Technical Memorandum

To:	City of Fort Bragg
From:	Chad Coleman
Reviewed By:	Kevin Thomas John Potts
Date:	April 27, 2018
Project:	Brackish Water Desalination Plant Feasibility Study
Subject:	Memo Cover and Contents

This study evaluates the use of brackish water reverse osmosis (RO) treatment for the City of Fort Bragg's (City) plan to supplement the drinking water supply in the following memos.

Based on the early analysis by our team, we consider the following items to be most critical to the City as future phases of the project are considered:

- Brine concentrate disposal method and location
- Raw water quality relative to TSS because if TSS is elevated another treatment process is required for RO to work
- Locate RO plant at WTP site to reduce capital and operating costs
- Facility sizing consistent with UWMP/General Plan
- Portfolio memo (separate or part of UWMP) to demonstrate need for brackish RO rather than other conventional supplies
- Brine discharge consultation with agency stakeholders
- Local/political support for new water supply
- Evaluation of potential opposition/litigation
- Avoiding sensitive resources (wetlands, cultural resources) to streamline permitting
- Preparing a MND vs. an EIR (cost/risk tradeoffs)

A brief description of the contents of each memo is provided below for reference.

Desalination System Sizing and Design Criteria Memo

This memo documents the water quality assumptions and objectives of the City of Fort Bragg Brackish Water Desalination Plant Feasibility Study. These criteria guide the recommendations for RO treatment and conceptual site planning. Finally, this memo identifies potential data gaps and additional refinement that will be required to advance a desalination system design.

Attachments:

1. Conceptual Process Flow Diagram
2. Conceptual Operations Building Floor Plan
3. Source Water Analytes Example

Regulatory Issues Memo

This memo identifies key regulatory permitting issues and strategies based on a conceptually defined project but does not provide project-specific or site-specific regulatory permitting recommendations.

A Permit Summary Table is included at the end of the memo as a reference to potential regulatory permits organized by regulatory agency.

Raw Water Source and Siting Considerations Memo

This memo addresses raw water source considerations and makes broad recommendations to the City regarding source selection and overall siting considerations. Potential well sites are discussed in generic terms with regards to potential advantages and drawbacks in relation to the other components of the Project. The interconnectedness of the site selection for the brackish raw water source and the RO treatment facilities and the City's existing water and wastewater infrastructure is highlighted in this memo.

Technical Issues Memo

This memo identifies issues of a technical nature and explains their impact on the proposed Project. These technical issues should be addressed during early planning and development elements of the Project as they will have the potential to impact the Project in significant ways.

Construction Cost Opinions Memo

This memo provides a conceptual level opinion of probable construction cost for the desalination process. The memo also includes a brief discussion of available funding and delivery methods for the proposed Project. For all components, conceptual level order of magnitude estimates are provided for planning and prioritization purposes. An estimate at this level does not constitute a detailed estimate, and the accuracy should be considered at a range of ±50%.

Attachments:

1. Itemized Opinion of Probable Construction Cost

Operating Cost Estimate Memo

The memo provides a conceptual level opinion of annual operating cost which will be suitable for use in setting operating budgets during project planning stages. The memo may be used to assist City Officials in understanding order of magnitude level costs so that future planning and design activities can be reasonably considered. The memo includes some consideration for the uncertainty at this stage of the Project evaluation mostly related to Project component site selection.

Technical Memorandum

To:	City of Fort Bragg
From:	Bryan Burnitt
Reviewed By:	Chad Coleman
Date:	April 27, 2018
Project:	Brackish Water Desalination Plant Feasibility Study
Subject:	Desalination System Sizing and Design Criteria

Purpose

This study evaluates the use of brackish water reverse osmosis (RO) treatment for the City of Fort Bragg's (City) plan to supplement the drinking water supply in the anticipation of one or more of the following climatological, developmental or regulatory impacts in the future:

- Decrease in surface water reliability from reduction in rainfall frequency and/or intensity
- Increase in groundwater salinity from seawater intrusion caused by sea level rise
- Reduction in surface water withdraw allowance from the State regulatory agencies
- Increase in water demand within in the City service area from development

This memo documents the water quality assumptions and objectives of the City of Fort Bragg Brackish Water Desalination Plant Feasibility Study. These criteria guide the recommendations for RO treatment and conceptual site planning. Finally, this memo identifies potential data gaps and additional refinement that will be required to advance a desalination system design.

Design Criteria

There are three basic methods for desalination: thermal, electrical, and pressure. Reverse osmosis is a pressure method and is the most economical and has the most developed technology for a system of the size under consideration. Reverse osmosis is the only method with realistic application to the City of Fort Bragg and is the only method considered in this analysis.

The design criteria referenced in this memo result from information provided by the City and include best practice assumptions for brackish water RO treatment. The City brackish groundwater quality data was provided to Coleman Engineering by the City and was reported

to come from a well near the Noyo River. The planning level documents identify a supplemental brackish water treatment system sized to produce 200,000 gallons per day (gpd). Assuming a 75-percent recovery rate through the RO treatment, this finished water flow would require approximately 185 gallons per minute (gpm) raw water flow. This flow appears reasonable given well production rates and the allowable withdraw limits reported.

The design criteria for the recommended desalination system are discussed in detail in the following sections of this memo and are summarized in Table 1.

Table 1. Reverse Osmosis Design Criteria

Design Parameter	Design Criteria
Pre-Treatment Processes	
Disinfection[1]	TBD
Antiscalant[2]	1.0 - 3.0 mg/L
Reverse Osmosis System	
System Type	Single-pass, Two-stage
Design Feed Flow, gpm	165 -185
Design Permeate Flow, gpm	140
Design Concentrate Flow, gpm	25 - 45
Maximum Normal Operating TDS, mg/L	2,500
Operating Flux, gfd	14 - 18
Operating Pressure, psi	100
Recovery, %	75 - 85

[1] Disinfection of groundwater is unlikely, but will need to be considered after site-specific water quality sampling

[2] Antiscalant chemical must be determined after source water is determined

gfd – gallons per square foot per day; gpm – gallons per minute; mg/L – milligrams per liter; psi – pounds per square inch

Based on the design criteria, multiple manufacturers' system recommendations were solicited. Of the system evaluated, the following systems were included as viable options that meet the design criteria.

- Westech

- Harn R/O
- H_2O Innovation
- Engineered Fluid, Inc.

The conceptual Process Flow Diagram (Attachment 1) and the Conceptual Operations Building Floor Plan (Attachment 2) show the schematic and conceptual building plan for planning purposes.

Raw Water Quality

The well water quality parameters from the City are presented below in Table 2. This water quality data reflects a single sample taken during a period of relatively high rainfall in 1999; therefore, it may document low values for total dissolved solids (TDS) because of a more pronounced fresh water influence. For that reason, the values from this sample were approximately doubled for average TDS to provide more realistic, long-term criteria to design the treatment system.

Table 2. Noyo River Well Water Quality Summary and Design Criteria

Water Quality Constituent	1999 Report	Design Criteria
Total Dissolved Solids, mg/L	838	1,500 (2,500 max)
Silt Density Index (SDI)	N/A	<5
Iron, mg/L	0.18	0.3
Manganese, mg/L	0.18	0.3
Odor, TON	ND	ND
Silver, mg/L	ND	ND
Sulfate, mg/L	98	180
Zinc, mg/L	0.021	0.04
pH	7.5	7.5

mg/L – milligrams per liter; N/A – not available; ND – not detected; TON – threshold odor number

Table 2 includes an assumption for SDI, a critical parameter for pretreatment design, which was not included with the well data provided by the City. The assumption is reasonable for a

groundwater source, but if a source with an SDI greater than 5 is selected, then more extensive pretreatment will be required.

Alkalinity, calcium and magnesium will also need to be evaluated for scaling to determine pretreatment requirements. More comprehensive and detailed water quality analysis should include these constituents and will be required prior to detailed design. Attachment 3 provides an example of a water quality analytes to be tested for the brackish source water.

Based on the assumptions and for this evaluation, an elaborate solids removal pretreatment system is not anticipated. Cartridge filters are included as a raw water pre-treatment system to decrease time between membrane cleaning and are standard with most RO systems. In addition, scale inhibitor pretreatment chemicals are included. Scale inhibitor dosage is assumed based on similar brackish groundwater treatment RO systems, but final chemical selection and dosage will be determined during detailed design.

Finally, disinfection may be required to prevent microbial fouling of the RO membranes. Assuming an anaerobic groundwater source, disinfection has not been included at this stage because microbial activity will likely be minimal.

Finished Water Quality

As stated above, the City desires to use the proposed RO system to provide supplemental drinking water supply. Options for RO effluent discharge locations are listed below. Of these locations, only the first location takes advantage of the existing treatment systems to eliminate redundant post-treatment or re-treatment.

1. Blend with Fort Bragg Water Treatment Plant (WTP) treated water directly upstream of the disinfection process
2. Discharge RO treated water into the raw water storage and conveyance system for retreatment at the conventional water treatment plant.
3. Complete independent finished treatment process including disinfection

A single pass, two-stage RO system can achieve the water quality required for any of the options above given the raw water quality assumptions. Note that producing distribution-ready drinking water from the RO system requires post-treatment including disinfection, pH adjustment, and potentially remineralization.

Using the assumed brackish well water quality in Table 2, Table 3 shows expected RO permeate results compared with the maximum contaminant level (MCL) requirements of the WTP. The estimates assume a recovery rate of 75% and salt rejection of 95% from the RO system. Actual recovery rate and rejection may vary from these estimates depending on source water quality.

Table 3. Finished Water Quality

Water Quality Constituent	MCL	Design Criteria
Unregulated Parameters		
Flow, gpm	N/A	140
Primary Standards		
Turbidity, NTU	1.0	<0.1
Secondary Standards		
Total Dissolved Solids, mg/L	1,000	100
Iron, mg/L	0.30	0.02
Odor, TON	3	ND
Sulfate, mg/L	500	<10
Other Constituents of Interest		
Manganese, mg/L	0.05	0.02
Silver, mg/L	ND	ND
Zinc, mg/L	5	<0.01
pH	6.5 - 8.5	5.5 - 6.0 [1]

gpm – gallons per minute; mg/L – milligrams per liter; N/A – not available; ND – not detected; NTU – nephelometric turbidity units; TON – threshold odor number

[1] Finished water from RO treatment will be relatively low in pH and is very likely to require pH adjustment.

Concentrate Quality

RO treatment generates a waste discharge stream of concentrated brine called concentrate. The concentrate flow relates directly to the source water quality and the recovery rate assumptions established above. To provide a conservative estimate (i.e., highest concentrations), the high-end rejection rate of 99% is used. Using the available well water quality, Table 4 shows the projected concentrate flows and predicted concentrate water quality.

Table 4. Brine Concentrate Water Quality

Water Quality Constituent	1,500 TDS	2,500 TDS
Flow, gpm	45	
Total Dissolved Solids, mg/L	5,940	9,900
Iron, mg/L	1.2	
Manganese, mg/L	1.2	
Sulfate, mg/L	388	
Zinc, mg/L	0.2	
pH	7.5	

Options for disposal of the concentrate are discussed in the Technical Issues Memo.

Chemical Consumption and Storage

For this study, it is assumed that chemical consumption for the proposed RO system comes from pretreatment requirements. Additional site space and chemical use may be required for post-desalination treatment if the RO effluent cannot be blended directly into the WTP disinfection process or other raw water. If remineralization is required, additional space may be required for calcite beds, carbon dioxide facilities, and/or other facilities.

Based on the assumption that only pretreatment chemicals should be required, Table 5 describes the chemical applications and projected consumption.

Table 5. Reverse Osmosis Chemical Use

Use / Chemical	Average Dosage[1] (mg/L)	Weekly Demand @ 185 gpm
Antiscalant / 100% active chemical	2.0	31 pounds

[1] Active chemical dose

Site Considerations and Requirements

The site for the desalination process and the raw water source have not been selected by the City at this time. The following section describes the general considerations for the RO treatment process that meet the design criteria described above.

The technical memos listed below provide more detailed recommendations and evaluations of their respective areas of the Project:

- Regulatory Issues Memo
- Raw Water Supply Memo
- Technical Issues Memo

Pretreatment

1. Disinfection – Disinfection of RO feed water is required in microbially-active raw water sources. At this time, a microbially-active raw water source is not anticipated, so a disinfection system is not included. If a microbially-active raw water source is selected, some information is included below for reference.

   Liquid sodium hypochlorite disinfection has benefits based on its availability and cost effectiveness. When used as RO pretreatment, chlorine or any other oxidizing disinfection can damage the membranes if removal of the oxidant is not completed before contact with the RO membranes. In a chlorine system, sodium bisulfite provides a widely available dechlorination option.

   Ultraviolent (UV) disinfection presents no risk of damage to the RO system, but may have some operational and cost disadvantages. When evaluating disinfection, UV should be included as a viable option.

2. Antiscalant – Establishing the need for antiscalant chemical(s) requires a more detailed, and site specific raw water chemistry profile than is available at this time (refer to Attachment 3). The use of a groundwater source with potential for higher calcium and magnesium content makes antiscalant chemical a reasonable expectation. Evaluation of the best chemical type and dose should occur once a raw water source is selected.
3. Filtration – It is recommended that cartridge filtration be strongly considered in any RO design to protect the membranes. Typical cartridge filtration equipment used in RO pretreatment include filters with self-cleaning features for low-cost, long-term operation.

Operations Building

The RO system manufacturers recommend indoor installation which results in better operation and maintenance of the system. The Operations Building includes the following areas and equipment:

- Reverse Osmosis Skid
- Office
- Sampling Laboratory

- Electrical/Mechanical Room
- Chemical Feed Equipment
- Cartridge Filters
- Clean-in-Place System

Based on proposed skids ranging in size from 4'x22' to 8'x25' and allowing for reasonable accessibility around all equipment, the Operations Building will be approximately 28'x36'. The minimum practical site for vehicle access would be 50'x60'. Attachment 2 shows a Conceptual Operations Building Floor Plan.

The RO system would be best located in close proximity to the existing water treatment facilities. Ideally, the RO operations building would be located adjacent to the water treatment plant. The advantages of colocation of these facilities include:

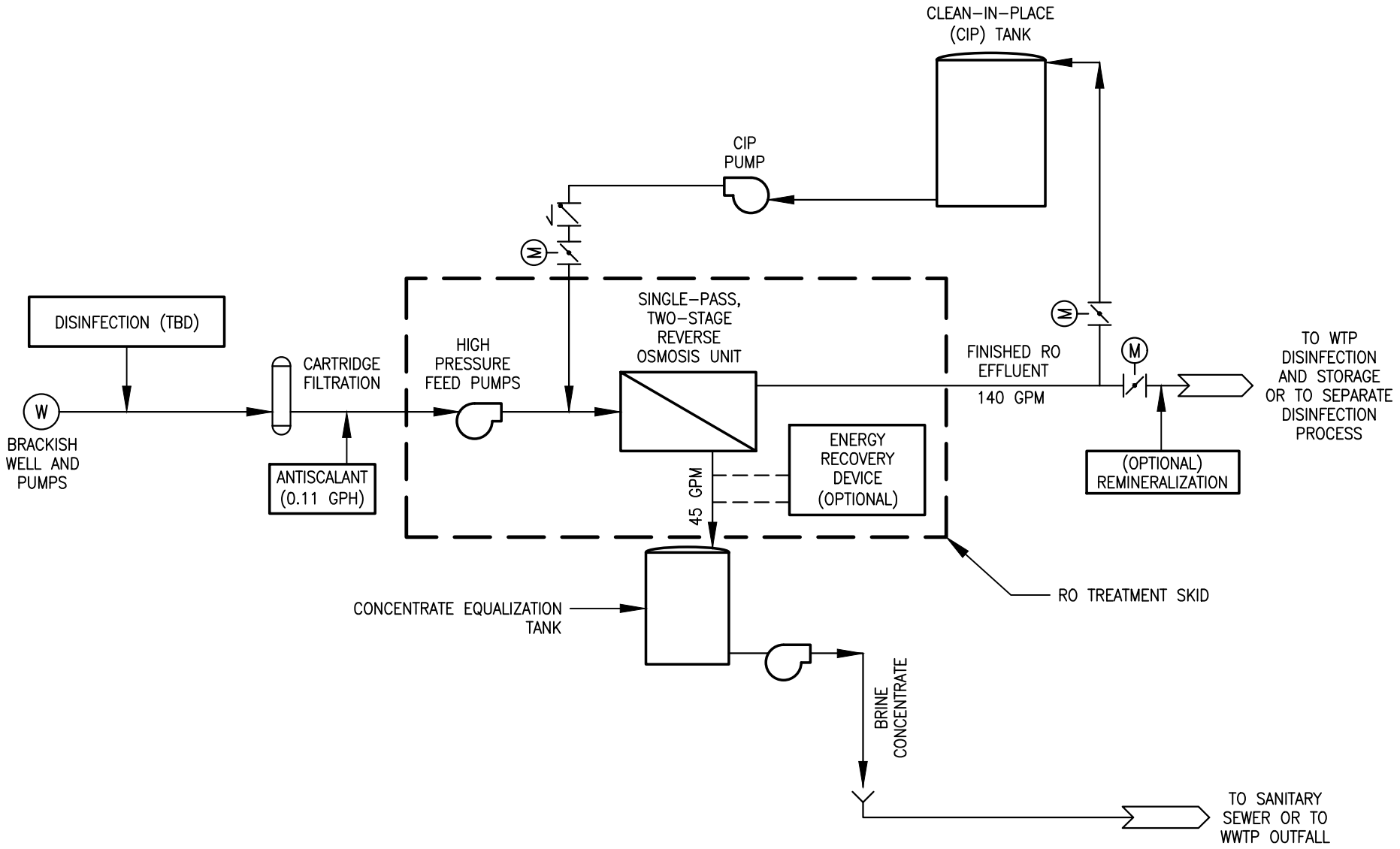
- Integration with the existing conventional water treatment operations and facilities
- Blending RO permeate with the water treatment process
- Minimization of permeate water transmission piping and/or redundant treatment processes
- Access to required utilities (electricity, water, wastewater)
- Minimization of potential real estate costs

The determination of the Operations Building site location will direct most of the inquiries and decisions for the other components of the Project. The determination as to whether or not a reasonable site is available should be established early in the next phase of design considerations.

Summary

A brackish RO system to produce 140 gpm of treated water is feasible assuming the well water quality stated in Table 2. The first steps to determine the viability of desalination treatment should focus on the following aspects of the preliminary design, all of which are discussed in the attached memos:

- Location options for the Operations Building
- Discharge location options for RO concentrate
- Feasibility of integrating an RO system with the existing water treatment systems
- Potential brackish raw water sources and water quality monitoring at those locations



COLEMAN ENGINEERING

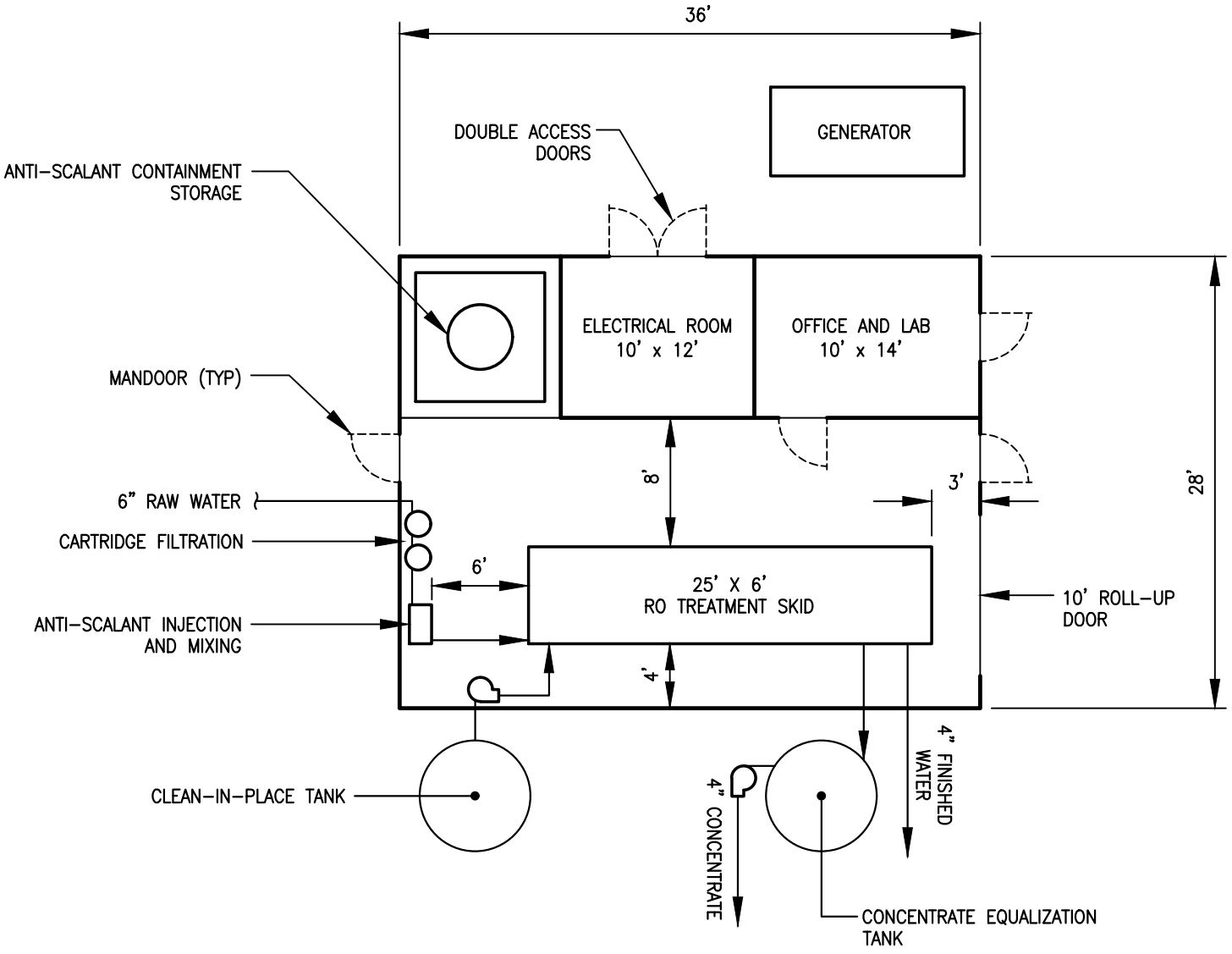
ATTACHMENT 1: CONCEPTUAL PROCESS FLOW DIAGRAM

BRACKISH WATER DESALINATION PLANT FEASIBILITY STUDY

CITY OF FORT BRAGG

COLEMAN ENGINEERING
1358 Blue Oaks Boulevard, Suite 200, Roseville California (916) 791–1188

DATE: MARCH 2018
DRAWN: WCJ
CHECKED: BAB
SCALE: AS SHOWN
JOB #: FTBR17–002



ATTACHMENT 2: CONCEPTUAL OPERATIONS BUILDING FLOOR PLAN
BRACKISH WATER DESALINATION PLANT FEASIBILITY STUDY

CITY OF FORT BRAGG

COLEMAN ENGINEERING
1358 Blue Oaks Boulevard, Suite 200, Roseville California (916) 791-1188

DATE: MARCH 2018
DRAWN: WCJ
CHECKED: BAB
SCALE: 1"=10'
JOB #: FTBR17-002

ATTACHMENT 3: Source Water Analyte Example

Sample identification: .....
Feed source: .....
Conductivity: ..... pH: ..... Temperature (°C): .....

Feed water analysis: *Please give units (mg/L as ion or ppm as $CaCO_3$ or meq/L)*				
	NH_4^+	.....	CO_2	.....
	K^+	.....	CO_3^{2-}	.....
	Na^+	.....	HCO_3^-	.....
	Mg^{2+}	.....	NO_3^-	.....
	Ca^{2+}	.....	Cl^-	.....
	Ba^{2+}	.....	F^-	.....
	Sr^{2+}	.....	SO_4^{2-}	.....
	Fe^{2+}	.....	PO_4^{2-}	.....
	Fe (tot)	.....	S^{2-}	.....
	Mn^{2+}	.....	SiO_2 (colloidal)	.....
	Boron	……..	SiO_2 (soluble)	.....
	Al^{3+}	.....		

Other ions: .....

TDS (by method): .....
TOC: .....
BOD: .....
COD: .....
AOC: .....
BDOC: .....

Total alkalinity (m-value): .....
Carbonate alkalinity (p-value): .....
Total hardness: .....
Turbidity (NTU): .....
Silt density index (SDI): .....
Bacteria (count/ml): .....
Free chlorine: .....

Remarks: .....
(odor, smell, color, biological activity, etc.) .....
.....
.....

Analysis by: .....

Date: .....

Technical Memorandum

To:	City of Fort Bragg
From:	Kevin Thomas
Reviewed By:	Chad Coleman
Date:	April 27, 2018
Project:	Brackish Water Desalination Plant Feasibility Study
Subject:	Regulatory Issues

Purpose

This Regulatory Issues Technical Memo (TM) has been prepared for the City of Fort Bragg (City) in order to define and discuss the potential required regulatory permits and environmental approvals for the proposed Fort Bragg Brackish Water Desalination Plant Project (Project). The TM identifies key regulatory permitting issues and strategies based on a conceptually defined project, and does not provide project-specific or site-specific regulatory permitting recommendations. Due to the myriad potential physical siting, design, alignment and operational options that could be pursued as part of a potential future project, any future specific desalination proposal should include a project-specific regulatory permitting review in light of the general parameters set forth in this TM.

Summary

This TM addresses the following topics, with Potential Regulatory Permits addressed in greater detail in Section 3 below.

Key Regulatory Permitting Issues & Strategies

The following are recommended siting and design approaches to minimize the overall project risk, schedule, and cost:

1) Brackish Desalination – Generally speaking, brackish desalination is far less controversial and carries less overall risk, cost and schedule implications than pursuit of an ocean desalination project (using a "screened open ocean intake" or a subsurface intake). As the City has indicated its preference for pursuit of a brackish desalination project, we simply note this as highly favorable from a regulatory permitting perspective.
2) Comingled Brine Concentrate Disposal – For the purposes of this TM, we will assume that the concentrate (the byproduct of desalination, sometimes called brine) can be

discharged through the City's existing wastewater treatment plant (WWTP) outfall. This is the preferred method for concentrate discharge as set forth by the State Water Resources Control Board (Water Board) in its recently adopted Ocean Plan Amendments, as "comingling" of the concentrate with the WWTP discharge reduces the salinity impact of the concentrate.[1] Although the existing WWTP diffusers are likely adequate to meet Ocean Plan Amendment standards, hydrodynamic concentrate discharge modeling would be required to determine existing diffuser adequacy. Should use of the existing WWTP outfall not be suitable for use, one or more concentrate discharge alternatives would need to be explored, any of which would require more complex regulatory permitting and associated increased cost, risk and schedule implications.

3) Energy Requirements – From both an operational cost and regulatory permitting perspective, the energy requirements of a desalination project are an important consideration. Although brackish desalination is not as energy intensive as ocean desalination, it nonetheless usually requires more energy (and associated greenhouse gas emissions) than conventional water sources such as groundwater wells, imported water, and recycled water.[2] Interested stakeholders may want to see that the City has minimized energy demand and even considered offsetting the project's "incremental" energy demand increase through use of such measures as solar photovoltaic panels on facility rooftop or parking areas, and/or purchasing of "carbon offsets."

4) Facility Siting Considerations – The desalination facility itself should ideally be located as far as practical from the coastline, on existing disturbed/developed property, ideally owned by the City or another public agency. If reasonably practical, the desalination facility site should be located outside of the Coastal Zone (see Figure 1 below). The site would ideally be located in close proximity to the raw water source, drinking water distribution system, and/or WWTP outfall connection. Determining the ultimate site should take into consideration all costs and benefits, including: capital infrastructure cost, operational efficiency and accessibility, and optimization of co-located facilities in order to minimize the total length of raw water, permeate and concentrate conveyance and pumping facilities.

5) Conveyance Alignments – Linear transmission facilities (raw water, permeate, concentrate) would ideally be located within existing roads or other public easements, such that the transmission facilities do not traverse natural drainages or other natural habitat. Where such crossings are necessary, the transmission line should be "hung" on

[1] https://www.waterboards.ca.gov/water_issues/programs/ocean/desalination/
[2] http://www.allianceforwaterefficiency.org/WorkAea/linkit.aspx?LinkIdentifier=id&ItemID=8380

an existing roadway bridge deck, or trenchless construction should be used to minimize impacts to natural drainages and sensitive biological resources (see **Figure 1** below, showing existing major drainages and natural habitat to be avoided).

6) Facility Sizing – Several coastal communities have recently been successful in the regulatory permitting and approval process for a brackish desalination facility sized to meet approved development consistent with the local agency's General Plan and the water retailer's Urban Water Management Plan. Accordingly, for this project, ideally the desalination facility capacity and operational scenarios will be defined in order to meet seasonal or emergency conditions or as part of a balanced water supply portfolio consistent with an adopted Urban Water Management Plan. Regulatory agencies and other stakeholders will likely want to understand how the desalination project relates to the City's efforts at conservation, recycling and other water supply options. More importantly, the City will need to develop a facility sizing strategy that communicates the purpose and need for the project, particularly in relationship to any potential future growth or specific development proposals.

   Other than political and financial considerations,[3] the facility sizing may be the most sensitive issue from a regulatory permitting perspective, assuming the above issues #1 - #5 can be satisfactorily addressed. Several local coastal communities (Santa Cruz, Cambria, Morro Bay, Monterey) have had difficulty getting regulatory agency approval of desalination projects (even brackish or subsurface) where stakeholders were concerned that the desalination project would provide more water than needed for approved growth.

7) State and Federal Funding & Permitting – Of final note is that, as the City examines potential funding sources and permitting requirements, special care should be given in developing the environmental permitting work program depending on the nature of any state or federal funding. For example, should the City pursue State Revolving Fund (SRF) low interest loans or other State grants, these usually come with very specific environmental compliance requirements, including evaluation of federal issues through a "CEQA-Plus" process.[4] Similarly, should the City be successful in obtaining federal grants or loans, the project would require compliance with the National Environmental Policy Act (NEPA) and other funding requirements of the federal funding agency (such as Bureau of Reclamation).

[3] The cost of water, outside the scope of this TM, is often a key issue in determining whether or not to pursue desalination. Other local communities, such as South Coast Water District, have examined the relative cost and reliability of new water supply sources (https://www.scwd.org/civicax/filebank/blobdload.aspx?blobid=8044).

[4] https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

Environmental Benefits

The City's development of a brackish groundwater project has several potential environmental benefits, which should be clearly communicated to the public and other stakeholders as the Project moves through the feasibility study stage and beyond. These potential benefits include but are not limited to:

1) Reducing pressure on limited, sensitive or otherwise constrained freshwater resources;
2) Creating a new source of water, locally controlled, and hydrologically independent ("drought proof");
3) Providing for water reliability during seasonal/emergency conditions and as a counter balance to climate change related water supply variability; and
4) Depending on well siting, the brackish groundwater wells could favorably contribute to limiting or correcting seawater intrusion and associated salinity impacts to groundwater.

Regulatory Permitting Schedule and Costs

Permitting requirements, including schedule and cost implications, can be developed as part of a potential future conceptual design for the project. In general, following the strategies and criteria noted above will substantially reduce overall permitting risk, cost and schedule requirements. For a "right-sized" community-scale brackish desalination facility that avoids sensitive habitat and natural drainage crossings, the regulatory permitting process can likely fit within the Project's preliminary design, final engineering and construction bid document process (regulatory permitting should not slow down the overall Project design, entitlement and construction process).

For rough planning purposes, the City could use 12 – 18 months for conceptual design and initial City approvals (including California Environmental Quality Act compliance), and another 12 months for regulatory approvals from other stakeholder agencies (a total of 24 to 30 months to have all approvals in hand, ready for construction). This would allow approximately 6 months to develop a "Purpose and Need" statement as part of evaluating the City's overall water supply portfolio. Note that the actual total time for Project conceptual design and regulatory permitting approvals, including initial the CEQA process, varies widely depending on a variety of factors, including changes in the Project Description, local elected officials' concerns, enhanced community outreach programs, and/or opposition from local stakeholders.

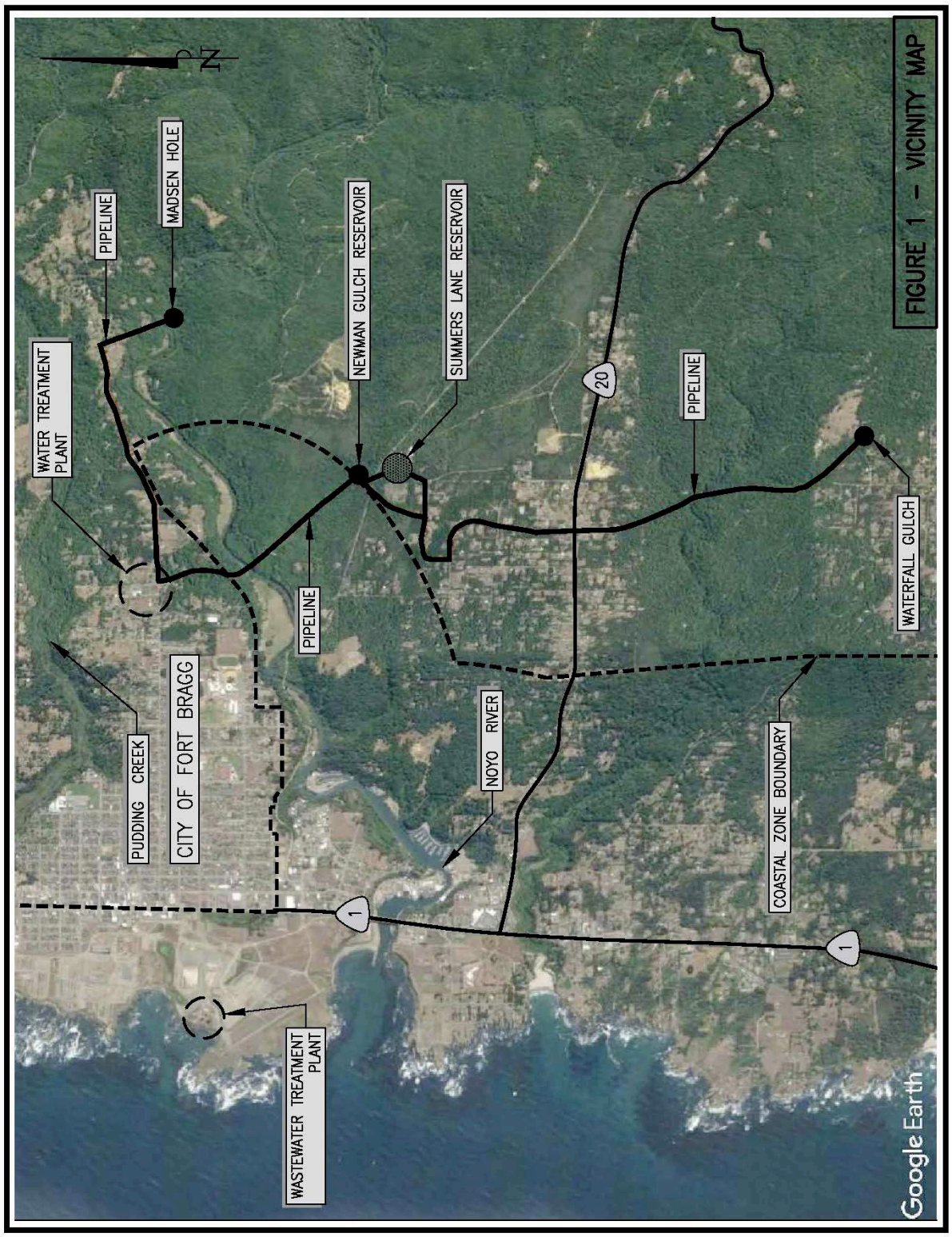


FIGURE 1 – VICINITY MAP
N
MADSEN HOLE
PIPELINE
WATER TREATMENT PLANT
NEWMAN GULCH RESERVOIR
SUMMERS LANE RESERVOIR
20
PIPELINE
WATERFALL GULCH
PIPELINE
CITY OF FORT BRAGG
PUDDING CREEK
NOYO RIVER
COASTAL ZONE BOUNDARY
1
1
WASTEWATER TREATMENT PLANT
Google Earth

Regulatory Agency Permits

The Brackish Water Desalination Plant Project would be subject to the California Environmental Quality Act (CEQA) for all local and state agency approvals (including initial Project approval by the City of Fort Bragg), and would also be subject to the National Environmental Policy Act (NEPA) should the project require any federal permits, approvals or funding. In addition to CEQA and NEPA compliance, the Project may require various other permits and approvals by local, state and federal agencies. The following provides a preliminary overview of potential permits and approvals, noting that this assessment must be further refined and updated following development of more specific Brackish Water Desalination Plant concepts, in consultation with the City of Fort Bragg and other key stakeholders.

California Environmental Quality Act

Pursuant to the requirements of the CEQA,[5] a lead agency (e.g., the City of Fort Bragg) must make a determination if a proposed action can be defined as a "project" (i.e., a discretionary action that is not otherwise exempt from CEQA). If the determination is made that the proposed action is indeed a "project," the lead agency can then make a subsequent determination if that project is exempt from CEQA. It is highly unlikely that a new brackish desalination facility could be found to be exempt from CEQA (Cambria Community Services District was able to obtain a CEQA exemption from the Governor's Office for an emergency water supply project, but this would be unlikely to obtain for the City's Project for a variety of factual, procedural and political reasons).

Even if a CEQA exemption is obtained, this would not exempt the Project from NEPA or other federal regulations (if necessary). In addition, the CEQA exemption could be subject to challenge from any other regulatory agency that would need to rely on the City's CEQA document for its regulatory permits or approvals. The potential for a CEQA exemption could be further explored once a project-specific concept and Purpose and Need is established. Therefore, for the purposes of this TM, it is assumed that the Project would require CEQA compliance through either an Initial Study/Mitigated Negative Declaration (IS/MND) or an Environmental Impact Report (EIR).

Initial Study/Mitigated Negative Declaration (IS/MND)

If the project is not exempt from CEQA, then an IS/MND may be appropriate. An IS/MND is appropriate when there are no significant impacts (and no other parties raise a "fair argument" based on "substantial evidence in the record" that a significant impact may occur). The IS/MND and associated significance determinations would be supported by appropriate technical studies addressing such topics as air quality, greenhouse gas

[5] http://www.opr.ca.gov/ceqa/

emissions, noise, sensitive biological and cultural resources, water quality, beach access and visual effects, coastal hazards, hydrology/groundwater resources, Ocean Plan consistency (for concentrate discharge), and consistency with applicable plans and policies including local and regional growth plans and the California Coastal Act.

An IS/MND may be perceived by stakeholders as a "lower standard" of CEQA review than an EIR, due to less opportunity for public involvement. In addition, an IS/MND is more difficult to defend should CEQA litigation be filed, due to the lower "fair argument" standard of an MND and inability to approve a project with "unavoidable significant impacts." In addition, other Responsible Agencies under CEQA (those local and State agencies for which the Project requires a discretionary permit or approval), would have to agree that an MND is the appropriate CEQA document and have the right to prepare supplemental CEQA documents should they feel the MND is not adequate for their discretionary approval process (as has recently occurred with several ocean desalination projects).

An IS/MND requires approximately 9-12 months to complete, including a 30-day public comment period, after which the City of Fort Bragg would file a Notice of Determination (NOD) following adoption of the MND as adequate under CEQA and approval of the project. The NOD filing initiates a 30-day CEQA legal challenge period. All local and state permits or approvals could not be obtained until the City of Fort Bragg completes the CEQA process (in this case, adoption of the MND).

Environmental Impact Report (EIR)

If there are one or more potentially significant environmental impacts, or if other factors such as stakeholder or Responsible Agency input dictate, the City of Fort Bragg may determine that an EIR is more appropriate than an IS/MND. The EIR would require approximately 12 - 18 months to complete (or more), would provide for additional public review, is more legally defensible, as it allows the City of Fort Bragg to approve the Project even if there are potentially significant environmental impacts, and is more difficult to successfully challenge in court. The EIR includes a 45-day public review period, and an additional 10-day availability period of the Final EIR prior to certification by the City of Fort Bragg as adequate under CEQA.

Following EIR certification and project approval, the City of Fort Bragg would file a NOD, starting the 30-day CEQA challenge period. After the NOD is filed, the City of Fort Bragg could obtain any other necessary local or state permits or approvals. This 12 - 18 month CEQA process would allow time for concurrent development of a Project concept and Purpose and Need statement, although additional time may be required for City and stakeholder development of the Purpose and Need, alternative water supply analysis, and conceptual design, prior to initiating the CEQA process.

National Environmental Policy Act

The Project would require NEPA compliance by any federal agency for which the Project requires a federal permit or approval, or for which federal funding is being sought. Unlike CEQA, the NEPA compliance procedures vary slightly for each federal agency.[6] Under NEPA, a federal project or action is evaluated for the potential environmental effects. Certain federal permits or approvals may be covered under existing programmatic NEPA documents, such as the U.S. Army Corps of Engineer's Nationwide Permit Program. For more complex permits or for federal funding, a separate Project-specific NEPA document may be required; the specifics would depend on the nature of the requested permit or approval and consistency with applicable federal regulations.

Once an agency develops a project or action, the next step is to make a determination of whether or not the proposed project or action is covered under NEPA, and if so, what level of analysis is then required. These levels of analysis include: preparation of a Categorical Exclusion (CatEx), preparation of an Environmental Assessment (EA) leading to a Finding of No Significant Impact (FONSI); or preparation of an Environmental Impact Statement (EIS) leading to a Record of Decision (ROD). For an EA or EIS, the federal agency will need to evaluate alternatives, and as such, it would be important to demonstrate avoidance or minimization to adverse effects upon federally protected resources and consistency with applicable federal regulations, including those governing cultural and historic resources, wetlands, Endangered Species Act consistency, Clean Air Act conformity, and environmental justice.

Generally, the CEQA document tends to set the tone and inform the federal agencies on the appropriate NEPA document. If the CEQA document is an IS/MND, then generally an EA/FONSI or Categorical Exclusion (CatEx) is expected (but not an EIS). If an EIR is the CEQA document, then generally an IS/EA is expected (but is rarely paired with a NEPA CatEx, and in this case an EIS is not expected).

If the Project requires a separate NEPA document other than a CatEx (an EA/FONSI or an EIS), the cost, risk and schedule impact of the NEPA compliance process would likely be considerable, as the NEPA process tends to be longer and more complex than the CEQA process. As soon as specific federal permits or funding is identified, the City should meet with the applicable federal agencies and determine the appropriate NEPA process. At the discretion of the federal NEPA agency, a joint NEPA/CEQA (combined) document could be prepared, or the NEPA document could be prepared on a separate review path from the CEQA document (which is often the case especially when federal funding is being pursued but not yet identified).

[6] https://ceq.doe.gov/laws-regulations/agency_implementing_procedures.html

Potential Federal Agency Permits or Approvals

The potential need for federal permits or approvals would depend on project-specific development concepts. In general, as noted above, if the Project can avoid protected federal resources (such as open trenching across jurisdictional wetlands, and native habitat impacts with associated potential for endangered species), the Project may not require any federal permits or approvals. The most likely federal permit would be from the United States Army Corps of Engineers (USACE) Regulatory Branch should the Project require discharge of fill into a drainage or modification of the existing WWTP diffuser to meet Ocean Plan Amendment concentrate discharge standards. In either case, the USACE would likely handle NEPA compliance as part of its permitting process, and the Project could likely be processed with a Nationwide Permit (such as NWP 7 for outfall structures, or NWP 12 for utility lines).[7] Even if the Project avoids direct discharge into a regulated waterway, the Project may be required to notify the USACE of the proposed improvements traversing the drainage path, referred to as a "Pre-Construction Notification."

The USACE regulates activities pursuant to Section 404 of the Federal Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act. USACE consults with other federal agencies, including the U.S. Coast Guard, the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) for compliance with the Endangered Species Act, Marine Mammal Protection Act and Essential Fish Habitat. USACE will also consult with other potentially affected federal agencies through the Fish and Wildlife Coordination Act, as well as consult with the State Historic Preservation Officer for National Historic Preservation Act compliance and the Coastal Commission for Coastal Zone Management Act federal consistency determination.

Other federal permits or approvals could be required, depending on project-specific design and siting. One such example is in the event the Project required an easement or lease of any federal lands, which would then trigger both NEPA compliance and a federal land real estate approval (such as a Finding of Suitability to Lease, an encroachment permit or an easement).

Potential State Agency Permits or Approvals

Depending on project-specific issues and siting, the following state agency permits or approvals may be required:

The California Coastal Commission (Coastal Commission) regulates development activities pursuant to the California Coastal Act of 1976. In the case of the Project, Coastal Commission jurisdiction would include any development (construction or discharge) below the mean high

[7] http://www.spn.usace.army.mil/Portals/68/docs/regulatory/NWP/NWP17_Split.pdf
http://www.spn.usace.army.mil/Portals/68/docs/regulatory/NWP/NWP17_RC.pdf

tide, including any change in use of the existing WWTP outfall and associated concentrate discharge. The Coastal Commission also has federal Coastal Zone Management Act (CZMA) authority over federal actions within the Coastal Zone and retains Coastal Act jurisdiction over certain areas within the City of Fort Bragg's Coastal Zone. Although the City has Coastal Act jurisdiction above the mean high tide, City Coastal Act approvals are appealable[8] to the Coastal Commission for:

(1) Developments located between the sea and the first public road paralleling the sea or within 300 feet of the inland extent of any beach or of the mean high tideline of the sea where there is no beach, whichever is the greater distance;

(2) Developments approved by the local government not included in paragraph (1) that are located on tidelands, submerged lands, and public trust lands, within 100 feet of any wetland, estuary, or stream, or within 300 feet of the top of the seaward face of any coastal bluff;

(3) Any development which constitutes a major public works project or a major energy facility (whether approved or denied by the local government), as defined by Section 13012 of the Coastal Commission Regulations and the Coastal Act.

The Project is therefore anticipated to require a Coastal Development Permit (CDP) for any construction within the City's Coastal Zone, as well as a CDP from the Coastal Commission for any change in use of the existing WWTP outfall, modification to outfall diffusers (if required), and/or for the concentrate discharge.

The Regional Water Quality Control Board (Regional Board) regulates activities pursuant to Section 401 of the Clean Water Act (CWA), the California Porter-Cologne Water Quality Control Act, and the California Ocean Plan. A key State permit for the Project would be a new or amended NPDES Permit to address changes in discharge from the existing WWTP outfall. The NPDES Permit would demonstrate compliance with Porter-Cologne, the Ocean Plan and other applicable State water resource regulations associated with ocean discharge. Other Regional Board permits may be required, such as a Waste Discharge Requirements (WDR) permit for disposal of well development water. California Ocean Plan consistency determination also requires Regional Board consultation with the State Water Resources Control Board (Water

[8] Any applicant or person who participates in the local permitting process for a project, or who otherwise communicates their concerns to the local government, may file an appeal. Also, an appellant must have exhausted all local appeals unless the local government charges a fee to appeal, restricts the class of people who can file appeals, or failed to follow the hearing and notice requirements for issuing a coastal development permit. Any two Coastal Commissioners may also appeal projects to the Commission. The grounds for appealing a project are limited to whether the project conforms to the requirements of the LCP or the public access policies of the Coastal Act. Issues that are not addressed by the LCP are not valid appeal grounds.

Board). The Project may also require one or more permits from the Water Board related to water rights, depending on the nature of source water and relationship to existing City water rights.

The California State Lands Commission (SLC) regulates any geophysical surveys, development activities, and leasing activities associated with State lands. For the Project, a new or amended lease may be required for change in use of the existing WWTP outfall. The SLC is a key permitting agency for ocean desalination and coordinates closely with the Regional Board, Water Board and Coastal Commission on all ocean desalination project permits.

The California Department of Fish and Wildlife (CDFW) regulates activities pursuant to the Fish and Game Code Section 1600-1616, as well as the California Endangered Species Act and Marine Managed Areas. Should the Project's facilities require traversing an existing drainage, the Project would have to either obtain a Streambed Alteration Agreement or, even with trenchless construction, notify CDFW of the proposed improvements above or below any CDFW regulated drainage. In addition, there are several marine protected areas within close proximity to Fort Bragg coastal areas, which would need to be evaluated with respect to the Project's concentrate discharge in compliance with the Coastal Ace and Ocean Plan Amendment.[9]

The new water supply and associated potable water supply system would require a Drinking Water Permit from the Water Board's Division of Drinking Water, to demonstrate compliance with the State's drinking water quality regulations.[10]

Other state permits or approvals could be required, depending on project-specific design and siting. These include encroachment permits or easements for any facilities traversing State lands (such as California State Parks or Caltrans), and compliance with applicable State-agency administered grant or loan programs, such as the Water Board's SRF loan program.[11]

Potential Local Agency Permits or Approvals

The City of Fort Bragg would be the Project proponent and CEQA Lead Agency. Mendocino County Division of Environmental Health regulates activities associated with monitoring and test pumping wells and may require a new groundwater well permit depending on the proposed water source. Should any facilities extend into unincorporated areas of the County, an encroachment permit would be required from Mendocino County. Depending on Project-specific details, facilities may require right-of-way, encroachment or access agreements from private parties. The Project would require a Permit to Construct and Permit to Operate from the Mendocino County Air Quality Management District (MAQMD), which may also require a

[9] https://noyocenter.org/trails-parks/marine-protected-areas-2/
[10] https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/Permits.shtml
[11] https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/

permit for any emergency backup diesel generator. The Project would require municipal service for electricity, telecommunications, drainage, and sanitary sewer disposal from applicable local agencies.

Table 1: Permit Summary

Agency/Department	Permit/Approval	Required For
Federal		
United States Army Corp of Engineers (USACE)	Section 404 of the Clean Water Act (33 USC §1344), and Section 10 of the Rivers and Harbors Appropriation Act (33 USC §403)	Required for discharge of dredged or fill material into navigable waters of the United States (Section 404 Permit), structures in navigable waters (Section 10 Permit), and activities—including the placement of structures—affecting navigable waters (i.e., new/modified intake/discharge tunnels).
NOAA National Marine Fisheries Service (NMFS)	Consultation in accordance with Section 7 of the federal Endangered Species Act (ESA), Section 104 of the Marine Mammal Protection Act of 1972 (16 USC §1374), and Section 305(b), Magnuson-Stevens Fishery Conservation and Management Act (16 USC 1855 (b))	Required for Interagency cooperation to avoid take of marine mammals and protect essential fish habitat. Consultation required for potential concentrate discharge impacts and any temporary work, construction, or operation in the marine environment.
United States Coast Guard	Local Notice to Mariners	Required for screened ocean intake and concentrate discharge facilities. Required for any temporary work, construction or operation in the marine environment that may affect vessels and waterways within Coast Guard District jurisdiction. Notice issued by Coast Guard for channel conditions, obstructions, menaces to navigation danger areas, etc.
United States Fish and Wildlife Service	Section 7 consultation under the Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA) (16 USC 703-711), and Fish and Wildlife	Required to evaluate potential effects of Project construction and operation on any federally protected (i.e. endangered and threatened) plant/wildlife species or habitat.

Agency/Department	Permit/Approval	Required For
	Coordination Act (16 USC 661-667c)	
State Historic Preservation Officer	Consultation with the SHPO or Tribal Historic Preservation Officer in accordance with National Historic Preservation Act Section 106 Consultation requirements.	For any federal action affecting resources eligible for the National Register or meeting the eligibility criteria for National Register cultural or historic resources.
Federal Agency (TBD)	NEPA compliance	Federal funding, permits or use of federal lands
	Land Use Approval (FOSL/easement)	Use of federal lands (if required)
State		
State Water Resources Control Board	Ocean Plan consistency	Consultation with the Regional Board, Coastal Commission and State Lands Commission with respect to Ocean Plan Amendment consistency relative to ocean desalination projects.
	Drinking Water Permit	Division of Drinking Water approval for any new potable water supply system.
	SRF Loan (if applicable)	CEQA-Plus compliance and related loan application process for SRF loan (if applicable).
	Water Rights Permit(s)	For new brackish groundwater well (if applicable).
Regional Water Quality Control Board (Regional Board)	Ocean Plan consistency	Ocean Plan Amendment consistency determination.
	Clean Water Act, Section 402: National Pollutant Discharge Elimination System (NPDES Permit)	NPDES Permit required for concentrate discharge through existing WWTP outfall (new or amended permit).

Agency/Department	Permit/Approval	Required For
	Section 401 of the Clean Water Act (Water Quality Certification)	Required for any USACE Clean Water Act Section 404 permitting.
	NPDES General Permit for Storm Water Discharges Associated with Construction Activity (General Permit)	Required for discharges that could affect surface, coastal, or groundwater whose projects disturb one (1) or more acres of soil or whose projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres. Specifically required for Project construction activity, which includes clearing, grading, and ground disturbances.
	Waste Discharge Requirements (WDR)	Required for construction dewatering and for post-construction brine concentrate discharge.
California Coastal Commission	Coastal Development Permit (CDP) in accordance with the California Coastal Act (Pub. Res. Code §30000 et seq.)	Required for development within the Coastal Zone including marine improvements below the mean high tide, as well as development proposed on tidelands, submerged lands, and public trust lands (e.g., changes in use for the existing WWTP outfall, and concentrate discharge). Onshore improvements within the City's CDP jurisdiction are also appealable to the Coastal Commission.
California Department of Fish and Wildlife (CDFW)	Lake/Streambed Alteration Agreement (Fish and Game Code §1602)	Required for any activities that divert, change, or deposit debris, waste, or other materials within the bed, channel, or bank of any river, stream, or lake, including inland waters and within some areas of bays and estuaries (may be required for conveyance facilities traversing jurisdictional drainages).

Agency/Department	Permit/Approval	Required For
	California Endangered Species Act Consultation	Required if the Project involves the potential for impacts to CDFW-listed candidate, threatened, or endangered species. An Incidental Take Permit is required if protected species would be "taken" as part of an otherwise lawful activity.
California Department of Transportation (Caltrans)	Encroachment Permit (Streets & Highway Code §660 et seq.)	May be required for conveyance components that would be installed within State highway rights-of-way under Caltrans jurisdiction.
California State Lands Commission	General Surface Lease (Right-of-Way Permit) (Pub. Resources Code §6000 et seq.; 14 Cal. Code Regs. §1900 et seq.)	Required for any construction occurring on CSLC lands, located below the Mean High Tide Line. Required to modify the existing WWTP outfall lease to allow the change in use/concentrate discharge.
Other State Agencies	Encroachment/Lease	May be required for construction dewatering should Project facilities require temporary or permanent encroachment upon State lands, such as California State Parks.
Local		
City of Fort Bragg	CEQA Compliance	As CEQA Lead Agency.
	Project Approval	As Project proponent.
	Coastal Development Permit	For development within the Coastal Zone.
County of Mendocino	Environmental Health Department groundwater well permit.	For new groundwater well (if required).
	Encroachment Permit.	For any facilities located in unincorporated County areas.
Mendocino County AQMD	Permit to Construct.	

Agency/Department	Permit/Approval	Required For
	Permit to Operate.	
Various utilities and private parties	Electrical service, telecommunications service, etc.	

Additional Resources

California Desalination Planning Handbook - http://www.water.ca.gov/desalination/docs/Desal_Handbook.pdf

Marine and Coastal Impacts of Ocean Desalination in California, Water in the West, May 2016 - http://waterinthewest.stanford.edu/sites/default/files/Desal_Whitepaper_FINAL.pdf

Technical Memorandum

To:	City of Fort Bragg
From:	Bryan Burnitt
Reviewed By:	Chad Coleman
Date:	April 27, 2018
Project:	Brackish Water Desalination Plant Feasibility Study
Subject:	Raw Water Source and Siting Considerations

Purpose

As a part of the City of Fort Bragg Brackish Water Desalination Plant Feasibility Study (Project), this memo addresses raw water source considerations and makes broad recommendations to the City of Fort Bragg (City) regarding source selection and overall siting considerations. Potential well sites are discussed in generic terms with regards to potential advantages and drawbacks in relation to the other components of the Project. This memo includes factors to be evaluated and additional information required to select an appropriate raw water source.

Evaluation Components

The following section outlines some of the key factors that should be considered in selecting the appropriate raw water source for the Project.

Proximity to Drinking Water Infrastructure

The most important factor outside of the technical treatment design is siting of the desalination facilities in relation to the required infrastructure. As a supplementary drinking water source, the Project should seek to leverage any existing treatment and storage infrastructure. To this end, collocation of the Project's key components (raw water source, treatment, waste disposal) will limit the cost associated with transmission (pipelines, pumping, etc.) and redundant treatment and storage. It is likely that transmission of at least one of the process streams (brackish raw water, desalinated water, or brine concentrate) will be required. In short, the goal of evaluating the raw water source location is to limit the piping and pumping infrastructure to the fewest process flows.

Ideal siting would place the Brackish Water Well and RO treatment system adjacent to the existing conventional drinking water treatment plant (WTP). The brackish raw water would be

desalinated and comingled with the treated fresh water immediately prior to disinfection and storage/distribution.

City staff have confirmed that there is space at the existing WTP site to accommodate a 50-foot x 60-foot brackish water treatment system.

Also, City staff have confirmed that they feel that the closest possible brackish groundwater site is approximately 7,500-feet from the WTP site. There is not likely to be any brackish groundwater underlying the WTP site according to City staff.

Proximity to Wastewater Infrastructure

Proximity to the wastewater treatment plant (WWTP) should also be evaluated. Desalination processes generate a concentrated waste stream that must be disposed of according to regulatory requirements. Described in more detail in the Regulatory Memo, the existing WWTP outfall provides a viable means for the concentrate disposal. There is a possibility that the WWTP could receive the concentrate in the collection system, but a detailed evaluation would be required to establish the viability of that approach. If it is determined that collection system disposal is viable, then the impact of this factor is relatively minor in the raw water source selection criteria.

It appears from aerial mapping that the approximate distance from the WTP site to the WWTP site is 14,000-feet.

City staff have confirmed that there is space at the existing WWTP site to accommodate a 50-foot x 60-foot brackish water treatment system.

Key Questions:

- Can the concentrated brine be discharged to the wastewater collection system? Consideration to the following must be given:
    - Wastewater treatment process disruption
    - Corrosion and scaling deposition in the collection system

Water Quality

The critical technical design factor is the physical properties and quality of the brackish raw water. For this evaluation, brackish raw water quality has been assumed based on limited groundwater data. Exploration of potential brackish raw water sources should evaluate key constituents with the following general guidelines.

- Total dissolved solids (TDS) less than 2,500 mg/L
- Silt Density Index (SDI) less than 5

- Minimal biological activity
- Compatibility with WWTP maximum contaminant level (MCL) limits

If the TDS exceeds the guideline above, then a more energy intensive reverse osmosis (RO) system with more expensive membranes will be necessary for treatment. If the turbidity and biological activity are outside of the recommended guidelines, additional pretreatment will be required upstream of the RO treatment. Finally, the concentrate loading on the WWTP could affect the WWTP discharge compliance, so evaluation of potential contaminants is also important.

SDI and biological activity should not be problematic for "deeper", anaerobic well water. The System Sizing and Design Criteria and the Construction Cost Memos assume the brackish water will be drawn from a well that meets these criteria.

Electrical Access

Availability of the power utility should be included as raw water sites are being evaluated. Two-phase or three-phase power will be required for the pumping of the source water depending on the pumping head that is required. All sites evaluated should confirm access to power prior to more detailed evaluation. Three-phase power is typically preferred for its efficiency.

Property Costs

While it may seem obvious, the use of existing City property for all new facilities should be evaluated for the technical criteria first before new property sites are considered. The use of new sites would require more cost and likely additional permitting and regulatory considerations.

Use of Existing Well

The use of an existing well may appear as an ideal option initially, but an existing well presents short-term and potentially long-term disadvantages. If the well was originally installed in anticipation of fresh groundwater, a shift toward brackish intrusion could accelerate corrosion and/or fouling of the well casing and screen. In addition, funding sources may not look favorably on connecting the treatment system to an existing well which has an unclear operating life. Use of an existing well as the new brackish water source is not recommended.

Summary

The location of the components associated with the proposed brackish treatment system impact the selection of each of the others. The most important items to resolve before beginning raw water site selection are:

- Discharge location for RO concentrate

- Groundwater quality at existing well sites in the area
- Potential Operations Building locations

Technical Memorandum

To:	City of Fort Bragg
From:	John Potts
Reviewed By:	Chad Coleman
Date:	March 8, 2018
Project:	Brackish Water Desalination Plant Feasibility Study
Subject:	Technical Issues

Purpose

This Technical Issues Technical Memo (TM) has been prepared for the City of Fort Bragg (City) to identify issues of a technical nature and explain their impact on the proposed Fort Bragg Water Desalination Plant Project (Project). These technical issues should be addressed during early planning and development elements of the Project as they will have the potential to impact the Project in significant ways. This TM will set forth the recommended criteria and approach to follow during future work on the Project.

Summary

The treated water supply requirement is 200,000 gallons per day (gpd) which can also be stated as 140 gallons per minute (gpm). Dissolved solids concentration in the raw water was established to be 1,500 parts per million (ppm) initial design and 2,500 ppm in the future, assuming salt content will increase as the brackish water well is pumped. Based on this dissolved solid content of the brackish raw water and the predominant dissolved solid being sodium and chloride (salt), the treatment system will be a membrane treatment system using brackish water reverse osmosis (BWRO) membranes. The unit configuration will be 2-stage and operate with a design recovery rate (R) range of 75% to 87%. The reverse osmosis configuration is to include energy recovery. The operating conditions and projected data are based on these criteria and are shown in Table 1.

Table 1. Projected Operating Conditions

Parameter	75% R/ 1,500 TDS	75% R/ 2,500 TDS	87% R/ 1,500 TDS	87% R/ 2,500 TDS
Raw Water (MGD/gpm)	0.27/185	0.27/185	0.23/160	0.23/160
Permeate (MGD/gpm)	0.2/140	0.2/140	0.2/140	0.2/140
Concentrate (MGD/gpm)	0.07/49	0.07/49	0.03/21	0.03/21
Operating Pressure (psi)	85	120	100	135
Concentrate TDS (ppm)	6,000	10,000	11,500	19,100
Permeate TDS (ppm)	50	70	80	110

gpm – gallons per minute; MGD – million gallons per day; psi – pounds per square inch; ppm – parts per million; R – recovery rate; TDS – total dissolved solids

Brackish Water Intake & Conveyance

The proposed raw water source is brackish and will remain brackish. It is likely that the salt content of the water will increase over time. All components of the raw water intake and conveyance system that may contact raw water must be selected to resist the corrosive effects of brackish water. This applies to the well casing, raw water pump, wellhead piping, and raw water transmission piping. It is recommended that the well casing and screen material be 316 stainless steel (SS), the raw water pump and column piping be constructed of 316 SS, the above-ground wellhead piping, including valves, fittings, and instruments be constructed of 316 SS, and the buried raw water piping be constructed of high density polyethylene (HDPE) pipe with HDPE fittings. PVC pipe is not recommended for the buried piping, since the fittings would likely be constructed of cast iron which could be susceptible to corrosion by the brackish water.

Power Requirements & Sources

Electrical power is required at the supply well and the BWRO treatment facility. Power supply to the well is expected to be in the range of 50 kilowatt (kW) as the motor horsepower is expected to range between 25 and 75 depending on the distance between the well and the water treatment facility. The proposed BWRO treatment facility will require electrical power source capable of supplying approximately 75 kW. The primary electrical component of the membrane treatment facility is the feed pump which will vary between 20 and 40 horsepower, depending on the rate of recovery and dissolved solids content of the raw water.

The most versatile and cost-effective source for the electrical power is the public utility supplying this area. Alternative energy sources are discussed in the next section of this TM. The

raw water pipe should be sized to produce a velocity of approximately 4 feet per second at design flow rate. If the raw water well is greater than a few thousand feet from the BWRO facility, it is recommended to consider installing raw water piping sized to accommodate future raw water needs.

Alternative Power Supply

The location of the well and the BWRO facility play a large role in the practical use of alternative electrical energy sources. Each of these two units require a nominal amount of power and, as components of the water treatment system, require complete reliability of that power source. This requirement means that solar or wind will require back up of a connection to the public electrical system to provide assurance that drinking water supply will always be available, regardless of wind and sun conditions. Gas powered devices, such as turbines and fuel cells, require extension of gas supply to the site and will likely produce a higher operating cost than public electrical supply. However, these types of alternative energy can be incorporated in the project.

Use of Existing Raw Water Storage and Conveyance Facilities

Raw water produced by the proposed brackish water supply well will be brackish and therefore should not be placed directly in the existing surface raw water storage and conveyance system. However, if the brackish water supply well and BWRO treatment facility are co-located near the fresh raw water collection and/or storage system, the BWRO permeate water could be placed into the fresh raw water storage and conveyance system. This addition would supplement the total raw water capacity and increase production capacity at the existing water treatment plant. The permeate water will be low in TDS and should not contain constituents that would interfere with operation of the existing water treatment facility. The BWRO permeate water would be “re-treated” through the existing water treatment process which produces a small increase in plant operating cost.

Concentrate Discharge

The membrane treatment process creates a stream of high quality water, or permeate, and a second stream consisting of the dissolved solids that were present in the raw water but in a concentrated form, or concentrate. As shown in Table 1, this concentrate will have TDS values between 6,000 and 19,000 ppm. This concentration of salt cannot be discharged onto the ground or in existing surface water bodies that are not tidal, as that concentration of salt is not compatible with the existing environment at either location.

The most suitable discharge location for the concentrate from the proposed BWRO plant is the existing wastewater system ocean outfall and diffuser. This is an existing resource and use of this resource represents a significant savings to the proposed facility. The flow rate of

concentrate will vary in the range of 20 – 50 gpm (from Table 1), and the existing ocean outfall is a 24-inch pipe. The flow rate of concentrate is not large enough to have a significant impact on the hydraulics of the ocean outfall. However, this matter must be addressed during future planning or design elements of the Project. The concentrate should not be placed into the sanitary sewer collection system without an examination of how the relatively high concentrations of salt will affect biological treatment within the wastewater treatment plant. In general, salt levels above 1,000 PPM can have negative impacts on the wastewater treatment process.

The concentrate will contain only the naturally-occurring, dissolved minerals present in the groundwater. As such, it is not expected to require treatment prior to being discharged into the existing ocean outfall. An initial task in the preliminary design phase of this project is to conduct water quality testing on a sample of the raw water as soon as the water supply well is constructed. Testing must include analysis for heavy metals, perchlorate, and any other normally naturally occurring components or frequently encountered manmade contaminate elements, and this testing must be conducted to the lowest possible detection limits. Raw water will be concentrated between 4.0 and 7.7 times which will concentrate any trace elements in the concentrate by that same factor. This testing will help to determine if there are any constituents in the concentrate that may need to be treated prior to discharge.

Product Water Quality & Blending

Permeate produced by the BWRO facility will be compatible with the existing treated water. The membrane treated water will be lower in dissolved solids than the current drinking water and will blend without negative impacts with the existing drinking water. Post treatment of the permeate may need to provide pH adjustment.

Figure 1. Permeate Blending Locations

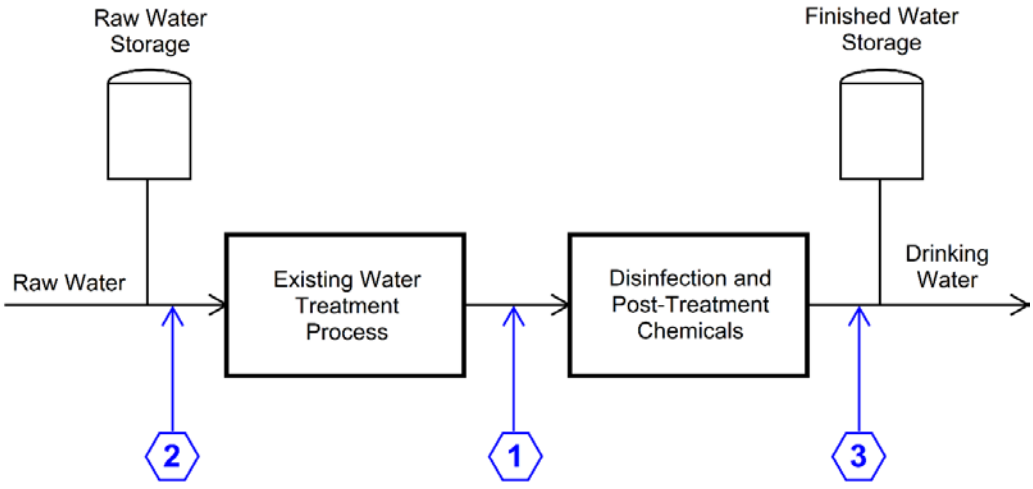


Figure 1 shows a schematic representation of permeate blending locations in order of preference (1 to 3). At this point in the evaluation, the most cost-effective process would blend the permeate with the water produced by the existing conventional water treatment plant prior to the addition of post-treatment chemicals (e.g., secondary disinfectant, corrosion inhibitor, and fluoride) at Location 1. The primary savings is the elimination of redundant chemical injection equipment for the permeate water to be finished to permitted drinking water.

Location 2 introduces permeate as a raw water source as discussed above in the discussion of the use of existing water collection facilities section. This location has similar advantages to Location 1 but does require “re-treatment” of the permeate at a nominal cost.

If the permeate cannot be conveyed directly to the existing WTP, the proposed BWRO facility could be located near a finished water distribution storage tank, and the permeate blended directly into a clear well storage tank at Location 3. This approach will require that the BWRO include facilities to add post-treatment chemicals to the permeate and is the least favorable.

Technical Memorandum

To:	City of Fort Bragg
From:	Bryan Burnitt
Reviewed By:	Chad Coleman
Date:	April 27, 2018
Project:	Brackish Water Desalination Plant Feasibility Study
Subject:	Construction Cost Opinions

Purpose

As a part of the City of Fort Bragg Brackish Water Desalination Plant Feasibility Study (Project), this memo provides a conceptual level opinion of probable construction cost for the desalination process. The memo also includes a brief discussion of available funding and delivery methods for the proposed Project.

Because no design has been completed and no actual sites have been considered, the value of these Cost Opinions is limited to setting order-of-magnitude expectations. After sites are selected and design begins, these costs will be refined and will become much more reliable.

Cost Components

For all components, conceptual level order of magnitude estimates are provided for planning and prioritization purposes. An estimate at this level does not provide a detailed estimate, and the accuracy should be considered at a range of ±50%. The following sections discuss the items included in each component.

The estimates include 10% for engineering and other indirect costs and 50% contingency. These soft costs should be carried and assumed as valid due to the lack of design detail at this stage of the project.

Desalination Operations Facility

The Desalination System Sizing and Design Criteria Memo establishes the basis for the cost estimate for the desalination operations facility. The reverse osmosis (RO) treatment system cost reflects estimates from three separate manufacturers and includes the following:

- Pre-treatment disinfection system

- Frame and skid for equipment including piping and valving
- High pressure RO feed pump
- Pressure vessels and membranes
- RO instrumentation and controls
- Cartridge filters
- Scale inhibitor feed system
- Clean-in-place system
- Design service assistance
- Installation supervision

Energy recovery devices (ERDs) are commonly used on RO systems, but the relatively low pressure required for the proposed brackish RO system makes an ERD impractical and not cost effective. Therefore, an ERD is not included in the cost estimate. For reference, an ERD for the proposed system would cost approximately $20,000.

The estimate also excludes the following:

- Post-treatment systems
- SCADA or integration of controls with external treatment process
- Operating costs (chemicals, power, etc.), included in the Operating Cost Memo
- Extensive finished water discharge piping (i.e., assumes RO system is near the discharge location)
- Raw water pumping and piping, included as separate components
- Brine concentrate pumping and piping, included as separate component

The assumed Operations Building layout can be found in the Conceptual Operations Building Floor Plan (Attachment 2 of the Sizing and Design Criteria Memo). The building layout reflects input from the RO manufacturers regarding access and clearance. Identifying an existing building that would meet the key dimensions shown on the site layout could reduce the cost of the process facility.

New Well on City Property

This component covers the possibility that a new well must be installed. The estimate assumes installation of a 100 to 150-foot well with stainless steel casing and stainless steel screens. The well site is assumed to be owned by the City so cost of real estate acquisition are not included.

New Raw Water Conveyance

This component covers the conveyance of brackish groundwater from the approximate location of the well site referenced in the Project scope to the treatment facility. The City indicated the well evaluation was tied to the Noyo River Intake and the preferred and most cost-effective location for the RO treatment facility is collocated with the existing water treatment plant (WTP). These locations are approximately 9,000-feet apart. The estimate assumes installation of 6-inch high density polyethylene (HDPE) pipe from the well site to the treatment facility.

If existing transmission lines exist that are compatible with brackish ground water, cost could be saved for this component. Another option to reduce this potential cost would be to identify a well site closer to the treatment facility.

Brine Concentrate Disposal

The final component requires extensive coordination with the wastewater treatment plant (WWTP) to establish the means and methods for disposal. It is assumed for this estimate that the concentrate must be disposed of at the effluent outfall of the WWTP. The WWTP is located approximately 11,500 feet from the WTP. The estimate assumes installation of 4-inch HDPE pipe from the WTP to the WWTP. The estimate also includes a Brine Waste Pump for the concentrate and a 1,500-gallon polymer equalization tank.

A majority of the cost for concentrate disposal would be eliminated if it is determined that direct discharge into the wastewater collection system is acceptable. This approach should be evaluated very closely to determine impacts to collection system components (e.g., corrosion and capacity) and treatment plant disruption.

Cost Summary

The cost estimate is divided into separate line items to help the City understand potential components of a complete desalination project and where significant savings can be found. Table 1 summarizes the component estimates with the breakdown costs for each component included in Attachment 1.

Table 1. Cost Summary

Component	Cost (rounded)	Cost Saving Options
Desalination Operations Facility	$ 2,460,000	Use of Existing Building
New Well on City Property	$ 700,000	Locate an Existing Brackish Well
New Brackish Raw Water Conveyance	$ 850,000	Use of Existing Raw Water Line; Collocation of Well and Operations Facility
Brine Concentrate Disposal	$ 1,200,000	Disposal into Gravity System
TOTAL =	$ 5,210,000	

Funding Options

The Department of Water Resources (DWR) has $56M in Proposition 1, Round 4 Grants that will be awarded on a first come first serve basis for desalination projects. The application portal will open March 9, 2018. With this feasibility study the City of Fort Bragg could easily apply for CEQA and Design grants under the Water Desalination Grant Program. The City would have to provide a 50% match in project funds under this grant funding opportunity.

As a small community, it is likely that the City would also qualify for loan and grant funding from the USDA-Rural Utilities Service (RUS) program. RUS funding is a commonly used approach by communities of less than 10,000 population. Funding terms are based on community income levels and other typical criteria.

Other funding sources are also possible. Next phases of the project development should include making specific contacts with funding agencies and beginning to understand criteria and eligibility requirements so that the project can be packaged and designed to be qualifying across the broadest range of possible funding sources.

Attachment 1

Coleman Engineering, Inc. — Opinion of Probable Construction Cost

Client:	**City of Fort Bragg**	**Date:**	4/25/2018
Project:	**Brackish Water Desalination Plant Feasibility Study**	**Prepared By:**	BB
Project #:	**FTBG17-002**	**Checked By:**	CRC

No.	Item	Quantity	Unit	Unit Cost	Cost
Desalination Operations Facility					
	Mobilization / Demobilization	10%	%	$140,000	$140,000
	SWPPP and Erosion Control	2%	%	$27,000	$27,000
	Pre-Treatment Disinfection System	1%	LS	$20,000	$20,000
	Reverse Osmosis Treatment System	1	LS	$520,000	$520,000
	Building	1,008	SF	$300	$302,000
	Site Preparation	10%	%	$82,000	$82,000
	Site Piping and Appurtenances	15%	%	$136,000	$136,000
	Electrical and Controls	30%	%	$312,000	$312,000
				SUB-TOTAL ESTIMATED COST =	$1,539,000
				ENGINEERING AND OTHER INDIRECT COSTS @ 10% =	$153,900
				CONCEPTUAL LEVEL CONTINGENCY @ 50% =	$770,000
					$2,463,000
New Well Location					
	Mobilization / Demobilization	10%	%	$35,000	$35,000
	Site Grading, Piping, and Security	1	LS	$50,000	$50,000
	New Well Installation including Pump	1	LS	$268,000	$268,000
	Electrical and Controls	30%	%	$80,000	$80,000
				SUB-TOTAL ESTIMATED COST =	$433,000
				ENGINEERING @ 10% =	$43,300
				CONCEPTUAL LEVEL CONTINGENCY @ 50% =	$217,000
					$693,000
New Raw Water Conveyance					
	Mobilization / Demobilization	10%	%	$48,000	$48,000
	SWPPP and Erosion Control	2%	%	$9,000	$9,000
	6-inch HDPE Pipe	9,000	LF	$20	$180,000
	Average 2' wide, 6' deep common earth trench and backfill	9,000	LF	$22	$198,000
	Miscellaneous fittings, valves, and road repair	25%	%	$95,000	$95,000
				SUB-TOTAL ESTIMATED COST =	$530,000
				ENGINEERING @ 10% =	$53,000
				CONCEPTUAL LEVEL CONTINGENCY @ 50% =	$265,000
					$848,000
Brine Concentrate Disposal					
	Mobilization / Demobilization	10%	%	$69,000	$69,000
	SWPPP and Erosion Control	1	LS	$20,000	$20,000
	4-inch HDPE Pipe	11,500	LF	$16	$184,000
	Average 2' wide, 6' deep common earth trench and backfill	11,500	LF	$22	$253,000
	Brine Discharge Pump, 100 gpm	1	EA	$30,000	$30,000
	1,500-gallon Polymer Equalization Tank	1	EA	$7,500	$7,500
	Miscellaneous fittings, valves, and road repair	25%	%	$109,000	$109,000
	Electrical and Controls	15%	%	$88,000	$88,000
				SUB-TOTAL ESTIMATED COST =	$760,500
				ENGINEERING @ 10% =	$76,050
				CONCEPTUAL LEVEL CONTINGENCY @ 50% =	$381,000
					$1,218,000

Basis for Cost Projection:

- ☑ Conceptual
- ☐ PreDesign
- ☐ 50% Draft Design
- ☐ Final Design

Technical Memorandum

To:	City of Fort Bragg
From:	John Potts
Reviewed By:	Chad Coleman
Date:	March 8, 2018
Project:	Brackish Water Desalination Plant Feasibility Study
Subject:	Operating Cost Estimate

Purpose

This Operating Cost Estimate Technical Memo (TM) has been prepared for the City of Fort Bragg (City) in order to identify an estimate of annual operating cost for a brackish water desalination facility that would augment water supply from the current water treatment facilities.

The TM will provide conceptual level opinion of annual operating cost which will be suitable for use in setting budgets for future studies and planning and will include sufficient detail to set operating budgets prior to the facility being designed. The purpose of this conceptual level opinion of annual operating cost will be to assist the City Officials to understand order of magnitude level costs so that future planning and design activities can be reasonably considered.

Operating Cost Components

Operating cost for a brackish water desalination facility of the size, treatment process, and components recommended in this Report include the following components:

1. Electrical Power to the Reverse Osmosis System
2. Electrical Power for a Brackish Raw Water Supply Well
3. Electrical Power for Concentrate Discharge
4. Reverse Osmosis Pretreatment Chemicals
5. Post Treatment Operations and Chemicals
6. Operating Manpower
7. Maintenance Manpower
8. Maintenance Supplies

This TM addresses each of these components in subsequent sections of this TM.

1) Electrical Power to the Reverse Osmosis System – This is frequently the highest single component of operating cost for a brackish water desalination water supply system. The largest energy demand is the feed pump, sometimes referred to as the high pressure pump. The power required for the recommended system depends on the total dissolved solids (TDS) of the raw water. Higher TDS requires higher pressure and higher horsepower. Using an average TDS of 2,000 mg/L, the estimated power requirement is 1.5 KWH/1,000 gal. Ancillary electrical loads for the reverse osmosis system are estimated at 0.5 KWH/1,000 gal for a total of 2.0 KWH/1,000 gal.

   Assuming the reverse osmosis unit is in operation 75% of the time producing 200,000 gal/day, and power cost is $0.20/KWH, the annual cost for power to the treatment process would be $21,900.

2) Electrical Power for a Brackish Raw Water Supply Well – This study recommends that a new raw water supply well be constructed on City owned property located approximately 9,000-feet from the water plant site or at the existing water plant site. This estimate of operating cost will assume the well is located 9,000 feet from the water plant site and therefore the well pump must be able to pump 250,000 gal/day, or 175 gal/minute to account for concentrate flow. The pump must lift the water an assumed 75-feet and the pressure required to reach the water plant is assumed to be 150-feet. The raw water should enter the reverse osmosis plant with a residual pressure of 75-feet leading to a pump head requirement of 300-feet. The raw water well pump will require an estimated 30 horsepower or 23 KW.

   Assuming the well operates 75% of the year, it will be in operation 6,570 hours requiring 151,110 KWH for an estimated annual cost of $30,220. This would be reduced to approximately $17,000 if the well is located at the plant site.

3) Electrical Power for Concentrate Discharge – The concentrate must be pumped from the water plant site to the existing wastewater ocean outfall, a distance of approximately 11,500-feet. The pump will be capable of pumping 100 gal/minute at a discharge pressure of approximately 60-feet. The pump will require a 7.5 horsepower motor and assuming it operates 75% of the time will use approximately 37,000 KWH/year. The estimated annual cost is $7,400.

4) Reverse Osmosis Pretreatment Chemicals – This TM assumes that only scale inhibitor will be added to the raw water as pretreatment to the reverse osmosis process. Other chemicals may be needed based on the actual raw water quality and reverse osmosis configuration. However, the cost for these chemicals is not expected to be significant and would likely be offset by a reduced amount of scale inhibitor required. The assumed

dose of scale inhibitor is 2.0 ppm which requires approximately 4.5 pounds/day and the cost of scale inhibitor is estimated to be $10/pound. Assuming the reverse osmosis plant operates 75% of the time, the estimated annual cost for scale inhibitor is $12,400.

5) Post Treatment Operations and Chemicals – This report recommends placing the new reverse osmosis treatment system at the existing water treatment plant. Water produced by the RO system will join the existing treated water for blending, post treatment disinfection, storage, and pumping to the customers. This means that there will be no new costs associated with this plant for those activities. This is the preferred configuration in order to minimize costs for blending and other post treatment handling.

   Though we don't recommend location of the RO treatment discharge remote from the WTP, we have estimated the post treatment operations and chemical costs independent of the WTP just to establish an order of magnitude cost for budgeting purposes. If the proposed RO plant is not located at the existing plant site, water produced will require chlorination prior to being blended into the distribution system. It is assumed that there will not be storage and that the RO plant will discharge into the distribution system when it is in operation. Based on a chlorine dose of 5.0 ppm, this will require approximately 8 pounds/day of chlorine with an estimated cost of $0.50/pound for an annual estimated cost of approximately $1,100.

6) Operating Manpower – The recommended reverse osmosis operating system will be placed at the existing water treatment plant site. The current operating staff will be responsible for monitoring operation of the reverse osmosis unit; however, the unit will be automated for startup and shut down. Operations staff should visit the unit periodically each day for an estimated 2 hours. This will require approximately 14 hours per week or approximately 25% of one operator. This operator requirement has an estimated annual coast of $22,500.

   If the proposed RO plant is not located at the existing plant, operations staff should visit the plant daily for an estimated 3 hours daily. This will require approximately 21 hours per week or approximately 40% of one operator. This operator requirement has an estimated annual coast of $36,000.

7) Maintenance Manpower – Reverse osmosis systems do not require significant operating staff due to the automated nature of the system. However, the automated nature of the system requires instrumentation that does require routine maintenance, calibration of instruments and adjustment of components. It is estimated that the proposed reverse osmosis unit will require an additional 20% of a maintenance personnel. This maintenance requirement has an estimated annual coast of $20,000.

8) Maintenance Supplies – In addition to the increase in maintenance manpower, the proposed reverse osmosis system will require replacement parts to maintain the sensors and keep the unit operating reliably and automatically. The estimated value of this component of operating cost is $10,000.

9) Summary of Operating Cost – The total estimated operating cost outlined in the previous sections are summarized in the table below. All operating costs assume that the proposed reverse osmosis plant would operate 75% of the year at a production rate of 200,000 gpd. The water plant would produce 54.75M gallons of water under these assumptions, leading to an average operating cost of $2.27 per 1,000 gallons.

Table 1. Cost Summary

Operations Cost Category	Estimated Annual Cost	Notes
Electrical Power to the Reverse Osmosis System	$21,900	
Electrical Power for a Brackish Raw Water Supply Well	$30,220	Could be $17,000 if the Brackish Well is at the existing WTP Site.
Electrical Power for Concentrate Discharge	$7,400	
Reverse Osmosis Pretreatment Chemicals	$12,400	
Post Treatment Operations and Chemicals	$0	Could be $1,100 if RO plant is not located at the existing plant
Operating Manpower	$22,500	Could be $36,000 if the RO plant is not located at the water plant
Maintenance Manpower	$20,000	
Maintenance Supplies	$10,000	
Total =	$124,420	