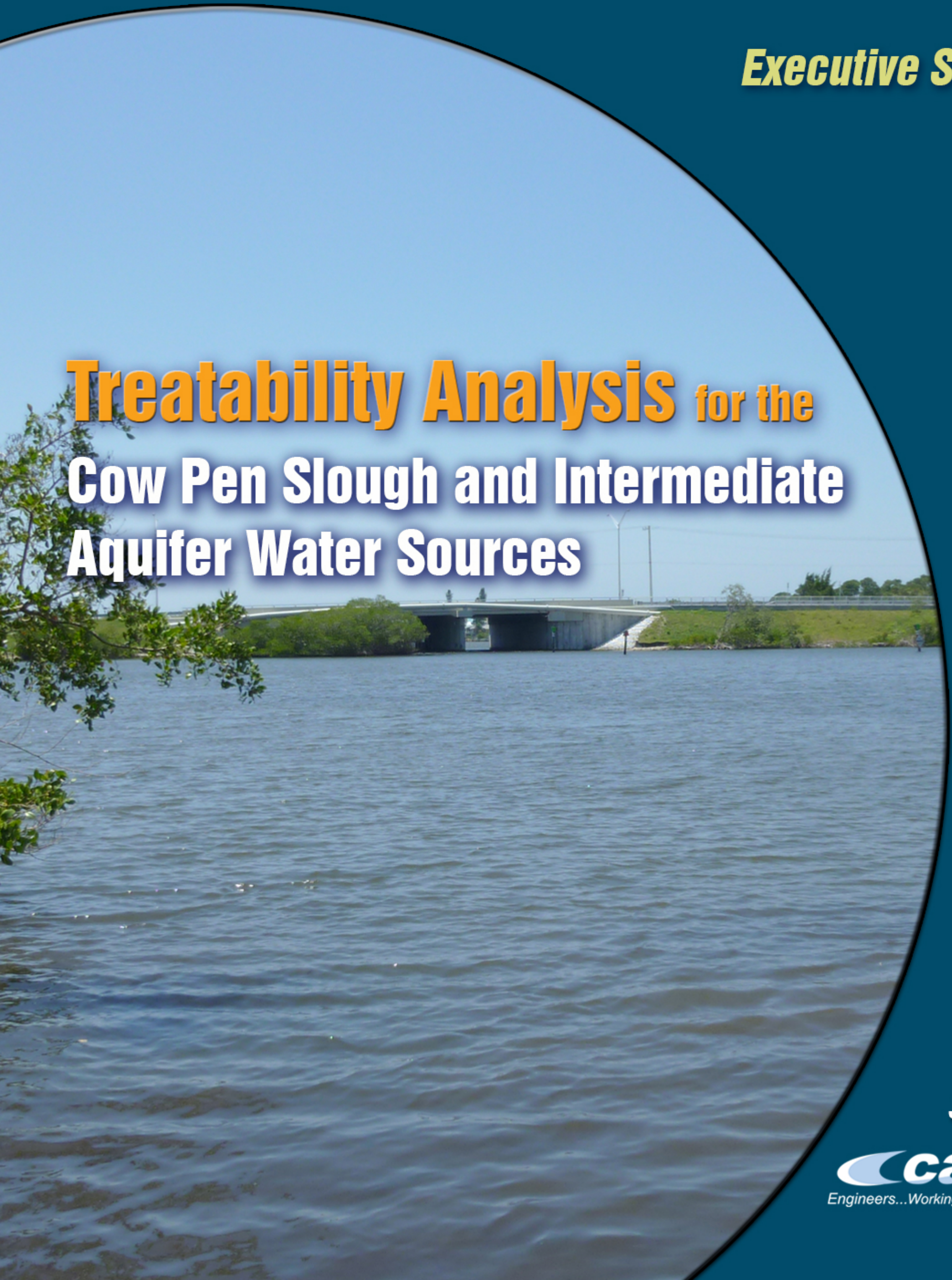
Sarasota County

Southwest Florida Water Management District

final report

Executive Summary



Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources

January 2014

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Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources

Prepared for:

Co-funded by:

Prepared by:

in association with

Final Report

January 2014

SARASOTA COUNTY

TREATABILITY ANALYSIS FOR THE COW PEN SLOUGH AND INTERMEDIATE AQUIFER WATER SOURCES

TABLE OF CONTENTS

Page No.

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

PURPOSE

The overall objectives of the Dona Bay Comprehensive Watershed Management Plan (Kimley-Horn & Associates, Inc. 2007) are to provide a more natural freshwater/saltwater regime in tidal portions of Dona Bay, provide a more natural freshwater flow pattern in the Dona Bay watershed, protect existing and future property owners from flood damage, protect existing water quality, and develop potential alternative water supply options that are consistent with and support other plan objectives.

The purpose of this project, the Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources (Treatability Analysis Project), was to determine the most technically feasible and economical options for treating the alternative water supply as part of the larger Dona Bay Watershed Management Plan. It included a surface water treatability study and an evaluation of an intermediate aquifer test well. The project was funded through a co-funding agreement between Sarasota County (County) and the Southwest Florida Water Management District (SWFWMD).

BACKGROUND

The County and regional agencies, including SWFWMD and Peace River Manasota Regional Water Supply Authority (Authority), have undertaken several studies since the early 2000s to develop the overall Dona Bay project.

Through the previous investigations, the County and agencies have identified the Dona Bay Watershed/Cow Pen Slough (CPS) as a potential new source of water supply. This Treatability Analysis Project furthers the previous evaluations and feasibility studies performed for the Dona Bay Watershed, and focuses specifically on developing and analyzing treatment alternatives for the anticipated new water supply. Figure ES.1 summarizes the relationship of this project with the next major steps for the overall Dona Bay project.

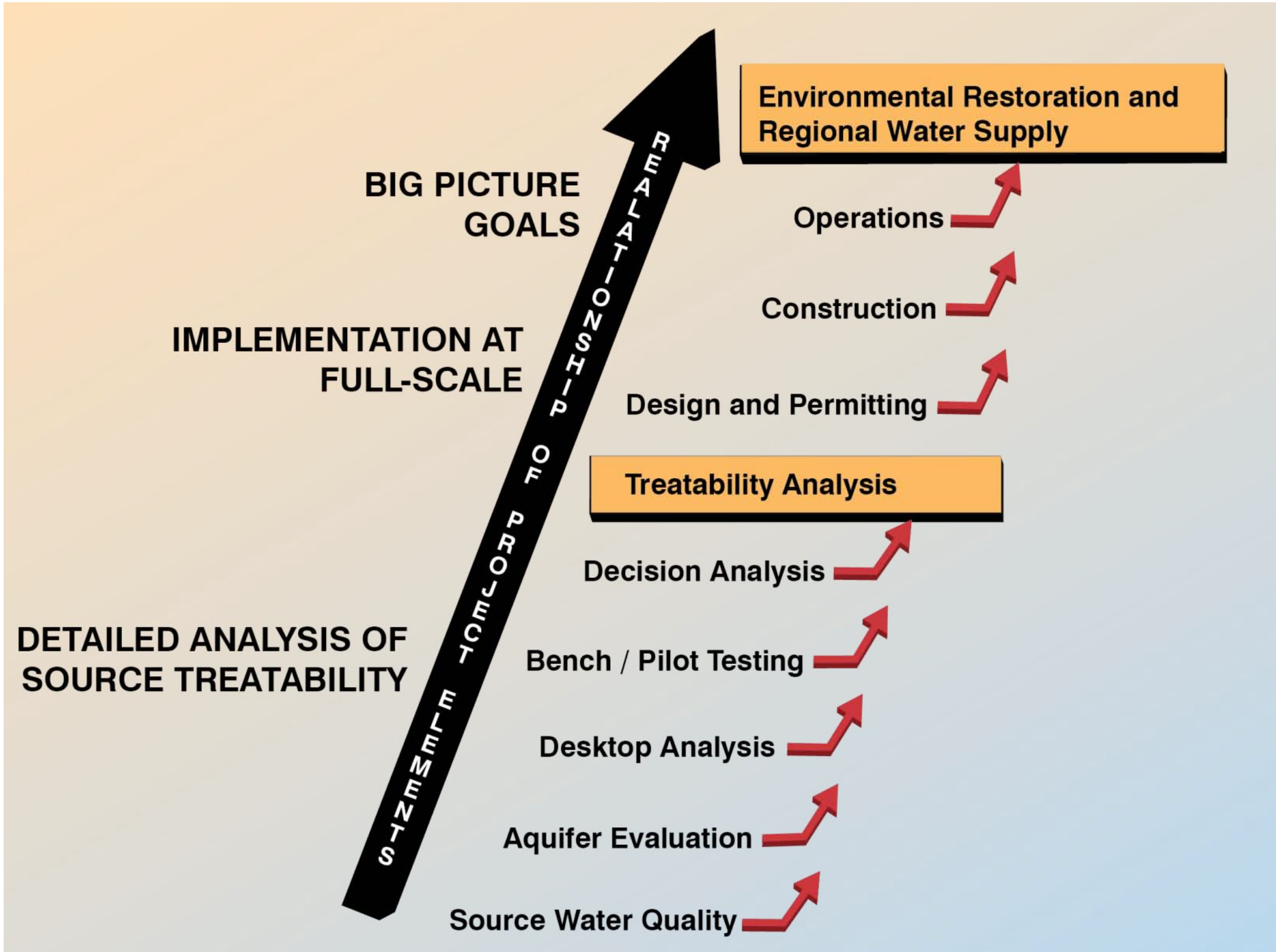

FIGURE ES.1

Relationship of Treatability Analysis with Overall Dona Bay Project and Ultimate Goals

PROJECT COMPONENTS AND OBJECTIVES

The major components and objectives of the Treatability Analysis Project included:

1. Review of pertinent reports and studies related to the overall Dona Bay project.
2. Evaluation of the CPS and Intermediate Aquifer water sources.
3. Evaluation of the reservoir withdrawal water quality via modeling.
4. Desktop analysis to identify, develop, and assess treatment alternatives, including structured decision analysis to screen top-ranked treatment alternatives.
5. Bench-scale and pilot-scale testing to close data gaps for the pertinent top-ranked treatment alternatives.
6. Development of cost opinions for the top-ranked treatment alternatives.

RESULTS AND CONCLUSIONS

The key results and conclusions from the project are summarized in the following sections.

Review of Pertinent Reports and Studies

Pertinent scientific and engineering studies related to the overall Dona Bay project were reviewed to establish the project background, identify project constraints, and confirm the project goals. Additionally, a wide range of unit treatment processes, which could be pertinent to this project, were identified and reviewed to establish the appropriate technology background.

Evaluation of the CPS and Intermediate Aquifer Water Sources

An analysis of water quality from the two sources of interest, CPS and the Intermediate Aquifer, was performed. Historical CPS raw water quality data available from the County and previous studies, from 2003 and 2006-2010 timeframes, were analyzed and data gaps were identified. These included limited data for TDS, hardness, dissolved organic carbon (DOC), suspended solids, several synthetic organic compounds (SOCs) and emerging contaminants, and speciation of metals such as iron. A supplementary, detailed sampling was performed in 2011 (as part of this project) to close these data gaps and address seasonal water quality variability of CPS. Table ES.1 includes the results from the 2011 sampling. The CPS surface water is challenging with the following parameters requiring treatment: turbidity, microbial parameters, organic matter, hardness, total dissolved solids (TDS), iron, and taste and odor (T&O). Organic content, color, and hardness in the CPS source are relatively high, along with excursions of TDS over the secondary regulatory standard. The high levels of hardness and the TDS excursions necessitate a desalting step.

Table ES.1 Summary of Raw Surface Water Quality for Cow Pen Slough
Treatability Analysis For Cow Pen Slough and Intermediate Aquifer Water Sources
Sarasota County

Parameter	Units	MCL	SMCL	# Samp.	Min.	Max.	Avg.	SD
pH	su		6.5 to 8.5	13	6.6	8.0	7.4	0.5
Alkalinity, $CaCO_3$	mg/L			13	32	166	118	41
TDS	mg/L		500	13	156	1000	505	201
TOC	mg/L			13	10.2	25.9	16.1	4.9
DOC	mg/L			13	10.4	24.6	15.6	4.5
Color (Apparent)	CU			11	72	>550	229	186
Color (True)	CU		15	11	43	453	142	140
Iron-Total	mg/L		0.3	13	0.161	1.66	0.59	0.51
Mn-Total	mg/L		0.05	13	0.0059	0.0413	0.018	0.010
Aluminum	mg/L		0.2	2	0.0249	0.154	0.089	0.091
Sulfate	mg/L		250	13	37	526	180	125
Chloride	mg/L		250	2	29	67	48	27
Hardness, $CaCO_3$	mg/L			13	82	695	311	151
Bromide	mg/L			13	<0.044	0.240	0.103	0.069
Turbidity	NTU	TT		13	1.1	9.7	4.0	2.4
Odor	TON		3	3	2	32	12	17
MIB	ng/L			5	<5	36	20	17
Geosmin	ng/L			5	<3	340	74	149
Radionuclides				Some detected, all below MCL				
VOCs				None detected				
SOCs				Glyphosate detected, below MCL				
Glyphosate	mg/L	0.7		3	<0.0021	0.015	0.006	0.008
EDCs/PPCPs				Few detected, 2 with MCLs but detected below MCL				
Atrazine	ng/L	3000		1	18	18	18	0
Simazine	ng/L	4000		1	32	32	32	0

Notes:
Data are from recent sampling performed in 2011 performed as part of this project. Historical data are evaluated in Chapter 3.
MCL = maximum contaminant limit; SMCL = secondary MCL.
SD = standard deviation.
TT = treatment technique is required.
TOC removal requirement depends on source water TOC and alkalinity concentrations.

Discharge and rainfall data were obtained for the County's existing sampling station at CPS-2, using the database available at the website for the Sarasota County Water Atlas. These data are included in Figure ES.2 along with the identification of the sampling events conducted in 2011 for this study.

The Intermediate Aquifer was investigated as an additional source of water supply, to determine if water from this source could potentially be blended with surface water in the proposed reservoir at the former Venice Minerals and Mining Facility to increase reliability. Water quality data from the Intermediate Aquifer performance test (APT) performed by the County were analyzed.

The investigation showed that the Intermediate Aquifer contains relatively higher concentrations of the following key parameters of concern: TDS (1,600 mg/L), sulfate (910 mg/L), aluminum (0.28 mg/L), and fluoride (2.2 mg/L). All these parameters demonstrated levels above the corresponding secondary maximum contaminant limit (SMCL).

Evaluation of Reservoir Withdrawal Water Quality via Modeling

Raw water quality data were used to model changes in water quality anticipated in the reservoir that is planned at the Venice Minerals site as part of the overall Dona Bay project.

Historical and recently collected water quality data for CPS and reported chemical composition data for the Intermediate Aquifer were used along with the water quality model CE QUAL W2 to simulate conditions in the reservoir under various water transfer scenarios. Surface water alone and blending of both CPS and Intermediate Aquifer water were evaluated in this study with regard to using this strategy to meet raw water supply goals and manage water quality in the surface water reservoir. Compared to the CPS, the Intermediate Aquifer contains higher concentrations of TDS and sulfate. These parameters, along with the presence of aluminum and fluoride, negate the potential of blending raw groundwater in the reservoir to increase reliability.

The modeling showed that concentrations of several parameters would be moderated in the reservoir compared to the instantaneous lows and highs observed in the CPS. This is an especially important consideration in designing and costing the treatment components for the removal of color/organics and hardness/TDS. The reservoir evaluation also concluded that nitrogen limitation would promote cyanobacterial growth (T&O issues). Seasonal management of reservoir water quality through selective transfer may be limited.

Discharge and Rainfall Data for CPS-2 Monitoring Station

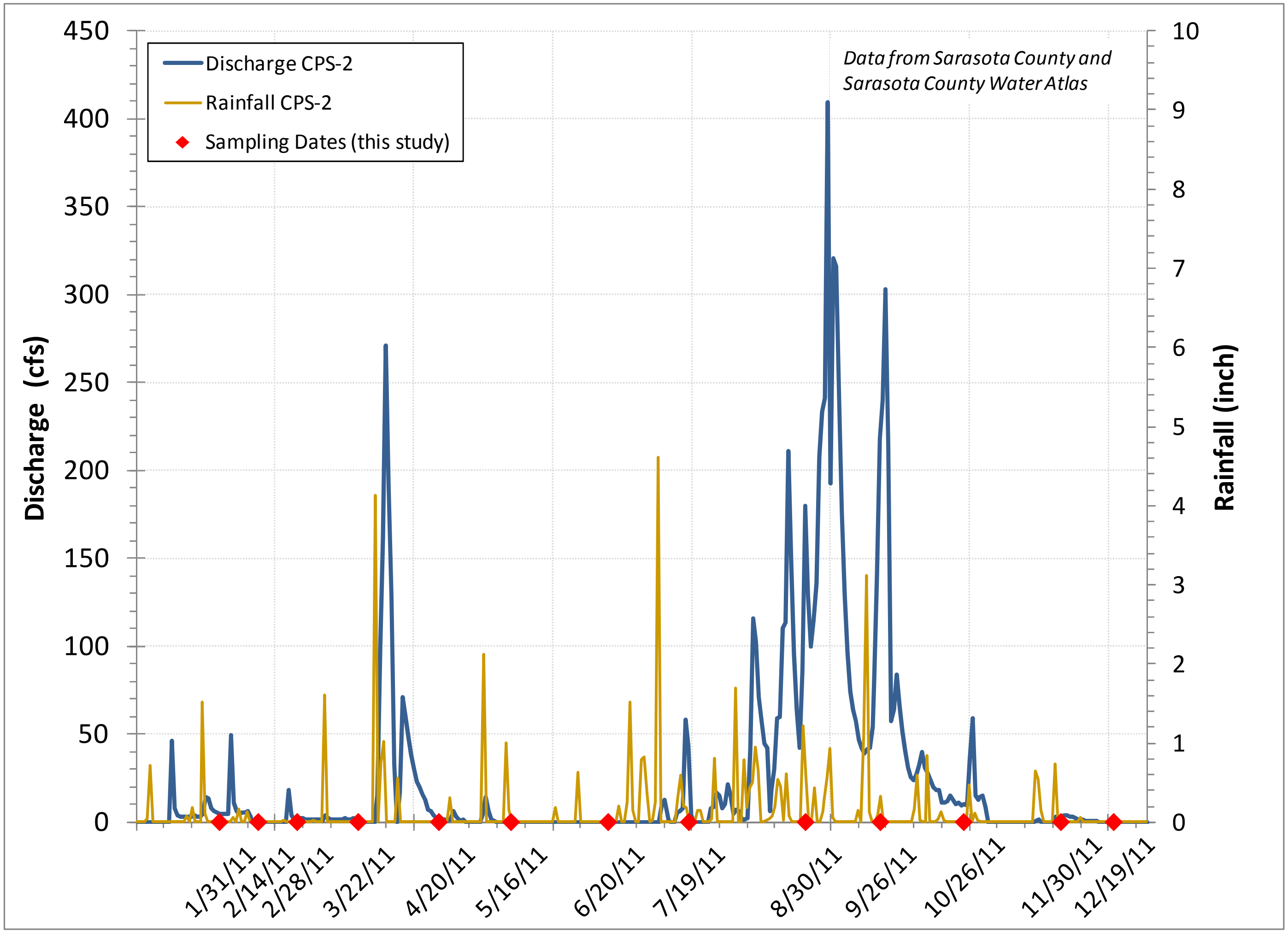

FIGURE ES.2

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Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources

Sarasota County

Desktop Analysis to Identify, Evaluate, and Screen Treatment Alternatives

The raw and reservoir water quality assessments, as well as the reviews of unit treatment processes, were used as the basis for identifying treated water quality goals and subsequently appropriate treatment alternatives. Treated water quality goals were identified to meet regulatory standards with a margin of safety.

Fifteen candidate alternatives for the surface water treatment component (defined herein as including processes for taste and odor control, organics removal, and particle filtration) and three alternatives for the desalting component (namely, side-stream electrodialysis reversal (EDR), side-stream reverse osmosis (RO), and full-stream nanofiltration (NF)), for hardness and TDS reduction, were developed to meet the target treatment goals.

The treatment alternatives were subsequently screened using structured decision analysis and selected decision criteria, including both non-economic (benefits) and economic (relative cost) criteria. The non-economic criteria and sub-criteria, as well as their relative weights, were established in a workshop with project stakeholders and are summarized in Table ES.2. The identification of the alternatives inherently included finished water quality and compatibility (i.e., pH, hardness, corrosivity, disinfection by-products) requirements; therefore, water quality or compatibility were not included as separate criteria.

Figure ES.3 summarizes the results for the alternatives for the surface water treatment component, in terms of relative non-economic and economic scores. The decision analysis resulted in the identification of five top-ranked, promising treatment alternatives for the surface water treatment component (Table ES.3). These five top-ranked alternatives had similarities in relative costs and benefits.

EDR and RO were carried forward as desalting alternatives, while NF was eliminated, as it would require full-stream treatment, which would result in higher chemical and energy usage and greater concentrate volume production.

Bench-Scale Testing

To close data gaps in the conventional pretreatment step in four of the five top-ranked treatment alternatives, five coagulants were tested to optimize the removal of organics and color from the CPS source. The coagulants included aluminum chlorohydrate (ACH), ferric chloride, aluminum sulfate, ferric sulfate, and polyaluminum hydroxychloride (PACl). ACH demonstrated the best overall performance.

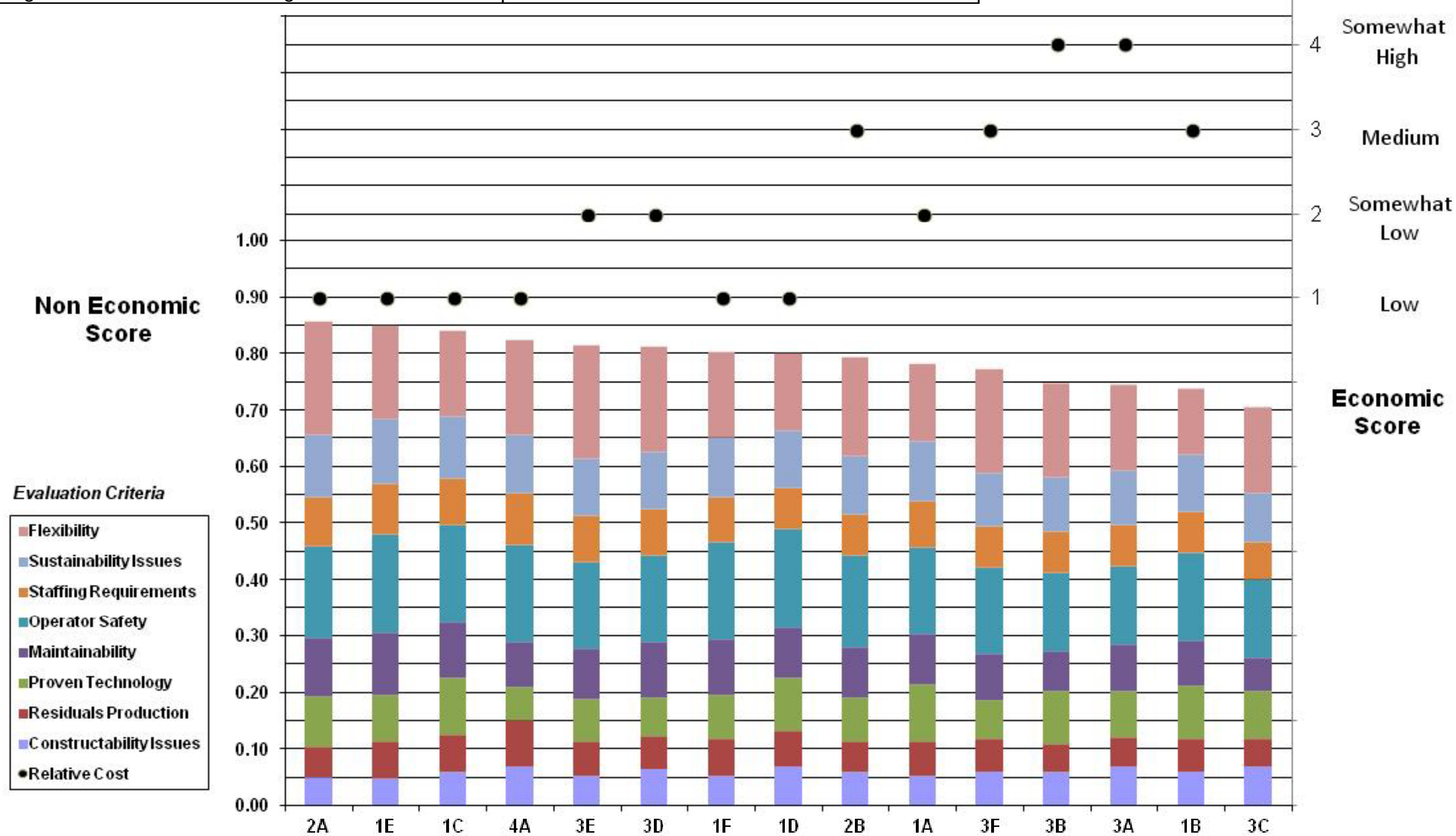
Table ES.2 Summary of Non-Economic Evaluation Criteria, Measurement, and Weights Used in the Decision Analysis
Treatability Analysis For Cow Pen Slough and Intermediate Aquifer Water Sources
Sarasota County

Primary Criteria Description	Sub Criteria Description	Wt. (%)	Goal/Measurement	Scale Range	
				Lowest = 1	Highest = 5
Sustainability 12.3%	Sustainability Issues Public perception Efficiencies – chemical, energy, production.	12.3	Public perception Less chemical use/carbon footprint is better. Less total energy use is better. Greater percent production efficiency is better.	Lowest efficiencies and least acceptance	Highest efficiencies and most acceptance
Operability 42.9%	Residuals Disposal	8.7	Less volume is better. Less challenging handling is better. Concentrate volume is not an issue.	Highest residuals and disposal challenges	Lowest residuals and disposal challenges
	Staffing Requirements	9.8	Less training requirement is better. Less staffing requirement is better.	Most training and staffing requirements	Least training and staffing requirements
	Operator Safety	18.8	Less dangerous chemicals is better. Processes with higher degree of danger are worse.	Highest safety risk	Lowest safety risk
	Maintainability	11.9	Less mechanical intensity is better. Easier to obtain spare parts is better. Easier to maintain is better.	Most difficult to maintain	Easiest to maintain
Reliability 30.3%	Proven Technology	10.1	More proven, more installations, more experience, more service history is better. Florida (similar water quality) larger plant size is more proven (1 mgd minimum).	Least references and successful installations	Most references and successful installations
	Flexibility	20.2	Higher ability to remove compounds that could be regulated is better. Ability to treat varying water quality is better.	Least flexible	Most flexible
Constructability 8.2%	Constructability Issues Footprint Flexibility in construction	8.2	Less footprint is better. More flexibility in expansion and maintenance of operations during construction is better. Less environmental impacts during construction is better.	Least flexible to construct and highest footprint	Most flexible to construct and lowest footprint

Summary of Results from Desktop Evaluation of Surface Water Treatment Alternatives

FIGURE ES.3

1A =PAC - Conventional Pretreatment - Dual Media Filter	3A =PAC - Direct Pretreatment - MF/UF
1B =PAC - High Rate Pretreatment - Dual Media Filter	3B =PAC - Conventional Pretreatment - MF/UF
1C =GAC - Conventional Pretreatment - Dual Media Filter	3C =PAC - High Rate Pretreatment - MF/UF
1D =GAC - High Rate Pretreatment - Dual Media Filter	3D =BRF - Direct Pretreatment - MF/UF
1E =BRF - Conventional Pretreatment - Dual Media Filter	3E =BRF - Conventional Pretreatment - MF/UF
1F =BRF - High Rate Pretreatment - Dual Media Filter	3F =BRF - High Rate Pretreatment - MF/UF
2A =Conventional Pretreatment - Biological Filter	4A =BRF - Fixed-Bed Anion Exchange - MF/UF
2B =High Rate Pretreatment - Biological Filter	



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Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources

Sarasota County

Table ES.3	**Top Ranked Treatment Alternatives Treatability Analysis For Cow Pen Slough and Intermediate Aquifer Water Sources Sarasota County**
# Alternative ID	**Alternative Description**
Surface Water Treatment Component	
2A	Conventional Pretreatment - Biological Filter
1E	BRF - Conventional Pretreatment - Dual Media Filter
1C	Conventional Pretreatment - Dual Media Filter (w/ GAC cap)
4A	BRF – Fixed-Bed Anion Exchange (FBIX) - MF/UF
3E	BRF - Conventional Pretreatment - MF/UF
Desalting Component	
RO	Reverse Osmosis (side stream treatment)
EDR	Electrodialysis Reversal (side stream treatment)

Notes:
Conventional Pretreatment = coagulation/flocculation/sedimentation; BRF = biological roughing filter; GAC = granular activated carbon; MF/UF = microfiltration/ultrafiltration.

Pilot-Scale Testing

The goals of the pilot study task were to evaluate the performance of one of the top-ranked treatment alternatives, and to further develop and/or verify design criteria for the associated unit processes based on continuous flows. The complete treatment train alternative comprising the combination of Alternative 4A with RO desalting (i.e., BRF – FBIX – UF – RO) was selected for pilot testing to close data gaps for FBIX treatment and to verify/optimize selected parameters for BRF, UF, and RO.

The pilot site was located at Knights Trail Road in Sarasota County, which is part of a larger property owned by the County. The pilot plant was operated for a period of nine months and treated a maximum raw water flow of 30 gallons per minute (gpm).

The overall treatment train was effective in addressing the goals of the pilot study and met all water treatment objectives during both dry- and wet-season testing. Stable hydraulic performance and water quality were observed for the unit processes. Spikes in instantaneous color/organics levels during the wet season were addressed by implementing a two-stage FBIX system that enhanced color/organics removal via increased media depth.

Compared to the instantaneous CPS water quality, the reservoir will mitigate spikes of color and organics in the wet season, while in the dry season the color/organics levels will be higher in the withdrawal water. A two-stage (for RO) or three-stage (for EDR) FBIX process, or an appropriate coagulant dose with pH adjustment, is required for treating the reservoir withdrawal water and meeting the associated goals for color/organics.

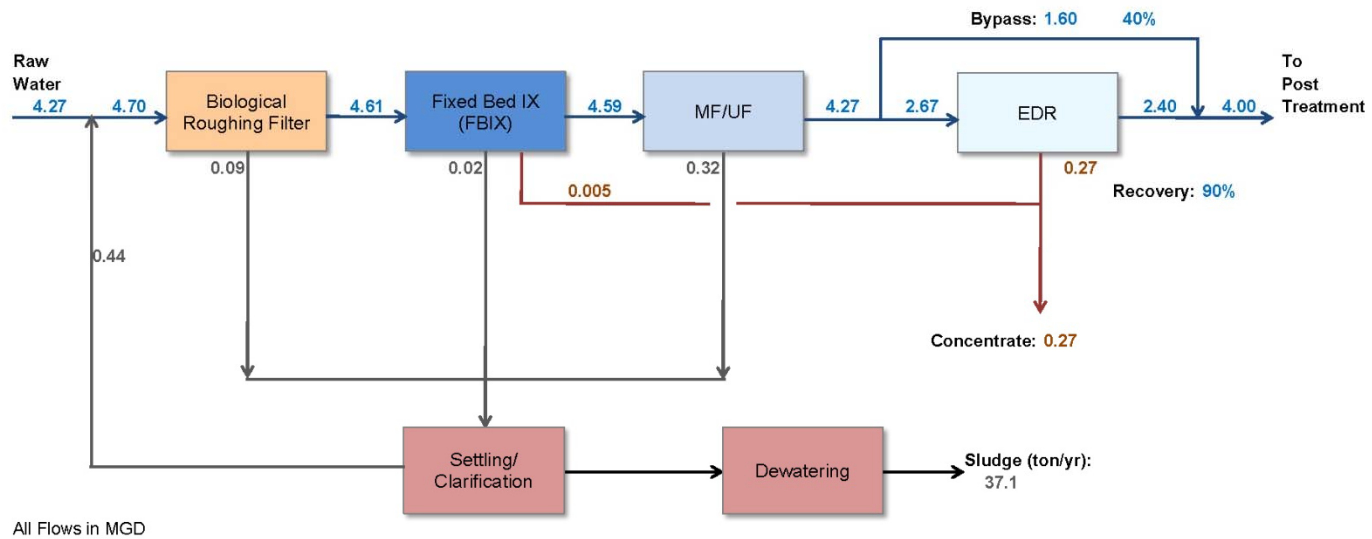
Cost Opinions

The capital cost opinion was developed based on an initial rated max day design capacity of 5 mgd, while sizing of certain pertinent facilities (i.e. buildings) at the expected build-out capacity of 15 mgd max day. For the O&M cost opinion, the corresponding annual average daily flow was set at 4 mgd.

Cost opinions were developed for the two surface water alternatives that were tested via pilot and/or bench scale, i.e Alternatives 4A and 3E, and assuming either EDR using the existing process at Carlton WTF, or RO for the desalting step. The corresponding flow schematics (using 4 mgd average annual daily flow) for the four complete treatment trains are included in Figures ES.4 through ES.7. Results from the bench-scale and pilot-scale testing were used to refine the design criteria and thus costs of the treatment alternatives.

Flow Schematic for Alternative 4A and EDR

FIGURE ES.4



Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources

Flow Schematic for Alternative 3E and EDR

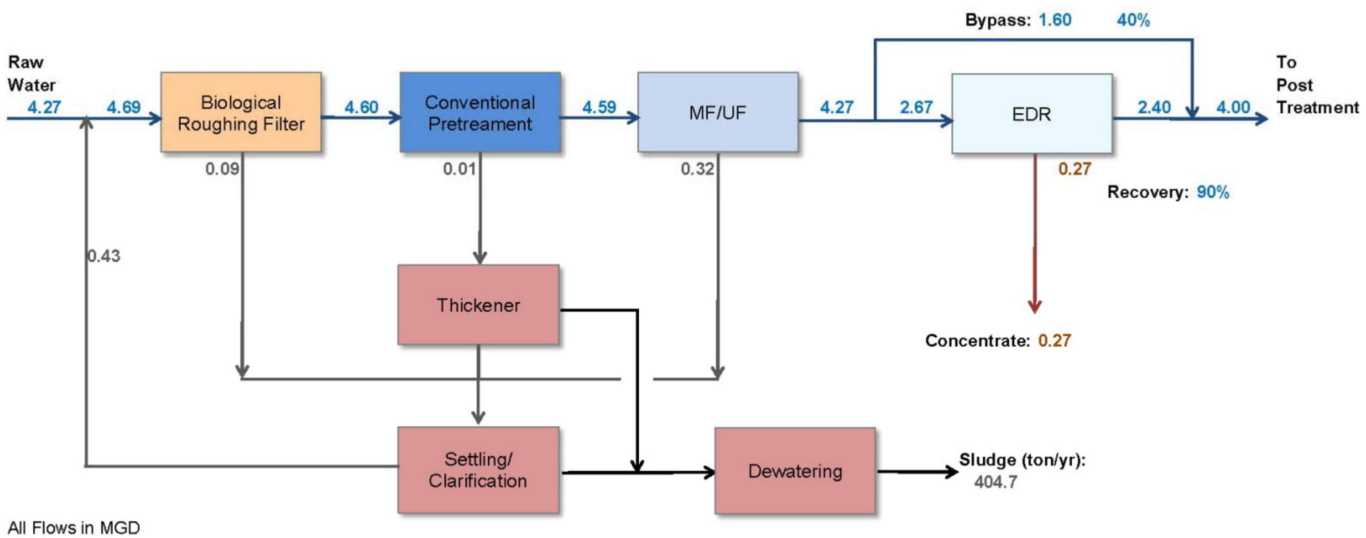


FIGURE ES.5

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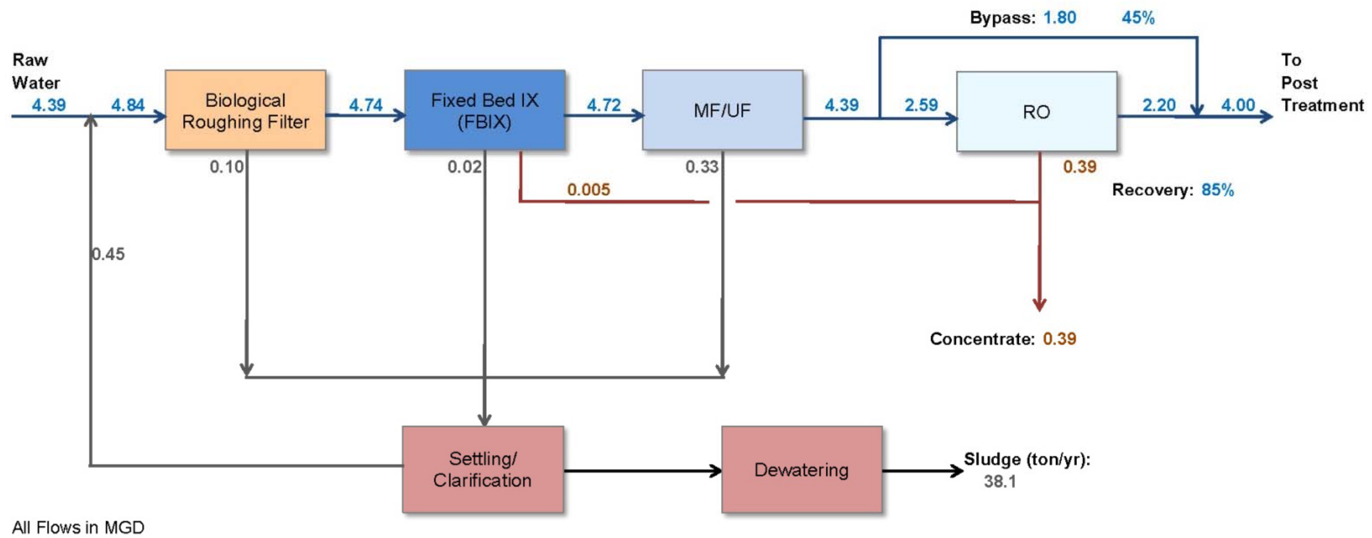
Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources

Sarasota County

Flow Schematic for Alternative 4A and RO

FIGURE ES.6



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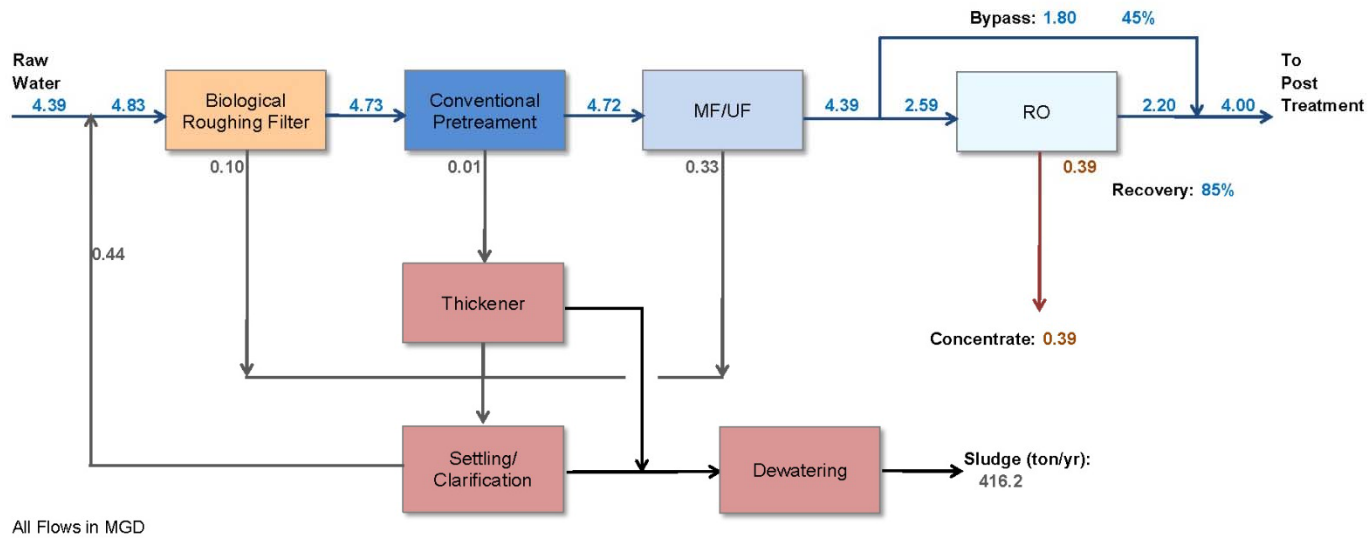
Flow Schematic for Alternative 3E and RO

FIGURE ES.7



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Treatability Analysis for the Cow Pen Slough and Intermediate Aquifer Water Sources

Sarasota County

Table ES.4 summarizes the capital cost opinions in terms of both total cost ($M) and unit cost ($/gpd). Table ES.5 includes the amortized capital cost, annual O&M costs, and the total treatment cost.

Table ES.4 Summary of Probable Capital Cost Opinions
Treatability Analysis For Cow Pen Slough and Intermediate Aquifer Water Sources
Sarasota County

Surface Water Treatment Alternative	4A	3E	4A	3E
Desalting Scenario	**EDR**	**EDR**	**RO**	**RO**
Surface Water Treatment Component				
Probable Capital Cost ($)	33,550,000	33,750,000	31,480,000	34,610,000
Unit Capital Cost ($/gpd product)	6.33	6.37	5.72	6.29
Desalting Component (TDS/Hardness Removal)				
Probable Capital Cost ($)	-	-	12,580,000	12,580,000
Unit Capital Cost ($/gpd product)	-	-	2.52	2.52
Total				
Probable Capital Cost ($)	33,550,000	33,750,000	44,050,000	47,190,000
Unit Capital Cost ($/gpd product)	6.71	6.75	8.81	9.44

Notes:

(1) Costs are for 5 mgd initial rated treatment capacity, corresponding to 4 mgd AADF. Buildings are included at assumed 15 mgd final rated capacity, corresponding to 12 mgd AADF.
(2) Alternatives under the EDR scenario use the EDR process and building at Carlton WTF for TDS/hardness reduction.
(3) Analysis does not include chlorine contact basin (for disinfection requirements), storage, or high service pumping.
(4) Cost opinions are conceptual level, most suitable for comparison only.

Table ES.5 Summary of Probable Total Cost Opinions
Treatability Analysis For Cow Pen Slough and Intermediate Aquifer Water Sources
Sarasota County

Surface Water Treatment Alternative	4A	3E	4A	3E
Desalting Scenario	**EDR**	**EDR**	**RO**	**RO**
Surface Water Treatment Component				
Amortized Capital Cost ($)	2,520,000	2,540,000	2,370,000	2,600,000
Annual O&M ($)	1,186,000	1,469,000	1,081,000	1,398,000
Total Annualized Cost ($)	3,706,000	4,009,000	3,451,000	3,998,000
Desalting Component (TDS/Hardness Removal)				
Amortized Capital Cost ($)	-	-	950,000	950,000
Annual O&M ($)	298,000	298,000	273,000	273,000
Total Annualized Cost ($)	298,000	298,000	1,223,000	1,223,000
Total				
Amortized Capital Cost ($)	2,520,000	2,540,000	3,320,000	3,550,000
Annual O&M ($)	1,484,000	1,767,000	1,354,000	1,671,000

Notes:

(1) Costs are for 5 mgd initial rated treatment capacity, corresponding to 4 mgd AADF. Buildings priced at expected build-out of15 mgd final rated capacity, corresponding to 12 mgd AADF.
(2) Alternatives under the EDR scenario are based on using the existing EDR process and building at Carlton WTF for TDS/hardness reduction.
(3) Analysis does not include chlorine contact basin (for disinfection requirements), storage or high service pumping.
(4) Cost opinions are conceptual level, most suitable for comparison only.

RECOMMENDATION AND NEXT STEPS

This study provided a systematic evaluation of the treatability of the CPS source water, and identified five top-ranked surface water treatment alternatives and three desalting alternatives. This project showed the CPS is a potential alternative water supply option that is consistent with and supports other objectives of the comprehensive Dona Bay Watershed Management Plan. Developing CPS as an alternative water supply option supports plan objectives by providing a more natural freshwater/saltwater regime in tidal portions of Dona Bay, helping to protect existing and future property owners from flood damage, and by protecting existing water quality in Dona Bay.

Suggested next steps before the design phase of the treatment facility include the following:

- Discuss/coordinate with regulatory agencies and stakeholders (DOH, FDEP, ACOE, SWFWMD, PR/MRWSA, and others).
- Continue raw water sampling to further capture source water quality parameters.
- Analyze results from additional samples collected and address any potential refinements, if any, to design criteria/cost opinions.
- Develop bench/pilot test program to be used during predesign and address disinfection by-products formation potential.
- Develop plan to analyze/address potential change in watershed.
- Develop phasing plan to meet future needs.

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