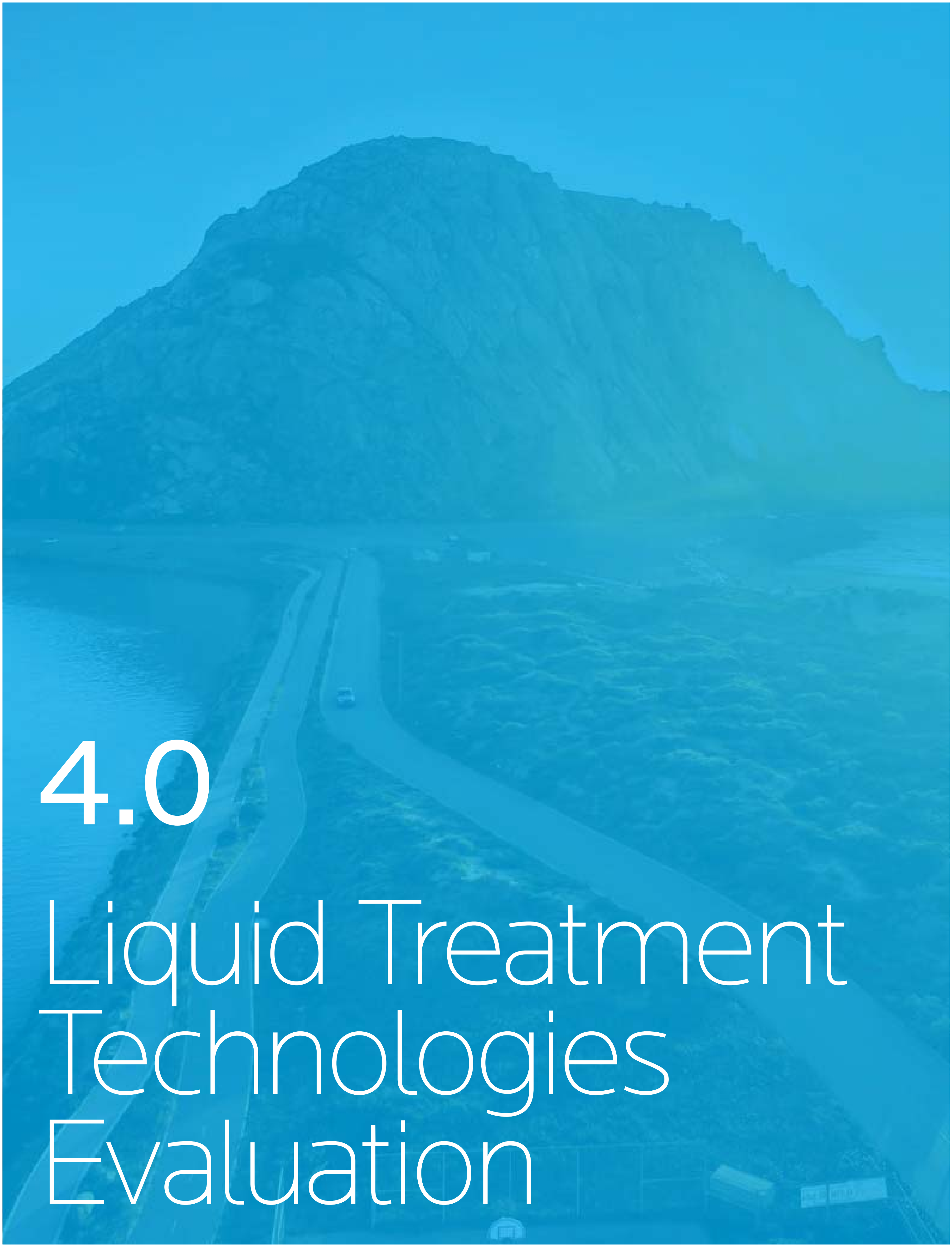
Design Max. Day Pollutant Load	=	*Design Ann. Avg. Pollutant Load [lb/d] (from Equation 2)*	*x*	*Max. Day Load Peaking Factor [-] (from Peaking Factor Analysis)*	*(7)*

The projected loads in Table 3-17 were established using average peaking factors for years 2010 to 2014 as determined in Section 3.4. For example, the projected maximum month design BOD load was determined using a peaking factor of 1.26. Note however, there is variation in the peaking factor for the five year period (as shown in the probability plots in Appendix D). Considering the changes in the collection system over the last few years - as a result of the drought and/or water conservation efforts - there is the potential that selection of the average peaking factor is not representative of the stochastic nature of a given system. We therefore evaluated the impact of selecting the average peaking factor value rather than for example the 25th percentile value (which would result in a more aggressive design basis), or the 75th percentile value (a more conservative design basis). Such an analysis is beneficial in order to assess the robustness of the basis of design criteria relative to inherent uncertainties in the historical data utilized to develop future projections.

Our approach involved using the population projections provided by the City and applying median, 25th and 75th percentile peaking factors over the build-out period (i.e., 2015 – 2040). Note that there is no discernable annual trend in the maximum month or peak day peaking factors and the peaking factors are satisfactorily represented using a standard normal distribution (see Figures D-1 – D-4 in Appendix D), thus application of these percentiles in warranted. Shown in Figures D-5 – D-8 (Appendix D) are the range of maximum month and peak day projected design loads over the 25-year project period. Our analysis suggests that the basis of design is robust given the data available at the time of writing of this report. The variance in the projected maximum monthly and peak day BOD loads using 25th and 75th percentile estimates of the peaking factors is less than 10%. The variance in the projected maximum month TSS load is in a similar range. There is a somewhat greater variance in the projected influent TSS load, which has the potential to influence the performance of conventional primary treatment processes under these conditions. It is recommended that this be taken into consideration as part of the process evaluation.

Table 3-17 Basis of Design Flow and BOD, TSS and TKN Loads and Pollutant Concentration

PARAMETER		ANN. AVG.	MIN. 2H	MIN. DAY	MAX. MONTH	PEAK DAY	PEAK HOUR
Flow	mgd	**0.97**	0.32	0.67	1.16	2.75	7.03
BOD							
Concentration	mg/L	**440**			470		
Load	lb/d	**3,600**	1,100	2,250	4,500	5,900	
Load Peaking Factor	--	**--**	0.30	0.63	1.26	1.65	
TSS							
Concentration	mg/L	**490**			540		
Load	lb/d	**4,000**	880	1,800	5,300	7,500	
Load Peaking Factor	--	**--**	0.22	0.45	1.33	1.90	
TKN							
Concentration	mg/L	**70**			74		
Load	lb/d	**570**	170	360	720	940	
Load Peaking Factor	--	**--**	0.30	0.63	1.26	1.65	



4.0 Liquid Treatment Technologies Evaluation

4.0 Liquid Treatment Technologies Evaluation

4.1 OVERVIEW

As described in Chapter 1, TM-7 Liquid Treatment Evaluation evaluated liquid treatment technologies used to meet various water quality goals, which are dependent on the different types of potential end-uses. The State regulations for the treated water quality are different for ocean discharge, reuse applications such as irrigation or agriculture use, or groundwater recharge through IPR. Thus, the technologies evaluated for liquids treatment were in alignment with the City's overarching goal of achieving the highest and best use of this new water resource and offsetting the City's need to purchase less reliable and more expensive imported water. The various treatment technologies were evaluated based on 11 criteria and ultimately narrowed down to two viable alternatives: a conventional liquid treatment alternative and a combined secondary/tertiary treatment alternative.

This Chapter 4 of the FMP provides an overview of TM-7. In addition to the liquid treatment technologies evaluation from TM-7, this chapter also provides an overview of potential odor control facilities for handling odors emitted by both liquid and solids treatment facilities.

Table 4-1 presents an overview of the discussion in this chapter.

Table 4-1 Overview of Liquid Treatment Technologies Evaluation

ITEM	DESCRIPTION
End Uses for WRF Effluent	Provides a summary of the end use options for WRF effluent that has been treated to different water quality standards.
Evaluation Process and Criteria	Describes the liquid treatment technologies evaluation process based on the goal of establishing a conventional treatment train and a combined secondary/tertiary treatment train.
Treatment Technologies Coarse Screen Evaluation	Provides a summary of the liquid treatment technologies considered and the results of the conventional treatment, combined secondary/tertiary treatment, and advanced treatment evaluations.
Odor Control Facilities	Provides an overview of odor control facilities to handle odors from liquid and solids treatment processes.
Summary	Describes the results of the evaluation and the conventional treatment train and combined secondary/tertiary treatment train to be further evaluated in the FMP.

4.2 LIKELY END USES FOR WRF EFFLUENT

The City is currently developing a Master Water Reclamation Plan to determine how best it might use and distribute reclaimed water from the WRF. This FMP considers the following potential end-use options for the effluent from the proposed WRF; these are anticipated to be the end-use options that will emerge from the Master Water Reclamation Plan:

- **Ocean discharge**
  - The City has the ability to discharge effluent through an existing outfall under their NPDES permit (CA0047781).
  - In keeping with the City Council's goals for the WRF, ocean discharge would only be pursued for: a) short-term use prior to development of water reuse opportunities; b) brine discharge; or c) wet weather disposal if irrigation reuse is the most viable recycled water market.
- **Unrestricted irrigation reuse applications**
  - The City is particularly interested in evaluating options and requirements to facilitate irrigation of avocado orchards within the Morro Valley during dry weather conditions that would provide a water supply benefit to the City.
  - Furthermore, the City is interested in exploring options and the treatment process(es) required to send the WRF effluent to either a) the ocean discharge or b) groundwater recharge during non-irrigation periods (i.e., wet weather months).
- **Groundwater recharge through Indirect Potable Reuse (IPR)**
  - The City is interested in the opportunity to enhance overall sustainability by developing an IPR program.

These options will serve the community by providing a sustainable approach to its local water resources and by enhancing the reliability of the City's broader water supply portfolio.

Each of the potential end-uses listed above has water quality requirements that must be achieved by the liquid treatment process. The water quality standards associated with these requirements are presented in Chapter 2.0. Only liquid treatment technologies that can meet these water quality requirements were considered.

4.3 EVALUATION PROCESS AND CRITERIA

After water quality standards were established, treatment alternatives were evaluated to determine liquid treatment options that meet the City's desired end-use goals. The evaluation resulted in the development of two liquid treatment process trains: 1) a conventional treatment alternative and 2) a combined secondary/tertiary treatment alternative.

4.3.1 Evaluation of Conventional Treatment Components

To develop a preferred conventional process treatment train, alternative systems or equipment were identified for each of three separate conventional treatment unit processes: biological treatment, filtration, and disinfection. Working with City technical staff, a set of criteria were defined to allow a qualitative comparison of the systems or equipment identified for each unit process. Those criteria are listed in Table 4-2.

Table 4-2 Conventional Treatment Evaluation and Weighting

CRITERIA	WEIGHTING, %		
	BIOLOGICAL TREATMENT	FILTRATION	DISINFEC-TION
Comparative Capital Cost: This criterion compares the relative capital costs of each alternative. Alternatives with perceived lower capital cost receive a higher score.	20	20	20
Comparative Operating Cost: This criterion compares the relative operating costs of each alternative. Alternatives with perceived lower operating cost receive a higher score.	20	20	20
Odor Mitigation: This criterion compares both the odor generation and mitigation of just the biological treatment alternatives. Alternatives perceived to produce fewer odors and allow for easier odor mitigation receive a higher score.	10	N/A	N/A
Technical Complexity: This criterion compares the technical process complexities of each alternative. Alternatives perceived to be simpler to operate and with the fewest process complexities receive a higher score.	5	10	10
Reliability: This criterion compares the process reliability of each alternative. Alternatives perceived to be more reliable receive a higher score.	10	10	10
Staff Requirements: This criterion compares the number of staff, level of training required, and time required to operate/maintain for each alternative. Alternatives that require less staff, lower training levels, and less operation/maintenance (O&M) time receive a higher score.	5	5	5
Scalability: This criterion compares the ability to add capacity to each alternative. Alternatives that are more modular and easier to expand receive a higher score.	5	10	10
Product Water Quality: This criterion compares the water quality produced by each alternative. Alternatives that produce better quality water receive a higher score.	10	N/A	25
Beneficial Reuse Opportunities: This criterion compares the ability of each filtration alternative to produce product water that can be used for beneficial reuse. Alternatives that can produce tertiary treated water or better receive a higher score.	N/A	25	N/A

CRITERIA	WEIGHTING, %		
	BIOLOGICAL TREATMENT	FILTRATION	DISINFEC-TION
Flexibility for Title 22 Redundancy: This criterion compares the cost and complexity to include redundant treatment processes for the biological treatment alternatives. Alternatives that allow for redundant biological treatment systems at a lower cost receive a higher score.	5	N/A	N/A
Visual Impact/Footprint: This criterion compares the visual impact and footprint of each alternative. Alternatives perceived to have less visual impacts and smaller footprints receive a higher score.	10	N/A	N/A
	100	100	100

In addition to the criteria themselves, a weighting (% out of 100) was then assigned to each criterion so that those criteria that are more important to meet the City's goals, or of higher priority to City technical staff, make up a higher percentage of the total score.

The importance to meeting the City's goals and the City staff's priorities varied among each of the unit processes. Therefore, as shown in Table 4-2, the weighting factor for each criterion varied between the three different unit processes.

In the sections that follow, technology alternatives for each unit process are given scores for each criterion using a scale of 1 to 5 as shown in Table 4-3. The criteria, weighting, and scoring used for the evaluation of each unit process were developed by and with City staff during a workshop on September 16, 2015.

Table 4-3 Alternatives Evaluation Rating System

SCORE	DEFINITION
5	Satisfies project objectives with significant noted advantages
4	Satisfies project objectives with noted advantages
3	Satisfies project objectives
2	Satisfies project objectives with noted disadvantages
1	Satisfies project objectives with significant noted disadvantages

4.3.2 Evaluation of Combined Secondary/Tertiary Treatment Components

The combined secondary/tertiary treatment alternative has several components common to the conventional treatment alternative. The results of the evaluations for these in-common treatment components, which were developed for the conventional treatment alternative, were used to develop the combined secondary/tertiary treatment alternative. The secondary (biological) and tertiary treatment steps were combined into one process using a single secondary/tertiary treatment technology. Membrane bioreactor (MBR) is the recommended technology for combined secondary/tertiary treatment.

4.4 TREATMENT TECHNOLOGIES COARSE SCREEN EVALUATION

This section presents an overview of liquid treatment technologies, discusses specific advantages/disadvantages of the technologies, and qualitatively compares the treatment technology alternatives. The three categories of liquid treatment considered are listed in Table 4-4.

Table 4-4 Liquid Treatment Categories

TREATMENT CATEGORY	TREATMENT PROCESS
Conventional Treatment	Preliminary, Primary, Biological, and Tertiary Treatment
Combined Secondary/Tertiary Treatment	MBR
Advanced Treatment	RO, Advanced Oxidation Process (AOP)

The recommendations made in this section are intended to provide focus for the development of a new WRF while at the same time allowing for creativity and innovation during the project implementation phase. The recommendations also provide the basis to develop conceptual space planning and construction cost budgeting for the project.

City staff determined that only proven technologies that have been used successfully in multiple similar applications were to be considered in this evaluation. Capacity-related design criteria are provided in Chapter 6.0.

4.4.1 Conventional Treatment

Several unit process options were considered for each treatment step as shown in Table 4-5. Different technologies for each unit process are discussed in more detail in TM-7. At the end of the biological treatment, tertiary treatment and disinfection technology discussions, a tabular comparison of advantages and disadvantages is provided.

Table 4-5 Summary of Conventional Treatment Unit Processes

TREATMENT STEP	UNIT PROCESSES
Preliminary Treatment	■ Influent Screens ● Shaftless Spiral Screen ● Mechanically-Cleaned Bar Screen ■ Grit Removal ● Horizontal Flow Grit Chambers ● Aerated Grit Chambers ● Vortex Grit Chambers
Primary Treatment	■ Primary Clarifiers ● Rectangular Clarifiers ● Circular Clarifiers
Biological Treatment	■ Suspended Growth Biological Treatment ● Activated Sludge (AS) ● Sequencing Batch Reactor (SBR) ● Oxidation Ditch ● Aerated Lagoons/ Pond Systems ■ Fixed Film Biological Treatment ● Trickling Filters (TFs) and Rotating Biological Contactors (RBCs) ● Moving Bed Bioreactors (MBBR) ● Biological Aerated Filter (BAF) ■ Hybrid Biological Treatment ● Integrated Fixed-Film Activated Sludge (IFAS) ■ Membrane Bioreactor (MBR)
Tertiary Treatment	■ Disc Filters ■ Media Filters
Disinfection	■ Chlorine ■ Ozone ■ Ultraviolet Light (UV)

4.4.1.1 Preliminary Treatment

Preliminary treatment includes influent screens and grit removal. Different types of screening and grit removal equipment were evaluated as shown in Table 4-5.

Figure 4-1 CleanFlo® Spiral Screen & Wash Press (WesTech)

Figure 4-2 Mahr® Bar Multi-Rake Bar Screen

Influent screens provide a physical barrier between the influent sewer and the wastewater treatment plant site piping and equipment. The function of influent screens is to remove large solids that potentially could damage downstream treatment equipment. The two types of influent screens considered were shaftless spiral screens and mechanically-cleaned bar screens (shown on Figure 4-1 and Figure 4-2, respectively).

Grit in municipal wastewater consists of sand, gravel, and other heavy, solid, inorganic materials which have specific gravities or settling velocities greater than organic materials in the wastewater. Grit removal is performed to protect downstream mechanical equipment from abrasion, reduce potential for deposits in pipelines and channels, and reduce frequency of sludge digester cleaning caused by grit accumulation. The three basic designs for grit removal considered were horizontal flow, aerated, and vortex. An example of a vortex grit removal system is shown on Figure 4-3.

Figure 4-3 PistaGrit® Vortex Grit Removal System (Smith & Loveless)

Preliminary screening and grit removal design criteria are provided in Chapter 6.0. Because several types and manufacturers of screening and grit removal equipment are capable of meeting the performance needs of the project, detailed selection of the equipment can be made during the design phase of project delivery.

4.4.1.2 Primary Treatment

The objective of primary treatment is to remove settleable solids from the liquid stream. The use of primary clarifiers at the WRF will have an impact on the selection and design of any solids treatment processes, and vice versa. The application of anaerobic digestion to produce biogas, for example, is beneficial where primary treatment is used to capture organics. In this example, the organic material is stabilized in the digesters rather than the liquid stream biological process. Factors such as costs and impacts on organic carbon availability to the biological treatment process are evaluated in greater detail in Chapters 6.0 and 11.0. Ultimately, it was determined that primary clarifiers would not be cost effective for this project.

4.4.1.3 Biological Treatment

The function of secondary (biological) treatment is to remove biodegradable organic material and nutrients (nitrogen and/or phosphorus). Removal is achieved using an aerobic process where microorganisms, primarily bacteria, oxidize the organic matter into simpler products (carbon dioxide and water).

The function of biological nitrogen removal is to remove nitrogen gas, which is achieved through a multi-step process. In the first step, ammonia is oxidized to nitrate (via nitrite) by ammonia oxidizing bacteria (AOB). The nitrate is subsequently reduced to nitrogen gas by denitrifying bacteria (DNB) as shown on Figure 4-4. Air, which is required by AOB for nitrification, is provided to the biological process typically using fine bubble diffusers in the oxic zones.

The denitrification process requires organic carbon as the electron donor. The primary carbon source will be from the organic load in the influent flow stream. Where sufficient endogenous organic carbon is not available in the influent to the biological process (i.e., where the BOD is low), exogenous (supplemental) carbon must be provided. This is often provided using methanol or glycerol. In recent years, however, fermentation of either primary sludge (where primary clarifiers are included in the process design) or mixed liquor have effectively been utilized to supply organic carbon for biological processes. Therefore, the inclusion of primary or advanced primary treatment should be carefully considered ensuring sufficient organic carbon is consistently available in the biological treatment process.

Enhanced biological phosphorus removal (EBPR) is accomplished by including anaerobic zones prior to the anoxic zones. Under anaerobic conditions, polyphosphate accumulating bacteria release phosphorus. Under subsequent oxic conditions, these bacteria take up more phosphorus than required for growth. This excess phosphorus is stored in the bacterial cells as polyphosphate storage polymers (see Figure 4-4, right panel).

To achieve the effluent quality required based on the range of end-use options (see Section 4.2), it is recommended that the biological treatment process at the WRF be designed to achieve both BOD and nutrient removal. Nutrient removal will likely only include nitrogen removal since phosphorus removal is typically required only for a few inland surface water (non-ocean) discharges to sensitive water bodies.

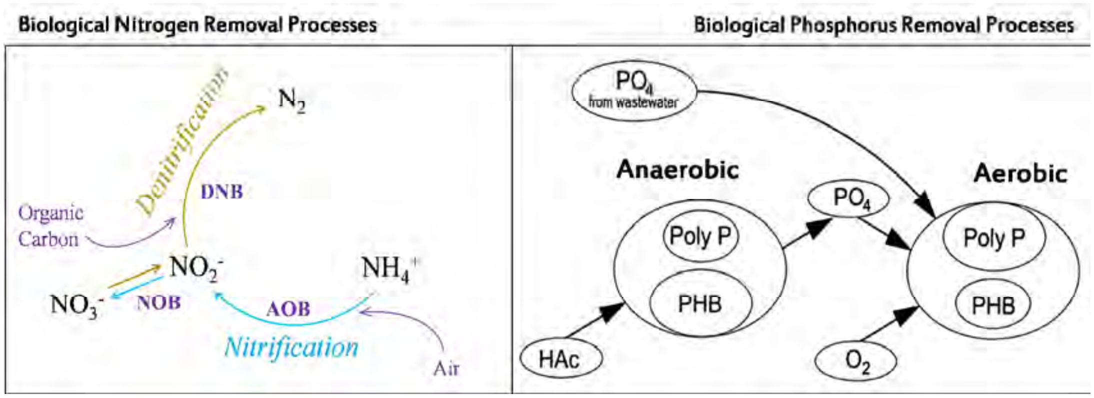


Figure 4-4 **(Left Panel) Transformations of Inorganic Nitrogen which Occur in BNR. (Right Panel) Processes Related to EBPR**

Biological treatment unit operations and technologies can be grouped into three categories: suspended growth systems (containing bacteria in *floc*), fixed film processes (consisting of only biofilms and no floc), and hybrid systems (containing both floc and a biofilm). As show in Table 4-6, several options were considered under each of the three categories. An overview of these process/technology options used to achieve biological treatment at the WRF is presented in TM-7. The following is a summary of the advantages and disadvantages of each as well as coarse screening results. As shown in the table, five processes were not carried forward for further evaluation.

Table 4-6 Comparison of Conventional Biological Treatment Technologies

PROCESS	ADVANTAGES	DISADVANTAGES
Suspended Growth Biological Treatment Technologies		
Activated Sludge (AS)	▪ Common, well-known treatment technology with extensive list of constructed facilities ▪ Suitable for BNR	▪ Less efficient than SBR and Oxidation Ditch when adding redundancy, which increases capital cost ▪ Inefficiency relative to process redundancy leading to higher construction cost
Sequencing Batch Reactor (SBR)	▪ Single batch operation tank results in smaller footprint than AS or Oxidation Ditch ▪ Modular design results in more efficient approach to process redundancy than AS or Oxidation Ditch ▪ Modular design provides enhanced flexibility for alignment with changing plant capacity needs	▪ Higher level of sophistication and maintenance than AS or Oxidation Ditch, which is associated with more sophisticated Programmable Logic Controller (PLC) control and automated valves ▪ Requires downstream flow equalization prior to tertiary treatment
Oxidation Ditch	▪ Extended HRT provides enhanced process stability under highly variable loading conditions.	▪ Longer detention time requires greater volume which means longer footprint and higher construction cost than AS or SBR. ▪ Larger volume results in greater inefficiency relative to process redundancy than AS.
Aerated Lagoons/ Pond Systems	Aerated Lagoons/Pond Systems were not carried forward for further evaluation because they require significantly more space than the other biological treatment options, do not provide treatment of the quality consistent with end-use goals, and are not compatible with neighboring land use due to vectors, odors, and poor aesthetics.	
Fixed Film Biological Treatment Technologies		
TFs and RBCs	TFs and RBCs were not carried forward for further evaluation because of higher effluent BOD and TSS concentrations and turbidity, uncontrolled solids sloughing requiring the combination with a small activated sludge basin, and difficulty in accomplishing nitrogen or phosphorus removal.	
MBBR	MBBR was not carried forward for further evaluation due to the need for expensive synthetic media and operational complexity (retaining media during surface foam removal).	
BAF	BAF was not carried forward for further evaluation due to increased head requirements (compared to other alternatives) and significant automation requirements (operational complexity).	
Hybrid Biological Treatment Systems		
IFAS	IFAS was not carried forward for further evaluation for reasons similar to MBBR (expensive media, complex operation, media retention difficulty, and increased maintenance).	

As shown in Table 4-6, three suspended growth biological technologies were carried forward from coarse screening: AS, SBR, and oxidation ditch. These alternatives were then evaluated based on the criteria and rating procedures listed in Section 4.3. The results of the evaluation are presented in Table 4-7.

Table 4-7 Matrix Evaluation of Biological Treatment Alternatives

CRITERIA	WEIGHT %	ACTIVATED SLUDGE		SBR		OXIDATION DITCH	
		RAW SCORE	WEIGHTED SCORE	RAW SCORE	WEIGHTED SCORE	RAW SCORE	WEIGHTED SCORE
Comparative Capital Cost	20	3	0.60	4	0.80	2	0.40
Comparative Operating Cost	20	3	0.60	3	0.60	2	0.40
Odor Mitigation	10	4	0.40	4	0.40	3	0.30
Technical Complexity	5	4	0.20	3	0.15	4	0.20
Reliability	10	4	0.40	4	0.40	4	0.40
Staff Requirements	5	3	0.15	2	0.10	4	0.20
Scalability	5	3	0.15	5	0.25	2	0.10
Product Water Quality	10	4	0.40	4	0.40	4	0.40
Flexibility for Title 22 Redundancy	5	3	0.15	5	0.25	2	0.10
Visual Impact/Footprint	10	3	0.30	4	0.40	2	0.20
Total			**3.35**		**3.75**		**2.70**

The evaluation of the conventional biological treatment alternatives resulted in SBR receiving the highest score. Therefore, SBR was carried forward as the preferred alternative for site planning and construction cost budgeting. An overview of the SBR process is provided below.

Sequencing Batch Reactor (SBR)

SBR is a batch operation activated sludge technology that has been widely used since the late 1970s after development of simple PLCs, level sensors, and automatic valves. This technology is particularly useful for smaller communities and industrial plants with intermittent flows. SBRs combine mixing, aeration, and clarification in a single tank utilizing fill, drain and aeration controls. Basic SBRs employ multiple steps: fill, react (aeration), settle and decant (see Figure 4-5). An idle phase is sometimes included in the cycle following the settle step where concentrated mixed liquor can be wasted from the SBR. In the absence of an idle stage, mixed liquor wasting may be used to remove MLSS from the SBR. The complete range of biological processes (BOD removal, BNR, and EBPR) are readily accomplished in an SBR by effective management of the react cycle to include the anaerobic and/or anoxic phases in addition to the aerobic phase, as required. Typical experience with SBRs indicates that a better effluent quality can be achieved compared to AS processes. The batch operation of SBRs is designed based on the projected maximum month and maximum day flows and loads (see Chapters 2. 0 and 6.0 for details). SBRs have the flexibility to accommodate large variations in flow by variation of the batch cycle periods, if necessary. Nonetheless, like all the other biological processes considered herein, influent flow equalization will be required for the WRF to treat flows higher than the maximum day condition.

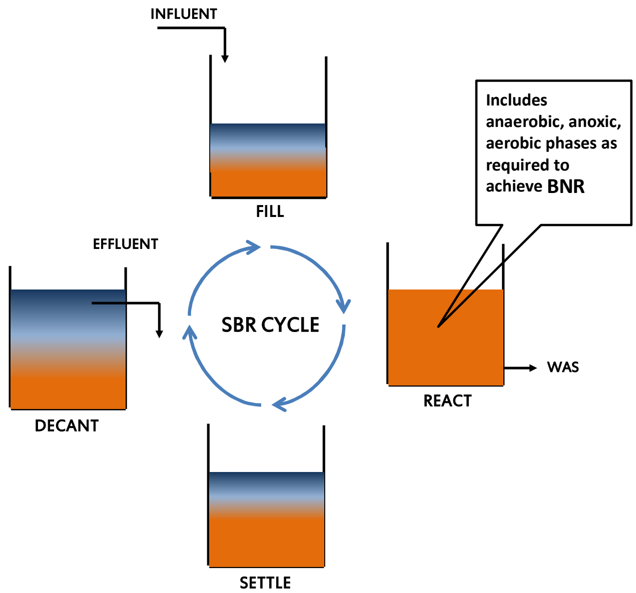


Figure 4-5 Typical SBR Cycle

4.4.1.4 Tertiary Treatment

Tertiary treatment processes are used after biological treatment to produce higher quality effluent, which is typically driven by more stringent discharge or reuse requirements to achieve regulatory compliance. Depending on the intended use for the treated water, filtration is often required after secondary treatment processes to reduce suspended solids (including particulate BOD) concentrations. Other tertiary treatment processes (activated carbon adsorption, ion exchange, gas stripping, etc.) include techniques for reduction of specific inorganic (e.g., heavy metals) or organic constituents required for specific industrial reuses (e.g., cooling towers, process water). These tertiary treatment options are less common and not typically required for municipal wastewater treatment. The filtration technologies considered for the City's proposed WRF included disc filters (see Figure 4-6), media filters, and membrane filters. A summary of the advantages and disadvantages of each technology is provided in Table 4-8.

Figure 4-6 AquaDisk® Disc Filter (Aqua-Aerobic Systems)

Table 4-8 Comparison of Tertiary Treatment Technologies

	ADVANTAGES	DISADVANTAGES
Disc Filters	■ Small footprint ■ Cost competitive ■ Lower backwash water volume than media filters ■ Lower headloss than media filters ■ Handles peak flow well	■ Prone to biological fouling ■ Less robust than media filters during periods of lower feed water quality ■ Slightly lower water quality than media filtration
Media Filters	■ Improved water quality over disc filters ■ More consistent performance under varying influent water quality	■ Larger footprint ■ Higher headloss ■ Higher construction cost than disc filters
Membrane Filters	■ An order of magnitude (x 10) better effluent turbidity than other filtration technologies ■ Provides adequate pretreatment ahead of reverse osmosis	■ Higher construction and operating cost than other tertiary filtration technologies

Disc Filters and Media Filters were then evaluated for tertiary filtration as show in Table 4-9. Membrane Filters were not included in the evaluation because MF/RO will be required to some degree for either groundwater recharge and/or avocado irrigation. Depending on the RO capacity required to meet end-use water demands, the best approach may be to size MF/RO for the entire flow. However, if required RO capacity is small, the more cost-effective approach may be a small MF/RO capacity and disc filters for the balance of plant flow to provide Title 22 filtration only. Both RO scenarios were considered further in Chapter 6.0.

Table 4-9 Matrix Evaluation of Tertiary Filtration Alternatives

CRITERIA	WEIGHT	DISC FILTERS		MEDIA FILTERS	
		RAW SCORE	WEIGHTED SCORE	RAW SCORE	WEIGHTED SCORE
Comparative Capital Cost	20	4	0.8	3	0.6
Comparative Operating Cost	20	3	0.6	3	0.6
Technical Complexity	10	4	0.4	3	0.3
Reliability	10	3	0.3	3	0.3
Staff Requirements	5	4	0.2	4	0.2
Scalability	10	4	0.4	3	0.3
Beneficial Reuse Opportunities	25	4	1.0	4	1.0
Total			**3.70**		**3.30**

Disc filtration technology received the highest score due to lower relative capital cost and simple operation. Disc filters are very capable of achieving Title 22 product water quality and several vendors have secured Title 22 acceptance from the California Division of Drinking Water (DDW) for their equipment.

4.4.1.5 Disinfection

Disinfection is the last step in the treatment process before discharge or reuse and involves the destruction or inactivation of disease-causing organisms, which in wastewater consists of bacteria, protozoa, helminths, and viruses. Disinfection of municipal wastewater is typically accomplished through chemical agents (e.g., chlorine, sodium hypochlorite, ozone, chloramines, etc.) or physical means (UV). TM-7 considered three disinfection alternatives: UV disinfection (see Figure 4-7), chlorine disinfection (see Figure 4-8), ozone disinfection. The advantages and disadvantages of each are listed in Table 4-10. With chlorine and ozone, disinfection byproducts can be a concern. Disinfection of effluent with chlorine can lead to formation of trihalomethane (THM) carcinogens over prolonged contact time. Disinfection with ozone can lead to the formation of bromate if bromide is present in high enough concentrations. Exposure to bromate may affect kidney function in some people.

Figure 4-7 UV AOP at OCWD's GWRS Facility (UV Expansion Designed by B&V)

Figure 4-8 Chlorine Contact Basin

Table 4-10 Comparison of Disinfection Technologies

TYPE	ADVANTAGES	DISADVANTAGES
Chlorine	■ Effective disinfection ■ Residual disinfection for subsequent water reuse applications ■ Cost-effective	■ Larger footprint than UV disinfection ■ Potential for THM formation ■ Dechlorination required prior to discharge ■ Chlorination and dechlorination introduce TDS to product water
Ozone	■ Strong disinfectant with short contact time and small footprint ■ Minimal disinfection byproduct concern (except for bromoform, however the bromate precursor is generally not at problematic concentrations in municipal wastewater)	■ High construction, operation, and maintenance costs ■ No residual disinfection
UV	■ Small footprint ■ No disinfection byproduct formation ■ No chemical handling safety concerns	■ Higher operating and maintenance cost ■ No residual disinfection

Ozone disinfection was eliminated from further evaluation due to the high construction, operation, and maintenance costs. Chlorine disinfection and UV disinfection were then evaluated as shown in Table 4-11.

Table 4-11 Matrix Evaluation of Disinfection Alternatives

CRITERIA	WEIGHT	UV DISINFECTION		CHLORINE DISINFECTION	
		RAW SCORE	WEIGHTED SCORE	RAW SCORE	WEIGHTED SCORE
Comparative Capital Cost	20	3	0.6	3	0.6
Comparative Operating Cost	20	2	0.4	3	0.6
Technical Complexity	10	3	0.3	3	0.3
Reliability	10	3	0.3	4	0.4
Staff Requirements	5	3	0.15	3	0.15
Scalability	10	4	0.4	3	0.3
Product Water Quality	25	4	1.0	3	0.75
Total			**3.15**		**3.10**

Evaluation of UV and chlorine disinfection resulted in UV disinfection with the higher score. While the scores were fairly close, UV disinfection was carried forward as the favored alternative for site planning and construction cost budgeting as it is the preferred disinfection technology for use with advanced oxidation, which is required for IPR via groundwater recharge.

4.4.2 Combined Secondary/Tertiary Treatment

As mentioned in Section 4.3, a treatment alternative using a combined secondary/tertiary treatment process will be evaluated alongside the recommended conventional treatment alternative in Chapter 6.0. Similar to the conventional treatment alternative, the combined secondary/tertiary treatment alternative included preliminary treatment, potentially primary treatment, advanced treatment (see Section 4.4.3), and disinfection. The secondary (biological) and tertiary treatment steps were combined into one process using a single secondary/tertiary treatment technology. MBR was the recommended technology for combined secondary/tertiary treatment.

4.4.2.1 MBR

MBR is a technology that has become popular within the last 10-15 years. MBR includes biological treatment with activated sludge. Solids separation is accomplished with membranes integral to the biological system rather than conventional secondary clarifiers. The submerged membranes are operated under vacuum with product water drawn through the membranes with permeate pumps or using a gravity-assist siphon system. The solids remaining on the surface of the membranes are returned to the head of the aeration basins. A portion of the solids are wasted just as with conventional activated sludge. MBRs require finer screening (2 millimeters [mm] screens) than conventional activated sludge to remove hair and other fine materials that can wrap around and clog the membranes. An example of an MBR facility is shown in Figure 4-9.

MBR membranes provide a barrier to solids; therefore, an MBR produces higher quality product water (better than conventional tertiary filtration) and does so more consistently than conventional activated sludge clarifiers, which are subject to upsets. The positive solids barrier also allows operation at high solids loading rates, which results in a smaller treatment footprint.

Figure 4-9 MBR at Butler Drive WRF

A summary of MBR advantages compared to conventional treatment with SBR are summarized below:

- Provides simultaneous secondary and tertiary treatment
- Provides superior and consistent product water quality that is equivalent to membrane filtration
- Produces water quality sufficient for RO feed
- Smaller footprint than conventional treatment
- Positive solids barrier results in greater process stability than conventional treatment
- Smaller volume of air scrubbed for odor control than conventional treatment

MBR technology provides a number of significant advantages over conventional treatment and is also competitive in terms of capital cost. When MBR technology is compared to conventional secondary treatment plus membrane filtration, the capital cost of the MBRs is lower while providing the same product water quality. One disadvantage of the MBR option is that operating costs are higher than conventional treatment.

4.4.3 Advanced Treatment

As described in Chapter 2.0, advanced treatment is needed to meet Title 22 requirements for groundwater recharge for IPR. Advanced treatment is used to remove dissolved salts, small pathogens (viruses), total organic carbon (TOC), specific organic and inorganic chemicals, and emerging contaminants (prescription drugs, etc.). Some salt removal will be required to meet treatment requirements for groundwater recharge or avocado irrigation. Several technologies are available to remove dissolved salts; ion exchange, electrodialysis reversal and RO. Of these, only RO is effective in removing viruses, emerging contaminants, TOC, etc., as required for IPR. Title 22 regulations for IPR via groundwater recharge include limits for these constituents and dictate RO and AOP as required treatment. Removal of salts, viruses, emerging contaminants, etc. would be required for any future DPR. Designing the WRF with advanced treatment to remove emerging contaminants in the future is also one of the City Council's goals.

RO systems apply water under pressure to semi-permeable membranes. Product water passes through the membrane, and contaminants are retained. RO systems are used for demineralization, and organics and virus removal and primarily target the removal of dissolved contaminants via a diffusion-controlled separation process (American Water Works Association, 2007). The contaminated stream, or brine stream, would be disposed of in the ocean through the existing ocean outfall.

Title 22 regulations for IPR via groundwater recharge require an AOP to achieve required pathogen and chemical contaminant removal. AOPs involve the generation and application of highly reactive free radical intermediates for the destruction of various contaminants. The hydroxyl radical (OH°) is the most potent oxidant used in the treatment of water and wastewater. A combination of UV and hydrogen peroxide (H_2O_2) is the most common method of AOP.

4.5 ODOR CONTROL FACILITIES

The WRF site is surrounded by undeveloped hills. The prevailing winds typically travel from west to east. The closest neighbors to the south include the Bayside Care Center and Casa de Flores Residence. They are located approximately one quarter mile south of the plant with a hill separating the plant from the Center and Residence. On the east side, there is a single home located approximately one mile away, which is separated from the WRF site by a hill. To the west and to the north, the closest neighbors include a small subdivision.

The City has established a goal to provide robust and effective odor control measures so as to have the WRF be compatible with surrounding land uses and minimize the chance of potential impacts to neighbors. The preliminary layout of the new plant site includes provisions for robust, proven odor control facilities for planning purposes, as described herein.

Selection of the facilities requiring odor control and the type of odor control system(s) to be provided typically requires knowledge of hydrogen sulfide (H_2S) concentrations at each facility, air flow modeling, and the City's targeted odor level goals. The City's targeted odor levels are typically prescribed as an odor unit at a specific location. For example, the target may be 3 odor units at the plant boundary. An odor unit is defined as the number of dilutions of fresh air required for 50 percent of the people to no longer be able to smell odor in a sample. To explain further, if a 1 liter of sample requires 10 liters of fresh air to dilute so 50 percent of the people can no longer smell odor, then the sample contains 10 odor units. The Owner's targeted odor levels can have a significant impact on the required odor treatment facilities and cost and as such should be considered with all available information.

For site planning purposes, space and equipment was allocated at two locations for treatment of odors. The first facility, the Influent Scrubber Complex, would be located near the head of the plant and would serve to process odors from the headworks and influent equalization basin. For the purposes of this FMP, H_2S concentrations were assumed to be 50 parts per million (ppm) average with a peak of 200 ppm.

The second facility, the Solids Scrubbing Complex, would be located adjacent to the Dewatering Building for treatment of Dewatering Building and Sludge Storage Basin odors. The H_2S levels from these facilities are typically much less than those at the influent to the plant, but also contain other odorous organic compounds. For the Dewatering Building, foul air would be collected from point sources including the dewatering equipment and the sludge storage bins/hoppers. This approach would reduce the footprint and cost of the odor control system by capturing and collecting the higher odor concentration sources. General building or "sweep" air would not be treated and would be vented to atmosphere.

Table 4-12 summarizes the preliminary air volume and flowrates to be treated at each facility and scrubber complex. The table includes flowrates based on 3 air changes per hour (ac/hr) and 6 ac/hr. Selection of the final design air changes per hour would be determined during final design based on the facility materials of construction, system configuration, and safety. Although a lower rate of air change would reduce the size and cost of the odor treatment facility, the contained foul air space would be more concentrated resulting in a more corrosive environment within the contained air space, which accelerates deterioration of the building material and equipment within that space. Also, it is critical that operator comfort and safety be considered in the design; the number of air changes per hour and approach to odor control will consider providing the ability to exhaust air at higher rates or provide additional odor treatment capability to allow safe and comfortable entry for periods when operations and maintenance workers need to be in normally odorous spaces.

Table 4-12 Preliminary Odor Control Ventilation Rates

FACILITY	VOLUME (CF)	FLOWRATE 3 AC/HR (CFM)	FLOWRATE 6 AC/HR (CFM)
Influent Scrubber Complex (ISC)			
Headworks(1)	3,000	150	300
Influent Equalization Basin(3)	220,000	11,000	22,000
ISC Total	**223,000**	**11,150**	**22,300**
Solids Scrubber Complex (SSC)			
Dewatering Building(1) (2)	29,000	1,450	2,900
Sludge Storage Basin(3)	27,000	1,350	2,700
SSC Total	**56,000**	**2,800**	**5,600**

(1) Includes 15 percent Contingency
(2) Includes dewatering equipment and storage/loading bins
(3) Air volume based on water surface at mid-depth.

4.5.1 Odor Treatment Technologies

A wide range of technologies exist for the treatment of odors at water reclamation facilities. Treatment can be accomplished in either the liquid or vapor phase. Technologies include, but are not limited to, biological treatment such as biofilters and biotrickling filters, scrubbers including wet (chemical) and dry (carbon), and various proprietary technologies including Vapex, hydroxyl ion fogger, and Bioxide. Each technology provides specific benefits and selection of the appropriate odor control system for any facility should be performed on a case-by-case basis addressing the specific site conditions and City's goals. For the Influent Scrubber Complex and site planning purposes, a biotrickling filter followed by carbon scrubbers would serve as the treatment methodology. The more highly concentrated odor collected from the influent channels, bar screens, and grit removal system would be treated through the biotrickling filter followed by the carbon scrubbers while the lower concentrated odor collected from equalization basin would be treated through the carbon scrubbers only. Carbon scrubbing is a reliable and highly effective odor polishing system. The Solids Scrubbing Complex would include carbon scrubbers only. While the biotrickling filter is effective in reducing high concentrations of H_2S as found at headworks, carbon is ideal for treating low H_2S concentrations and the other odorous organic compound typically found in raw dewatered sludge.

4.6 SUMMARY

In this chapter two liquid treatment alternatives were identified for further evaluation in Chapter 6.0. Treatment trains for the two alternatives are shown on Figure 4-10 and Figure 4-11. A detailed comparison of these two alternatives is provided in Chapter 6.0 of this FMP.

4.6.1 Conventional Liquid Treatment Alternative

A conventional treatment alternative was developed by evaluating unit process alternatives for each treatment step. The recommended alternative is shown on Figure 4-10. Preliminary treatment will include screening and grit removal equipment, which will be selected during the design phase of project delivery. The use of primary treatment will be further evaluated in Chapters 6.0 and 11.0. While shown in the figure, ultimately primary clarification was eliminated from the selected process as a result of the evaluation presented in Chapter 5.0.

The recommended biological treatment unit process is SBR. The recommended tertiary treatment unit processes are a combination of disc filters and membrane filters. RO treatment will be required to meet end-use water quality requirements, and it is important to note that membrane filtration is required upstream of RO. Should the end-use category (e.g. irrigation) not require RO, disc filters would be used. The recommended disinfection alternative is UV; however, for IPR (and likely future DPR), AOP using H_2O_2 is required.

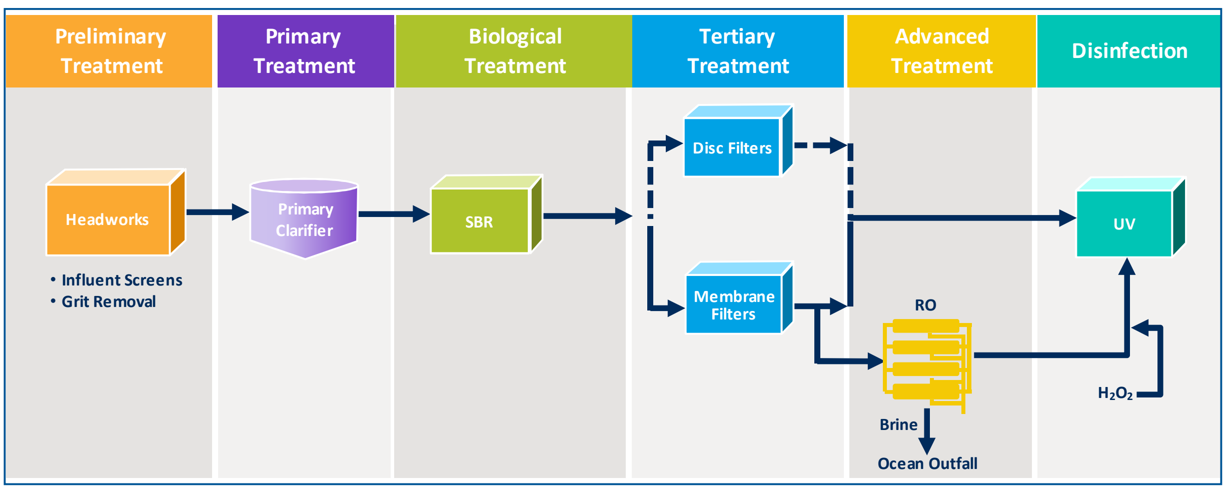


Figure 4-10 Conventional Treatment Alternative

4.6.2 Combined Secondary/Tertiary Liquid Treatment Alternative

Based on the use of MBR technology, a combined secondary/tertiary treatment alternative was developed as shown on Figure 4-11. This alternative is capable of meeting the water quality requirements for each of the end-use goals discussed in Section 4.2. The preliminary treatment, primary treatment, advanced treatment, and disinfection processes are the same as those for the conventional treatment alternative.

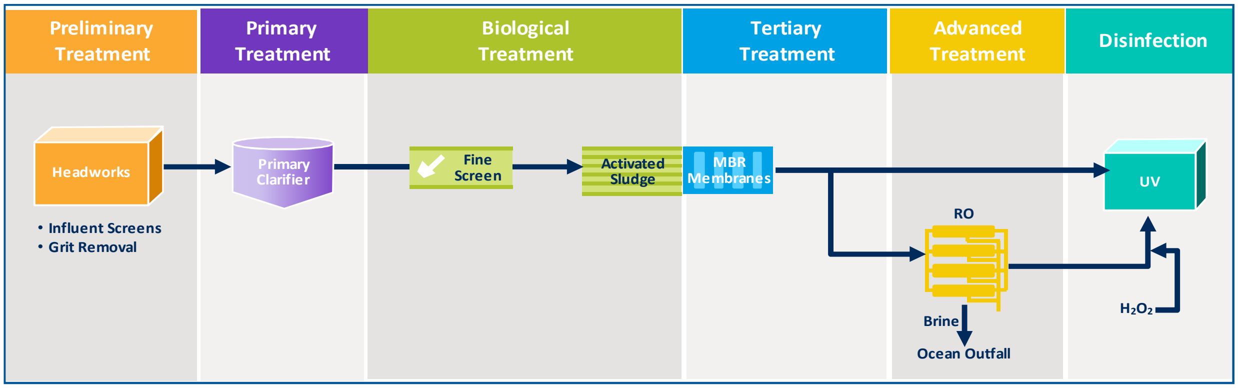


Figure 4-11 Combined Secondary/Tertiary Treatment Alternative

5.0 Solids Management/Treatment Alternatives Evaluation

5.0 Solids Management/Treatment Alternatives Evaluation

This chapter provides a summary of TM-6, Solids Management and Treatment Alternatives Evaluation . The purpose of that evaluation was to determine the preferred way for the City to handle, treat, and dispose of residual solids from the treatment process.

This chapter also provides a summary of TM-9, Organic Waste Treatment Feasibility Study. The purpose of that evaluation was to assess the potential benefits of accepting hauled waste streams at the WRF.

Pertinent data, results, and recommendations from these TMs are included herein. Refer to these TMs for additional details.

5.1 OVERVIEW

Options for the treatment and reuse or disposal of biosolids were evaluated. Biosolids are produced in the liquid treatment process when solids and liquids are separated. The biosolids may either be disposed of in a landfill or reused for beneficial purposes. Disposal and reuse of biosolids is regulated at the federal, state, and local level, where one or more treatment processes are required to further reduce the liquid content of the solids and/or to stabilize the solids.

Table 5-1 presents an overview of the discussion in this chapter.

Table 5-1 Overview of Solids Management/Treatment Alternatives Evaluation

ITEM	DESCRIPTION
Biosolids Regulations	Evaluations were based on the regulations discussed in Chapter 2.
Biosolids Treatment Alternatives	Technologies for sludge thickening (6), digestion (2), dewatering (5), composting (3), and thermal drying (3) were reviewed.
Biosolids Disposal and Reuse	Disposal options were reviewed for six landfill sites. Reuse options reviewed included: onsite composting, contracted biosolids management (three companies), and land application (San Luis Obispo, Kern, and King's Counties).
Energy Recovery	The FMP reviewed gas recovery to offset fuel consumption at the WRF. Options considered were internal combustion engines, fuel cells, gasification, and organic waste co-generation to increase biogas production.
Organic Waste Treatment Feasibility	Potential benefits of accepting hauled waste streams at the WRF were considered. Options included FOG, septic waste, RV waste, and green waste (yard waste).
Alternatives	Four biosolids treatment and alternative options were developed.

5.2 BIOSOLIDS REGULATIONS

In order to understand the selection of biosolids treatment technologies, it is important to understand that technologies are chosen to meet specific regulations, classifications, reuse and disposal goals, as well as aesthetic needs. The primary focus of current biosolids regulations is land application.

Regulations that govern the classification and land application of biosolids include the treatment plant owner's NPDES Permit/WDR issued by the SWRCB, the U.S. EPA Sewage Sludge Regulations (Federal Register 40 CFR Part 503), the SWRCB Water Quality Order No. 2004-0012 - DWQ (General Order), and any Biosolids Ordinance from the county where the biosolids are land applied. Any offsite facility that would receive biosolids must be permitted by the RWQCB through either the General Order or a site-specific permit. A review of the Federal, State, and local biosolids regulations is presented in Chapter 2.0 of this FMP.

5.3 BIOSOLIDS TREATMENT ALTERNATIVES EVALUATION

This section presents an overview of biosolids treatment technologies, discusses advantages and disadvantages of the technologies, and qualitatively compares the use of aerobic digestion without primary clarifiers versus anaerobic digestion with primary clarifiers. A summary of the biosolids treatment technologies considered is provided in Table 5-2.

Table 5-2 Solids Treatment Technologies

TREATMENT CATEGORY	TREATMENT PROCESSES/TECHNOLOGIES
Sludge Thickening	■ Gravity Thickener ■ Dissolved Air Flotation Thickening (DAFT) ■ Gravity Belt Thickener ■ Rotary Drum Thickener ■ Screw Thickener ■ Thickening Centrifuge
Digestion	■ Aerobic Digestion without Primary Clarifiers ■ Anaerobic Digestion with Primary Clarifiers
Dewatering	■ Sludge Drying Beds ■ Belt Filter Press ■ Screw Press ■ Rotary Press ■ Centrifuge
Composting	■ Windrows ■ Aerated Piles ■ In-Vessel
Thermal Drying	■ Rotary Drum Dryer ■ Fluidized Bed System ■ Screw/Paddle Dryer ■ Belt Dryer

The recommendations made in this section are intended to provide focus for the development of a new WRF while at the same time allowing for creativity and innovation during the project implementation phase. The recommendations will also provide the basis to develop conceptual space planning and construction cost budgeting for the project.

Proven technologies that have been used successfully in multiple, similar applications were considered in this evaluation. Capacity-related design criteria are provided in Chapter 6.0 of this FMP.

5.3.1 Sludge Thickening Technologies

Thickening is a process used to increase the percent solids content by removing a portion of the liquid, which can reduce pumping and storage requirements. The solids content of sludge (including primary, activated, trickling filter, and mixed) from a municipal WWTP can differ greatly depending on the production process and the method of operation. Typical solids concentration values of un-thickened sludge can be expected to be in the range of 1-6 percent total solids. Thickening is generally accomplished by physical means such as co-settling, gravity settling, flotation, centrifugation, gravity belt, or rotary drum (Tchobanoglous, Burton, & Stensel, 2003). Thickened sludge behaves as a liquid and can be pumped. In general, thickening concentrates sludge to approximately 3-6 percent solids.

Six different thickening technologies were considered for the WRF as shown in Table 5-2 above. For facilities similar in scale to the WRF, mechanical thickening processes are preferred over gravity thickening or DAFT, which occupy more space and are less efficient. The remaining four alternatives shown in Figure 5-1 are suitable to be carried forward for detailed selection during the design phase of the project.

Figure 5-1 Four Suitable Sludge Thickening Technologies: Gravity Belt Thickener (Huber Corporation, 2013), Rotary Drum Thickener (Parkson, 2013), Screw Thickener (Huber Corporation, 2013), and Thickening Centrifuge

5.3.2 Digestion

The vast majority of treatment plants stabilize solids and biosolids to reduce odors, pathogens, and the potential for putrefaction. Additionally, stabilization can be effective at volume reduction, production of valuable gas, and improving the dewaterability of sludge. Depending on the type of digestion used, 35-50 percent of the volatile suspended solids can be reduced through digestion, which significantly reduces the amount of biosolids requiring further processing or disposal (Metcalf & Eddy, Inc., 1979). Aerobic and mesophilic anaerobic digestion are the most common methods for stabilization and produce Class B biosolids. It is possible to produce Class A biosolids using thermophilic anaerobic digestion with adequate demonstration of retention time.

5.3.2.1 Aerobic Digestion

Aerobic digestion is a process through which volatile solids reduction and stabilization occurs in an oxygen rich environment. As the supply of available food is depleted, microorganisms begin to consume their own protoplasm, thereby reducing the volume of the processed biosolids. As shown on Figure 5-2, the aerobic digestion process takes place in an open-top vessel, and is used primarily in smaller sized plants (<5 mgd) due to relatively easy control of the process, relatively lower capital equipment costs (the process occurs in an open-topped vessel), and the lack of need to handle and process flammable gas. The final product can be an odorless, biologically stable end product. However, the aerobic process has a high recurring energy cost due to the need to supply oxygen. The volatile solids reduction is typically between 35-45 percent (Metcalf & Eddy, Inc., 1979), which is lower than anaerobic digestion. The resultant biosolids are not readily dewatered, further impacting recurring costs.

Figure 5-2 Aerobic Digester

5.3.2.2 Anaerobic Digestion

Anaerobic digestion involves the decomposition of organic and inorganic matter in the absence of oxygen. Anaerobic digestion is considered to be the dominant approach for stabilizing solids as a result with emphasis on energy conservation and recovery and the desire to obtain beneficial reuse of biosolids (Tchobanoglous, Burton, & Stensel, 2003). Additionally, anaerobic digestion can produce methane-rich digester gas that may be able to offset some energy needs of the plant.

Figure 5-3 Anaerobic Digester at City's WWTP

Anaerobic digestion is most commonly utilized at larger WWTP facilities and facilities with primary clarifiers since primary sludge can enhance anaerobic digester performance. The volatile solids reduction is typically between 45-50 percent (Metcalf & Eddy, Inc., 1979). The City's existing anaerobic digester is shown on Figure 5-3.

Unlike aerobic digestion, anaerobic digestion entails recycling of high ammonia loads back to the liquid stream, which can impact the design of the biological treatment system. In addition, the primary clarifiers used with anaerobic digestion reduce the carbon concentration upstream of the biological treatment system. Because a carbon source is needed for denitrification, a supplemental source of carbon may be required.

5.3.2.3 Aerobic vs. Anaerobic Digestion Evaluation

For digestion, the option of aerobic vs. anaerobic digestion was evaluated. Criteria were established to evaluate these two alternatives. A weight (% out of 100) was then assigned to each criterion. Criteria with greater impact to the project were given a higher weight. Alternatives were given scores for each criterion using a scale of 1 to 5 as shown in Table 5-3. The criteria, weighting, and scoring used for the evaluation were developed by and with City staff during a workshop on September 16, 2015. Criteria descriptions and weighting are provided in Table 5-4.

Table 5-3 Alternatives Evaluation Rating System

SCORE	DEFINITION
5	Satisfies project objectives with significant noted advantages
4	Satisfies project objectives with noted advantages
3	Satisfies project objectives
2	Satisfies project objectives with noted disadvantages
1	Satisfies project objectives with significant noted disadvantages

Treatment of external organic waste at the WRF such as FOG, septage, and other organics can impact the costs and benefits of anaerobic digestion. For the purpose of this evaluation of aerobic vs. anaerobic digestion, these types of external sources were not considered and are discussed in Section 0.

Table 5-4 Digestion Evaluation Weighting

CRITERIA	DESCRIPTION	WEIGHT %
	Capital Costs	
Digestion Facilities	This criterion compares the relative capital costs of the digestion facilities. Alternatives with lower capital cost received a higher score.	15
Primary Clarifiers (PC)	This criterion compares the relative capital costs of the primary clarifiers. Alternatives with lower capital cost received a higher score.	10
Secondary Load Reduction via PCs (smaller tankage)	This criterion compares the relative capital costs savings for secondary treatment facilities when primary clarifiers are used. Alternatives with lower secondary treatment capital cost received a higher score.	10

CRITERIA	DESCRIPTION	WEIGHT %
Operational Costs		
Digestion	This criterion compares the relative energy costs for operation of the digesters. Alternatives with lower energy cost received a higher score.	15
Secondary Load Reduction via PCs (smaller tankage)	This criterion compares the relative energy cost savings for operating of secondary treatment facilities when primary clarifiers are used. Alternatives with lower energy cost received a higher score.	10
Solids Volume Reduction (reduced hauling cost)	This criterion compares the relative cost of hauling digested sludge based on the total volume produced. Alternatives with a higher solids volume reduction received a higher score.	10
Odor Potential	This criterion compares the relative operational costs for odor treatment. Alternatives that produce less odor impact received a higher score.	15
Energy Recovery Potential	This criterion compares the relative benefits of recovering energy from the digestion process. Alternatives with higher potential for energy recovery received a higher score.	15

Table 5-5 presents a qualitative assessment of the evaluation criteria for each biological treatment alternative along with a rationale for the assessment. The qualitative assessment was used to develop the scoring in Table 5-6.

Table 5-5 Qualitative Assessment of Digestion Alternatives

CRITERIA	AEROBIC DIGESTION WITHOUT PCS	ANAEROBIC DIGESTION WITH PCS	COMMENTS
Capital Costs			
Digestion Facilities	5	3	Aerobic digesters do not require the associated gas handling and digester heating equipment and have a lower capital cost than anaerobic digesters.
PCs	3	1	Aerobic digesters do not require primary clarifiers. Anaerobic digesters require primary clarifiers, which increases the capital cost.
Secondary Load Reduction via PCs (smaller tankage)	1	3	PCs used with anaerobic digesters remove organic load and result in smaller secondary treatment aeration basins as compared to aerobic digesters.

CRITERIA	AEROBIC DIGESTION WITHOUT PCS	ANAEROBIC DIGESTION WITH PCS	COMMENTS
Operational Costs			
Digestion	3	4	Aerobic digesters require aeration that results in higher energy costs than anaerobic digesters, which only require mixing and not aeration.
Secondary Load Reduction via PCs (smaller tankage)	1	3	PCs used with anaerobic digesters remove more organic load than aerobic digesters without PCs, which reduces secondary treatment aeration cost.
Solids Volume Reduction (reduced hauling cost)	1	2	Anaerobic digestion with PCs has a higher reduction of solids volume than aerobic digestion without PCs.
Odor Potential	4	3	Anaerobic digesters produce more pungent odors compared to the musty odor associated with aerobic digestion.
Energy Recovery Potential	1	3	Anaerobic digester gas can be captured and used for energy generation unlike aerobic digesters.

Table 5-6 Matrix Evaluation of Digestion Alternatives

WEIGHT	CRITERIA	AEROBIC WITHOUT PRIMARY CLARIFIERS		ANAEROBIC WITH PRIMARY CLARIFIERS	
		Raw Score	Weighted Score	Raw Score	Weighted Score
Capital Costs					
15%	Digestion Facilities	5	0.75	3	0.45
10%	Primary Clarifiers	3	0.2	1	0
10%	Secondary Load Reduction via PC's	1	0	3	0.2
Operational Costs					
15%	Digestion	3	0.45	4	0.6
10%	Secondary Load Reduction via PC's	1	0	3	0.2
10%	Solids Volume Reduction	1	0	2	0.1
15%	Odor Potential	4	0.6	3	0.45
15%	Energy Recovery Potential	1	0	3	0.3
	Total		**2.55**		**2.85**

Evaluation of the digestion alternatives resulted in anaerobic digestion with primary clarifiers receiving the highest score.

5.3.3 Dewatering Technologies

Dewatering is a method of solids concentration and volume reduction. Generally, dewatering concentrates sludge to higher than 15 percent solids concentration, which allows the solids to be trucked in most cases. Dewatering stabilized sludge prior to disposal or reuse results in volume reduction, which reduces hauling, handling, and disposal costs. Dewatering also better prepares biosolids for composting or thermal treatment at elevated temperatures and/or pressures, further reduces odors, and allows sludge to be handled more easily (as a solid).

Dewatering processes can include passive processes, such as sludge drying beds (or solar drying), and mechanically assisted processes, such as presses or centrifuges.

Five different dewatering technologies were considered for the WRF as shown in Table 5-2. Sludge drying beds were eliminated due to odor concerns, inconsistent performance caused by seasonal fluctuations, and site space requirements. The remaining four alternatives shown on Figure 5-4 are suitable to be carried forward for final selection during the design phase of the project.

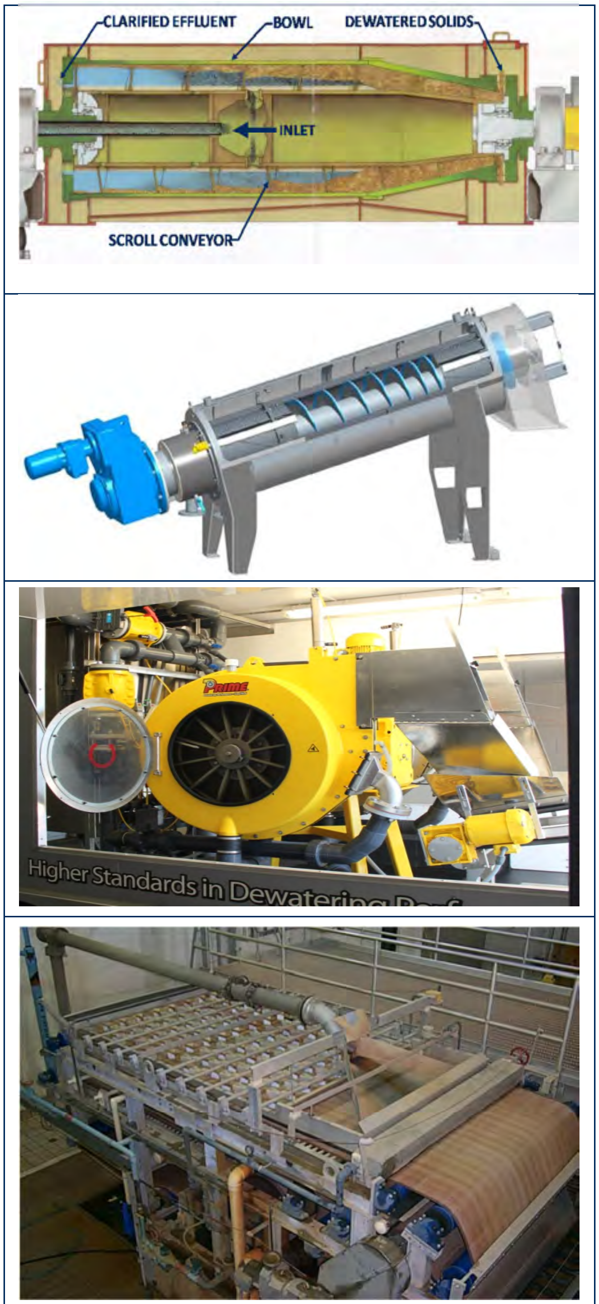


Figure 5-4 Dewatering Technologies: Centrifuge, Screw Press (Hydroflux Industrial, 2013), Rotary Press, Belt Filter Press

5.3.4 Composting

Following stabilization and dewatering, biosolids may be composted and then reused as an agricultural soil amendment or landscaping product. Composting is a natural process of aerobic, thermophilic microbiological degradation of organic matter into a stabilized product useful for agricultural and horticultural purposes. Virtually all carbonaceous, biodegradable materials are compostable under suitable environmental conditions that include appropriate moisture content, an aerobic environment, and desired carbon to nitrogen ratio. The conditions can be controlled through the addition and selection of amendment (wood chips, yard waste, etc.) and aeration or mechanical turning to provide oxygen to the microbes. In most cases, a period of maturation is required after composting where the compost is moved to a location onsite or off site and allowed to finish for a period of time before being screened and used as a soil amendment. Screening of the finished product is required to remove oversized solids and removal of residual physical contaminants.

Through composting, biosolids undergo accelerated biological degradation to produce an odor and pathogen-free product that can be utilized as a soil amendment, subject to limitations imposed by regulatory entities. Volatile organic solids are reduced, and as the organic material decomposes, the temperature of the compost increases, destroying pathogenic organisms. Class A biosolids can be produced when temperatures are raised to a minimum of 104 degrees Fahrenheit for 5 days, with a minimum of 131 degrees Fahrenheit for 4 hours. Compost can be produced through a variety of means including windrows, aerated piles, and in-vessel systems.

These three composting systems were considered for use at the WRF. Both the windrow and aerated pile systems require significant amounts of land and are prone to odor control issues. The in-vessel system has a higher capital cost, but requires less space, has a higher composting efficiency, and allows for better control of odors. The in-vessel system is the preferred method for use with the alternatives that utilize composting and is described in the following section.

5.3.4.1 In-Vessel Systems

In-vessel systems utilize enclosed reactors to contain the composting process. The term "in-vessel" includes a variety of alternatives such as: 1) fabric/membrane-covered static aerated piles; 2) contained composting vessels such as drums and container or tunnel-like systems; and 3) any type of (typically agitated) composting process located within a building envelope. For the purposes of this evaluation, the term "in-vessel" means an enclosed system similar to the drum system shown on Figure 5-5 or the container or tunnel-like system. These types of in-vessel composting systems (IVCs) have smaller footprints than the static pile or windrow methods; however, the capital cost is greater. The drum-like IVC is mechanically mixed within the fully enclosed vessel and uses forced air to keep the compost aerobic.

Figure 5-5 In-Vessel Composting System (DTEnvironmental)

The container or tunnel-like system is a fully enclosed batch process. The loaded material is not mixed so it requires adequate porosity allowing air (oxygen) to pass through: fans push the air into the plenum beneath the floor via embedded spigot pipes designed to provide even air distribution. Air flows up through the organic matter and into the head space at the top of the tunnel where it is collected, mixed with fresh air as needed, and then re-circulated into the plenum at the base of the tunnel. Some systems may be equipped with a hot water-to-air heat exchanger to control the temperature of the air flow before it is introduced into the air plenum of the IVC. Some systems may also be equipped with a floor heating system for additional IVC temperature control.

IVC systems are typically equipped with temperature sensors for enhanced process control along with monitoring and recording. In addition, because in-vessel systems are enclosed, they can be equipped with odor control systems unlike windrows and uncovered static aerated piles.

5.3.5 Thermal Drying

Thermal drying involves the application of heat to evaporate moisture from the solids, improving the handling characteristics and reducing the mass of solids for final disposal. Heat drying produces a marketable product, which meets the 40 CFR Part 503 requirements for Class A biosolids. The product retains its nutrient value after thermal treatment and is suitable for beneficial reuse as a fertilizer, soil conditioner, or fuel (biomass). A detailed market assessment and research are required if attempting to sell dry solids as a product. Determining the viability of selling dried solids as a product is a task for preliminary design.

A number of different drying technologies are available, and technology selection is determined by capacity requirements and product quality. Drying technologies are generally categorized as direct or indirect systems. For direct dryers, the solids are heated by direct contact with a hot gas. With indirect dryers, heat is transferred by conduction from the heat carrier to the biosolids through a metal surface. In general, direct drying systems require exhaust air treatment after the air is exposed to the heated biosolids.

Four thermal drying systems were considered for use at the WRF: rotary drum dryer, fluidized bed system, screw/paddle dryer, and belt dryer. Both the rotary drum dryer and fluidized bed system are typically used at facilities requiring drying capacities well above that at the WRF. They have high capital costs, require significant energy input, and have relatively high emissions. The screw/paddle dryer and belt dryer are better suited for treatment plants that are similar in size to the WRF as noted in the following sections. Both are suitable drying systems for use at the WRF with alternatives that utilize heat drying.

5.3.5.1 Screw/Paddle Dryer

Screw dryers and paddle dryers use conductive heat from heated thermal fluid to evaporate water from the biosolids. These types of dryers have been in service for over a decade in North America, offered through several vendors, including Komline-Sanderson, Fenton, and Therma-Flite. The design of each of these vendors' systems varies, but all include a cake feed hopper equipped with a feed screw or pump, a screw or paddle to move cake through the drying chamber, and a scrubber/condenser to treat dryer exhaust air, which can recover heat from condensate for other plant uses. Screw and paddle dryers are simple to start and stop; however, since the systems can also run unattended, they are often operated continuously with minimal operator oversight.

The Therma-Flite system is an example of screw dryer system. The Therma-Flite BIO-SCRU® dryer uses a hollow screw technology, with heated thermal fluid circulated through the screw and outer jacket of the drying chamber to provide heat to evaporate moisture in the dewatered biosolids.

The Therma-Flite dryer consists of five main sections as shown in Figure 5-6:

1. Feed hopper for the dewatered biosolids
2. Thermal fluid heater
3. Drying screw/chamber
4. Scrubber/condenser
5. Cooling screw

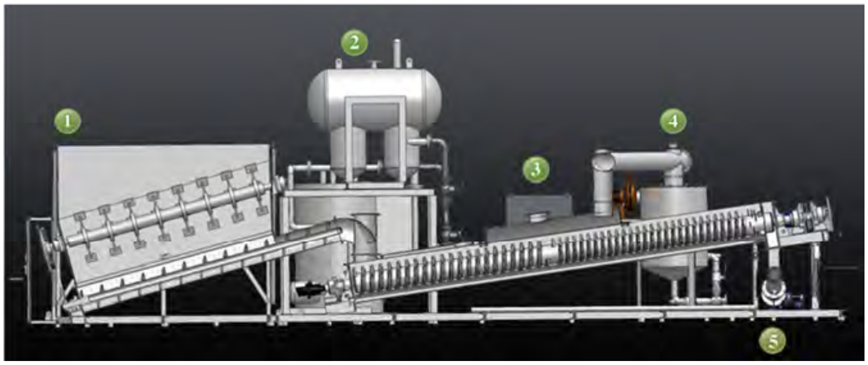


Figure 5-6 Therma-Flite BIO-SCRU Dryer (Courtesy of Therma-Flite)

5.3.5.2 Belt Dryer

A number of belt drying systems are available that pass heated air through a porous belt to dry dewatered cake. Vendors of these systems include Andritz, Huber, and STC, among others. The specific configuration varies among the vendors, but most of these systems have somewhat similar operating principles and energy requirements. The Andritz belt drying system consists of a single belt system that uses back mixing to form pellets prior to the drying process. Dewatered biosolids and a portion of the dried product are fed together to a feeding/mixing screw to achieve a combined solids concentration of approximately 55 percent TS. The mixed solids are distributed over the surface of the porous drying belt where they are exposed to the heated air flow. The air used in the drying process is heated in a burner (using natural gas or fuel oil) or indirectly in a heat exchanger (using hot water or recovered heat). After passing through the drying zone, the product is cooled to 90°C to 95°C using a belt cooler. At the end of the belt, the dried product is discharged to storage or for use in the back mixing process. Water jacketed cooling screws are typically used to cool the product prior to storage. Exhaust process air can be treated through biofilters or other odor control technology; however, there are belt drying installations without odor control that operate without complaint. An Andritz belt drying installation is shown in Figure 5-7.

Figure 5-7 Andritz Belt Dryer

Belt dryer systems differ from other drying technologies in that heat cannot be recovered for other process use. Because of the lower operating temperatures of belt dryers, waste heat is not typically suitable for digester or process heating.

Andritz has more than 30 belt dryer installations in Europe and several drying installations in operation or construction in North America.

5.4 BIOSOLIDS DISPOSAL AND REUSE

After biosolids are treated and stabilized, they must be disposed of or reused. Table 5-7 lists the disposal and reuse options considered, and where they have been applied elsewhere.

Table 5-7 Disposal and Reuse Options

DISPOSAL/REUSE	LOCATIONS OR OPTIONS
Disposal Options	■ Simi Valley Landfill ■ Kettleman Hills Landfill ■ Altamont Landfill ■ Redwood Landfill ■ Cold Canyon Landfill ■ Chicago Grade Landfill
Reuse Options	■ Onsite Composting ■ Contracted Biosolids Management ● Liberty Composting, Inc. ● Synagro ● Engle & Gray, Inc. ■ Land Application ● San Luis Obispo County ● Kern County ● Kings County

5.4.1 Disposal

Biosolids can be disposed of in landfills. According to information provided by Waste Management, the following California landfill facilities accept biosolids for disposal: Simi Valley Landfill (Simi Valley, CA), Kettleman Hills Landfill (Kettleman Hills, CA), Altamont Landfill (Livermore, CA), Redwood Landfill (Novato, CA). Biosolids disposal requirements at these facilities are as follows:

1. Moisture content must be less than 50 percent
2. Biosolids must be treated to at least Class B
3. Title 22 requirements apply
4. Transportation cost is $125/hour, portal to portal

Based on the landfill fees and transportation costs, a total disposal cost was calculated for each facility and is provided in Table 5-8. Costs are current as of the date of publication of TM-6, October 2015.

Table 5-8 Landfill Total Disposal Cost

LANDFILL	DISTANCE (MI)	DRIVE TIME (HRS)	LANDFILL FEE ($/TON)	TOTAL COST ($/TON)[1]
Simi Valley	174	3.2	65.50	**85.50**
Kettleman Hills	80	1.5	48.00	**57.38**
Altamont	229	4.2	35.00	**61.25**
Redwood	261	4.8	35.00	**65.00**

[1]Includes hauling cost of $125/hr and assumes a 20 ton truck capacity.

Two other local landfills were contacted to inquire if they accept biosolids: Cold Canyon Landfill and Chicago Grade Landfill. The information provided is discussed below.

- **Cold Canyon Landfill**

  2268 Carpenter Canyon Rd, San Luis Obispo, CA 93401
  Cold Canyon Landfill does not have a limit on the amount of biosolids they can accept; however, if the biosolids are unsuitable for their use, then they might impose their own limits. Prior to receiving any biosolids, Cold Canyon would require the City to profile and permit the biosolids to prove that they meet their acceptance criteria. This would include tests for total petroleum hydrocarbons, volatile organic compounds (VOCs), and CA Title 22 (CAM-17) Metals. They will require one sample for every 1,000 cubic yards of material.

- **Chicago Grade Landfill**

  2290 Homestead Rd, Templeton, CA 93465
  Chicago Grade Landfill accepts biosolids on a case-by-case basis and, like the Cold Canyon Landfill, they require lab analysis of the biosolids. Chicago Grade Landfill only accepts biosolids between June and September.

5.4.2 Reuse

Instead of disposal in landfills, biosolids can be reused for beneficial purposes such as soil amendment for agricultural purposes through composting and land application. The following sections provide an overview of beneficial biosolids reuse options that the City could hypothetically implement.

5.4.2.1 On-Site Composting

On-site composting utilizing an in-vessel system will produce a Class A EQ product. If the City were to decide to implement on-site composting, the City would be responsible for managing (or hiring a third party to manage) the composted biosolids and would need to develop its own resale market for the Class A product. The nearest counties where such a market might be developed include San Luis Obispo, Kings, and Kern.

5.4.2.2 Contracted Biosolids Management

Based on the type of biosolids expected to be produced at the WRF, the City has several options for contracted biosolids management. The City currently contracts with Liberty Composting in Kern County to have them haul about 270 wet tons per year of biosolids to their facility. Other facilities provide a similar service as described in the following sections.

Liberty Composting, Inc.

Liberty Composting, Inc. is located in Kern County and is permitted by CalRecycle to receive and treat biosolids produced at wastewater treatment plants. All biosolids received by Liberty Composting are composted, and the finished product is classified as Class A EQ biosolids. In addition to Class B biosolids, they can also accept dewatered sludge that does not meet class B requirements, but this will require making arrangements in advance to reserve capacity at their facility. The estimated cost to dispose of biosolids through Liberty Composting is $46/ton, which includes pickup, hauling, and tipping fees.

Synagro

Synagro provides biosolids management (including composting) similar to Liberty Composting and operates their South Kern Compost Manufacturing Facility in Kern County as well. Like Liberty, Synagro is permitted by CalRecycle to compost biosolids produced at WWTPs. All biosolids received by Synagro are currently composted and then sold to third party applicators. In addition to Class B biosolids, they can also accept dewatered sludge that does not meet class B requirements. The estimated cost to dispose of biosolids through Synagro at their South Kern Facility is $75 per wet ton, which includes pickup, hauling, and tipping fees. They have another facility in California called Central Valley Composting. The estimated cost to dispose of biosolids at this facility is $61 per wet ton.

Engle & Gray, Inc.

Engel & Gray, Inc. operates a 40-acre regional composting facility in Santa Maria, CA. Their address is 745 W Betteravia Rd. They have provided hauling of biosolids for WWTPs in San Luis Obispo and Pismo Beach. When contacted, Engel & Gray said they would accept biosolids from the WRF, but would have to negotiate with the City regarding total cost. Their tipping fee would be around $50 per wet ton based on prior quotes provided to the City.

5.4.3 Land Application

Following treatment and stabilization, biosolids can be land applied for the purpose of conditioning the soil or fertilizing crops. Nearly half of the biosolids produced in the United States are land applied to beneficially improve soils (US EPA, 2013). The types of land that may benefit from the application of biosolids include:

- Agricultural land, forests, and reclamation sites collectively called nonpublic contact sites (areas not frequently visited by the public).
- Public parks, plant nurseries, roadsides, golf courses, lawns, and home gardens (areas where people are likely to come into contact with biosolids applied to land). The Part 503 rule, however, does not regard lawns and home gardens as public contact sites, and fewer types of biosolids may be land applied to these sites.

Biosolids are generally land applied by spraying or spreading the product on the ground surface (e.g., on pastures, range and forest land, or lawn), or by tilling (incorporating) into the soil after being surface applied or injected directly below the surface. Biosolids applied to the land must meet risk-based pollutant limits specified in Part 503 and as described in Chapter 2.0 of the FMP.

The following is a description of local regulations for the land application of biosolids in San Luis Obispo, Kings, and Kern counties:

- San Luis Obispo County Ordinance No. 3080 allows one thousand five hundred cubic yards of Class A EQ biosolids to be land applied on agricultural land annually. This ordinance is in effect until March 2018 and significantly limits the ability to land apply biosolids in San Luis Obispo County. Composted biosolids are exempt from this ordinance.
- Kings County allows for the land application of Class A EQ composted biosolids.
- Kern County banned the land application of all biosolids in 2006. However, the ban has been challenged in court and is currently in litigation. A court injunction currently allows for the land application of composted biosolids pending a ruling by the court.

Other nearby counties that may allow land application of biosolids include Monterey County and Santa Barbara County. More detailed information has been requested from CalRecycle regarding biosolids land application ordinance in these counties, but was not available at the time this FMP was written.

5.5 ENERGY RECOVERY OPTIONS

In addition to reducing the volume of biosolids through anaerobic digestion, gas from the anaerobic digestion process typically contains 55-65 percent methane and 35-45 percent carbon dioxide by volume. The methane gas component can be utilized to offset fuel consumption at the plant. Gas is collected under the cover of the digester and is conveyed through piping. Gas and air are not allowed to mix as explosive conditions can result. Internal combustion engines can be fueled with digester gas to generate heat and electricity in lieu of the commercial natural gas and power supplies. Reciprocating engines and turbines (or microturbines) that have been modified to utilize methane gas are commonly used for this purpose. Heat from the engine's cooling system is utilized to heat the digester or operations buildings, and electric generators connected to the engine produce electricity. Engines can also drive pumps and blowers. Because digester gas contains contaminants such as siloxanes, hydrogen sulfide, nitrogen, and water, which can damage mechanical equipment and hinder efficient operation, gas must be cleaned and conditioned before use in internal combustion engines. Other energy recovery options include fuel cells and gasification, but were not considered to be viable options for recovering energy due to the limited amount of digester gas that would be produced at the WRF.

Determining whether energy recovery can be cost-effective at treatment facilities, and determining the payback period for investment, requires a consideration of the equipment cost, power cost, impact on operational complexity, and ongoing maintenance costs. This is provided in Chapter 6.0.

5.6 ORGANIC WASTE TREATMENT FACILITY

TM-9 evaluated the potential benefits of accepting hauled waste streams at the WRF, including:

- FOG
- Septic Waste
- RV Waste
- Green Waste (Yard Waste)

Such wastes could be accepted at the WRF to enhance energy production, provide revenue, or add a new regional benefit to the facility. FOG, septic waste and RV waste typically have a low total-solids content of less than 15 percent; FOG is often referred to as high-strength waste (HSW). Other green waste, also referred to as yard waste, has a high total-solids content typically greater than 35 percent.

Facilities and systems required to receive and process different waste types were evaluated. The benefits, risks, example layout and space requirements, and operational impacts of the waste sources are also developed and presented. The sections below summarize the evaluations for the hauled waste streams at the WRF.

5.6.1 Fats-Oil-Grease Evaluation

In recent years, there has been a growing interest in the industry to expand the use of anaerobic digestion facilities for co-digestion of FOG. The benefit appears to be multi-dimensional, since a number of states are starting to regulate the amount of FOG allowed into a sewer network in order to avoid sanitary sewer overflows. While co-digestion can be advantageous to the utility, there are also materials handling and process issues associated with FOG treatment. FOG types, existing co-digestion facilities, benefits, operational impacts, and equipment considerations were evaluated. A brief summary of the FOG projections and biogas analysis, which were used to determine the cost-benefit of accepting FOG, is provided in the following section.

5.6.1.1 FOG Projections and Biogas Potential

Oil and grease projections were provided by the City based on a survey of local restaurants. The projected quantity of available brown grease equates to 160 lbs/d or 20 gallons per day assuming medium output and an average density of 8.2 pounds per gallon (lbs/gal). Preliminary analysis suggests an increase in biogas production in the range of 1.4 to 3.0 scfm (see Table 5-9). With this limited increase in biogas production, the energy cost savings equates to around $14 per day assuming an electrical cost of $0.08 per kilowatt-hour (kW-hr). As a result, it is not expected that the capital investment in a FOG receiving and pretreatment system would be recovered through energy generation alone and so co-digestion of FOG was not carried forward for site planning purposes.

Table 5-9 Brown Grease Digestion Assumptions and Resulting Increases in Biogas Production

	Brown Grease Available		VSr[1]	Biogas Production Rate[1]	Biogas Increase from BG[2]	Biogas Increase from BG[2]
	lbs/yr	lbs/day	%	scf/lb VSr	scfd[3]	scfm[4]
Low Output	40,600	111	90	20	2,002	1.4
Medium Output	58,900	161			2,905	2.0
High Output	88,400	242			4,359	3.0

1 Grease trap waste volatile solids reduction (VSr) and biogas production rate based on project experience.
2 Biogas increase is due to conversion of brown grease to methane alone and does not include symbiotic effects for VS destruction of municipal wastewater treatment (sludge) solids, which may further increase biogas production.
3 scfd = standard cubic feet per day
4 scfm = standard cubic feet per minute

5.6.2 Septic Waste Evaluation

Septic waste is commonly accepted at WWTPs to offer a service to the community and to generate revenue through tipping fees. Septage contains high organic and suspended solids concentrations, often with a high volume of inert solids material. Screening is commonly used to remove large debris, heavy objects, and stringy material in order to protect equipment such as pumps and mixers from clogs and associated ragging issues. Removing this material will also prevent solids from settling in tanks and from clogging pipes.

5.6.2.1 Waste Characteristics

Septage characteristics can be extremely variable depending upon the source, tank size, pumping frequency, seasonal variations, and other factors. Ideally, average characteristics are determined through sampling and analysis. However, if there is a lack of information on septic waste for a given area, Table 3 from Water Environment Foundation (WEF) (see Table 5-10) can be used to provide the range and assumed "typical" characteristics for domestic septage waste; commercial source septage characteristics could vary significantly from these values.

Table 5-10 Domestic Septage Characteristics (WEF, 1994)

CONSTITUENT	CONCENTRATION (MG/L) RANGE	CONCENTRATION (MG/L) TYPICAL VALUE
Total Solids (TS)	5,000 - 100,000	40,000
Suspended Solids (SS)	4,000 - 100, 000	15,000
Volatile Suspended Solids (VSS)	1,200 - 14,000	7,000
Biochemical Oxygen Demand (BOD5)	2,000 - 30,000	6,000
Chemical Oxygen Demand (COD)	5,000 - 80,000	30,000
Ammonia	100 - 800	400
Total Phosphorus	50 - 800	250
Heavy Metals	100 - 1,000	300

Septage quantities will vary depending on service area and tipping fees as haulers often balance cost of disposal and travel time into their decision as to where to discharge. No estimates were available for expected septic waste loads at the time this FMP was prepared. As such, the following estimates were assumed in order to further evaluate septage treatment facilities:

- Septage Truck Tank Volume = 2,000 gal
- Number of Trucks per Hour = 1
- Operating Hours per Day = 8

Based on these assumptions, the WRF would receive around 16,000 gallons of septage per day, which is expected to be less than 1 percent of the overall plant capacity. A single station is appropriate for this volume of flow.

5.6.2.2 Hauled Waste Incorporation into the Treatment Process

While septic waste can have a high chemical oxygen demand (COD) content, this waste type is typically not added to anaerobic digesters due to the high inert solids contamination and the unpredictable strength and content of the individual loads. This helps protect the digesters from accumulation of inert solids as well as from process upsets due to unknown inhibitory compounds in the received waste load. Septage will be screened prior to pumping and discharge to the headworks facilities.

5.6.2.3 Operational Impacts

Septic waste will undergo pretreatment prior to discharge upstream of the screening facilities at the WRF. Septage sampling can be an important tool for operators due to the potential adverse process effects from certain loads. Sampling will allow problem loads and haulers to be identified if needed. Haulers are often asked to remove a sample from the hose during discharge and to place the sample in a nearby refrigerator. Typical sampling includes measuring basic parameters such as those listed in Table 5-10. Some plants choose to analyze a sample from each truck load while others perform analysis as needed due to observed process upsets. In addition to sampling, impacts from problem loads can also be minimized by developing contracts with only a few trusted haulers. Proper screening is important as it protects downstream piping and equipment from clogging and damage. Typically, the removed screenings are disposed of in landfills. The nature of the waste type and need for additional storage and screening equipment will require an increase in operator maintenance.

5.6.2.4 Equipment Considerations

Septage receiving typically includes a receiving station with haul identification ID and volume recording, pretreatment, a holding tank, and discharge. Haulers deliver loads to the plant in tanker trucks using a hose to transfer the load from the truck to the receiving station. The transfer may be from the truck by gravity or through a pressurization process called “air-padding.” Receiving stations will either have a gravity system or quick connect in-line treatment. A quick connect station has been selected for space planning purposes. Septage receiving stations with quick connects commonly have mechanical equipment in an in-line system. An example of a system provided by JWC Environmental is shown on Figure 5-8. This layout typically includes a rock trap to remove heavy objects such as rocks and metal, a grinder to macerate rags and other solids, a flow meter for recording flow, a screening element to remove solids, and an auger to transfer removed solids to a disposal bin. A washdown area will be provided to keep the area clean and odor free and will include a concrete washdown pad with a hose and a drain at the center to collect washdown, truck cleaning, and spillage. The drain will be routed back to the headworks.

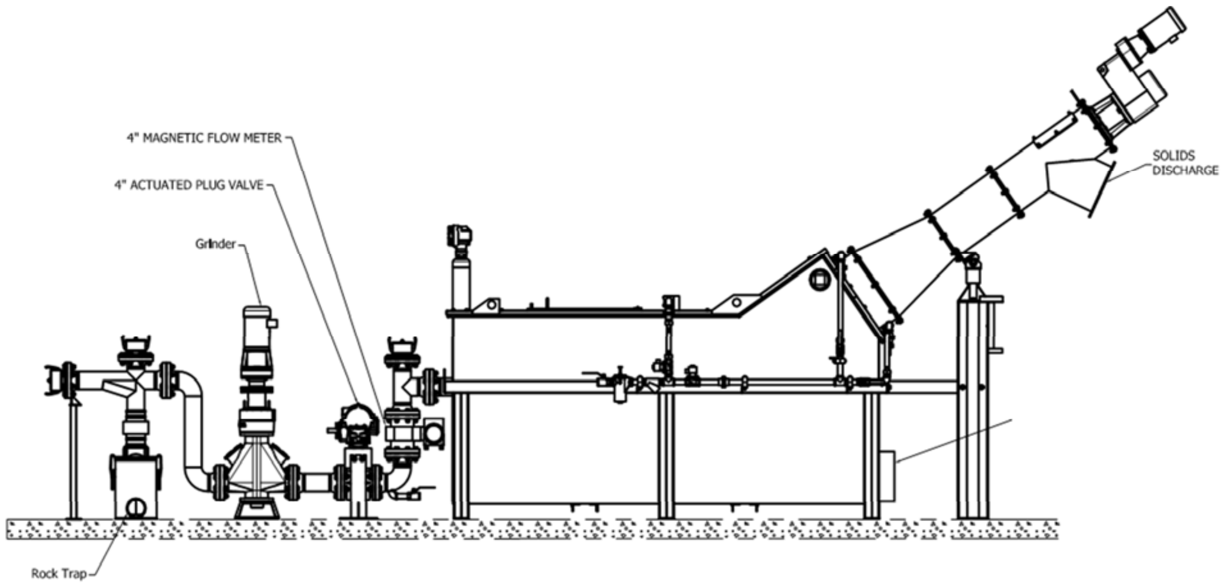


Figure 5-8 In-Line Septage Receiving Station (JWC Environmental)

5.6.3 Recreational Vehicle Waste Evaluation

The City's existing WWTP accepts waste from RVs in the Corporation Yard, and City staff have indicated that the benefits from accepting RV waste do not outweigh the costs, which include cleaning and maintenance of the receiving station and increased security and vandalism concerns. In addition, the RV Waste station at the WWTP does not get much use. For these reasons, RV waste was not included in the evaluation of potential organic waste receiving and processing facilities.

5.6.4 Green Waste Evaluation

Based on information received from San Luis Obispo County's Integrated Waste Management Authority (IWMA), the amount of green waste collected in 2014 in Morro Bay amounted to 800 tons. Green waste, also referred to as yard waste, has a high total-solids content of typically greater than 35 percent. Due to its high total solids and lignin content, yard waste is not well suited for digestion or co-digestion to increase digester gas production.

Green waste could be accepted at the WRF if the decision is made to compost biosolids onsite in the future. The composting process is most efficient when biosolids are mixed with green waste, which adds carbon and acts as a bulking agent. The City would likely contract with local landscaping companies or the local waste management company to accept deliveries of green waste, which would consist of shredded tree branches, lawn clippings, and other pruned landscape material.

5.6.4.1 Overview of County-Wide Efforts to Manage Organic Wastes

Acceptance of organic waste at the WRF would be coordinated with county-wide efforts to manage organic waste. In this case, organic waste was considered to be both green waste and source-separated organics (i.e., food waste). Information on these county-wide efforts was provided by Bill

Worrell from the IWMA of the County (Worrell, 2015) and supplemented with additional information from B&V.

With the closure of the green waste composting facility at Cold Canyon Landfill in late 2010, green waste has either been used as alternative daily cover (ADC) at the Cold Canyon Landfill or transported to Engle & Gray's composting facility in Santa Maria.

Since 2010, several new developments, including regulatory drivers related to the management of organics, are worth noting:

- In 2011, Assembly Bill (AB) B 341 was enacted, which raised the statewide diversion goal from 50 percent to 75 percent.
- In 2014, AB 1826 and AB 1594 were enacted. AB 1826 established a mandatory organics management program which will require the state's commercial sector, including restaurants, supermarkets, large venues and food processors, to separate their food scraps and yard trimmings and arrange for organics recycling service. This requirement phases in, with the first deadline commencing on April 1, 2016, for businesses that generate eight cubic yards or more of organics per week. AB 1594 eliminates the diversion credit for using green waste as alternative daily cover at the landfill commencing on January 1, 2020.
- CalRecycle and the State Water Resources Control Board both issued new compost regulations in August 2015. Effective January 1, 2016, the regulations exempt publicly owned treatment works (POTW) facilities that receive defined types of organic solid waste for co-digestion with POTW wastewater from CalRecycle's regulations. POTWs must develop standard operating procedures (SOPs) for the acceptance of anaerobically digestible material and notify the Regional Water Quality Control Board that those SOPs are being implemented.

In a concept paper issued by the California Air Resources Board (CARB) on May 7, 2015, an initial goal of organics diversion from landfills is set at 75 percent by the year 2020 followed by 90 percent organics diversion from landfills by 2025; this would result in the need for 100 new or expanded composting facilities.

The 2014 diversion rate for the County was 67 percent. To meet a 75 percent diversion goal by 2020, an additional 60,000 tons of waste must be diverted from landfills. In addition, the green waste currently being used as ADC will not be counted towards diversion starting on January 1, 2020. Given the need to increase diversion from the landfill and the AB 1826 mandate for commercial organics diversion, a comprehensive long term organics management plan is needed.

The waste management company, Waste Connections, requested proposals from Engle & Gray, Mid State Solid Waste and the technology firm Hitachi Zosen Inova (HZI) to manage all organic waste. Engle & Gray and HZI submitted responsive proposals. At the May 13, 2015, San Luis Obispo County IWMA Board Meeting, Waste Connections unveiled their plan for the long-term management of all organic waste, including food waste. The plan would incorporate the entire Waste Connections' service area from San Simeon to Nipomo and cover a 21 year period beginning in January 2016 through the end of 2037. The plan has two phases as described below.

Interim Phase (January 2016 to mid-2017): Beginning in January 2016, Waste Connections (and its subsidiaries) would expand the existing residential green waste collection program to include food waste in the same bin. At the same time, Waste Connections would roll out the organics collection program to commercial customers starting with business accounts that are required to divert organics by April 2016.

The organic waste collected from residential and commercial customers would be taken to Cold Canyon Landfill and transferred into large semi-tractor trailers (transfer trucks). The transfer trucks would then take the organics to the Engle & Gray composting facility in Santa Maria which is permitted to process both yard waste and commercial and residential organics.

Long-term Phase (mid-2017 to end of 2037): Based on the proposals, Waste Connections selected HZI to build an Anaerobic Digestion Facility applying their high-solids (high TS) continuous-flow Kompogas technology. The facility would be designed to process approximately 23,000 tons per year (tpy) of collected green waste, and residential and commercial source-separated organics. The biogas may be converted to generate power and heat or upgraded to biomethane for vehicle fuel or pipeline injection.

The HZI Anaerobic Digestion Facility would be located at Waste Connection's existing yard on Old Santa Fe Road adjacent to San Luis Obispo's Regional Airport. This industrial site is centrally located in the County's service area.

Waste Connections would enter into a long-term agreement with HZI, where HZI will build the anaerobic digestion facility at Waste Connection's yard using an existing building and Waste Connections would agree to deliver organics to the plant through 2037. In return HZI would design, build, own and operate (DBOO) the Anaerobic Digestion Facility through 2037 for a negotiated fee, subject to cost of living increases and adjustments for the sale price of electricity and/or biomethane and/or compost/compost tea and other uncontrollable costs.

If the plant is not built, then the franchise agreement would not be extended and the Interim Phase of Waste Connections transporting organic waste from the City of Morro Bay and other communities to Santa Maria for processing would continue past mid-2017.

5.7 SUMMARY OF BIOSOLIDS TREATMENT AND DISPOSAL ALTERNATIVES

Based on the disposal and reuse options presented above and workshops with the City on September 16, 2015, four alternatives were developed for biosolids treatment and disposal. These four alternatives are discussed below and are further evaluated in Chapter 6 and 11 of this FMP.

5.7.1 Alternative 1: Status Quo with Class B Digested Sludge to Liberty Composting

Alternative 1 includes thickening, anaerobic digestion, and dewatering of waste activated sludge (WAS) to produce a Class B product as shown on Figure 5-9. This alternative matches the current treatment process at the WWTP, and the City would continue contracting with a service provider, such as Liberty Composting, to haul and further process biosolids.

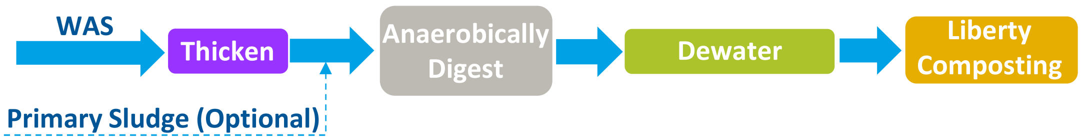


Figure 5-9 Alternative 1

5.7.2 Alternative 2: Un-Stabilized Dewatered WAS Only to Liberty Composting

Alternative 2 includes WAS dewatering only as shown on Figure 5-10. The City would continue contracting with a service provider, such as Liberty Composting, for hauling and further treatment of biosolids. Annual disposal costs will be higher than Alternative 1 due to higher liquid content of solids and increased total tonnage requiring disposal; however, capital and O&M costs will be lower due to fewer treatment processes.

Figure 5-10 Alternative 2

5.7.3 Alternative 3: Class A EQ In-Vessel Compost of Anaerobic Digested Sludge With/Without Energy Production

Alternative 3 includes thickening, anaerobic digestion, dewatering, and in-vessel composting of biosolids to produce a Class A EQ product as shown on Figure 5-11. The product can be sold or land applied as a soil amendment. In addition, energy production using digester gas is potentially viable.

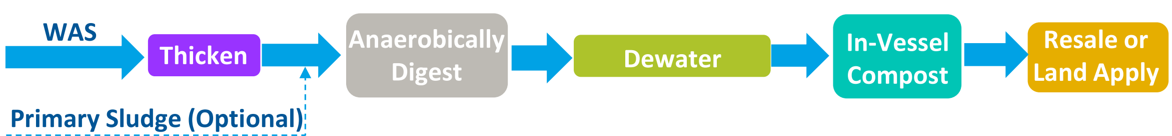


Figure 5-11 Alternative 3

5.7.4 Alternative 4: Dewatering and Thermal Drying of WAS to Landfill or Other

Alternative 4 includes dewatering followed by thermal drying for treatment of WAS to produce a Class A product as shown on Figure 5-12. The Kettleman Hills Landfill uses biosolids predominately as daily cover for their landfill. Per Waste Management, biosolids used in this manner must have a moisture content less than 50 percent. Dewatering of biosolids followed by thermal drying will achieve this level of moisture reduction. Other disposal options for thermal-dried biosolids include land application or resale.

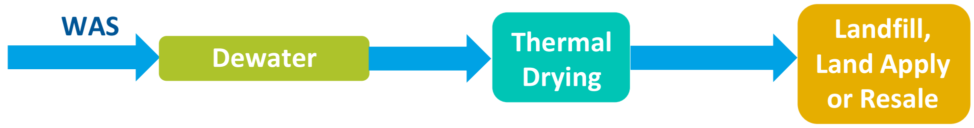
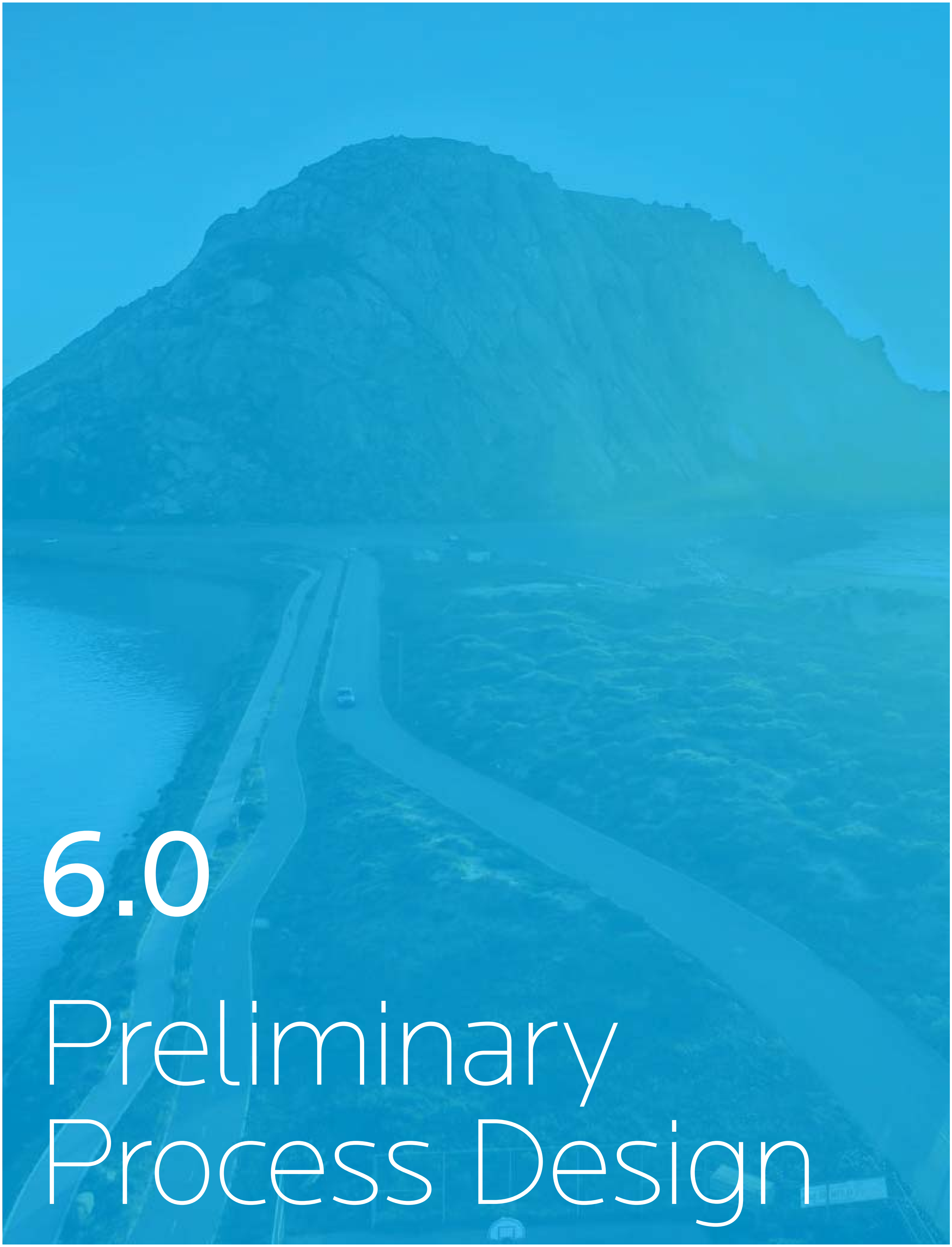


Figure 5-12 Alternative 4



6.0

Preliminary Process Design

6.0 Preliminary Process Design

This chapter presents the preliminary process design for the FMP and builds upon information developed in Chapters 2.0, 3.0, 4.0 and 5.0.

6.1 CHAPTER OVERVIEW

Table 6-1 summarizes the information discussed in this chapter.

Table 6-1 Overview of Information Presented in this Chapter

ITEM	DESCRIPTION
Basis of Design Criteria	Discusses the influent flow and load at full buildout conditions and at startup and initial operation and discusses effluent quality/permit limits.
Process Design Overview	Further develops liquid treatment technologies and solids management/ treatment alternatives evaluated in Chapters 4 and 5. Presents process schematics for SBR design with and without primary treatment and anaerobic digestion and MBR design with and without primary treatment and anaerobic digestion.
Process Flowsheets for Further Consideration	Develops the process flowsheets for the preliminary design and evaluation: Refined SBR Design Option and Refined MBR Design Option.
Design Criteria for Liquid Treatment Processes	Presents design criteria for the headworks facilities, influent flow equalization, primary treatment facilities, biological treatment process, tertiary treatment process, disinfection process, and advanced water purification facilities.
Design Criteria for Solids Treatment Processes	Presents design criteria for WAS monitoring, sludge storage tank, and sludge dewatering.

6.2 INFLUENT FLOW AND LOAD BASIS OF DESIGN

6.2.1 Full Buildout Basis of Design

Details related to the development of the flow and load basis of design for the proposed Morro Bay WRF are presented in Chapter 3. A summary of the process basis of design at full build-out conditions is provided in Table 6-2.

Table 6-2 Maximum Build-out Flow and Load Basis of Design Summary

PARAMETER	UNIT	MIN. 2-H	MIN. DAY	ANN. AVG.	MAX. MONTH	PEAK DAY	PEAK HOUR
Flow	mgd	0.32	0.67	0.97	1.16	2.75	7.03
BOD							
Concentration	mg/L	-	-	440	470	--	--
Load	lb/d	1,100	2,250	3,600	4,500	5,900	--
TSS							
Concentration	mg/L	-	-	490	540	--	--
Load	lb/d	880	1,800	3,950	5,250	7,500	--
TKN							
Concentration	mg/L	-	-	70	74	--	--
Load	lb/d	170	360	570	720	940	--

6.2.2 Design Temperatures

The design temperatures (Table 6-3) are based on influent temperature data from 2010-2014 for the MBCSD WWTP. Over these 5 years, the months of July, August, and September each experienced an average influent temperature of 22°C. A monthly average influent temperature of 17°C was observed for both January and February, 2010-2014. A minimum temperature of 14°C occurred 3 times and a maximum temperature of 24°C occurred 14 times over the evaluation period. Interestingly, 13 of the 14 occurrences of 24°C took place in 2014. Temperature data is also presented in Chapter 3.0.

Table 6-3 Influent Temperature Basis of Design

CONDITION	DESIGN TEMPERATURE (°C)
Maximum	24
Summer	22
Annual Average	19
Winter	17
Minimum	14

6.2.3 Influent Flow and Load at Start-Up/Initial Conditions

When the proposed Morro Bay WRF is commissioned, the flow and loads are not anticipated to be at the build-out conditions. Start-up of the proposed WRF is anticipated to occur around 2020 to

2021. The flow and loads at the startup condition were estimated employing the same approaches used in Chapter 3.0. A summary of the process basis of design at start-up conditions is provided in Table 6-4. The basis of design temperatures at start-up are assumed to be identical to those at build-out conditions (Table 6-3).

Table 6-4 Start-Up Flow and Load Basis of Design Summary

PARAMETER	UNIT	MIN. 2-H	MIN. DAY	ANN. AVG.	MAX. MONTH	PEAK DAY	PEAK HOUR
Flow	mgd	0.28	0.64	0.85	1.02	2.35	6.16
BOD							
Concentration	mg/L	--	--	440	470	--	--
Load	lb/d	975	2,000	3,200	4,000	5,250	--
TSS							
Concentration	mg/L	--	--	490	540	--	--
Load	lb/d	770	1,600	3,500	4,600	6,600	--
TKN							
Concentration	mg/L	--	--	70	74	--	--
Load	lb/d	150	320	500	630	830	--

6.3 PROCESS DESIGN OVERVIEW

It is the City's objective that the proposed WRF be designed to always produce, at minimum, a disinfected, tertiary effluent. Morro Bay is considering the potential effluent end uses including Title 22 unrestricted irrigation reuse, irrigation of avocado orchards, indirect potable reuse through groundwater recharge, and ocean discharge. A detailed discussion of the effluent quality goals and requirements is provided in Chapter 2.0. Chapters 4.0 and 5.0 evaluated technology alternatives for solid and liquid stream treatment to achieve the targeted effluent and biosolids qualities, respectively. The culmination of these efforts was the recommendation that two treatment process options be considered for further assessment. The two options were: (1) a conventional option employing the sequencing batch reactor (SBR) technology and (2) an option employing the membrane bioreactor (MBR) technology.

Both the SBR and MBR options were initially evaluated with multiple alternate design options. The SBR and MBR options were both assessed with and without primary clarification. Furthermore, Chapter 4.0 identified three separate tertiary treatment train alternatives corresponding to four alternative effluent end uses, including IPR, Title 22 unrestricted reuse, avocado irrigation, and discharge to an ocean outfall. Four biosolids disposal options were also considered: hauling to an offsite composting facility, landfilling, land application, and resale. Chapter 3.0 evaluated the treatment processes required to achieve these disposal options, which can be broadly categorized as options with and without anaerobic digestion for stabilization.

With multiple end use options for both the effluent and solids from the proposed WRF, there are a total of 24 process flowsheet permutations (not including possible blending of effluents treated with and without reverse osmosis (RO)). In order to facilitate an efficient process design, four process flowsheet alternatives, with multiple options within each, were developed. The four flowsheet options within each, were developed. The four flowsheet options were organized into process design alternatives based on SBR with anaerobic digestion (Figure 6-1**Error! Reference source not found.**), SBR without anaerobic digestion (Figure 6-2), MBR with anaerobic digestion (Figure 6-3), and MBR without anaerobic digestion (Figure 6-4).

For all four flowsheets, the raw influent would undergo screening and grit removal, with the screening and grit hauled offsite to a landfill. The resulting influent flow would be sampled and the flowrate measured. All process designs include an equalization basin to attenuate the influent and recycle stream flows and loads to the downstream process. The equalized flow is sent to the primary clarifiers in the SBR and MBR alternatives with anaerobic digestion, directly to the SBR, or directly to fine screens that precede the MBR in the alternatives without anaerobic digestion.

For the process designs utilizing the SBR for biological treatment, the secondary effluent flow would be equalized prior to tertiary treatment. This is because the secondary effluent flow can be intermittent due to the cyclical and batch nature of the SBR process. Three tertiary options were evaluated for the SBR to meet multiple end uses:

1. Disk filtration and ultraviolet (UV) disinfection to meet Title 22 unrestricted reuse water quality requirements and ocean discharge of the disinfected tertiary effluent.
2. Membrane filtration followed by RO and UV disinfection for avocado irrigation;
3. Membrane filtration followed by RO and a UV-advanced oxidation process (UV-AOP) for IPR.

For process designs based on the MBR, flow to the MBR would undergo fine screening in order to protect the membranes. Note that the tertiary treatment options differ from those of the SBR and include the following three that are listed:

1. UV disinfection to meet Title 22 unrestricted reuse water quality requirements or ocean discharge.
2. RO and UV disinfection for avocado irrigation. Note that use of the MBR eliminates the need for a membrane filter;
3. RO and UV-AOP for IPR. Note that at the time of this writing (Summer 2016) an MBR-RO-UV.AOP IPR project has not been permitted in the State of California.

Solids handling would be similar for the SBR and MBR design alternatives and can be categorized by the use of anaerobic digestion and primary treatment. Within the proposed design options, anaerobic digestion is only considered when primary clarification is used, as primary sludge is a major contributor to the solids load of the digester and therefore, the biogas yield. The waste activated sludge (WAS) from the SBR or MBR would be stored prior to thickening. The thickened WAS, primary sludge, and scum would be collected in the thickened sludge storage tank and pumped to the anaerobic digester. Temporary storage of these streams would enable uniform loading of the anaerobic digester. Subsequently the digested solids would be dewatered, and hauled to an offsite composing facility as Class B biosolids or composted onsite to produce a Class A product that can be sold or land applied as a soil amendment.

For the design option without primary treatment, WAS could be stored prior to the dewatering. The dewatered solids would be hauled to an offsite composting facility as unclassified biosolids or thermally dried to produce a Class A product suitable for resale, land application, or landfill coverage.

Waste from the disc filters and/or the membrane filtration process, along with supernatant from the thickeners and dewatering units, and possibly the compost vessels would be sent to the influent equalization basin.

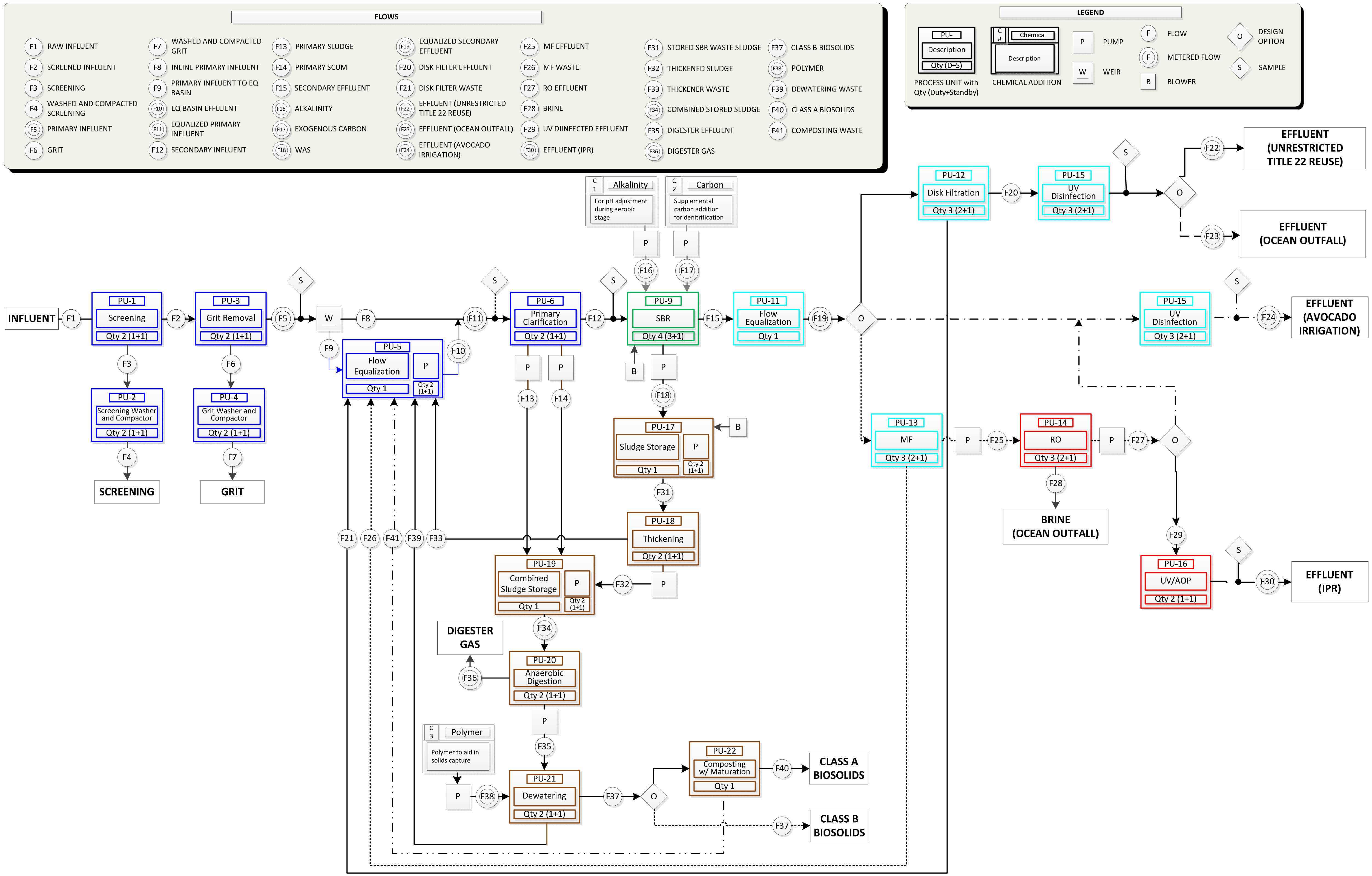


Figure 6-1 SBR Design Option with Primary Treatment and Anaerobic Digestion

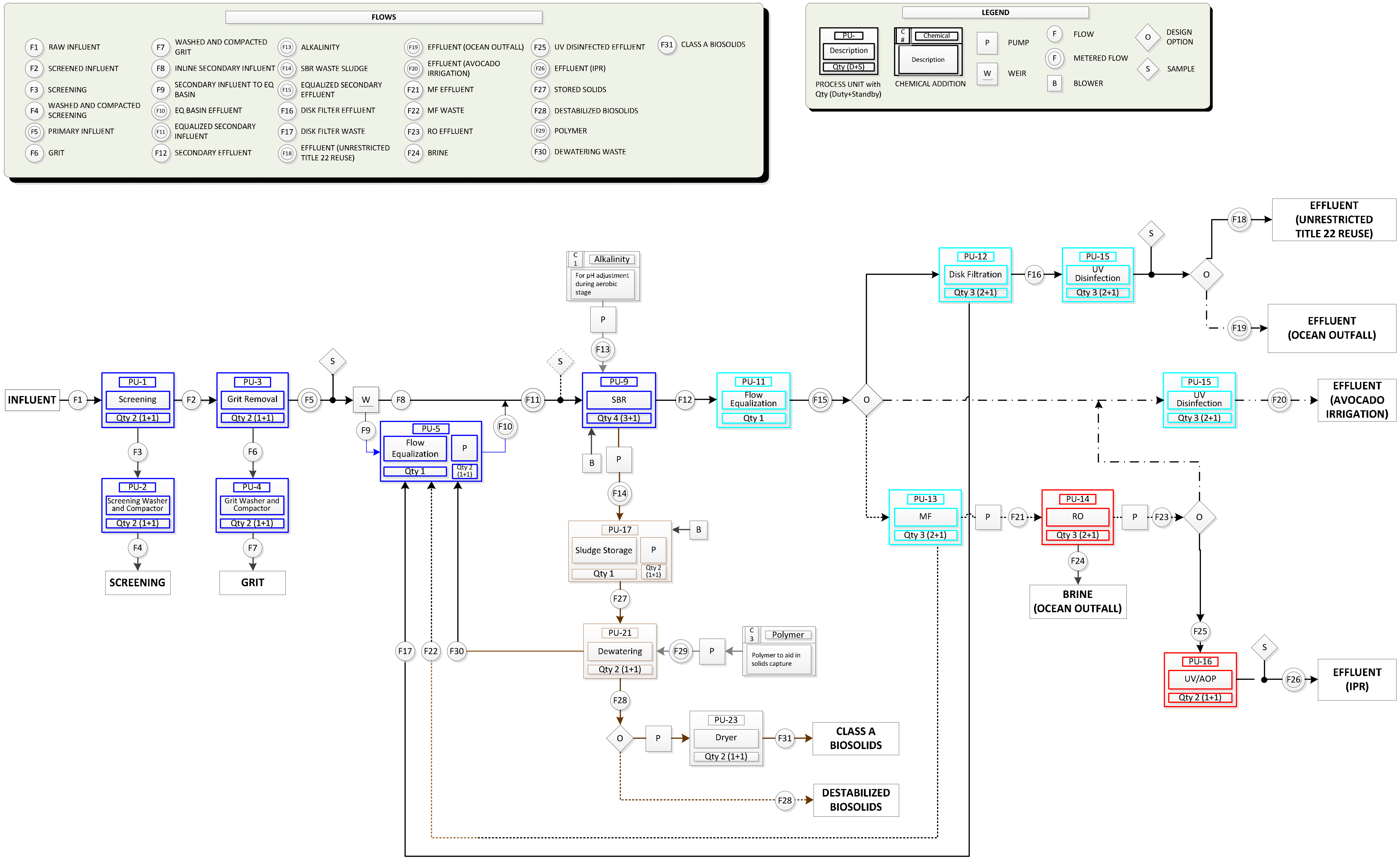


Figure 6-2 SBR Design Option without Primary Treatment and Anaerobic Digestion

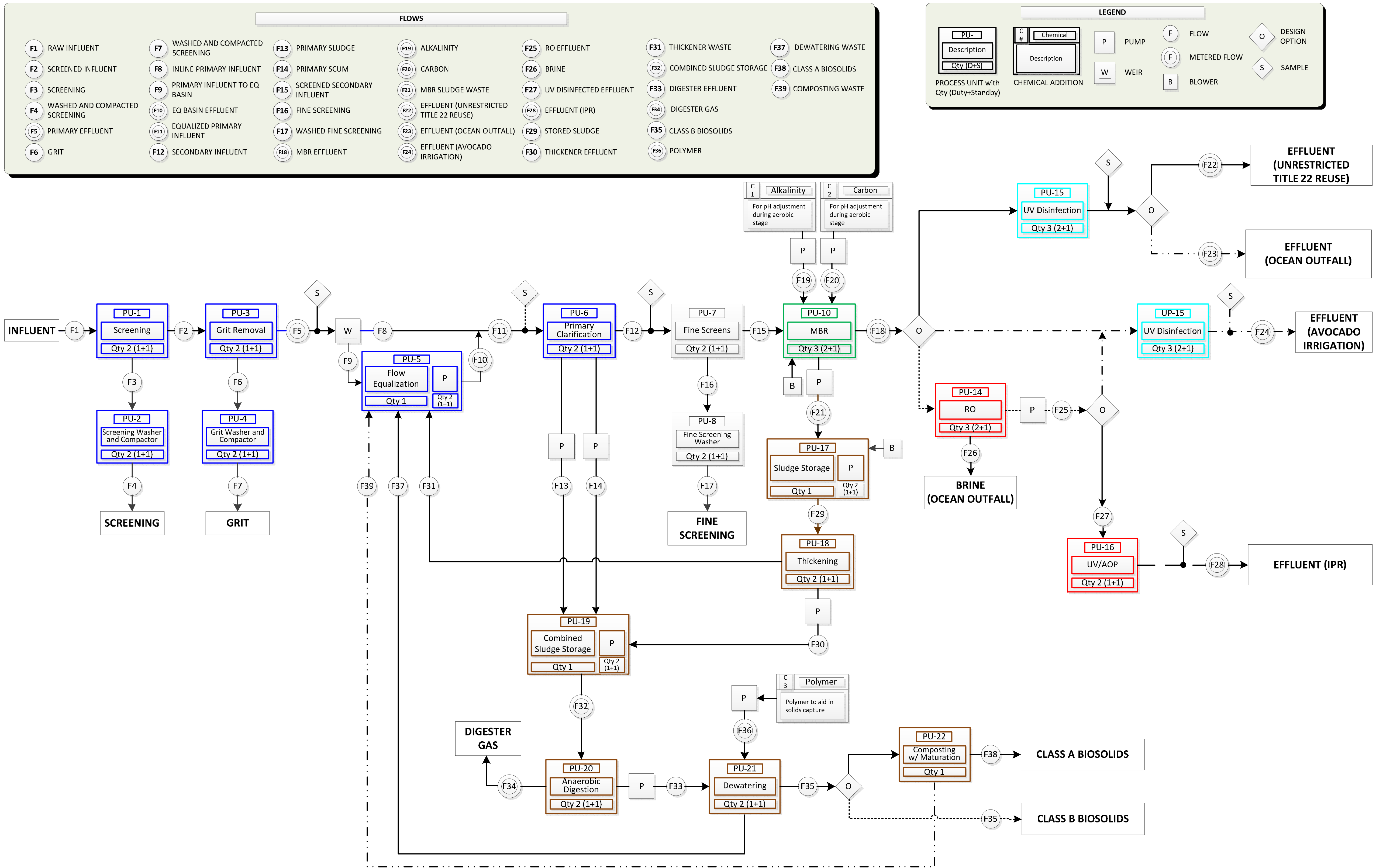


Figure 6-3 MBR Design Option with Primary Treatment and Anaerobic Digestion

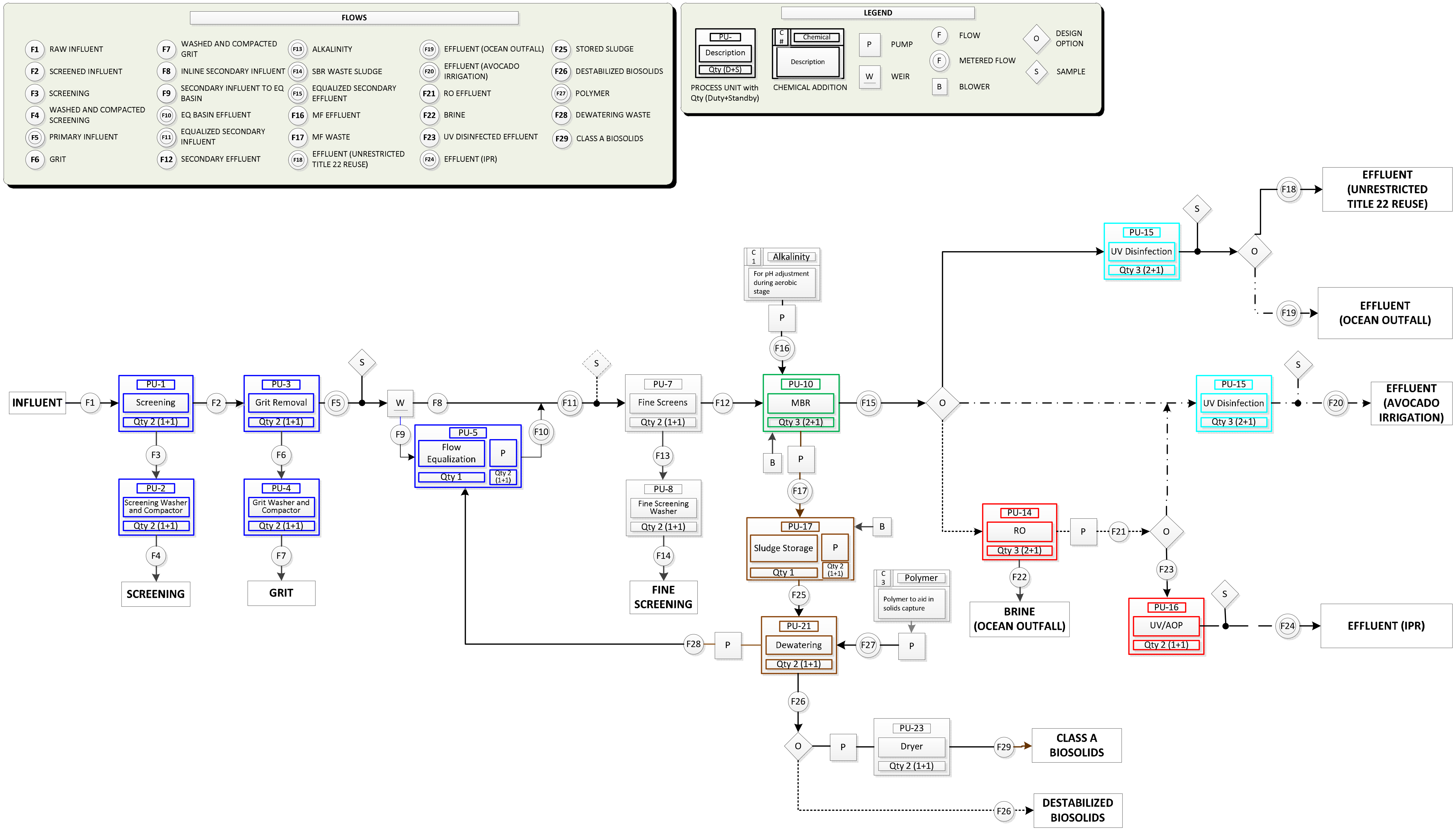


Figure 6-4 MBR Design Option without Primary Treatment and Anaerobic Digestion

6.4 SELECTION OF PROCESS FLOWSHEETS FOR FURTHER CONSIDERATION

As part of the development of this FMP, the four flowsheets shown in Figure 6-1 to Figure 6-4 were presented to City staff. Discussions focused on two elements of the integrated process design:

- ***Solids Handling Options***. As noted in the four flowsheets, the design permutations include a range of unit operations to achieve solids of varying quality. City staff were able to confirm that the current disposal option for destabilized waste sludge will be available at the current cost for the foreseeable future. Preliminary analysis suggested that, with the inclusion of anaerobic digestion and primary clarifiers, the costs to construct and operate those facilities outweigh the energy production benefits. Integration of a biosolids digestion and dewatering system did not present a net benefit to the City. Therefore, SBR and MBR process design options will include only dewatering of WAS, which will be hauled offsite for regional composting and reuse.
- ***Tertiary Filtration Options for the SBR Process Design***. Both SBR process design options include: (1) disk filtration to achieve unrestricted Title 22 reuse options and ocean discharge and (2) membrane filtration (microfiltration (MF) or ultrafiltration (UF)) as pretreatment for RO. The City has emphasized that the overarching goal for the new WRF is to offset potable water use rather than simply dispose a highly treated effluent to the ocean. In consideration of this goal, the project team (City, Program Manager, and B&V) discussed the merits of using only membrane filtration downstream of the SBR. This would have the benefit of setting up the WRF for relatively seamless integration of an advanced water purification (AWP) facility in the future for potable reuse. However, there would be an increase in the operating costs of the facility in the initial period of operation as membrane filtration is typically more expensive to operate than disk filters. City staff noted that this marginal increase in operating costs may be smaller than the cost of leaving the disk filters as stranded assets once a potable reuse program is underway in Morro Bay. Therefore, the SBR process option will be designed using membrane filtration downstream of the SBR.

As a result of these decisions, the FMP preliminary design and evaluation focused on two process flowsheets - the Refined SBR option (

Figure 6-5) and the Refined MBR option (

Figure 6-6).

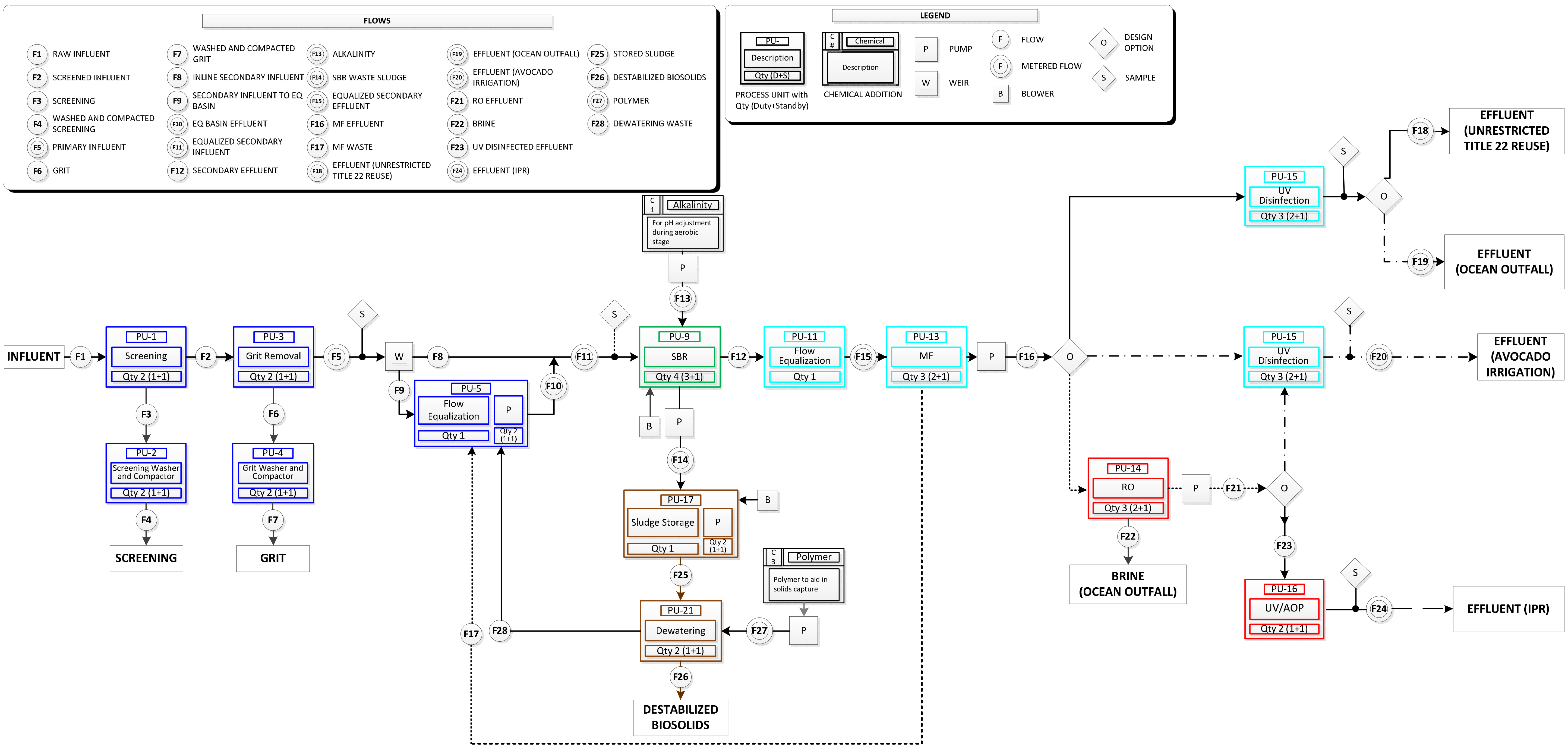


Figure 6-5 Refined SBR Option

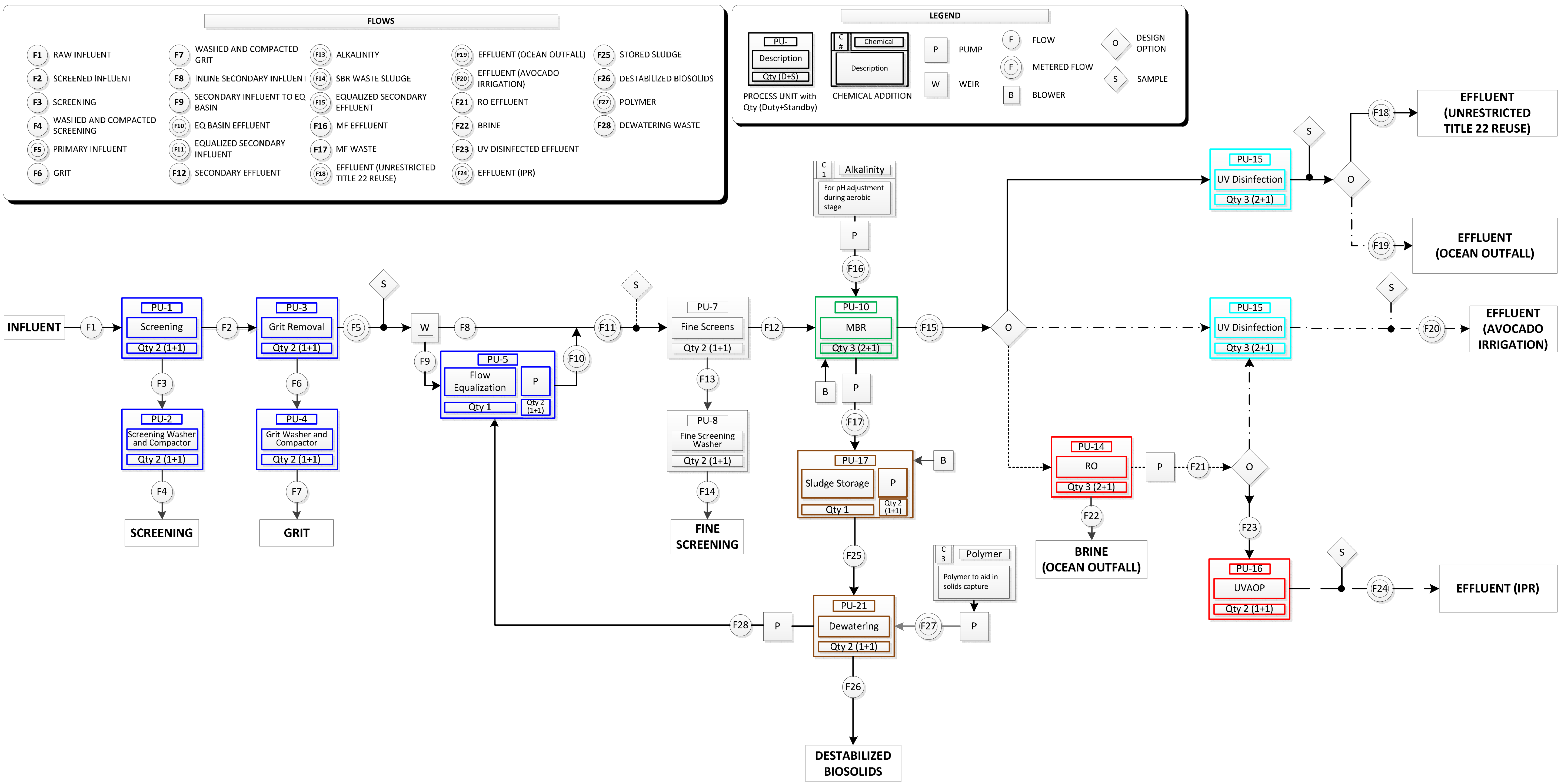


Figure 6-6 Refined MBR Option

6.5 DESIGN CRITERIA FOR PRELIMINARY TREATMENT PROCESSES

The following sections provide preliminary sizing criteria for the various unit processes for the two holistic treatment trains/flow sheets being evaluated. Note that these are preliminary in nature for purposes of site planning and budget development. The final criteria will be developed and selected in subsequent phases of project planning and design.

6.5.1 Headworks Facilities

Raw influent would undergo preliminary treatment in the headworks facilities. The influent would be screened using mechanical bar screens (Table 6-5), and grit would be removed using a vortex grit removal system (Table 6-6). Both the screening washer/compactor (Table 6-7) and the grit washer/compactor (Table 6-8) separate the organics from the screenings and return the washings to the liquid mainstream, upstream of the screens, for treatment. The screenings and grit also would be dewatered to significantly reduce the volume for landfill disposal. The washed and dewatered screenings and grit would be hauled offsite to a landfill.

In the following design criteria tables, the applicable process unit (PU) number is designated, corresponding to the numbering system in

Figure **6-5** and

Figure 6-6.

6.5.2 Screening (PU-1)

Table 6-5 Design Criteria for Influent Screening

DESIGN CRITERIA	VALUE
Type	Mechanical bar screen
Total number of units	2 (1 duty + 1 standby)
Basis of design criteria	Each screen designed for PHF
Design flow	7 mgd
Bar spacing (clear opening)	1/4-inch (6-mm)
Approach velocity design criteria	
Minimum	1.2 ft/s
Maximum	4 ft/s
Angle of inclination from horizontal	60 degrees
Materials of construction	Type 316 SS

6.5.3 Grit Removal (PU-2)

Table 6-6 Design Criteria for Grit Removal

DESIGN CRITERIA	VALUE
Grit removal type	Vortex
Total number of units	2 (1 duty + 1 standby)
Basis of design criteria	Each grit chamber designed for PHF (designed for high efficiciency grit removal at lower flow conditions)
Design flow	7 mgd

6.5.4 Screening Washer and Compactor (PU-3)

Table 6-7 Design Criteria for Screening Washer and Compactor

DESIGN CRITERIA	VALUE
Type	Screw screenings/compactor
Total number of units	2 (1 duty + 1 standby)
Basis of design criteria	Screenings related to PHF

6.5.5 Grit Washer and Compactor (PU-4)

Table 6-8 Design Criteria for Grit Washer and Compactor

DESIGN CRITERIA	VALUE
Type	Grit Washer/Classifier
Total number of units	1
Basis of design criteria	Grit related to PHF

6.5.6 Influent Flow Monitoring

The first monitoring location, downstream of screening and grit removal, would be used to measure the influent flow to the facility and trigger the diversion of flow to and from the equalization basin. For this measurement, a Parshall Flume is recommended with design criteria as outlined in Table 6-9.

Table 6-9 Design Criteria for Influent Flow Monitoring Downstream of Headworks

DESIGN CRITERIA	VALUE
Flow meter type	Parshall flume
Total number of units	1
Basis of design criteria	PHF
Design flow	0.2 – 7.2 mgd
Throat width	1 ft
Minimum upstream straight channel length	12 ft
Minimum downstream straight channel length	3 ft
Level measurement device type	Ultrasonic

6.5.7 Influent Sampling

An influent sampling station is recommended downstream of the headworks facility to obtain water quality parameters. The design criteria for the influent sampler are provided in Table 6-10.

Table 6-10 Design Criteria for Influent Sampler

DESIGN CRITERIA	VALUE
Sampler type	Refrigerated composite sampler
Sampling strategy	Flow proportional (to influent flow)

6.5.8 Influent Flow Equalization

6.5.8.1 Equalization Basin (PU-5)

The flow equalization basin would be sized such that all downstream facilities would treat the equalized peak day flow (PDF). A multiple compartment, offline flow equalization tank with a single pump station is recommended, following the design criteria given in Table 6-11. In this way, the equalization tank may be effectively maintained with separate compartment(s) taken offline for maintenance without loss of utility. Details related to equalization tank sizing are provided in Appendix G. In summary, historical hourly flow data from 2003-2014 were used to estimate projected flows at design conditions. Flows exceeding PDF were assumed to be diverted to the equalization basin and the basin was emptied up to an equalized flow of PDF when influent flows came in under the PDF limit. The highest required storage volume was used to size the basin, with a safety factor of 1.2 implemented.

Mixing in the equalization tank is recommended to reduce settling and minimize odors. The equalization pumps would be designed to pump the stored influent flow back into the main liquid stream as treatment capacity is available.

Table 6-11 Design Criteria for Influent Flow Equalization

DESIGN CRITERIA	VALUE
Type	Offline equalization tank
Number	1
Tank type	Concrete tank (sloped to pump location)
Basis of design criteria	Wet weather equalization
Volume	3.3 MG
No. of compartments	3 (with overflow between compartments)
Aeration/Mixing	Recommended
Type	Coarse bubble diffusers or jet mixing
Basis of design	20 scfm/1000 cf
Equalization pumps	
Number of pumps	4 (3 duty +1 standby)
Type	Submersible
System Design Capacity (gpm)	200 – 1,700
Design Capacity Each (gpm @ total dynamic head (TDH))	200 – 560 @ 40 ft[1]
Control	VFD

[1] Note that TDH requirements are only preliminary and may be revised as the design is developed.

6.5.8.2 Equalized Flow Monitoring

Flow monitoring would be required on the equalization basin effluent, in order to correctly proportion the equalization basin contribution according to the dynamic nature of the influent. In addition, the combined main stream and equalization basin flow would be monitored to track the total primary effluent or secondary influent. The recommended monitoring location and metering type are provided in Table 6-12 and Table 6-13. Both meters must accommodate peak hourly flow (PHF).

Table 6-12 Design Criteria for Flow Monitoring of Equalization Basin Effluent

DESIGN CRITERIA	VALUE
Flow meter type	Magmeter
Total number of units	1
Basis of design criteria	PHF
Design flow	7 mgd

Table 6-13 Design Criteria for Flow Monitoring of Combined Flow

DESIGN CRITERIA	VALUE
Flow meter type	Magmeter
Total number of units	1
Basis of design criteria	PHF
Design flow	7 mgd

6.5.8.3 Equalized Flow Sampling

Sampling of the flow downstream of the equalization basin is recommended, but not required. This sampling location would be beneficial to the optimization of the downstream process. The design criteria for the influent sampler are provided in Table 6-14.

Table 6-14 Design Criteria for Equalized Flow Sampler

DESIGN CRITERIA	VALUE
Sampler type	Refrigerated composite sampler
Sampling strategy	Flow proportional

6.5.9 Fine Screening Facilities

6.5.9.1 Fine Screens (PU-7)

Fine screens would be required to protect the membranes of the MBR from debris, such as hair that can get tangled in the membranes. The design criteria for the fine screens are provided in Table 6-15. The fine screening material would be hauled offsite to a landfill with the screening and grit from the headworks.

Table 6-15 Design Criteria for Fine Screens

DESIGN CRITERIA	VALUE
Type	Rotary perforated plate
Opening size	2 mm or smaller
Number	2 (1 duty + 1 standby during annual average flow)
Basis of design criteria	Each designed for PDF
Hydraulic loading rate	– 2.75 mgd

6.5.10 Hydraulic Profile

Hydraulics for the plant will be detailed during the design phase, however, a preliminary plant hydraulic profile was developed using an average annual flow of 0.97 MGD. The preliminary hydraulics served as a basis for calculation of the plant O&M costs discussed in a subsequent chapter of the FMP. Figure 6-7 provides the preliminary hydraulic profile for the plant liquid treatment process facilities.

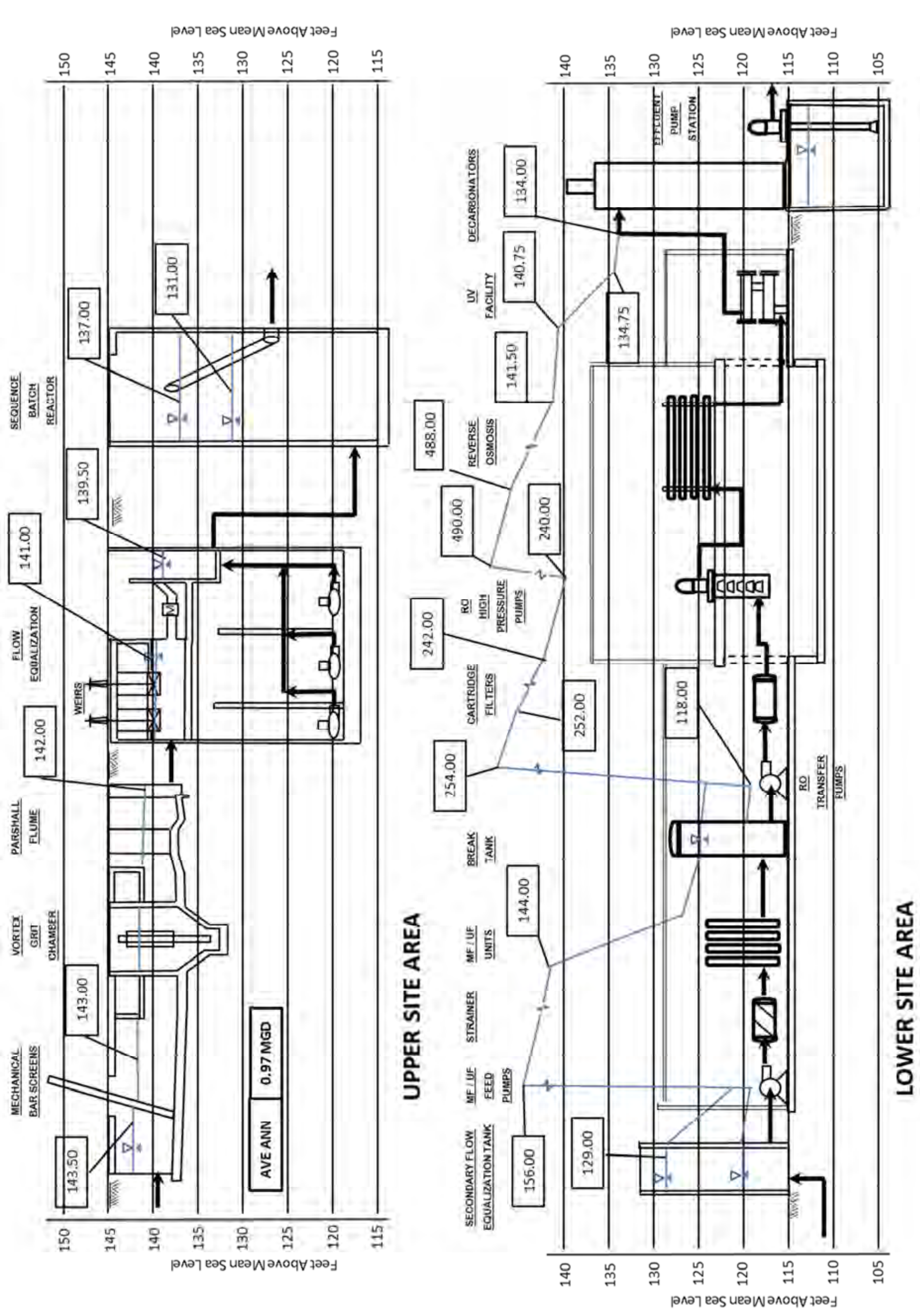


Figure 6-7 Hydraulic Profile

6.6 DESIGN CRITERIA FOR BIOLOGICAL TREATMENT PROCESS OPTIONS

6.6.1 Overview of Biological Treatment Process Design Criteria

It is recommended that the biological treatment process (SBR or MBR) be designed based on the maximum month (MM) flow and load conditions with the capacity to hydraulically accept the equalized PDF. The biological treatment process was designed to achieve the secondary effluent quality noted in Table 6-16.

Table 6-16 General Design Criteria for Biological Process

DESIGN CRITERIA	VALUE
Basis of Design Criteria	
Pollutant load	MM
Hydraulic capacity	PDF
Target biological process performance	
Biochemical oxygen demand	≤ 10 mg/L
Total nitrogen	≤ 10 mg/L
Total phosphorus	N/A
Minimum design solids retention time (SRT)	10 d
Aerobic	7.5 days
Anoxic	2.5 days

6.6.2 Biological Treatment Process Modeling

Two separate process models were developed to evaluate SBR and MBR sizing based on the process flow designs depicted in Figure 6-5 and Figure 6-6. These models were subsequently used to estimate projections for effluent concentrations, biosolids production, recycle stream flows and loads, and oxygen utilization, which are used to size and design ancillary facilities.The process models were developed using BioWin™ version 5.0, a commercially available process simulator. Process model schematics, in addition to modeling assumptions and biokinetic and stoichiometric parameters, are included in Appendix E.

Mass balances for the SBR and MBR process flow designs are provided for annual average (AA) and MM winter conditions in Table 6-17 through Table 6-20. The mass balances were defined for treatment options achieving Title 22 quality effluent. Streams with negligible flows or loads were omitted from the tables (e.g., screenings). Contributions by polymer or alkalinity flows are not included.

Table 6-17 Mass Balance for the SBR Option under AA Conditions

The flow numbers specified in the tables correspond to the flows defined in

Figure 6-5.

			LOADS							CONCENTRATIONS						
STREAM NUMBER	STREAM NAME	FLOW	TSS	VSS	COD	CBOD	TKN	NH4	NOX	TSS	VSS	COD	CBOD	TKN	NH4	NOX
		GPD	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
F1	Raw Influent	970,000	3,976	3,157	7,382	3,562	567	374	0.0	491	390	912	440	70	46	0.0
F2	Screened Influent	970,000	3,976	3,157	7,382	3,562	567	374	0.0	491	390	912	440	70	46	0.0
F5	Primary Influent	970,000	3,976	3,157	7,382	3,562	567	374	0.0	491	390	912	440	70	46	0.0
F11	Equalized Secondary Influent	1,157,238	4,248	3,345	7,733	3,647	587	375	4.2	440	346	801	378	61	39	0.4
F12	Secondary Effluent	1,078,566	113	78	538	44	33	3.4	24	13	8.7	60	4.8	3.6	0.4	2.7
F14	WAS	81,422	3,183	2,200	3,280	974	192	0.3	1.8	4,685	3,237	4,827	1,433	282	0.4	2.7
F15	Equalized Secondary Effluent	1,078,566	113	78	538	44	33	3.4	24	13	8.7	60	4.8	3.6	0.4	2.7
F16	MF Permeate	970,709	0.1	0.1	381	8.2	23	3.1	22	0.0	0.0	47	1.0	2.9	0.4	2.7
F17	MF Waste	107,857	113	78	157	35	9.3	0.3	2.4	125	87	175	39	10	0.4	2.7
F18	Effluent (Unrestricted Title 22 Reuse)	970,709	0.1	0.1	381	8.2	23	3.1	22	0.0	0.0	47	1.0	2.9	0.4	2.7
F25	Stored Sludge	81,422	3,183	2,200	3,280	974	192	0.3	1.8	4,685	3,237	4,827	1,433	282	0.4	2.7
F26	Destabilized Solids	2,041	3,024	2,090	3,087	924	180	0.0	0.1	177,554	122,690	181,219	54,274	10,593	0.4	2.7
F27	Dewatering Overflow	79,381	159	110	194	49	11	0.3	1.8	240	166	292	74	17	0.4	2.7

Table 6-18 Mass Balance for the SBR Option under MM (Winter) Conditions

The flow numbers specified in the tables correspond to the flows defined in

Figure 6-5.

			LOADS							CONCENTRATIONS						
STREAM NUMBER	STREAM NAME	FLOW	TSS	VSS	COD	CBOD	TKN	NH4	NOX	TSS	VSS	COD	CBOD	TKN	NH4	NOX
		GPD	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
F1	Raw Influent	1,160,000	5,240	4,182	9,501	4,550	716	473	0.0	541	432	981	470	74	49	0.0
F2	Screened Influent	1,160,000	5,240	4,182	9,501	4,550	716	473	0.0	541	432	981	470	74	49	0.0
F5	Primary Influent	1,160,000	5,240	4,182	9,501	4,550	716	473	0.0	541	432	981	470	74	49	0.0
F11	Equalized Secondary Influent	1,349,322	5,648	4,466	9,999	4,680	746	474	5.3	502	397	888	416	66	42	0.5
F12	Secondary Effluent	1,289,896	200	139	748	74	45	5.5	36	19	13	70	6.9	4.2	0.5	3.3
F14	WAS	62,976	4,177	2,901	4,309	1,317	253	0.3	1.8	7,948	5,520	8,198	2,505	480	0.5	3.3

			LOADS							CONCENTRATIONS						
STREAM NUMBER	STREAM NAME	FLOW	TSS	VSS	COD	CBOD	TKN	NH4	NOX	TSS	VSS	COD	CBOD	TKN	NH4	NOX
		GPD	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
F15	Equalized Secondary Effluent	1,289,896	200	139	748	74	45	5.5	36	19	13	70	6.9	4.2	0.5	3.3
F16	MF Permeate	1,160,906	0.2	0.1	490	10	30	5.0	32	0.0	0.0	51	1.1	3.1	0.5	3.3
F17	MF Waste	128,990	199	138	259	64	15	0.6	3.6	185	129	240	59	14	0.5	3.3
F18	Effluent (Unrestricted Title 22 Reuse)	1,160,906	0.2	0.1	490	10	30	5.0	32	0.0	0.0	51	1.1	3.1	0.5	3.3
F25	Stored Sludge	62,976	4,177	2,901	4,309	1,317	253	0.3	1.8	7,948	5,520	8,198	2,505	480	0.5	3.3
F26	Destabilized Solids	2,644	3,968	2,756	4,069	1,250	238	0.0	0.1	179,864	124,919	184,425	56,670	10,805	0.5	3.3
F27	Dewatering Overflow	60,332	209	145	240	66	14	0.3	1.7	415	288	476	132	28	0.5	3.3

Table 6-19 Mass Balance for the MBR Option under AA Conditions

The flow numbers specified in the tables correspond to the flows defined in Figure 6-6.

			LOADS							CONCENTRATIONS						
STREAM NUMBER	STREAM NAME	FLOW	TSS	VSS	COD	CBOD	TKN	NH4	NOX	TSS	VSS	COD	CBOD	TKN	NH4	NOX
		GPD	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
F1	Raw Influent	970,000	3,976	3,157	7,382	3,562	567	374	0.0	491	390	912	440	70	46	0.0
F2	Screened Influent	970,000	3,976	3,157	7,382	3,562	567	374	0.0	491	390	912	440	70	46	0.0
F5	Primary Influent	970,000	3,976	3,157	7,382	3,562	567	374	0.0	491	390	912	440	70	46	0.0
F11	Equalized Secondary Influent	996,545	4,126	3,259	7,543	3,602	576	374	1.5	496	392	907	433	69	45	0.2
F12	Screened Secondary Influent	996,545	4,126	3,259	7,543	3,602	576	374	1.5	496	392	907	433	69	45	0.2
F15	Secondary Effluent	971,340	0.0	0.0	380	7.9	21	1.0	54	0.0	0.0	47	1.0	2.6	0.1	6.7
F17	WAS	28,255	2,999	2,029	3,015	801	174	0.0	1.6	12,720	8,607	12,785	3,395	738	0.1	6.7
F18	Effluent (Unrestricted Title 22 Reuse)	971,340	0.0	0.0	380	7.9	21	1.0	54	0.0	0.0	47	1.0	2.6	0.1	6.7
F25	Stored Sludge	28,255	2,999	2,029	3,015	801	174	0.0	1.6	12,720	8,607	12,785	3,395	738	0.1	6.7
F26	Destabilized Biosolids	1,710	2,849	1,928	2,854	760	165	0.0	0.1	199,666	135,099	199,998	53,276	11,539	0.1	6.7
F28	Dewatering Overflow	26,545	150	101	161	40	9.3	0.0	1.5	677	458	725	182	42	0.1	6.7

Table 6-20 Mass Balance for the MBR Option under MM (Winter) Conditions

The flow numbers specified in the tables correspond to the flows defined in Figure 6-6.

			LOADS							CONCENTRATIONS						
STREAM NUMBER	STREAM NAME	FLOW	TSS	VSS	COD	CBOD	TKN	NH4	NOX	TSS	VSS	COD	CBOD	TKN	NH4	NOX
		GPD	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	LB/D	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L
F1	Raw Influent	1,160,000	5,240	4,182	9,501	4,550	716	473	0.0	541	432	981	470	74	49	0.0
F2	Screened Influent	1,160,000	5,240	4,182	9,501	4,550	716	473	0.0	541	432	981	470	74	49	0.0
F5	Primary Influent	1,160,000	5,240	4,182	9,501	4,550	716	473	0.0	541	432	981	470	74	49	0.0
F11	Equalized Secondary Influent	1,200,165	5,435	4,315	9,714	4,604	729	473	2.1	543	431	970	460	73	47	0.2
F12	Screened Secondary Influent	1,200,165	5,435	4,315	9,714	4,604	729	473	2.1	543	431	970	460	73	47	0.2
F15	Secondary Effluent	1,161,620	0.0	0.0	488	9.4	26	1.4	62	0.0	0.0	50	1.0	2.7	0.2	6.4
F17	WAS	42,395	3,906	2,650	3,939	1,069	228	0.1	2.3	11,039	7,491	11,132	3,022	644	0.2	6.4
F18	Effluent (Unrestricted Title 22 Reuse)	1,161,620	0.0	0.0	488	9.4	26	1.4	62	0.0	0.0	50	1.0	2.7	0.2	6.4
F25	Stored Sludge	42,395	3,906	2,650	3,939	1,069	228	0.1	2.3	11,039	7,491	11,132	3,022	644	0.2	6.4
F26	Destabilized Biosolids	2,230	3,710	2,518	3,726	1,016	216	0.0	0.1	199,375	135,296	200,199	54,569	11,580	0.2	6.4
F28	Dewatering Overflow	40,165	195	133	213	54	12	0.1	2.1	583	395	635	160	37	0.2	6.4

6.6.3 Sequencing Batch Reactor (PU-9)

6.6.3.1 SBR System Design

The required SBR redundancy requirements are provided in Table 6-21. A summary of the SBR size and an overview of the SBR operation are presented in Table 6-22. The stages of an SBR cycle would include discrete periods of filling, reaction, settling, decanting, and wasting, with decanting and wasting occurring simultaneously. The fill and react stages would alternate between anoxic and aerobic conditions. The total aeration time, occurring across both stages, is given in the table.

The complete SBR process would consist of all the necessary subsystems for SBR operation, which are described in the following subsections. Each of the components described would be controlled by the SBR programmable logic controller (PLC).

Table 6-21 Redundancy Requirements for the SBR

CONDITION	REDUNDANCY REQUIREMENT
Annual average	Operate with 1 SBR out of service
Maximum month	Operate with all SBRs in service
Peak day	Operate with all SBRs in service

Table 6-22 Design Criteria for the SBR

DESIGN CRITERIA	VALUE
Tank type	Concrete basins (circular, square, or rectangular)
Number	4 (3 duty + 1 standby at AAF)
Basin geometry (assuming square basins)	
Length	58 ft
Width	58 ft
Overall height	23 ft
Water depth (volume/basin)	
Minimum	14.8 ft (0.372 million gal.)
Nominal	17.5 ft (0.439 million gal.)
Maximum	21.0 ft (0.528 million gal.)
SBR cycle description (MM design conditions)	
Fill time/cycle	1.20 h/cycle
React time/cycle	1.65 h/cycle
Settle time/cycle	0.75 h/cycle
Decant time/cycle	1.20 h/cycle
Sludge wasting time/cycle	18 min/cycle
Target aeration time/cycle	1.80 h/cycle
Total cycle time	4.80 h/cycle (5 cycles/day)
Design SRT	12.5 days
Design MLSS Conc. (MM at min. water depth)	4,500 mg/L

WAS production rates at build-out conditions are provided in Table 6-23. Under the AA maintenance (*AA Maint*) condition, one SBR would be out of service. A higher WAS flow is determined for AA conditions when compared to MM, due to the expectation that lower mixed liquor and WAS concentrations would be maintained at AA conditions.

Table 6-23 WAS Production Summary at Build-out Conditions

DESIGN CRITERIA	UNIT	AA	AA MAINT.	MM WINTER	MM SUMMER
Estimated WAS concentration	mg/L	5,530	7,450	8,700	8,450
WAS flow	gpd	69,000	51,450	57,550	57,560
WAS mass flow	lb/d	3,180	3,200	4,180	4,060

A summary of the aeration requirements for the SBR process option at design conditions is provided in Table 6-24. The airflow requirements indicate the maximum value within the cycle, since the demand changes with time. Note that the flows and loads of the AA start-up condition fall between the minimum day and annual average conditions at build-out. Due to the overlap in the range of flows and loads, the airflow requirements are only given for build-out conditions.

Table 6-24 Aeration Design Summary at Build-out Conditions

DESIGN CRITERIA	UNIT	MIN. 2-HR	MIN. DAY	ANN. AVG.	AA MAINT.	MAX. MONTH	PD
Oxygen requirements (OTR)	lb-O_2/h	70	130	210	280	345	452
Alpha	--	0.5	0.5	0.5	0.5	0.5	0.5
Beta	--	0.95	0.95	0.95	0.95	0.95	0.95
Total Air requirements (Flowrate)	scfm	1,320[2]	1,320[2]	1,855	3,500	3,420	3,850

[2] Aeration requirements for minimum 2-hr and minimum day conditions are governed by mixing. Alternatively, the SBR control logic can be implemented such that the mixers are turned on during the react oxic phase when the air requirement is less than that required for the biological process.

6.6.3.2 SBR Mixers

Each SBR includes mixers to ensure homogenous mixing conditions during anoxic phases. A summary of the SBR mixer design basis is provided in Table 6-25.

Table 6-25 SBR Mixers

DESIGN CRITERIA	VALUE
Number of mixers per SBR	1
Mixing energy	0.25 hp/1000 ft^3
Mixer size	15 hp

6.6.3.3 SBR Decanters

An overview of the design criteria for the decanter in each SBR is provided in Table 6-26.

Table 6-26 SBR Decanters Design Criteria

DESIGN CRITERIA	VALUE
Number of decanters per SBR	1
Average decant flow at PDF	2.75 mgd
Decanter design	SBR system supplier dependent

6.6.3.4 SBR Process Air Blowers

Process air for the SBRs would be provided by positive displacement blowers. The blowers would discharge into a common header that would convey the air to the four SBRs. A summary of the blower design requirements is shown in Table 6-27. Each blower would:

- Be housed in a dedicated sound proof enclosure containing all the components.
- Provided with a dedicated inlet filter integral to the blower package, with a minimum filter efficiency of 90 percent at 10 microns.
- Be provided with vibration and temperature detection with alarm and shutdown set points for equipment protection.
- Include an inlet filter with:
  - A differential pressure switch with a high differential pressure alarm indicating the need for filter element change-out;
  - A relief valve; and
  - A temperature detection system with an alarm for high inlet air temperature.
- Incorporate discharge temperature transmitters with alarms for high temperature.

Table 6-27 SBR Process Air Blower Design Summary

DESIGN CRITERIA	VALUE
Number of blowers	2 (1 duty + 1 standby)
Air flow rate range	1,320-2,740 scfm
Max. discharge pressure	10 psig
Blower Size	100 hp[3]
Control	VFD
Inlet filter	Required
Filter efficiency (minimum)	90% at 10 µm

6.6.3.5 SBR WAS Pumping

A single set of WAS pumps would be utilized to pump the WAS from the four SBRs. A summary of the basis of design criteria for the WAS pumping system is shown in Table 6-28. Each pump would be equipped with inlet and outlet valves for complete isolation of the pump for maintenance.

Table 6-28 SBR WAS Pumps Design Criteria

DESIGN CRITERIA	VALUE
Number of WAS pumps	2 (1 duty + 1 standby)
Type	Rotary lobe or progressive cavity
Design capacity	35-50 gpm at TDH 10 ft[2]
Drive motor size	0.15 hp
Control	Fixed speed

[3] Preliminary estimate only. Blower design and size will need to be verified during project implementation phase.

6.6.4 Membrane Bioreactor (PU-10)

6.6.4.1 MBR System Design

For planning purposes, a Modified Ludzack-Ettinger (MLE) process is being assumed, adapted for integration with an MBR. The MLE process consists of an anoxic zone followed by an aerobic (or oxic) zone and is commonly used to achieve the effluent quality targets noted in Table 6-16. In the conventional MLE process, the sludge from the solids separation process downstream of the biological process (e.g., clarifier or membrane) is sent to the anoxic tanks in addition to the contents of the oxic zone (i.e., mixed liquor). In the MLE adapted for MBRs (MLE-MBR, shown in Figure 6-8), the sludge from the MBR tank would be pumped back to the oxic tank, rather than the anoxic tank and the mixed liquor from the oxic tank would be pumped back to the anoxic zone and combined with the influent. The reason for this configuration is to limit the influx of dissolved oxygen (DO) from the membrane tank, where the DO typically ranges between 4 and 6 mg/L, into the anoxic tank, where the target DO is 0 mg/L. Due to the low biodegradable organic carbon to oxidizable nitrogen ratio of the Morro Bay influent, a second anoxic basin would follow the aerobic basin. The second anoxic basin is used to further remove excess nitrate via denitrification with an exogenous carbon source.

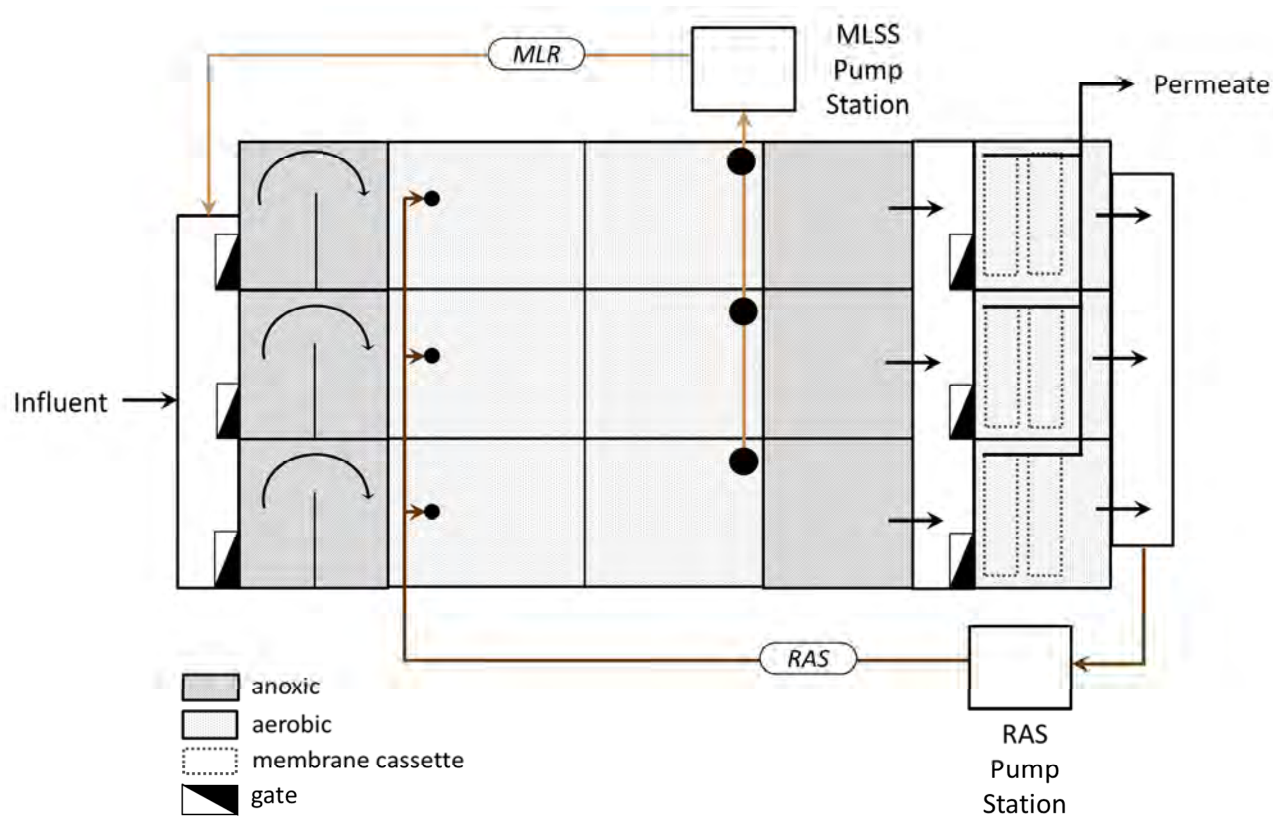


Figure 6-8 Proposed MLE-MBR Treatment Train Layout

This design consists of a three-train design, such that one biological process train could be taken out of service at the AA conditions with no impact on treatment capacity or efficacy (Table 6-29) This approach would conform to the Title 22 redundancy criteria. MBR-specific design criteria are provided in Table 6-30.

Cleaning operations are an important aspect of MBR operations (Table 6-30). There are two basic types of membrane cleaning operations:

- Maintenance clean (to remove material from the membrane surface which are relatively easily removed using a low dose of chemicals and agitation); and
- Recovery clean (to remove material which are substantially impacting membrane performance).

Maintenance cleanings are performed frequently (1-2 times per week), after which the membrane flux often returns to the original value. However, flat plate MBR suppliers do not implement a maintenance cleaning operation, typically as a result of the lower rate of fouling of the plate surface. Recovery cleanings involve the most exhaustive cleaning operations (akin to steam cleaning of a carpet with chemicals, etc.), and are completed multiple times a year for hollow-fiber systems and more frequently for flat plate systems (as a result of not needing the maintenance cleaning). Note that all cleaning operations are fully automated and performed in-situ (i.e., membranes do not have to be removed from the tank). Membrane cassettes/cartridges, other than the one being cleaned, remain fully operational; there is no impact of the ability of the plant to process incoming flow.

Table 6-29 Redundancy Requirements for the MBR

CONDITION	BNR REDUNDANCY	MBR REDUNDANCY
AA	Operate with 1 BNR train out of service	Operate with 1 MBR train out of service in maintenance condition
MM	Operate with all BNR trains in service	Operate with 1 MBR train out of service in maintenance condition
PD	Operate with all BNR trains in service	Operate with all MBR trains in service

Table 6-30 Design Criteria for the MLE-MBR

DESIGN CRITERIA	VALUE
Number of Trains	3 (see Table 6-29 for redundancy requirements)
Tank volume	
Anoxic	33,300 gal.
Aerobic	100,000 gal.
Post-Anoxic	10,000 gal.
Membrane tank	25,600 gal.
Design MLSS (MM)	Refer to mass balance
Membrane Design Criteria	
Flux at MM (winter) maintenance conditions	17 gfd (gal/ft^2-d)
Minimum membrane surface area/train	35,500 ft^2
Membrane maintenance cleaning[4]	
Maintenance cleaning frequency	1x/day – 1-2x/week
Maintenance cleaning duration	30 – 60 minutes/cassette
Chemical used	Sodium hypochlorite
Concentration	200 – 1,000 mg/L
Membrane recovery cleaning[5]	
Recovery cleaning frequency	1-4x/year
Recovery cleaning duration	6-24 h/cleaning
Chemicals used/concentration	Sodium hypochlorite/1,000 – 3,500 mg/L
	Citric acid/2,000 – 5,000 mg/L

[4] Typical maintenance cleaning criteria for a range of MBR system suppliers is provided here. The specific maintenance cleaning regime will need to be established during the detailed design phase in conjunction with selected MBR system supplier.
[5] Typical recovery cleaning criteria for a range of MBR system suppliers is provided here. The specific maintenance cleaning regime will need to be established during the detailed design phase in conjunction with selected MBR system supplier.

The MBR WAS production is provided in Table 6-31 and the aeration requirements are given in Table 6-32 for the oxic zone only. The MBR aeration requirements are governed by the air scour.

Table 6-31 MBR WAS Production Summary at Build-out Conditions

DESIGN CRITERIA	UNIT	ANN. AVG.	AA MAINT.	MM WINTER	MM SUMMER
Estimated WAS concentration	mg/L	12,700	12,700	11,050	10,750
WAS flow	gpd	28,250	28,250	42,400	42,400
WAS mass flow	lb/d	3,000	3,000	3,900	3,800

Table 6-32 MBR Aeration Design Summary at Build-out Conditions

DESIGN CRITERIA	UNIT	MIN. 2-HR	MIN. DAY	ANN. AVG.	AA MAINT.	MAX. MONTH	PEAK DAY
Oxygen requirements (OTR)	lb-O_2/h	56	104	167	167	217	285
Alpha (BNR tank)	--	0.5	0.5	0.5	0.5	0.5	0.5
Beta	--	0.95	0.95	0.95	0.95	0.95	0.95
Air requirements (flowrate)	scfm	600[6]	900	1,550	1,520	2,190	3,000

6.6.4.2 Anoxic Zone Mixers

The anoxic and post-anoxic zones would require mixing to maintain a suspended sludge. A summary of the MBR mixer design is provided in Table 6-33.

Table 6-33 Anoxic Zone Mixers

DESIGN CRITERIA	UNIT	ANOXIC	2ND ANOXIC
Number of mixers per basin	---	TBD[1]	TBD[1]
Mixing energy	hp/1000 ft^3	0.25	0.25
Mixer size	hp	4	1.3
1. Number of mixers is dependent on the tank geometry, which is beyond the scope of this study			

[6] Aeration requirements for minimum 2-hr are governed by mixing. Alternatively, the BNR tanks can be designed to incorporate mixers in the aerobic zones which are turned on at low load conditions, when the air requirements are below biological process needs.

6.6.4.3 BNR Process Air Blowers

Process air for the MBRs would be provided by positive displacement blowers. The blowers would discharge into a common header that would convey the air to the two basins in the three trains. A summary of the blower design requirements is shown in Table 6-34. The blower enclosure and equipment protection would be the same as those designated for the SBR.

Table 6-34 MBR Process Air Blower Design Summary

DESIGN CRITERIA	VALUE
Number of blowers	3 (2 duty + 1 standby)
Air flow rate range	600-1,500 scfm
Discharge pressure	8.5 psig
Blower size	100 hp
Control	VFD
Inlet filter	Required
Filter efficiency (minimum)	90% at 10μm

6.6.4.4 MBR Air Scour Blowers

MBR air scour blowers would be required to periodically scour the membrane surface. The design requirements would depend on the membrane supplier. Basic requirements are provided in Table 6-35, however these should be refined during the project implementation phase.

Table 6-35 Membrane Air Scour Blowers

DESIGN CRITERIA	VALUE
Number of blowers	3 (2 duty + 1 standby)
Air flow rate range	0.01-0.012 scfm/ft^2
Discharge pressure	6 psig
Blower size	31 hp
Control	Fixed speed
Inlet filter	Required
Filter efficiency (minimum)	90% at 10 μm

6.6.4.5 MBR Permeate Pumps

Table 6-36 provides design criteria for the MBR permeate pumps.

Table 6-36 MBR Permeate Pumps Design Criteria

DESIGN CRITERIA	VALUE
Number of permeate pumps	3 (2 duty + 1 standby)
Type	Centrifugal
Design capacity	1,910 gpm @ TDH 25 ft
Drive motor size	15 hp [7]
Control	Fixed speed

6.6.4.6 MBR WAS Pumps

MBR WAS pump criteria is given in Table 6-37.

Table 6-37 MBR WAS Pumps Design Criteria

DESIGN CRITERIA	VALUE
Number of WAS pumps	2 (1 duty + 1 standby)
Type	Rotary lobe or progressive cavity
Design capacity	30 gpm @ TDH 10 ft
Drive motor size	0.09 hp[7]
Control	Variable speed

[7] Power is only preliminary and could be modified as the design develops.

6.6.4.7 BNR-MLR Pumps

A single set of Mixed Liquor Recycle (MLR) pumps would be utilized to pump the MLSS from the end of the aerobic zone to the anoxic zone of the BNR tanks. A summary of the basis of design criteria for the MLR pumping system is shown in Table 6-38. Each pump would include inlet and outlet valves for complete isolation of the pump for maintenance and pressure gauges and check valves on the discharge side.

Table 6-38 BNR-MLR Pumps Design Criteria

DESIGN CRITERIA	VALUE
Number of MLR pumps	2 (1 duty + 1 standby)
Type	Rotary lobe or progressive cavity
Design capacity	4,025 gpm @ TDH 5 ft
Drive motor size	5 hp[7]
Control	VFD

6.6.5 Supplemental Alkalinity Requirements (C1)

The biological process of nitrification consumes alkalinity, driving down the pH. In order to maintain a pH that does not inhibit biological activity and meet discharge regulations, the pH is controlled with an alkalinity feed to the aerobic zone. It is recommended that the source of alkalinity be sodium or magnesium hydroxide for its ease of use compared with lime, a low-cost alternative with significantly higher operational requirements. The dose required for alkalinity (Table 6-39) was determined using the process models. The model was simulated to maintain pH 7.0 in the aerobic tank in order to avoid biological limitations.

Table 6-39 Design Criteria for Alkalinity Feed System

DOSE	UNIT	SBR	MBR
AA	lb $CaCO_3$/day	1,100	1,300
MM Winter	lb $CaCO_3$/day	1,500	1,600
MM Summer	lb $CaCO_3$/day	1,500	1,600
PD	lb $CaCO_3$/day	1,950	2,100
*$CaCO_3$ = Calcium Carbonate			

6.6.6 Secondary Effluent Equalization Basin (PU-9)

A secondary effluent equalization basin would be required downstream of the SBR due to the potential for intermittent effluent flow. Currently, the cycle of the 4 SBRs is timed so that one SBR is decanting at all times. Under this design, no secondary equalization would be required. However, if the cycle changes, the decant flow could become intermittent, requiring an equalization basin. In Table 6-40, the tank volume is designed for 3 hours of storage at AA flows. A safety factor of 1.15 was applied to the storage volume. The volume of the equalization basin would provide flexibility to the operation of the SBR cycle.

Table 6-40 Design Criteria for Secondary Effluent Flow Equalization

DESIGN CRITERIA	VALUE
Type	Inline equalization
Volume	120,000 gal.

6.6.7 Secondary Effluent Flow Monitoring

Flow monitoring would be required prior to the tertiary treatment processes. The recommended meter type and design criteria are provided in Table 6-41.

Table 6-41 Design Criteria for Influent Flow Monitoring Downstream of Headworks

DESIGN CRITERIA	VALUE
Flow meter type	Magmeter
Total number of units	1
Basis of design criteria	PHF

6.7 DESIGN CRITERIA FOR TERTIARY TREATMENT PROCESS SYSTEMS

6.7.1 Membrane Filtration System (PU-13)

MF/UF is a physical separation process in which suspended/colloidal solids are removed from the feed stream through a porous membrane. Membrane filtration using microfiltration or ultrafiltration (i.e., MF/UF) is used to produce high quality effluent for unrestricted reuse and also serve as a pretreatment process for the RO system. There are currently two configurations available for MF/UF systems: submerged and pressurized systems. In submerged systems, the membranes are installed within basins and the filtrate drawn out by pulling a vacuum on the lumen side of the membranes. The membranes for a pressurized system are installed within vertical pressure vessels, arranged in racks and placed on a concrete slab. Although the configurations are very different, the performance and filtrate water quality of the membranes are effectively the same.

For the future Morro Bay WRF, a pressurized MF/UF system is considered, primarily because given the relatively small capacity of the WRF, a pressurized system would most likely be more cost effective. Individual membrane modules are easily accessed in the pressurized systems offering operational benefits such as easy visual inspection of modules during membrane integrity testing. The MF/UF system was sized for the PDF. The design criteria are provided in Table 6-42.

Table 6-42 Design Criteria for the Membrane Filtration System

DESIGN CRITERIA	VALUE
Total number of trains	3
Number of trains in service	ADF: 2 MMF: 2 PDF: 3
Basis of design criteria	PDF
Nominal design flux	25 gfd (gal/ft^2-d) at MMF conditions (i.e., 2 trains in service)
Minimum surface area	72,300 ft^2
Minimum number of cassettes	7
Membrane backwashing	
Nominal backwash interval	25 – 30 min
Typical backwash duration	90 – 120 s
Membrane Clean in Place (CIP)[8]	
CIP cleaning frequency	1-2x/month
CIP cleaning duration	4 – 6 h per skid
Chemical used	Sodium hypochlorite
Concentration	200 – 1,000 mg/L
Membrane recovery cleaning[9]	
Maintenance cleaning frequency	1x/day – 1-2x/week
Maintenance cleaning duration	30 – 60 minutes/skid
Chemical used/Concentration	Sodium hypochlorite/500 – 1,000 mg/L
	Citric acid/300 – 500 mg/L
	Sodium hydroxide/raise pH to ~11-13

An MF/UF filtrate storage tank would be included as part of the overall MF/UF system design between the MF/UF and downstream disinfection or RO unit operations. The MF/UF filtrate storage tank would also serve as the supply for the MF/UF system backwash pumps. The MF/UF filtrate

[8] Typical maintenance cleaning criteria for a range of MBR system suppliers is provided here. The specific maintenance cleaning regime will need to be established during the detailed design phase in conjunction with selected MBR system supplier.

[9] Typical maintenance cleaning criteria for a range of MBR system suppliers is provided here. The specific maintenance cleaning regime will need to be established during the detailed design phase in conjunction with selected MBR system supplier.

storage tank would be sized to accommodate the larger volume for the following: a 15-minute retention time at the PDF or adequate storage for MF/UF backwash plus a 20% margin of safety volume. The preliminary design criteria for the MF/UF filtrate storage tank is provided in Table 6-43.

Table 6-43 Design Criteria for the MF/UF Filtrate Storage Tank

DESIGN CRITERIA	VALUE
Type	Inline storage
Design basis	15 min HRT at PDF
Tank material	FRP or welded steel
Volume	28,700 gal.

The waste stream resulting from a membrane cleaning (CIP or maintenance clean) will have to be stored temporarily in a waste holding/neutralization tank prior to being returned to the plant's equalization tank. The tank volume is dependent on the MF/UF system supplier; therefore, it is recommended that the CIP WAS/neutralization tank and return pumping system be included in the MF/UF system supplier's scope of supply.

6.7.2 Ultraviolet Disinfection Process

An in-line (enclosed) UV disinfection system would be provided to disinfect the membrane filtrate or MBR filtrate. A summary of the UV system design criteria is provided in Table 6-44.

Table 6-44 Design Criteria for UV Disinfection System

DESIGN CRITERIA	VALUE
Total number of UV trains	3
Number of UV trains in service	ADF: 2 MMF: 2 PDF: 3
Design capacity per UV train	955 gpm
Pretreatment level	MF/UF
Design basis UVT	≥ 65%
Minimum dose	80 mJ/cm^2
UV lamp type	Low pressure high output

6.8 DESIGN CRITERIA FOR ADVANCED WATER PURIFICATION FACILITY

The AWPF consists of a series of advanced water treatment processes to provide a multiple barrier approach to chemical and pathogen contaminant removal. Several alternative treatment process configurations can be utilized to meet the desired water quality target to achieve potable reuse. An AWPF consisting of RO and UV-mediated AOP were considered for the Morro Bay WRF as shown in the flowsheets for the refined process alternatives (

Figure 6-5 and

Figure 6-6). The AWPF is designed to treat instantaneous flows ranging from the annual average to the maximum month condition. Higher flows (e.g., peak day condition) will be temporarily stored upstream of the AWPF and subsequently treated.

6.8.1 Reverse Osmosis System (PU-14)

The RO system would consist of multiple components including:

- RO transfer pumps to pump the MF/UF permeate through the cartridge filters.
- Cartridge filters for protection of the RO membranes.
- RO high-pressure feed pumps to pump the water through the RO modules.
- RO skids which hold the RO modules.
- Decarbonation system to raise the pH of the product water.

An overview of the design basis for these components is provided here.

6.8.1.1 RO Transfer Pumps and Cartridge Filters

RO transfer pumps would pump MF/UF filtrate from the MF/UF filtrate storage tank through the cartridge filters to the suction side of the RO feed pumps. The RO transfer pumps would be variable speed pumps and discharge into a common header which carries the flow to the cartridge filters.

Cartridge filters are recommended immediately ahead of the RO system to guard against solids entering the system from process tanks, gaskets, chemical impurities, or other sources. The spiral wound RO elements can be easily clogged resulting in shortened RO-membrane life. Cartridge filters would consist of wound hollow core polypropylene elements. The cartridges would be periodically replaced based on the differential pressure across the system. A summary of the design criteria for the RO transfer pumps and cartridge filters are provided in Table 6-45.

Table 6-45 Design Criteria for RO Transfer Pumps and Cartridge Filters

DESIGN CRITERIA	VALUE
RO transfer pumps	
Number of pumps	2 (1 duty +1 standby)
Type	Centrifugal – horizontal end suction
System design capacity	590 - 806 gpm (startup conditions ADF – Buildout Max. Month)
Design capacity each	590 – 806 gpm @ THD 140 ft[10]
Motor drive	VFD
Cartridge filters	
Number of filters	3
Nominal pore size	5 micron
Design capacity (each filter)	806 gpm

6.8.1.2 Reverse Osmosis High-Pressure Feed Pumps

RO high-pressure feed pumps increase the pressure of the RO feed water. Each RO train has its own feed pump. In this way, the pressure of the RO feed water for each train may be different depending on the degree of fouling in the train. The RO high-pressure feed pumps would be vertical turbine pumps, each mounted in a dedicated suction can. A summary of the design criteria for the RO high-pressure feed pumps is provided in Table 6-46.

Table 6-46 Design Criteria for RO High-Pressure Feed Pumps

DESIGN CRITERIA	VALUE
Number of pumps	Same as number of RO trains(3)
Type	Vertical turbine
Design capacity each (gpm @ TDH)	200 – 650 gpm @ 250 ft[11]
Control	VFD

[10] Note that TDH requirements are only preliminary and may be revised based as the design is developed.
[11] Note that TDH requirements are only preliminary and may be revised based as the design is developed.

6.8.1.3 Reverse Osmosis System Trains

The RO system would be a high pressure membrane process designed to remove dissolved constituents from the process feed water. To be conservative for the FMP, a relatively reliable flux of 12 gfd was considered with a recovery of 80 percent. Both the flux and the recovery may be determined to be higher as part of the future project implementation and detailed design. The RO trains were designed to meet the redundancy requirements noted above. RO membranes are periodically cleaned to restore operating permeability. Typically, RO membranes are cleaned when the permeability reduces to approximately 85% of the initial stable operating (*new-system*) permeability or when differential pressure loss along the membrane increases by 15% or salt passage increases by 15%. Cleaning frequencies are highly variable and dependent on factors such as RO feed water quality. RO membrane cleaning would be implemented using a Clean In Place (CIP) system. The CIP system may be supplied with the RO system and consists of the complete chemical solution preparation and chemical circulation pumps. The solution preparation system is typically designed for dry chemical addition into a tank through a hopper. A small pH adjustment chemical addition station (55-gal drum scale) is also typically included to adjust the pH of the cleaning solution.

Table 6-47 Design Criteria for RO System Skids

DESIGN CRITERIA	VALUE
Number of trains/skids	3
Redundancy	ADF: N-1 MMF: N-1
Recovery	80%
Design RO permeate capacity of each train	start-up: 282 gpm full build-out: 321 gpm (max. month capacities)
Nomimal design flux	12 gfd
Number of stages	2
Elements per stage	6
RO Clean in Place (CIP)[12]	
CIP cleaning frequency	1x/quarter
CIP cleaning duration	6 – 12 h per train
Chemical used/Concentration	sodium hydroxide/achieve pH ~11 S.U
	citric acid/1,000 mg/L

[12] Typical maintenance cleaning criteria for a range of MBR system suppliers is provided here. The specific maintenance cleaning regime will need to be established during the detailed design phase in conjunction with selected MBR system supplier.

6.8.2 Advanced Oxidation (PU-14)

Disinfection and UV-mediated advanced oxidation (UV/AOP) of the product water is required by the Department of Drinking Water (DDW) for IPR. As part of addressing the pathogen removal goals required by DDW, the proposed design was predicated on the UV/AOP system providing 6-log reduction of each of the target pathogens to meet the overall pathogen log reduction requirements. The UV/AOP system would also be designed to meet the current GWR IPR Regulations for advanced oxidation of target compounds, which require 0.5-log reduction of 1,4 Dioxane or a 0.3 log – 0.5 log removal of approved indicator compounds. Basis of design criteria for the UV/AOP system is provided in Table 6-48.

Table 6-48 Design Criteria for UV/Advanced Oxidation Process

DESIGN CRITERIA	VALUE
Number of UV/AOP trains	2
No. of Operating Trains	ADF: 1 MMF: 1
Capacity of each train	564 gpm
RO permeate UV transmittance	> 95%
UV system	
Lamp type	Low pressure high output
Number of reactors per train	2
Oxidant	
Oxidant selection	Hydrogen peroxide
Oxidant dose	3 mg/L

6.8.3 Decarbonation System

The acidification of the RO feed water increases the concentration of carbon dioxide (CO_2). CO_2 is not removed by RO and remains in the RO permeate, lowering the pH. Decarbonation towers are typically used to strip out excess CO_2 from the RO permeate and increase the pH of the product water. The decarbonation towers are counter current stripping columns with plastic media. The effluent from the UV/AOP process is fed at the top and air is fed from the bottom. The tower effluent is collected in a small tank located at the base of the towers and is pumped to the end-use point. The media used have a high surface area to enhance gas-liquid mass transfer. A summary of the decarbonation towers basis of design criteria are provided in Table 6-49.

Table 6-49 Design Criteria for Decarbonation Towers

DESIGN CRITERIA	VALUE
Number of decarbonation towers	2
Maximum capacity of each tower	320 gpm
Tower material	FRP
Packing type/material	Polyproylene/random packing
Estimated tower diameter	5 ft
Estimated tower height	25 ft
Number of blowers	2, 1 per tower
Blower type	Centrifugal
Blower capacity	2,100 cfm[13]
Blower size	15 hp[14]

Post-treatment, including the addition of chemicals to increase the alkalinity and hardness, may be required downstream of the decarbonation system. The requirements for such post treatment chemicals (e.g., lime addition) depend on the end-use target (i.e., food-crop irrigation or potable reuse). Several factors are relevant to design of the system and should be considered in detail are part of the project implementation.

6.8.4 Effluent Flow Monitoring

Flow monitoring is also required on the effluent. The recommended meter type and design criteria for these locations are provided in Table 6-50.

Table 6-50 Design Criteria for Effluent Flow Monitoring

DESIGN CRITERIA	VALUE
Flow meter type	magmeter
Total number of units	1
Basis of design criteria	PHF

[13] Preliminary estimate only. Blower requirements will have to be refined during detailed design of AWP facility.
[14] Preliminary estimate of blower motor hp only. Blower size, design and capacity will be refined and may be revised during detailed design

6.8.5 Effluent Flow Sampling

Sampling of the effluent quality is required before discharge. The design criteria for the effluent sampler are provided in Table 6-51.

Table 6-51 Design Criteria for Effluent Flow Sampler

DESIGN CRITERIA	
Sampler type	Refrigerated composite sampler
Sampling strategy	Flow proportional

6.9 DESIGN CRITERIA FOR SOLIDS TREATMENT PROCESSES

The WAS production was estimated from the process model, described in Sections 6.6.3.1 and 6.6.4.1.

6.9.1 WAS Monitoring

The WAS flowrate is monitored and controlled to achieve the design SRT. The recommended monitoring type and design criteria for WAS are provided in Table 6-52.

Table 6-52 Design Criteria for Influent Flow Monitoring Downstream of Headworks

DESIGN CRITERIA	VALUE
Flow meter type	Magmeter
Total number of units	1
Basis of design criteria	PHF

6.9.2 Sludge Storage Tank (PU-17)

The sludge storage tank basis of design is 3 days of storage at MMF conditions, to accommodate WAS accumulation over a long weekend during the maximum month condition. The storage volume is different for each process design configuration due to differences in WAS production and WAS concentration for the process designs. A safety factor of 1.15 was applied to the storage volume. The design criteria are provided in Table 6-53.

Table 6-53 Design Criteria for the Sludge Storage Tank

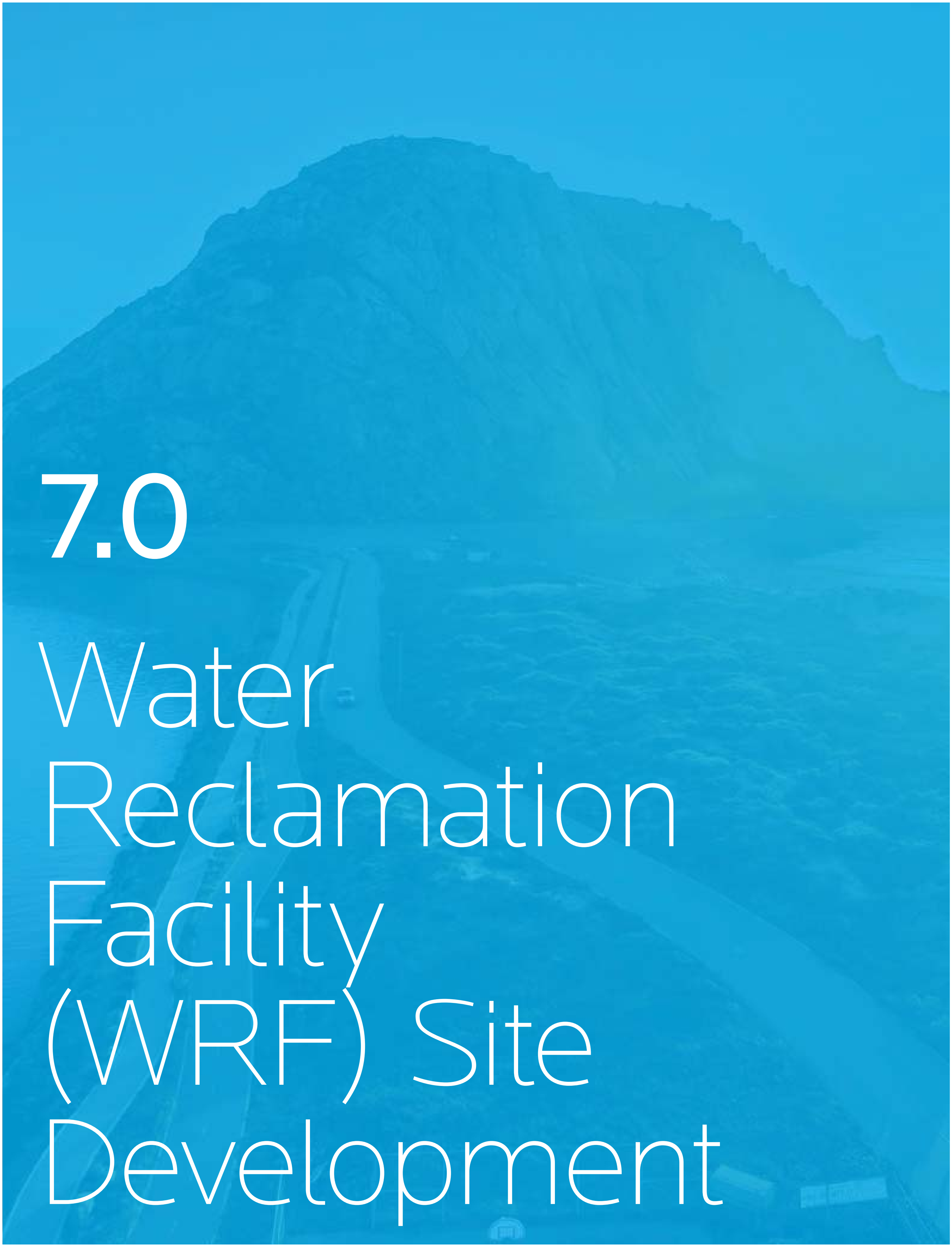
DESIGN CRITERIA	UNIT	SBR	MBR
Number	--	1	1
Basis of design criteria	--	MM	MM
Days of storage	d	3	3
Volume	gal.	240,000	135,000

6.9.3 Sludge Dewatering (PU-21)

Three technologies are considered equivalent for sludge dewatering: the gravity belt thickener, screw press, and centrifuge. Table 6-54 provides the basis of design criteria for the dewatering equipment. The basis of design for the solids dewatering system is that the system operates 4 days/week for 7 hours/day at the annual average conditions. At the maximum condition, this equates to an operating regimes as follows: approximately 7 hours/day for 5 days/week and approximately 8 hours/day, 5 days/week for the MBR.

Table 6-54 Design Criteria for the Dewatering

DESIGN CRITERIA	UNIT	SBR	MBR
Number	--	2 (1 duty +1 standby)	2 (1 duty +1 standby)
Accepted technologies	--	Gravity belt thickener, screw press, centrifuge	
Schedule	--	7 hours/day; 4 days/week	
Solids loading rate	lb/d	19,100	18,000
Flowrate	gpm	290	120



7.0 Water Reclamation Facility (WRF) Site Development

7.0 Water Reclamation Facility (WRF) Site Development

This chapter provides a summary of the WRF onsite support facilities presented in TM-4 and subsequent site development activities. Pertinent assumptions and recommendations are included. In addition, architectural considerations for the WRF facilities are provided including preliminary materials selections and conceptual site renderings.

7.1 OVERVIEW

The WRF site will ultimately include three types of facilities: the wastewater treatment plant and advanced water purification plant to provide the City a new, sustainable water source, onsite support facilities including office and maintenance buildings to support the treatment plant. The FMP also accounts for the possibility that, in the future, the City may choose to relocate its corporation yard and Public Works Department office to this site.

Examples of onsite support facilities include the Operations Building, Maintenance Building, and electrical feed and standby power facilities. In TM-4, onsite facilities required to support the WRF were developed. The potential components of a corporation yard, should the City choose to relocate it to the site, are summarized. Basic planning criteria and assumptions were established in order to determine the footprints required for space planning purposes and site development. In TM-6, 7, and 9, alternatives for biosolids treatment, liquid treatment, and organic waste treatment were evaluated, which resulted in two holistic WRF treatment trains or "flow sheets"; a conventional treatment train and a membrane bioreactor (MBR) treatment train. Summaries of the treatment facilities are provided in Chapters 4.0 and 5.0 and conceptual design and sizing criteria are provided in Chapter 6.0.

7.2 ONSITE SUPPORT FACILITIES

One of the City Council goals for the project is to evaluate the potential to combine other City functions at the WRF site. Therefore, in addition to the WRF process facilities, the FMP addresses other facilities not related to the WRF in order to evaluate their feasibility and to allow the City the option to pursue one or more of these non-WRF facilities at the site. These include:

1. Operations and Maintenance Buildings
2. Corporation Yard and Storage
3. Potential Future Site Solar Farm
4. Potential Water Resources Education Center
5. Electrical Feed and Stand-By Power
6. Hazardous Materials Containment and Handling

A meeting was held with the City on September 4, 2015 to discuss expectations for the onsite support facilities. Decisions reached by the City during the meeting were incorporated into TM-4. Development of the facilities was also influenced by similar facilities at the existing WWTP, information from the support documents listed in TM -1, and similar projects. The following sections provide a summary of the planning level design criteria for the onsite support facilities and the estimated space needs for each facility.

7.2.1 Operations Building and Maintenance Building

The Operations Building will serve a similar purpose as the Administration Building at the existing WWTP. The Operations Building will be used for office-related activities, training, and laboratory analysis. The Maintenance Building will serve a similar purpose as the existing WWTP Maintenance Building and be used for repair and servicing of treatment plant equipment. The existing Administration and Maintenance Buildings were used as a basis for establishing the needs of the new Operations and Maintenance Buildings. The following sections include a summary of the existing buildings' amenities and assumptions for the sizing and features of the new buildings.

7.2.1.1 Existing WWTP Administration Building and Maintenance Building

The existing Administration Building is one story and has a footprint of roughly 65' x 46' or 3,000 square feet. It has the following features:

- Men's Restroom
- Women's Restroom
- Men's Locker Room
- Vestibule
- Janitor's Closest
- Training Room
- Boiler Room
- Tool and Equipment Storage
- Control Room and Control Access
- Storage Room
- Office
- Boot Vestibule
- Laboratory
- Electrical Room
- Generator Room
- Compressor Room
- Oil Storage
- Boot Wash Area

The existing Maintenance Building is one story and also has a footprint of roughly 58' x 39' or 2,260 square feet. It has the following features:

- Two crane runway beams
- Equipment supports
- Isolated floor drain trench

7.2.1.2 New WRF Operations Building

For the purposes of space planning, the following assumptions were made regarding the new WRF Operations Building:

- Single Story
- ADA Accessible
- 7,000 square feet (100' x 70')
  - Training/Conference/Education Room (20' x 30')
  - Break Room (12' x 21')
  - Four Enclosed Offices (12' x 13' each)
  - Reception Desk (9' x 10')
  - Open Work Area with 6 Cubicles (25' x 50')
  - Copy Room (6' x 13')
  - Janitor and Sprinkler Riser Room (10' x 10')
  - Laboratory (24' x 32')
  - Men's Toilet and Locker Rooms (23' x 23')

   - Women's Toilet and Locker Rooms (23' x 17')
   - Control Room (12' x 18')
   - Outside Boot Wash (5' x 7')
   - Boot Storage (5' x 8')

7.2.1.3 New WRF Maintenance Building

For the purposes of space planning, the following assumptions were made regarding the new WRF Maintenance Building:

- Single Story
- 3,500 square foot (50' x 70') enclosed Maintenance Building
   - Open floor with bridge crane
   - Work benches
   - Storage racks for spare parts and tools
   - Storage cabinets for lubricants and related gear
- 4,500 square foot attached Parking Canopy for Large Vehicles (50' x 90')

7.2.2 Corporation Yard and Storage

The Corporation Yard and Storage Area at the new WRF is proposed to be similar in size to the one at the existing WWTP and adjacent City facilities. Space requirements and facility layouts will also consider use by the Recreation and Parks Department and several divisions within the Public Works Department, including Streets Division, Vehicle Maintenance Division, Water Division, Collections Division, Dial a Ride, and Trolley.

As described in this section, the Corporation Yard facilities are generally comprised of vehicle parking and maintenance garages, equipment and material storage, and offices for City staff. These same facilities and uses are required for the WRF. It is therefore advantageous to combine the Corporation Yard and WRF functions to provide efficiencies in cost and size.

The following sections include a summary of the existing Corporation Yard and Storage facilities and assumptions for the sizing and features of the Corporation Yard and Storage facilities.

7.2.2.1 Corporation Yard Space Planning

In 2008, the City hired RRM Design Group to prepare a Master Plan document for the City's Corporation Yard to identify deficiencies and recommend needed improvements. The following is a summary of the findings from that document.

The existing Corporation Yard houses the City's:

- Parks Storage Building
- Vehicle Maintenance Bays and underground fueling facility
- Water Storage Buildings
- Streets Sign Shop
- Streets Sign, Decoration and Barricade Storage Sheds

- Common Offices and Restrooms
- Desalination Plant
- Covered Parking

The RRM Master Plan document identified space needs for the recommended improvements to the Corporation Yard. The total building, office, storage and parking space requirement for existing City services based at the Corporation Yard was approximately 82,000 square feet.

7.2.3 Site Solar Farm

The community has established a goal for energy recovery and a solar farm would help offset energy usage at the WRF. The primary goals of the solar farm would be to a) provide a renewable energy source for the WRF; and b) offset greenhouse gases produced by the WRF and onsite facilities. For conceptual-level planning, up to an 800 kW, ground-mounted, fixed track solar farm was used for space planning. Assuming solar production of approximately ¼ acre per 100 kW, an 800 kW solar farm would require 2 acres (200' x 435'). A similar type solar panel arrangement is shown in Figure 7-1.

Figure 7-1 ConEdison White River West, Corcoran, CA

Based on feedback from the community, the City requested that a roof-mounted solar panel arrangement be considered in addition to the ground-mounted system. This setup is similar to the array shown on Figure 7-2. A rooftop array requires 4-foot minimum setbacks from the edge with a parapet, or 8-foot minimum setbacks without a parapet, for access to the modules. Additionally, the rooftop arrays should be no greater than 150 feet in any direction without an additional 4-foot access pathway.

Figure 7-2 Rooftop Solar Panel Array

Potential locations for 2 acres (87,120 square feet) worth of solar panels are shown on

Figure 7-14 at the end of this Chapter. The two locations on graded slopes would have ground-mounted panels adding up to 62,200 square feet. The Corporation Yard has approximately 25,000 square feet of rooftop space for rooftop solar panels. Rooftop space on top of the WRF facilities could also be considered for solar panel placement.

7.2.4 Electrical Feed and Standby Power

Space will be allocated on the WRF site for electrical feed and stand-by power facilities. The electrical feed facilities will include Pacific Gas & Electric (PG&E) electrical transformers, switchgear, and metering equipment to connect to the existing overhead distribution lines. The stand-by power facilities would include a pad-mounted generator in an enclosure. The generator would either be powered by natural gas or diesel, which would require a belly tank (below the generator) or a stand-alone fuel tank. There is currently no natural gas supply to the site, so a new natural gas pipeline would be required.

7.2.4.1 Electrical Feed Facilities

Based on the current level of design of the WRF treatment alternatives (including advanced treatment facilities) and onsite support facilities, a 12kV power supply to the site will be required. The PG&E overhead distribution lines running to the nearby Bayside Care Center appear to be 12kV. Service to the new WRF facilities will be provided from the existing 12kV overhead lines (pending PG&E approval). New transformers and switchgear equipment will be required to serve the WRF facilities and transition from overhead to underground power. For space planning, the PG&E electrical switchgear and metering equipment would be located on the stand-by power facilities concrete pad (see Section 7.2.4.2).

The following alternative sources of power may also be located at the WRF:

- Natural Gas (metering assemblies supported on concrete pad)
- Solar (See Section 7.2.3)

7.2.4.2 Stand-By Power Facilities

The primary source of stand-by power for the WRF will be an engine generator. The existing WWTP 250 kW generator is located in a 22’ x 24’ room in the Administration Building and uses diesel fuel. The stand-by generator at the WRF need not be located in a building, but will be located in an enclosure. The City prefers a natural gas fueled generator in lieu of diesel-fueled, if feasible. The nearest potential user of natural as is the Bayside Care Center adjacent to Highway 1 and approximately 0.5 miles from the WRF. Coordination with PG&E would be required to determine the location and size of the natural gas piping and whether or not the existing supply is sufficient to meet the needs of the generator.

For space planning of the Stand-By Power Facilities, the following assumptions were made:

- 1,000 kW stand-by generator to serve essential equipment during an outage
- Enclosed generator with space for a stand-along diesel fuel tank (if needed)
- Space for natural gas metering equipment

The estimated footprint needed for the Stand-By Power Facilities is 50' x 60' (3,000 square feet).

7.2.5 Hazardous Materials Containment and Handling

Provisions can be provided at the WRF site to handle hazardous materials used for the treatment process, possible hazardous wastes, and septic truck waste.

7.2.5.1 WRF Hazardous Materials

Hazardous material associated with the treatment process may include MF/RO membrane cleaning chemicals, disinfection chemicals, and other treatment-related chemicals. All bulk chemical storage will be located in chemical containment areas that are sized to contain spills. Spills will be conveyed to blind sumps for manual pumping and disposal by truck.

7.2.5.2 Household Hazardous Waste (HHW) Station

The existing WWTP includes a household hazardous waste (HHW) station operated by the Integrated Waste Management Authority (IWMA). The footprint for this existing facility is approximately 100' x 50' or 5,000 square feet. Space can be provided at the new Corporation Yard for a similarly-sized HHW station. If pursued, this station will be open to the public during working hours. It will be isolated from the City-owned facilities by security fencing and separate public acess will be provided.

7.2.5.3 Septic Truck Receiving

The City may pursue receiving sewage from private septic trucks. For space planning purposes, a 10'x20' concrete pad for septage receiving equipment will be provided. The receiving area will include provisions for spill containment and washdown. Additional information on septage receiving is provided in Chapter 5.0.

7.2.6 Summary of Onsite Support Facilities

Following the development of TM-4, several of the onsite support facilities were modified due to changes to the WRF site location and the City's needs. The onsite support facilities incorporated into the conceptual site layout are as follows:

- **WRF Operations and Maintenance Buildings**: The WRF Operations Building spaces (office, restroom, etc.) were combined with other City public works office space in the Corporation Yard Common Spaces building discussed in Section 7.3.3. While certain facilities were co-located with the Corporation Yard, these facilities can be built without the Corporation Yard if the City chooses to not move forward with that facility at this time. The WRF Maintenance Building and Parking Canopy are co-located in the Corporation Yard (see Section 7.3.3). The Parking Canopy was reduced in size as there are opportunities for shared parking with other public works departments.
- **Corporation Yard and Storage**: The layout of the Corporation Yard and Storage was developed by the City and MKN and Associates and is briefly summarized in Section 7.3.3.

Site Solar Farm: **The City Council set goals to assess the opportunity to incorporate solar at the WRF site as part of the project. It is currently envisioned that if solar is implemented, the City will do so in the future as a separate project. Opportunities for locating 2 acres worth of ground and roof-mounted solar panels on the site are depicted in**

- Figure 7-14.

- **Water Resources Education Center**: The City currently provides tours of the existing WWTP for educational purposes. Due to the remote location of the WRF, the City does not anticipate establishing a specific Education Center at the site. Should space be needed for visitors to meet, it is available in a large conference room in the Corporation Yard Common Spaces building. Various public education components, such as displays and signs, could be built into the facilities in the future.

- **Electrical Feed and Stand-By Power**: The electrical feed facilities (PG&E and WRF) will be housed in the Electrical Building described in Section 7.3.2. The Stand-By Power facilities will be located on the pad identified as Standby/Emergency Power in Section 7.3.2.

- **Hazardous Materials Containment and Handling**: The WRF chemicals will be contained in the Chemical/Clean in Place (CIP) Chemical Storage facility described in Section 7.3.2. A possible City-collected hazardous materials area is shown on Figure 7-13.

7.3 WRF SITE LAYOUT

The liquid and solids treatment alternatives evaluations are provided in Chapters 4.0 and 5.0, respectively. In Chapter 6.0, conceptual design criteria and sizing are developed for each stage of liquid and solids treatment.

After over two years of study to extensively assess a wide variety of potential sites for the project, including several City Council briefings, Community Workshops, and publication of several technical reports, City Council directed staff to implement acquisition of property from the "Tri-W" property near South Bay Boulevard. The following sections summarize the site layout and space planning requirements for the conventional and MBR holistic treatment trains at the South Bay Boulevard site.

7.3.1 Site Layout Considerations

The South Bay Boulevard property is owned by Tri-W Enterprises and is located in San Luis Obispo County off of Highway 1 and northeast of the City of Morro Bay. The APN is 073-101-017 and the entire property is approximately 396 acres. As shown on at the end of this Chapter, the approximate lot size the City is considering for purchase is 34 acres, of which about 10 acres at the east end of the property would be used for the WRF and Corporation Yard facilities. The 10-acre WRF site is bounded by hills and is adjacent to a seasonal drainage course which is designated as waters of the U.S.. During final design it may be possible to reduce impacts within 50 feet of the bank of the creek, but some impacts within this buffer may be required and will be analyzed in the EIR, along with proposed mitigation measures. No impacts within 25 feet of the bank of the creek are proposed. In addition, the site spans a natural drainage swale that captures runoff from the surrounding hills. A series of v-ditches running perpendicular to the uphill slopes will be required to capture runoff and convey it to the seasonal stream. Significant grading (cut and fill) is required to construct the facilities in a manner that maximizes hydraulic efficiencies, reduces soil hauling (import/export), and allows for adequate access.

The site is divided into three tiers to maximize use of the existing grading, minimize cut and fill quantities, and maximize process stream hydraulics. Space is allocated for parking, sidewalks, site runoff collection, and hillside drainage diversion.

The City is currently in the process of developing easement areas at the WRF site for access and utilities as shown in at the end of this Chapter. As currently envisioned, the main access road running along the east edge of the property will be centered on a 60-foot wide easement, have two 14-foot wide lanes and 8-foot paved shoulders on each side, similar to the City's Collector Street Detail shown in Figure 7-3. All other access roads are 22 feet wide. Thirty-foot radius turns are provided throughout the site to allow access for and maneuvering of larger vehicles. The City is currently negotiating with the property owner to obtain the property and the necessary easements, so the above dimensions are subject to change.

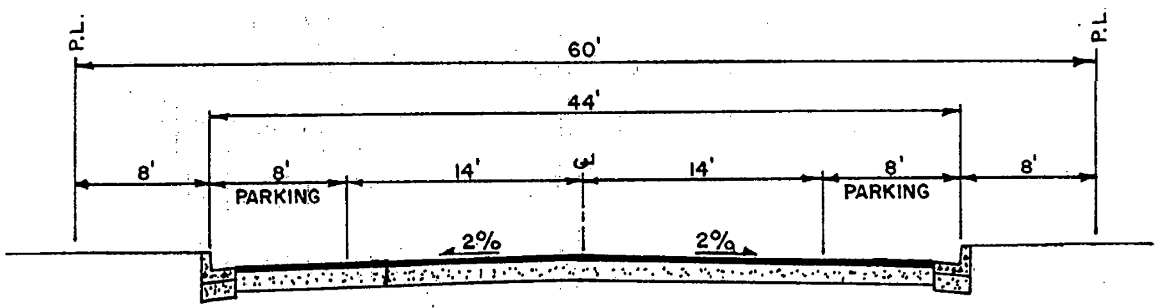


Figure 7-3 City Collector Street Detail

7.3.2 WRF Space Planning

For space planning purposes, the conventional treatment alternative was chosen as the representative treatment train to arrange on the South Bay Boulevard site. It was assumed that the MBR treatment alternative would have similar space planning needs since the MBR would take the place of the SBR. A conceptual site plan is provided on at the end of this Chapter. A summary of the WRF facilities is provided in Table 7-1.

Table 7-1 Summary of WRF Facilities

FACILITY	AREA (SF)	TYPE	NOTES
Headworks	3,500	Building	Partially buried. Top of structure is at same grade as road on north side.
Odor Control	1,750	Building	Partially buried. Top of structure is around same elevation as Headworks, Equalization Basin, and SBR.

FACILITY	AREA (SF)	TYPE	NOTES
Equalization Basin	20,910	Covered concrete basin	Partially buried. Top of structure is at same grade as north (uphill) side. South face will be completely exposed.
Sequencing Batch Reactor Basin	13,284	Concrete Basin (half is covered, half has grated walkways)	Partially buried. Top of structure is at same grade as north (uphill) side. South face will be completely exposed.
Dewatering Building	3,854	Building	Building on grade
Sludge Storage Tank	531	Circular Tank	On grade
Standby/Emergency Power	1,140	Equipment on pad	Large generator on concrete pad on grade
Electrical Building	1,860	Building	Building on grade
Secondary Equalization Tank	1,257	Circular Tank	On grade
Microfiltration, Reverse Osmosis, Ultraviolet Building	6,724	Building	MF/UV on first story, which will be designed to support future second story for RO equipment
Effluent Pump Station	2,625	Building	Building on grade
Waste Discharge Pump Station	1,800	Building	Building on grade
Remote Operations Building	1,350	Building	Building on grade
Chemical/ Clean in Place (CIP) Chemical Storage	4,800	Canopy	Pre-engineered metal canopy to cover chemical tanks in concrete containment area (partially buried).
Septage Receiving Station	220	Equipment on pad	Minor equipment on concrete pad on grade
Storm Basin	1,225	Pond	Stormwater detention pond
TOTAL AREA	**66,830**		

As shown in at the end of this chapter, the following major process facilities are located on a cut surface to provide a stable foundation for hydraulic structures:

- Headworks
- Flow Equalization Basin
- SBR Structure
- Dewatering Building
- Sludge Storage Tank
- MF/RO/UV Building
- Effluent Pump Station
- Waste Discharge Pump Station
- Secondary Equalization Tank

- All other facilities are located on a combination of cut surface and engineered fill.

7.3.3 Operations and Maintenance Facilities

As shown in Figure 7-13 at the end of this Chapter, the southernmost tier on the site is reserved for the WRF operations and maintenance facilities, including co-located water and wastewater collection maintenance facilities. In addition, the City may want to relocate other facilities from the existing Corporation Yard to this site. In addition, space at the southern end of the tier is allocated for a stormwater basin. Table 7-2 provides a summary of the facilities located in the Corporation Yard.

Table 7-2 Corporation Yard Facilities

FACILITY	AREA (SF)	TYPE	NOTES
Corporation Yard Common Areas	11,545	Building	Indoor space for WRF and Public Works staff; includes offices, laboratory, control room, restrooms, etc.
Parking & Circulation Driveways	TBD	Asphalt	Parking and circulation roads for WRF and Public Works staff and visitors. Area to be finalized as part of final design and arrangement of buildings/facilities.
Collection	756	Building	For collections department
Water	756	Building	For water department
Parks	900	Building	For parks department
Vehicle Maintenance	3,036	Building	For vehicle maintenance department
Streets	1,225	Building	For streets department
Trolley/Dial-A-Ride	9	Key Station	
WRF Maintenance	3,500	Building	For WRF maintenance
Facilities	900	Building	For facilities department
Parks Vehicle Equipment Storage	0	Combined w/facilities parking	Near parks storage
Vehicle Maintenance Vehicle Equipment Storage	325	Uncovered parking	Near vehicle maintenance
Water Vehicle Equipment Storage	2,792	Covered parking	Near water bldg
Streets Vehicle Equipment Storage	5,253	Covered parking	Near streets bldg
Collection Vehicle Equipment Storage	2,500	Covered parking	Near collections bldg
Trolley/Dial-A-Ride Storage	4,144	Enclosed, drive-thru parking	Near common spaces
Facilities Vehicle Storage	3,706	Covered parking	Near facilities bldg
Wash Rack	800	Uncovered	
Outdoor Storage Aisles	7,500	Outdoor mat'ls storage bins, 3 of 4 covered	(4) 75' x 25' aisles, on outskirts
General laydown area	2,500	Uncovered	100' x 25' area, on outskirts
WRF Parking Canopy	2,100	Covered parking	
TOTAL AREA	**54,247**		

7.4 ARCHITECTURAL TREATMENT

The building forms and exterior materials proposed at the South Bay Boulevard site are drawn directly from the investigations and recommendations presented during the Visual Preference Survey process at public workshops over the last year. The location of the site has further informed architectural character, given its relationship with other development along the Highway 1 corridor.

Generally, the building forms being used are recognizably agricultural, using simple rectangular floor plates and gable roofs at varying slopes that reflect the use of the enclosed volumes. These building shapes are articulated where appropriate with clerestories and with roof vents, again in familiar proportions. The orientation of and relationship between roofs is chosen to maximize solar exposure for the potential application of photovoltaics for power generation.

The overall impression of the architecture of the complex is intended to read from the public view as something like a dairy farm or ranch. While the individual buildings borrow their configuration from the agricultural model, exterior materials will be applied in response to functional requirements for durability and maintainability, and will produce a slightly more contemporary, less literal version of this building type. Roofs are proposed as standing-seam metal and walls are a combination of exposed concrete masonry, metal siding, cement board siding, and plaster.

Colors have been selected for compatibility with the prevalent pattern along this stretch of Highway 1, of red roofs and white or light brown walls, as seen at Cuesta College, Camp San Luis, and a number of the barns on farm properties. To give the WRF its own personality and blend well with the surrounding environment a softened, terra-cotta red has been chosen for roofs and light sand color at walls.

Tree plantings will further reinforce the historical settlement pattern of the area and provide some visual screening of structures, using drought tolerant species such as deodor cedar.

Figure 7-6 though Figure 7-13 at the end of this Chapter provide conceptual visualizations of the site. These are preliminary in nature to provide the City a first glimpse into what the final facility might look like in the future. That said, the final site layout and architectural treatment remain to be determined during final design.

Figures

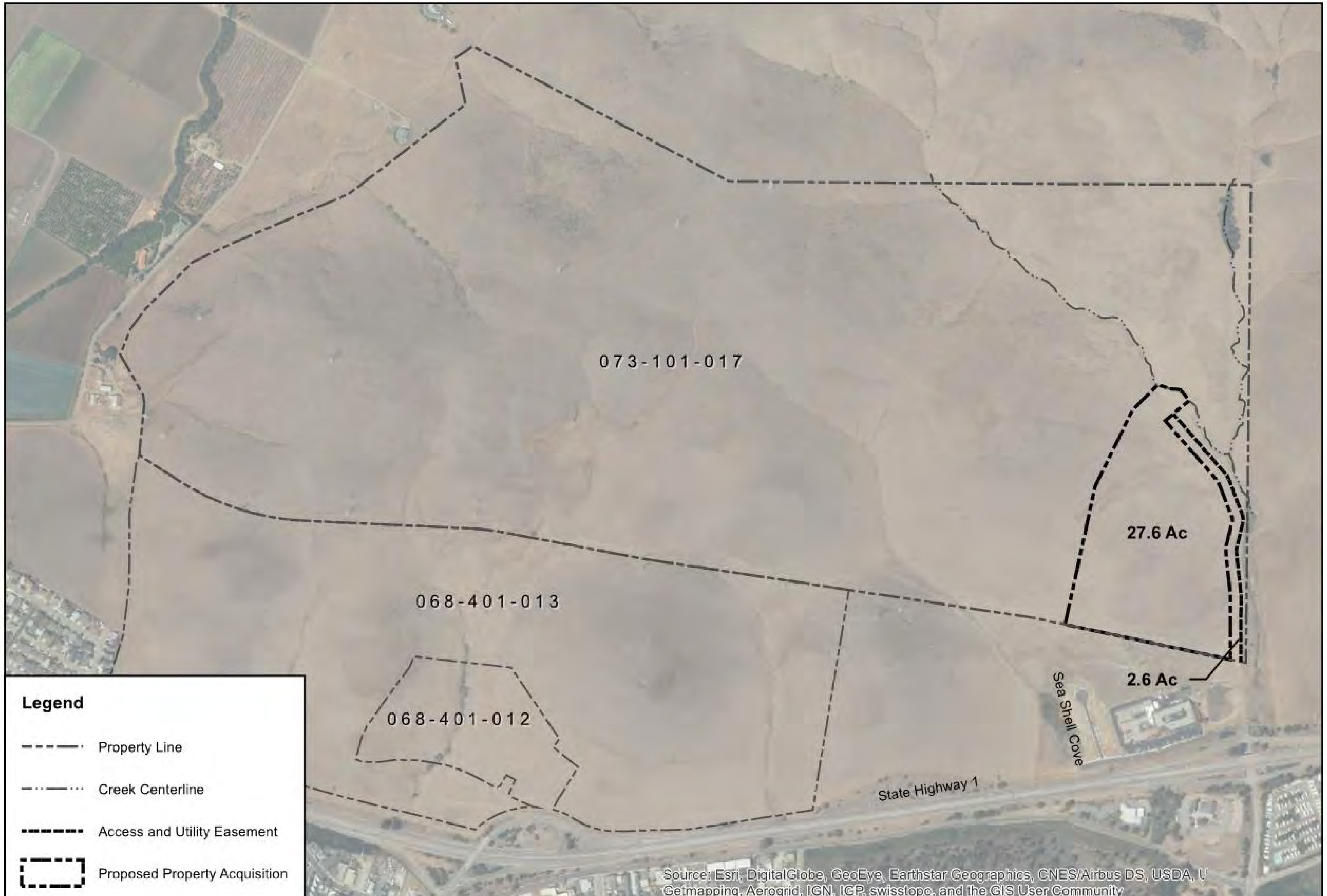


Figure 7-4 Land Acquisition Map (MKN, 2016)

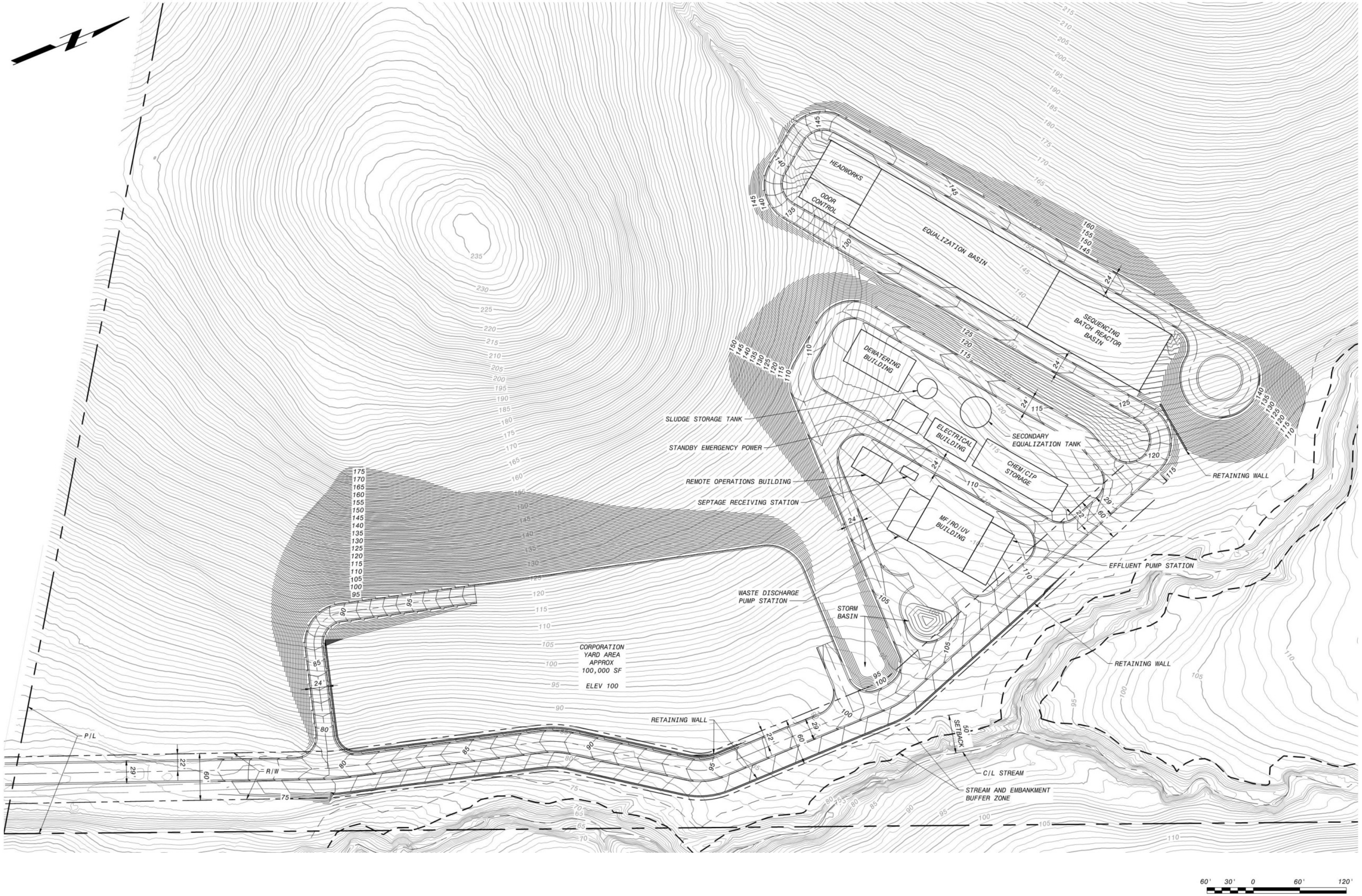


Figure 7-5 Conceptual Site Plan

Figure 7-6 WRF Site Setting Showing Proximity to Highway 1 and South Bay Boulevard

Figure 7-7 Preliminary WRF Site Plan – Phase 1 (WRF Facilities and Water/Wastewater Facilities Only)

Figure 7-8 Preliminary WRF Site Plan – Phase 2 (Includes Relocated City Corporation Yard)

Figure 7-9 Views of WRF from Highway 1

Figure 7-10 View of Phase 1 WRF, Looking South

Figure 7-11 View of Phase 2 WRF, Looking South

Figure 7-12 View of Phase 2 WRF, Looking Southeasterly

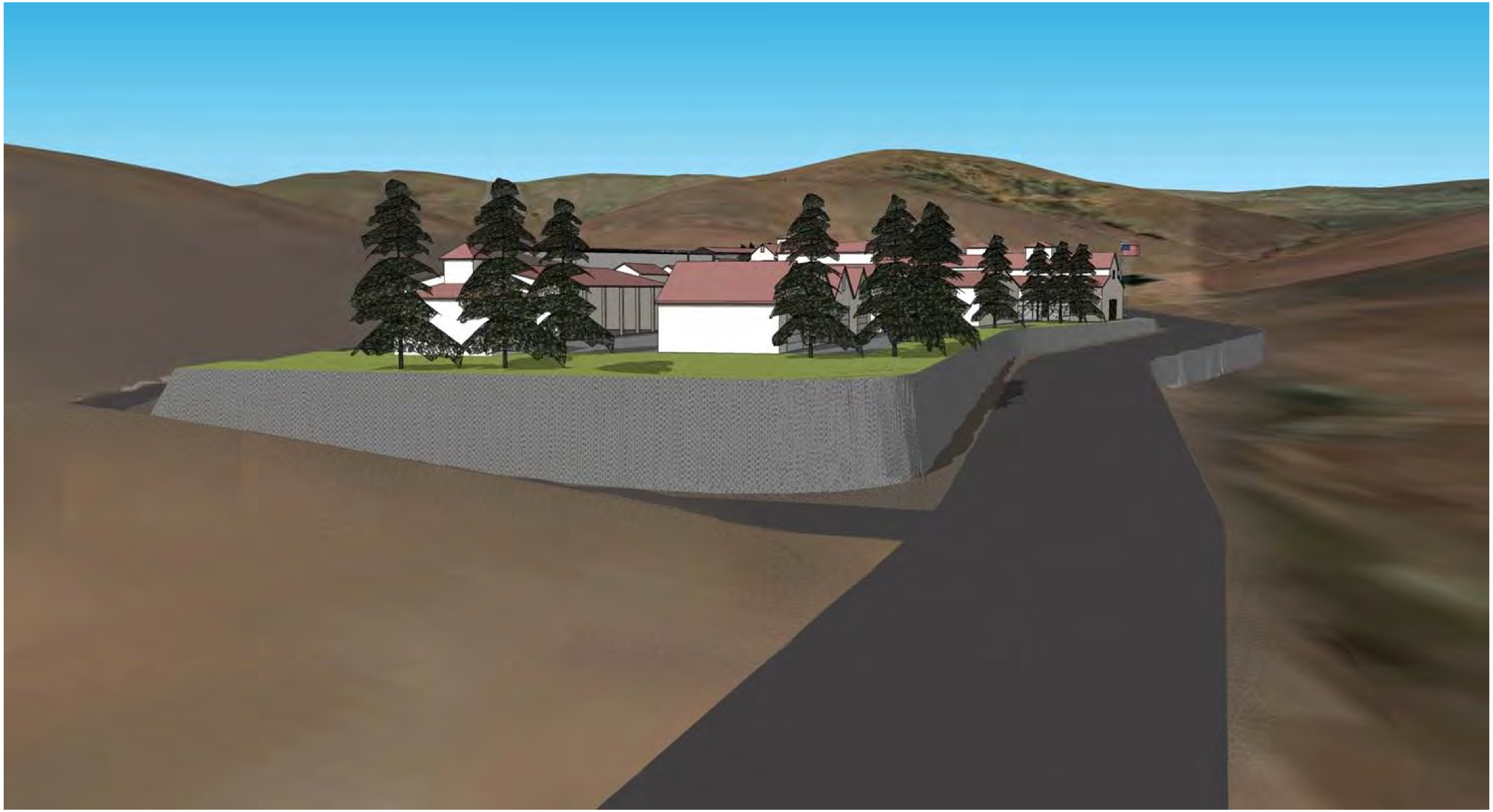
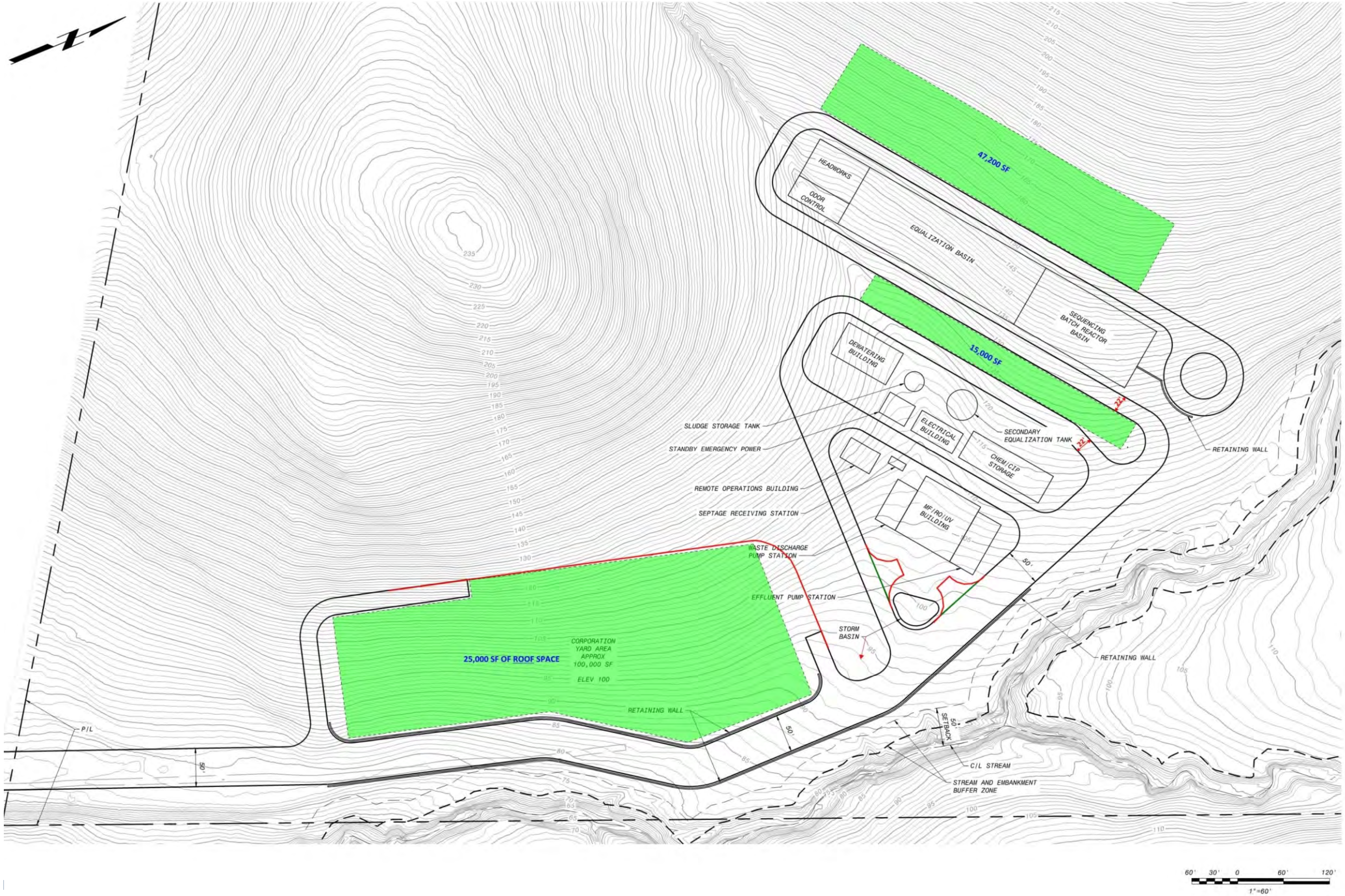
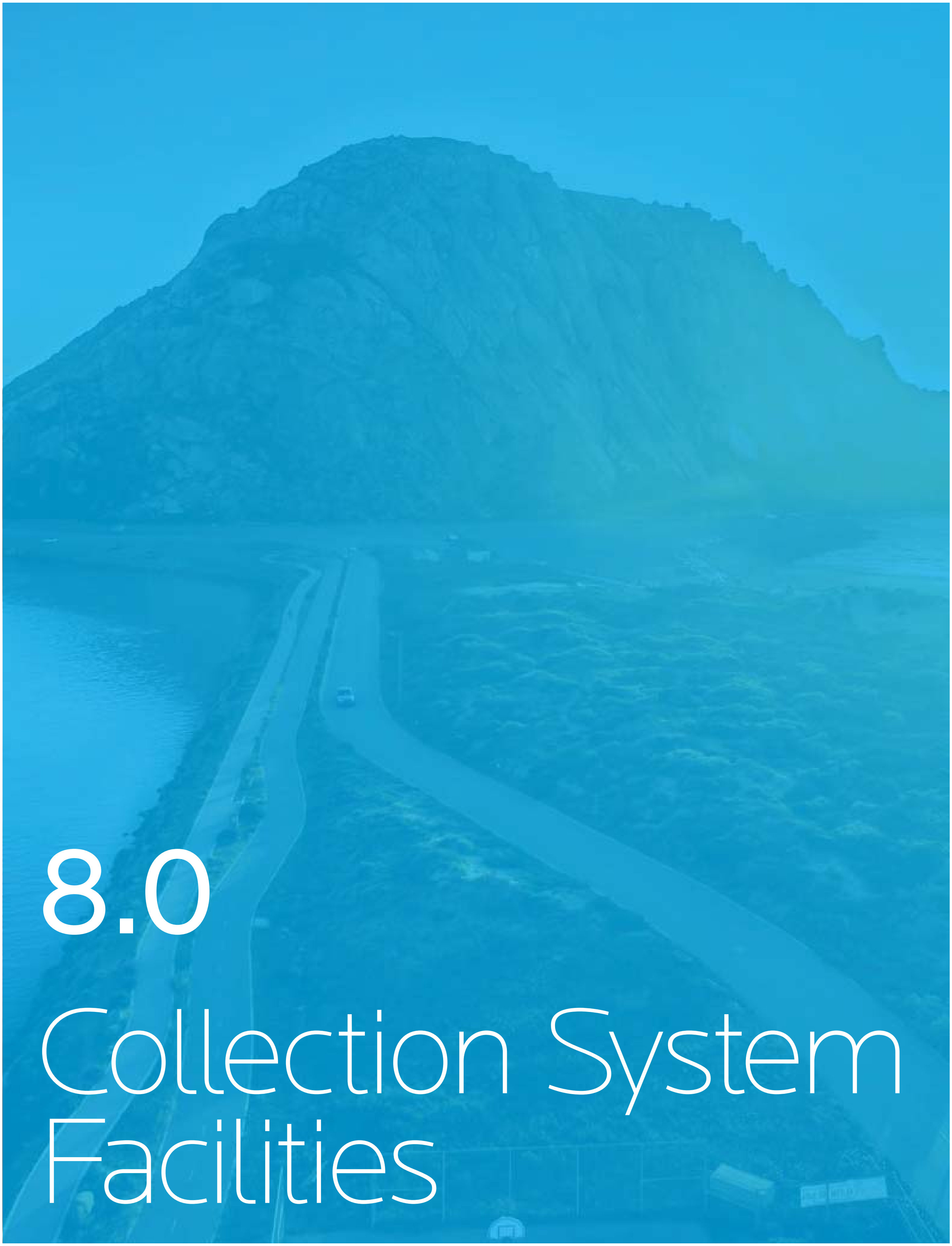


Figure 7-13 View of Phase 2 WRF from South Bay Boulevard


47,200 SF
HEADWORKS
ODOR CONTROL
EQUALIZATION BASIN
SEQUENCING BATCH REACTOR BASIN
15,000 SF
DEWATERING BUILDING
ELECTRICAL BUILDING
CHEM/CIP STORAGE
SECONDARY EQUALIZATION TANK
MF/RO/UV BUILDING
SLUDGE STORAGE TANK
STANDBY EMERGENCY POWER
REMOTE OPERATIONS BUILDING
SEPTAGE RECEIVING STATION
WASTE DISCHARGE PUMP STATION
EFFLUENT PUMP STATION
STORM BASIN
RETAINING WALL
25,000 SF OF ROOF SPACE
CORPORATION YARD AREA APPROX 100,000 SF
ELEV 100
P/L
50'
SETBACK
C/L STREAM
STREAM AND EMBANKMENT BUFFER ZONE
60' 30' 0 60' 120'
1"=60'



8.0

Collection System Facilities

8.0 Collection System Facilities

The primary purpose of this chapter is to evaluate the possible offsite facility options for the collection and conveyance of the wastewater to the new WRF. This chapter also provides preliminary design criteria for the lift station, force main, and waste stream disposal/peak wet weather flow pipeline. Eight possible sites for the new lift station to convey the flows to the new WRF were evaluated based upon 10 criteria. Based on this preliminary evaluation, the eight sites were narrowed down to two preferred sites which were then evaluated in more detail. Information provided in this chapter is summarized in Table 8-1 and described in more detail in the sections that follow.

It is important to note that all of the City's wastewater is currently conveyed to the existing WWTP on Atascadero Road, the lowest point in the existing sewer collection system. Since this is the case, the evaluation in this chapter seeks to locate the new pump station in close proximity to the existing WWTP. Any other alternative would require significant, costly, and environmentally impactful reconfiguration of the existing sewer system and need to construct multiple additional facilities.

Table 8-1 Overview of Collection System Facilities Information

ITEM	DESCRIPTION
Process Overview	Description of development process for offsite facilities concepts, including a WRF process overview schematic.
Existing Collection System	Summary of key findings and recommendations from the Sewer Collection System Master Plan Update (SCSMPU) and relevant background data useful for planning the new offsite support facilities.
New Lift Station Site Alternative Analysis	Alternatives Analysis to compare eight potential lift station sites and screening process to reduce the number of potential sites down to two preferred sites.
Conceptual Design for Preferred Sites	Lift station design flows and detailed description of major lift station components including preliminary pump station parameters, wetwell layout, provisions for flood protection, control building, odor control, and emergency power.
Lift Station Layouts	Lift station layouts for two preferred locations near the existing WWTP.
Architectural Considerations	Preliminary materials selection for aesthetic and space planning.
Conveyance Facilities	Offsite piping requirements to convey wastewater flows from the existing collection system and new lift station to the WRP and new discharge pipelines to convey flows from the treatment facilities.

8.1 PROCESS OVERVIEW

The initial phases of the evaluation consisted of workshops and meetings with the City technical staff to review potential concepts that could accomplish the City's goals. Preferred concepts were identified and evaluated in more detail and are presented in TM-5. The screening and evaluations which were presented in TM-5 are summarized in this chapter.

During the preliminary screening, workshops were held with City technical staff to identify and screen potential concepts that could meet the objectives for offsite facility options for the collection and conveyance of wastewater flows to the new WRF.

Figure 8-1 presents a schematic illustration of the proposed offsite facilities, which include connections to the existing collection system, a new lift station and force main to pump wastewater to the new WRF, and a waste discharge pipeline to convey either wastewater treatment waste stream disposal or peak wet weather flows from the new WRF to the existing ocean outfall. The proposed WRF will also require electrical power and potable water supplies.

Finally, the schematic also depicts possible additional pipelines to deliver treated water to potential end uses for the treated effluent. Definition of specific end uses and facilities to supply those end uses will be provided in the Master Water Reclamation Plan (MWRP) being prepared by the City as described earlier in the FMP.

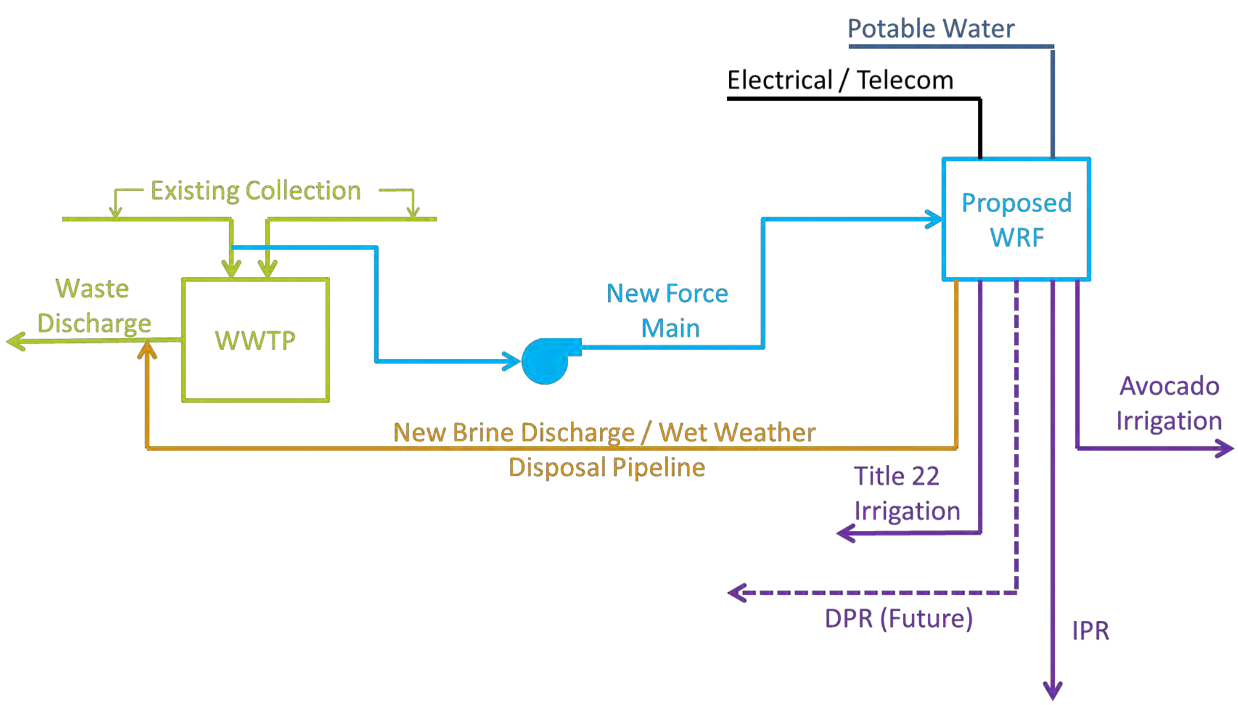


Figure 8-1 Morro Bay WRF Process Overview Schematic

8.2 EXISTING COLLECTION SYSTEM

This section presents a summary of the existing Morro Bay collection system.

In 2004, the City authorized Wallace Group to prepare a comprehensive Sewer Collection System Master Plan Update (SCSMPU). The update included analyses of the City's wastewater flows, collection system capacity, an evaluation of the lift stations and force mains, and a prioritized listing of capital improvements to improve system reliability. The collections system map from that study is provided in Figure 8-2.

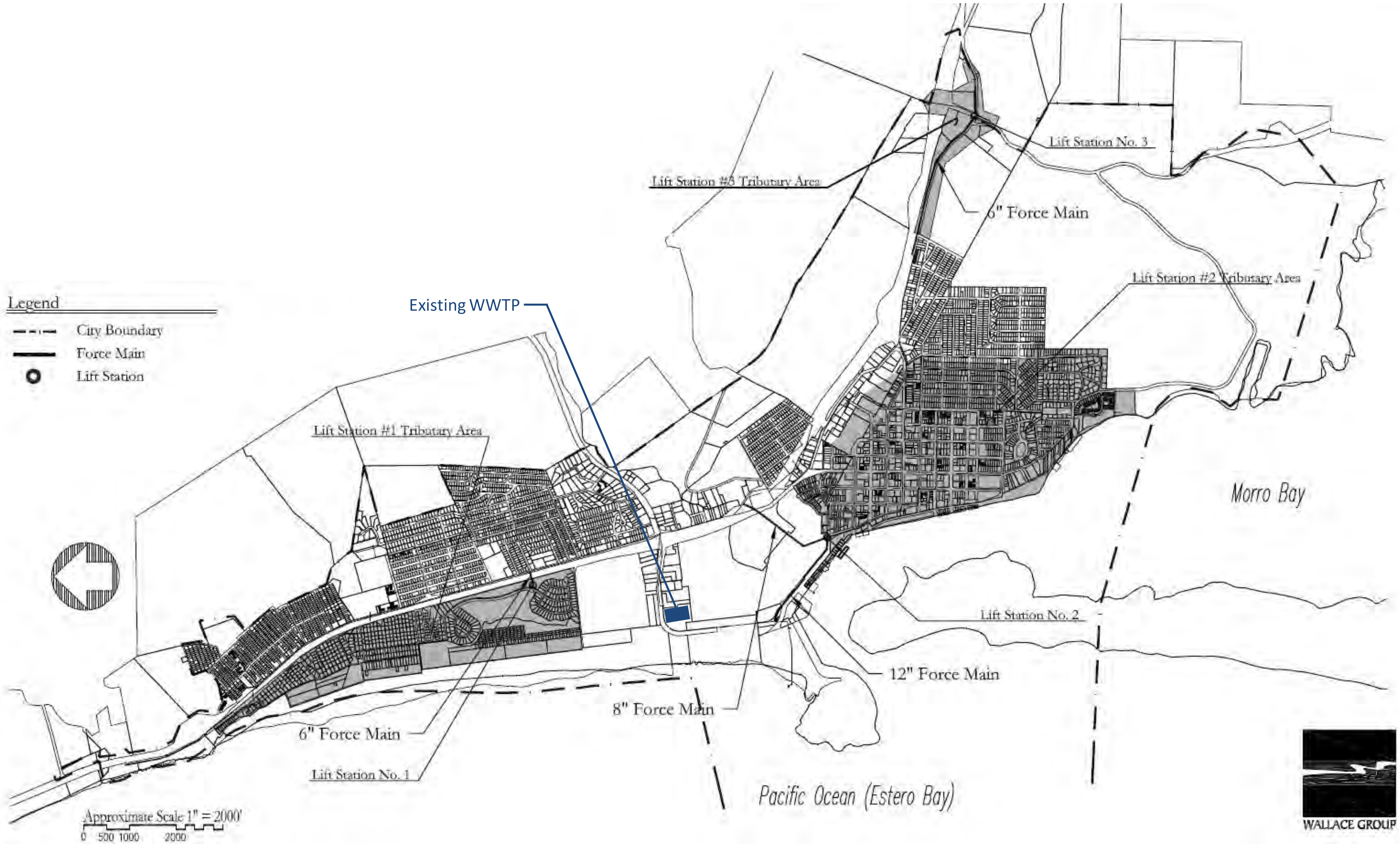


Figure 8-2 Morro Bay Collection System Overview Map

The City's existing collection system is comprised of eleven drainage basins. Wastewater is delivered to the WWTP by three gravity pipelines. The 18-inch Morro Bay/Cayucos Joint Sewer and the Cayucos Sanitary District Dedicated Sewer are both located in Atascadero Road. An additional gravity sewer conveying sewage from Lift Station #2 is located on Embarcadero Street, which runs west of the Morro Dunes Trailer Park and WWTP. The existing collection system includes three lift stations. The existing lift stations are listed below, and hydraulic parameters are presented in Table 8-2.

- Lift Station 1 is located in the Cloisters development at 2601 Coral Street.
- Lift Station 2 is located on the backside (east) of the parking lot of the Embarcadero.
- Lift Station 3 is located on Quintana Road just west of the intersection of South Bay Boulevard.

Table 8-2 Lift Station Hydraulic Parameters

ITEM	LIFT STATION 1	LIFT STATION 2	LIFT STATION 3
Peak Hour Wet Weather Flow, gpm (future)	518	903	228
Lift Station Capacity, gpm, Simplex (Duplex)	227 (550)	694 (1,000)	220 (440)
Pump Type	Submersible	Submersible	Submersible
Design Flow / Head (gpm/TDH)	380 at 42 ft	750 at 31.05 ft	220 at 150 ft
Wetwell Operating Volume, Gallons	1,030	1,128	329
*gpm = gallons per minute, ft= feet, TDH = total dynamic head			

TM-5 discusses key findings and recommendations from the SCSMPU, including inflow and infiltration (I&I) recommended reductions, deficient sewer findings, and a review of key headworks hydraulics and equipment improvements. These topics are summarized below in order to capture relevant background data that is useful for planning the new offsite support facilities.

Inflow & Infiltration: Forecasted reductions of I&I were not included in the offsite facility analysis (i.e., accounted for in the anticipated wetwell volume and lift station pump sizing). However, as the City's I&I Source Reduction Program achieves wet weather flow reductions that result in lower peak storm flows, the re-evaluation of lift station facilities and force main sizing may be warranted.

The Sewer System Master Plan schedule for update in FY16/17. This update will include an evaluation of I&I and flow monitoring. In addition, it will reevaluate the condition and capacity of sewers in Main Street and Atascadero Road.

Deficient Sewers: For the FMP, sewer deficiencies along Atascadero Road (Between Highway 1 and the existing WWTP) were included in the evaluation. Gravity sewer upgrades may no longer be needed under some of the lift station site alternatives evaluated herein, as sewer flows would be intercepted upstream, if implemented. The SCSMPU determined that a capital improvement project to address these deficiencies would cost about $530,250 (2006 dollars), including construction, engineering, and administration costs for replacement of 1,010 linear feet (LF) of 18-inch diameter sewer with new 27-inch diameter sewer.

Existing WWTP Headworks Facility: The opportunity to use the existing headworks facilities and other related infrastructure was considered in the new lift station site location and planning strategy. An improvement project to upgrade the headworks facility was designed in 2014. The design addressed several new mechanical equipment items needed to enhance reliability and improve operations, including new self-cleaning bar screens, sluice trough, and a washing press. The existing self-cleaning bar screens and all new equipment are designed and configured for the existing channel and, therefore, may not be the most efficient design for a new headworks facility. In addition, as discussed in TM-3, the existing WWTP will need to remain online during construction until the new WRF and associated facilities are operational, so there may be minimal opportunity to reuse existing WWTP facilities.

8.3 NEW LIFT STATION SITE ALTERNATIVES ANALYSIS

This section describes the evaluation process for the potential new lift station sites identified in TM-5. The purpose of the alternatives analysis was to compare the benefits and issues associated with eight potential lift station sites through a screening process and to reduce the number of potential sites down to two preferred sites. These two preferred sites were selected during a workshop with City technical staff held on September 4, 2015 that reviewed the process and findings of TM-5. Further conceptual details were developed for this FMP.

8.3.1 Screening Criteria

The screening process was a qualitative evaluation. A set of nine evaluation criteria were established to allow for a comparison of the merits and shortcomings of each site. The criteria developed for this process were:

- **Parcel Size, Location, and Accessibility** – The location and size of the parcel was reviewed to determine if the site could accommodate a new lift station, including space for vehicular access and appurtenant facilities. Proximity to existing streets or points of access was given a higher rating. A conservative lift station layout was prepared to establish a conceptual level site footprint and is presented in TM-5.
- **Parcel Ownership** – Parcel ownership was identified using the County's assessment information for the 2015/2016 tax year.
- **Land Acquisition** –The potential need to acquire the parcel was identified. Private property acquisition introduces an additional cost to the project and the timing to secure a property introduces a schedule risk.
- **Parcel Zoning Information** – The parcel zoning was identified using the County's Department of Planning and Building's online Geographic Information System (GIS) information to assess compatible land use and potential needs for rezoning to allow for pump station construction. Rezoning needs could potentially negatively impact the project schedule.
- **Potential for Community Impacts** – The potential impact to adjacent and neighboring properties was evaluated based on the land use and zoning. Consideration was also given to

concerns about potential noise and odor impacts, aesthetics, and impacts to future development opportunities.

- **Reuse of Existing Facilities** – The proximity of the parcel was reviewed to identify potential opportunities to reuse existing facilities, such as the existing WWTP headworks.
- **Benefit to Future CIP Projects** – This criterion gave credit to alternatives that intercept wastewater flows upstream of sewers slated to be upgraded due to being undersized. Intercepting flows upstream offloads the undersized sewers, eliminating the need to replace them and therefore providing a cost savings to the City's Capital Improvement Program (CIP).
- **Supports WWTP Site Redevelopment** – Parcel locations that enhance the City's ability to redevelop the WWTP site were higher rated than the option of building the new lift station on the existing WWTP site.
- **Cost and Constructability** – The cost and constructability of the lift station site were qualitatively assessed based on issues for each site. Factors included new infrastructure required to reach the proposed location, depth of excavation, reuse of existing infrastructure, benefit to future CIP projects, rezoning of parcel, permitting, construction access, floodplain, groundwater conditions, and site improvements and grading required.

8.3.2 Development of Alternatives

A total of eight potential lift station sites were identified as part of the evaluation of proposed offsite facilities required for the City's wastewater collection system improvements. Each was identified as being capable of meeting the City's objective of capturing and conveying flows from the existing wastewater collection system to the new WRF. The eight alternative sites are shown in Figure 8-3. A detailed discussion of the alternatives analysis is presented in TM No. 5.

Figure 8-3 Lift Station Alternative Sites Map

8.3.3 Qualitative Screening Process

Table 8-3 summarizes the qualitative results of the screening evaluation of new lift station site alternatives from the information presented in TM No. 5.

Table 8-3 Qualitative Comparison of Alternative Lift Station Sites

Criteria	Alternative Site No. 1	Alternative Site No. 2	Alternative Site No. 3	Alternative Site No. 4	Alternative Site No. 5	Alternative Site No. 6	Alternative Site No. 7	Alternative Site No. 8
Parcel Size, Location, and Accessibility	Adequate	Adequate. Can potentially use High School driveway access.	Adequate. Can potentially use existing access road.	Adequate	Adequate. Can use Atascadero Road and right of way for access.	Adequate. May be able to use adjacent road for access.	Not Adequate	Adequate
Parcel Ownership	Owner: CSD and City of Morro Bay	Owner: Ogle Charles P Tre Etal.	Owner: G6 Hospitality Property LLC	Owner: Kridi Tom G Tre Etal.	Owner: Ogle Charles P Tre Etal.	Owner: Ogle Charles P Tre Etal.	Owner: G6 Hospitality Property LLC	Owner: Salwasser George J & Charlotte E.
Land Acquisition	Parcel already owned	Required	Required	Required	Required	Required	Required	Required
Parcel Zoning	Government	Commercial	Commercial	Commercial	Commercial	Industrial	Motel	Single Family Residence
Potential for Community Impacts	Low impact	Medium impact. Adjacent to High School.	Medium impact. Adjacent to mobile home park and Motel 6.	High impact	Medium impact	Medium impact. Near mobile home park.	High impact. Adjacent to two motels.	High impact
Reuse of Existing Facilities	Possible to reuse headworks. Maximizes reuse of existing infrastructure.	None	None	None	Can intercept sewers as they combine to enter existing WWTP reusing existing infrastructure	None	None	None
Benefit to Future CIP Projects	None	Eliminates 575 feet of deficient sewer pipe	No impact	Eliminates 1,000 feet of deficient sewer pipe	No impact	No impact	No impact	Eliminates 1,000 feet of deficient sewer pipe
Supports WWTP Site Redevelop-ment	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cost and Construct-ability	Reuse existing infrastructure. No land acquisition. No parcel rezoning. Minimal excavation. Uses existing access roads. Requires shorter sewer segments and reduced wetwell depth; tunnel not required	New sewer (1550 ft +/-) Tunnel for Hwy 1 crossing not required	New Sewer (1025' +/-) Tunnel for Hwy 1 crossing not required	New sewer (2,100' +/-) Extra deep wetwell Deep gravity sewer w/ hwy crossing	Reuse existing infrastructure. Requires clearing, potentially environmental sensitive Requires shorter sewer segments and reduced wetwell depth; tunnel not required	New sewer (600' +/-) Deep wetwell Requires shorter sewer segments and reduced wetwell depth; tunnel not required	New sewer (1675' +/-) Deep wetwell Tunnel for Hwy 1 crossing not required	New Sewer (2250' +/-) Deep Wetwell Deep gravity sewer w/ hwy crossing

8.3.4 Recommended Lift Station Alternatives

Following completion of the screening analysis, a workshop with City technical staff was held on September 4, 2015 to review the process and secure feedback and direction for selection of the two sites to be carried forward for further detailed evaluation. At the workshop, the City agreed that two new alternatives, both of which are variations of the eight evaluated alternatives, would be evaluated in detail.

- **Alternative Site No. 1A**: Alternative 1A consists of constructing the new lift station on the site of an existing park maintenance shed located near the City's water treatment plant, on the site of the City's existing Corporation Yard, located on Atascadero Road. This revised location is intended to maximize the opportunity for redevelopment of the existing WWTP site and avoid the need to acquire property by utilizing City-owned property. The need for new property acquisition introduces a schedule risk outside of the City's control, so this alternative mitigates that risk.
- **Alternative Site No. 5A**: Alternative 5A consists of constructing the lift station directly adjacent to Atascadero Road within public right of way for all of the facilities. This alternative shares the benefit of Alternative 1A; it avoids need and potential risk to the schedule associated with acquiring private property.

8.4 CONCEPTUAL DESIGN FOR PREFERRED SITES

This section describes conceptual design information for the two preferred lift station sites and associated offsite support facilities. This section also includes an overview of collection system design flows and a more detailed description of the major lift station components. Conceptual-level site layouts are presented for space planning and arrangements specific to the two preferred sites and form the basis for planning criteria and assumptions applied during the FMP development.

8.4.1 Flow Analysis of Hydraulic Design Criteria

The proposed lift station will be designed to convey all of the City's wastewater flows to the WRF. Preliminary design criteria for wastewater flows are provided in Table 8-4 . These criteria are presented in Chapter 3, which provides more detailed discussion of the supporting data and analyses used to arrive at those criteria.

Table 8-4 New Lift Station Flow Criteria

CATEGORY	DESIGN VALUE
Pump Station Firm Capacity Flow,(1) mgd	7.05
Duty Pump System	
Maximum Flow, mgd	7.05
Peak Season Dry Weather Flow (PSDWF), Ave Day (2), mgd	1.05

Notes.
(1) Firm capacity is equal to the design flow with duty pumps in operation (standby pump capacity is not included).
(2) Historical Flows for 1995 – 2009 as provided by the 2010 FMP as reported in TM2.

For the initial conceptual sizing of the lift station and force main, it was assumed that these facilities would be designed to convey up to 7.05 mgd.

8.4.2 Pump Selection

The wide range of operating conditions shown in Table 8-4, combined with the need to provide both fail-safe and cost-efficient pump operations, suggests that pump selection consider separate operating parameters to meet peak hour wet weather flow conditions and more typical dry weather daily flows.

For the purpose of this FMP, preliminary pump selection was based on meeting peak hour wet weather flows using two on-duty pumps each sized to deliver 2,447 gpm (3.53 mgd) against 376 feet of TDH. A third pump of equal size would be provided for stand-by service and to meet critical redundancy requirements during a peak hour wet weather event.

Peak hour dry weather flow conditions would be handled using two on-duty pumps each sized to deliver 1,050 gpm (1.50 mgd) against 250 feet of TDH. Standby pumping requirements for the dry weather flow condition could be provided by one of the larger pumps.

To meet both wet and dry weather flow conditions, the lift station pumping units would consist of a total of five solids-handling, submersible centrifugal pumps. Preliminary pump performance parameters are shown in Table 8-5. The pumps would be outfitted with variable frequency drives (VFDs) to allow the pumps to convey flows that more closely match the incoming flows, minimize wet well retention times, and maintain continuous flow to the new WRF.

The lift station pump configuration strategy of 3+1 pump operating configuration can also be explored as an alternative lift station design approach.

Table 8-5 Lift Station Pump Parameters

CATEGORY	DESIGN VALUE
Pump Type	Submersible Centrifugal
Number	5 (3 wet, 2 dry)
Speed	Variable (VFD)
Wet Weather Pump Conditions	
Capacity, gpm (each)	2,447 (3.53 mgd)
TDH, ft	376
Horsepower, each	400
Dry Weather Pump Conditions	
Capacity, gpm (each)	1,050
TDH, ft	158
Horsepower, each	75

8.4.3 Wetwell Design

For planning purposes, it was assumed that submersible solids handling wastewater pumps would be installed in a rectangular shaped wet well-constructed of reinforced concrete. This is consistent with the City's existing lift stations.

Table 8-6 summarizes preliminary wet well dimensions. These dimensions are consistent with the structure size and storage capacity presented in the *TM – Design Alternative for Rancho Colina Site*, prepared by Michael K. Nunley & Associates, 2014 [MKN&A, 2014].

Table 8-6 Summary of Wetwell Dimensions

CATEGORY	DESIGN VALUE
Width, ft	16
Length, ft	30
Depth, ft	26
Capacity, gal	93,350

As part of the FMP, the arrangement and storage capacity of the wet well was confirmed to meet site requirements and hydraulic operating conditions. Wet well capacity will also consider the storage requirements under the operating and emergency conditions presented below:

- **Minimum Storage** – Minimum wetwell storage would allow for a self-cleaning operation. Minimum storage levels are achieved when the wetwell is drawn down and allows for cleaning of floor of debris, carrying solids to the dedicated clean pump cycle for removal.
- **Storage for Normal Operating Conditions** – Wetwell storage for normal operations is driven by peak influent flows and the pump system optimum efficiency point. Lift station pump cycle times were evaluated for minimum day and average day flows to prevent excessive pump cycling.
- **Storage for Emergency Conditions** – Additional emergency storage above normal levels considers response times from an unplanned or planned shutdown and allows time for system operators to respond accordingly.

8.4.4 Flood Protection

Both of the site alternatives lie within the 100-year flood plain of Morro Creek as defined in the current Flood Insurance Rate Map (FIRM), including potential influences of storm surge, tsunami and sea level rise. To protect critical equipment from damage, structures and/or site grading housing or supporting said equipment would be set a minimum of two feet above the 100-year flood elevation. For example, the minimum elevation requirement would apply to the top slab/access hatches for the wetwell, the floor elevation of the control building and the supporting foundation for the emergency generator.

As noted earlier in this chapter, it is beneficial to locate the new pump station in close proximity to the existing WWTP, as this is the lowest point in the City's sewer collection system. Any other alternative would require significant, costly, and environmentally impactful reconfiguration of the existing sewer system and need to construct multiple additional facilities, including new sewer pipelines and possibly multiple pump stations.

While location of the new pump station results in it being located in a flood plain, it results in more efficient, less impactful, lower cost new infrastructure. The California Coastal Commission has been consulted on the possibility that the lift station would be located in the flood plain. They have indicated that location in the flood plain is likely to be acceptable.

Table 8-7 summarizes the minimum grades for all lift station facilities at Site Nos. 1A and 5A.

Table 8-7 Lift Station Minimum Structure Elevations for Flood Protection

CRITERIA	ALTERNATIVE SITE NO. 1A	ALTERNATIVE SITE NO. 5A
100-year Flood Elevation (with Surge and Sea Level Rise)(1) (ft)	20.60	19.96
100-year Flood Elevation (with no tide adjustment)(2) (ft)	20.61	19.97
Minimum Top of Concrete Elevation (ft)	22.61	21.97
Existing Grade Ranges (Elevation)	17-18	15-19

Notes:
(1) 100-year Flood Elevation is based on the City of Morro Bay Technical Memorandum titled Morro Creek Flood Analysis with Wave Run-up and Sea Level Rise, 01/10/2012, prepared for the WWTP EIR and approved by FEMA. Grids 161 & 182
(2) 100-year Flood Elevation (with no tide adjustment) is based on the City of Morro Bay Technical Memorandum titled Morro Creek Flood Analysis (with no tide adjustment), 01/10/2012, prepared for the WWTP EIR and approved by FEMA. Grids 161 & 182

8.4.5 Control Building

A separate control building would be provided to house electrical equipment, a motor control center, switchgear, and controls for the submersible pump facilities. A building power roof ventilator would provide room ventilation. Architectural considerations related to the design criteria for the control building are provided in Section 8.6.1.

8.4.6 Odor Control

Odor control measures will be a key component for the lift station facilities due to their close proximity to residential, schools, and commercial neighbors and potential residual effects on downstream WRF plant odors.

Several different approaches were identified in TM-5 and are evaluated in this FMP to both minimize odor production and collect and treat odorous airstreams. A combination of control measures is typically used to achieve effective and economical odor control at a wastewater or solids processing plant.

Strategies for odor control may include:

- Control of odorants through use of chemical addition to the wastewater
- Process and operational control measures
- Containment and collection of odorous gas emissions
- Treatment of odorous foul airstreams to minimize release of odors
- Dispersion of any residual odorants released to the atmosphere

The City currently implements dosing of calcium ammonium nitrate (Simplot CAN-17) at the existing lift stations. This FMP recommends the same chemical addition to be implemented at the new lift station. In addition, odor control through containment would be implemented by using sealed hatches to reduce the release of odors into the environment.

8.4.7 Standby Backup Power

A standby diesel engine-generator would be required to provide backup power to the new lift station upon loss of electric utility power. Preliminary sizing calculations result in a 1,000 kW standby diesel engine-generator to provide adequate power to meet firm pumping capacity and additional loads from other appurtenances. The engine-generator would be housed in a weatherproof sound-attenuated enclosure, above the flood plain elevation.

The preliminary sizing parameters for the standby engine-generator are summarized in Table 8-8

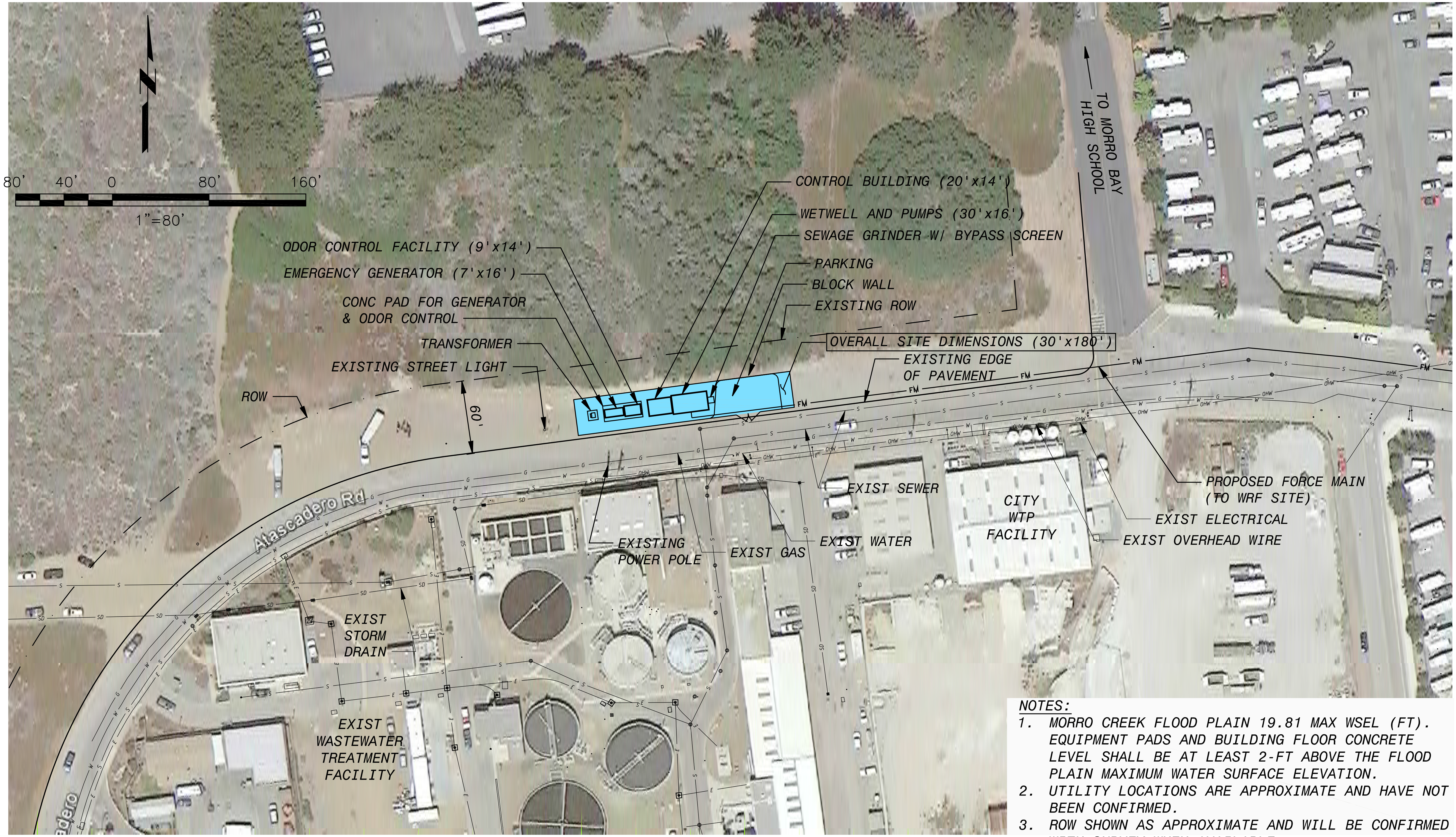
Table 8-8 Standby Diesel Engine-Generator

CATEGORY	VALUE
Standby Rating	1,000 kW
Unit Size (L x W X H)	346" x 108" x 114"
Recommended Manufacturer	Cummins, Caterpillar
Fuel Type	Diesel, UL listed sub-base fuel tank
Enclosure	Weatherproof / Level III Sound Attenuation
Appurtenances	Exhaust Silencer, Control System

8.5 LIFT STATION SITE LAYOUTS

The criteria established in Sections 8.4.2-8.4.7 were used to develop preliminary site layouts for Alternative Site Nos. 1A and 5A. These are depicted on Figures 8-4 and 8-5.

Figure 8-4 Alternative 1A



NOTES:
1. MORRO CREEK FLOOD PLAIN 19.81 MAX WSEL (FT). EQUIPMENT PADS AND BUILDING FLOOR CONCRETE LEVEL SHALL BE AT LEAST 2-FT ABOVE THE FLOOD PLAIN MAXIMUM WATER SURFACE ELEVATION.
2. UTILITY LOCATIONS ARE APPROXIMATE AND HAVE NOT BEEN CONFIRMED.
3. ROW SHOWN AS APPROXIMATE AND WILL BE CONFIRMED WITH SURVEY WHEN AVAILABLE.
4. DIMENSIONS SHOWN ARE FOR PLANNING LEVEL LIFT STATION LAYOUT CONCEPTS.

ALTERNATIVE 5A

Figure 8-5 Alternative 5A

8.6 ARCHITECTURAL CONSIDERATIONS

This section describes architectural considerations for the lift station and associated offsite support facilities. This section also includes a conceptual rendering of the lift station facilities. Architectural considerations form the basis for the planning level capital cost estimates completed during this FMP.

8.6.1 Preliminary Materials Selection

Materials selection for the control building will be based upon building construction materials similar to the architectural and structural design of the City's existing lift stations No. 2 and No. 3. This includes using components such as CMU block building walls and a metal roof.

8.7 CONVEYANCE FACILITIES

This section presents conceptual design information for the offsite conveyance facilities. This section also includes an overview of conceptual alignments for planning purposes and associated design considerations.

8.7.1 Alignment of Offsite Conveyance Pipelines

The offsite piping systems for the new WRF would be comprised of a new force main to convey wastewater flows from the existing collection system and new lift station to the WRF and a new discharge pipeline to convey waste water treatment process waste streams or peak wet weather flows from the treatment processes at the WRF to a connection to the existing ocean outfall near the existing WWTP. Additional City recycled water and/or water mains may also be required along with a booster system to provide fire protection and potable water at the new City WRF site.

On June 14, 2016, the Morro Bay City council directed staff to proceed with the South Bay Boulevard site for the planning and permitting for the WRF Project. The new WRF location is adjacent to Highway 1, requiring re-evaluation of off-site facilities presented in TM-5, which considered conveyance alignments along Highway 41. Given that the new location of the potential WRF requires longer pipeline alignment infrastructure and potential for additional pumping demands, the team determined that an alternative alignments study was warranted for the conveyance piping. The team evaluated two alternative alignments and provided a preliminary assessment for each considering criteria such as construction cost, impacts to City existing street right-of-way, stream and highway crossings, and pumping costs. The two alternative alignments considered include;

- East Conceptual Alignment Option - Route along the East Side HWY 1.
- West Conceptual Alignment Option - Route within Quintana Rd.

For space planning purposes, it was assumed that the alignment route would require up to three pipelines: sewer forcemain, brine discharge, and recycle water.

The East and West conceptual alignments for offsite pipelines are shown on Figure 8-6 & Figure 8-7, respectively.

Figure 8-6 East Alignment Option to WRF Site

Figure 8-7 West Alignment Option to WRF Site

8.7.1.1 East Alignment Description

The East Conceptual Alignment begins at the new lift station and travels east along the north side of Atascadero Road. It is important to note that this segment of the alignment is highly constrained with utilities. As described in TM-5, two of the principal trunk sewers leading to the WWTP are in this corridor. Water and natural gas and other dry utilities exist in this area. To avoid the congested utilities within Atascadero Road, the alignment travels south to reach the backside of property lots and travels along an existing parkway / bikepath which is located on the backside of Power Plant parcel. The alignment continues east and then crosses below Highway 1 and travels south along Main Street and continues to Radcliff Avenue. The conceptual Highway crossing for the East Alignment is shown on Figure 8-8.

Figure 8-8 East Alignment Highway 1 Crossing

The alignment heads north along Radcliff Avenue then east through a residential neighborhood along Bolton Drive. The alignment continues east adjacent to Highway 1 along rural undeveloped private properties with multiple locations where crossing across small drainage courses is required. The alignment travels within private property, which would require additional negotiations with property owners for temporary and permanent easements (Dynegy and PG&E). Once the alignment reaches South Bay Boulevard, it continues in a northerly direction and reaches the proposed WRF facilities. The alignment travelling through rural land is depicted on Figure 8-9.

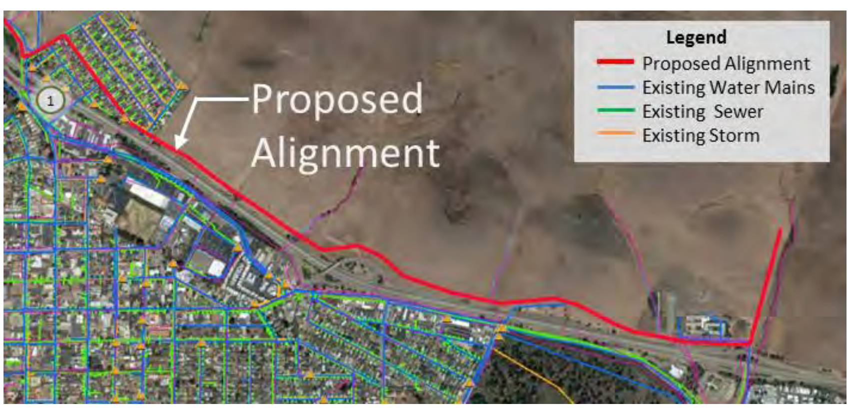


Figure 8-9 East Alignment through Residential Neighborhood and Rural Land

To accommodate maintenance requirements for pipeline infrastructure within the undeveloped segment, gravel roads are recommended in order to provide access to above grade pipe appurtenances, such as blow-off or air-valve facilities.

8.7.1.2 West Alignment Description

The West Conceptual Alignment begins at the new lift station and travels east along the north side of Atascadero Road. As indicated in the East Alignment description, this segment of the alignment is highly constrained with utilities. To avoid the congested utilities within Atascadero Road, the alignment travels south to reach the backside of property lots and travels along an existing parkway / bikepath which is located on the backside of the Power Plant parcel. The alignment continues east along Main Street within the existing street right-of way and continues to Quintana Road. The alignment continues to southeast direction along Quintana Road and traverses through street crossings of Kennedy Way and Morro Bay Boulevard. The alignment continues along Quintana Road and travels thru street intersections of Kings Avenue, Bella Vista Drive, and La Loma Avenue. The alignment along Quintana Road is shown in Figure 8-10.

Figure 8-10 West Alignment within the City of Morro Bay's Quintana Road

The alignment extends to a proposed Highway 1 crossing, which is located approximately 1,325 feet west of South Bay Boulevard. The crossing will go under the highway. After crossing Highway 1, the alignment continues along Teresa Road to South Bay Boulevard and continues to the north to the proposed WRF site. The conceptual Highway crossing for the West Alignment is shown on Figure 8-11.

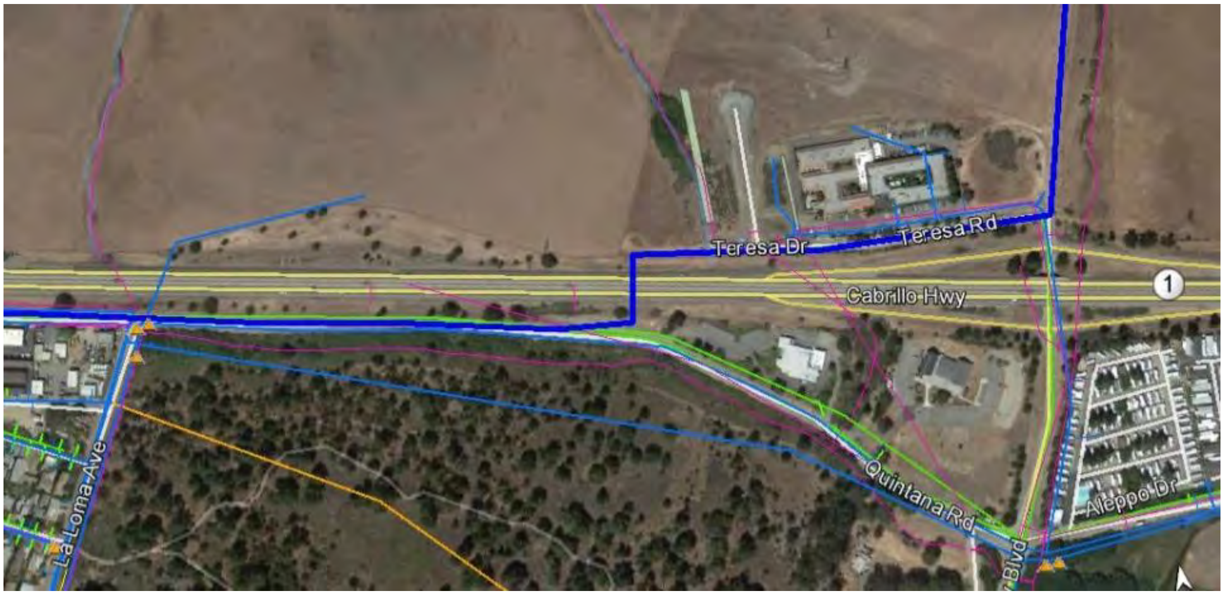


Figure 8-11 West Alignment Proposed Crossing of Highway 1

For both alignments, a Highway 1 crossing is required to reach the WRF site. To meet California Department of Transportation (Caltrans) requirements for crossing Highway 1, a casing pipe would be required for the pipeline crossing. The casing pipe would need to extend beyond the limits of the Highway 1 right-of-way. It was assumed the casing pipe would be a steel pipe and would be installed using jack-and-bore construction. The casing length would need to be approximately 500 feet to cross the Highway 1 right-of-way and avoid potential conflicts with City frontage streets and other facilities. Horizontal directional drilling could be an alternate installation technique for the Highway 1 crossing.

Utility information was reviewed based upon the City's available GIS database of water, sewer, and storm drain infrastructure and was considered during the development of the conceptual alignments.

Preferred Alignment Recommendation

As described earlier, the engineering team evaluated the two alternative alignments and provided a preliminary assessment for each. While both alignments are feasible, the West Alignment was determined to be favorable since the estimated construction cost was lower when compared to the east alignment.

The East Alignment construction cost was higher due to the multiple drainage course crossings that would require horizontal directional drilling technology to limit environmental impacts across each crossing. The West Alignment considered a single HDD crossing below the traffic circle on Morro Bay Blvd and Quintana Road which would help limit disturbance to traffic and existing utilities. Annual pumping costs for the west alignment were also more favorable since the west alignment elevation profile high point elevation grade (West: 150' ft vs East: 230') was lower and provided lower pumping annual costs.

Given that the West Alignment was the preferred alternative, it was determined that the west alignment route from the existing WWTP site to the new WRF site would establish the design criteria for further hydraulic parameters and sizing of the force main and waste discharge lines discussed in the next section.

8.7.1.3 Force Main Sizing Criteria

A conceptual-level review was performed to optimize the diameter of the force main, hydraulic losses, minimum and maximum velocity requirements, and costs. A larger diameter force main would provide a lower velocity and lower frictional headlosses under high flow conditions, resulting in reduced operating costs for the lift station. The larger diameter pipeline may also result in significantly lower velocities under minimum flow conditions, however, creating a significant maintenance concern with debris accumulation and potential for increased odor generation. The review concluded that that an optimal diameter for the force main would be 16 inches. This diameter would provide a sufficient velocity to flush solids at average minimum flows while providing a manageable normal operating gradient for efficient pump operation. Preliminary force main sizing parameters are shown in Table 8-9, and a forcemain hydraulic profile is shown on Figure 8-12.

Table 8-9 Preliminary Force Main Sizing Parameters

CATEGORY	DESIGN VALUE
Diameter, inch	16
Material	Butt-Fused HDPE, Ductile Iron (cement mortar or glass-lined, coating TBD)
Pipeline Pressure Class, PSI	250
Length, miles	2.92

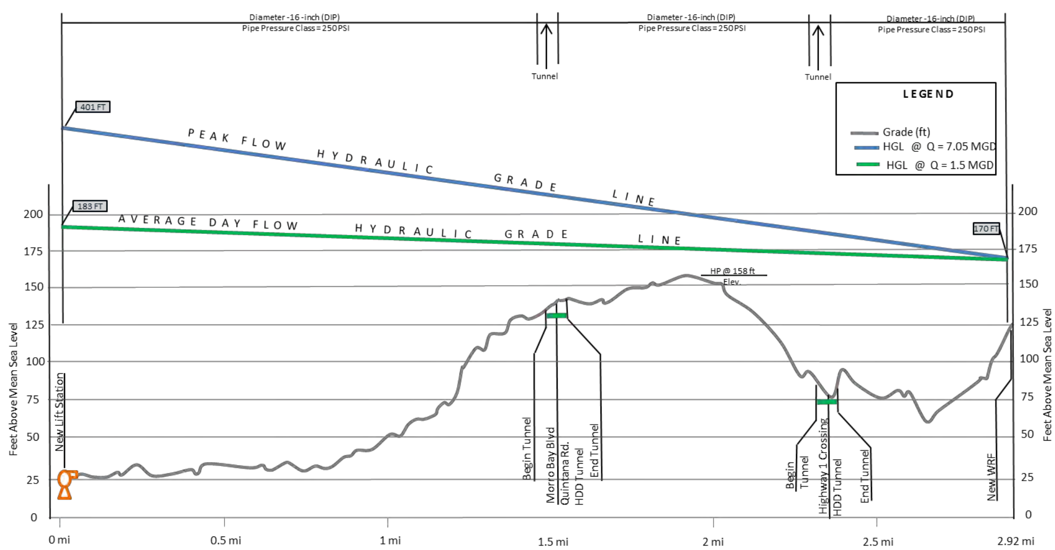


Figure 8-12 16-Inch Diameter Force Main Hydraulic Profile

8.7.2 Waste Discharge Pipeline

The treatment processes at the new WRF site would likely require a discharge pipeline to convey brine or extreme wet weather flows to the existing outfall at the WWTP site.

The following sections describe the preliminary criteria for the discharge pipeline.

8.7.2.1 Waste Discharge Pipeline Alignment

The conceptual alignment for the waste discharge pipeline is considered to be the same preferred alignment as identified in the West Alignment Alternative outlined in section 8.7.1.2 and would follow a similar alignment to the force main. The waste discharge pipeline would begin at the WRF site and travel to the existing WWTP at Atascadero road. Similar to the force main, a casing pipe would be required for the crossing of the Highway 1. The casing could be shared with the new force main.

For purposes of this FMP, a new effluent junction box structure is proposed for a permanent connection to the existing ocean outfall. The junction box structure would be located near the existing WWTP along Atascadero Road.

Preliminary evaluation has determined that the West Alignment is the preferred routing for both the force main and the waste discharge pipeline. However, this will require careful planning and routing of new proposed pipelines within City streets congested with existing utilities. The California DDW provides design guidance criteria for the separation of water mains and non-potable conveyance pipelines. These standards help mitigate risk and are most effective protection against drinking water contamination issues. As part of the FMP evaluation, a congested City right of way was depicted to confirm minimum separation requirements would be able to be met along the West Alignment. Figure 8-13 depicts the congested street area along Quintana Road located just west of the Morro Bay Boulevard traffic circle, which has multiple water mains along the street right of way.

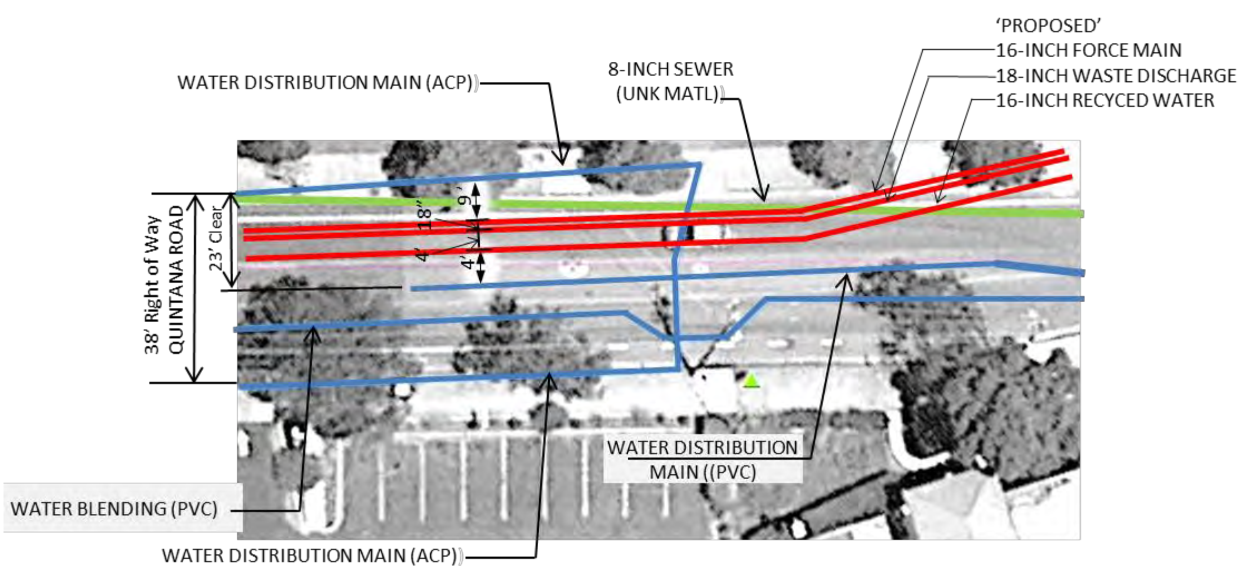


Figure 8-13 Utility Separation – Special Construction Considerations

As shown in the figure above, this street right of way along Quintana Road contains four existing water distribution mains and existing sewer. Given the available 23-ft clearance between existing water mains, the proposed new alignment is routed within this corridor and includes construction space for up to three new proposed utilizes (FM, WD, RW). About 4-ft of available clearance between existing water mains and new non-potable pipelines is estimated and the California Department of Health Services minimum separation requirements is able to be met. However, new pipe construction must meet special material requirements including:

- Plastic Sewer Pipe with Rubber Ring Joints (Per ASTM D3034) Or Equivalent.
- Ductile Iron Pipe with Compression Joints.

During detailed design phase of the offsite facilities, minimum separation requirements will need to be considered along the entire alignment. Based upon preliminary review of the alignment from inspection of City GIS utility database Atlas, it appears that the West Alignment is feasible. During detailed design, additional record drawing and field verification should confirm that this alignment is feasible. If the space requirements cannot be met, then a hybrid alignment approach could be selected that utilizes both the East and West alignments for the force main and waste discharge pipeline, respectively.

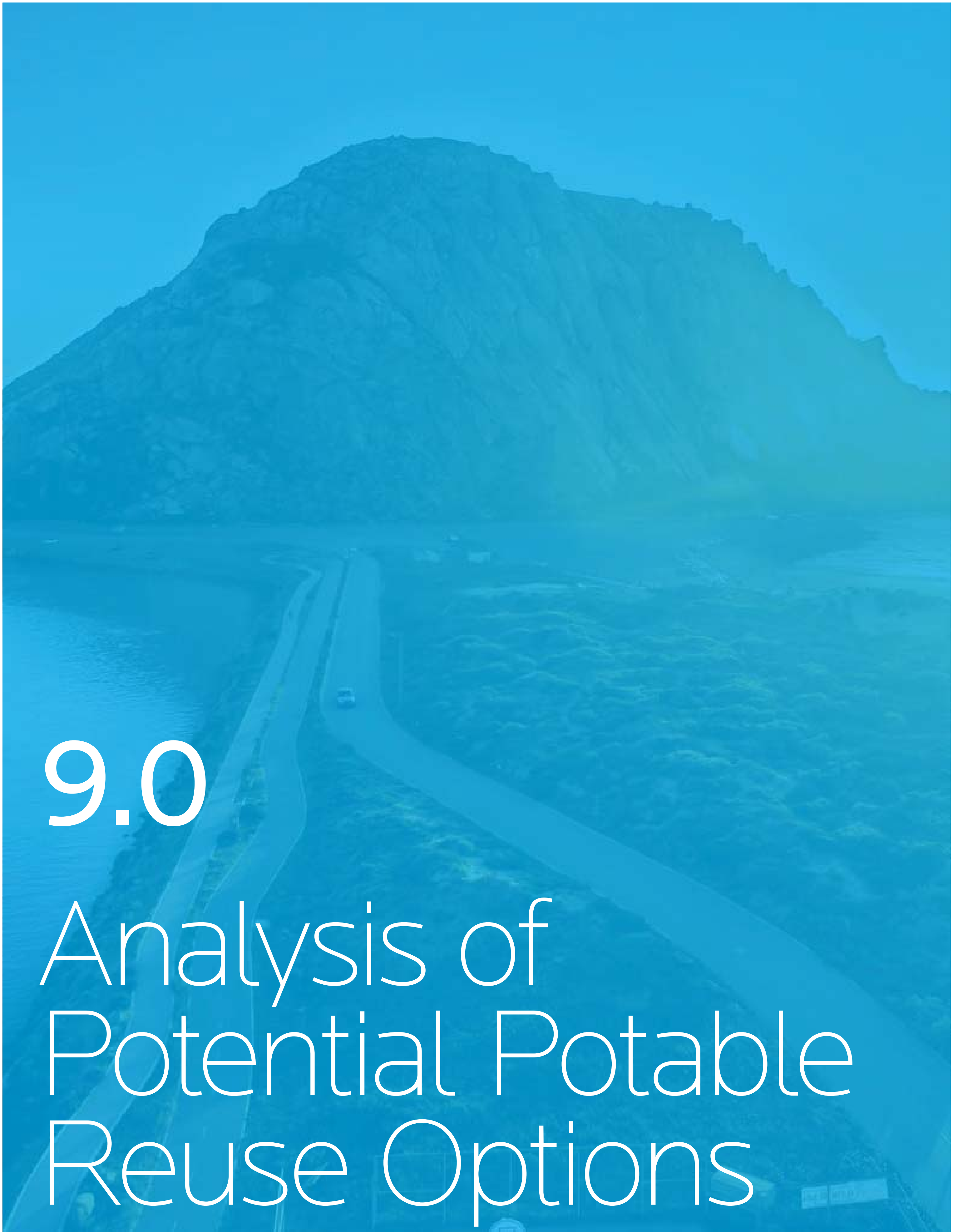
8.7.2.2 Waste Discharge Pipeline Design

The discharge pipeline sizing criteria are summarized in Table 8-10. Selecting the size for the discharge pipeline was determined based upon the flow projections from the new WRF to the ocean outfall. The hydraulic peak flow condition was used for selecting the preliminary pipe size for the brine pipeline. The peak flow was considered to be 7.05 mgd, which represents the peak hour flow for the WRF, as described in the flow projections in Chapter 3.

Considering the terrain along the alignment between the WRF and the existing outfall system, there is a prominent hill with elevation high point along Quintana Road. The recommended design strategy includes an initial waste discharge pump station at the WRF and pressure pipe along the initial segment of the waste discharge pipe alignment, extending between the WRF and to near the intersection of Quintana Rd and Kings Ave (approximate elevation high point at 150'; Existing A03 Sewer Basin). At Quintana Rd and Kings Avenue, a new proposed pressure regulating station would control flow from the pressurized pipe segment and convey flow into a new gravity pipeline to continue along the route of the west alignment to Atascadero Road and into the existing ocean outfall. The recommended gravity pipeline system would start at the existing AO3 Sewer Basin Area (Quintana Rd / Kings Avenue) and convey flow through existing Sewer Basin A02 and through the Treatment Basin as similar to existing gravity sewerage facilities outlined in the Morro Bay Sewer Master Plan.

Table 8-10 Brine/Wet Weather Discharge Pipeline Design Criteria

CATEGORY	DESIGN VALUE
WASTE DISCHARGE - PRESSURE SEGMENT	
Pressure Pipe Diameter, inch	16
Material	PVC, HDPE, DIP
Pressure Control Vault	
Valve	Pressure Reducing Valve
WASTE DISCHARGE - GRAVITY SEGMENT	
Gravity Sewer Segment, Diameter, inch	18
Available Slope (Ft/Ft) (Ave)	.0125
Design Depth	0.75D
"N"" Value	.009
Material	PVC, HPDE, RCP, VCP



9.0 Analysis of Potential Potable Reuse Options

9.0 Analysis of Potential Potable Reuse Options

This chapter provides a summary of the analysis of potential potable reuse options presented in TM-8, Potable Reuse Strategy and Offsite Facility Requirements. Also incorporated is the appropriate information provided in TM-7, Liquid Treatment.

9.1 OVERVIEW

Table 9-1 presents an overview of the discussion in this chapter.

Table 9-1 Overview of Analysis of Potential Potable Reuse Options

ITEM	DESCRIPTION
Regulatory Framework	For purposes of the FMP, potable reuse options considered were IPR and two forms of DPR: DPR with Advanced Treated Wastewater (DPR-ATW) and DPR with Finished Water (DPR-FW). Three examples of DPR projects were reviewed. The strategies and facility requirements considered for the analysis were based on the regulatory discussion presented in FMP Chapter 2.
Integrating DRP into the New WRF	The three critical considerations for process and technology selection were: multi-barrier protections, redundancy, and robustness and resiliency.
Conceptual DPR Alternatives Evaluation	Four conceptual conveyance strategies for DPR were identified and evaluated

9.2 REGULATORY FRAMEWORK

This section discusses the two forms of potable reuse (indirect potable reuse (IPR) and direct potable reuse (DPR)), describes representative DPR projects worldwide, and briefly mentions current activities related to development of a regulatory framework for DPR in California.

9.2.1 Potable Reuse

In potable reuse, effluent from the WRP would be highly treated to meet drinking water quality regulations. For IPR, the highly treated wastewater is conveyed to an environmental buffer (e.g., a groundwater aquifer or surface water reservoir) where it will blend with naturally occurring water. The blended water is then extracted for further treatment prior to introduction into the potable water distribution system (See Figure 9-1). The figure also illustrates DPR for potable reuse, as described in more detail below.

In some instances, IPR can also be accomplished by treating the wastewater by spreading to take advantage of soil aquifer treatment. The environmental buffer provides an additional level of protection of public health by diluting the highly treated wastewater with naturally occurring water sources, and by providing water purveyors time to act to protect public health if problems occur in the wastewater treatment process.

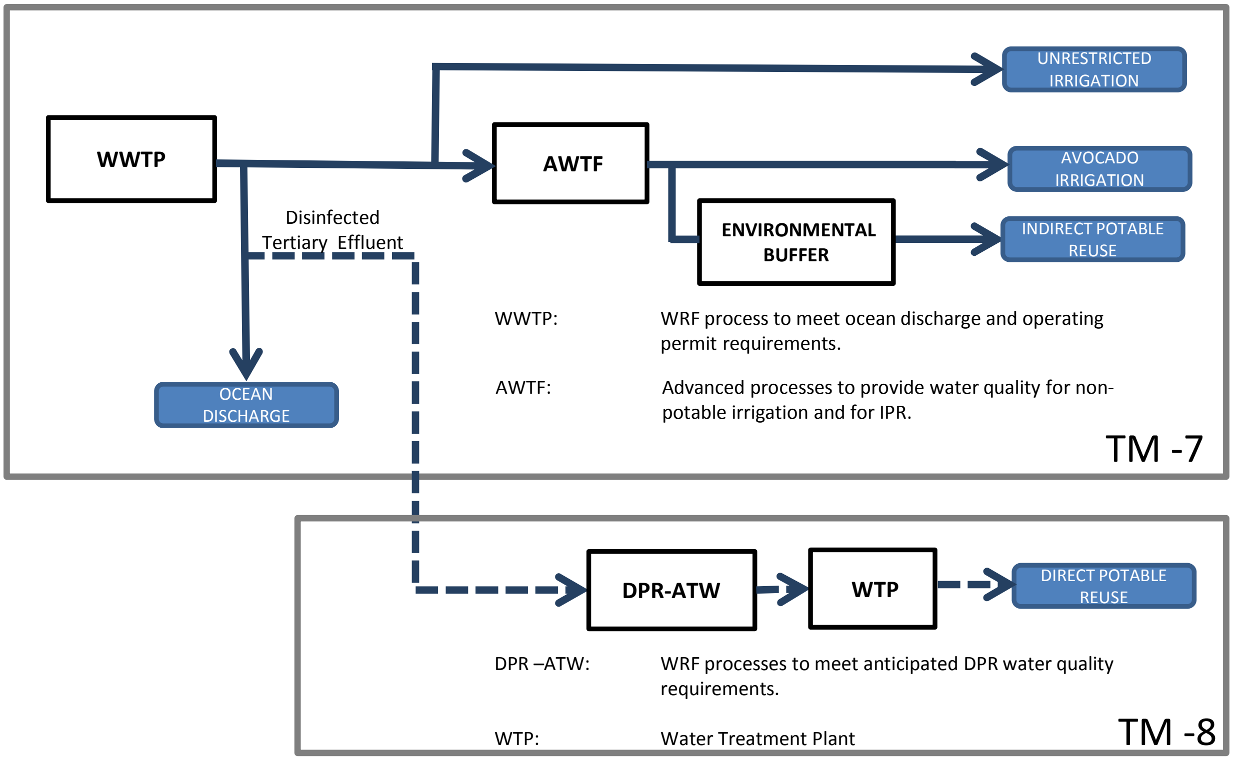


Figure 9-1 Flow Diagram for Potable Reuse

DPR occurs when the advanced treated wastewater is introduced into an existing potable water distribution system without an environmental buffer. There are two forms of DPR, as described in Table 9-2.

Table 9-2 Forms of Direct Potable Reuse

DPR CATEGORY	DESCRIPTION & KEY ELEMENTS
DPR with Advanced Treated Wastewater (DPR-ATW)	• Treated wastewater (treatment process includes advanced water treatment) is introduced into a raw water supply immediately **upstream** of a drinking water treatment facility. • No environmental buffer is included, but an engineered storage buffer can be included to manage mixing of the treated wastewater with the WTP influent
DPR with Finished Water (DPR-FW)	• Treated effluent is introduced directly into a potable water distribution system, **downstream** of a drinking water treatment facility (DWTF) directly into the potable water distribution system • Advanced wastewater treatment (AWT) facility is designed and permitted as a drinking water treatment facility • An engineered buffer can be included upstream of the point of introduction

The main distinction between an IPR project and the two forms of DPR is the introduction of treated wastewater into an environmental buffer for IPR before being withdrawn for potable purposes. IPR existing regulations have been developed with strong reliance on the environmental buffer providing for the occurrence of natural biological processes as well as mixing and dilution to further advance and improve the quality of the treated wastewater. There is also recognition that the environmental buffer acts as a barrier to prevent poor-quality treated wastewater from entering the water supply.

For DPR to occur, it will be necessary to compensate for the lack of an environmental barrier. This will entail providing a robust combination of technologies to address a broad variety of pathogens and contaminants, incorporating resiliency to make rapid adjustments to correct or restore plant performance, and providing system redundancy through use of multiple unit processes to address common wastewater constituents.

9.2.2 Current Representative DPR Projects

Treatment technologies capable of producing an advanced treated wastewater that meets current drinking water standards have been demonstrated in numerous investigations and pilot studies. One frequently-used technology is RO. In many cases where RO is used, the treated effluent is of higher quality than most conventionally treated drinking waters with respect to TOC, TDS, and trace contaminants. However, Federal and State regulating agencies have yet to reach a consensus regarding an appropriate framework and governing parameters for potable reuse.

Table 9-3 presents three examples of DPR projects that have been implemented, along with a description of the treatment technologies used at each project.

9.2.3 Status of Regulatory Framework for DPR in California

To date, regulations have not been specifically developed for DPR projects at either the State or Federal level. For the two Texas projects listed in Table 9-3, approvals were granted on a case-by-case basis without the benefit of any comprehensive guidance resources specifically addressing issues associated with DPR.

In California, Water Code Section 13560-13569, which was enacted in February 2009, directs the SWRCB DDW to take several steps to investigate and report to the Legislature on the feasibility of developing uniform water recycling criteria for both direct and indirect potable reuse. To guide this effort, the law requires DDW to convene and administer an Expert Panel. The role of the Expert Panel and on-going activities are described in Chapter 2.0 of this FMP.

Table 9-3 Representative DPR Projects

PROJECT OWNER	DPR CATEGORY	PROJECT DESCRIPTION
Wichita Falls, TX (Emergency Water Supply)	DPR-ATW	• Chlorinated secondary effluent is further treated using microfiltration (MF), RO, and ultraviolet (UV) disinfection. • The advanced treated wastewater is then blended 50/50 with other raw water supplies before receiving further treatment at the City's drinking water treatment facility. • This project began operation in July 2014 and was implemented on an emergency basis in response to severe drought conditions. The microfiltration/reverse osmosis (MF/RO) advanced treatment system was installed originally to treat a brackish surface water source and is to be converted back to this use in the future. • Following significant rainfall events in 2015, the facility was taken offline.
Colorado River Municipal Water District Big Spring, TX	DPR-ATW	• Filtered secondary effluent is further treated with MF, RO, and UV-AOP (advanced oxidation process) to produce Advanced Treated Water. • The treated water is then blended with other raw water supplies in a transmission line. The blended water is then treated in one of several drinking water treatment facilities before distribution. • This DPR project has been operational since spring 2013.
Windhoek, Namibia	DPR-FW	• Starting in 1968, reclaimed water was added to the drinking water supply system. • The treatment plant was last upgraded in 2002, and consists of ultra-filtration (UF), ozone-AOP, and chlorination. • Blending of finished water (without RO treatment) with other drinking water occurs directly in the pipeline that feeds the drinking water distribution network.

9.3 INTEGRATING DPR INTO THE NEW WRF

This section describes the considerations for process and technology selection associated with integrating DPR into the new WRF and discusses DPR treatment process trains incorporating RO and without RO.

9.3.1 Considerations for Process and Technology Selection

TM-7 defines process facilities to (a) provide disinfected tertiary effluent for ocean discharge and (b) advanced treatment to Title 22 standards for general irrigation, agriculture irrigation, and IPR uses. TM-8 defines process facilities to augment those in TM-7 to provide DPR. The three critical elements to developing DPR using disinfected tertiary effluent from the proposed Morro Bay WRF include:

- A **multi-barrier process train** capable of contaminant and pathogen removal.
- A **redundant process train** consisting of multiple unit operations targeting removal/reduction of a given contaminant and/or pathogen such that if one process is out of service or fails, the efficacy of the overall process train remains intact.
- A **robust and resilient process-train** designed to achieve removal or reduction of a broad spectrum of contaminants (e.g., trace organics such as pharmaceuticals or personal-care products) and pathogens.

In addition to developing a process-train which meets the above criteria, it is essential that the operational and management protocols ensure a resilient process-train which efficiently and effectively addresses potential failures and responds rapidly so as to mitigate potential health risks.

A wide range of technologies are available to achieve the treatment requirements for DPR. In fact, some of the technologies (such as RO and AOP) are widely used as part of IPR projects. Broadly speaking, the treatment trains for DPR can be grouped into two categories: those utilizing RO and non-RO based treatment trains. Engineered storage buffers can be incorporated into any DPR treatment train to enhance process robustness and resiliency.

9.3.2 DPR Treatment Process Trains Incorporating RO

In these processes, disinfected tertiary effluent is filtered using MF and subsequently treated using RO. These unit operations are discussed as part of advanced water treatment processes in TM-7. This process train can be modified to include ozone and biologically active filtration (BAF) upstream of the RO system (as shown on Figure 9-2) to enhance abiotic and biological oxidation of chemical contaminants. The addition of these unit operations would increase the disinfection credits and improves the performance of the MF system. All of the DPR projects implemented to date (see Section 9.2) incorporated RO as part of the treatment process.

Ozone is most commonly generated onsite at WRFs using electrical energy (high voltage 6-20 kV). Free *radicals formed when ozone decomposes in water are very strong oxidants and enable effective abiotic* oxidation of contaminants in reactors with short hydraulic retention times. Essential components of ozone application for DPR include feed gas preparation, ozone generator(s), ozone contactors and ozone destruction equipment (for ozone containing off-gas from the contactor). The use of ozone could result in formation of undesirable byproducts such as NDMA and bromate. Thus, ozone is often used in concert with a BAF process to oxidize the AOC and by-products.

The BAF process incorporates the benefits of conventional media filtration and biological activity. In essence, a BAF has biofilm growing on activated carbon media. As a result of the high surface area and porosity of the activated carbon and the AOC produced through use of ozone, an effective biological consortium can develop in the BAF.

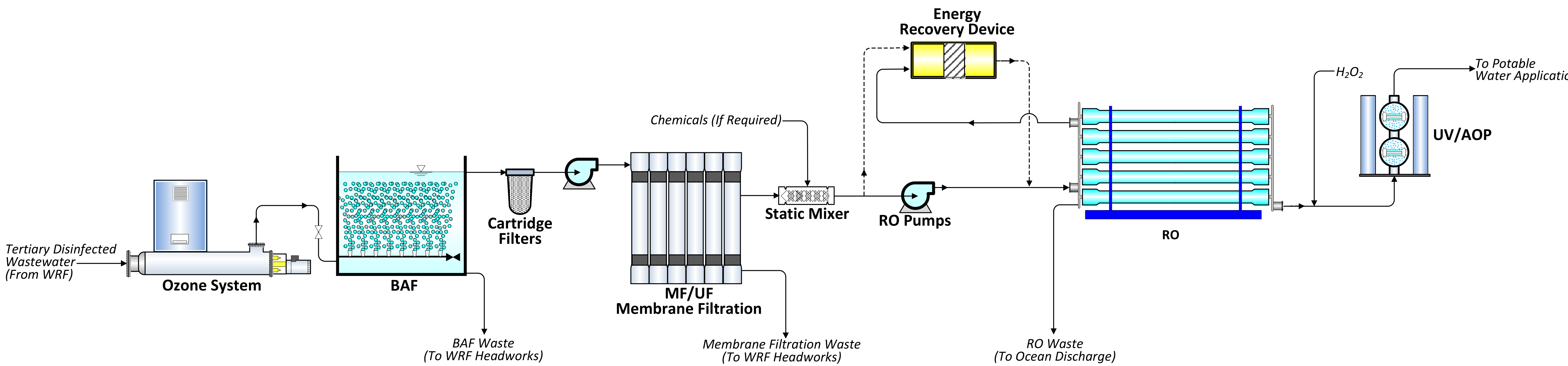


Figure 9-2 DPR Process Flow Diagram

Note that in the absence of the BAF, these bacteria could grow in downstream unit operations or result in biofilm formation in the DPR distribution system.

UV disinfection can be coupled with an abiotic oxidation (hydrogen peroxide is commonly used) to implement UVAOP. UV and hydroxide form hydroxyl radicals which are strong oxidizing agents. UV/AOP can be used for oxidation of trace low molecular weight organics present in the water even after multiple treatment barriers and is particularly effective for oxidation and removal of NDMA and 1,4-dioxane from the treated water.

As a final step, the DPR process train may require chemical stabilization to ensure that the chemical characteristics of the treated effluent are suitable for the distribution system. This could involve decarbonation using an alkalinity source.

9.3.3 DPR Treatment Process Trains without RO

This technology treatment train considers eliminating the RO step to help remove the costly brine concentrate waste that is especially challenging in inland locations. Since the RO step is the specific treatment process that physically removes TDS and target constituents from the product water, this treatment strategy relies on converting chemical constituents and employing a engineered storage buffer as a final treatment step to replace the RO functionality.

9.4 CONCEPTUAL DPR ALTERNATIVES

This section identifies four conceptual conveyance strategies for DPR and provides a qualitative screening analysis of the alternatives. This section discusses the two forms of potable reuse (IPR and DPR), describes representative DPR projects worldwide, and briefly mentions current activities related to development of a regulatory framework for DPR in California.

9.4.1 Identification of Alternatives

As described in Section 9.2, DPR occurs when advanced treated wastewater is introduced at various locations into an existing potable water distribution system. For the purposes of the FMP, it was assumed that the DPR AWT processes would be introduced upstream of a drinking water treatment system to provide robust combination of technologies to protect public health.

Four alternatives for DPR were developed which connect an existing raw water supply to WTPs in the Morro Bay vicinity: SLO WTP Whale Rock Supply Pipeline, Whale Rock Reservoir (WRR), Existing City WTP, and New City WTP.

Using Whale Rock Reservoir (WRR) as an environmental buffer was not studied and, therefore, it is currently unclear whether WRR qualifies as an environmental buffer in the context of IPR. For purposes of the FMP, a WRR reuse conveyance opportunity was identified and included as an alternative based upon discussions with City staff. Further evaluations would be required to confirm the validity of the WRR alternative.

Figure 9-3 presents an overview of the four conceptual alternatives.

Alternative No. 1 - San Luis Obispo Water Treatment Plant's Whale Rock Supply

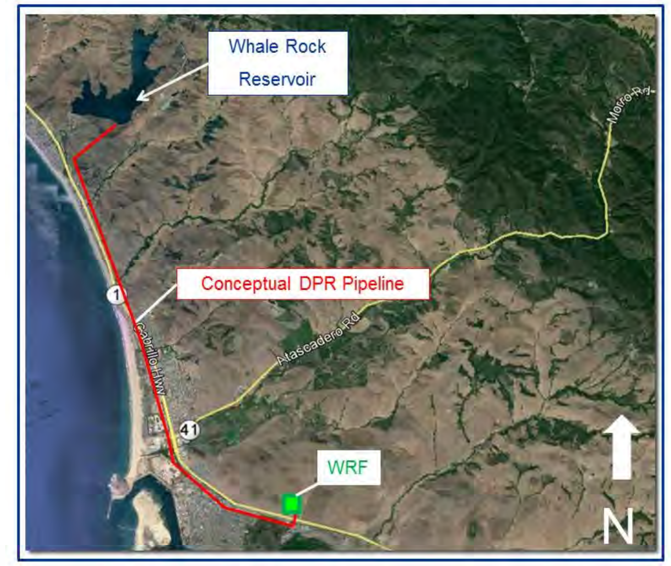
Not to Scale

Description of San Luis Obispo Water Treatment Plant Supply.

- Plant Capacity: 16 million gallons per day
- Treats water supplies for potable water purposes from the Salinas Reservoir, Whale Rock Reservoir, Nacimiento Reservoir, and groundwater.
- Owned and operated by the City of San Luis Obispo.

Key Considerations.

- DPR Conveyance Pipeline Alignment Distance: 9.7 miles to Water Treatment Plant
- The South Bay Boulevard Site is in the vicinity of the existing raw water supply pipeline to San Luis Obispo Water Treatment Plant via the Whale Rock Reservoir conveyance pipeline.
- San Luis Obispo Water Treatment Plant may have sufficient capacity to accept a recycled water supply and offer some blending ratio for the DPR water.
- City of Morro Bay does not currently receive water from San Luis Obispo, therefore a new water credit or in-lieu exchange agreement may be required.
- Coordinate with agencies and approvals required



Alternative No. 2 - Whale Rock Reservoir

Not to Scale

Description of Whale Rock Reservoir.

- Capacity: 38,967 acre-feet (12,697 million gallons)
- Stores water for the City of San Luis Obispo, Cal Poly State University, Cayucos Area Water Organization, and California Men's Colony.
- The Whale Rock Dam was designed and constructed by the State Department of Water Resources in 1961.

Key Considerations.

- DPR Conveyance Pipeline Alignment Distance: 7.6 miles
- The City of Morro Bay only has an emergency supply agreement with the purveyors of the Whale Rock system and the existing connection to the Whale Rock system is between a raw water line coming from Whale Rock Reservoir and a City of Morro Bay potable pipeline.
- Whale Rock Reservoir may have sufficient capacity to offer a good blending ratio for the DPR water.
- Morro Bay does not currently receive source water from Whale Rock Reservoir, therefore a new water credit exchange agreement may be required.
- Coordinate with agencies and approvals required

Alternative No. 3 - City of Morro Bay WTP

Not to Scale

Description of City of Morro Bay WTP.

- Capacity: Capable of producing 645 acre-ft/year
- City of Morro Bay WTP is currently only used as an emergency supply or to manage peak demands.
- The City owns and operates the WTP.

Key Considerations.

- DPR Conveyance Pipeline Alignment Distance: 2.9 miles
- The operational strategy would have to be altered for the facility to be used as a DPR water receiver.
- The City of Morro Bay WTP does not have sufficient capacity to offer a good blending ratio for the DPR water.
- Most Local DPR option.
- Treatment technology improvements would likely be required to accept reclaimed water.
- Existing infrastructure may need to be up-sized to convey treated water to the City's potable distribution system.

Alternative No. 4 - Conceptual City of Morro Bay Water Treatment Plant

Not to Scale

Description of Conceptual City of Morro Bay Water Treatment Plant.

- Plant Capacity: TBD
- Would treat water supplies for potable water purposes. Potential sources are Salinas Reservoir, Whale Rock Reservoir, Nacimiento Reservoir, groundwater, and effluent from the WRF.

Key Considerations.

- DPR Conveyance Pipeline Alignment Distance: Adjacent to Water Reclamation Facility
- Little to no additional infrastructure required to get DPR water to WTP. Would be able to share in construction of the WRF infrastructure.
- Would support water independence for the City.
- Infrastructure would be required to tie into City's potable distribution system.

Figure 9-3 Alternatives for DPR Conveyance

9.4.2 Evaluation Process

This section describes the evaluation process for the four conceptual DPR alternatives. The evaluation was performed to compare the benefits and issues associated with the alternatives through a qualitative screening process and to rank the alternatives.

9.4.2.1 Screening Criteria

Five criteria were established to provide a comparison of each option:

- **Conveyance Pipeline Length, Location, and Accessibility** – A high-level investigation was conducted to identify three conveyance pipeline alignments from the WRF to the proposed DPR offtake connection point. The offtake connection location was considered to be at the intersection between new pipeline and existing raw water buried infrastructure. The connection point facilities would include infrastructure such as piping, a booster pump or pressure regulation valve, vault facilities to allow for hydraulic control and matching pressure to allow for flow conveyance. Alignments of shorter distance and with fewer highway crossings were given a positive rating.
- **Land Acquisition** – The potential need to acquire new land was assessed. Private property acquisition introduces an additional cost to the project, and the timing to secure a property introduces a schedule risk. Alternatives that avoided additional land acquisition were given a neutral rating and alternatives that required additional land acquisition were given a negative ranking.
- **Potential for Community Impacts** – The potential impact to adjacent and neighboring properties was evaluated based on the land use and zoning. Consideration was also given to concerns about potential noise and odor impacts, aesthetics, and impacts to future development opportunities. Alternatives which require new facilities that would impact neighbors with any of the considerations mentioned above were assigned a negative rating, while those that did not were assigned a neutral rating.
- **Reuse of Existing Facilities** – The alternatives were reviewed to identify potential opportunities to reuse existing facilities, such as the existing City WTP. Alternatives that maximized the reuse of existing facilities were given a positive rating.
- **In-Lieu Water Exchange –** Alternatives that delivered water to other communities (other public water supplies with end users such as City of SLO, Cal Poly, etc.) would likely require an in-lieu water exchange agreement since the Morro Bay DPR strategy would augment water supply to other communities. Alternatives that augmented the City's local supply directly and avoided need for water exchange of other inter-community agreements were given a positive rating.

9.4.2.2 Screening Results

Table 9-4 presents the qualitative comparison of the four DPR alternatives.

Table 9-4 Qualitative Comparison of DPR Alternatives

CRITERIA	ALT. 1 SLO WTP WHALE ROCK SUPPLY PIPELINE	ALT. 2 WHALE ROCK RESERVOIR	ALT. 3 EXISTING CITY WTP	ALT. 4 NEW CITY WTP
New Conveyance Pipeline Length and Alignment	~500 Ft	7.6 Miles City Street ROW / Highway 1	2.9 Miles City Street ROW / Highway 1	~500 Ft
Land Acquisition	None	None	None	Required
Potential for Community Impacts	No new facilities required	No new facilities required	Impacts neighboring property owners	Impacts neighboring property owners
Reuse of Existing Facilities	None	None	Reuses existing City Water Treatment Plant with expansion	None
In-Lieu Water Exchange	San Luis Obispo WTP treated water does not connect back into the City of Morro Bay Water System	City of Morro Bay does not currently receive any water from Whale Rock Reservoir	Connection from existing City WTP to the City's Water system exists	Connection from New City WTP to the City's Water System would be designed along with WTP

A score for each criterion was assigned to the DPR alternatives based on a comparison of the alternatives ability to satisfy the project objectives. The scoring system is outlined on Table 9-5. The scores based on the comparison criteria for each of the four alternatives are summarized in Table 9-6.

Table 9-5 Alternatives Evaluation Rating System

SCORE	DEFINITION
5	Satisfies project objectives with significant noted advantages
4	Satisfies project objectives with noted advantages
3	Satisfies project objectives
2	Satisfies project objectives with noted disadvantages
1	Satisfies project objectives with significant noted disadvantages

Table 9-6 Comparison of DPR Alternatives

CRITERIA	ALT. 1 SAN LUIS OBISPO WTP WHALE ROCK SUPPLY PIPELINE	ALT. 2 WHALE ROCK RESERVOIR	ALT. 3 EXISTING CITY WATER TREATMENT PLANT	ALT. 4 NEW CITY WATER TREATMENT PLANT
Conveyance Pipeline Length and Alignment	4	1	3	4
Land Acquisition	3	3	3	2
Potential for Community Impacts	3	3	2	2
Reuse of Existing Facilities	3	3	4	3
In-Lieu Water Exchange	2	2	4	4
Institutional Barriers	1	1	3	3
TOTAL	**16**	**13**	**19**	**18**

Table 9-7 presents an estimated cost comparison of conveyance facilities required for implementation of the alternatives.

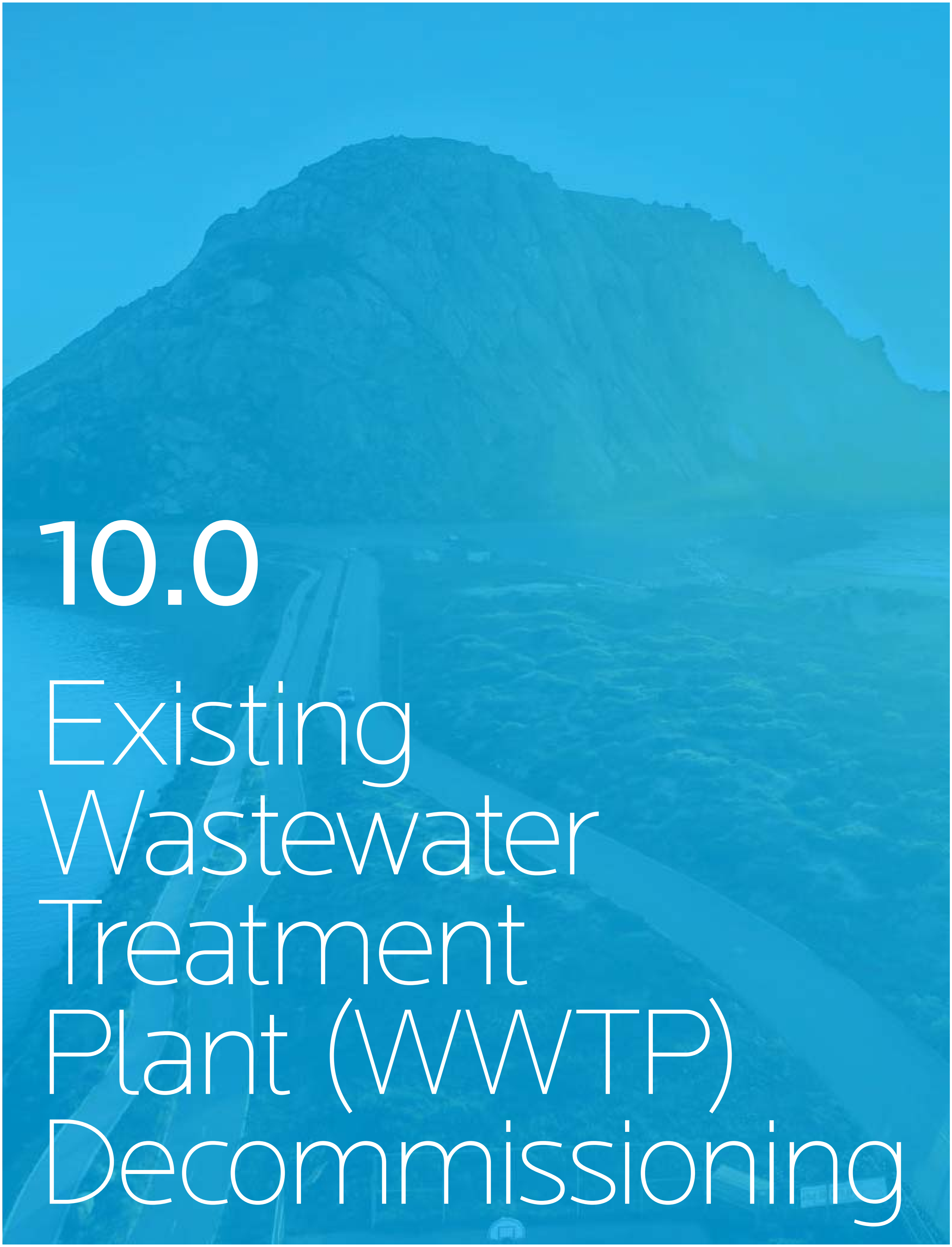
Table 9-7 Estimated Cost Comparison of DPR Alternatives

CRITERIA	ALTERNATIVE NO. 1 SAN LUIS OBISPO WTP WHALE ROCK SUPPLY PIPELINE	ALTERNATIVE NO. 2 WHALE ROCK RESERVOIR	ALTERNATIVE NO. 3 EXISTING CITY WATER TREATMENT PLANT	ALTERNATIVE NO. 4 NEW CITY WATER TREATMENT PLANT
Estimated Costs - Conveyance & Pump Station & Water Treatment Facilities	**$** ($4 Million)	**$$$** ($24 Million)	**$$$** ($26 Million)	**$$** ($17 Million)

LEGEND: $ = $4-$10 Million, $$ = $10-$20 Million, $$$ = $20-$30 Million

Notes:

1. SLO WTP regulatory and facility capacity criteria was not reviewed in detail.
2. Capital costs for DPR ATW process train was not included in this comparison analysis.
3. Costs are conceptual and approximated for comparison of alternatives. They should not be used for budgeting purposes without more detailed analysis. Costs are capital costs only.



10.0

Existing Wastewater Treatment Plant (WWTP) Decommissioning

10.0 Existing Wastewater Treatment Plant (WWTP) Decommissioning

10.1 OVERVIEW

This chapter of the FMP provides an evaluation of the requirements and high-level costs associated with decommissioning of the existing WWTP. For the purposes of this FMP, decommissioning is assumed to mean shutdown, demolition, and complete removal of all WWTP facilities and infrastructure at the site followed by backfilling, compaction, and grading to leave it cleared, cleaned and available for other uses in the future.

Table 10-1 presents an overview of the discussion in this Chapter.

Table 10-1 Overview of WWTP Decommissioning

TOPIC	DESCRIPTION
Existing WWTP and Site	The relevant history and overview of the site of the existing WWTP is described.
Demolition and Removal of the WWTP	The demolition and removal of the existing site structures and equipment is outlined including disposal recommendations.
Regulatory Environment	Decommissioning will proceed in compliance with the regulations and requirements presented in Chapter 2.
Recommendations	A recommended decommissioning process summary is described. Key features of the decommissioning are identified.
Demolition Costs	The basis for the Opinion of Probable Construction Cost for the decommissioning of the existing WWTP is described and cost summary is provided.

10.2 EXISTING WWTP AND SITE

The WWTP was originally constructed in 1953 with subsequent expansions in 1964 and 1982. The plant currently has an ADWF rating of 2 mgd though the secondary treatment facilities are only rated at 1 mgd. Flow in excess of 1 mgd requires bypassing of a portion of the primary effluent and blending with disinfected secondary effluent prior to discharge to an ocean outfall.

The existing WWTP site is shown on Figure 10-1. Features to be noted regarding the site include:

- The WWTP site is located at 160 Atascadero Road in Morro Bay. The site is approximately 300 feet north of Morro Creek.
- As shown on Figure 10-1, the roughly 5.7 acre site is bordered by the City's Corporation Yard to the east, a trailer storage facility to the south, and an RV park to the west. The trailer storage facility and the RV park will remain in place and are not involved in the WWTP decommissioning. This FMP does not evaluate the costs to relocate the Corporation Yard.

- A self-contained household hazardous waste and electronic waste collection facility operated by IWMA is co-located on the WWTP site. It is assumed the facility will be removed at the time of WWTP decommissioning and relocated, potentially to the WRF site.
- Groundwater was found at depths from 7 to 13 feet below the ground surface in soil borings performed by Geotechnical Consultants Inc., as a part of the 1982 WWTP upgrade. As a part of more recent work (MWH, July 2010), Earth Systems Pacific found groundwater at 10 feet below the ground surface in October 2009 borings reported in the Fugro Consultants Inc. soils report.

Figure 10-1 Existing WWTP Site and Surroundings

10.3 DEMOLITION AND REMOVAL OF THE WWTP

10.3.1 WWTP Structure and Site Inventory and Disposition

All existing structures within the fence line of the existing WWTP are identified on Figure 10-2 and will be demolished and removed as a part of this work except the following:

- Air Release Structure – This is the outfall structure which will be left in place for future use with the new WRF. It will also be available for use by CSD.
- Headworks/Influent Lift Station – It is possible that part of this building will be retained and reused with the new Morro Bay WRF. However, for the purposes of this FMP it is assumed that it would be demolished.

The structures to be demolished include:

- Administration Building
- Primary Sedimentation Tanks
- Biofilter Pump Station and Motor Control Center (MCC) Building
- Biofilters
- Secondary Sedimentation Tank
- Secondary MCC Building
- Chlorine Building
- Chlorine Contact Tank
- Digesters
- Maintenance Building
- Hydropneumatic Tank
- Waste Gas Burner
- Collection Shed
- Sludge Drying Beds

Demolition of the structures described above comprises a footprint of 41,000 square feet. This value does not include the household hazardous waste facility which is operated by the San Luis Obispo IWMA. As described previously, this structure will be relocated by IWMA prior to commencing decommissioning activities. Due to its proximity to the ocean, dewatering is potentially necessary during demolition of below grade structures.

The demolition and removal of the twelve sludge drying beds located on the southern end of the site will add approximately 69,000 square feet of demolition work. Areas on the site not covered by structures or sludge drying beds are either paved or covered with some type of surfacing such as landscape rock. Approximately 52,000 square feet of on-site paving will need to be demolished and removed. The approximately 87,000 square feet of landscape rock and dirt surfacing will not be removed but will be regraded with the site once at the conclusion of the demolition activities.

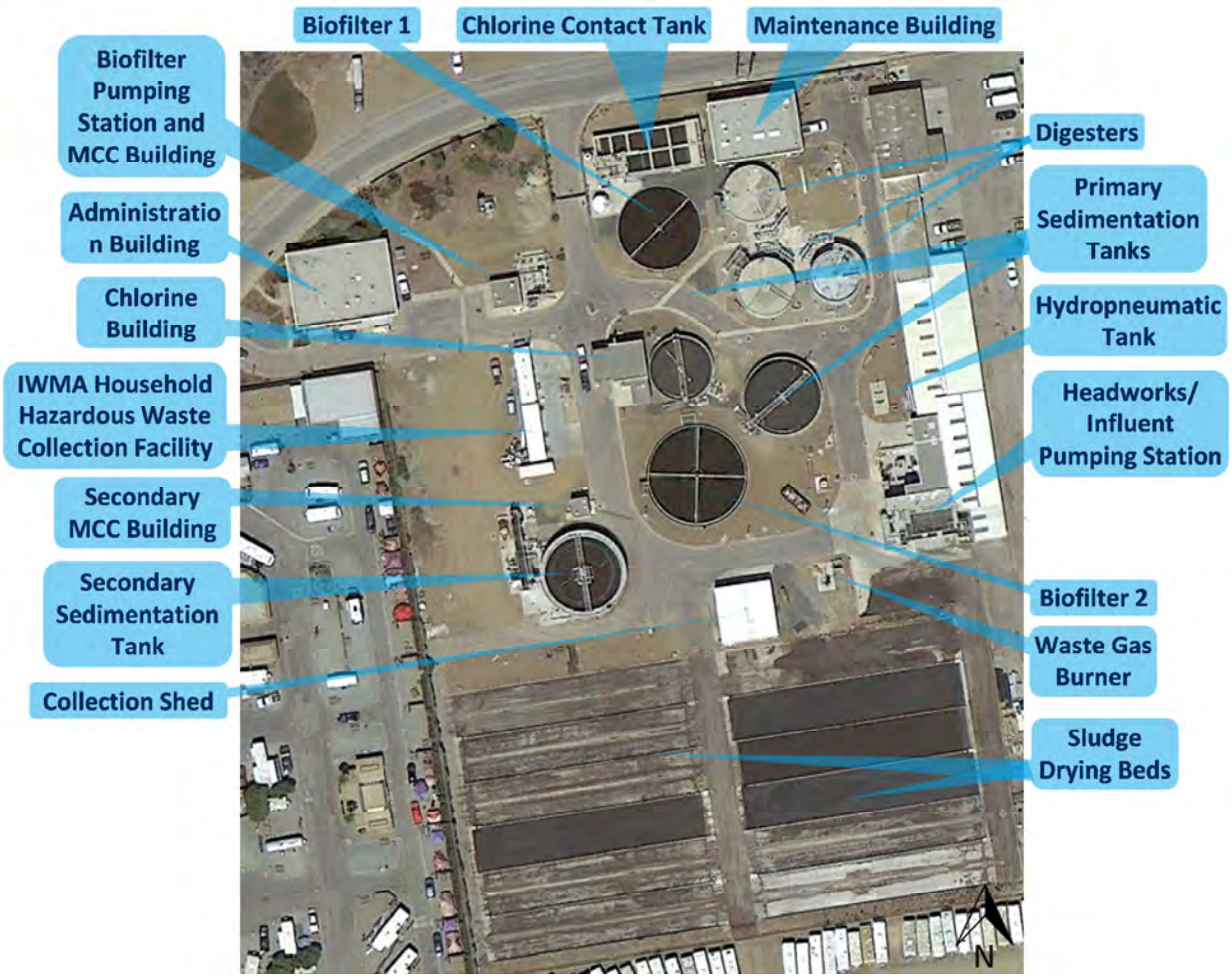


Figure 10-2 Site Layout

Once the demolition is complete, the construction waste would be hauled to one of several Class 3 landfills located near Morro Bay. The closest is the Cold Canyon Landfill shown on Figure 10-3, which is located approximately 23 miles one way from the WWTP. Hazardous waste materials would need to be hauled to a Class 1 or Class 2 landfill such as the Kettleman Hills waste management facility in Kettleman, California, which is approximately 80 miles one way from the project site.

Figure 10-3 Construction and Hazardous Waste Haul Routes

10.3.2 WWTP Equipment Inventory and disposition

The principal process and non-process equipment associated with the existing WWTP has been inventoried and tabulated in Appendix G to identify the recommended disposition as one of the following:

- Discard – Contractor will haul material to a landfill.
- Salvage – Contractor will dismantle the equipment and sell the salvageable metal materials like steel, iron, and copper for scrap.
- Reuse – Items of equipment can be either reused at the new WRF or at the existing headworks facility should it be kept in operation.

Although well maintained, most of the equipment at the existing WWTP has been identified to be either discarded or salvaged. This assumption is based on the following:

- The majority of the equipment is at least thirty years old and nearing the end of its useful design life.
- Much of this equipment was designed for specific treatment process parameters and these parameters will likely be different at the new WRF.
- There will be an interim period during commissioning of the new WRF where the WWTP must remain in service, or it will be desirable to have the WWTP available as a backup. It should be noted that during such periods, the existing WWTP cannot be taken offline completely. The plant functions with a biological process that cannot be stopped and then re-started; therefore, a small base flow will be required at the existing WWTP in order to keep the biofilm viable and active in the trickling filters. The small base flow will provide a minimal amount of BOD to the trickling filters and will also keep the primary sedimentation tanks from going anaerobic. The digesters can likely be taken offline, but there may be value in keeping at least one digester online as well. The remainder of the flow can be sent to the new WRF. Therefore, most of the equipment must remain in service to accomplish those needs.

Heavy equipment made of steel and iron that is not deemed reusable is assumed to have a salvageable value. The weight of this equipment was estimated in Appendix G and is summarized below in Table 10-2. The laboratory equipment from the administration building was assumed to be reusable.

Table 10-2 Equipment Summary

DISPOSITION	QUANTITY
Reuse	0 - 1 Tons
Salvage	20 - 40 Tons
Discard	All other equipment identified in Appendix G

It is assumed that the industrial lubricants, solvents, and other materials associated with the equipment in the maintenance building would be restocked and used at the WRF. Chemical stores of ferrous chloride (2500 gallon tank owned by City), sodium hypochlorite (6000 gallon tank owned by supplier), and sodium bisulfite (1000 gallon tank owned by supplier) would be managed so as to be minimal at the time of decommissioning.

Any unused chemicals could either be returned to the vendor if unopened, used at the new WRF, sold, or discarded.

10.4 REGULATORY ENVIRONMENT

The decommissioning will proceed in compliance with several key regulatory requirements of State, Local and Federal Agencies having jurisdiction over the decommissioning, demolition and site restoration work proposed in this FMP. A complete discussion of regulatory and permitting requirements is provided in Chapter 2.0 of this FMP.

10.5 RECOMMENDATIONS

10.5.1 Decommissioning Process Summary

It was assumed that the existing plant will continue in operation until the new WRF is in full operation and the system is no longer delivering flow to the existing WWTP. At that time, the decommissioning process can begin and the following steps are anticipated:

Decommissioning of the Existing WWTP

1. Flow to the existing WWTP (from both the City and CSD) has ceased and the liquid treatment train is taken out of service. Liquid train basins and process units can be pumped down, cleaned and demolition can begin. Liquid from the cleaning process can be pumped or transported to the new WRF for treatment.

2. The digesters and sludge drying beds stay in service initially until the remaining sludge has been processed through and meets the stabilization and dewatering requirements of the current NPDES permit at which point it can be transported to the landfill for final disposal. (Alternately, the digesters could be pumped down and the sludge transported to the new WRF for treatment in accordance with the requirements of the new NPDES permit, if compatible with drying processes and NPDES permit requirements at the new plant.)

3. Once emptied of sludge, the digesters and drying beds can be cleaned and demolition can begin. Liquid from the cleaning process can be transported to the new WRF for treatment.

4. Complete demolition and removal of all structures from the site is to be performed. The disposition of construction materials and equipment (reuse, salvage or disposal) shall be as per the demolition plan. Facilities associated with the household hazardous waste program will be removed by IWMA.

5. Facilities identified, which are to be part of the new treatment system such as the headworks / lift station and a connection point for the new land outfall to the existing ocean outfall, shall be protected and upgraded as per the FMP.

6. Structures and equipment are to be completely removed (above and below grade) along with all buried yard-piping. Trenches and excavations left behind from the demolition work are to be backfilled and compacted with clean structural fill and brought up to grade.

7. Disposal of hazardous waste and remediation of contaminated soils are to be performed in accordance with the requirements of the EIR for any hazardous waste and contamination detected during the Phase I ESA or found during the demolition process.

8. Upon completion of the demolition work and upgrades performed on facilities which are to remain, the site is to be graded to fit the basic drainage pattern of the surrounding topography and is to be surfaced with a thin layer of crushed rock or gravel.

At this point, the decommissioning task should be complete and the site should be left in a condition from which the work associated with the next use for the site can begin.

It should be noted that, prior to proceeding with the actual decommissioning, the City or CSD may wish to leave the WWTP in a standby mode for a period of time either for reasons of project scheduling or to have it available as a back-up contingency.

10.5.2 Key Features

A method was developed herein for decommissioning of the existing WWTP, which includes demolition and restoration as below:

- Demolition and removal of all structures and equipment from the existing site. The exception to this is the outfall structure, which will remain in place for connection of the new facility.
- Reuse of select equipment described in Section 10.3.2.
- Salvage of select equipment. The contractor will decide what pieces of equipment to salvage and it was assumed that the return from salvage would offset the cost of demo.
- Site restoration including backfill of all excavations and returning the site to level grade and resurfacing of site with a thin layer of crushed rock or gravel.

10.5.3 Regulatory Environment

Permitting of the decommissioning work will be incorporated in with the City's overall WRF project. Performance of a Phase 1 ESA to better define the presence of hazardous materials and contamination is recommended to support the EIR.

10.6 DEMOLITION COSTS

An engineer's opinion of probable cost for this work was developed based upon the following:

1. Demolition and removal of all structures (above and below grade) including walls, floors, roof, interior framing, slabs, and foundations.

2. Removal of all equipment, supplies and furnishings at each structure or facility with the final disposition being reuse, salvage or disposal (landfill disposal).

3. Removal of all yard piping, electrical and chemical duct banks. Pipelines located greater than six feet below grade would be filled with concrete slurry and abandoned in place.

4. Removal and landfilling of all surface improvements, paving, sidewalks, fencing, etc. Structural fill would bring excavations back up to grade and the site would be bladed smooth to match the surrounding topography.

It was anticipated that providing complete removal of all the existing facilities would leave the site available for any potential redevelopment and would also result in the most conservative implementation cost.

10.6.1 Demolition Opinion of Probable Cost

Table 10-3 provides a summary of the engineer's opinion of probable cost, after taking into consideration potential sales of used equipment and scrap material.

A detailed engineer's opinion of probable costs associated with the demolition of the WWTP is provided in Appendix H and is summarized in Table 10-3 below. All of the prices and total provided in this cost opinion are in 2015 dollars. The demolition cost accounts for the following:

- Complete demolition of the existing WWTP as described above.
- Disposal, salvage, or reuse of all equipment and materials.
- Backfilling and regrading the site.

Table 10-3 Cost Summary

ITEM	COST
General Requirements[1]	$274,000
Sitework	$303,000
Structures	$2,379,000
Sludge Drying Beds	$356,000
Contingency[2]	$1,656,000
TOTAL PROBABLE DEMOLITION COST	**$4,968,000**

1. The general requirements were calculated as a percent of the sitework, structures, sludge drying beds, and contingency costs.
2. Contingency is 50% of total per AACE Level 5.

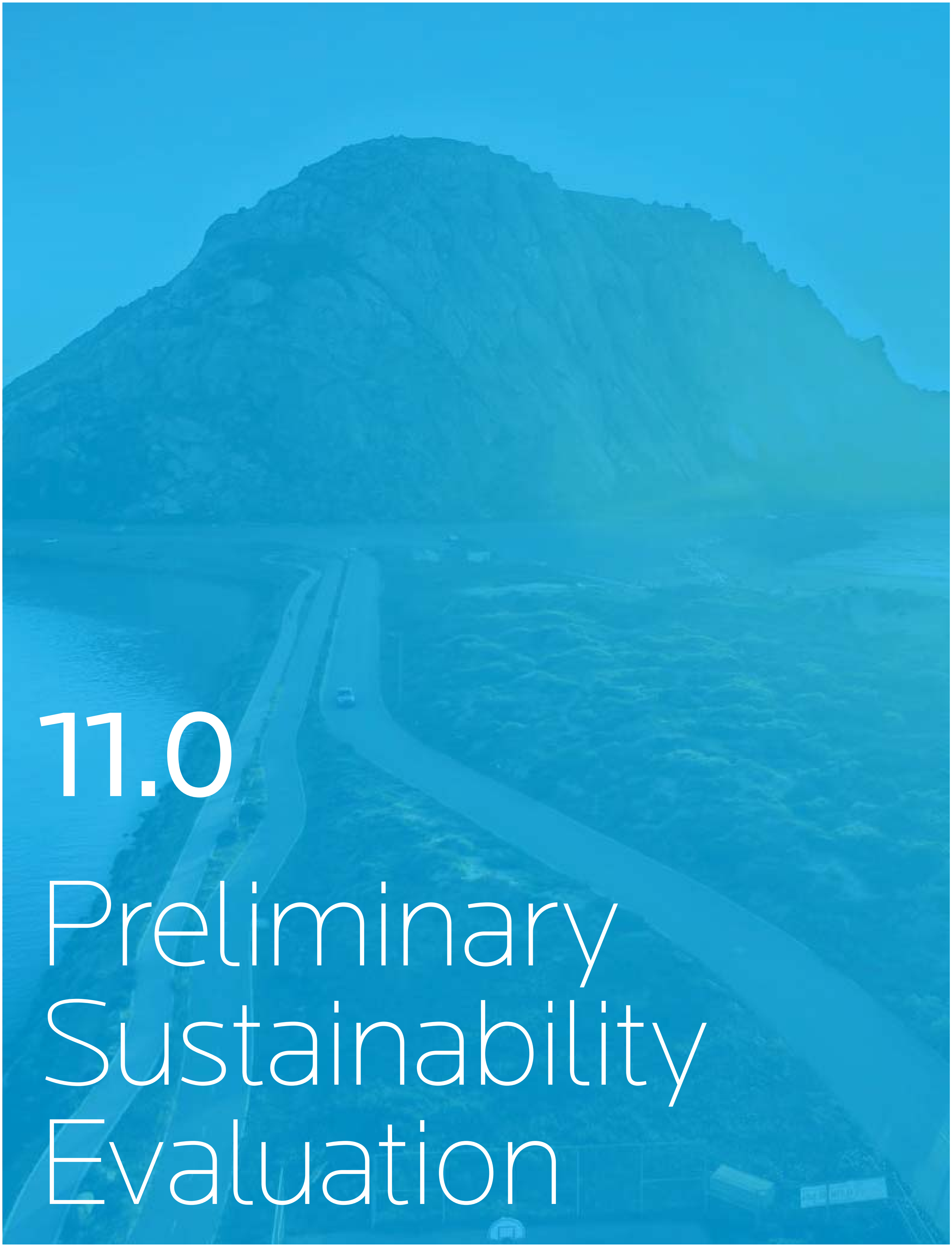
The cost above is based on the Contractor having salvage rights to all of the equipment that will be discarded. It is anticipated that equipment with metal materials such as steel, iron, or copper will have value as scrap and it is assumed that the selling of this equipment for scrap will offset the contractor's costs associated with the demolition, disassembly, and removal of the equipment.

The demolition cost opinion also includes an allowance for the removal of hazardous waste. A Lead Building Inspection Report indicated that lead based coatings exist at the site. We recommend that a thorough inspection of the existing structures be conducted to support the EIR and to confirm whether other hazardous materials or site contamination occur at the site. As those studies occur, the City can update the allowance contained in the cost opinion.

This demolition cost estimate also assumes the complete removal of each structure down to the foundation. It should be noted that leaving deep foundations and walls below a certain point (if compatible with the future site use) would reduce the overall cost of demolition.

10.6.2 Cost Estimate

The total cost of demolition for the existing WWTP is estimated to be $4,968,000. This includes a contingency of 50 percent which is consistent with AACE guidelines for a level 5 estimate. The demolition cost is to be shared with the Cayucos Sanitary District based on criteria in the existing Joint Powers Agreement or as negotiated in a new agreement for the revised shared facilities.



11.0

Preliminary Sustainability Evaluation

11.0 Preliminary Sustainability Evaluation

11.1 CHAPTER OVERVIEW

The City is committed to employing sustainability principals as part of development of the WRF. The WRF is inherently part of the City's commitment to sustainability, as it will provide a safe, reliable new water source for the City and reduce dependence on expensive and energy intensive importation of water supplies.

This chapter presents a planning level sustainability evaluation using the Envision Rating System, and provides recommendations for enhancing sustainability during the detailed design and construction stages.

Table 11-1 Overview of Sustainability Evaluation

SUSTAINABILITY EVALUATION	
TOPIC	**DESCRIPTION**
Definition of Envision	Introduces Envision Rating System.
Evaluating Relevant Credits for Process Flowsheet Options	Describes how relevant credits were selected for the planning level sustainability evaluation.
Envision Scores for Process Flowsheet Options	Presents results from sustainability evaluation.
Recommendations for Sustainable Design and Construction	Provides guidance to enhance project sustainability during design and construction stages.

11.2 WHAT IS ENVISION

Envision™ is a rating system developed by the Institute for Sustainable Infrastructure (ISI) in partnership with the Zofnass Program for Sustainable Infrastructure at Harvard University. The rating system may be utilized to evaluate the multi-bottom line sustainability benefits of infrastructure projects. Envision was launched in 2012 and has gained wide-spread acceptance since. The Envision system rates infrastructure projects holistically, assessing a project's contribution to the economic, environmental and social aspects of sustainability. Importantly, the rating system not only measures sustainable performance of a project but when used as a planning tool it expands opportunities for enhancement and improvement of the project. Envision is a comprehensive system which covers all aspects of infrastructure including energy, water, waste, transport, landscape, and information. The rating system comprises 60 credits in five categories, summarized in Table 11-2.

11.3 EVALUATING RELEVANT CREDITS FOR PROCESS FLOWSHEET OPTIONS

For the Morro Bay WRF project, the 60 Envision credits were evaluated to determine which ones are applicable to evaluate the two process flowsheet options – the refined SBR option and refined MBR option described in Chapter 6 - at this stage of the project. A detailed description of the evaluation of the applicability of the Envision Credits is provided in Table 11-3. The applicable credits were scored.

Table 11-2 Envision Sustainability Rating System Categories

ENVISION CATEGORY	SUBCATEGORIES	DESCRIPTION
QUALITY OF LIFE	Purpose Community Wellbeing	Addresses a project's impact on communities from the health and wellbeing of individuals and the wellbeing of the larger social fabric as a whole.
LEADERSHIP	Collaboration Management Planning	Comprised of the tasks that demonstrate effective leadership and commitment by all parties involved in a project. Meaningful commitment from the owner, team leaders, & constructors.
RESOURCE ALLOCATION	Materials Energy Water	Measures the use of renewable and non-renewable resources for the project.
NATURAL WORLD	Siting Land & Water Biodiversity	Allows project teams to assess the effect of the project on the preservation and renewal of ecosystem functions. Addresses how to understand and minimize negative impacts while considering ways in which the infrastructure can interact with natural systems in a synergistic and positive way.
CLIMATE AND RISK	Emission Resilience	Looks at two main concepts: minimizing emissions and ensuring that infrastructure projects are resilient to short-term hazards or altered long-term future conditions.

Table 11-3 Preliminary Assessment of Applicability of Envision Credits

		IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE	TOTAL POINTS EARNED	Applicable Y/N	Applicable Score	TOTAL APPLICABLE SCORE
QUALITY OF LIFE	QL1.1 Improve community quality of life	2	5	**10**	20	25	10	Yes	10	25
	QL1.2 Stimulate sustainable growth and development	1	**2**	5	13	16	2	Yes	2	16
	QL1.3 Develop local skills and capabilities	1	2	5	12	15	0	No		
	QL2.1 Enhance public health and safety	2	—	—	**16**	—	16	Yes	16	16
	QL2.2 Minimize noise and vibration	**1**	—	—	8	11	1	Yes	1	11
	QL2.3 Minimize light pollution	1	2	4	8	11	0	No		
	QL2.4 Improve community mobility and access	1	4	7	14	—	0	No		
	QL2.5 Encourage alternative modes of transportation	1	3	6	12	15	0	No		
	QL2.6 Improve site accessibility, safety and wayfinding	—	3	6	12	15	0	No		
	QL3.1 Preserve historic and cultural resources	1	—	7	13	16	0	No		
	QL3.2 Preserve views and local character	1	3	6	11	14	0	No		
	QL3.3 Enhance public space	1	3	**6**	11	13	6	Yes	6	13
						Innovation Credit--->	0	No		
						Total:	**35**		**35**	**81**

		IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE	TOTAL POINTS EARNED	Applicable Y/N	Applicable Score	TOTAL APPLICABLE SCORE
LEADERSHIP	LD1.1 Provide effective leadership and commitment	2	4	9	17	—	0	No		
	LD1.2 Establish a sustainability management system	1	4	7	14	—	0	No		
	LD1.3 Foster collaboration and teamwork	1	**4**	8	15	—	4	Yes	4	15
	LD1.4 Provide for stakeholder involvement	1	5	9	**14**	—	14	Yes	14	14
	LD2.1 Pursue by-product synergy opportunities	1	3	6	**12**	15	12	Yes	12	15
	LD2.2 Improve infrastructure integration	1	3	**7**	13	16	7	Yes	7	16
	LD3.1 Plan for long-term monitoring and maintenance	1	3	—	10	—	0	No		
	LD3.2 Address conflicting regulations and policies	1	**2**	4	8	—	2	Yes	2	8
	LD3.3 Extend useful life	1	3	**6**	12	—	6	Yes	6	12
							0	**No**		
							45		**45**	**80**

		IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE	TOTAL POINTS EARNED	Applicable Y/N	Applicable Score	TOTAL APPLICABLE SCORE
RESOURCE ALLOCATION	RA1.1 Reduce net embodied energy	**2**	6	12	18	—	2	Yes	2	18
	RA1.2 Support sustainable procurement practices	2	3	6	9	—	0	No		
	RA1.3 Use recycled materials	**2**	5	11	14	—	2	Yes	2	14
	RA1.4 Use regional materials	3	**6**	9	10	—	6	No		
	RA1.5 Divert waste from landfills	**3**	6	8	11	—	3	No		
	RA1.6 Reduce excavated materials taken off site	2	**4**	5	6	—	4	Yes	4	6
	RA1.7 Provide for deconstruction and recycling	**1**	4	8	12	—	1	Yes	1	12
	RA2.1 Reduce energy consumption	**3**	7	12	18	—	3	Yes	3	18
	RA2.2 Use renewable energy	4	6	13	16	20	0	No		
	RA2.3 Commission and monitor energy systems	—	3	—	11	—	0	No		
	RA3.1 Protect fresh water availability	2	4	9	**17**	21	17	Yes	17	21
	RA3.2 Reduce potable water consumption	4	9	**13**	17	21	13	No		
	RA3.3 Monitor water systems	1	3	6	11	—	0	no		
						Innovation Credit--->	7	Yes	7	9
						Total:	**58**		**36**	**98**

		IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE	TOTAL POINTS EARNED	Applicable Y/N	Applicable Score	TOTAL APPLICABLE SCORE
NATURAL WORLD	NW1.1 Preserve prime habitat	—	—	9	14	18	0	No		
	NW1.2 Protect wetlands and surface water	1	4	9	14	18	0	No		
	NW1.3 Preserve prime farmland	—	—	6	12	15	0	No		
	NW1.4 Avoid adverse geology	1	2	3	5	—	0	No		
	NW1.5 Preserve floodplain functions	2	5	8	14	—	0	No		
	NW1.6 Avoid unsuitable development on steep slopes	1	—	4	6	—	0	No		
	NW1.7 Preserve greenfields	3	6	10	15	23	0	No		
	NW2.1 Manage stormwater	—	4	9	17	21	0	No		
	NW2.2 Reduce pesticide and fertilizer impacts	1	2	5	9	—	0	No		
	NW2.3 Prevent surface and groundwater contamination	1	4	9	14	18	0	No		
	NW3.1 Preserve species biodiversity	2	—	—	13	16	0	No		
	NW3.2 Control invasive species	—	—	5	9	11	0	No		
	NW3.3 Restore disturbed soils	—	—	—	8	10	0	No		
	NW3.4 Maintain wetland and surface water functions	3	6	9	15	19	0	No		
						Innovation Credit--->	0	No		
						Total:	**0**		**0**	**0**

		IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE	TOTAL POINTS EARNED	Applicable Y/N	Applicable Score	TOTAL APPLICABLE SCORE
CLIMATE & RISK	CR1.1 Reduce greenhouse gas emissions	**4**	7	13	18	25	4	No		
	CR1.2 Reduce air pollutant emissions	2	6	—	**12**	15	12	Yes	12	15
	CR2.1 Assess climate threat	—	—	—	15	—	0	No		
	CR2.2 Avoid traps and vulnerabilities	2	6	12	16	**20**	20	Yes	20	20
	CR2.3 Prepare for long-term adaptability	—	—	—	**16**	20	16	Yes	16	20
	CR2.4 Prepare for short-term hazards	3	—	10	**17**	21	17	Yes	17	21
	CR2.5 Manage heat islands effects	1	2	4	**6**	—	6	No		
						Innovation Credit--->	0	No		
						Total:	**75**		**65**	**76**

11.4 ENVISION SCORES FOR PROCESS FLOWSHEET OPTIONS

A summary of the Envision Scoring in each category is shown in Figure 11-1. As noted previously, only the applicable credits were scored. In general the FMP process design gets high credits in the Climate and Risk, Leadership and Quality of Life categories. In total, at this preliminary FMP development stage of the project, either of the proposed process design options has the potential to receive 54% of the applicable points (181 out of 335). Such a score could result in a platinum level ISI Envision certification for the project. Undoubtedly, the rating will need to be revised as the project is implemented in more detail. Importantly, however, as is described later, this preliminary assessment has uncovered potential areas for project enhancement which will enable the City to deliver a project with the industry's highest sustainability marks. Details related to the scoring in each category are provided below.

ENVISION SUMMARY SHEET

Credit Category	Applicable Points	Points Earned	Percent Earned
QUALITY OF LIFE	81	35	43%
LEADERSHIP	80	45	56%
RESOURCE ALLOCATION	98	36	37%
NATURAL WORLD	0	0	
CLIMATE & RISK	76	65	86%
Total Project Points	335	181	54%

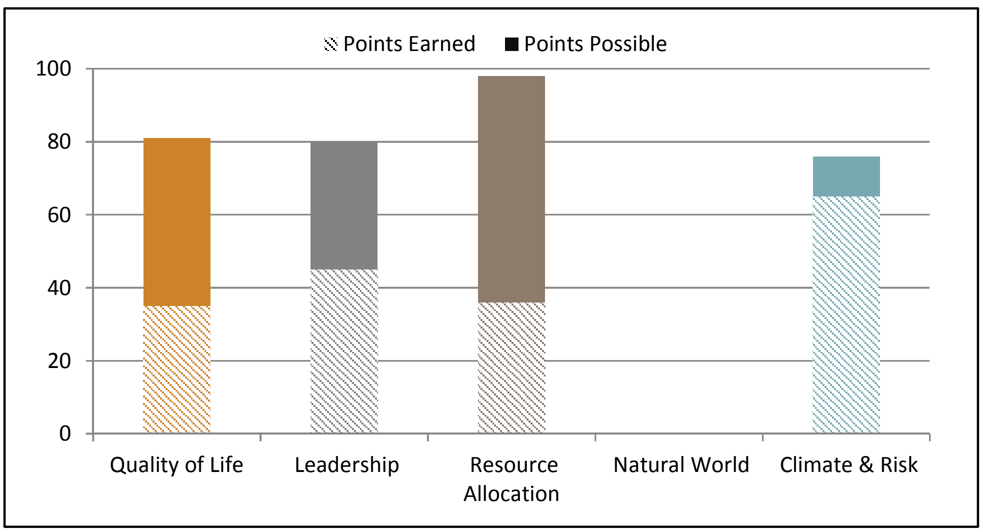


Figure 11-1 Summary of Envision Score for Proposed Morro Bay WRF

11.4.1 Quality of Life

Five of the thirteen Quality of Life credits were identified as relevant for the Morro Bay process evaluation (Table 11-4). The new WRF will inherently have positive impacts on the health, well-being and economic prosperity of the community. Both process flowsheet options will produce exceptional effluent quality. In fact, the quality of the membrane filtrate (SBR option) and MBR effluent are effectively identical.

Table 11-4 Envision Scores for Applicable Quality of Life Credits

	IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE
QL1.1 Improve community quality of life	2	5	10	20	25
QL1.2 Stimulate sustainable growth and development	1	2	5	13	16
QL2.1 Enhance public health and safety	2	—	—	16	—
QL2.2 Minimize noise and vibration	1	—	—	8	11
QL3.3 Enhance public space	1	3	6	11	13

11.4.2 Leadership

Six of the ten Leadership credits were identified as applicable for the Morro Bay WRF process evaluation. Water reuse is an example of a by-product synergistic opportunity the design enhances. For this reason, the Morro Bay project was given a high score of Conserve in this category. Note that developing potable reuse options (I/DPR) would further enhance the score. Water reuse enables collaboration between the City and the potential public or private reclaimed water users. This results in high scores for fostering collaboration and teamwork and improving infrastructure integration. Depending on the timing, implementation of direct potable reuse (DPR) may offer an opportunity to foster extensive collaboration with regulators, particularly if the timing of Morro Bay is an early adopter of DPR in California. Finally, the process is designed to accommodate future improvements and expansion which results in a high score in the Extend Useful Life credit.

Table 11-5 Envision Scores for Applicable Leadership Credits

	IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE
LD1.3 Foster collaboration and teamwork	1	4	8	15	—
LD1.4 Provide for stakeholder involvement	1	5	9	14	—
LD2.1 Pursue by-product synergy opportunities	1	3	6	12	15
LD2.2 Improve infrastructure integration	1	3	7	13	16
LD3.2 Address conflicting regulations and policies	1	2	4	8	—
LD3.3 Extend useful life	1	3	6	12	—

11.4.3 Resource Allocation

Most of the resource allocation credits are relevant for the Morro Bay process evaluation (9 out of 14). Resource allocation measures the use of water, energy and materials for the project and gives credit for efficiency and resource recovery.

Energy. The MBR option is expected to use about 30% more energy than SBR; thus, the SBR option would receive a higher score under reduce energy consumption. Net embodied energy is the energy used to produce materials or chemicals. The MBR option requires more chemicals for the biological process. The SBR option includes MF/UF which requires chemicals for membrane cleaning. Additional processes required for potable reuse would further increase the net embodied energy use. Water reuse is given credit for using regional materials; by reusing water locally, pumping costs and energy use are reduced.

Materials. The differences in sludge production between the two alternatives are relatively minor and could result in a marginally higher rating for the MBR (due to lower off-site hauling of dewatered sludge). Construction impacts are generally lower for options with a smaller footprint; for example, MBR has a smaller footprint and would reduce excavation and excavated materials taken off-site.

Water. All wastewater treatment projects will inherently protect fresh water availability. Water reuse projects receive an even higher score by further protecting fresh water resources. Similarly, water reuse projects receive a high score for reducing potable water consumption. This is true for both potable and non-potable reuse; if water is reused for irrigation, it can be assumed that the same amount of potable water use is offset. Due to its water reuse component, the Morro Bay project could potentially receive extra Innovation credits which reward exceptional performance for state-of-the-art sustainable infrastructure.

Table 11-6 Envision Scores for Applicable Resource Allocation Credits

	IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE
RA1.1 Reduce net embodied energy	2	6	12	18	—
RA1.3 Use recycled materials	2	5	11	14	—
RA1.4 Use regional materials	3	6	9	10	—
RA1.5 Divert waste from landfills	3	6	8	11	—
RA1.6 Reduce excavated materials taken off site	2	4	5	6	—
RA1.7 Provide for deconstruction and recycling	1	4	8	12	—
RA2.1 Reduce energy consumption	3	7	12	18	—
RA3.1 Protect fresh water availability	2	4	9	17	21
RA3.2 Reduce potable water consumption	4	9	13	17	21

11.4.4 Natural World

None of the fifteen credits under the category Natural World were identified as relevant for the process evaluation. Most of the credits in this category are site specific and site selection is outside the scope of this evaluation.

11.4.5 Climate & Risk

Differences in energy use between process options will indirectly impact greenhouse gas and air pollutant emissions. By implementing water reuse, the project receives high scores in climate change adaptability. Water reuse improves the resiliency of water infrastructure, making the city more resilient to potential future drought and water scarcity caused by climate change. The project could potentially receive extra Innovation credits in this category as well.

Table 11-7 Envision Scores for Applicable Climate and Risk Credits

	IMPROVED	ENHANCED	SUPERIOR	CONSERVE	RESTORE
CR1.1 Reduce greenhouse gas emissions	4	7	13	18	25
CR1.2 Reduce air pollutant emissions	2	6	—	12	15
CR2.2 Avoid traps and vulnerabilities	2	6	12	16	20
CR2.3 Prepare for long-term adaptability	—	—	—	16	20
CR2.4 Prepare for short-term hazards	3	—	10	17	21
CR2.5 Manage heat islands effects	1	2	4	6	—

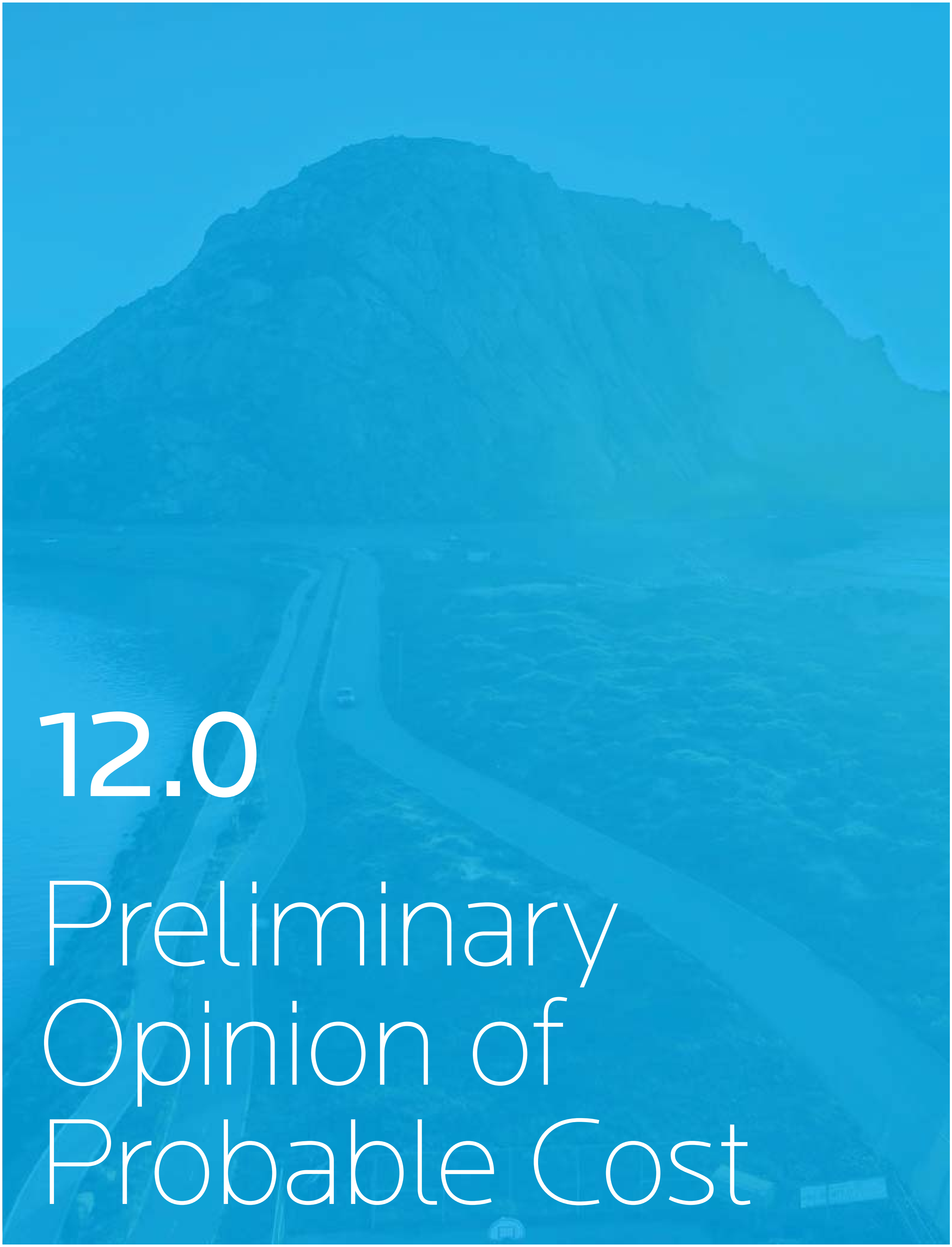
11.5 RECOMMENDATIONS FOR SUSTAINABLE DESIGN AND CONSTRUCTION

Envision can be used to evaluate and enhance sustainability at any project stage from planning to construction. The following general recommendations should be considered during design and construction.

ENVISION CATEGORY	RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION
QUALITY OF LIFE	• Establish a sustainability management system to set goals and measure performance. • Foster collaboration between consultants and wastewater utility during design process; and between wastewater utility, consultants, and contractors during construction. • Engage community in design and inform them about potential construction impacts in advance. • Improve infrastructure integration by coordinating with the potable water utility and other water reuse demands. • Extend useful life of infrastructure by designing a system that facilitates future expansion, and by using durable materials during construction.

ENVISION CATEGORY	RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION
LEADERSHIP	• Consider ways that the WRF can improve the community and stimulate sustainable growth such as by providing an inexpensive and sustainable source of water to nearby businesses, or becoming an educational center. • Hire locally. This applies during design, construction, and operations. Support local educational development. • Minimize impacts of noise and vibration during construction and operations. • Minimize light pollution during construction and operations. • Design site in a way that improves community mobility and access. • Encourage alternative modes of transportation by, for example, reimbursing employees for using public transportation, building bike racks and showers. • Design site architecture to preserve views and local character • Consider including a public space on site.
RESOURCE ALLOCATION	• Select a contractor with sustainable procurement practices. • Maximize use of recycled or local materials for construction. • Divert waste from landfills during construction by finding potential users or recycling. • Reuse excavated material on site • Design system so that it is easy to deconstruct at the end of its useful life • Consider adding renewable energy such as wind or rooftop solar • Install an energy monitoring system to monitor and improve energy efficiency
NATURAL WORLD	Site selection is critical to reduce natural world impacts. When selecting a site, consider avoiding the following whenever possible: • Prime habitat • Wetlands and surface water • Prime farmland • Adverse geology • Floodplains • Steep slopes • Greenfields Other recommendations include: • Design site so that stormwater is managed onsite. Consider permeable pavements and other green infrastructure. • Design the landscaping to minimize or avoid pesticide and fertilizer use. • Prevent water contamination during construction • Restore soils disturbed during construction

ENVISION CATEGORY	RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION
CLIMATE AND RISK	• Reduce greenhouse gas emissions by designing energy efficient lighting and HVAC. • Reduce air pollutant emissions during construction • Consider potential future flow fluctuations in process and hydraulic design. • Develop a comprehensive Climate Impact Assessment and Adaptation Plan, which includes: o Evaluation of short and long-term vulnerabilities and risks o Plans for resiliency and adaptation o Plans for extreme weather events such as floods and heat waves • Manage heat island effect by designing surfaces with a low solar reflectance index



12.0 Preliminary Opinion of Probable Cost

12.0 Preliminary Opinion of Probable Cost

The City of Morro Bay has established wastewater treatment goals for the new WRF. To meet these goals an alternative analyses of some of the latest treatment technology solutions was conducted and have recommended two alternatives that will provide Morro Bay with maximum flexibility for recycled water needs. Capital and operating and maintenance costs were developed for both of these alternatives. The two alternatives for the first phase of this project are:

- A conventional treatment alternative that incorporates the SBR process and includes microfiltration and UV. While microfiltration and UV are not required to meet the initial treatment goals, some level of filtration is required for the initial phases for this alternative. If the City did not have longer term plans for indirect potable reuse then conventional filtration such as disc filters would be incorporated. However, rather than spend money in the initial phases on filtration that would not be applicable in future phases, the City has elected to include microfiltration and UV in the initial phases.
- A combined secondary/tertiary treatment alternative that incorporates MBR process and includes UV.

Both of the treatment alternatives are capable of producing treated recycled water that is compliant with the regulations for using the water for landscaping, irrigation, golf courses, cooling towers etc. For the treated water to be used for indirect potable reuse then the following treatment processes will be required and are part of the second phase of this project:

- Reverse osmosis
- Additional UV system

12.1 OPINION OF PROBABLE COST FOR RECOMMENDED TREATMENT ALTERNATIVES

These alternatives have been discussed in Chapter 6. The costs for the two alternatives are in Table 12-1 below. Detailed cost analyses are in Appendix H for the information in the following tables. Costs for the plant should Cayucos be added are also included in Appendix I.

Table 12-1 Opinion of Probable Cost for the Two Alternatives

	WRF SBR TREATMENT OPTION & CONVEYANCE FACILITIES	WRF MBR TREATMENT OPTION & CONVEYANCE FACILITIES
Phase 1		
WRF On-site facilities	$ 38,429,700	$ 41,563,600
Water/Wastewater Operations Facilities	$ 9,435,700	$ 9,435,700
Access road to Water/Wastewater Operations Facilities	$ 289,500	$ 289,500
Microfiltration/UV Facility	$ 7,926,700	$ 5,687,200

	WRF SBR TREATMENT OPTION & CONVEYANCE FACILITIES		WRF MBR TREATMENT OPTION & CONVEYANCE FACILITIES	
Fire Protection Building	$	736,700	$	736,600
Conveyance & Offsite Facilities	$	10,504,000	$	10,499,900
General Conditions	$	6,732,200	$	6,821,300
Building Permits & Sales Tax	$	3,609,700	$	3,745,900
Insurances	$	2,096,900	$	2,127,100
Construction Subtotal	**$**	**79,761,000**	**$**	**80,907,000**
Contractor OH&P (8%)	$	6,380,900	$	6,472,500
Construction Contingency (25%)	$	21,535,500	$	21,844,800
Engineering & Design (8%)	$	8,614,200	$	8,737,900
Escalation (2%)	$	2,325,800	$	2,359,200
Total Phase 1	**$**	**118,618,000**	**$**	**120,321,000**
Phase 2				
RO Equipment	$	6,324,000	$	6,346,700
Recycle Water PS & Pipeline	$	1,803,600	$	1,803,000
General Conditions	$	812,800	$	815,000
Building Permits & Sales Tax	$	573,000	$	574,800
Insurances	$	256,900	$	257,600
Construction Subtotal	**$**	**9,770,000**	**$**	**9,797,000**
Contractor OH&P (8%)	$	781,600	$	783,800
Construction Contingency (25%)	$	2,638,000	$	2,645,200
Engineering & Design (8%)	$	1,055,200	$	1,058,100
Escalation (2%)	$	284,900	$	285,700
Total Phase 2	**$**	**14,530,000**	**$**	**14,570,000**

A summary of the costs for the two phases of the project are in Table 12-2.

Table 12-2 Cost Summary Table

	WRF SBR TREATMENT OPTION & CONVEYANCE FACILITIES		WRF MBR TREATMENT OPTION & CONVEYANCE FACILITIES	
Phase 1				
Construction Subtotal	$	79,761,000	$	80,907,000
Contractor OH&P	$	6,380,900	$	6,472,500
Construction Contingency	$	21,535,500	$	21,844,800
Engineering & Design	$	8,614,200	$	8,737,900
Escalation	$	2,325,800	$	2,359,200
Total Phase 1	**$**	**118,618,000**	**$**	**120,321,000**
Phase 2				
Construction Subtotal	$	9,770,000	$	9,796,995
Contractor OH&P	$	781,600	$	783,760
Construction Contingency	$	2,638,000	$	2,645,189
Engineering & Design	$	1,055,200	$	1,058,076
Escalation	$	284,900	$	285,680
Total Phase 2	**$**	**14,530,000**	**$**	**14,570,000**
Total Phase 1 & 2	**$**	**133,147,000**	**$**	**134,891,000**

12.2 CONTINGENCY

There is a 25% contingency that has been included in the cost estimates. The amount associated for contingency costs is a notable amount but is necessary for the current level of completion of the project. Currently the project has been developed to a concept level which is frequently associated with a 10% completion. There are many unknowns at this point and 25% for this level of project completion is typical in the industry. The types of things that are currently unknown that could require use of the contingency budget are:

- Geotechnical and how much rock may be required to be removed during construction.
- Subsurface conditions for the pipeline alignment for the recycle pipeline.
- Specific requirements as dictated by currently un-finalized permit conditions and the environmental documents.

The contingency budget is very important as so many other issues could arise during the project.

12.3 BASIS OF OPERATION AND MAINTENANEC COST ESTIMATES

Operation and maintenance (O&M) costs were estimated for the two process flowsheet options presented in Chapter 6. For the purposes of this FMP, O&M costs included the costs associated power consumption, chemical usage and process equipment repair/replacement. The approach used was to estimate the cost of the "base-process" designed to produce water for unrestricted non-potable reuse (in accordance with Title 22) and discharge to the ocean. O&M costs for water treated in the Advanced Water Purification Process (AWPF) were then calculated based on the percentage of the average daily flow (ADF) treated in the AWPF. The basis for O&M calculations are noted below.

- Flow basis – Annual Average Daily Flow at buildout (0.97 mgd)
- Project Life: 20-year
- Interest rate: 3%
- Cost of power: $0.15/kWh
- Systems included in power consumption estimates:
    - Preliminary treatment (screenings, grit removal, fine screening (MBR option only)
    - Biological treatment (SBR or MBR, with ancillary systems – e.g., blowers, RAS/MLR pumps, permeate pumps, WAS pumping)
    - Tertiary treatment (MF/UF and/or UV-disinfection)
    - Advanced Water Purification (RO system, UV-AOP, decarbonation)
    - Effluent Pump Station
    - Sludge handing (WAS storage mixers, dewatering)
- Power consumption is estimated based on the following plant operating conditions:
    - Liquid stream processes - 24-hour operation
        - For SBR option – 100% of the flow is filtered through MF/UF, then either disinfected using UV or sent to AWP (see below)
        - Flow to AWP – set as a percentage (varied from 0-100%, remainder disinfected using UV)
    - Solids dewatering – 7 h/day; 4 d/week
- Chemical consumption is estimated based on the following chemical application-points (as applicable for the two process options):
    - MBR System:
        - Sodium hypochlorite for Maintenance Clean (MC) and Recovery Clean (RC)
        - Citric acid for MC and RC
    - MF/UF System:
        - Sodium Hypochlorite for Clean-in-Place (CIP) & Maintenance Wash (MW)
        - Citric Acid for CIP & MW
        - Sodium Bisulfite for CIP waste neutralization

    - Sodium Hydroxide (Caustic) for CIP waste neutralization
  - Advanced Water Purification:
    - Sulfuric Acid upstream of RO System
    - Sodium Hydroxide for RO Permeate

- Chemical doses are estimated based on typical values in other facilities with similar processes (MBR or AWPF)
- Equipment replacement and repair costs have been estimated at 0.75% of the estimated capital cost of equipment

12.4 OVERVIEW OF OPERATING COSTS

Shown in Figure 12-1 below is the range of power consumption (in kWh/d) at the buildout ADF condition. The range was generated through a sensitivity analysis on process systems based on anticipated, assumed or known uncertainties in the design of the process systems. Inspection of Figure 12-1 indicates that if the Morro Bay WRF were operated strictly to achieve Title 22 reuse (i.e., 0% to AWPF), the power consumption for the SBR and MBR options would be comparable. As expected, production of potable water results in a significant increase in the energy consumption.

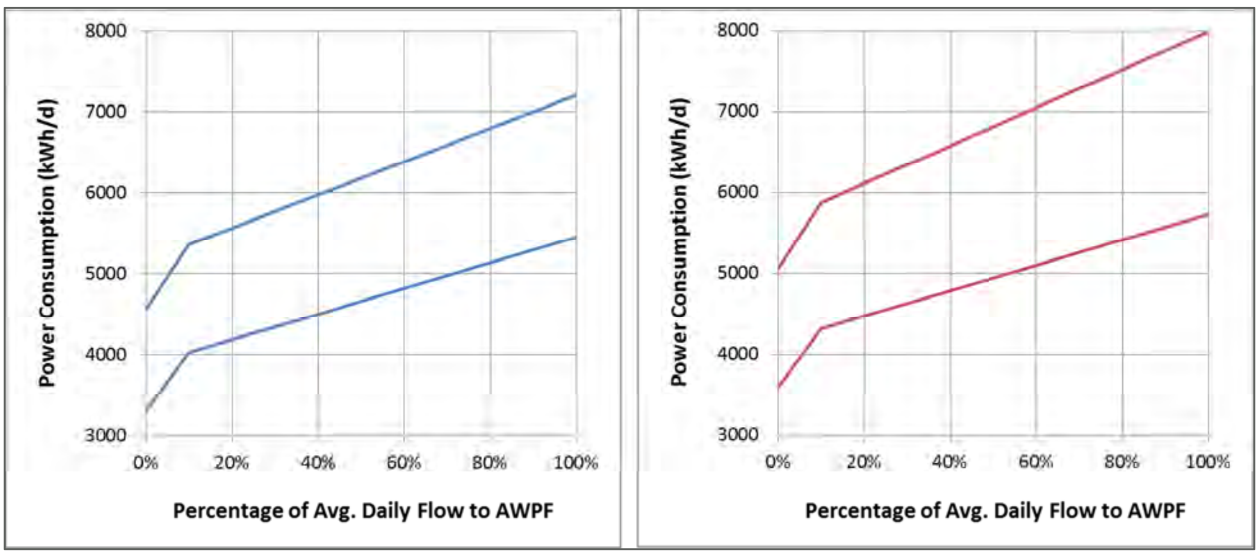


Figure 12-1 Power Consumption

Figure 12-2 shows the estimates for annual costs of power based on the estimates for consumption shown in Figure 12-1. The annualized power costs were determined based on a 20 year project life.

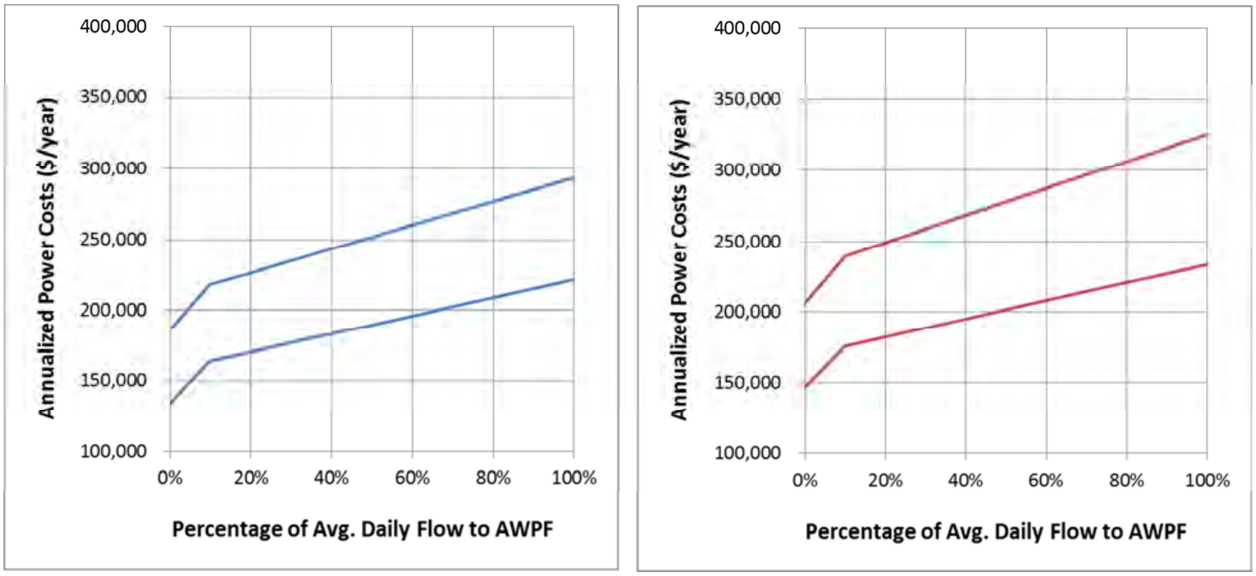


Figure 12-2 Annual Power Costs

Summarized in Figure 12-3 below are estimates of annual operating costs of power, chemicals and equipment replacement for the SBR option (left panel) and MBR option (right panel). In general, the MBR option is more expensive to operate than the SBR option. With no AWPF, the MBR-based process option is approximately 20% more expensive and approximately 10% more expensive in the case where 100% of the forward flow is directed to an AWPF.

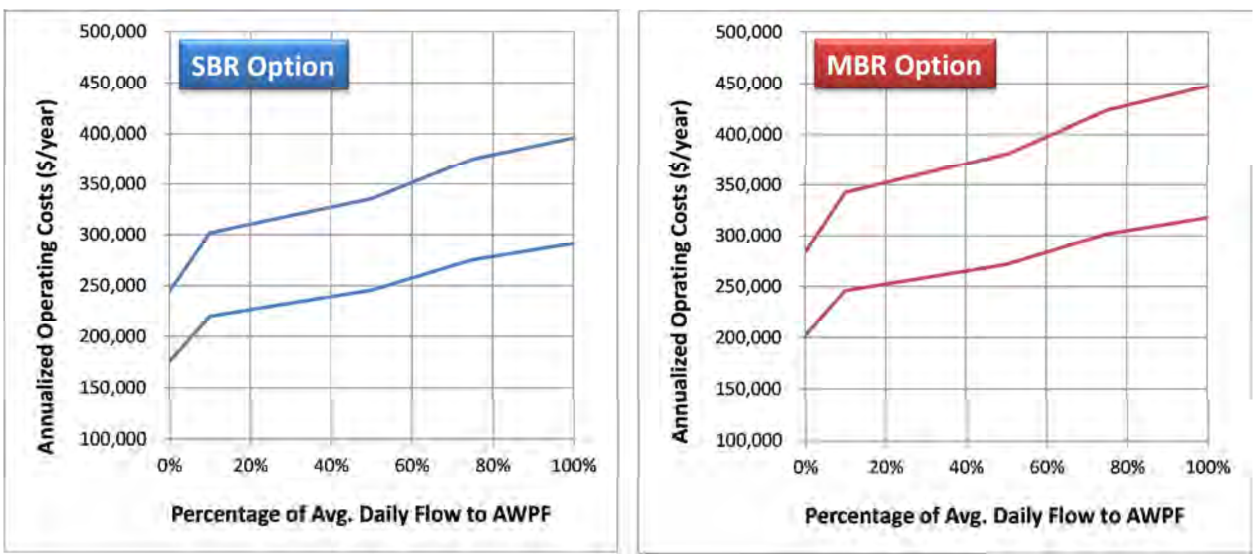


Figure 12-3 Annual Operating Power Costs

Appendix A

Appendix A

MASTER REFERENCE LIST

APPENDIX A – Master Reference List

Major reference sources consulted for this FMP are listed below.

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Appendix B

Appendix B

OVERVIEW OF TITLE 22 REUSE REGULATIONS

APPENDIX B – Overview of Title 22 Reuse Regulations

Reuse of recycled wastewater in California for either irrigation or groundwater recharge is regulated by Title 22 of the California Code of Regulations. Title 22 treatment is a method of tertiary wastewater treatment approved by the California State Water Resources Control Board Division of Drinking Water (DDW) for many water reuse applications.

B.1 RECYCLED WATER FOR IRRIGATION AND OTHER USES

Title 22, Chapter 4 of the California Code of Regulations, outlines the level of treatment required for allowable uses for recycled water, including irrigation, fire fighting, residential landscape watering, industrial uses, food crop production, construction activities, commercial laundries, road cleaning, recreational purposes, decorative fountains, and ponds.

Four treatment levels are defined in the regulations for various recycled water uses in California: disinfected tertiary recycled water, disinfected secondary-2.2 recycled water, disinfected secondary-23 recycled water and undisinfected secondary recycled water.

Water quality objectives vary for different uses. Water quality for unrestricted urban use (e.g., irrigation of parks are schools) is primarily driven by public safety and suitability for application. Safety assurances are written into Title 22 requirements through standards for effluent coliform concentrations and usage restrictions, such as pipeline distance from potable water pipelines, proximity to groundwater, prevention of cross-connection between potable and non-potable systems, and restrictions near eating facilities and drinking fountains. (MKN&A, 2014)

B.1.1 Industrial Use

Industrial use of recycled water is not specifically addressed by existing regulations. These projects are considered on a case-by-case basis. Frequently, the required effluent water quality is determined by the particular industrial process needs. (Carollo, 2007)

B.1.2 Cooling

Recycled water used for industrial or commercial cooling or air conditioning that involves the use of a cooling tower, evaporative condenser, spraying, or any mechanism that creates a mist shall be disinfected tertiary recycled water. If a mist is not created then the water shall be at least Disinfected Secondary-23.

Whenever a cooling system, using recycled water in conjunction with an air conditioning facility, utilizes a cooling tower or otherwise creates a mist that could come into contact with employees or members of the public, the cooling system must use a drift eliminator while in operation. In addition, chlorine, or other biocide, must be used to treat the cooling system recirculating water to minimize the growth of microorganisms. (Carollo, 2007)

B.1.3 Other Purposes

Disinfected tertiary recycled water may also be used for the following:

- Flushing toilets and urinals;
- Priming drain pipes;
- Industrial process water that may come into contact with workers;
- Structural fire fighting;

- Decorative fountains;
- Commercial laundries;
- Consolidation of backfill around potable water pipelines;
- Artificial snowmaking; and
- Commercial mechanical car washes.

Recycled water used for flushing sanitary sewers shall be at least undisinfected secondary recycled water. (Carollo, 2007)

B.2 INDIRECT POTABLE REUSE VIA GROUNDWATER RECHARGE

Title 22 of the California Code of Regulations covers groundwater recharge of reclaimed water for both surface and subsurface applications.

B.2.1 Groundwater Recharge with Surface Application

Title 22, Article 5.1 covers indirect potable reuse (IPR) through groundwater recharge for surface applications. The following presents a summary of the principal regulations that impact the required treatment process and performance:

Minimum Treatment

- Disinfected filtered tertiary recycled water

Pathogen Removal

- 12-log enteric virus removal
- 10-log Giardia removal
- 10-log cryptosporidium removal
- Minimum of 3 separate treatment processes with each process credited at least 1-log removal for each pathogen, but no more than 6-log removal
- Each month of underground retention credits 1-log virus removal
- Six months of underground retention can credit 10-log Giardia cyst and 10-log Cryptosporidium removal each

Nitrogen Removal

- Recycled water 10 mg/L total nitrogen limit

Other Regulated Contaminants (Monitor and Possible Mitigation)

- Selected organic and inorganic chemicals
- Radionuclides
- Disinfection byproducts
- Secondary drinking water MCLs

Reclaimed Water Contribution (RWC)

- Initial max RWC of 20%, or up to 100% with treatment to reduce TOC, mg/L < 0.5/proposed initial RWC
- RWC can be increased based on previous 52 weeks TOC, mg/L < 0.5/proposed RWC

- RWC increased in steps (50%, 75%, up to 100%)

Soil Aquifer Treatment

- TOC removal credit based on a soil aquifer treatment factor approved by DDW

Additional Monitoring

- CA priority toxic pollutants
- Any constituents added by DDW based on engineering report review
- Emerging contaminant indicators

Minimum Underground Retention

- Based on engineering report response time, but 2 months minimum

B.2.2 Groundwater Recharge with Subsurface Application

Title 22, Article 5.2 covers indirect potable reuse through groundwater recharge for subsurface applications. The following presents a summary of the principal regulations that impact the required treatment process and performance:

Minimum Treatment

- Reverse Osmosis
- Advanced oxidation process (AOP) that provides the log removals listed in Table B-1:

Table B-1. AOP Log Removal Requirements

0.5-LOG REMOVAL OF INDICATOR COMPOUND FOR EACH GROUP	0.3-LOG REMOVAL OF INDICATOR COMPOUND FOR EACH GROUP
Hydroxy Aromatic	Saturated Aliphatic
Amino/Acylamino Aromatic	Nitro Aromatic
Nonaromatic (carbon double bond)	
Deprotonated Amine	
Alkoxy Polyaromatic	
Alkoxy Aromatic	
Alkyl Aromatic	

- Or AOP that provides 0.5-log removal of 1.4 dioxane in lieu of Table B-1

Pathogen Removal

- 12-log enteric virus removal
- 10-log Giardia cyst removal
- 10-log cryptosporidium removal
- Minimum of 3 separate treatment processes with each process credited at least 1-log removal for each pathogen, but no more than 6-log removal
- Each month of underground retention credits 1-log virus removal

Nitrogen Removal

- 10 mg/L total nitrogen limit

Other Regulated Contaminants (Monitor and Possible Mitigation)

- Selected organic and inorganic chemicals
- Radionuclides
- Disinfection byproducts
- Lead and copper
- Secondary drinking water MCLs

Reclaimed Water Contribution (RWC)

- Initially up to 100% with TOC limit of 0.5 mg/L

Additional Monitoring

- CA priority toxic pollutants
- Any constituents added by DDW based on engineering report review
- Emerging contaminant indicators

Minimum Underground Retention

- Based on engineering report response time, but 2 months minimum

B.3 TITLE 22 REDUNDANCY

California Division of Drinking Water, Title 22, Chapter 3, Article 10 Regulations require the measures listed in Table B-2 to ensure treatment reliability when individual process units are out of service. These redundancy measures will be incorporated into any end-use alternatives requiring Title 22 treatment.

Table B-2. Mandatory and Reliability Requirements for Unit Processes in Producing California Title 22 Water for Unrestricted Use

PRIMARY TREATMENT – ONE OF THE FOLLOWING:	(a) Multiple primary treatment units capable of producing primary effluent with one unit not in operation.	(b) Standby primary treatment unit process.	(c) Long-term storage or disposal provisions.	--	--
SECONDARY TREATMENT - ONE OF THE FOLLOWING:	(a) Alarm and multiple biological treatment units capable of producing oxidized wastewater with one unit not in operation.	(b) Alarm, short-term retention or disposal provisions, and standby replacement equipment.	(c) Alarm and long-term storage or disposal provisions.	(d) Automatically actuated long-term storage or disposal provisions.	--
SECONDARY CLARIFIERS - ONE OF THE FOLLOWING:	(a) Multiple sedimentation units capable of treating the entire flow with one unit not in operation.	(b) Standby sedimentation unit process.	(c) Long-term storage or disposal provisions.	--	--
COAGULATION - <u>ALL MANDATORY</u>	(1) Standby feeders,	(2) Adequate chemical stowage and conveyance facilities,	(3) Adequate reserve chemical supply, and	(4) Automatic dosage control.	--
COAGULATION - RELIABILITY - ONE OF THE FOLLOWING:	(a) Alarm and multiple coagulation units capable of treating the entire flow with one unit not in operation	(b) Alarm, short-term retention or disposal provisions, and standby replacement equipment	(c) Alarm and long-term storage or disposal provisions;	(d) Automatically actuated long-term storage or disposal provisions, or	(e) Alarm and standby coagulation process.
FILTRATION - ONE OF THE FOLLOWING:	(a) Alarm and multiple filter units capable of treating the entire flow with one unit not in operation.	(b) Alarm, short-term retention or disposal provisions and standby replacement equipment.	(c) Alarm and long-term storage or disposal provisions.	(d) Automatically actuated long-term storage or disposal provisions.	(e) Alarm and standby filtration unit process.

CHLORINE DISINFECTION - ALL MANDATORY	(1) Standby chlorine supply,	(2) Manifold systems to connect chlorine cylinders,	(3) Chlorine scales,	(4) Automatic devices for switching to full chlorine cylinders. Automatic residual control of chlorine dosage, automatic measuring and recording of chlorine residual, and hydraulic performance studies may also be required.	--
CHLORINE DISINFECTION RELIABILITY - ONE OF THE FOLLOWING:	(a) Alarm and standby chlorinator;	(b) Alarm, short-term retention or disposal provisions, and standby replacement equipment;	(c) Alarm and long-term storage or disposal provisions;	(d) Automatically actuated long-term storage or disposal provisions; or	(e) Alarm and multiple point chlorination, each with independent power source, separate chlorinator, and separate chlorine supply.

Many of the reliability alternatives above allow for the use of storage or alternative disposal options. Article 10 also defines these options as follows:

i. Short-term retention or disposal shall consist of facilities reserved for the purpose of storing or disposing of untreated or partially treated wastewater for at least a 24-hour period. The facilities shall include all the necessary diversion devices, provisions for odor control, conduits, and pumping and pump back equipment. All of the equipment other than the pump back equipment shall be either independent of the normal power supply or provided with a standby power source.

ii. Long-term storage or disposal shall consist of ponds, reservoirs, percolation areas, downstream sewers leading to other treatment or disposal facilities or any other facilities reserved for the purpose of emergency storage or disposal of untreated or partially treated wastewater. These facilities shall be of sufficient capacity to provide disposal or storage of wastewater for at least 20 days, and shall include all the necessary diversion works, provisions for odor and nuisance control, conduits, and pumping and pump back equipment. All of the equipment other than the pump back equipment shall be either independent of the normal power supply or provided with a standby power source.

iii. Diversion to a less demanding reuse is an acceptable alternative to emergency disposal of partially treated wastewater provided that the quality of the partially treated wastewater is suitable for the less demanding reuse.

iv. Subject to prior approval by the regulatory agency, diversion to a discharge point which requires lesser quality of wastewater is an acceptable alternative to emergency disposal of partially treated wastewater.

v. Automatically actuated short-term and long-term storage or disposal provisions shall also include, all the necessary sensors, instruments, valves and other devices to enable fully automatic diversion of untreated or partially treated wastewater to approved emergency storage or disposal in the event of failure of a treatment process and a manual reset to prevent automatic restart until the failure is corrected.

Appendix C

Appendix C

EVALUATION OF PEAK HOURLY FLOW PEAKING FACTOR

APPENDIX C –Evaluation of Peak Hourly Flow Peaking Factor

The peak hourly flow peaking factor was determined by analyzing MBCSD historical hourly flow data spanning from 2003 to 2014 (Figure C-1). Note in Figure C-1, there were multiple hours where the influent flow was reported to be at the maximum capacity of the influent flow meter (6,992 gpm according to plant staff). Table C-1 provides known plant equipment failures and weather events that resulted in influent flow meter surcharging. If surcharging occurred due to equipment failure, the data was removed from further evaluation. If wet weather was responsible for surcharging or the reason was unknown, the hourly flow was changed in the data set to be approximately 6,800 gpm.

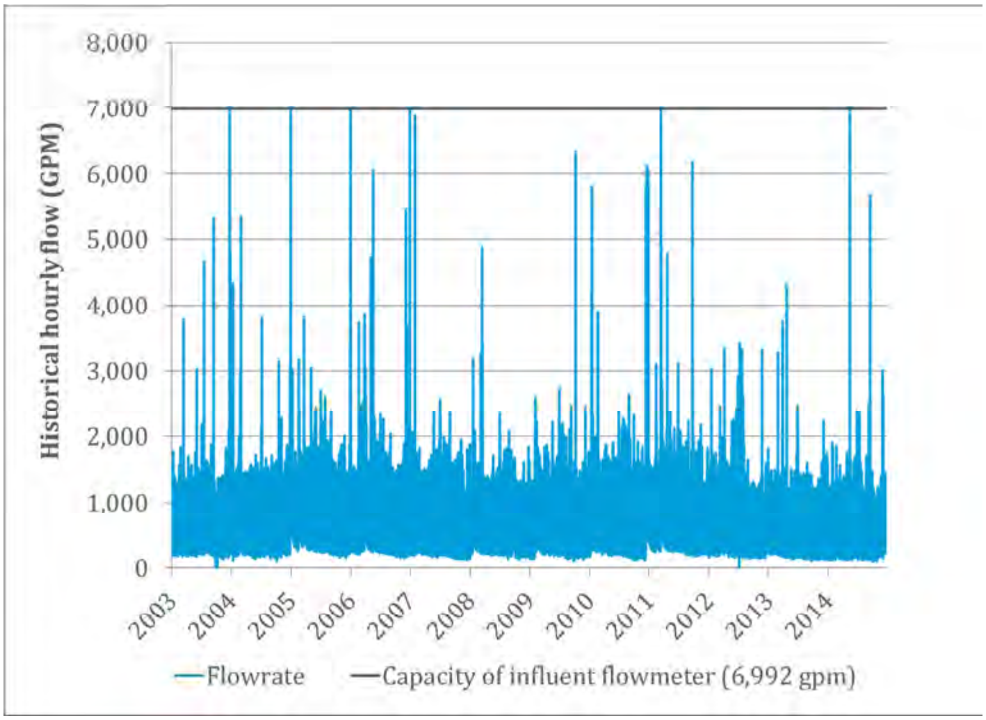

Figure C-1. Historical Hourly Flow

Table C-1. Surcharging Event Details

DATE	EVENT
12/22/2003	Maingate closure due to earthquake.
12/31/2004	Surcharging caused by flooding at plant from Morro Creek.
3/22/2005	Unknown
12/31/2006	Unknown
2/1/2007	Surcharge in flume due to gate closure during switchgear testing.
3/18/2008	Surcharging due to all three main influent pump VFD failure.
10/13/2009	Surcharging due to influent pump failure.
12/22/2010-12/29/2010	Surcharging due to heavy rain.
3/19/2011 – 3/21/2011	Surcharging due to heavy rain.
6/2/2012 – 8/7/2012	Surcharging due to the screen on the grinder unit being plugged with rags. Rags were removed and influent flows returned to normal range.

For the revised data set, the PHFs are organized by their probability on an annual basis in Table C-2. The PHF probability plot for the entire data set is given in Figure C-2. A PHF of 7.25 (7.03 mgd) was selected. For the 12 years evaluated, 0.02% of the data exceeded 7.03 mgd, which equals 20 hours worth of flow that surpasses the design peaking factor. For these occurrences, the City will need to attenuate the flow in the collection system. Evaluating the data on a year-to year basis, a maximum of 2 hourly events exceeding the peak hourly flow occurred within a single year (Figure C-3).

Table C-2. Summary of Hourly Flow to AADF Ratio for Years 2003-2014

YEAR	AVG.	STD. DEV.	PERCENTILE								
			Min.	5th	25th	50th	75th	95th	99th	99.5th	Max.
2003	0.995	0.472	0.01	0.32	0.58	1.04	1.29	1.69	2.06	2.18	9.26
2004	0.994	0.459	0.14	0.32	0.60	1.04	1.25	1.70	2.14	2.46	7.05
2005	1.002	0.464	0.18	0.34	0.65	1.02	1.24	1.79	2.36	2.71	4.40
2006	1.002	0.519	0.17	0.33	0.63	1.02	1.23	1.71	2.44	3.00	8.18
2007	0.998	0.451	0.15	0.31	0.60	1.06	1.27	1.73	2.17	2.37	3.39
2008	0.997	0.477	0.16	0.31	0.63	1.03	1.24	1.66	2.53	3.37	6.17
2009	0.993	0.447	0.14	0.31	0.60	1.05	1.26	1.71	2.15	2.41	3.59
2010	0.997	0.568	0.14	0.30	0.61	1.00	1.21	1.73	3.03	4.01	7.24
2011	0.997	0.539	0.20	0.34	0.62	1.00	1.22	1.70	2.70	3.52	7.73
2012	0.939	0.430	0.19	0.27	0.59	0.98	1.19	1.62	2.01	2.26	4.39
2013	1.000	0.474	0.16	0.29	0.59	1.07	1.29	1.69	2.07	2.38	6.41
2014	1.003	0.494	0.15	0.28	0.59	1.06	1.29	1.71	2.23	2.59	10.44

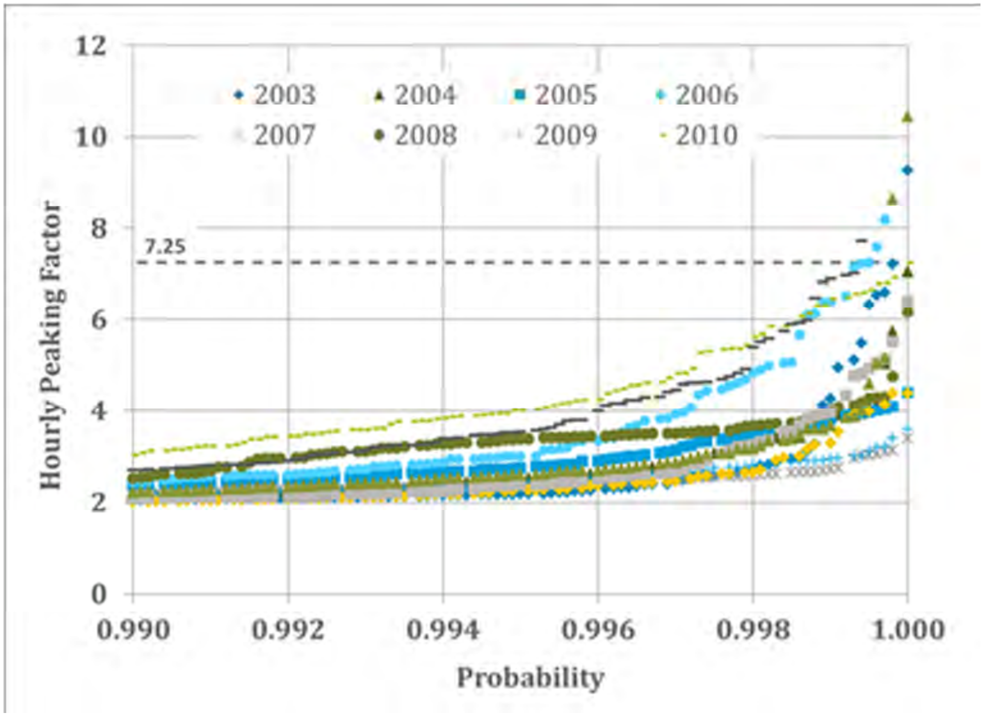

Figure C-3. Hourly Peaking Factor Probability by Year

Appendix D

Appendix D

PROBABILITY OF PEAKING FACTORS FOR LOADS

APPENDIX D – Probability of Peaking Factors for Loads

Figures D-1 and D-2 show the distribution of annual maximum month and maximum day peaking factors for BOD for the years 2010 to 2014. The distribution of peaking factors for TSS are given in Figures D-3 and D-4. Presented in each plot is the normal distribution which best describes these data. The goodness of fit metrics for the normal distribution fit are shown in the text box within the figure and estimates for 25th, 50th (i.e., median), 75th and 95th percentile estimates for the distribution fit are indictated. The projected loads identified in Section 5 are based on the average peaking factor (i.e., 50% probability).

Figures D-5 and D-6 show the distribution of annual maximum month and maximum day BOD loads based on the 25th, 50th, and 75th percentile estimates for the peaking factors. Corresponding plots for TSS load are depicted in Figures D-7 and D-8.

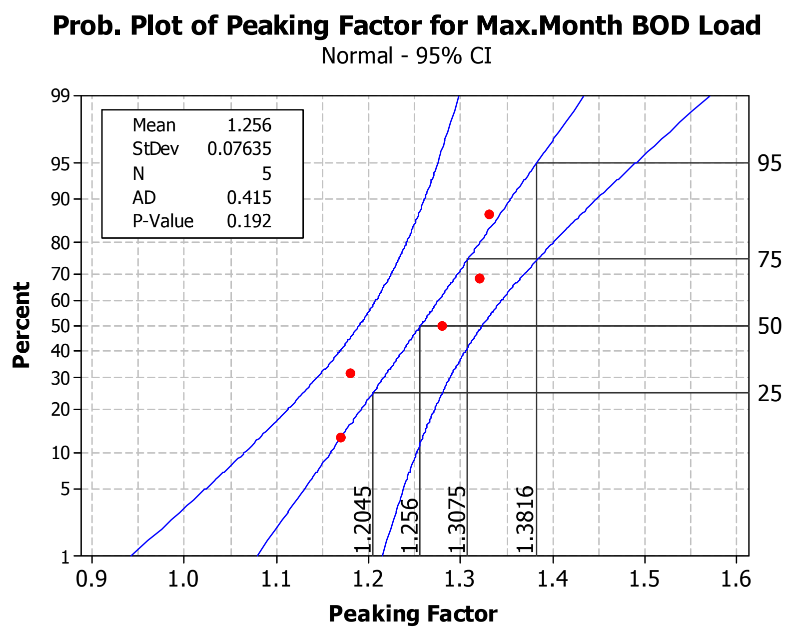

Figure D-1. Probability Plot of Peaking Factor for Maximum Month BOD Load

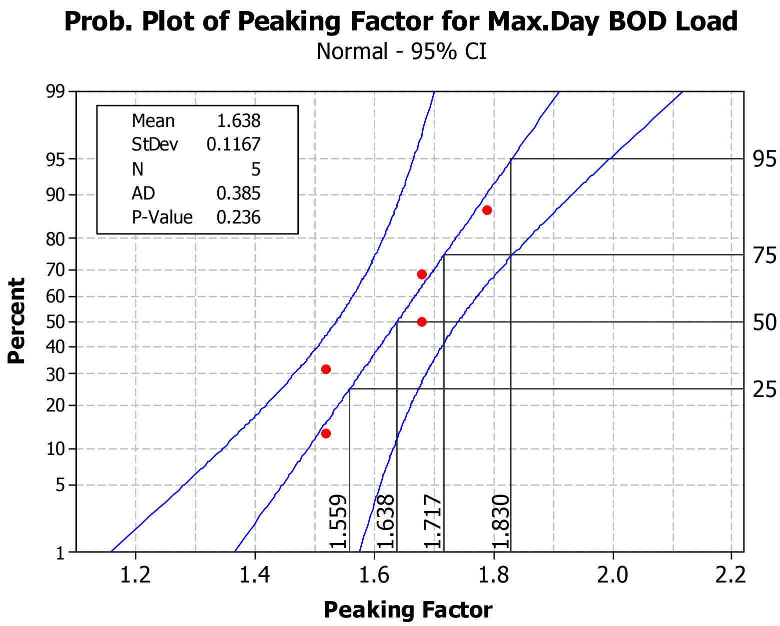

Figure D-2. Probability Plot of Peaking Factor for Maximum Day BOD Load

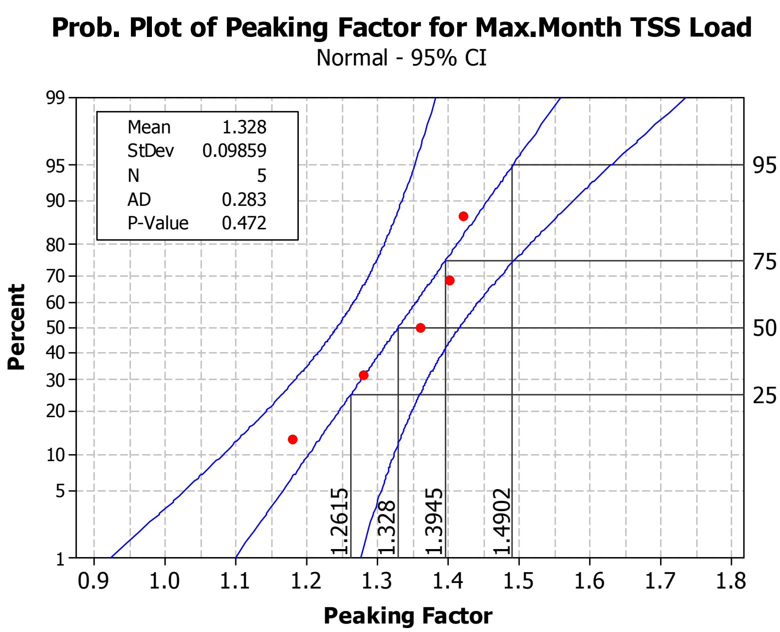

Figure D-3. Probability Plot of Peaking Factor for Maximum Month TSS Load

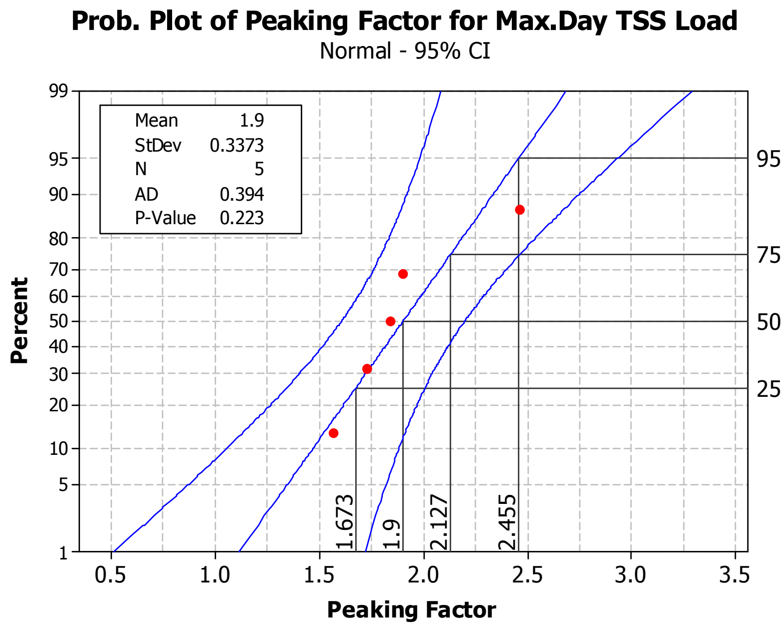

Figure D-4. Probability Plot of Peaking Factor for Maximum Day TSS Load

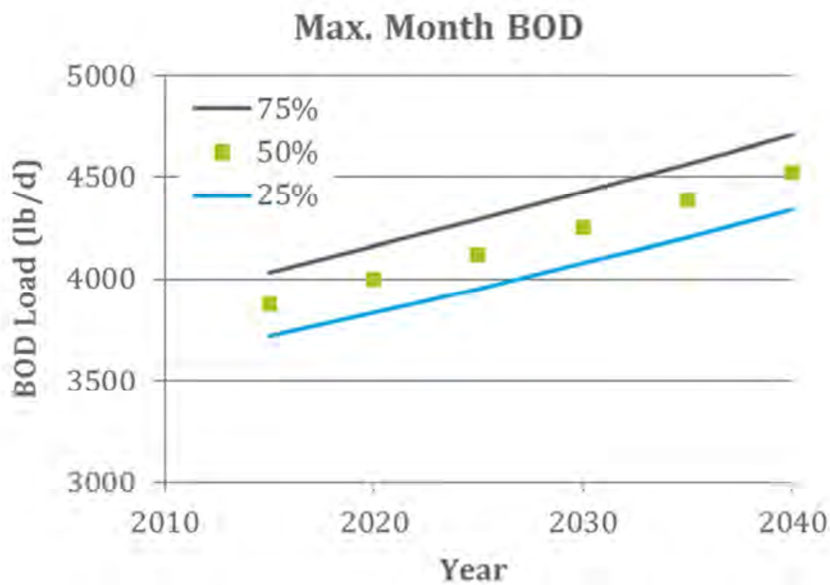

Figure D-5. Probability of Maximum Month BOD Load

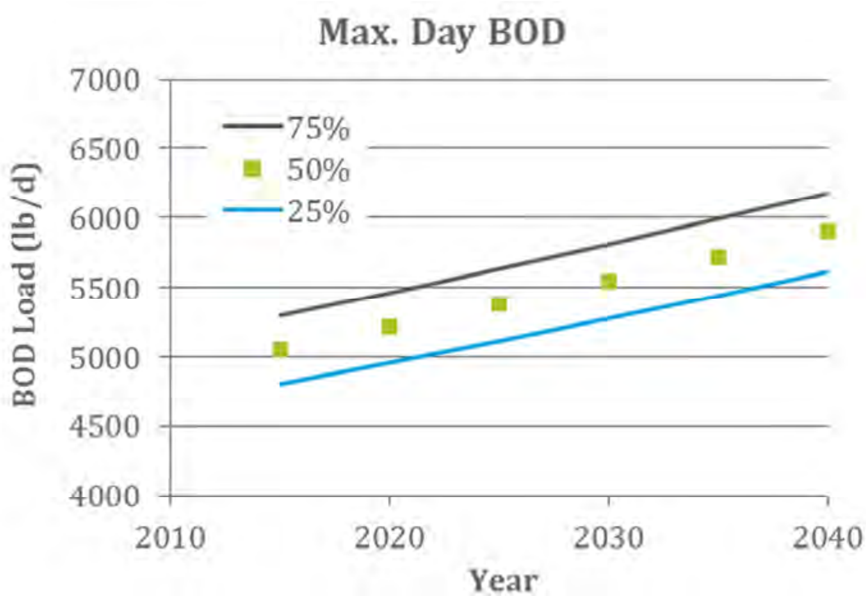

Figure D-6. Probability of Maximum Day BOD Load

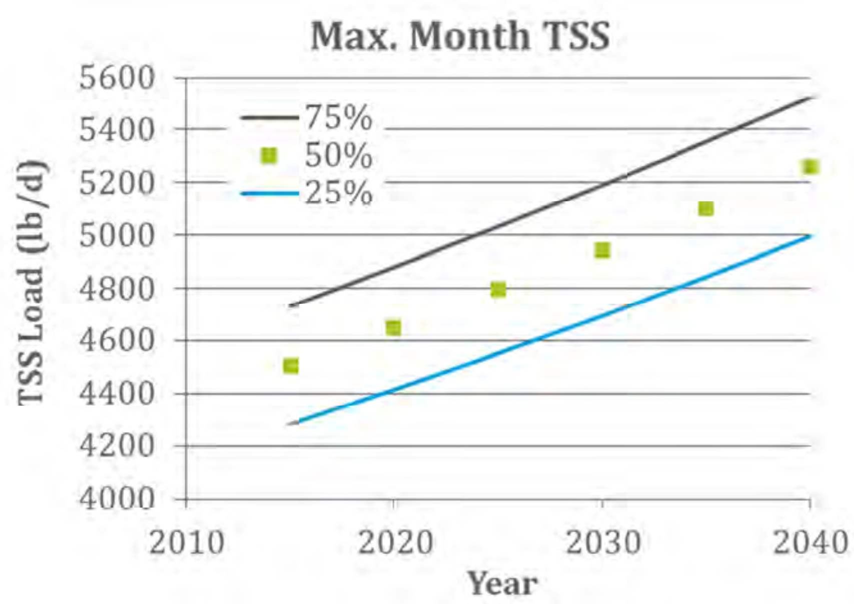

Figure D-7. Probability for Maximum Month TSS Load

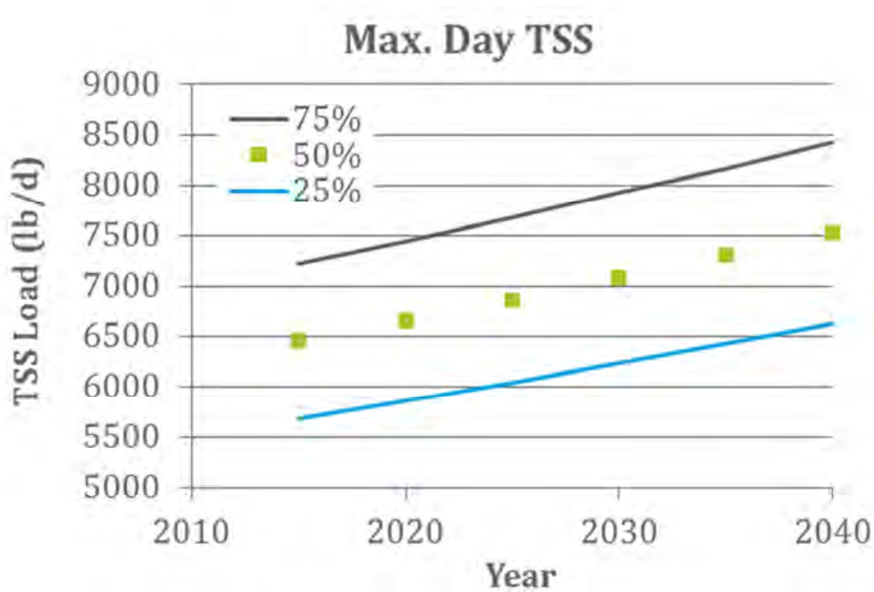

Figure D-8. Probability for Maximum Day TSS Load

Appendix E

Appendix E

OVERVIEW OF PROCESS MODELING

APPENDIX E –Overview of Process Modeling

E.1 DESCRIPTION OF PROCESS MODELS

Two models were developed in Biowin™ to simulate the SBR and MBR options. The model configurations for both process designs are given in Figure E-1 and Figure E-2. The modeling assumptions are provided for each individual model in Table E-1 and Table E-2.

E.1.1 Model for SBR Option (Liq. Stream: SBR, Filtration. Solids: Dewatering)

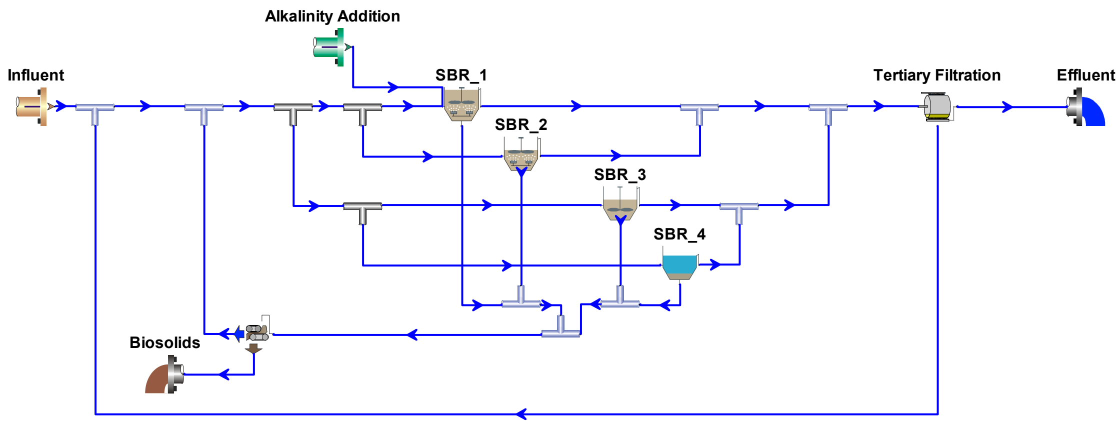

Figure E-1. SBR Model Configuration

Table E-1. Modeling Assumptions for Simulation of the SBR Option

PROCESS UNIT	ASSUMPTION
Influent	MM conditions
WAS	
Concentration	8,000 mg/L (determined by settling model)
Flowrate	SRT controlled
Dewatering Equipment	
Solids removal	95%
Underflow percent solids	20%
Tertiary Filter	
Solids removal	99.90%
Underflow percent solids	solids removed in 10% of flow
Recycle rate	10% of flow

E.1.2. Model for MBR Option (Liq. Stream: MBR. Solids: Dewatering)

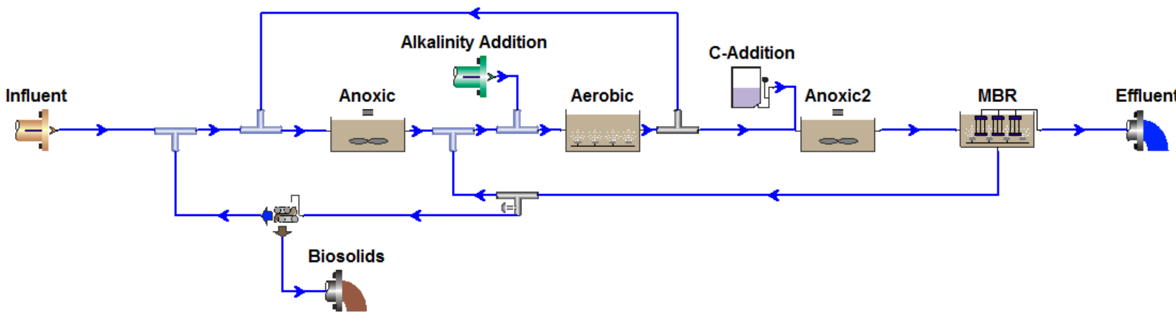

Figure E-2. MBR Model Configuration

Table E-2. Modeling Assumptions for Simulation of MBR Option

PROCESS UNIT	ASSUMPTION
Influent	MM conditions
MBR recycle flowrate	4X influent flowrate
MLSS recycle flowrate	5X influent flowrate
MBR	
flux	17 gal/ft^2/d
number of cassettes	6 total
surface area/cassette	17,760 ft^2
volume per cassette	330 ft^3
WAS flowrate	SRT controlled
Dewatering Equipment	
solids removal	95%
underflow percent solids	20%

E.2 PROCESS MODELS INFLUENT CHARACTERISTICS

Table E-3 provides the influent characteristics at the AA, MM, and PD conditions for all four process models. The influent COD and TKN fractionation is shown in Table E-4.

Table E-3. Modeled Influent Characteristics

PARAMETER	UNITS	AA	MM	PD
Flow	MGD	0.97	1.16	2.75
Total Carbonaceous BOD	mg BOD/L	440.00	470.00	257.00
Volatile suspended solids	mg VSS/L	392.00	432.00	262.00
Total suspended solids	mg TSS/L	490.00	540.00	327.00
Total Kjeldahl Nitrogen	mg N/L	70.00	72.00	41.00
Total P	mg P/L	10.00	10.00	10.00
Nitrate N	mg N/L	0	0	0
pH	-	7.80	7.80	7.80
Alkalinity	mmol/L	6.00	6.00	6.00
Calcium	mg/L	80.00	80.00	80.00
Magnesium	mg/L	15.00	15.00	15.00
Dissolved oxygen	mg/L	0	0	0

Table E-4. Influent Fractionation

PARAMETER	UNITS	VALUE
Fbs - Readily biodegradable (including Acetate)	g COD/g of total COD	0.160
Fac - Acetate	g COD/g of readily biodegradable COD	0.150
Fxsp - Non-colloidal slowly biodegradable	g COD/g of slowly degradable COD	0.862
Fus - Unbiodegradable soluble	g COD/g of total COD	0.050
Fup - Unbiodegradable particulate	g COD/g of total COD	0.130
Fna - Ammonia	g NH3-N/g TKN	0.660
Fnox - Particulate organic nitrogen	g N/g Organic N	0.500
Fnus - Soluble unbiodegradable TKN	g N/g TKN	0.020
FupN - N:COD ratio for unbiodegradable part. COD	g N/g COD	0.035
Fpo4 – Phosphate	g PO4-P/g TP	0.500
FupP - P:COD ratio for unbiodegradable part. COD	g P/g COD	0.011
FZbh - OHO COD fraction	g COD/g of total COD	0.0200
FZbm - Methylotroph COD fraction	g COD/g of total COD	1.000E-4
FZaob - AOB COD fraction	g COD/g of total COD	1.000E-4
FZnob - NOB COD fraction	g COD/g of total COD	1.000E-4
FZamob - ANAMMOX COD fraction	g COD/g of total COD	1.000E-4
FZbp - PAO COD fraction	g COD/g of total COD	1.000E-4
FZbpa - Propionic acetogens COD fraction	g COD/g of total COD	1.000E-4
FZbam - Acetoclastic methanogens COD fraction	g COD/g of total COD	1.000E-4
FZbhm - H_2-utilizing methanogens COD fraction	g COD/g of total COD	1.000E-4
FZe - Endogenous products COD fraction	g COD/g of total COD	0

E.2.1. Biokinetic Parameters

The biokinetic parameters associated with these organisms are provided in Table E-5 through Table E-12. Other parameters critical to biokinetics are provided, including pH limits (Table E-13), switch parameters (Table E-14), and common parameters (Table E-15).

Table E-5. AOB Biokinetic Parameters

PARAMETER	UNITS	VALUE
Maximum specific growth rate	1/d	0.9000
Substrate (NH_4) half saturation	mg N/L	0.7000
Byproduct NH_4 logistic slope	-	50.0000
Byproduct NH_4 inflection point	mg N/L	1.4000
AOB denite DO half saturation	mg/L	0.1000
AOB denite HNO_2 half saturation	mg N/L	5.0000E-6
Aerobic decay rate	1/d	0.1700
Anoxic/anaerobic decay rate	1/d	0.0800
$KiHNO_2$	mmol/L	0.0050

Table E-6. NOB Biokinetic Parameters

PARAMETER	UNITS	VALUE
Maximum specific growth rate	1/d	0.7000
Substrate (NO_2) half saturation	mg N/L	0.1000
Aerobic decay rate	1/d	0.1700
Anoxic/anaerobic decay rate	1/d	0.0800
$KiNH_3$	mmol/L	0.0750

Table E-7. Anammox Biokinetic Parameters

PARAMETER	UNITS	VALUE
Maximum specific growth rate	1/d	0.1000
Substrate (NH_4) half saturation	mg N/L	2.0000
Substrate (NO_2) half saturation	mg N/L	1.0000
Aerobic decay rate	1/d	0.0190
Anoxic/anaerobic decay rate	1/d	0.0095
$KiNO_2$	mg N/L	1000.0000
Nitrite sensitivity constant	L/(d mg N)	0.01600

Table E-8. OHO Biokinetic Parameters

PARAMETER	UNITS	VALUE
Maximum specific growth rate	1/d	3.2000
Substrate half saturation	mg COD/L	5.0000
Anoxic growth factor	-	0.5000
Denite N_2 producers (NO_3 or NO_2)	-	0.5000
Aerobic decay rate	1/d	0.6200
Anoxic decay rate	1/d	0.2330
Anaerobic decay rate	1/d	0.1310
Hydrolysis rate	1/d	2.1000
Hydrolysis half saturation	-	0.0600
Anoxic hydrolysis factor	-	0.2800
Anaerobic hydrolysis factor (AS)	-	0.0400
Anaerobic hydrolysis factor (AD)	-	0.2000
Adsorption rate of colloids	L/(mg COD d)	0.1500
Ammonification rate	L/(mg N d)	0.0400
Assimilative nitrate/nitrite reduction rate	1/d	0.5000
Fermentation rate	1/d	1.6000
Fermentation half saturation	mg COD/L	5.0000
Fermentation growth factor (AS)	-	0.2500
Endogenous products decay rate	1/d	0
Free nitrous acid inhibition	mmol/L	1.0000E-7

Table E-9. Methylotroph Biokinetic Parameters

PARAMETER	UNITS	VALUE
Maximum specific growth rate	1/d	1.3000
Methanol half saturation	mg COD/L	0.5000
Denite N_2 producers (NO_3 or NO_2)	-	0.5000
Aerobic decay rate	1/d	0.0400
Anoxic/anaerobic decay rate	1/d	0.0300
Free nitrous acid inhibition	mmol/L	1.0000E-7

Table E-10. PAO Biokinetic Parameters

PARAMETER	UNITS	VALUE
Maximum specific growth rate	1/d	0.9500
Maximum specific growth rate, P-limited	1/d	0.4200
Substrate half saturation	mg COD (PHB)/mg COD (Zbp)	0.1000
Substrate half saturation, P-limited	mg COD (PHB)/mg COD (Zbp)	0.0500
Magnesium half saturation	mg Mg/L	0.1000
Cation half saturation	mmol/L	0.1000
Calcium half saturation	mg Ca/L	0.1000
Aerobic/anoxic decay rate	1/d	0.1000
Aerobic/anoxic maintenance rate	1/d	0
Anaerobic decay rate	1/d	0.0400
Anaerobic maintenance rate	1/d	0
Sequestration rate	1/d	4.5000
Anoxic growth factor	-	0.3300

TableE-11. Acetogen Biokinetic Parameters

PARAMETER	UNITS	VALUE
Maximum specific growth rate	1/d	0.2500
Substrate half saturation	mg COD/L	10.0000
Acetate inhibition	mg COD/L	10000.0000
Anaerobic decay rate	1/d	0.0500
Aerobic/anoxic decay rate	1/d	0.5200

Table E-12. Methanogen Biokinetic Parameters

PARAMETER	UNITS	VALUE
Acetoclastic maximum specific growth rate	1/d	0.3000
H_2-utilizing maximum specific growth rate	1/d	1.4000
Acetoclastic substrate half saturation	mg COD/L	100.0000
Acetoclastic methanol half saturation	mg COD/L	0.5000
H_2-utilizing CO_2 half saturation	mmol/L	0.1000
H_2-utilizing substrate half saturation	mg COD/L	0.1000
H_2-utilizing methanol half saturation	mg COD/L	0.5000
Acetoclastic propionic inhibition	mg COD/L	10000.0000
Acetoclastic anaerobic decay rate	1/d	0.1300
Acetoclastic aerobic/anoxic decay rate	1/d	0.6000
H_2-utilizing anaerobic decay rate	1/d	0.1300
H_2-utilizing aerobic/anoxic decay rate	1/d	2.8000

Table E-13. pH

PARAMETER	UNITS	VALUE
OHO low pH limit	-	4.0000
OHO high pH limit	-	10.0000
Methylotrophs low pH limit	-	4.0000
Methylotrophs high pH limit	-	10.0000
Autotrophs low pH limit	-	5.5000
Autotrophs high pH limit	-	9.5000
PAO low pH limit	-	4.0000
PAO high pH limit	-	10.0000
OHO low pH limit (anaerobic)	-	5.5000
OHO high pH limit (anaerobic)	-	8.5000
Propionic acetogens low pH limit	-	4.0000
Propionic acetogens high pH limit	-	10.0000
Acetoclastic methanogens low pH limit	-	5.0000
Acetoclastic methanogens high pH limit	-	9.0000
H_2-utilizing methanogens low pH limit	-	5.0000
H_2-utilizing methanogens high pH limit	-	9.0000

Table E-14. Switch Parameters

PARAMETER	UNITS	VALUE
Aerobic/anoxic DO half saturation	mg O_2/L	0.0500
Anoxic/anaerobic NO_x half saturation	mg N/L	0.1500
AOB DO half saturation	mg O_2/L	0.2500
NOB DO half saturation	mg O_2/L	0.5000
ANAMMOX DO half saturation	mg O_2/L	0.0100
Anoxic NO_3 (->NO_2) half saturation	mg N/L	0.1000
Anoxic NO_3 (->N_2) half saturation	mg N/L	0.0500
Anoxic NO_2 (->N_2) half saturation	mg N/L	0.0100
NH3 nutrient half saturation	mg N/L	0.0050
PolyP half saturation	mg P/mg COD	0.0100
VFA sequestration half saturation	mg COD/L	5.0000
P uptake half saturation	mg P/L	0.1500
P nutrient half saturation	mg P/L	0.0010
Autotroph CO_2 half saturation	mmol/L	0.1000
H_2 low/high half saturation	mg COD/L	1.0000
Propionic acetogens H_2 inhibition	mg COD/L	5.0000
Synthesis anion/cation half saturation	meq/L	0.0100

Table E-15. Common Shared Parameters

PARAMETER	UNITS	VALUE
Biomass volatile fraction (VSS/TSS)	-	0.9200
Endogenous residue volatile fraction (VSS/TSS)	-	0.9200
N in endogenous residue	mg N/mg COD	0.0700
P in endogenous residue	mg P/mg COD	0.0220
Endogenous residue COD:VSS ratio	mg COD/mg VSS	1.4200
Particulate substrate COD:VSS ratio	mg COD/mg VSS	1.6000
Particulate inert COD:VSS ratio	mg COD/mg VSS	1.6000

E.2.2. Stoichiometric Parameters

The stoichiometric parameters associated with these organisms are provided in **Table –Table** .

Table E-16. AOB Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Yield	mg COD/mg N	0.1500
AOB denite NO_2 fraction as TEA	-	0.5000
Byproduct NH_4 fraction to N_2O	-	0.0025
N in biomass	mg N/mg COD	0.0700
P in biomass	mg P/mg COD	0.0220
Fraction to endogenous residue	-	0.0800
COD:VSS ratio	mg COD/mg VSS	1.4200

Table E-17. NOB Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Yield	mg COD/mg N	0.0900
N in biomass	mg N/mg COD	0.0700
P in biomass	mg P/mg COD	0.0220
Fraction to endogenous residue	-	0.0800
COD:VSS ratio	mg COD/mg VSS	1.4200

Table E-18. Anammox Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Yield	mg COD/mg N	0.1140
Nitrate production	mg N/mg Biomass COD	2.2800
N in biomass	mg N/mg COD	0.0700
P in biomass	mg P/mg COD	0.0220
Fraction to endogenous residue	-	0.0800
COD:VSS ratio	mg COD/mg VSS	1.4200

Table E-19. OHO Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Yield (aerobic)	-	0.6660
Yield (fermentation, low H_2)	-	0.1000
Yield (fermentation, high H_2)	-	0.1000
H_2 yield (fermentation low H_2)	-	0.3500
H_2 yield (fermentation high H_2)	-	0
Propionate yield (fermentation, low H_2)	-	0
Propionate yield (fermentation, high H_2)	-	0.7000
CO_2 yield (fermentation, low H_2)	-	0.7000
CO_2 yield (fermentation, high H_2)	-	0
N in biomass	mg N/mg COD	0.0700
P in biomass	mg P/mg COD	0.0220
Endogenous fraction - aerobic	-	0.0800
Endogenous fraction - anoxic	-	0.1030
Endogenous fraction - anaerobic	-	0.1840
COD:VSS ratio	mg COD/mg VSS	1.4200
Yield (anoxic)	-	0.5400
Yield propionic (aerobic)	-	0.6400
Yield propionic (anoxic)	-	0.4600
Yield acetic (aerobic)	-	0.6000
Yield acetic (anoxic)	-	0.4300
Yield methanol (aerobic)	-	0.5000
Adsorp. max.	-	1.0000
Max fraction to N_2O at high FNA over nitrate	-	0.0500
Max fraction to N_2O at high FNA over nitrite	-	0.1000

Table E-20. Methylotroph Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Yield (anoxic)	-	0.4000
N in biomass	mg N/mg COD	0.0700
P in biomass	mg P/mg COD	0.0220
Fraction to endogenous residue	-	0.0800
COD:VSS ratio	mg COD/mg VSS	1.4200
Max fraction to N_2O at high FNA over nitrate	-	0.1000
Max fraction to N_2O at high FNA over nitrite	-	0.1500

Table E-21. PAO Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Yield (aerobic)	-	0.6390
Yield (anoxic)	-	0.5200
Aerobic P/PHA uptake	mg P/mg COD	0.9300
Anoxic P/PHA uptake	mg P/mg COD	0.3500
Yield of PHA on sequestration	-	0.8890
N in biomass	mg N/mg COD	0.0700
N in sol. inert	mg N/mg COD	0.0700
P in biomass	mg P/mg COD	0.0220
Fraction to endogenous part.	-	0.2500
Inert fraction of endogenous sol.	-	0.2000
P/Ac release ratio	mg P/mg COD	0.5100
COD:VSS ratio	mg COD/mg VSS	1.4200
Yield of low PP	-	0.9400

Table E-22. Acetogen Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Yield	-	0.1000
H_2 yield	-	0.4000
CO_2 yield	-	1.0000
N in biomass	mg N/mg COD	0.0700
P in biomass	mg P/mg COD	0.0220
Fraction to endogenous residue	-	0.0800
COD:VSS ratio	mg COD/mg VSS	1.4200

Table E-23. Methanogen Stoichiometric Parameters

PARAMETER	UNITS	VALUE
Acetoclastic yield	-	0.1000
Methanol acetoclastic yield	-	0.1000
H_2-utilizing yield	-	0.1000
Methanol H_2-utilizing yield	-	0.1000
N in acetoclastic biomass	mg N/mg COD	0.0700
N in H_2-utilizing biomass	mg N/mg COD	0.0700
P in acetoclastic biomass	mg P/mg COD	0.0220
P in H_2-utilizing biomass	mg P/mg COD	0.0220
Acetoclastic fraction to endog. residue	-	0.0800
H_2-utilizing fraction to endog. residue	-	0.0800
Acetoclastic COD:VSS ratio	mg COD/mg VSS	1.4200
H_2-utilizing COD:VSS ratio	mg COD/mg VSS	1.4200

E.2.3. Physiochemical Parameters

Physiochemical parameters and other general parameters critical to the model are provided in **Table** E-24.

Table E-24. General Parameters

PARAMETER	UNITS	VALUE
Molecular weight of other anions	mg/mmol	35.5000
Molecular weight of other cations	mg/mmol	39.1000
Mg to P mole ratio in polyphosphate	mmol Mg/mmol P	0.3000
Cation to P mole ratio in polyphosphate	meq/mmol P	0.1500
Ca to P mole ratio in polyphosphate	mmol Ca/mmol P	0.0500
Cation to P mole ratio in organic phosphate	meq/mmol P	0.0100
Bubble rise velocity (anaerobic digester)	cm/s	23.9000
Bubble Sauter mean diameter (anaerobic digester)	cm	0.3500
Anaerobic digester gas hold-up factor	-	1.0000
Tank head loss per metre of length (from flow)	m/m	0.0025
Acetoclastic COD:VSS ratio	-	35.5000
H_2-utilizing COD:VSS ratio	-	39.1000

Table E-25. Mass Transfer

PARAMETER	UNITS	VALUE
K_l for H_2	m/d	17.0000
K_l for CO_2	m/d	10.0000
K_l for NH_3	m/d	1.0000
K_l for CH_4	m/d	8.0000
K_l for N_2	m/d	15.0000
K_l for N_2O	m/d	8.0000
K_l for O_2	m/d	13.0000

Table E-26. Henry's Law Constants

PARAMETER	UNITS	VALUE
CO_2	M/atm	0.0340
O_2	M/atm	0.0013
N_2	M/atm	6.500E-4
N_2O	M/atm	0.0250
NH_3	M/atm	58.0000
CH_4	M/atm	0.0014
H_2	M/atm	7.800E-4

Table E-27. Physico-chemical rates

PARAMETER	UNITS	VALUE
Struvite precipitation rate	1/d	3.000E+10
Struvite redissolution rate	1/d	3.000E+11
Struvite half sat.	mg TSS/L	1.0000
HDP precipitation rate	L/(mol P d)	1.000E+8
HDP redissolution rate	L/(mol P d)	1.000E+8
HAP precipitation rate	mol HDP/(L d)	5.000E-4

Table E-28. Physico-chemical constants

PARAMETER	UNITS	VALUE
Struvite solubility constant	mol/L	6.918E-14
HDP solubility product	mol/L	2.750E-22
HDP half sat.	mgTSS/L	1.0000
Equilibrium soluble PO4 with Al dosing at pH 7	mgP/L	0.0100
Al to P ratio	molAl/molP	0.8000
$Al(OH)_3$ solubility product	mol/L	1.259E+9
$AlHPO_4^+$ dissociation constant	mol/L	7.943E-13
Equilibrium soluble PO4 with Fe dosing at pH 7	mgP/L	0.0100
Fe to P ratio	molFe/molP	1.6000
$Fe(OH)_3$ solubility product	mol/L	0.0500
$FeH2PO_4^{++}$ dissociation constant	mol/L	5.012E-22

Table E-29. Aeration Parameters

PARAMETER	UNITS	VALUE
Alpha (surf) OR Alpha F (diff)	-	0.5000
Beta	-	0.9500
Surface pressure	kPa	101.3250
Fractional effective saturation depth (Fed)	-	0.3250
Supply gas CO_2 content	vol. %	0.0350
Supply gas O_2	vol. %	20.9500
Off-gas CO_2	vol. %	2.0000
Off-gas O_2	vol. %	18.8000
Off-gas H_2	vol. %	0
Off-gas NH_3	vol. %	0
Off-gas CH_4	vol. %	0
Surface turbulence factor	-	2.0000
Set point controller gain	-	1.0000

Table E-30. Modified Vesilind Parameters

PARAMETER	UNITS	VALUE
Maximum Vesilind settling velocity (V_o)	ft/min	0.387
Vesilind hindered zone settling parameter (K)	L/g	0.370
Clarification switching function	mg/L	100.000
Specified TSS conc.for height calc.	mg/L	2500.000
Maximum compactability constant	mg/L	15000.000

Table E-31. Double Exponential Parameters

PARAMETER	UNITS	VALUE
Maximum Vesilind settling velocity (V_o)	ft/min	0.934
Maximum (practical) settling velocity (V_o')	ft/min	0.615
Hindered zone settling parameter (K_h)	L/g	0.400
Flocculent zone settling parameter (K_f)	L/g	2.500
Maximum non-settleable TSS	mg/L	20.0000
Non-settleable fraction	-	0.0010
Specified TSS conc. for height calc.	mg/L	2500.0000

Table E-32. Emission Factors

PARAMETER	UNITS	VALUE
Carbon dioxide equivalence of nitrous oxide	-	296.0000
Carbon dioxide equivalence of methane	-	23.0000

Appendix F

Appendix F

INFLUENT FLOW EQUALIZATION ANALYSIS

APPENDIX F –Influent Flow Equalization Analysis

Using the same data set as that used to determine the peak hourly flow factor, the projected hourly flow at design conditions was calculated by multiplying each hour's peaking factor by the projected AADF. The ratio of the hourly flow to the annual average flow for a given year was calculated using these data. These hourly ratios were used to determine the projected hourly influent flow to the proposed Morro Bay WRF for an arbitrary 12-year period where the influent flow pattern is identical to that experienced between 2003 and 2014. An important assumption here is that of *stationarity* – meaning that the influent flow pattern in the future is identical to that experienced in the past. Specifically, that the mean, variance and autocorrelation structure of the time series of flow data does not change in the years to come. There is an ongoing debate in the hydrology and hydroclimatology community regarding the basis of this commonly used assumption. However, in the absence of better predictive data for the proposed Morro Bay WRF, this assumption is considered reasonable here.

The resulting influent flow pattern for the future 12-year period is shown in Figure F-1. Also shown are the basis of design ADF, MMF and PDF for the proposed facility. Inspection of Figure F-1 indicates the occurrence of 1,619 hours when the influent flow exceeds the PDF (i.e., 2.75 mgd). The majority of the exceedances (53%) would occur in the months of December through March. Interestingly however, approximately 20% of the exceedances would occur in July based on the historical data.

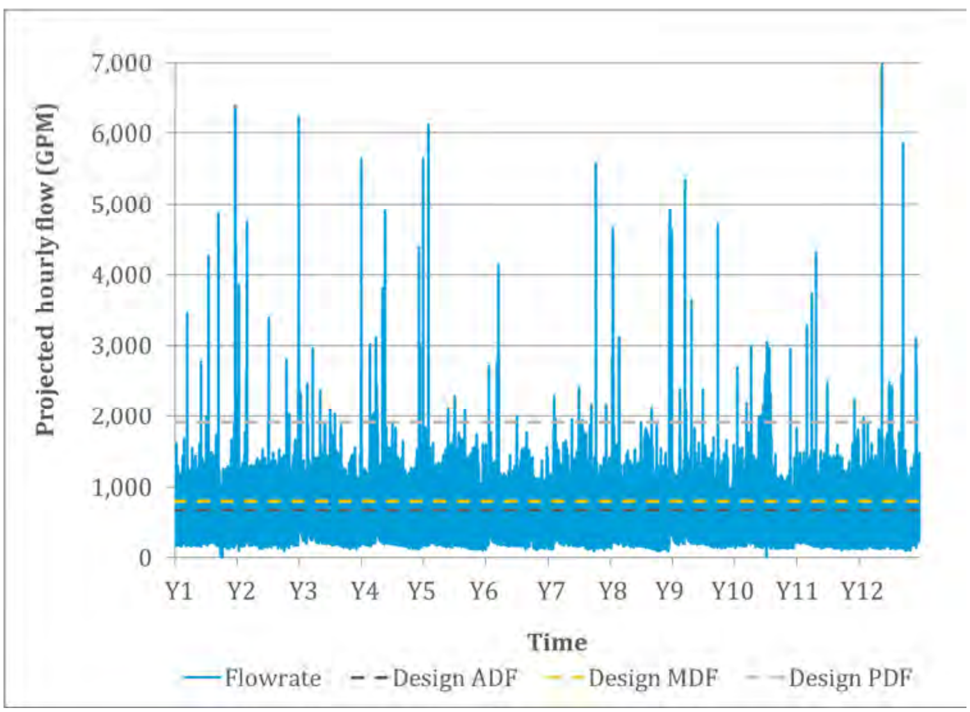

Figure F-1. Projected Hourly Flow

The equalization requirements were determined using these data and application of a simplified equalization tank fill/pump algorithm. Where the influent flow is greater than the PDF of the proposed facility, the difference between the flow and the PDF is directed to the equalization tank. As the flow abates, the equalization tank volume is reduced by pumping the contents to the WRF. The resulting influent volume stored in the proposed equalization tank over the 12-year period is shown in Figure F-2 and a summary of the required storage volume for the five most significant events (in descending order) is shown in Table F-1. This analysis suggests that an influent equalization volume of 3.2 million gallons is required, assuming a safety factor of 1.15.

This high volume requirement is not specifically a result of the high flow rates resulting from rain events. Rather, the duration of the rain/high flow events. As shown in Figures F-3 to F-7, events such as those experienced in the past result in high flows into the plant for as long as six days.

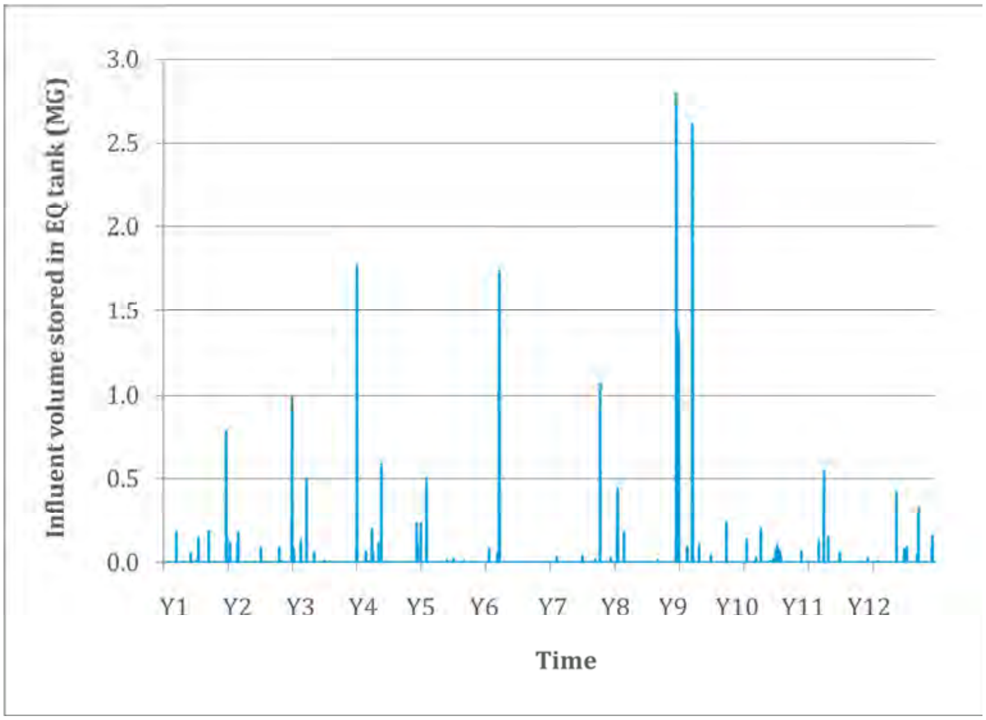

Figure F-2. Storage Volume Required in Equalization Tank

Table F-1. Design Storage Capacity at Buildout, Based on Historical Events

EVENT LABEL	BASED ON EVENT	DESIGN STORAGE CAPACITY (MG)
1	Dec. 18-23, 2010	3.3
2	March 19-24, 2011	3.0
3	Jan. 2-4, 2011	1.6
4	Jan. 1-4, 2006	2.1
5	March 13-14, 2009	1.3

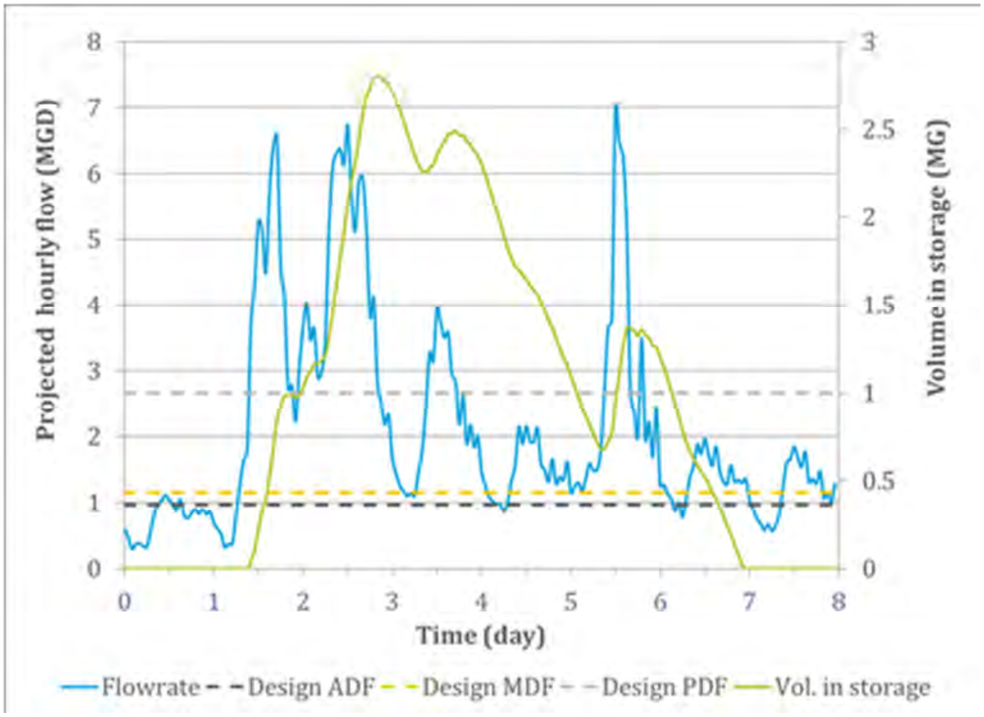

Figure F-3. Projected hourly flow and required equalization basin storage volume required at design flows, based on rain event from Dec. 2010.

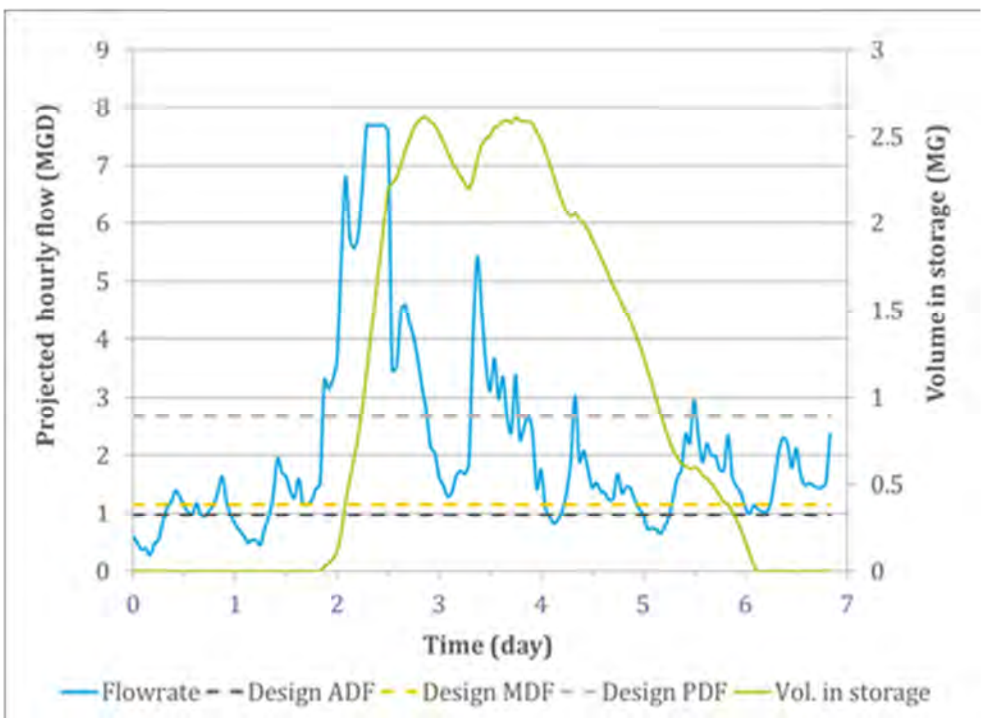

Figure F-4. Projected hourly flow and required equalization basin storage volume required at design flows, based on rain event from March 2011.

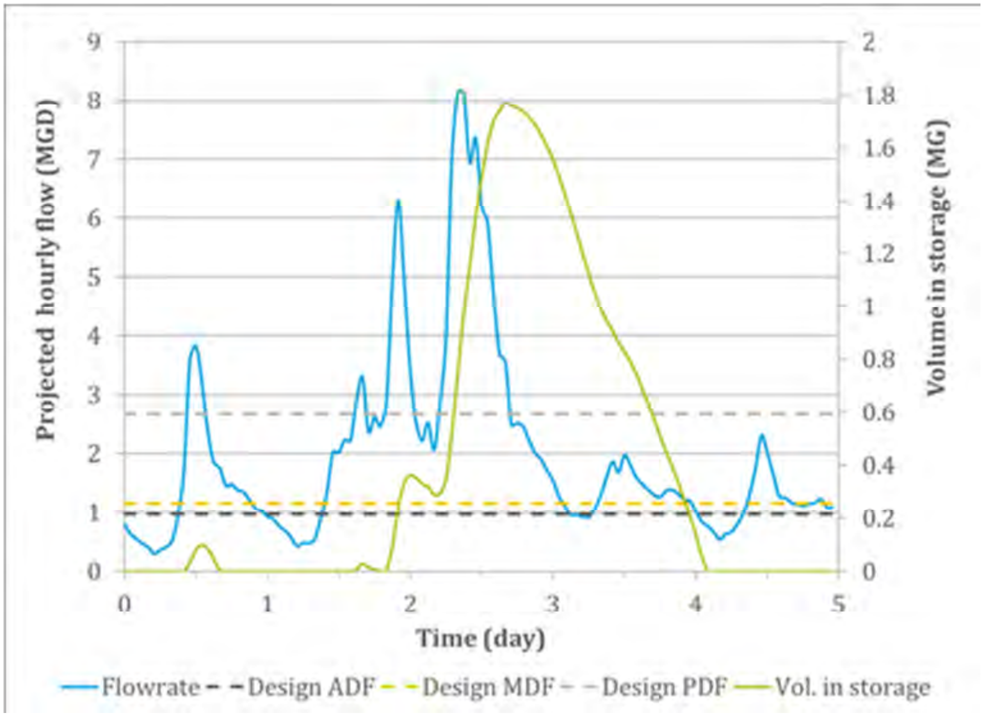

Figure F-5. Projected hourly flow and required equalization basin storage volume required at design flows, based on rain event from Jan. 2011.

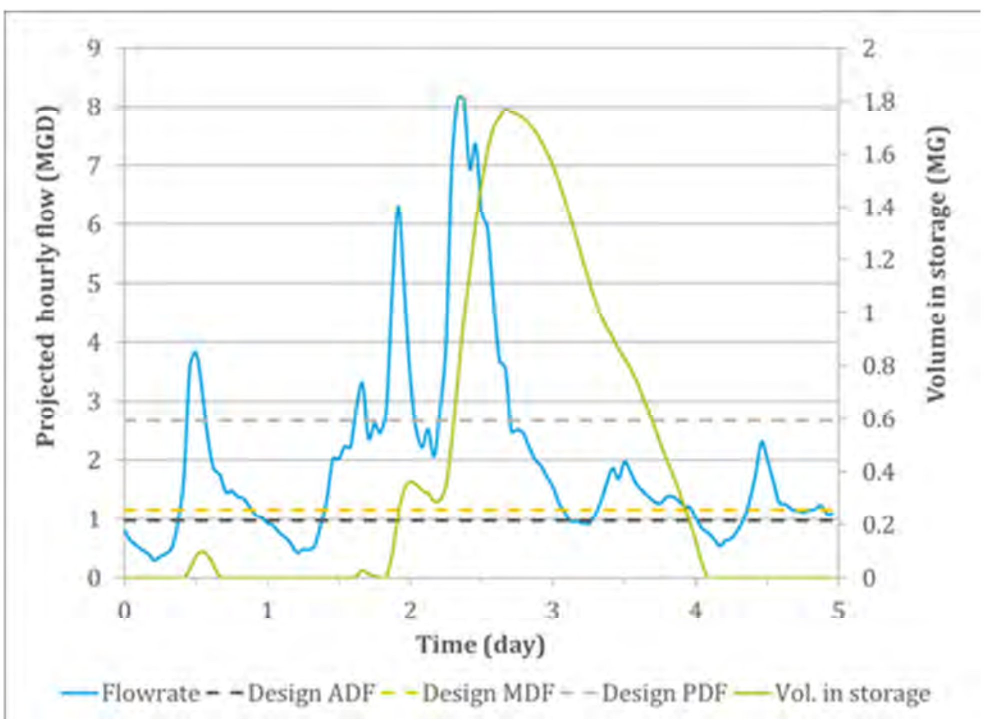

Figure F-6. Projected hourly flow and required equalization basin storage volume required at design flows, based on rain event from Jan. 2006.

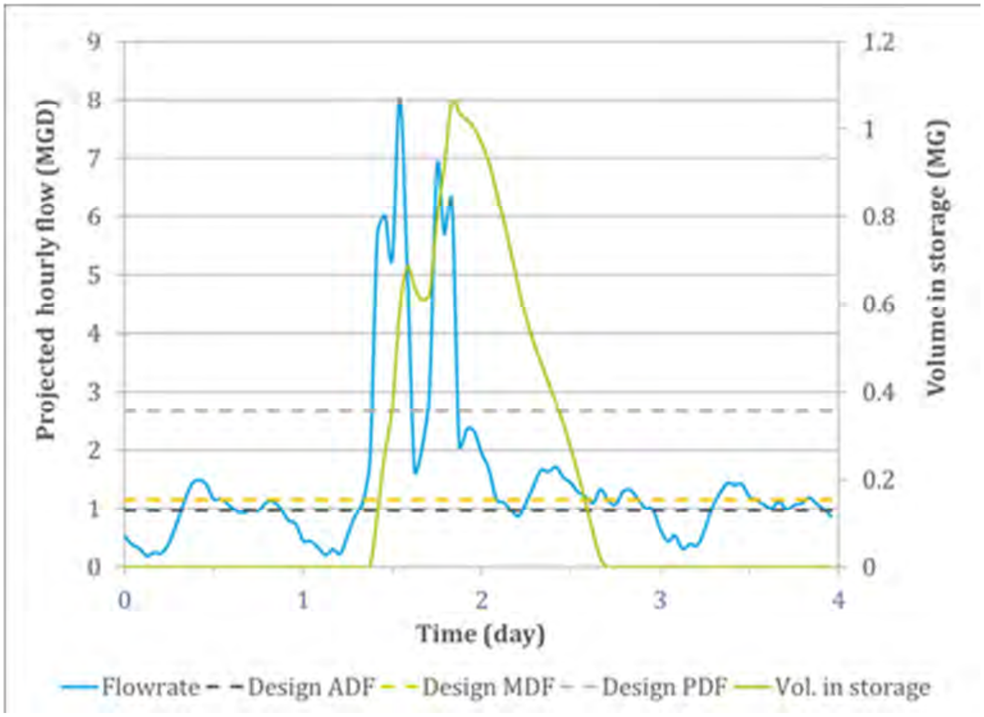

Figure F-7. Projected hourly flow and required equalization basin storage volume required at design flows, based on rain event from March 2009.

Appendix G

Appendix G

EQUIPMENT OVERVIEW

Equipment Inventory and Disposition

DWG	Structure	Equipment	Discard	Salvage	Reuse	Weight (lbs)
M 101	Administration Building	HVAC Equipment		X		4000
		Plumbing Equipment	X	X		250
		Laboratory Equipment			X	610
		Emergency Eye Wash and Shower	X			40
		Emergency Generator	X			3000
		Motor Operated Louver	X			10
		Pumps		X		50
M 201	Headworks Building	Mechanically Cleaned Bar Screen		X		4000
		Jib Crane and Hoist		X		2250
		Sluice Gates		X		3600
		Influent Pumps		X		9000
		Sump Pumps		X		300
		Grit Pumps		X		400
		Aeration Air Blower		X		2200
		Grit Separators	X			2500
		Grit Dewaterer	X			2500
		Roll-Off Grit Containers	X			7500
		HVAC Equipment		X		400
M 301	Primary Sedimentation Tanks	Sludge and Scum Collectors	X			1000
		Sludge Pumps		X		400
		Sludge/Scum Flow Meter	X			20
		Scum Pumps		X		200
M 451	Biofilter Pumping Station	Biofilter Circulation Pumps		X		6000
		Biofilter Effluent Pumps		X		5000
		Sluice Gates		X		2400
		MCC HVAC Equipment		X		400
	Biofilters	No equipment identified				-
M 601	Secondary Sedimentation Tank	Agitation Air Blowers		X		2600
		Sludge Collector	X			1000
		RAS Pumps		X		400
		RAS Flow Meter	X			100
		WAS Pumps		X		400
		WAS Flowmeter	X			100
		Secondary Scum Pumps		X		200
		Scum Skimmer	X			1000
M 701	Chlorine Building	Chlorinators and Gas Flow Indicators	X			-
		RAS Injector and Flowmeter	X			100
		Chlorine Gas Filters	X			-
		Chlorine PRVs	X			-
		Chlorine Gas Detector	X			-
		Emergency Eye Wash and Shower		X		50
		HVAC Equipment		X		200
		Chlorine Cylinder Crane and Accessories		X		100
		Chlorine Cylinder Scales and Accessories	X			-
		Chlorine Expansion Tanks	X			-
M 751	Chlorine Contact Tank	Chlorine Residual Analyzer	X			-
		Sulfur Dioxide Injector	X			-
		Telescoping Skimming Valves		X		200
		3W Pumps		X		400
		Flowmeters	X			-
		Flash Mixer	X			-
		Sluice Gates		X		2400
		Strainers	X			-
		Post/3W Chlorinator Injector	X			-
		Backwash Control Valve	X			-

M 801	Digesters	Sludge Circ Pumps		X		600
		Hot Water Circ Pumps		X		600
		Primary Sludge/Primary Scum Control Valve	X			-
		Gas Circ Blowers	X			-
		Gas Induction Assemblies	X			-
		Sludge Heat Exchangers	X			-
		Flowmeters	X			-
		Control Valves	X			-
		Digester Floating Cover	X			-
M 901	Mechanical Building	Crane		X		2000
		Roll Up Door		X		500
		Drinking Fountain		X		10
		Water Heater		X		200
		HVAC Equipment		X		4000
		Boilers		X		4000
		Blowdown Tank	X			-
		Chemical Ball Feeder	X			-
		Water Softener		X		100
		Backflow Preventer Valve	X			-
		Hot Water Circ Pumps		X		80
		Heat Reservoir Expansion Tank	X			-

Notes:

1. Items identified as "discard" are assumed to not be saleable or reusable due to the fact that the equipment is customized for a specific performance or that the equipment is old.
2. Items identified as "salvage" are assumed to have resale value.
3. Items identified as "reuse" are assumed to be in good enough condition to be used at the new WRF.

Appendix H

Appendix H

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST (MB ONLY)

Morro Bay 10% Conceptual Cost Estimate

Summary Report

SBR Option - Phase 1

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	**1,023,157**
1020 Yard Piping	**1,988,170**
1030 Yard Electrical	**1,141,279**
1040 Headworks	**3,171,926**
1050 Odor Control - #1 - Headworks and SBR	**709,787**
1070 Equalization Basin	**7,938,089**
1080 Sequence Batch Reactor Basin (SBR)	**6,936,934**
1090 Dewatering Building	**3,429,739**
1100 Odor Control - #2 - Dewatering Bldg	**632,387**
1110 Sludge Storage Tank Area	**713,530**
1120 Standby/Emergency Power	**638,576**
1130 Secondary Equalization Tank	**404,785**
1140 Electrical Building	**1,703,183**
1170 Chemical/Clean In Place Chemical Storage	**2,566,650**
1180 Septage Receiving Station	**432,027**
1200 Remote Operations Building	**374,946**
1.1.00 WRF On-Site Facilities	**33,805,165**
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	**1,581,755**
5020 Administration/Operations Facility	**4,474,875**
5050 Sitework	**1,432,220**
5060 Yard Piping	**440,870**
5070 Yard Electrical	**370,493**
1.1.10 Water/Wastewater Operations Facilities	**8,300,213**
1.1.20 Access Road to WWOF Area	
1010 Sitework	**169,494**
1020 Yard Piping	**85,189**
1.1.20 Access Road to WWOF Area	**254,684**
1.1.50 MF/UV Facility	
1150 Microfiltration, Reverse Osmosis, UV Building	**6,972,807**
1.1.50 MF/UV Facility	**6,972,807**
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	**648,030**
1.1.60 Fire Pump Building	**648,030**
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	**481,155**
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	**2,010,840**
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	**6,747,934**
1.2.00 Conveyance and Offsite Facilities	**9,239,930**
01 Phase 1	**59,220,828**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	13,667,110			11.52%	
Material	35,864,997			30.24%	
Subcontract	7,403,110			6.24%	
Equipment	2,085,420			1.76%	
Other	200,191			0.17%	
	59,220,828	**59,220,828 USD**		**49.93**	**49.93%**
SubMU (60% directs at 20%)	7,106,499		12.000 %	5.99%	
	7,106,499	**66,327,327 USD**		**5.99**	**55.92%**
Subcontractor Bond	994,910		1.500 %	0.84%	
	994,910	**67,322,237 USD**		**0.84**	**56.76%**
General Conditions	6,732,224		10.000 %	5.68%	
	6,732,224	**74,054,461 USD**		**5.68**	**62.43%**
Building Permits	740,545		1.000 %	0.62%	
Sales Tax	2,869,200		8.000 %	2.42%	
	3,609,745	**77,664,206 USD**		**3.04**	**65.47%**
Builders Risk Insurance	155,328		0.200 %	0.13%	
Gen Liability Insurance	776,642		1.000 %	0.65%	
GC Bonds	1,164,963		1.500 %	0.98%	
	2,096,933	**79,761,139 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**79,761,139 USD**			**67.24%**
Contractor Total OH&P	6,380,891		8.000 %	5.38%	
	6,380,891	**86,142,030 USD**		**5.38**	**72.62%**
Construction Contingency	21,535,507		25.000 %	18.16%	
	21,535,507	**107,677,537 USD**		**18.16**	**90.78%**
Engineering & Design	8,614,203		8.000 %	7.26%	
	8,614,203	**116,291,740 USD**		**7.26**	**98.04%**
Escalation	2,325,835		2.000 %	1.96%	
	2,325,835	**118,617,575 USD**		**1.96**	**100.00%**
Total		***118,617,575 USD***			

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	
1150001002.01001 Site Paving - Roads and C&G - WRF	**451,290**
1150001002.02001 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WRF	**541,240**
1150001002.03001 Site Retaining Walls - WRF	**30,627**
1010 Sitework	**1,023,157**
1020 Yard Piping	
1150002002.01001 Yard Piping - Utilties - WRF	**449,438**
1150002002.02001 Yard Piping - Process	**1,538,732**
1020 Yard Piping	**1,988,170**
1030 Yard Electrical	
1150002002.03001 Yard Electrical	**1,141,279**
1030 Yard Electrical	**1,141,279**
1040 Headworks	
1170001002.01001 Facility Excavation & Backfill - Headworks	**145,138**
1170001003.01100 Concrete Ftg - Backwall/Retaining Wall Under SOG - Headworks	**36,334**
1170001003.01200 Concrete SOG - 2' - Headworks	**110,273**
1170001003.01300 Concrete Walls - 2' - Headworks	**128,513**
1170001003.01400 Concrete Interior Misc - Headworks - Allowance	**86,876**
1170001004.01001 Exterior Masonry Walls - Headworks	**94,750**
1170001005.01001 Metals - Headworks	**228,382**
1170001006.01001 FRP - Headworks	**70,341**
1170001007.01001 Dampproofing - Headworks	**3,189**
1170001007.02001 Roofing - Headworks	**17,500**
1170001008.01001 Openings - Headworks	**27,369**
1170001009.01001 Finishes - Headworks	**95,850**
1170001011.01001 Process Equipment - Headworks	**856,376**
1170001014.01001 Conveying Equipment - Hoisting - Headworks	**200,000**
1170001015.01100 Mechanical - Process Piping - Headworks	**589,008**
1170001015.01200 Mechanical - Plumbing Piping - Headworks	**55,881**
1170001015.01300 Mechanical - HVAC - Headworks	**210,000**
1170001016.01001 Electrical & I&C - Headworks	**216,149**
1040 Headworks	**3,171,926**
1050 Odor Control - #1 - Headworks and SBR	
1170001002.02001 Facility Excavation & Backfill - Odor Control	**5,840**
1170001003.02200 Concrete SOG - Odor Control Pad - 2'	**55,769**
1170001003.02400 Concrete Interior Misc - Odor Control #1 - Allowance	**13,400**
1170001005.02001 Metals - Odor Control #1	**17,363**
1170001009.02001 Finishes - Odor Control	**8,485**
1170001011.02001 Process Equipment - Odor Control	**257,924**
1170001015.02100 Mechanical - Process Piping/Ductwork - Odor Control	**260,705**
1170001015.02200 Mechanical - Plumbing Piping - Odor Control	**13,700**
1170001016.02001 Electrical & I&C - Odor Control	**76,601**
1050 Odor Control - #1 - Headworks and SBR	**709,787**
1070 Equalization Basin	
1170001002.03001 Facility Excavation & Backfill - EQ Basin	**764,768**
1170001003.03100 Concrete Ftg - Backwall/Retaining Wall Under SOG - EQ Basin	**298,774**
1170001003.03200 Concrete SOG/Tank Bottom - 3' - EQ Basin	**1,055,915**
1170001003.03300 Concrete Wall - Back/Ret Wall 3' - EQ Basin	**425,170**

Spreadsheet Level	Total Amount
1170001003.03310 Concrete Wall - Exterior Walls 2' - EQ Basin	488,724
1170001003.03320 Concrete Wall - Interior Walls 2' - EQ Basin	638,489
1170001003.03330 Elevated Concrete Deck - EQ Basin - 1'	683,778
1170001003.03400 Concrete Interior Misc - EQ Basin - Allowance	22,375
1170001005.03001 Metals - EQ Basin	82,988
1170001006.03001 FRP - EQ Basin	26,061
1170001007.03001 Dampproofing - EQ Basin	8,957
1170001008.03001 Openings - EQ Basin	25,644
1170001009.03001 Finishes - EQ Basin	1,300,480
1170001011.03001 Process Equipment - EQ Basin	988,368
1170001015.03100 Mechanical - Process Piping - EQ Basin	615,709
1170001015.03200 Mechanical - Plumbing Piping - EQ Basin	13,700
1170001015.03300 Mechanical - HVAC - EQ Basin	41,000
1170001016.03001 Electrical & I&C - EQ Basin	457,189
1070 Equalization Basin	7,938,089
1080 Sequence Batch Reactor Basin (SBR)	
1170001002.04001 Facility Excavation & Backfill - SBR	395,082
1170001003.04100 Concrete Ftg - Backwall/Retaining Wall Under SOG - SBR	150,858
1170001003.04200 Concrete SOG/Tank Bottom - 3' - SBR	616,273
1170001003.04300 Concrete Wall - Back/Ret Wall 3' - SBR	278,782
1170001003.04310 Concrete Wall - Exterior Walls 2' - SBR	381,282
1170001003.04320 Concrete Wall - Interior Walls 2' - SBR	294,461
1170001003.04330 Elevated Concrete Deck - SBR - 1'	473,598
1170001003.04400 Concrete Interior Misc - SBR - Allowance	22,375
1170001005.04001 Metals - SBR	82,988
1170001006.04001 FRP - SBR	14,280
1170001007.04001 Dampproofing - SBR	6,485
1170001008.04001 Openings - SBR	8,928
1170001009.04001 Finishes - SBR	836,657
1170001011.04001 Process Equipment - SBR	1,470,111
1170001015.04100 Mechanical - Process Piping - SBR	853,110
1170001016.04001 Electrical & I&C - SBR	1,051,663
1080 Sequence Batch Reactor Basin (SBR)	6,936,934
1090 Dewatering Building	
1170001002.05001 Facility Excavation & Backfill - Dewatering Bldg	8,527
1170001003.05200 Concrete SOG - 2' - Dewatering Bldg	119,427
1170001003.05400 Concrete Interior Misc - Dewatering Bldg - Allowance	69,500
1170001004.05001 Exterior Masonry Walls - Dewatering Bldg	141,712
1170001005.05001 Metals - Dewatering Bldg	216,035
1170001007.05001 Roofing - Dewatering Bldg	19,270
1170001008.05001 Openings - Dewatering Bldg	40,327
1170001009.05001 Finishes - Dewatering Bldg	32,350
1170001011.05001 Process Equipment - Dewatering Bldg	1,476,018
1170001014.05001 Conveying Equipment - Hoisting - Dewatering Bldg	200,000
1170001015.05100 Mechanical - Process Piping - Dewatering Bldg	666,608
1170001015.05200 Mechanical - Plumbing Piping - Dewatering Bldg	27,181
1170001015.05300 Mechanical - HVAC - Dewatering Bldg	154,160
1170001015.05400 Mechanical - Fire Protection - Dewatering Bldg	13,489
1170001016.05001 Electrical & I&C - Dewatering Bldg	245,135
1090 Dewatering Building	3,429,739
1100 Odor Control - #2 - Dewatering Bldg	

Spreadsheet Level	Total Amount
1170001002.28001 Facility Excavation & Backfill - Odor Control #2	5,840
1170001003.28200 Concrete SOG - Odor Control #2 Pad - 2'	55,769
1170001003.28400 Concrete Interior Misc - Odor Control #2 - Allowance	13,400
1170001005.28001 Metals - Odor Control #2	17,363
1170001009.28001 Finishes - Odor Control #2	8,485
1170001011.28001 Process Equipment - Odor Control #2	257,924
1170001015.28100 Mechanical - Process Piping/Ductwork - Odor Control #2	183,304
1170001015.28200 Mechanical - Plumbing Piping - Odor Control #2	13,700
1170001016.28001 Electrical & I&C - Odor Control #2	76,601
1100 Odor Control - #2 - Dewatering Bldg	632,387
1110 Sludge Storage Tank Area	
1170001002.06001 Facility Excavation & Backfill - Sludge Storage Tank Area	6,841
1170001003.06201 Concrete Tank Pad - 3' - Sludge Storage Tank Area	65,663
1170001003.06400 Concrete Interior Misc - Sludge Storage - Allowance	12,400
1170001009.06001 Finishes - Sludge Storage	3,950
1170001011.06001 Process Equipment - Sludge Storage	106,339
1170001013.06100 Storage Tank - Bolted Steel Glass-Lined - Sludge Storage Tank	420,000
1170001015.06100 Mechanical - Process Piping - Sludge Storage	54,802
1170001015.06200 Mechanical - Plumbing Piping - Sludge Storage	5,980
1170001016.06001 Electrical & I&C - Sludge Storage	37,554
1110 Sludge Storage Tank Area	713,530
1120 Standby/Emergency Power	
1170001002.07001 Facility Excavation & Backfill - S/E Generator	2,841
1170001003.07200 Concrete PAD - 3' - S/E Generator	52,147
1170001005.07001 Metals - S/E Generator	13,432
1170001009.07001 Finishes - S/E Generator	5,000
1170001016.07001 Electrical & I&C - S/E Generator	565,155
1120 Standby/Emergency Power	638,576
1130 Secondary Equalization Tank	
1170001002.09001 Facility Excavation & Backfill - 2nd EQ Tank	6,841
1170001003.09200 Concrete Tank Pad - 3' - 2nd EQ Tank	65,663
1170001003.09400 Concrete Exterior Misc - 2nd EQ Tank - Allowance	12,400
1170001009.09001 Finishes - 2nd EQ Tank	1,685
1170001013.09100 Storage Tank - Bolted Steel Glass-Lined - 2nd EQ Tank	270,000
1170001015.09100 Mechanical - Process Piping - 2nd EQ Tank	27,401
1170001015.09200 Mechanical - Plumbing Piping - 2nd EQ Tank	5,980
1170001016.09001 Electrical & I&C - 2nd EQ Tank	14,815
1130 Secondary Equalization Tank	404,785
1140 Electrical Building	
1170001002.08001 Facility Excavation & Backfill - Electrical Bldg	4,636
1170001003.08200 Concrete SOG - 2' - Electrical Bldg	57,671
1170001003.08400 Concrete Interior Misc - Electrical Bldg - Allowance	13,400
1170001004.08001 Exterior Masonry Walls - Electrical Bldg	101,066
1170001005.08001 Metals - Electrical Bldg	49,254
1170001007.08001 Roofing - Electrical Bldg	9,300
1170001008.08001 Openings - Electrical Bldg	17,599
1170001009.08001 Finishes - Electrical Bldg	5,000
1170001015.08300 Mechanical - HVAC - Electrical Bldg	93,000
1170001016.08001 Electrical & I&C - Electrical Bldg	1,352,257
1140 Electrical Building	1,703,183
1170 Chemical/Clean In Place Chemical Storage	

Spreadsheet Level	Total Amount
1170001002.13001 Facility Excavation & Backfill - Chemical Storage	14,072
1170001003.13200 Concrete SOG - 2' - Chem Storage	172,576
1170001003.13600 Concrete Containment Walls - 1' - Chem Storage	154,870
1170001006.13001 FRP - Chem Storage	187,121
1170001009.13001 Finishes - Chem Storage	362,821
1170001011.13001 Process Equipment - Chem Storage	380,092
1170001013.13001 PEMB - Canopy - Chem Storage	168,000
1170001013.13100 Storage Tanks - Chem Storage	484,802
1170001015.13100 Mechanical - Process Piping - Chem Storage	394,207
1170001015.13200 Mechanical - Plumbing Piping - Chem Storage	45,440
1170001016.13001 Electrical & I&C - Chem Storage	202,649
1170 Chemical/Clean In Place Chemical Storage	2,566,650
1180 Septage Receiving Station	
1170001002.14100 Facility Excavation & Backfill - SRS	443
1170001003.14200 Concrete SOG/Pad - 1' - SRS	3,563
1170001003.14400 Concrete Exterior Misc - SRS - Allowance	7,925
1170001005.14001 Metals - SRS	9,932
1170001009.14001 Finishes - SRS	7,250
1170001011.14001 Process Equipment - SRS	231,697
1170001015.14100 Mechanical - Process Piping - SRS	107,203
1170001015.14200 Mechanical - Plumbing Piping - SRS	11,960
1170001016.14001 Electrical & I&C - SRS	52,054
1180 Septage Receiving Station	432,027
1200 Remote Operations Building	
1170001002.12001 Facility Excavation & Backfill - Ops Bldg	4,330
1170001003.12200 Concrete SOG - 2' - Ops Bldg	31,619
1170001005.12001 Metals - Ops Bldg	19,863
1170001008.12001 Openings - Ops Bldg	35,324
1170001009.12001 Finishes - Ops Bldg	35,000
1170001010.12001 Specialties - Ops Bldg	6,547
1170001012.12001 Furnishings - Ops Bldg	31,187
1170001013.12100 PEMB - Remote Ops Bldg	28,000
1170001015.12200 Mechanical - Plumbing Piping - Ops Bldg	20,440
1170001015.12300 Mechanical - HVAC - Ops Bldg	50,000
1170001015.12400 Mechanical - Fire Protection - Ops Bldg	8,500
1170001016.12001 Electrical & I&C - Ops Bldg	104,135
1200 Remote Operations Building	374,946
1.1.00 WRF On-Site Facilities	33,805,165
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	
1170001002.31001 Facility Excavation & Backfill - Maintenance Facility	21,123
1170001003.31200 Concrete SOG - 2' - Maint Facility	108,849
1170001003.31400 Concrete Interior Misc - Maint Facility - Allowance	20,900
1170001004.31001 Exterior Masonry Walls - Maintenance Facility	205,977
1170001005.31001 Metals - Maintenance Facility	260,537
1170001006.31001 FRP - Maintenance Facility	16,780
1170001007.31100 Roofing - Maintenance Facility	60,000
1170001008.31001 Openings - Maintenance Facility	65,830
1170001009.31001 Finishes - Maintenance Facility	110,209
1170001014.31001 Conveying Equipment - Hoisting - Maintenance Facility	200,000

Spreadsheet Level	Total Amount
1170001015.31200 Mechanical - Plumbing Piping - Maint. Facility	55,881
1170001015.31300 Mechanical - HVAC - Maintenance Facility	210,000
1170001016.31001 Electrical & I&C - Maintenance Facility	245,669
5010 Maintenance Facility	1,581,755
5020 Administration/Operations Facility	
1170001002.32001 Facility Excavation & Backfill - Admin/Ops Facility	71,032
1170001003.32200 Concrete SOG - 2' - Admin/Ops Facility	351,993
1170001004.32001 Exterior Masonry Walls - Admin/Ops Facility	384,491
1170001005.32001 Metals - Admin/Ops Facility	642,134
1170001007.32001 Roofing - Admin/Ops Facility	213,975
1170001008.32001 Openings - Admin/Ops Facility	193,847
1170001009.32001 Finishes - Admin/Ops Facility	551,525
1170001010.32001 Specialties - Admin/Ops Facility	62,734
1170001012.32001 Furnishings - Admin/Ops Facility	471,654
1170001015.32200 Mechanical - Plumbing Piping - Admin/Ops Facility	80,881
1170001015.32300 Mechanical - HVAC - Admin/Ops Facility	692,700
1170001015.32400 Mechanical - Fire Protection - Admin/Ops Facility	98,133
1170001016.32001 Electrical & I&C - Admin/Ops Facility	659,777
5020 Administration/Operations Facility	4,474,875
5050 Sitework	
1150001002.01005 Site Paving - Roads - WWOF	96,130
1150001002.01007 Site Paving - Interior - WWOF	154,426
1150001002.02005 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WWOF	1,056,733
1150001002.03005 Site Retaining Walls - WWOF	124,930
5050 Sitework	1,432,220
5060 Yard Piping	
1150002002.01005 Yard Piping - Utilities - WWOF Road	98,321
1150002002.01008 Yard Piping - Utilities - WWOF - Interior for Admin/Maint Facilit	342,549
5060 Yard Piping	440,870
5070 Yard Electrical	
1150002002.03011 Yard Electrical - Interior WWOF	370,493
5070 Yard Electrical	370,493
1.1.10 Water/Wastewater Operations Facilities	8,300,213
1.1.20 Access Road to WWOF Area	
1010 Sitework	
1150001002.01011 Site Paving - Roads - Access Road	99,084
1150001002.02011 Earthwork - Site Excavation Cut/Fill (NOA Soils) - Access Rd	70,410
1010 Sitework	169,494
1020 Yard Piping	
1150002002.01011 Yard Piping - Utilities - Access Road	85,189
1020 Yard Piping	85,189
1.1.20 Access Road to WWOF Area	254,684
1.1.50 MF/UV Facility	
1150 Microfiltration, Reverse Osmosis, UV Building	
1170001002.10001 Facility Excavation & Backfill - MF/UV	14,310
1170001003.10200 Concrete SOG - 2' - MF/UV	223,029
1170001003.10400 Concrete Interior Misc - MF/UV - Allowance	86,876
1170001003.10700 Concrete SOMD - 6" - MF/UV	57,757
1170001004.10001 Exterior Masonry Walls - MF/UV	337,803
1170001005.10001 Metals - MF/UV	738,235

Spreadsheet Level	Total Amount
1170001006.10001 FRP - MF/UV	33,561
1170001007.10001 Roofing - MF/UV	33,620
1170001008.10001 Openings - MF/UV	39,792
1170001009.10001 Finishes - MF/UV	64,300
1170001010.10001 Specialties - MF/UV	9,593
1170001011.10001 Process Equipment - MF/UV	1,538,109
1170001012.10001 Furnishings - MF/UV	4,047
1170001015.10100 Mechanical - Process Piping - MF/UV	1,111,409
1170001015.10200 Mechanical - Plumbing Piping - MF/UV	77,203
1170001015.10300 Mechanical - HVAC - MF/UV	537,920
1170001015.10400 Mechanical - Fire Protection - MF/UV	47,068
1170001016.10001 Electrical & I&C - MF/UV	2,018,176
1150 Microfiltration, Reverse Osmosis, UV Building	6,972,807
1.1.50 MF/UV Facility	6,972,807
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	
1170001002.16001 Facility Excavation & Backfill - Fire Pump Bldg	726
1170001003.16200 Concrete SOG - 1' - Fire Pump Bldg	4,276
1170001003.16400 Concrete Interior Misc - Fire Pump Bldg - Allowance	12,950
1170001004.16001 Exterior Masonry Walls - Fire Pump Bldg	24,717
1170001005.16001 Metals - Fire Pump Bldg	27,860
1170001007.16001 Roofing - Fire Pump Bldg	1,125
1170001008.16001 Openings - Fire Pump Bldg	18,948
1170001009.16001 Finishes - Fire Pump Bldg	10,900
1170001015.16100 Mechanical - Process Piping - Fire Pump Bldg	62,401
1170001015.16200 Mechanical - Plumbing Piping - Fire Pump Bldg	14,960
1170001015.16300 Mechanical - HVAC - Fire Pump Bldg	10,125
1170001015.16400 Mechanical - Fire Protection - Fire Pump Bldg	354,960
1170001016.16001 Electrical & I&C - Fire Pump Bldg	104,081
1210 Fire Pump Facility	648,030
1.1.60 Fire Pump Building	648,030
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	
1170001002.15001 Facility Excavation & Backfill - Brine PS	5,497
1170001003.15200 Concrete SOG/Pad - 1' - Brine PS	45,504
1170001005.15001 Metals - Brine PS	9,932
1170001009.15001 Finishes - Brine PS	7,250
1170001011.15001 Process Equipment - Brine PS	185,849
1170001015.15100 Mechanical - Process Piping - Brine PS	162,103
1170001015.15200 Mechanical - Plumbing Piping - Brine PS	11,960
1170001016.15001 Electrical & I&C - Brine PS	53,061
1165 Brine Pump Station (Adjacent to Eff PS)	481,155
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	
1150002002.20001 Yard Piping - Utilties - Lift Station	57,300
1170001002.20001 Site Demo - New Lift Station Area	93,425
1170001002.20011 Automatic Swing Gate - New Lift Station Area	8,500
1170001002.21001 Facility Excavation & Backfill - Wet Well/Lift Station	274,899
1170001003.20200 WetWell SOG - 2' - Lift Station	17,299
1170001003.20300 WetWell Walls - 1.5' - Lift Station	92,971
1170001003.20400 WetWell Elev Slab/Lid - 1.5' - Lift Station	39,794

Spreadsheet Level	Total Amount
1170001003.20500 Concrete Interior Misc - Lift Station - Allowance	69,500
1170001003.21200 Concrete SOG/Pad - 8" - Lift Station	112,793
1170001004.21001 Exterior Masonry Walls - Control Bldg	18,675
1170001004.21011 Exterior Masonry Walls - Perimeter Wall	98,869
1170001005.20001 Metals - Lift Station	66,315
1170001007.20001 Dampproofing - Wet Well	2,658
1170001007.21001 Roofing - Lift Station/Control Bldg	5,250
1170001008.20001 Openings - Lift Station	16,716
1170001009.20001 Finishes - Lift Station & Wet Well	65,609
1170001010.20001 Specialties - Lift Station/Control Bldg	1,119
1170001011.20001 Process Equipment - Lift Station	560,471
1170001012.21001 Furnishings - Lift Station/Control Bldg	1,273
1170001015.20100 Mechanical - Process Piping - Lift Station	87,203
1170001015.20200 Mechanical - Plumbing Piping - Lift Station/Control Bldg	17,200
1170001015.20300 Mechanical - HVAC - Lift Station/Control Bldg	9,800
1170001016.20001 Electrical & I&C - Lift Station	293,203
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	2,010,840
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	
1150001502.01001 Force Main & Brine Pipeline - Open Area	562,290
1150001502.02001 Force Main & Brine Pipeline - Open Area/Sidewalk/Path	74,094
1150001502.03001 Force Main & Brine Pipeline - Open Area with Trees	1,005,577
1150001502.04001 Force Main & Brine Pipeline - Road/City Installation	4,414,824
1150001502.04011 Force Main Pipeline - Road/City Installation - At Lift Station	29,354
1150001502.04021 Brine Pipeline - Road/City Installation - To Outfall Structure	138,498
1150001502.05001 Force Main & Brine Pipeline - Jack & Bore Locations	523,297
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	6,747,934
1.2.00 Conveyance and Offsite Facilities	9,239,930
01 Phase 1	**59,220,828**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	13,667,110			11.52%	
Material	35,864,997			30.24%	
Subcontract	7,403,110			6.24%	
Equipment	2,085,420			1.76%	
Other	200,191			0.17%	
	59,220,828	**59,220,828 USD**		**49.93**	**49.93%**
SubMU (60% directs at 20%)	7,106,499		12.000 %	5.99%	
	7,106,499	**66,327,327 USD**		**5.99**	**55.92%**
Subcontractor Bond	994,910		1.500 %	0.84%	
	994,910	**67,322,237 USD**		**0.84**	**56.76%**
General Conditions	6,732,224		10.000 %	5.68%	
	6,732,224	**74,054,461 USD**		**5.68**	**62.43%**
Building Permits	740,545		1.000 %	0.62%	
Sales Tax	2,869,200		8.000 %	2.42%	
	3,609,745	**77,664,206 USD**		**3.04**	**65.47%**
Builders Risk Insurance	155,328		0.200 %	0.13%	
Gen Liability Insurance	776,642		1.000 %	0.65%	
GC Bonds	1,164,963		1.500 %	0.98%	
	2,096,933	**79,761,139 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**79,761,139 USD**			**67.24%**
Contractor Total OH&P	6,380,891		8.000 %	5.38%	
	6,380,891	**86,142,030 USD**		**5.38**	**72.62%**
Construction Contingency	21,535,507		25.000 %	18.16%	
	21,535,507	**107,677,537 USD**		**18.16**	**90.78%**
Engineering & Design	8,614,203		8.000 %	7.26%	
	8,614,203	**116,291,740 USD**		**7.26**	**98.04%**
Escalation	2,325,835		2.000 %	1.96%	
	2,325,835	**118,617,575 USD**		**1.96**	**100.00%**
Total		***118,617,575 USD***			

Morro Bay 10% Conceptual Cost Estimate

Summary Report

SBR Option - Phase 2

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	
1150 Microfiltration, Reverse Osmosis, UV Building	**5,562,953**
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	**5,562,953**
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	**481,155**
3030 Recycle Pipeline from WRF to South of Hwy - 16"	**1,105,441**
1.2.10 Recycle Water Pump Station & Pipeline	**1,586,596**
02 Phase 2	**7,149,550**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	829,121			5.71%	
Material	6,045,191			41.61%	
Subcontract	166,402			1.15%	
Equipment	87,373			0.60%	
Other	21,462			0.15%	
	7,149,549	**7,149,549 USD**		**49.21**	**49.21%**
SubMU (60% directs at 20%)	857,946		12.000 %	5.90%	
	857,946	**8,007,495 USD**		**5.90**	**55.11%**
Subcontractor Bond	120,112		1.500 %	0.83%	
	120,112	**8,127,607 USD**		**0.83**	**55.94%**
General Conditions	812,761		10.000 %	5.59%	
	812,761	**8,940,368 USD**		**5.59**	**61.53%**
Building Permits	89,404		1.000 %	0.62%	
Sales Tax	483,615		8.000 %	3.33%	
	573,019	**9,513,387 USD**		**3.94**	**65.47%**
Builders Risk Insurance	19,027		0.200 %	0.13%	
Gen Liability Insurance	95,134		1.000 %	0.65%	
GC Bonds	142,701		1.500 %	0.98%	
	256,862	**9,770,249 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**9,770,249 USD**			**67.24%**
Contractor Total OH&P	781,620		8.000 %	5.38%	
	781,620	**10,551,869 USD**		**5.38**	**72.62%**
Construction Contingency	2,637,967		25.000 %	18.16%	
	2,637,967	**13,189,836 USD**		**18.16**	**90.78%**
Engineering & Design	1,055,187		8.000 %	7.26%	
	1,055,187	**14,245,023 USD**		**7.26**	**98.04%**
Escalation	284,900		2.000 %	1.96%	
	284,900	**14,529,923 USD**		**1.96**	**100.00%**
Total		***14,529,923 USD***			

Morro Bay 10% Conceptual Cost Estimate

Detailed Report

SBR Option - Phase 2

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	
1150 Microfiltration, Reverse Osmosis, UV Building	
1170001011.10001 Process Equipment - MF/UV	**4,737,447**
1170001015.10110 Mechanical - Process Piping - RO Equipment Add Only	**825,506**
1150 Microfiltration, Reverse Osmosis, UV Building	**5,562,953**
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	**5,562,953**
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	
1170001002.11001 Facility Excavation & Backfill - Eff. PS	**5,497**
1170001003.11200 Concrete SOG/Pad - 1' - Eff. PS	**45,504**
1170001005.11001 Metals - Eff. PS	**9,932**
1170001009.11001 Finishes - Eff. PS	**7,250**
1170001011.11001 Process Equipment - Eff. PS	**185,849**
1170001015.11100 Mechanical - Process Piping - Eff. PS	**162,103**
1170001015.11200 Mechanical - Plumbing Piping - Eff. PS	**11,960**
1170001016.11001 Electrical & I&C - Eff. PS	**53,061**
1160 Effluent Pump Station	**481,155**
3030 Recycle Pipeline from WRF to South of Hwy - 16"	
1150001502.01011 Recycle Pipeline - Open Area	**517,685**
1150001502.04031 Recycle Pipeline - Road/City Installation	**460,753**
1150001502.05011 Recycle Pipeline - Jack & Bore Location	**127,003**
3030 Recycle Pipeline from WRF to South of Hwy - 16"	**1,105,441**
1.2.10 Recycle Water Pump Station & Pipeline	**1,586,596**
02 Phase 2	**7,149,550**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	829,121			5.71%	
Material	6,045,191			41.61%	
Subcontract	166,402			1.15%	
Equipment	87,373			0.60%	
Other	21,462			0.15%	
	7,149,549	**7,149,549 USD**		**49.21**	**49.21%**
SubMU (60% directs at 20%)	857,946		12.000 %	5.90%	
	857,946	**8,007,495 USD**		**5.90**	**55.11%**
Subcontractor Bond	120,112		1.500 %	0.83%	
	120,112	**8,127,607 USD**		**0.83**	**55.94%**
General Conditions	812,761		10.000 %	5.59%	
	812,761	**8,940,368 USD**		**5.59**	**61.53%**
Building Permits	89,404		1.000 %	0.62%	
Sales Tax	483,615		8.000 %	3.33%	
	573,019	**9,513,387 USD**		**3.94**	**65.47%**
Builders Risk Insurance	19,027		0.200 %	0.13%	
Gen Liability Insurance	95,134		1.000 %	0.65%	
GC Bonds	142,701		1.500 %	0.98%	
	256,862	**9,770,249 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**9,770,249 USD**			**67.24%**
Contractor Total OH&P	781,620		8.000 %	5.38%	
	781,620	**10,551,869 USD**		**5.38**	**72.62%**
Construction Contingency	2,637,967		25.000 %	18.16%	
	2,637,967	**13,189,836 USD**		**18.16**	**90.78%**
Engineering & Design	1,055,187		8.000 %	7.26%	
	1,055,187	**14,245,023 USD**		**7.26**	**98.04%**
Escalation	284,900		2.000 %	1.96%	
	284,900	**14,529,923 USD**		**1.96**	**100.00%**
Total		***14,529,923 USD***			

Morro Bay 10% Conceptual Cost Estimate

Summary Report

MBR Option - Phase 1

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	**1,023,157**
1020 Yard Piping	**1,988,170**
1030 Yard Electrical	**1,141,279**
1040 Headworks	**3,026,567**
1050 Odor Control - Facility #1 - Headworks and SBR	**993,289**
1070 Equalization Basin	**7,974,663**
1085 Membrane Bio Reactor (MBR) Option	**9,643,370**
1090 Dewatering Building	**3,429,739**
1100 Odor Control - #2 - Dewatering Bldg	**632,387**
1110 Sludge Storage Tank Area	**583,780**
1120 Standby/Emergency Power	**638,576**
1130 Secondary Equalization Tank	**404,785**
1140 Electrical Building	**1,703,183**
1170 Chemical/Clean In Place Chemical Storage	**2,572,069**
1180 Septage Receiving Station	**431,980**
1200 Remote Operations Building	**374,946**
1.1.00 WRF On-Site Facilities	**36,561,940**
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	**1,581,755**
5020 Administration/Operations Facility	**4,474,875**
5050 Sitework	**1,432,220**
5060 Yard Piping	**440,870**
5070 Yard Electrical	**370,493**
1.1.10 Water/Wastewater Operations Facilities	**8,300,213**
1.1.20 Access Road to WWOF Area	
1010 Sitework	**169,494**
1020 Yard Piping	**85,189**
1.1.20 Access Road to WWOF Area	**254,684**
1.1.51 UV/RO Facility	
1151 UV, Reverse Osmosis Building	**5,002,822**
1.1.51 UV/RO Facility	**5,002,822**
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	**647,971**
1.1.60 Fire Pump Building	**647,971**
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	**480,548**
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	**2,007,867**
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	**6,747,934**
1.2.00 Conveyance and Offsite Facilities	**9,236,349**
01 Phase 1	**60,003,978**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	13,234,053			11.00%	
Material	37,444,298			31.12%	
Subcontract	7,112,756			5.91%	
Equipment	2,019,018			1.68%	
Other	193,854			0.16%	
	60,003,979	**60,003,979 USD**		**49.87**	**49.87%**
SubMU (60% directs at 20%)	7,200,477		12.000 %	5.98%	
	7,200,477	**67,204,456 USD**		**5.98**	**55.85%**
Subcontractor Bond	1,008,067		1.500 %	0.84%	
	1,008,067	**68,212,523 USD**		**0.84**	**56.69%**
General Conditions	6,821,252		10.000 %	5.67%	
	6,821,252	**75,033,775 USD**		**5.67**	**62.36%**
Building Permits	750,338		1.000 %	0.62%	
Sales Tax	2,995,544		8.000 %	2.49%	
	3,745,882	**78,779,657 USD**		**3.11**	**65.47%**
Builders Risk Insurance	157,559		0.200 %	0.13%	
Gen Liability Insurance	787,797		1.000 %	0.65%	
GC Bonds	1,181,695		1.500 %	0.98%	
	2,127,051	**80,906,708 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**80,906,708 USD**			**67.24%**
Contractor Total OH&P	6,472,537		8.000 %	5.38%	
	6,472,537	**87,379,245 USD**		**5.38**	**72.62%**
Construction Contingency	21,844,811		25.000 %	18.16%	
	21,844,811	**109,224,056 USD**		**18.16**	**90.78%**
Engineering & Design	8,737,924		8.000 %	7.26%	
	8,737,924	**117,961,980 USD**		**7.26**	**98.04%**
Escalation	2,359,240		2.000 %	1.96%	
	2,359,240	**120,321,220 USD**		**1.96**	**100.00%**
Total		***120,321,220 USD***			

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	
1150001002.01001 Site Paving - Roads and C&G - WRF	451,290
1150001002.02001 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WRF	541,240
1150001002.03001 Site Retaining Walls - WRF	30,627
1010 Sitework	1,023,157
1020 Yard Piping	
1150002002.01001 Yard Piping - Utilties - WRF	449,438
1150002002.02001 Yard Piping - Process	1,538,732
1020 Yard Piping	1,988,170
1030 Yard Electrical	
1150002002.03001 Yard Electrical	1,141,279
1030 Yard Electrical	1,141,279
1040 Headworks	
1170001002.01001 Facility Excavation & Backfill - Headworks	145,138
1170001003.01100 Concrete Ftg - Backwall/Retaining Wall Under SOG - Headworks	36,334
1170001003.01200 Concrete SOG - 2' - Headworks	110,273
1170001003.01300 Concrete Walls - 2' - Headworks	128,513
1170001003.01400 Concrete Interior Misc - Headworks - Allowance	86,876
1170001004.01001 Exterior Masonry Walls - Headworks	94,750
1170001005.01001 Metals - Headworks	173,587
1170001006.01001 FRP - Headworks	32,701
1170001007.01001 Dampproofing - Headworks	3,189
1170001007.02001 Roofing - Headworks	17,500
1170001008.01001 Openings - Headworks	27,369
1170001009.01001 Finishes - Headworks	95,850
1170001011.01001 Process Equipment - Headworks	803,451
1170001014.01001 Conveying Equipment - Hoisting - Headworks	200,000
1170001015.01100 Mechanical - Process Piping - Headworks	589,008
1170001015.01200 Mechanical - Plumbing Piping - Headworks	55,881
1170001015.01300 Mechanical - HVAC - Headworks	210,000
1170001016.01001 Electrical & I&C - Headworks	216,149
1040 Headworks	3,026,567
1050 Odor Control - Facility #1 - Headworks and SBR	
1170001002.02001 Facility Excavation & Backfill - Odor Control	5,840
1170001003.02200 Concrete SOG - Odor Control Pad - 2'	55,769
1170001003.02400 Concrete Interior Misc - Odor Control #1 - Allowance	13,400
1170001005.02001 Metals - Odor Control #1	17,363
1170001009.02001 Finishes - Odor Control	8,485
1170001011.02001 Process Equipment - Odor Control	257,924
1170001015.02100 Mechanical - Process Piping/Ductwork - Odor Control	544,207
1170001015.02200 Mechanical - Plumbing Piping - Odor Control	13,700
1170001016.02001 Electrical & I&C - Odor Control	76,601
1050 Odor Control - Facility #1 - Headworks and SBR	993,289
1070 Equalization Basin	
1170001002.03001 Facility Excavation & Backfill - EQ Basin	764,768
1170001003.03100 Concrete Ftg - Backwall/Retaining Wall Under SOG - EQ Basin	298,774
1170001003.03200 Concrete SOG/Tank Bottom - 3' - EQ Basin	1,092,507
1170001003.03300 Concrete Wall - Back/Ret Wall 3' - EQ Basin	425,170

Spreadsheet Level	Total Amount
1170001003.03310 Concrete Wall - Exterior Walls 2' - EQ Basin	488,710
1170001003.03320 Concrete Wall - Interior Walls 2' - EQ Basin	638,485
1170001003.03330 Elevated Concrete Deck - EQ Basin - 1'	683,778
1170001003.03400 Concrete Interior Misc - EQ Basin - Allowance	22,375
1170001005.03001 Metals - EQ Basin	82,988
1170001006.03001 FRP - EQ Basin	26,061
1170001007.03001 Dampproofing - EQ Basin	8,957
1170001008.03001 Openings - EQ Basin	25,644
1170001009.03001 Finishes - EQ Basin	1,300,480
1170001011.03001 Process Equipment - EQ Basin	988,368
1170001015.03100 Mechanical - Process Piping - EQ Basin	615,709
1170001015.03200 Mechanical - Plumbing Piping - EQ Basin	13,700
1170001015.03300 Mechanical - HVAC - EQ Basin	41,000
1170001016.03001 Electrical & I&C - EQ Basin	457,189
1070 Equalization Basin	7,974,663
1085 Membrane Bio Reactor (MBR) Option	
1170001002.17001 Facility Excavation & Backfill - MBR	158,053
1170001003.17100 Concrete Ftg - Backwall/Retaining Wall Under SOG - MBR	61,809
1170001003.17200 Concrete SOG/Tank Bottom - 3' - MBR	179,461
1170001003.17300 Concrete Wall - Back/Ret Wall 3' - MBR	130,523
1170001003.17310 Concrete Wall - Exterior Walls 2' - MBR	215,440
1170001003.17320 Concrete Wall - Interior Walls 2' - MBR	369,279
1170001003.17330 Elevated Concrete Deck - MBR - 1'	216,887
1170001003.17400 Concrete Interior Misc - MBR - Allowance	22,375
1170001005.17001 Metals - MBR	129,449
1170001006.17001 FRP - MBR	14,280
1170001007.17001 Dampproofing - MBR	3,120
1170001008.17001 Openings - MBR	20,088
1170001009.17001 Finishes - MBR	412,712
1170001011.17001 Process Equipment - MBR	4,510,602
1170001014.17001 Conveying Equipment - Hoisting - MBR	200,000
1170001015.17100 Mechanical - Process Piping - MBR	1,453,110
1170001016.17001 Electrical & I&C - MBR	1,546,183
1085 Membrane Bio Reactor (MBR) Option	9,643,370
1090 Dewatering Building	
1170001002.05001 Facility Excavation & Backfill - Dewatering Bldg	8,527
1170001003.05200 Concrete SOG - 2' - Dewatering Bldg	119,427
1170001003.05400 Concrete Interior Misc - Dewatering Bldg - Allowance	69,500
1170001004.05001 Exterior Masonry Walls - Dewatering Bldg	141,712
1170001005.05001 Metals - Dewatering Bldg	216,035
1170001007.05001 Roofing - Dewatering Bldg	19,270
1170001008.05001 Openings - Dewatering Bldg	40,327
1170001009.05001 Finishes - Dewatering Bldg	32,350
1170001011.05001 Process Equipment - Dewatering Bldg	1,476,018
1170001014.05001 Conveying Equipment - Hoisting - Dewatering Bldg	200,000
1170001015.05100 Mechanical - Process Piping - Dewatering Bldg	666,608
1170001015.05200 Mechanical - Plumbing Piping - Dewatering Bldg	27,181
1170001015.05300 Mechanical - HVAC - Dewatering Bldg	154,160
1170001015.05400 Mechanical - Fire Protection - Dewatering Bldg	13,489
1170001016.05001 Electrical & I&C - Dewatering Bldg	245,135

Spreadsheet Level	Total Amount
1090 Dewatering Building	3,429,739
1100 Odor Control - #2 - Dewatering Bldg	
1170001002.28001 Facility Excavation & Backfill - Odor Control #2	5,840
1170001003.28200 Concrete SOG - Odor Control #2 Pad - 2'	55,769
1170001003.28400 Concrete Interior Misc - Odor Control #2 - Allowance	13,400
1170001005.28001 Metals - Odor Control #2	17,363
1170001009.28001 Finishes - Odor Control #2	8,485
1170001011.28001 Process Equipment - Odor Control #2	257,924
1170001015.28100 Mechanical - Process Piping/Ductwork - Odor Control #2	183,304
1170001015.28200 Mechanical - Plumbing Piping - Odor Control #2	13,700
1170001016.28001 Electrical & I&C - Odor Control #2	76,601
1100 Odor Control - #2 - Dewatering Bldg	632,387
1110 Sludge Storage Tank Area	
1170001002.06001 Facility Excavation & Backfill - Sludge Storage Tank Area	6,841
1170001003.06201 Concrete Tank Pad - 3' - Sludge Storage Tank Area	65,663
1170001003.06400 Concrete Interior Misc - Sludge Storage - Allowance	12,400
1170001009.06001 Finishes - Sludge Storage	3,950
1170001011.06001 Process Equipment - Sludge Storage	106,339
1170001013.06100 Storage Tank - Bolted Steel Glass-Lined - Sludge Storage Tank	290,250
1170001015.06100 Mechanical - Process Piping - Sludge Storage	54,802
1170001015.06200 Mechanical - Plumbing Piping - Sludge Storage	5,980
1170001016.06001 Electrical & I&C - Sludge Storage	37,554
1110 Sludge Storage Tank Area	583,780
1120 Standby/Emergency Power	
1170001002.07001 Facility Excavation & Backfill - S/E Generator	2,841
1170001003.07200 Concrete PAD - 3' - S/E Generator	52,147
1170001005.07001 Metals - S/E Generator	13,432
1170001009.07001 Finishes - S/E Generator	5,000
1170001016.07001 Electrical & I&C - S/E Generator	565,155
1120 Standby/Emergency Power	638,576
1130 Secondary Equalization Tank	
1170001002.09001 Facility Excavation & Backfill - 2nd EQ Tank	6,841
1170001003.09200 Concrete Tank Pad - 3' - 2nd EQ Tank	65,663
1170001003.09400 Concrete Exterior Misc - 2nd EQ Tank - Allowance	12,400
1170001009.09001 Finishes - 2nd EQ Tank	1,685
1170001013.09100 Storage Tank - Concrete - 2nd EQ Tank	270,000
1170001015.09100 Mechanical - Process Piping - 2nd EQ Tank	27,401
1170001015.09200 Mechanical - Plumbing Piping - 2nd EQ Tank	5,980
1170001016.09001 Electrical & I&C - 2nd EQ Tank	14,815
1130 Secondary Equalization Tank	404,785
1140 Electrical Building	
1170001002.08001 Facility Excavation & Backfill - Electrical Bldg	4,636
1170001003.08200 Concrete SOG - 2' - Electrical Bldg	57,671
1170001003.08400 Concrete Interior Misc - Electrical Bldg - Allowance	13,400
1170001004.08001 Exterior Masonry Walls - Electrical Bldg	101,066
1170001005.08001 Metals - Electrical Bldg	49,254
1170001007.08001 Roofing - Electrical Bldg	9,300
1170001008.08001 Openings - Electrical Bldg	17,599
1170001009.08001 Finishes - Electrical Bldg	5,000
1170001015.08300 Mechanical - HVAC - Electrical Bldg	93,000

Spreadsheet Level	Total Amount
1170001016.08001 Electrical & I&C - Electrical Bldg	1,352,257
1140 Electrical Building	1,703,183
1170 Chemical/Clean In Place Chemical Storage	
1170001002.13001 Facility Excavation & Backfill - Chemical Storage	14,072
1170001003.13200 Concrete SOG - 2' - Chem Storage	178,176
1170001003.13600 Concrete Containment Walls - 1' - Chem Storage	154,689
1170001006.13001 FRP - Chem Storage	187,121
1170001009.13001 Finishes - Chem Storage	362,821
1170001011.13001 Process Equipment - Chem Storage	380,092
1170001013.13001 PEMB - Canopy - Chem Storage	168,000
1170001013.13100 Storage Tanks - Chem Storage	484,802
1170001015.13100 Mechanical - Process Piping - Chem Storage	394,207
1170001015.13200 Mechanical - Plumbing Piping - Chem Storage	45,440
1170001016.13001 Electrical & I&C - Chem Storage	202,649
1170 Chemical/Clean In Place Chemical Storage	2,572,069
1180 Septage Receiving Station	
1170001002.14100 Facility Excavation & Backfill - SRS	443
1170001003.14200 Concrete SOG/Pad - 1' - SRS	3,517
1170001003.14400 Concrete Exterior Misc - SRS - Allowance	7,925
1170001005.14001 Metals - SRS	9,932
1170001009.14001 Finishes - SRS	7,250
1170001011.14001 Process Equipment - SRS	231,697
1170001015.14100 Mechanical - Process Piping - SRS	107,203
1170001015.14200 Mechanical - Plumbing Piping - SRS	11,960
1170001016.14001 Electrical & I&C - SRS	52,054
1180 Septage Receiving Station	431,980
1200 Remote Operations Building	
1170001002.12001 Facility Excavation & Backfill - Ops Bldg	4,330
1170001003.12200 Concrete SOG - 1' - Ops Bldg	31,619
1170001005.12001 Metals - Ops Bldg	19,863
1170001008.12001 Openings - Ops Bldg	35,324
1170001009.12001 Finishes - Ops Bldg	35,000
1170001010.12001 Specialties - Ops Bldg	6,547
1170001012.12001 Furnishings - Ops Bldg	31,187
1170001013.12100 PEMB - Remote Ops Bldg	28,000
1170001015.12200 Mechanical - Plumbing Piping - Ops Bldg	20,440
1170001015.12300 Mechanical - HVAC - Ops Bldg	50,000
1170001015.12400 Mechanical - Fire Protection - Ops Bldg	8,500
1170001016.12001 Electrical & I&C - Ops Bldg	104,135
1200 Remote Operations Building	374,946
1.1.00 WRF On-Site Facilities	36,561,940
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	
1170001002.31001 Facility Excavation & Backfill - Maintenance Facility	21,123
1170001003.31200 Concrete SOG - 2' - Maint Facility	108,849
1170001003.31400 Concrete Interior Misc - Maint Facility - Allowance	20,900
1170001004.31001 Exterior Masonry Walls - Maintenance Facility	205,977
1170001005.31001 Metals - Maintenance Facility	260,537
1170001006.31001 FRP - Maintenance Facility	16,780
1170001007.31100 Roofing - Maintenance Facility	60,000

Spreadsheet Level	Total Amount
1170001008.31001 Openings - Maintenance Facility	65,830
1170001009.31001 Finishes - Maintenance Facility	110,209
1170001014.31001 Conveying Equipment - Hoisting - Maintenance Facility	200,000
1170001015.31200 Mechanical - Plumbing Piping - Maint. Facility	55,881
1170001015.31300 Mechanical - HVAC - Maintenance Facility	210,000
1170001016.31001 Electrical & I&C - Maintenance Facility	245,669
5010 Maintenance Facility	1,581,755
5020 Administration/Operations Facility	
1170001002.32001 Facility Excavation & Backfill - Admin/Ops Facility	71,032
1170001003.32200 Concrete SOG - 2' - Admin/Ops Facility	351,993
1170001004.32001 Exterior Masonry Walls - Admin/Ops Facility	384,491
1170001005.32001 Metals - Admin/Ops Facility	642,134
1170001007.32001 Roofing - Admin/Ops Facility	213,975
1170001008.32001 Openings - Admin/Ops Facility	193,847
1170001009.32001 Finishes - Admin/Ops Facility	551,525
1170001010.32001 Specialties - Admin/Ops Facility	62,734
1170001012.32001 Furnishings - Admin/Ops Facility	471,654
1170001015.32200 Mechanical - Plumbing Piping - Admin/Ops Facility	80,881
1170001015.32300 Mechanical - HVAC - Admin/Ops Facility	692,700
1170001015.32400 Mechanical - Fire Protection - Admin/Ops Facility	98,133
1170001016.32001 Electrical & I&C - Admin/Ops Facility	659,777
5020 Administration/Operations Facility	4,474,875
5050 Sitework	
1150001002.01005 Site Paving - Roads - WWOF Area	96,130
1150001002.01007 Site Paving - Interior - WWOF Area	154,426
1150001002.02005 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WWOF	1,056,733
1150001002.03005 Site Retaining Walls - WWOF	124,930
5050 Sitework	1,432,220
5060 Yard Piping	
1150002002.01005 Yard Piping - Utilities - WWOF Road	98,321
1150002002.01008 Yard Piping - Utilities - WWOF - Interior for Admin/Maint Facilit	342,549
5060 Yard Piping	440,870
5070 Yard Electrical	
1150002002.03011 Yard Electrical - Interior WWOF	370,493
5070 Yard Electrical	370,493
1.1.10 Water/Wastewater Operations Facilities	8,300,213
1.1.20 Access Road to WWOF Area	
1010 Sitework	
1150001002.01011 Site Paving - Roads - Access Road	99,084
1150001002.02011 Earthwork - Site Excavation Cut/Fill (NOA Soils) - Access Rd	70,410
1010 Sitework	169,494
1020 Yard Piping	
1150002002.01011 Yard Piping - Utilities - Access Road	85,189
1020 Yard Piping	85,189
1.1.20 Access Road to WWOF Area	254,684
1.1.51 UV/RO Facility	
1151 UV, Reverse Osmosis Building	
1170001002.10011 Facility Excavation & Backfill - UV/RO	14,310
1170001003.10211 Concrete SOG - 2' - UV/RO	223,029
1170001003.10411 Concrete Interior Misc - UV/RO - Allowance	86,876

Spreadsheet Level	Total Amount
1170001004.10011 Exterior Masonry Walls - UV/RO	337,803
1170001005.10011 Metals - UV/RO	385,080
1170001006.10011 FRP - UV/RO	33,561
1170001007.10011 Roofing - UV/RO	33,620
1170001008.10011 Openings - UV/RO	39,792
1170001009.10011 Finishes - UV/RO	54,300
1170001010.10011 Specialties - UV/RO	9,593
1170001011.10011 Process Equipment - UV	920,092
1170001012.10011 Furnishings - UV/RO	4,047
1170001015.10111 Mechanical - Process Piping - UV/RO	764,008
1170001015.10211 Mechanical - Plumbing Piping - UV/RO	77,203
1170001015.10311 Mechanical - HVAC - UV/RO	268,960
1170001015.10411 Mechanical - Fire Protection - UV/RO	23,534
1170001016.10011 Electrical & I&C - UV/RO	1,727,014
1151 UV, Reverse Osmosis Building	5,002,822
1.1.51 UV/RO Facility	5,002,822
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	
1170001002.16001 Facility Excavation & Backfill - Fire Pump Bldg	726
1170001003.16200 Concrete SOG - 1' - Fire Pump Bldg	4,218
1170001003.16400 Concrete Interior Misc - Fire Pump Bldg - Allowance	12,950
1170001004.16001 Exterior Masonry Walls - Fire Pump Bldg	24,717
1170001005.16001 Metals - Fire Pump Bldg	27,860
1170001007.16001 Roofing - Fire Pump Bldg	1,125
1170001008.16001 Openings - Fire Pump Bldg	18,948
1170001009.16001 Finishes - Fire Pump Bldg	10,900
1170001015.16100 Mechanical - Process Piping - Fire Pump Bldg	62,401
1170001015.16200 Mechanical - Plumbing Piping - Fire Pump Bldg	14,960
1170001015.16300 Mechanical - HVAC - Fire Pump Bldg	10,125
1170001015.16400 Mechanical - Fire Protection - Fire Pump Bldg	354,960
1170001016.16001 Electrical & I&C - Fire Pump Bldg	104,081
1210 Fire Pump Facility	647,971
1.1.60 Fire Pump Building	647,971
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	
1170001002.15001 Facility Excavation & Backfill - Brine PS	5,497
1170001003.15200 Concrete SOG/Pad - 1' - Brine PS	44,896
1170001005.15001 Metals - Brine PS	9,932
1170001009.15001 Finishes - Brine PS	7,250
1170001011.15001 Process Equipment - Brine PS	185,849
1170001015.15100 Mechanical - Process Piping - Brine PS	162,103
1170001015.15200 Mechanical - Plumbing Piping - Brine PS	11,960
1170001016.15001 Electrical & I&C - Brine PS	53,061
1165 Brine Pump Station (Adjacent to Eff PS)	480,548
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	
1150002002.20001 Yard Piping - Utilties - Lift Station	57,300
1170001002.20001 Site Demo - New Lift Station Area	93,425
1170001002.20011 Automatic Swing Gate - New Lift Station Area	8,500
1170001002.21001 Facility Excavation & Backfill - Wet Well/Lift Station	274,899
1170001003.20200 WetWell SOG - 2' - Lift Station	17,077

Spreadsheet Level	Total Amount
1170001003.20300 WetWell Walls - 1.5' - Lift Station	91,844
1170001003.20400 WetWell Elev Slab/Lid - 1.5' - Lift Station	39,535
1170001003.20500 Concrete Interior Misc - Lift Station - Allowance	69,500
1170001003.21200 Concrete SOG/Pad - 8" - Lift Station	111,428
1170001004.21001 Exterior Masonry Walls - Control Bldg	18,675
1170001004.21011 Exterior Masonry Walls - Perimeter Wall	98,869
1170001005.20001 Metals - Lift Station	66,315
1170001007.20001 Dampproofing - Wet Well	2,658
1170001007.21001 Roofing - Lift Station/Control Bldg	5,250
1170001008.20001 Openings - Lift Station	16,716
1170001009.20001 Finishes - Lift Station & Wet Well	65,609
1170001010.20001 Specialties - Lift Station/Control Bldg	1,119
1170001011.20001 Process Equipment - Lift Station	560,471
1170001012.21001 Furnishings - Lift Station/Control Bldg	1,273
1170001015.20100 Mechanical - Process Piping - Lift Station	87,203
1170001015.20200 Mechanical - Plumbing Piping - Lift Station/Control Bldg	17,200
1170001015.20300 Mechanical - HVAC - Lift Station/Control Bldg	9,800
1170001016.20001 Electrical & I&C - Lift Station	293,203
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	2,007,867
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	
1150001502.01001 Force Main & Brine Pipeline - Open Area	562,290
1150001502.02001 Force Main & Brine Pipeline - Open Area/Sidewalk/Path	74,094
1150001502.03001 Force Main & Brine Pipeline - Open Area with Trees	1,005,577
1150001502.04001 Force Main & Brine Pipeline - Road/City Installation	4,414,824
1150001502.04011 Force Main Pipeline - Road/City Installation - At Lift Station	29,354
1150001502.04021 Brine Pipeline - Road/City Installation - To Outfall Structure	138,498
1150001502.05001 Force Main & Brine Pipeline - Jack & Bore Locations	523,297
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	6,747,934
1.2.00 Conveyance and Offsite Facilities	9,236,349
01 Phase 1	**60,003,978**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	13,234,053			11.00%	
Material	37,444,298			31.12%	
Subcontract	7,112,756			5.91%	
Equipment	2,019,018			1.68%	
Other	193,854			0.16%	
	60,003,979	**60,003,979 USD**		**49.87**	**49.87%**
SubMU (60% directs at 20%)	7,200,477		12.000 %	5.98%	
	7,200,477	**67,204,456 USD**		**5.98**	**55.85%**
Subcontractor Bond	1,008,067		1.500 %	0.84%	
	1,008,067	**68,212,523 USD**		**0.84**	**56.69%**
General Conditions	6,821,252		10.000 %	5.67%	
	6,821,252	**75,033,775 USD**		**5.67**	**62.36%**
Building Permits	750,338		1.000 %	0.62%	
Sales Tax	2,995,544		8.000 %	2.49%	
	3,745,882	**78,779,657 USD**		**3.11**	**65.47%**
Builders Risk Insurance	157,559		0.200 %	0.13%	
Gen Liability Insurance	787,797		1.000 %	0.65%	
GC Bonds	1,181,695		1.500 %	0.98%	
	2,127,051	**80,906,708 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**80,906,708 USD**			**67.24%**
Contractor Total OH&P	6,472,537		8.000 %	5.38%	
	6,472,537	**87,379,245 USD**		**5.38**	**72.62%**
Construction Contingency	21,844,811		25.000 %	18.16%	
	21,844,811	**109,224,056 USD**		**18.16**	**90.78%**
Engineering & Design	8,737,924		8.000 %	7.26%	
	8,737,924	**117,961,980 USD**		**7.26**	**98.04%**
Escalation	2,359,240		2.000 %	1.96%	
	2,359,240	**120,321,220 USD**		**1.96**	**100.00%**
Total		***120,321,220 USD***			

Morro Bay 10% Conceptual Cost Estimate

Summary Report

MBR Option - Phase 2

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.56 UV/RO Facility - RO Equipment Add Only	
1151 UV, Reverse Osmosis Building	**5,582,953**
1.1.56 UV/RO Facility - RO Equipment Add Only	**5,582,953**
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	**480,548**
3030 Recycle Pipeline from WRF to South of Hwy - 16"	**1,105,441**
1.2.10 Recycle Water Pump Station & Pipeline	**1,585,989**
02 Phase 2	**7,168,942**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	829,121			5.69%	
Material	6,064,584			41.62%	
Subcontract	166,402			1.14%	
Equipment	87,373			0.60%	
Other	21,462			0.15%	
	7,168,942	**7,168,942 USD**		**49.20**	**49.20%**
SubMU (60% directs at 20%)	860,273		12.000 %	5.90%	
	860,273	**8,029,215 USD**		**5.90**	**55.11%**
Subcontractor Bond	120,438		1.500 %	0.83%	
	120,438	**8,149,653 USD**		**0.83**	**55.94%**
General Conditions	814,965		10.000 %	5.59%	
	814,965	**8,964,618 USD**		**5.59**	**61.53%**
Building Permits	89,646		1.000 %	0.62%	
Sales Tax	485,167		8.000 %	3.33%	
	574,813	**9,539,431 USD**		**3.95**	**65.47%**
Builders Risk Insurance	19,079		0.200 %	0.13%	
Gen Liability Insurance	95,394		1.000 %	0.65%	
GC Bonds	143,091		1.500 %	0.98%	
	257,564	**9,796,995 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**9,796,995 USD**			**67.24%**
Contractor Total OH&P	783,760		8.000 %	5.38%	
	783,760	**10,580,755 USD**		**5.38**	**72.62%**
Construction Contingency	2,645,189		25.000 %	18.16%	
	2,645,189	**13,225,944 USD**		**18.16**	**90.78%**
Engineering & Design	1,058,076		8.000 %	7.26%	
	1,058,076	**14,284,020 USD**		**7.26**	**98.04%**
Escalation	285,680		2.000 %	1.96%	
	285,680	**14,569,700 USD**		**1.96**	**100.00%**
Total		***14,569,700 USD***			

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.56 UV/RO Facility - RO Equipment Add Only	
1151 UV, Reverse Osmosis Building	
1170001011.10021 Process Equipment - RO	4,737,447
1170001015.10110 Mechanical - Process Piping - RO Equipment Add Only	845,506
1151 UV, Reverse Osmosis Building	5,582,953
1.1.56 UV/RO Facility - RO Equipment Add Only	5,582,953
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	
1170001002.11001 Facility Excavation & Backfill - Eff. PS	5,497
1170001003.11200 Concrete SOG/Pad - 1' - Eff. PS	44,896
1170001005.11001 Metals - Eff. PS	9,932
1170001009.11001 Finishes - Eff. PS	7,250
1170001011.11001 Process Equipment - Eff. PS	185,849
1170001015.11100 Mechanical - Process Piping - Eff. PS	162,103
1170001015.11200 Mechanical - Plumbing Piping - Eff. PS	11,960
1170001016.11001 Electrical & I&C - Eff. PS	53,061
1160 Effluent Pump Station	480,548
3030 Recycle Pipeline from WRF to South of Hwy - 16"	
1150001502.01011 Recycle Pipeline - Open Area	517,685
1150001502.04031 Recycle Pipeline - Road/City Installation	460,753
1150001502.05011 Recycle Pipeline - Jack & Bore Location	127,003
3030 Recycle Pipeline from WRF to South of Hwy - 16"	1,105,441
1.2.10 Recycle Water Pump Station & Pipeline	1,585,989
02 Phase 2	**7,168,942**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	829,121			5.69%	
Material	6,064,584			41.62%	
Subcontract	166,402			1.14%	
Equipment	87,373			0.60%	
Other	21,462			0.15%	
	7,168,942	**7,168,942 USD**		**49.20**	**49.20%**
SubMU (60% directs at 20%)	860,273		12.000 %	5.90%	
	860,273	**8,029,215 USD**		**5.90**	**55.11%**
Subcontractor Bond	120,438		1.500 %	0.83%	
	120,438	**8,149,653 USD**		**0.83**	**55.94%**
General Conditions	814,965		10.000 %	5.59%	
	814,965	**8,964,618 USD**		**5.59**	**61.53%**
Building Permits	89,646		1.000 %	0.62%	
Sales Tax	485,167		8.000 %	3.33%	
	574,813	**9,539,431 USD**		**3.95**	**65.47%**
Builders Risk Insurance	19,079		0.200 %	0.13%	
Gen Liability Insurance	95,394		1.000 %	0.65%	
GC Bonds	143,091		1.500 %	0.98%	
	257,564	**9,796,995 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**9,796,995 USD**			**67.24%**
Contractor Total OH&P	783,760		8.000 %	5.38%	
	783,760	**10,580,755 USD**		**5.38**	**72.62%**
Construction Contingency	2,645,189		25.000 %	18.16%	
	2,645,189	**13,225,944 USD**		**18.16**	**90.78%**
Engineering & Design	1,058,076		8.000 %	7.26%	
	1,058,076	**14,284,020 USD**		**7.26**	**98.04%**
Escalation	285,680		2.000 %	1.96%	
	285,680	**14,569,700 USD**		**1.96**	**100.00%**
Total		***14,569,700 USD***			

Appendix I

Appendix I

ENGINEER'S OPINION OF PROBABLE CONSTRUCTION COST (WITH CSD)

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	1,023,157
1020 Yard Piping	2,472,602
1030 Yard Electrical	1,483,662
1040 Headworks	3,949,501
1050 Odor Control - #1 - Headworks and SBR	709,787
1070 Equalization Basin	10,840,135
1080 Sequence Batch Reactor Basin (SBR)	9,282,691
1090 Dewatering Building	3,965,838
1100 Odor Control - #2 - Dewatering Bldg	632,387
1110 Sludge Storage Tank Area	820,001
1120 Standby/Emergency Power	830,119
1130 Secondary Equalization Tank	453,728
1140 Electrical Building	2,244,086
1170 Chemical/Clean In Place Chemical Storage	2,756,000
1180 Septage Receiving Station	432,027
1200 Remote Operations Building	374,946
1.1.00 WRF On-Site Facilities	42,270,667
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	1,581,755
5020 Administration/Operations Facility	4,474,875
5050 Sitework	1,432,220
5060 Yard Piping	543,312
5070 Yard Electrical - Interior	481,641
1.1.10 Water/Wastewater Operations Facilities	8,513,803
1.1.20 Access Road to WWOF Area	
1010 Sitework	169,494
1020 Yard Piping	105,409
1.1.20 Access Road to WWOF Area	274,903
1.1.50 MF/UV Facility	
1150 Microfiltration, Reverse Osmosis, UV Building	8,933,856
1.1.50 MF/UV Facility	8,933,856
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	648,030
1.1.60 Fire Pump Building	648,030
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	620,694
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	2,660,253
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	8,071,431
1.2.00 Conveyance and Offsite Facilities	11,352,378
01 Phase 1	**71,993,637**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	16,296,660			11.29%	
Material	45,128,900			31.26%	
Subcontract	7,900,159			5.47%	
Equipment	2,450,597			1.70%	
Other	217,322			0.15%	
	71,993,638	**71,993,638 USD**		**49.86**	**49.86%**
SubMU (60% directs at 20%)	8,639,236		12.000 %	5.98%	
	8,639,236	**80,632,874 USD**		**5.98**	**55.84%**
Subcontractor Bond	1,209,493		1.500 %	0.84%	
	1,209,493	**81,842,367 USD**		**0.84**	**56.68%**
General Conditions	8,184,237		10.000 %	5.67%	
	8,184,237	**90,026,604 USD**		**5.67**	**62.35%**
Building Permits	900,266		1.000 %	0.62%	
Sales Tax	3,610,312		8.000 %	2.50%	
	4,510,578	**94,537,182 USD**		**3.12**	**65.47%**
Builders Risk Insurance	189,074		0.200 %	0.13%	
Gen Liability Insurance	945,372		1.000 %	0.65%	
GC Bonds	1,418,058		1.500 %	0.98%	
	2,552,504	**97,089,686 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**97,089,686 USD**			**67.24%**
Contractor Total OH&P	7,767,175		8.000 %	5.38%	
	7,767,175	**104,856,861 USD**		**5.38**	**72.62%**
Construction Contingency	26,214,215		25.000 %	18.16%	
	26,214,215	**131,071,076 USD**		**18.16**	**90.78%**
Engineering & Design	10,485,686		8.000 %	7.26%	
	10,485,686	**141,556,762 USD**		**7.26**	**98.04%**
Escalation	2,831,135		2.000 %	1.96%	
	2,831,135	**144,387,897 USD**		**1.96**	**100.00%**
Total		***144,387,897 USD***			

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	
1150001002.01001 Site Paving - Roads and C&G - WRF	451,290
1150001002.02001 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WRF	541,240
1150001002.03001 Site Retaining Walls - WRF	30,627
1010 Sitework	1,023,157
1020 Yard Piping	
1150002002.01001 Yard Piping - Utilties - WRF	553,297
1150002002.02001 Yard Piping - Process	1,919,305
1020 Yard Piping	2,472,602
1030 Yard Electrical	
1150002002.03001 Yard Electrical	1,483,662
1030 Yard Electrical	1,483,662
1040 Headworks	
1170001002.01001 Facility Excavation & Backfill - Headworks	203,193
1170001003.01100 Concrete Ftg - Backwall/Retaining Wall Under SOG - Headworks	50,868
1170001003.01200 Concrete SOG - 2' - Headworks	154,381
1170001003.01300 Concrete Walls - 2' - Headworks	179,918
1170001003.01400 Concrete Interior Misc - Headworks - Allowance	121,626
1170001004.01001 Exterior Masonry Walls - Headworks	132,649
1170001005.01001 Metals - Headworks	228,382
1170001006.01001 FRP - Headworks	70,341
1170001007.01001 Dampproofing - Headworks	3,189
1170001007.02001 Roofing - Headworks	17,500
1170001008.01001 Openings - Headworks	27,369
1170001009.01001 Finishes - Headworks	134,190
1170001011.01001 Process Equipment - Headworks	1,164,376
1170001014.01001 Conveying Equipment - Hoisting - Headworks	200,000
1170001015.01100 Mechanical - Process Piping - Headworks	736,261
1170001015.01200 Mechanical - Plumbing Piping - Headworks	55,881
1170001015.01300 Mechanical - HVAC - Headworks	210,000
1170001016.01001 Electrical & I&C - Headworks	259,378
1040 Headworks	3,949,501
1050 Odor Control - #1 - Headworks and SBR	
1170001002.02001 Facility Excavation & Backfill - Odor Control	5,840
1170001003.02200 Concrete SOG - Odor Control Pad - 2'	55,769
1170001003.02400 Concrete Interior Misc - Odor Control #1 - Allowance	13,400
1170001005.02001 Metals - Odor Control #1	17,363
1170001009.02001 Finishes - Odor Control	8,485
1170001011.02001 Process Equipment - Odor Control	257,924
1170001015.02100 Mechanical - Process Piping/Ductwork - Odor Control	260,705
1170001015.02200 Mechanical - Plumbing Piping - Odor Control	13,700
1170001016.02001 Electrical & I&C - Odor Control	76,601
1050 Odor Control - #1 - Headworks and SBR	709,787
1070 Equalization Basin	
1170001002.03001 Facility Excavation & Backfill - EQ Basin	1,070,676
1170001003.03100 Concrete Ftg - Backwall/Retaining Wall Under SOG - EQ Basin	418,284
1170001003.03200 Concrete SOG/Tank Bottom - 3' - EQ Basin	1,529,510
1170001003.03300 Concrete Wall - Back/Ret Wall 3' - EQ Basin	595,238

Spreadsheet Level	Total Amount
1170001003.03310 Concrete Wall - Exterior Walls 2' - EQ Basin	684,214
1170001003.03320 Concrete Wall - Interior Walls 2' - EQ Basin	893,884
1170001003.03330 Elevated Concrete Deck - EQ Basin - 1'	957,288
1170001003.03400 Concrete Interior Misc - EQ Basin - Allowance	31,325
1170001005.03001 Metals - EQ Basin	82,988
1170001006.03001 FRP - EQ Basin	26,061
1170001007.03001 Dampproofing - EQ Basin	8,957
1170001008.03001 Openings - EQ Basin	25,644
1170001009.03001 Finishes - EQ Basin	1,820,672
1170001011.03001 Process Equipment - EQ Basin	1,322,432
1170001015.03100 Mechanical - Process Piping - EQ Basin	769,636
1170001015.03200 Mechanical - Plumbing Piping - EQ Basin	13,700
1170001015.03300 Mechanical - HVAC - EQ Basin	41,000
1170001016.03001 Electrical & I&C - EQ Basin	548,627
1070 Equalization Basin	10,840,135
1080 Sequence Batch Reactor Basin (SBR)	
1170001002.04001 Facility Excavation & Backfill - SBR	553,114
1170001003.04100 Concrete Ftg - Backwall/Retaining Wall Under SOG - SBR	211,202
1170001003.04200 Concrete SOG/Tank Bottom - 3' - SBR	862,782
1170001003.04300 Concrete Wall - Back/Ret Wall 3' - SBR	390,295
1170001003.04310 Concrete Wall - Exterior Walls 2' - SBR	533,795
1170001003.04320 Concrete Wall - Interior Walls 2' - SBR	412,246
1170001003.04330 Elevated Concrete Deck - SBR - 1'	663,037
1170001003.04400 Concrete Interior Misc - SBR - Allowance	31,325
1170001005.04001 Metals - SBR	82,988
1170001006.04001 FRP - SBR	14,280
1170001007.04001 Dampproofing - SBR	6,485
1170001008.04001 Openings - SBR	8,928
1170001009.04001 Finishes - SBR	1,171,320
1170001011.04001 Process Equipment - SBR	2,012,511
1170001015.04100 Mechanical - Process Piping - SBR	1,066,387
1170001016.04001 Electrical & I&C - SBR	1,261,995
1080 Sequence Batch Reactor Basin (SBR)	9,282,691
1090 Dewatering Building	
1170001002.05001 Facility Excavation & Backfill - Dewatering Bldg	8,527
1170001003.05200 Concrete SOG - 2' - Dewatering Bldg	119,427
1170001003.05400 Concrete Interior Misc - Dewatering Bldg - Allowance	69,500
1170001004.05001 Exterior Masonry Walls - Dewatering Bldg	141,712
1170001005.05001 Metals - Dewatering Bldg	216,035
1170001007.05001 Roofing - Dewatering Bldg	19,270
1170001008.05001 Openings - Dewatering Bldg	40,327
1170001009.05001 Finishes - Dewatering Bldg	32,350
1170001011.05001 Process Equipment - Dewatering Bldg	1,829,768
1170001014.05001 Conveying Equipment - Hoisting - Dewatering Bldg	200,000
1170001015.05100 Mechanical - Process Piping - Dewatering Bldg	799,929
1170001015.05200 Mechanical - Plumbing Piping - Dewatering Bldg	27,181
1170001015.05300 Mechanical - HVAC - Dewatering Bldg	154,160
1170001015.05400 Mechanical - Fire Protection - Dewatering Bldg	13,489
1170001016.05001 Electrical & I&C - Dewatering Bldg	294,162
1090 Dewatering Building	3,965,838
1100 Odor Control - #2 - Dewatering Bldg	

Spreadsheet Level	Total Amount
1170001002.28001 Facility Excavation & Backfill - Odor Control #2	5,840
1170001003.28200 Concrete SOG - Odor Control #2 Pad - 2'	55,769
1170001003.28400 Concrete Interior Misc - Odor Control #2 - Allowance	13,400
1170001005.28001 Metals - Odor Control #2	17,363
1170001009.28001 Finishes - Odor Control #2	8,485
1170001011.28001 Process Equipment - Odor Control #2	257,924
1170001015.28100 Mechanical - Process Piping/Ductwork - Odor Control #2	183,304
1170001015.28200 Mechanical - Plumbing Piping - Odor Control #2	13,700
1170001016.28001 Electrical & I&C - Odor Control #2	76,601
1100 Odor Control - #2 - Dewatering Bldg	632,387
1110 Sludge Storage Tank Area	
1170001002.06001 Facility Excavation & Backfill - Sludge Storage Tank Area	6,841
1170001003.06201 Concrete Tank Pad - 3' - Sludge Storage Tank Area	65,663
1170001003.06400 Concrete Interior Misc - Sludge Storage - Allowance	12,400
1170001009.06001 Finishes - Sludge Storage	3,950
1170001011.06001 Process Equipment - Sludge Storage	131,339
1170001013.06100 Storage Tank - Bolted Steel Glass-Lined - Sludge Storage Tank	483,000
1170001015.06100 Mechanical - Process Piping - Sludge Storage	65,762
1170001015.06200 Mechanical - Plumbing Piping - Sludge Storage	5,980
1170001016.06001 Electrical & I&C - Sludge Storage	45,065
1110 Sludge Storage Tank Area	820,001
1120 Standby/Emergency Power	
1170001002.07001 Facility Excavation & Backfill - S/E Generator	3,978
1170001003.07200 Concrete PAD - 3' - S/E Generator	73,007
1170001005.07001 Metals - S/E Generator	13,432
1170001009.07001 Finishes - S/E Generator	5,000
1170001016.07001 Electrical & I&C - S/E Generator	734,702
1120 Standby/Emergency Power	830,119
1130 Secondary Equalization Tank	
1170001002.09001 Facility Excavation & Backfill - 2nd EQ Tank	6,841
1170001003.09200 Concrete Tank Pad - 3' - 2nd EQ Tank	65,663
1170001003.09400 Concrete Exterior Misc - 2nd EQ Tank - Allowance	12,400
1170001009.09001 Finishes - 2nd EQ Tank	1,685
1170001013.09100 Storage Tank - Bolted Steel Glass-Lined - 2nd EQ Tank	310,500
1170001015.09100 Mechanical - Process Piping - 2nd EQ Tank	32,881
1170001015.09200 Mechanical - Plumbing Piping - 2nd EQ Tank	5,980
1170001016.09001 Electrical & I&C - 2nd EQ Tank	17,778
1130 Secondary Equalization Tank	453,728
1140 Electrical Building	
1170001002.08001 Facility Excavation & Backfill - Electrical Bldg	4,636
1170001003.08200 Concrete SOG - 2' - Electrical Bldg	57,671
1170001003.08400 Concrete Interior Misc - Electrical Bldg - Allowance	13,400
1170001004.08001 Exterior Masonry Walls - Electrical Bldg	101,066
1170001005.08001 Metals - Electrical Bldg	49,254
1170001007.08001 Roofing - Electrical Bldg	9,300
1170001008.08001 Openings - Electrical Bldg	17,599
1170001009.08001 Finishes - Electrical Bldg	5,000
1170001015.08300 Mechanical - HVAC - Electrical Bldg	93,000
1170001016.08001 Electrical & I&C - Electrical Bldg	1,893,160
1140 Electrical Building	2,244,086
1170 Chemical/Clean In Place Chemical Storage	

Spreadsheet Level	Total Amount
1170001002.13001 Facility Excavation & Backfill - Chemical Storage	14,072
1170001003.13200 Concrete SOG - 2' - Chem Storage	178,176
1170001003.13600 Concrete Containment Walls - 1' - Chem Storage	154,870
1170001006.13001 FRP - Chem Storage	187,121
1170001009.13001 Finishes - Chem Storage	362,821
1170001011.13001 Process Equipment - Chem Storage	451,342
1170001013.13001 PEMB - Canopy - Chem Storage	168,000
1170001013.13100 Storage Tanks - Chem Storage	597,302
1170001015.13100 Mechanical - Process Piping - Chem Storage	394,207
1170001015.13200 Mechanical - Plumbing Piping - Chem Storage	45,440
1170001016.13001 Electrical & I&C - Chem Storage	202,649
1170 Chemical/Clean In Place Chemical Storage	2,756,000
1180 Septage Receiving Station	
1170001002.14100 Facility Excavation & Backfill - SRS	443
1170001003.14200 Concrete SOG/Pad - 1' - SRS	3,563
1170001003.14400 Concrete Exterior Misc - SRS - Allowance	7,925
1170001005.14001 Metals - SRS	9,932
1170001009.14001 Finishes - SRS	7,250
1170001011.14001 Process Equipment - SRS	231,697
1170001015.14100 Mechanical - Process Piping - SRS	107,203
1170001015.14200 Mechanical - Plumbing Piping - SRS	11,960
1170001016.14001 Electrical & I&C - SRS	52,054
1180 Septage Receiving Station	432,027
1200 Remote Operations Building	
1170001002.12001 Facility Excavation & Backfill - Ops Bldg	4,330
1170001003.12200 Concrete SOG - 2' - Ops Bldg	31,619
1170001005.12001 Metals - Ops Bldg	19,863
1170001008.12001 Openings - Ops Bldg	35,324
1170001009.12001 Finishes - Ops Bldg	35,000
1170001010.12001 Specialties - Ops Bldg	6,547
1170001012.12001 Furnishings - Ops Bldg	31,187
1170001013.12100 PEMB - Remote Ops Bldg	28,000
1170001015.12200 Mechanical - Plumbing Piping - Ops Bldg	20,440
1170001015.12300 Mechanical - HVAC - Ops Bldg	50,000
1170001015.12400 Mechanical - Fire Protection - Ops Bldg	8,500
1170001016.12001 Electrical & I&C - Ops Bldg	104,135
1200 Remote Operations Building	374,946
1.1.00 WRF On-Site Facilities	42,270,667
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	
1170001002.31001 Facility Excavation & Backfill - Maintenance Facility	21,123
1170001003.31200 Concrete SOG - 2' - Maint Facility	108,849
1170001003.31400 Concrete Interior Misc - Maint Facility - Allowance	20,900
1170001004.31001 Exterior Masonry Walls - Maintenance Facility	205,977
1170001005.31001 Metals - Maintenance Facility	260,537
1170001006.31001 FRP - Maintenance Facility	16,780
1170001007.31100 Roofing - Maintenance Facility	60,000
1170001008.31001 Openings - Maintenance Facility	65,830
1170001009.31001 Finishes - Maintenance Facility	110,209
1170001014.31001 Conveying Equipment - Hoisting - Maintenance Facility	200,000

Spreadsheet Level	Total Amount
1170001015.31200 Mechanical - Plumbing Piping - Maint. Facility	55,881
1170001015.31300 Mechanical - HVAC - Maintenance Facility	210,000
1170001016.31001 Electrical & I&C - Maintenance Facility	245,669
5010 Maintenance Facility	1,581,755
5020 Administration/Operations Facility	
1170001002.32001 Facility Excavation & Backfill - Admin/Ops Facility	71,032
1170001003.32200 Concrete SOG - 2' - Admin/Ops Facility	351,993
1170001004.32001 Exterior Masonry Walls - Admin/Ops Facility	384,491
1170001005.32001 Metals - Admin/Ops Facility	642,134
1170001007.32001 Roofing - Admin/Ops Facility	213,975
1170001008.32001 Openings - Admin/Ops Facility	193,847
1170001009.32001 Finishes - Admin/Ops Facility	551,525
1170001010.32001 Specialties - Admin/Ops Facility	62,734
1170001012.32001 Furnishings - Admin/Ops Facility	471,654
1170001015.32200 Mechanical - Plumbing Piping - Admin/Ops Facility	80,881
1170001015.32300 Mechanical - HVAC - Admin/Ops Facility	692,700
1170001015.32400 Mechanical - Fire Protection - Admin/Ops Facility	98,133
1170001016.32001 Electrical & I&C - Admin/Ops Facility	659,777
5020 Administration/Operations Facility	4,474,875
5050 Sitework	
1150001002.01005 Site Paving - Roads - WWOF	96,130
1150001002.01007 Site Paving - Interior - WWOF	154,426
1150001002.02005 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WWOF	1,056,733
1150001002.03005 Site Retaining Walls - WWOF	124,930
5050 Sitework	1,432,220
5060 Yard Piping	
1150002002.01005 Yard Piping - Utilities - WWOF Road	122,336
1150002002.01008 Yard Piping - Utilities - WWOF Yard - Interior for Admin/Maint Facilit	420,976
5060 Yard Piping	543,312
5070 Yard Electrical - Interior	
1150002002.03011 Yard Electrical - Interior WWOF	481,641
5070 Yard Electrical - Interior	481,641
1.1.10 Water/Wastewater Operations Facilities	8,513,803
1.1.20 Access Road to WWOF Area	
1010 Sitework	
1150001002.01011 Site Paving - Roads - Access Road	99,084
1150001002.02011 Earthwork - Site Excavation Cut/Fill (NOA Soils) - Access Rd	70,410
1010 Sitework	169,494
1020 Yard Piping	
1150002002.01011 Yard Piping - Utilities - Access Road	105,409
1020 Yard Piping	105,409
1.1.20 Access Road to WWOF Area	274,903
1.1.50 MF/UV Facility	
1150 Microfiltration, Reverse Osmosis, UV Building	
1170001002.10001 Facility Excavation & Backfill - MF/UV	20,034
1170001003.10200 Concrete SOG - 2' - MF/UV	312,241
1170001003.10400 Concrete Interior Misc - MF/UV - Allowance	121,626
1170001003.10700 Concrete SOMD - 6" - MF/UV	80,860
1170001004.10001 Exterior Masonry Walls - MF/UV	472,924
1170001005.10001 Metals - MF/UV	1,034,192

Spreadsheet Level	Total Amount
1170001006.10001 FRP - MF/UV	33,561
1170001007.10001 Roofing - MF/UV	47,068
1170001008.10001 Openings - MF/UV	39,792
1170001009.10001 Finishes - MF/UV	64,300
1170001010.10001 Specialties - MF/UV	9,593
1170001011.10001 Process Equipment - MF/UV	2,074,109
1170001012.10001 Furnishings - MF/UV	4,047
1170001015.10100 Mechanical - Process Piping - MF/UV	1,389,262
1170001015.10200 Mechanical - Plumbing Piping - MF/UV	77,203
1170001015.10300 Mechanical - HVAC - MF/UV	672,400
1170001015.10400 Mechanical - Fire Protection - MF/UV	58,835
1170001016.10001 Electrical & I&C - MF/UV	2,421,811
1150 Microfiltration, Reverse Osmosis, UV Building	8,933,856
1.1.50 MF/UV Facility	8,933,856
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	
1170001002.16001 Facility Excavation & Backfill - Fire Pump Bldg	726
1170001003.16200 Concrete SOG - 1' - Fire Pump Bldg	4,276
1170001003.16400 Concrete Interior Misc - Fire Pump Bldg - Allowance	12,950
1170001004.16001 Exterior Masonry Walls - Fire Pump Bldg	24,717
1170001005.16001 Metals - Fire Pump Bldg	27,860
1170001007.16001 Roofing - Fire Pump Bldg	1,125
1170001008.16001 Openings - Fire Pump Bldg	18,948
1170001009.16001 Finishes - Fire Pump Bldg	10,900
1170001015.16100 Mechanical - Process Piping - Fire Pump Bldg	62,401
1170001015.16200 Mechanical - Plumbing Piping - Fire Pump Bldg	14,960
1170001015.16300 Mechanical - HVAC - Fire Pump Bldg	10,125
1170001015.16400 Mechanical - Fire Protection - Fire Pump Bldg	354,960
1170001016.16001 Electrical & I&C - Fire Pump Bldg	104,081
1210 Fire Pump Facility	648,030
1.1.60 Fire Pump Building	648,030
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	
1170001002.15001 Facility Excavation & Backfill - Brine PS	7,696
1170001003.15200 Concrete SOG/Pad - 1' - Brine PS	63,706
1170001005.15001 Metals - Brine PS	9,932
1170001009.15001 Finishes - Brine PS	7,250
1170001011.15001 Process Equipment - Brine PS	253,849
1170001015.15100 Mechanical - Process Piping - Brine PS	202,629
1170001015.15200 Mechanical - Plumbing Piping - Brine PS	11,960
1170001016.15001 Electrical & I&C - Brine PS	63,673
1165 Brine Pump Station (Adjacent to Eff PS)	620,694
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	
1150002002.20001 Yard Piping - Utilties - Lift Station	74,498
1170001002.20001 Site Demo - New Lift Station Area	93,425
1170001002.20011 Automatic Swing Gate - New Lift Station Area	8,500
1170001002.21001 Facility Excavation & Backfill - Wet Well/Lift Station	384,859
1170001003.20200 WetWell SOG - 2' - Lift Station	24,218
1170001003.20300 WetWell Walls - 1.5' - Lift Station	130,160
1170001003.20400 WetWell Elev Slab/Lid - 1.5' - Lift Station	55,711

Spreadsheet Level	Total Amount
1170001003.20500 Concrete Interior Misc - Lift Station - Allowance	97,301
1170001003.21200 Concrete SOG/Pad - 8" - Lift Station	157,910
1170001004.21001 Exterior Masonry Walls - Control Bldg	26,145
1170001004.21011 Exterior Masonry Walls - Perimeter Wall	138,417
1170001005.20001 Metals - Lift Station	92,841
1170001007.20001 Dampproofing - Wet Well	3,721
1170001007.21001 Roofing - Lift Station/Control Bldg	7,350
1170001008.20001 Openings - Lift Station	16,716
1170001009.20001 Finishes - Lift Station & Wet Well	91,852
1170001010.20001 Specialties - Lift Station/Control Bldg	1,119
1170001011.20001 Process Equipment - Lift Station	762,471
1170001012.21001 Furnishings - Lift Station/Control Bldg	1,273
1170001015.20100 Mechanical - Process Piping - Lift Station	109,003
1170001015.20200 Mechanical - Plumbing Piping - Lift Station/Control Bldg	17,200
1170001015.20300 Mechanical - HVAC - Lift Station/Control Bldg	13,720
1170001016.20001 Electrical & I&C - Lift Station	351,843
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	2,660,253
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	
1150001502.01001 Force Main & Brine Pipeline - Open Area	696,067
1150001502.02001 Force Main & Brine Pipeline - Open Area/Sidewalk/Path	88,149
1150001502.03001 Force Main & Brine Pipeline - Open Area with Trees	1,223,157
1150001502.04001 Force Main & Brine Pipeline - Road/City Installation	5,338,135
1150001502.04011 Force Main Pipeline - Road/City Installation - At Lift Station	35,156
1150001502.04021 Brine Pipeline - Road/City Installation - To Outfall Structure	159,526
1150001502.05001 Force Main & Brine Pipeline - Jack & Bore Locations	531,241
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	8,071,431
1.2.00 Conveyance and Offsite Facilities	11,352,378
01 Phase 1	**71,993,637**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	16,296,660			11.29%	
Material	45,128,900			31.26%	
Subcontract	7,900,159			5.47%	
Equipment	2,450,597			1.70%	
Other	217,322			0.15%	
	71,993,638	**71,993,638 USD**		**49.86**	**49.86%**
SubMU (60% directs at 20%)	8,639,236		12.000 %	5.98%	
	8,639,236	**80,632,874 USD**		**5.98**	**55.84%**
Subcontractor Bond	1,209,493		1.500 %	0.84%	
	1,209,493	**81,842,367 USD**		**0.84**	**56.68%**
General Conditions	8,184,237		10.000 %	5.67%	
	8,184,237	**90,026,604 USD**		**5.67**	**62.35%**
Building Permits	900,266		1.000 %	0.62%	
Sales Tax	3,610,312		8.000 %	2.50%	
	4,510,578	**94,537,182 USD**		**3.12**	**65.47%**
Builders Risk Insurance	189,074		0.200 %	0.13%	
Gen Liability Insurance	945,372		1.000 %	0.65%	
GC Bonds	1,418,058		1.500 %	0.98%	
	2,552,504	**97,089,686 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**97,089,686 USD**			**67.24%**
Contractor Total OH&P	7,767,175		8.000 %	5.38%	
	7,767,175	**104,856,861 USD**		**5.38**	**72.62%**
Construction Contingency	26,214,215		25.000 %	18.16%	
	26,214,215	**131,071,076 USD**		**18.16**	**90.78%**
Engineering & Design	10,485,686		8.000 %	7.26%	
	10,485,686	**141,556,762 USD**		**7.26**	**98.04%**
Escalation	2,831,135		2.000 %	1.96%	
	2,831,135	**144,387,897 USD**		**1.96**	**100.00%**
Total		***144,387,897 USD***			

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Morro Bay 10% Conceptual Cost Estimate

Summary Report

SBR Option with Cayucos Participation Included - Phase 2

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	
1150 Microfiltration, Reverse Osmosis, UV Building	**7,582,330**
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	**7,582,330**
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	**620,694**
3030 Recycle Pipeline from WRF to South of Hwy - 16"	**1,314,835**
1.2.10 Recycle Water Pump Station & Pipeline	**1,935,529**
02 Phase 2	**9,517,859**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	920,195			4.75%	
Material	8,303,898			42.86%	
Subcontract	166,402			0.86%	
Equipment	105,903			0.55%	
Other	21,462			0.11%	
	9,517,860	**9,517,860 USD**		**49.13**	**49.13%**
SubMU (60% directs at 20%)	1,142,143		12.000 %	5.90%	
	1,142,143	**10,660,003 USD**		**5.90**	**55.02%**
Subcontractor Bond	159,900		1.500 %	0.83%	
	159,900	**10,819,903 USD**		**0.83**	**55.85%**
General Conditions	1,081,990		10.000 %	5.58%	
	1,081,990	**11,901,893 USD**		**5.58**	**61.43%**
Building Permits	119,019		1.000 %	0.61%	
Sales Tax	664,312		8.000 %	3.43%	
	783,331	**12,685,224 USD**		**4.04**	**65.47%**
Builders Risk Insurance	25,370		0.200 %	0.13%	
Gen Liability Insurance	126,852		1.000 %	0.65%	
GC Bonds	190,278		1.500 %	0.98%	
	342,500	**13,027,724 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**13,027,724 USD**			**67.24%**
Contractor Total OH&P	1,042,218		8.000 %	5.38%	
	1,042,218	**14,069,942 USD**		**5.38**	**72.62%**
Construction Contingency	3,517,486		25.000 %	18.16%	
	3,517,486	**17,587,428 USD**		**18.16**	**90.78%**
Engineering & Design	1,406,994		8.000 %	7.26%	
	1,406,994	**18,994,422 USD**		**7.26**	**98.04%**
Escalation	379,888		2.000 %	1.96%	
	379,888	**19,374,310 USD**		**1.96**	**100.00%**
Total		***19,374,310 USD***			

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	
1150 Microfiltration, Reverse Osmosis, UV Building	
1170001011.10001 Process Equipment - MF/UV	6,525,447
1170001015.10110 Mechanical - Process Piping - RO Equipment Add Only	1,056,883
1150 Microfiltration, Reverse Osmosis, UV Building	7,582,330
1.1.55 MF/RO/UV Facility - RO Equipment Add Only	7,582,330
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	
1170001002.11001 Facility Excavation & Backfill - Eff. PS	7,696
1170001003.11200 Concrete SOG/Pad - 1' - Eff. PS	63,706
1170001005.11001 Metals - Eff. PS	9,932
1170001009.11001 Finishes - Eff. PS	7,250
1170001011.11001 Process Equipment - Eff. PS	253,849
1170001015.11100 Mechanical - Process Piping - Eff. PS	202,629
1170001015.11200 Mechanical - Plumbing Piping - Eff. PS	11,960
1170001016.11001 Electrical & I&C - Eff. PS	63,673
1160 Effluent Pump Station	620,694
3030 Recycle Pipeline from WRF to South of Hwy - 16"	
1150001502.01011 Recycle Pipeline - Open Area	635,265
1150001502.04031 Recycle Pipeline - Road/City Installation	551,649
1150001502.05011 Recycle Pipeline - Jack & Bore Location	127,921
3030 Recycle Pipeline from WRF to South of Hwy - 16"	1,314,835
1.2.10 Recycle Water Pump Station & Pipeline	1,935,529
02 Phase 2	**9,517,859**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	920,195			4.75%	
Material	8,303,898			42.86%	
Subcontract	166,402			0.86%	
Equipment	105,903			0.55%	
Other	21,462			0.11%	
	9,517,860	**9,517,860 USD**		**49.13**	**49.13%**
SubMU (60% directs at 20%)	1,142,143		12.000 %	5.90%	
	1,142,143	**10,660,003 USD**		**5.90**	**55.02%**
Subcontractor Bond	159,900		1.500 %	0.83%	
	159,900	**10,819,903 USD**		**0.83**	**55.85%**
General Conditions	1,081,990		10.000 %	5.58%	
	1,081,990	**11,901,893 USD**		**5.58**	**61.43%**
Building Permits	119,019		1.000 %	0.61%	
Sales Tax	664,312		8.000 %	3.43%	
	783,331	**12,685,224 USD**		**4.04**	**65.47%**
Builders Risk Insurance	25,370		0.200 %	0.13%	
Gen Liability Insurance	126,852		1.000 %	0.65%	
GC Bonds	190,278		1.500 %	0.98%	
	342,500	**13,027,724 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**13,027,724 USD**			**67.24%**
Contractor Total OH&P	1,042,218		8.000 %	5.38%	
	1,042,218	**14,069,942 USD**		**5.38**	**72.62%**
Construction Contingency	3,517,486		25.000 %	18.16%	
	3,517,486	**17,587,428 USD**		**18.16**	**90.78%**
Engineering & Design	1,406,994		8.000 %	7.26%	
	1,406,994	**18,994,422 USD**		**7.26**	**98.04%**
Escalation	379,888		2.000 %	1.96%	
	379,888	**19,374,310 USD**		**1.96**	**100.00%**
Total		***19,374,310 USD***			

Morro Bay 10% Conceptual Cost Estimate

Summary Report

MBR Option with Cayucos Participation Included - Phase 1

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	**1,023,157**
1020 Yard Piping	**2,472,602**
1030 Yard Electrical	**1,483,662**
1040 Headworks	**3,949,501**
1050 Odor Control - Facility #1 - Headworks and MBR	**993,289**
1070 Equalization Basin	**10,840,115**
1085 Membrane Bio Reactor (MBR) Option	**12,765,503**
1090 Dewatering Building	**3,965,838**
1100 Odor Control - #2 - Dewatering Bldg	**632,387**
1110 Sludge Storage Tank Area	**670,788**
1120 Standby/Emergency Power	**830,119**
1130 Secondary Equalization Tank	**453,728**
1140 Electrical Building	**2,244,086**
1170 Chemical/Clean In Place Chemical Storage	**2,756,000**
1180 Septage Receiving Station	**432,027**
1200 Remote Operations Building	**374,946**
1.1.00 WRF On-Site Facilities	**45,887,748**
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	**1,581,755**
5020 Administration/Operations Facility	**4,474,875**
5050 Sitework	**1,432,220**
5060 Yard Piping - WWOF Only	**543,312**
5070 Yard Electrical - Interior	**481,641**
1.1.10 Water/Wastewater Operations Facilities	**8,513,803**
1.1.20 Access Road to WWOF Area	
1010 Sitework	**169,494**
1020 Yard Piping	**105,409**
1.1.20 Access Road to WWOF Area	**274,903**
1.1.51 UV/RO Facility	
1151 UV, Reverse Osmosis Building	**6,418,511**
1.1.51 UV/RO Facility	**6,418,511**
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	**648,030**
1.1.60 Fire Pump Building	**648,030**
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	**620,694**
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	**2,660,253**
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	**8,071,431**
1.2.00 Conveyance and Offsite Facilities	**11,352,378**
01 Phase 1	**73,095,373**

Morro Bay 10% Conceptual Cost Estimate

Summary Report

MBR Option with Cayucos Participation Included - Phase 1

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	15,724,173			10.71%	
Material	47,267,352			32.20%	
Subcontract	7,537,849			5.14%	
Equipment	2,357,549			1.61%	
Other	208,450			0.14%	
	73,095,373	**73,095,373 USD**		**49.80**	**49.80%**
SubMU (60% directs at 20%)	8,771,445		12.000 %	5.98%	
	8,771,445	**81,866,818 USD**		**5.98**	**55.78%**
Subcontractor Bond	1,228,002		1.500 %	0.84%	
	1,228,002	**83,094,820 USD**		**0.84**	**56.61%**
General Conditions	8,309,482		10.000 %	5.66%	
	8,309,482	**91,404,302 USD**		**5.66**	**62.28%**
Building Permits	914,043		1.000 %	0.62%	
Sales Tax	3,781,388		8.000 %	2.58%	
	4,695,431	**96,099,733 USD**		**3.20**	**65.47%**
Builders Risk Insurance	192,199		0.200 %	0.13%	
Gen Liability Insurance	960,997		1.000 %	0.65%	
GC Bonds	1,441,496		1.500 %	0.98%	
	2,594,692	**98,694,425 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**98,694,425 USD**			**67.24%**
Contractor Total OH&P	7,895,554		8.000 %	5.38%	
	7,895,554	**106,589,979 USD**		**5.38**	**72.62%**
Construction Contingency	26,647,495		25.000 %	18.16%	
	26,647,495	**133,237,474 USD**		**18.16**	**90.78%**
Engineering & Design	10,658,998		8.000 %	7.26%	
	10,658,998	**143,896,472 USD**		**7.26**	**98.04%**
Escalation	2,877,929		2.000 %	1.96%	
	2,877,929	**146,774,401 USD**		**1.96**	**100.00%**
Total		***146,774,401 USD***			

Spreadsheet Level	Total Amount
01 Phase 1	
1.1.00 WRF On-Site Facilities	
1010 Sitework	
1150001002.01001 Site Paving - Roads and C&G - WRF	451,290
1150001002.02001 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WRF	541,240
1150001002.03001 Site Retaining Walls - WRF	30,627
1010 Sitework	1,023,157
1020 Yard Piping	
1150002002.01001 Yard Piping - Utilties - WRF	553,297
1150002002.02001 Yard Piping - Process	1,919,305
1020 Yard Piping	2,472,602
1030 Yard Electrical	
1150002002.03001 Yard Electrical	1,483,662
1030 Yard Electrical	1,483,662
1040 Headworks	
1170001002.01001 Facility Excavation & Backfill - Headworks	203,193
1170001003.01100 Concrete Ftg - Backwall/Retaining Wall Under SOG - Headworks	50,868
1170001003.01200 Concrete SOG - 2' - Headworks	154,381
1170001003.01300 Concrete Walls - 2' - Headworks	179,918
1170001003.01400 Concrete Interior Misc - Headworks - Allowance	121,626
1170001004.01001 Exterior Masonry Walls - Headworks	132,649
1170001005.01001 Metals - Headworks	228,382
1170001006.01001 FRP - Headworks	70,341
1170001007.01001 Dampproofing - Headworks	3,189
1170001007.02001 Roofing - Headworks	17,500
1170001008.01001 Openings - Headworks	27,369
1170001009.01001 Finishes - Headworks	134,190
1170001011.01001 Process Equipment - Headworks	1,164,376
1170001014.01001 Conveying Equipment - Hoisting - Headworks	200,000
1170001015.01100 Mechanical - Process Piping - Headworks	736,261
1170001015.01200 Mechanical - Plumbing Piping - Headworks	55,881
1170001015.01300 Mechanical - HVAC - Headworks	210,000
1170001016.01001 Electrical & I&C - Headworks	259,378
1040 Headworks	3,949,501
1050 Odor Control - Facility #1 - Headworks and MBR	
1170001002.02001 Facility Excavation & Backfill - Odor Control	5,840
1170001003.02200 Concrete SOG - Odor Control Pad - 2'	55,769
1170001003.02400 Concrete Interior Misc - Odor Control #1 - Allowance	13,400
1170001005.02001 Metals - Odor Control #1	17,363
1170001009.02001 Finishes - Odor Control	8,485
1170001011.02001 Process Equipment - Odor Control	257,924
1170001015.02100 Mechanical - Process Piping/Ductwork - Odor Control	544,207
1170001015.02200 Mechanical - Plumbing Piping - Odor Control	13,700
1170001016.02001 Electrical & I&C - Odor Control	76,601
1050 Odor Control - Facility #1 - Headworks and MBR	993,289
1070 Equalization Basin	
1170001002.03001 Facility Excavation & Backfill - EQ Basin	1,070,676
1170001003.03100 Concrete Ftg - Backwall/Retaining Wall Under SOG - EQ Basin	418,284
1170001003.03200 Concrete SOG/Tank Bottom - 3' - EQ Basin	1,529,510
1170001003.03300 Concrete Wall - Back/Ret Wall 3' - EQ Basin	595,238

Spreadsheet Level	Total Amount
1170001003.03310 Concrete Wall - Exterior Walls 2' - EQ Basin	684,193
1170001003.03320 Concrete Wall - Interior Walls 2' - EQ Basin	893,884
1170001003.03330 Elevated Concrete Deck - EQ Basin - 1'	957,288
1170001003.03400 Concrete Interior Misc - EQ Basin - Allowance	31,325
1170001005.03001 Metals - EQ Basin	82,988
1170001006.03001 FRP - EQ Basin	26,061
1170001007.03001 Dampproofing - EQ Basin	8,957
1170001008.03001 Openings - EQ Basin	25,644
1170001009.03001 Finishes - EQ Basin	1,820,672
1170001011.03001 Process Equipment - EQ Basin	1,322,432
1170001015.03100 Mechanical - Process Piping - EQ Basin	769,636
1170001015.03200 Mechanical - Plumbing Piping - EQ Basin	13,700
1170001015.03300 Mechanical - HVAC - EQ Basin	41,000
1170001016.03001 Electrical & I&C - EQ Basin	548,627
1070 Equalization Basin	10,840,115
1085 Membrane Bio Reactor (MBR) Option	
1170001002.17001 Facility Excavation & Backfill - MBR	221,274
1170001003.17100 Concrete Ftg - Backwall/Retaining Wall Under SOG - MBR	86,532
1170001003.17200 Concrete SOG/Tank Bottom - 3' - MBR	251,245
1170001003.17300 Concrete Wall - Back/Ret Wall 3' - MBR	182,733
1170001003.17310 Concrete Wall - Exterior Walls 2' - MBR	301,616
1170001003.17320 Concrete Wall - Interior Walls 2' - MBR	516,990
1170001003.17330 Elevated Concrete Deck - MBR - 1'	303,641
1170001003.17400 Concrete Interior Misc - MBR - Allowance	31,325
1170001005.17001 Metals - MBR	151,393
1170001006.17001 FRP - MBR	14,280
1170001007.17001 Dampproofing - MBR	3,120
1170001008.17001 Openings - MBR	20,088
1170001009.17001 Finishes - MBR	577,796
1170001011.17001 Process Equipment - MBR	6,231,662
1170001014.17001 Conveying Equipment - Hoisting - MBR	200,000
1170001015.17100 Mechanical - Process Piping - MBR	1,816,387
1170001016.17001 Electrical & I&C - MBR	1,855,420
1085 Membrane Bio Reactor (MBR) Option	12,765,503
1090 Dewatering Building	
1170001002.05001 Facility Excavation & Backfill - Dewatering Bldg	8,527
1170001003.05200 Concrete SOG - 2' - Dewatering Bldg	119,427
1170001003.05400 Concrete Interior Misc - Dewatering Bldg - Allowance	69,500
1170001004.05001 Exterior Masonry Walls - Dewatering Bldg	141,712
1170001005.05001 Metals - Dewatering Bldg	216,035
1170001007.05001 Roofing - Dewatering Bldg	19,270
1170001008.05001 Openings - Dewatering Bldg	40,327
1170001009.05001 Finishes - Dewatering Bldg	32,350
1170001011.05001 Process Equipment - Dewatering Bldg	1,829,768
1170001014.05001 Conveying Equipment - Hoisting - Dewatering Bldg	200,000
1170001015.05100 Mechanical - Process Piping - Dewatering Bldg	799,929
1170001015.05200 Mechanical - Plumbing Piping - Dewatering Bldg	27,181
1170001015.05300 Mechanical - HVAC - Dewatering Bldg	154,160
1170001015.05400 Mechanical - Fire Protection - Dewatering Bldg	13,489
1170001016.05001 Electrical & I&C - Dewatering Bldg	294,162

Spreadsheet Level	Total Amount
1090 Dewatering Building	3,965,838
1100 Odor Control - #2 - Dewatering Bldg	
1170001002.28001 Facility Excavation & Backfill - Odor Control #2	5,840
1170001003.28200 Concrete SOG - Odor Control #2 Pad - 2'	55,769
1170001003.28400 Concrete Interior Misc - Odor Control #2 - Allowance	13,400
1170001005.28001 Metals - Odor Control #2	17,363
1170001009.28001 Finishes - Odor Control #2	8,485
1170001011.28001 Process Equipment - Odor Control #2	257,924
1170001015.28100 Mechanical - Process Piping/Ductwork - Odor Control #2	183,304
1170001015.28200 Mechanical - Plumbing Piping - Odor Control #2	13,700
1170001016.28001 Electrical & I&C - Odor Control #2	76,601
1100 Odor Control - #2 - Dewatering Bldg	632,387
1110 Sludge Storage Tank Area	
1170001002.06001 Facility Excavation & Backfill - Sludge Storage Tank Area	6,841
1170001003.06201 Concrete Tank Pad - 3' - Sludge Storage Tank Area	65,663
1170001003.06400 Concrete Interior Misc - Sludge Storage - Allowance	12,400
1170001009.06001 Finishes - Sludge Storage	3,950
1170001011.06001 Process Equipment - Sludge Storage	131,339
1170001013.06100 Storage Tank - Bolted Steel Glass-Lined - Sludge Storage Tank	333,788
1170001015.06100 Mechanical - Process Piping - Sludge Storage	65,762
1170001015.06200 Mechanical - Plumbing Piping - Sludge Storage	5,980
1170001016.06001 Electrical & I&C - Sludge Storage	45,065
1110 Sludge Storage Tank Area	670,788
1120 Standby/Emergency Power	
1170001002.07001 Facility Excavation & Backfill - S/E Generator	3,978
1170001003.07200 Concrete PAD - 3' - S/E Generator	73,007
1170001005.07001 Metals - S/E Generator	13,432
1170001009.07001 Finishes - S/E Generator	5,000
1170001016.07001 Electrical & I&C - S/E Generator	734,702
1120 Standby/Emergency Power	830,119
1130 Secondary Equalization Tank	
1170001002.09001 Facility Excavation & Backfill - 2nd EQ Tank	6,841
1170001003.09200 Concrete Tank Pad - 3' - 2nd EQ Tank	65,663
1170001003.09400 Concrete Exterior Misc - 2nd EQ Tank - Allowance	12,400
1170001009.09001 Finishes - 2nd EQ Tank	1,685
1170001013.09100 Storage Tank - Concrete - 2nd EQ Tank	310,500
1170001015.09100 Mechanical - Process Piping - 2nd EQ Tank	32,881
1170001015.09200 Mechanical - Plumbing Piping - 2nd EQ Tank	5,980
1170001016.09001 Electrical & I&C - 2nd EQ Tank	17,778
1130 Secondary Equalization Tank	453,728
1140 Electrical Building	
1170001002.08001 Facility Excavation & Backfill - Electrical Bldg	4,636
1170001003.08200 Concrete SOG - 2' - Electrical Bldg	57,671
1170001003.08400 Concrete Interior Misc - Electrical Bldg - Allowance	13,400
1170001004.08001 Exterior Masonry Walls - Electrical Bldg	101,066
1170001005.08001 Metals - Electrical Bldg	49,254
1170001007.08001 Roofing - Electrical Bldg	9,300
1170001008.08001 Openings - Electrical Bldg	17,599
1170001009.08001 Finishes - Electrical Bldg	5,000
1170001015.08300 Mechanical - HVAC - Electrical Bldg	93,000

Spreadsheet Level	Total Amount
1170001016.08001 Electrical & I&C - Electrical Bldg	1,893,160
1140 Electrical Building	2,244,086
1170 Chemical/Clean In Place Chemical Storage	
1170001002.13001 Facility Excavation & Backfill - Chemical Storage	14,072
1170001003.13200 Concrete SOG - 2' - Chem Storage	178,176
1170001003.13600 Concrete Containment Walls - 1' - Chem Storage	154,870
1170001006.13001 FRP - Chem Storage	187,121
1170001009.13001 Finishes - Chem Storage	362,821
1170001011.13001 Process Equipment - Chem Storage	451,342
1170001013.13001 PEMB - Canopy - Chem Storage	168,000
1170001013.13100 Storage Tanks - Chem Storage	597,302
1170001015.13100 Mechanical - Process Piping - Chem Storage	394,207
1170001015.13200 Mechanical - Plumbing Piping - Chem Storage	45,440
1170001016.13001 Electrical & I&C - Chem Storage	202,649
1170 Chemical/Clean In Place Chemical Storage	2,756,000
1180 Septage Receiving Station	
1170001002.14100 Facility Excavation & Backfill - SRS	443
1170001003.14200 Concrete SOG/Pad - 1' - SRS	3,563
1170001003.14400 Concrete Exterior Misc - SRS - Allowance	7,925
1170001005.14001 Metals - SRS	9,932
1170001009.14001 Finishes - SRS	7,250
1170001011.14001 Process Equipment - SRS	231,697
1170001015.14100 Mechanical - Process Piping - SRS	107,203
1170001015.14200 Mechanical - Plumbing Piping - SRS	11,960
1170001016.14001 Electrical & I&C - SRS	52,054
1180 Septage Receiving Station	432,027
1200 Remote Operations Building	
1170001002.12001 Facility Excavation & Backfill - Ops Bldg	4,330
1170001003.12200 Concrete SOG - 1' - Ops Bldg	31,619
1170001005.12001 Metals - Ops Bldg	19,863
1170001008.12001 Openings - Ops Bldg	35,324
1170001009.12001 Finishes - Ops Bldg	35,000
1170001010.12001 Specialties - Ops Bldg	6,547
1170001012.12001 Furnishings - Ops Bldg	31,187
1170001013.12100 PEMB - Remote Ops Bldg	28,000
1170001015.12200 Mechanical - Plumbing Piping - Ops Bldg	20,440
1170001015.12300 Mechanical - HVAC - Ops Bldg	50,000
1170001015.12400 Mechanical - Fire Protection - Ops Bldg	8,500
1170001016.12001 Electrical & I&C - Ops Bldg	104,135
1200 Remote Operations Building	374,946
1.1.00 WRF On-Site Facilities	45,887,748
1.1.10 Water/Wastewater Operations Facilities	
5010 Maintenance Facility	
1170001002.31001 Facility Excavation & Backfill - Maintenance Facility	21,123
1170001003.31200 Concrete SOG - 2' - Maint Facility	108,849
1170001003.31400 Concrete Interior Misc - Maint Facility - Allowance	20,900
1170001004.31001 Exterior Masonry Walls - Maintenance Facility	205,977
1170001005.31001 Metals - Maintenance Facility	260,537
1170001006.31001 FRP - Maintenance Facility	16,780
1170001007.31100 Roofing - Maintenance Facility	60,000

Spreadsheet Level	Total Amount
1170001008.31001 Openings - Maintenance Facility	65,830
1170001009.31001 Finishes - Maintenance Facility	110,209
1170001014.31001 Conveying Equipment - Hoisting - Maintenance Facility	200,000
1170001015.31200 Mechanical - Plumbing Piping - Maint. Facility	55,881
1170001015.31300 Mechanical - HVAC - Maintenance Facility	210,000
1170001016.31001 Electrical & I&C - Maintenance Facility	245,669
5010 Maintenance Facility	1,581,755
5020 Administration/Operations Facility	
1170001002.32001 Facility Excavation & Backfill - Admin/Ops Facility	71,032
1170001003.32200 Concrete SOG - 2' - Admin/Ops Facility	351,993
1170001004.32001 Exterior Masonry Walls - Admin/Ops Facility	384,491
1170001005.32001 Metals - Admin/Ops Facility	642,134
1170001007.32001 Roofing - Admin/Ops Facility	213,975
1170001008.32001 Openings - Admin/Ops Facility	193,847
1170001009.32001 Finishes - Admin/Ops Facility	551,525
1170001010.32001 Specialties - Admin/Ops Facility	62,734
1170001012.32001 Furnishings - Admin/Ops Facility	471,654
1170001015.32200 Mechanical - Plumbing Piping - Admin/Ops Facility	80,881
1170001015.32300 Mechanical - HVAC - Admin/Ops Facility	692,700
1170001015.32400 Mechanical - Fire Protection - Admin/Ops Facility	98,133
1170001016.32001 Electrical & I&C - Admin/Ops Facility	659,777
5020 Administration/Operations Facility	4,474,875
5050 Sitework	
1150001002.01005 Site Paving - Roads - WWOF	96,130
1150001002.01007 Site Paving - Interior - WWOF	154,426
1150001002.02005 Earthwork - Site Excavation Cut/Fill (NOA Soils) - WWOF	1,056,733
1150001002.03005 Site Retaining Walls - WWOF	124,930
5050 Sitework	1,432,220
5060 Yard Piping - WWOF Only	
1150002002.01005 Yard Piping - Utilities - WWOF Road	122,336
1150002002.01008 Yard Piping - Utilities - WWOF - Interior for Admin/Maint Facilit	420,976
5060 Yard Piping - WWOF Only	543,312
5070 Yard Electrical - Interior	
1150002002.03011 Yard Electrical - Interior WWOF	481,641
5070 Yard Electrical - Interior	481,641
1.1.10 Water/Wastewater Operations Facilities	8,513,803
1.1.20 Access Road to WWOF Area	
1010 Sitework	
1150001002.01011 Site Paving - Roads - Access Road	99,084
1150001002.02011 Earthwork - Site Excavation Cut/Fill (NOA Soils) - Access Rd	70,410
1010 Sitework	169,494
1020 Yard Piping	
1150002002.01011 Yard Piping - Utilities - Access Road	105,409
1020 Yard Piping	105,409
1.1.20 Access Road to WWOF Area	274,903
1.1.51 UV/RO Facility	
1151 UV, Reverse Osmosis Building	
1170001002.10011 Facility Excavation & Backfill - UV/RO	20,034
1170001003.10211 Concrete SOG - 2' - UV/RO	312,241
1170001003.10411 Concrete Interior Misc - UV/RO - Allowance	121,626

Spreadsheet Level	Total Amount
1170001004.10011 Exterior Masonry Walls - UV/RO	472,924
1170001005.10011 Metals - UV/RO	539,112
1170001006.10011 FRP - UV/RO	33,561
1170001007.10011 Roofing - UV/RO	47,068
1170001008.10011 Openings - UV/RO	39,792
1170001009.10011 Finishes - UV/RO	54,300
1170001010.10011 Specialties - UV/RO	9,593
1170001011.10011 Process Equipment - UV	1,250,092
1170001012.10011 Furnishings - UV/RO	4,047
1170001015.10111 Mechanical - Process Piping - UV/RO	955,011
1170001015.10211 Mechanical - Plumbing Piping - UV/RO	77,203
1170001015.10311 Mechanical - HVAC - UV/RO	376,544
1170001015.10411 Mechanical - Fire Protection - UV/RO	32,948
1170001016.10011 Electrical & I&C - UV/RO	2,072,417
1151 UV, Reverse Osmosis Building	6,418,511
1.1.51 UV/RO Facility	6,418,511
1.1.60 Fire Pump Building	
1210 Fire Pump Facility	
1170001002.16001 Facility Excavation & Backfill - Fire Pump Bldg	726
1170001003.16200 Concrete SOG - 1' - Fire Pump Bldg	4,276
1170001003.16400 Concrete Interior Misc - Fire Pump Bldg - Allowance	12,950
1170001004.16001 Exterior Masonry Walls - Fire Pump Bldg	24,717
1170001005.16001 Metals - Fire Pump Bldg	27,860
1170001007.16001 Roofing - Fire Pump Bldg	1,125
1170001008.16001 Openings - Fire Pump Bldg	18,948
1170001009.16001 Finishes - Fire Pump Bldg	10,900
1170001015.16100 Mechanical - Process Piping - Fire Pump Bldg	62,401
1170001015.16200 Mechanical - Plumbing Piping - Fire Pump Bldg	14,960
1170001015.16300 Mechanical - HVAC - Fire Pump Bldg	10,125
1170001015.16400 Mechanical - Fire Protection - Fire Pump Bldg	354,960
1170001016.16001 Electrical & I&C - Fire Pump Bldg	104,081
1210 Fire Pump Facility	648,030
1.1.60 Fire Pump Building	648,030
1.2.00 Conveyance and Offsite Facilities	
1165 Brine Pump Station (Adjacent to Eff PS)	
1170001002.15001 Facility Excavation & Backfill - Brine PS	7,696
1170001003.15200 Concrete SOG/Pad - 1' - Brine PS	63,706
1170001005.15001 Metals - Brine PS	9,932
1170001009.15001 Finishes - Brine PS	7,250
1170001011.15001 Process Equipment - Brine PS	253,849
1170001015.15100 Mechanical - Process Piping - Brine PS	202,629
1170001015.15200 Mechanical - Plumbing Piping - Brine PS	11,960
1170001016.15001 Electrical & I&C - Brine PS	63,673
1165 Brine Pump Station (Adjacent to Eff PS)	620,694
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	
1150002002.20001 Yard Piping - Utilties - Lift Station	74,498
1170001002.20001 Site Demo - New Lift Station Area	93,425
1170001002.20011 Automatic Swing Gate - New Lift Station Area	8,500
1170001002.21001 Facility Excavation & Backfill - Wet Well/Lift Station	384,859
1170001003.20200 WetWell SOG - 2' - Lift Station	24,218

Spreadsheet Level	Total Amount
1170001003.20300 WetWell Walls - 1.5' - Lift Station	130,160
1170001003.20400 WetWell Elev Slab/Lid - 1.5' - Lift Station	55,711
1170001003.20500 Concrete Interior Misc - Lift Station - Allowance	97,301
1170001003.21200 Concrete SOG/Pad - 8" - Lift Station	157,910
1170001004.21001 Exterior Masonry Walls - Control Bldg	26,145
1170001004.21011 Exterior Masonry Walls - Perimeter Wall	138,417
1170001005.20001 Metals - Lift Station	92,841
1170001007.20001 Dampproofing - Wet Well	3,721
1170001007.21001 Roofing - Lift Station/Control Bldg	7,350
1170001008.20001 Openings - Lift Station	16,716
1170001009.20001 Finishes - Lift Station & Wet Well	91,852
1170001010.20001 Specialties - Lift Station/Control Bldg	1,119
1170001011.20001 Process Equipment - Lift Station	762,471
1170001012.21001 Furnishings - Lift Station/Control Bldg	1,273
1170001015.20100 Mechanical - Process Piping - Lift Station	109,003
1170001015.20200 Mechanical - Plumbing Piping - Lift Station/Control Bldg	17,200
1170001015.20300 Mechanical - HVAC - Lift Station/Control Bldg	13,720
1170001016.20001 Electrical & I&C - Lift Station	351,843
2010 Raw Wastewater Pump Station (New Lift Station at Exist Site)	2,660,253
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	
1150001502.01001 Force Main & Brine Pipeline - Open Area	696,067
1150001502.02001 Force Main & Brine Pipeline - Open Area/Sidewalk/Path	88,149
1150001502.03001 Force Main & Brine Pipeline - Open Area with Trees	1,223,157
1150001502.04001 Force Main & Brine Pipeline - Road/City Installation	5,338,135
1150001502.04011 Force Main Pipeline - Road/City Installation - At Lift Station	35,156
1150001502.04021 Brine Pipeline - Road/City Installation - To Outfall Structure	159,526
1150001502.05001 Force Main & Brine Pipeline - Jack & Bore Locations	531,241
3010 16" FM to WRF & 18" Brine Line from WRF to Outfall	8,071,431
1.2.00 Conveyance and Offsite Facilities	11,352,378
01 Phase 1	**73,095,373**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	15,724,173			10.71%	
Material	47,267,352			32.20%	
Subcontract	7,537,849			5.14%	
Equipment	2,357,549			1.61%	
Other	208,450			0.14%	
	73,095,373	**73,095,373 USD**		**49.80**	**49.80%**
SubMU (60% directs at 20%)	8,771,445		12.000 %	5.98%	
	8,771,445	**81,866,818 USD**		**5.98**	**55.78%**
Subcontractor Bond	1,228,002		1.500 %	0.84%	
	1,228,002	**83,094,820 USD**		**0.84**	**56.61%**
General Conditions	8,309,482		10.000 %	5.66%	
	8,309,482	**91,404,302 USD**		**5.66**	**62.28%**
Building Permits	914,043		1.000 %	0.62%	
Sales Tax	3,781,388		8.000 %	2.58%	
	4,695,431	**96,099,733 USD**		**3.20**	**65.47%**
Builders Risk Insurance	192,199		0.200 %	0.13%	
Gen Liability Insurance	960,997		1.000 %	0.65%	
GC Bonds	1,441,496		1.500 %	0.98%	
	2,594,692	**98,694,425 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**98,694,425 USD**			**67.24%**
Contractor Total OH&P	7,895,554		8.000 %	5.38%	
	7,895,554	**106,589,979 USD**		**5.38**	**72.62%**
Construction Contingency	26,647,495		25.000 %	18.16%	
	26,647,495	**133,237,474 USD**		**18.16**	**90.78%**
Engineering & Design	10,658,998		8.000 %	7.26%	
	10,658,998	**143,896,472 USD**		**7.26**	**98.04%**
Escalation	2,877,929		2.000 %	1.96%	
	2,877,929	**146,774,401 USD**		**1.96**	**100.00%**
Total		***146,774,401 USD***			

Morro Bay 10% Conceptual Cost Estimate

Summary Report

MBR Option with Cayucos Participation Included - Phase 2

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.56 UV/RO Facility - RO Equipment Add Only	
1151 UV, Reverse Osmosis Building	**7,582,330**
1.1.56 UV/RO Facility - RO Equipment Add Only	**7,582,330**
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	**620,694**
3030 Recycle Pipeline from WRF to South of Hwy - 16"	**1,314,835**
1.2.10 Recycle Water Pump Station & Pipeline	**1,935,529**
02 Phase 2	**9,517,859**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	920,195			4.75%	
Material	8,303,898			42.86%	
Subcontract	166,402			0.86%	
Equipment	105,903			0.55%	
Other	21,462			0.11%	
	9,517,860	**9,517,860 USD**		**49.13**	**49.13%**
SubMU (60% directs at 20%)	1,142,143		12.000 %	5.90%	
	1,142,143	**10,660,003 USD**		**5.90**	**55.02%**
Subcontractor Bond	159,900		1.500 %	0.83%	
	159,900	**10,819,903 USD**		**0.83**	**55.85%**
General Conditions	1,081,990		10.000 %	5.58%	
	1,081,990	**11,901,893 USD**		**5.58**	**61.43%**
Building Permits	119,019		1.000 %	0.61%	
Sales Tax	664,312		8.000 %	3.43%	
	783,331	**12,685,224 USD**		**4.04**	**65.47%**
Builders Risk Insurance	25,370		0.200 %	0.13%	
Gen Liability Insurance	126,852		1.000 %	0.65%	
GC Bonds	190,278		1.500 %	0.98%	
	342,500	**13,027,724 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**13,027,724 USD**			**67.24%**
Contractor Total OH&P	1,042,218		8.000 %	5.38%	
	1,042,218	**14,069,942 USD**		**5.38**	**72.62%**
Construction Contingency	3,517,486		25.000 %	18.16%	
	3,517,486	**17,587,428 USD**		**18.16**	**90.78%**
Engineering & Design	1,406,994		8.000 %	7.26%	
	1,406,994	**18,994,422 USD**		**7.26**	**98.04%**
Escalation	379,888		2.000 %	1.96%	
	379,888	**19,374,310 USD**		**1.96**	**100.00%**
Total		***19,374,310 USD***			

Morro Bay 10% Conceptual Cost Estimate

Detailed Report

MBR Option with Cayucos Participation Included - Phase 2

Spreadsheet Level	Total Amount
02 Phase 2	
1.1.56 UV/RO Facility - RO Equipment Add Only	
1151 UV, Reverse Osmosis Building	
1170001011.10021 Process Equipment - RO	6,525,447
1170001015.10110 Mechanical - Process Piping - RO Equipment Add Only	1,056,883
1151 UV, Reverse Osmosis Building	7,582,330
1.1.56 UV/RO Facility - RO Equipment Add Only	7,582,330
1.2.10 Recycle Water Pump Station & Pipeline	
1160 Effluent Pump Station	
1170001002.11001 Facility Excavation & Backfill - Eff. PS	7,696
1170001003.11200 Concrete SOG/Pad - 1' - Eff. PS	63,706
1170001005.11001 Metals - Eff. PS	9,932
1170001009.11001 Finishes - Eff. PS	7,250
1170001011.11001 Process Equipment - Eff. PS	253,849
1170001015.11100 Mechanical - Process Piping - Eff. PS	202,629
1170001015.11200 Mechanical - Plumbing Piping - Eff. PS	11,960
1170001016.11001 Electrical & I&C - Eff. PS	63,673
1160 Effluent Pump Station	620,694
3030 Recycle Pipeline from WRF to South of Hwy - 16"	
1150001502.01011 Recycle Pipeline - Open Area	635,265
1150001502.04031 Recycle Pipeline - Road/City Installation	551,649
1150001502.05011 Recycle Pipeline - Jack & Bore Location	127,921
3030 Recycle Pipeline from WRF to South of Hwy - 16"	1,314,835
1.2.10 Recycle Water Pump Station & Pipeline	1,935,529
02 Phase 2	**9,517,859**

Estimate Totals

Description	Amount	Totals	Rate	Percent of Total	
Labor	920,195			4.75%	
Material	8,303,898			42.86%	
Subcontract	166,402			0.86%	
Equipment	105,903			0.55%	
Other	21,462			0.11%	
	9,517,860	**9,517,860 USD**		**49.13**	**49.13%**
SubMU (60% directs at 20%)	1,142,143		12.000 %	5.90%	
	1,142,143	**10,660,003 USD**		**5.90**	**55.02%**
Subcontractor Bond	159,900		1.500 %	0.83%	
	159,900	**10,819,903 USD**		**0.83**	**55.85%**
General Conditions	1,081,990		10.000 %	5.58%	
	1,081,990	**11,901,893 USD**		**5.58**	**61.43%**
Building Permits	119,019		1.000 %	0.61%	
Sales Tax	664,312		8.000 %	3.43%	
	783,331	**12,685,224 USD**		**4.04**	**65.47%**
Builders Risk Insurance	25,370		0.200 %	0.13%	
Gen Liability Insurance	126,852		1.000 %	0.65%	
GC Bonds	190,278		1.500 %	0.98%	
	342,500	**13,027,724 USD**		**1.77**	**67.24%**
Construction Cost Subtotal		**13,027,724 USD**			**67.24%**
Contractor Total OH&P	1,042,218		8.000 %	5.38%	
	1,042,218	**14,069,942 USD**		**5.38**	**72.62%**
Construction Contingency	3,517,486		25.000 %	18.16%	
	3,517,486	**17,587,428 USD**		**18.16**	**90.78%**
Engineering & Design	1,406,994		8.000 %	7.26%	
	1,406,994	**18,994,422 USD**		**7.26**	**98.04%**
Escalation	379,888		2.000 %	1.96%	
	379,888	**19,374,310 USD**		**1.96**	**100.00%**
Total		***19,374,310 USD***			