EBMUD East Bayshore Recycled Water Project –

Scalping/MBR/Water Quality

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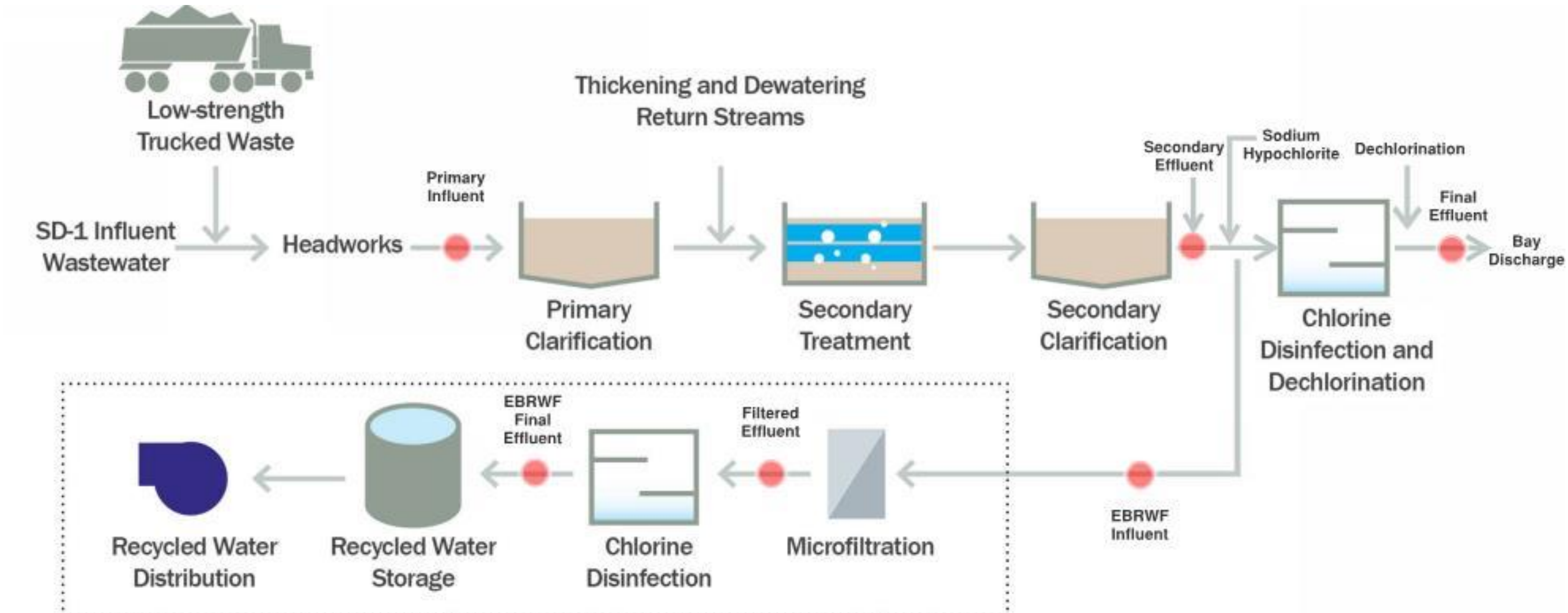
Presentation Outline

1. Introduction and Study Objectives
2. Water Quality Analysis
3. Water Quality Objectives
4. Recycled Water Demands
5. Treatment Alternatives Screening
6. Alternatives Evaluation

EBRWF Treatment Schematic Flow Diagram



EBRWF – Pall MF System

Same slide s 6 just Easier to follow

East Bayshore Recycled Water Facilities

Recycled Water Demands

Phase 1A: Average – 0.8 mgd; Peak – 1.8 mgd

MF System (Pall):

(1+1) Strainers; (4+1) 0.5 mgd MF skids

Chlorination:

Average dose – 8 mg/L; Max. dose – 20 mg/L

Chlorine Contact:

Theoretical contact time – 120 min.

Storage Reservoir:

Active volume – 1.5 Mgal
$Mg(OH)_2$ System: 2- 6,000 gal tanks; Design feed rate - 6.1 gal/hr

Existing EBRWF Distribution System

East Bayshore Recycled Water Quality Improvement Study Objectives

- Maximize recycled water uses in the EBRWF service area by expanding to Berkeley, Albany and Alameda
- Expand recycled water customer base to include commercial cooling towers, dual plumbing and other industrial uses
- Improve water quality to meet requirement of recycled uses

Water Quality Analysis

Brown AND Caldwell

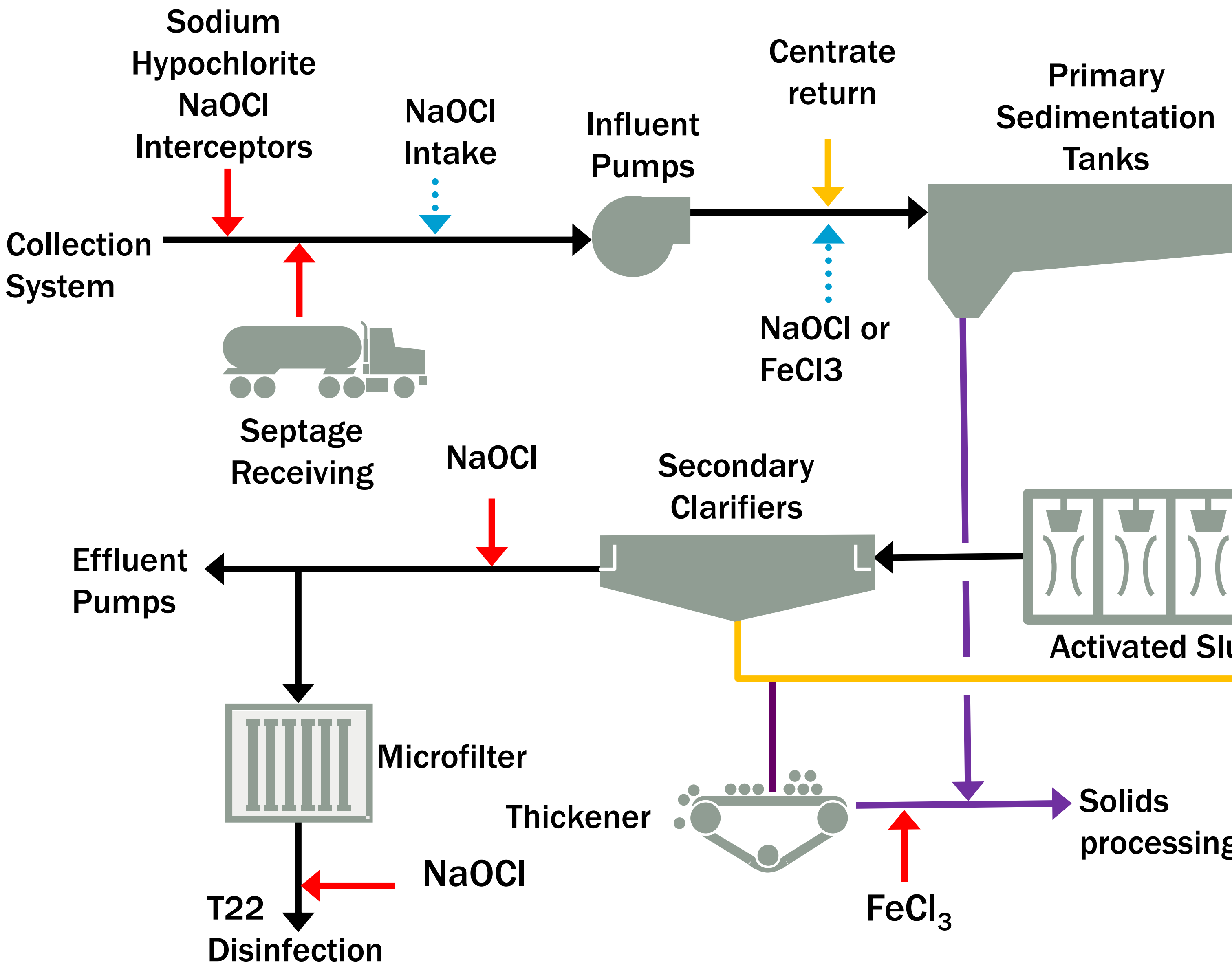
Parameters of Concern for Different End Uses

Parameter	Irrigation	Cooling Tower/Industrial	Dual Plumbing
Chloride	✓	✓	✓
Total Dissolved Solids (TDS)	✓	✓	
Nitrogen (Ammonia, Total)	✓	✓	
Phosphorus (Ortho-P, Total)	✓	✓	
Sodium Adsorption Ratio (SAR)	✓		
Iron (total and dissolved)	✓	✓	✓
Sulfide			✓
Sulfate			✓
Boron	✓		
pH		✓	✓
Total Hardness	✓	✓	

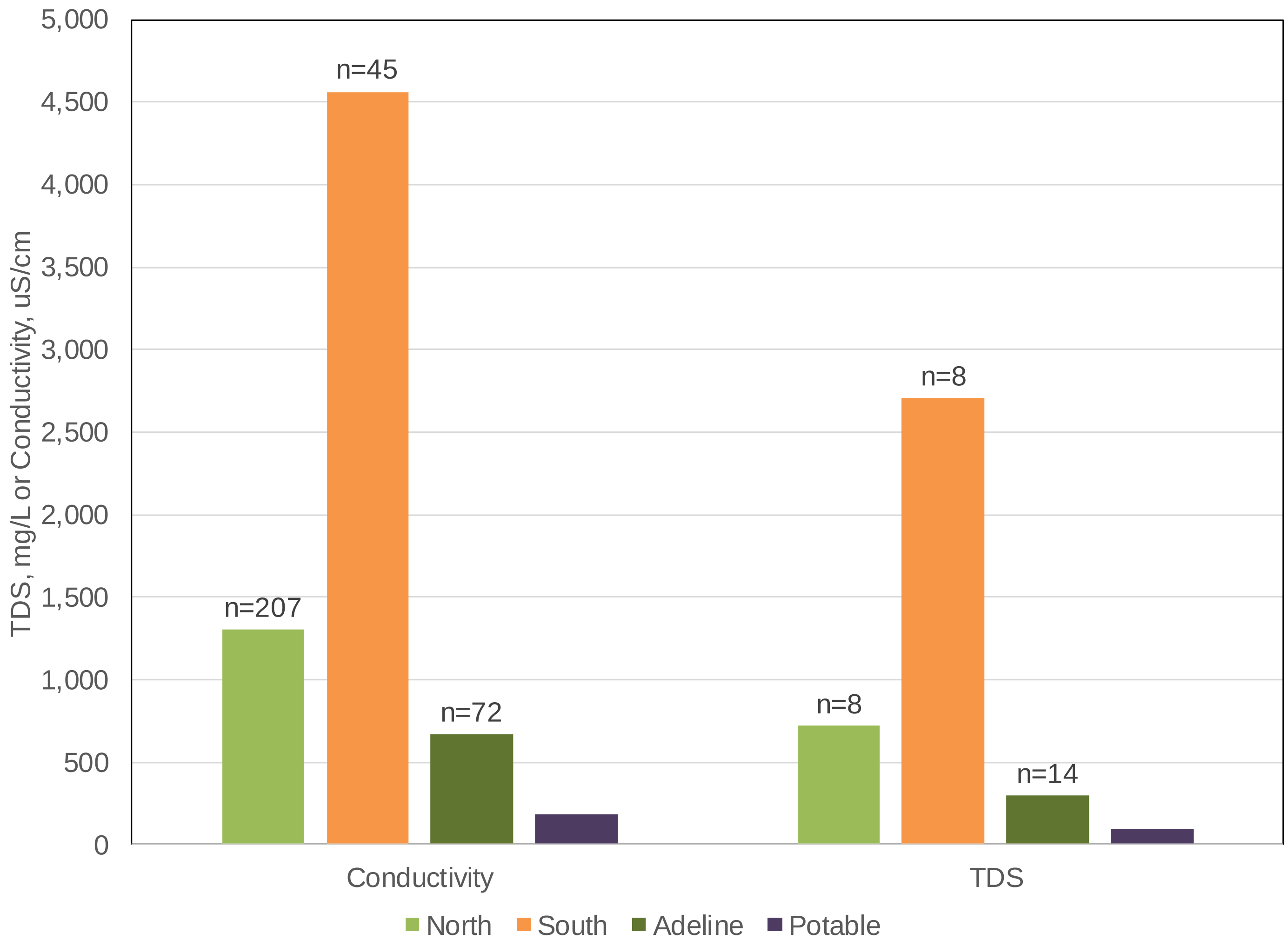
Summary of East Bayshore Effluent Quality

Parameter	Units	SE [1]	EBRWF Effluent [1]	Potable Water [2]	
		Average	Average	System Avg.	MCL
Chloride	mg/L	-	322	10	250
Total Dissolved Solids (TDS)	mg/L	-	856	94	500
Sodium Adsorption Ratio (SAR)	-	-	8	0.7 to 1.3	-
Ammonia-N	mg/L	44	44	-	-
Total Kjeldahl Nitrogen (TKN)	mg/L	46	45 [3]	-	-
Orthophosphate as P	mg-P/L	3.4	3.0	-	-
Total Phosphorus	mg-P/L	4.0	3.1 [3]	-	-
Iron, Total	mg/L	0.30	0.16	-	-
Sulfide	mg/L	-	-	-	-
Sulfate	mg/L	-	57	15	250
Magnesium	mg/L	17.6	18.6	1 to 12	-
pH	s.u.	6.8	7.2	8.2 to 9.6	-
Total Hardness (as $CaCO_3$)	mg/L	-	144	10 to 120	-

Notes:
(1) EBMUD data (Jan 2011 to Jun 2017)
(2) 2016 Annual Water Quality Report
(3) Plant effluent data


Sodium Hypochlorite NaOCl Interceptors
NaOCl Intake
Influent Pumps
Centrate return
Primary Sedimentation Tanks
Collection System
NaOCl or FeCl3
Septage Receiving
NaOCl
Secondary Clarifiers
Effluent Pumps
Activated Sludge
Microfilter
Thickener
Solids processing
NaOCl
T22 Disinfection
FeCl3

TDS Sources By Interceptor



Note: Potable water values from 2016 EBMUD Annual Water Quality Report (system average).
Pixar measured conductivity at 90 µS/cm (September 24, 2015) < 181 µS/cm (system average).

Summary

- TDS and conductivity varies throughout the year (higher in summer)
- Adeline Interceptor has lowest TDS (average ~300 mg/L) – best source for satellite treatment
- Ammonia, TDS, chloride in effluent are significantly higher than potable water
- Treatment process adds at least 30 mg/L of chloride and 12 mg/L sodium (10 and 6 percent of average effluent load, respectively).
- Trucked waste program contributes to significant TDS and ammonia in secondary effluent

Water Quality Objectives

End Uses within East Bayshore Area

- Irrigation
- Cooling water (commercial HVAC systems, Berkeley campus, pharmaceutical and light industrial)
- Dual plumbing
- Truck Fill Stations (Caltrans, etc.)
- Main WWTP or SD-1 uses

Landscape Irrigation – Constituents of Concern

Parameter	Irrigation	Cooling Tower/Industrial	Dual Plumbing
Chloride	✓	✓	✓
Total Dissolved Solids (TDS)	✓	✓	
Nitrogen (Ammonia, Total)	✓	✓	
Phosphorus (Ortho-P, Total)	✓	✓	
Sodium Adsorption Ratio (SAR)	✓		
Iron (total and dissolved)	✓	✓	✓
Boron	✓		
Sulfide			✓
Sulfate			✓
Magnesium			
pH		✓	✓
Total Hardness	✓	✓	

Irrigation – Water Quality Objectives

- Grasses are more tolerant of salinity, chloride, sodium and boron
- Trees are more sensitive to salinity, chloride, sodium and boron

(1) Average EBRWTF effluent values from 2011-2016. Potable water values from 2016 EBMUD Potable Water Quality Report

Parameter	EBRWF (1)	Potable Water (1)	Grasses	Coastal Redwoods	Sensitive Ornamentals
Chloride (mg/)	322	10	<350	140 (drip/surface irrigation)	100 (with sprinklers)
Total Dissolved Solids (TDS) (mg/L)	856	94	<1,670	<640	1,000 to 2,000
Sodium (mg/L)	230	6 to 33	<250	70 (sensitive ornamentals w/sprinklers)	70 (with sprinklers)
Sodium Adsorption Ratio (SAR)	8	0.7 to 1.3	<9	<3 (drip/surface irrigation)	3
Boron (mg/L)	0.3	<0.1	2.0 – 4.0	1.0 to 2.0	0.5 – 1.0

Cooling Tower/Industrial Uses

Issues of Concern

- Scaling
- Fouling
- Corrosion

Source: SPX Cooling Technologies, Overland Park, KSstems

Cooling Tower – RW Quality Objectives

Parameter	Units	EBRWF Effluent	Target RW Quality for Cooling Tower Make-up Water	
		Average	EBMUD (3.5 COC)	Industry Guidelines
Alkalinity as $CaCO_3$	mg/L	334	<142	230
Ammonia-N	mg-N/L	44	**0.6**	**1**
Chloride	mg/L	322	**<71**	**180**
Chlorine Residual, total	mg/L	2.1	<1.4	<4.0 (Free, NRWRP)
Conductivity	µS/cm	1,789	<685	-
Copper	mg/L	0.01	-	0.01
Calcium Hardness as $CaCO_3$	mg/L	64	<170	-
Iron, Total	mg/L	0.16	-	0.05
pH	s.u.	7.2	6.5-9.0	7.5
Orthophosphate as P	mg-P/L	3.0	<4.2	3
Phosphorus, total	mg-P/L	3.1	-	4
Silica as SiO_2	mg/L	22	<43	30 (GE Betz, NRWRP)
Sulfate	mg/L	56	<71	110
Total Dissolved Solids (TDS)	mg/L	856	<430	690
Total Suspended Solids (TSS)	mg/L	-	<7.1	<0.5/<10 (NRWRP)

Note: values in parenthesis were measured by Pixar (2015)

Summary of Water Quality Objectives

	Units	EBRWF Effluent [1]	Irrigation		Cooling	
Parameter		Average	Grasses	Sensitive Species	HVAC	Industrial
Ammonia-N	mg-N/L	44	NA	NA	0.6	1.0
Chloride	mg/L	322	<350	100	<71	180
Total Dissolved Solids (TDS)	mg/L	856	<1,670	1,000 to 2,000	<430	690
SAR	Ratio	8	<9	3	NA	NA

(1) Average EBRWTF effluent values from 2011-2016.

(2) Red values show where EBRWTF is greater than specific WQ objective

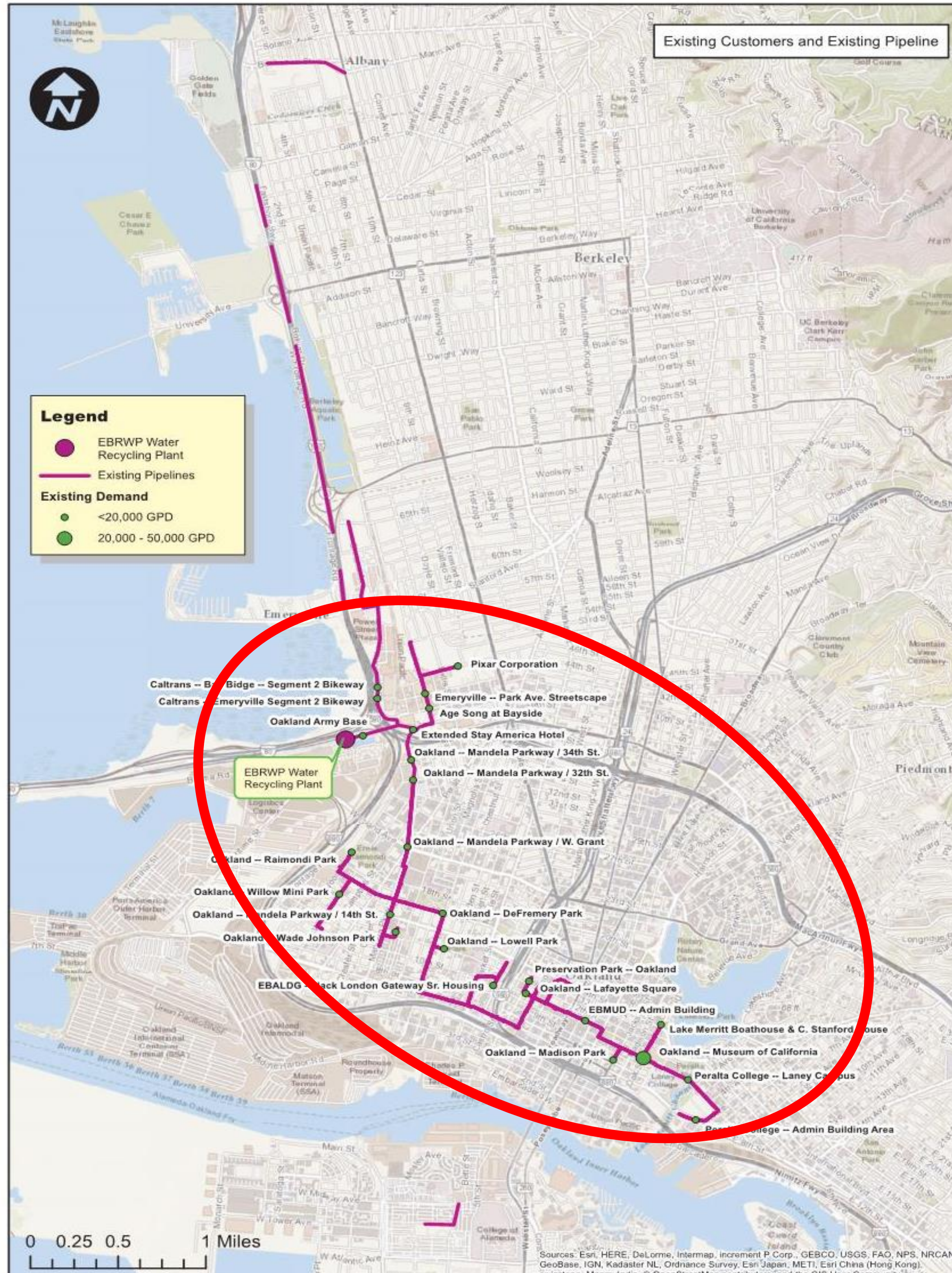
Preliminary Conclusions

- EBRWF effluent is suitable for grasses now
- Advanced treatment or satellite treatment required for sensitive grasses
- Significant additional treatment for ammonia, metals, and salts would be required to target additional industrial/cooling customers
- For dual plumbing, the more stringent water quality objectives should be met unless water age can be reduced

Recycled Water Demands – Current and Projected

Brown AND Caldwell

Existing Demands



EBMUD Potential New Purple Pipe to Service New Customers

Design Flow Demands

Alternative	Annual Average Flow, mgd	Max. Month Flow, mgd	Flow Segment
Irrigation (existing)	1	1.1	Existing pipeline
Irrigation (buildout)	2.9	4.8	Expand to Alameda, Frontage Road, Berkeley
Include Industrial (expand off existing)	1.3	1.6	Minor expansion off existing pipeline to reach industries in Emeryville
Include Industrial (buildout)	3.1	4.4	Expand to Alameda and Berkeley

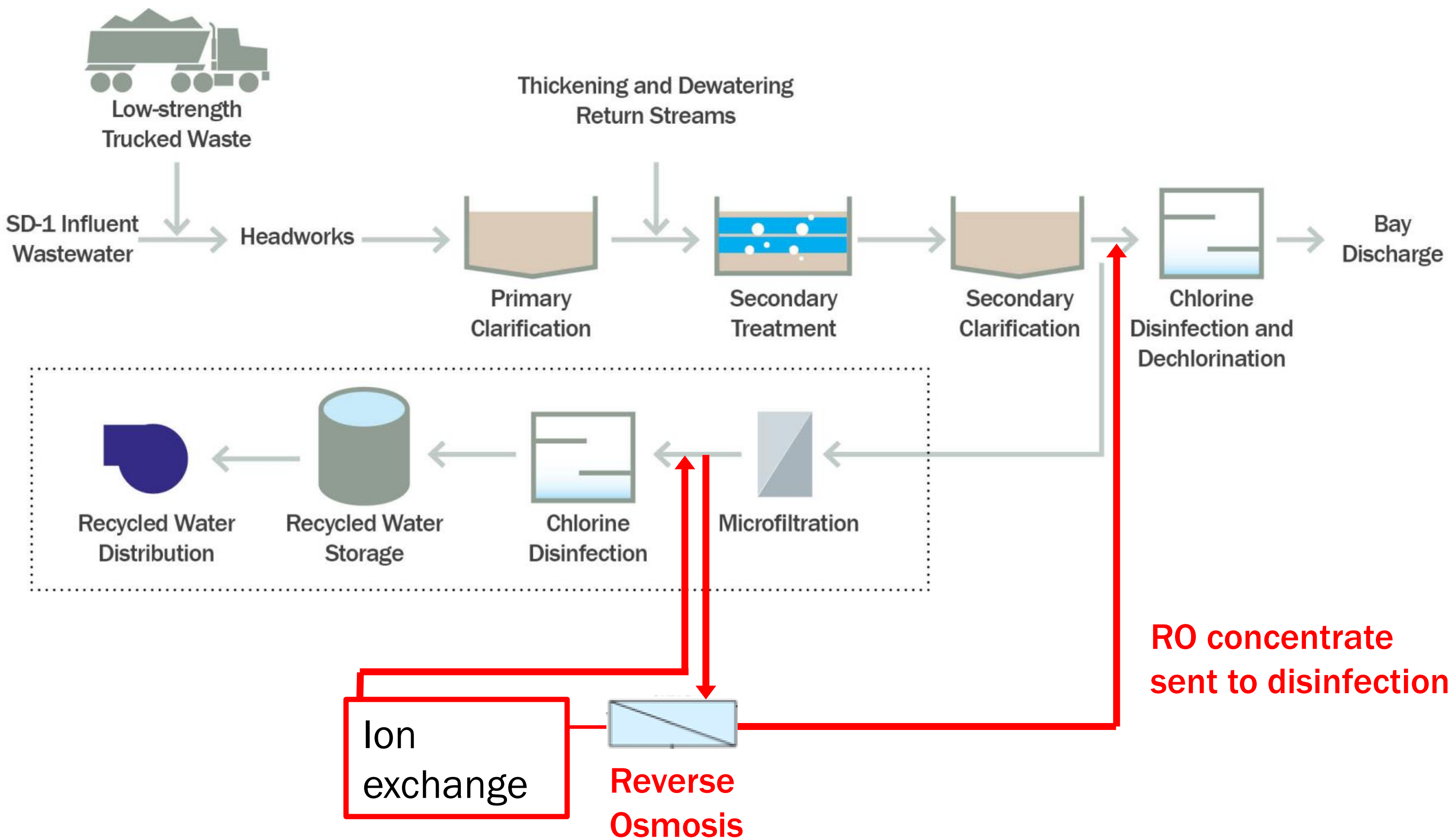
Screening Treatment Options

Brown AND Caldwell

Alternatives Selected for Screening

1. Expand pipeline to target lowest $/AFY projects
2. Periodic flushing to reduce high water age when demands are low
3. Seasonal shutdown of the EBRWF
4. Satellite treatment from Adeline and treat with Nereda
5. Add reverse osmosis and ion exchange to the EBRWF treatment train
6. Satellite treatment from Adeline and treat with an MBR

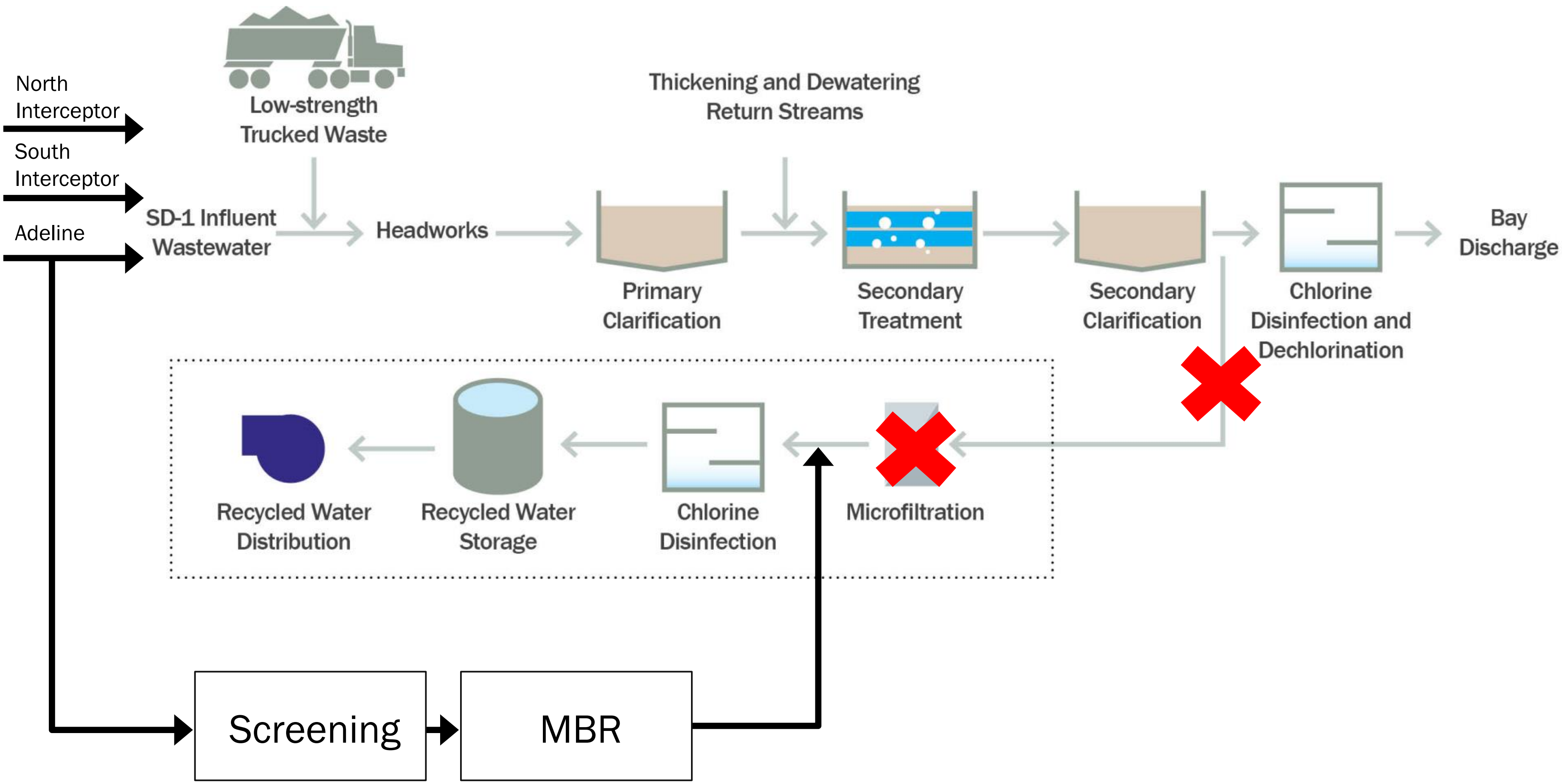
Add RO/IX Treatment at East Bayshore



Add RO and Ion Exchange at East Bayshore

Pros	Cons
Suitable to meet both industrial and dual-plumb customer water quality needs	Added capital costs plus O&M and energy costs associated with operating an RO system
RO is part of the potable reuse flow train so it could be reused as part of a potable reuse train	Need to manage two new streams (the concentrate with consideration for nutrient regulations, ion exchange regenerate)
No stranded assets (i.e., MF)	Two new processes to operate
	Additional polishing step (ion exchange or 2nd pass RO) required to meet ammonia water quality objective

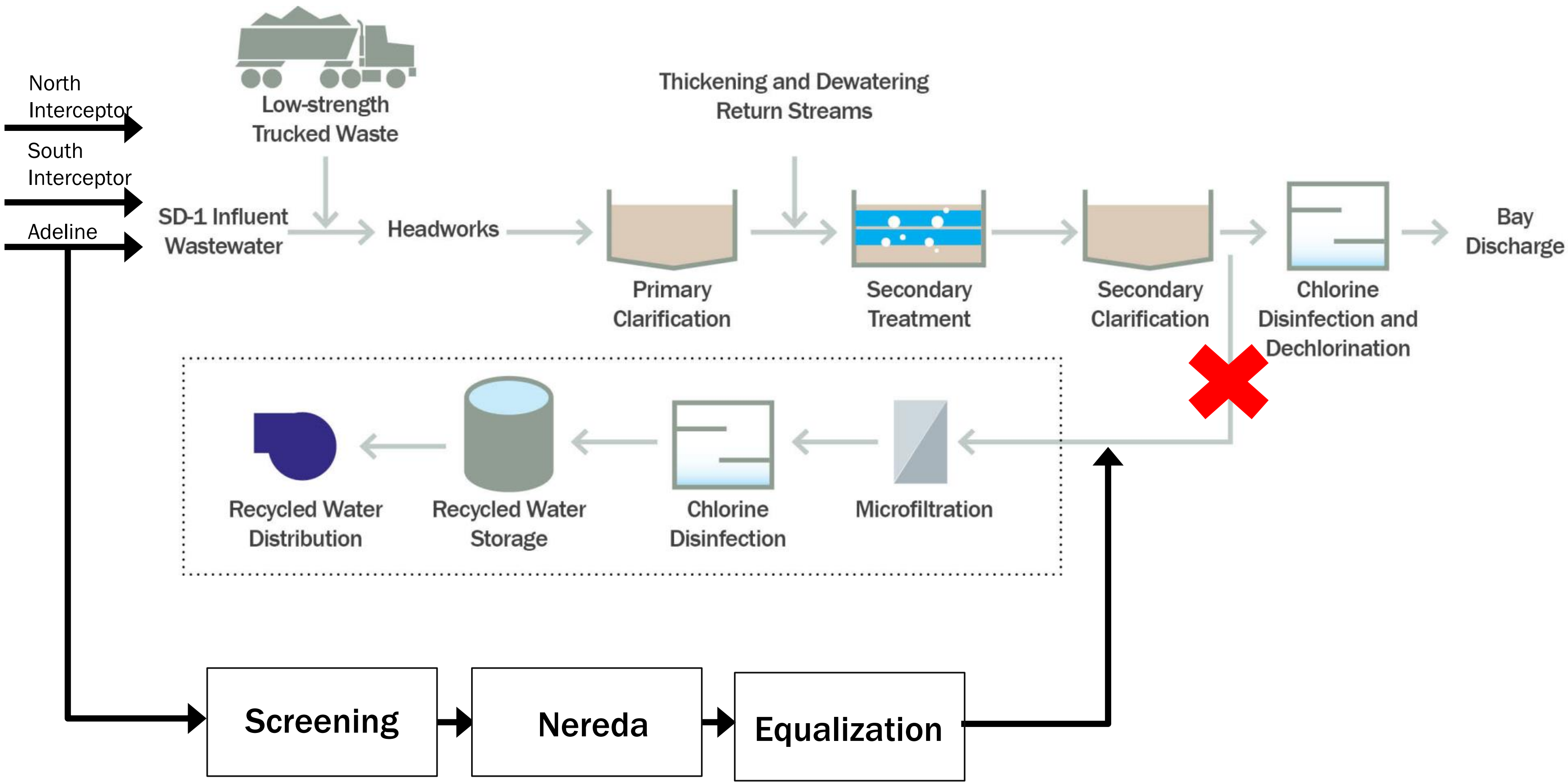
Satellite Treatment of Adeline with MBR



Satellite Treatment of Adeline with MBR

Pros	Cons
Combined secondary and tertiary treatment in one step	Existing MF becomes a stranded asset
Provides acceptable water quality for industrial and dual-plumbed uses	High capital cost, high energy cost
Eliminates the need for a separate TDS removal step	New process to operate
Provides nutrient removal	

Satellite Treatment of Adeline with Nereda/SBR



Adeline Satellite Treatment with Nereda/SBR for Nutrient Removal

Pros	Cons
Eliminates the need for a separate TDS reduction step	High capital cost/new infrastructure needed
Provides nutrient removal	Emerging technology/pilot testing recommended
Compact/simple technology	New process to operate
Lower energy demand compared to other BNR processes (e.g., MBR)	Chemical addition may be required to achieve lower effluent nutrient levels
No clarifiers needed	
MF is not a stranded asset	
Provides acceptable water quality for irrigation and industrial uses (e.g., cooling tower make-up water, dual plumbing)	

Treatment Alternatives Evaluation

Brown AND Caldwell

Treatment Alternatives Selected for Further Evaluation

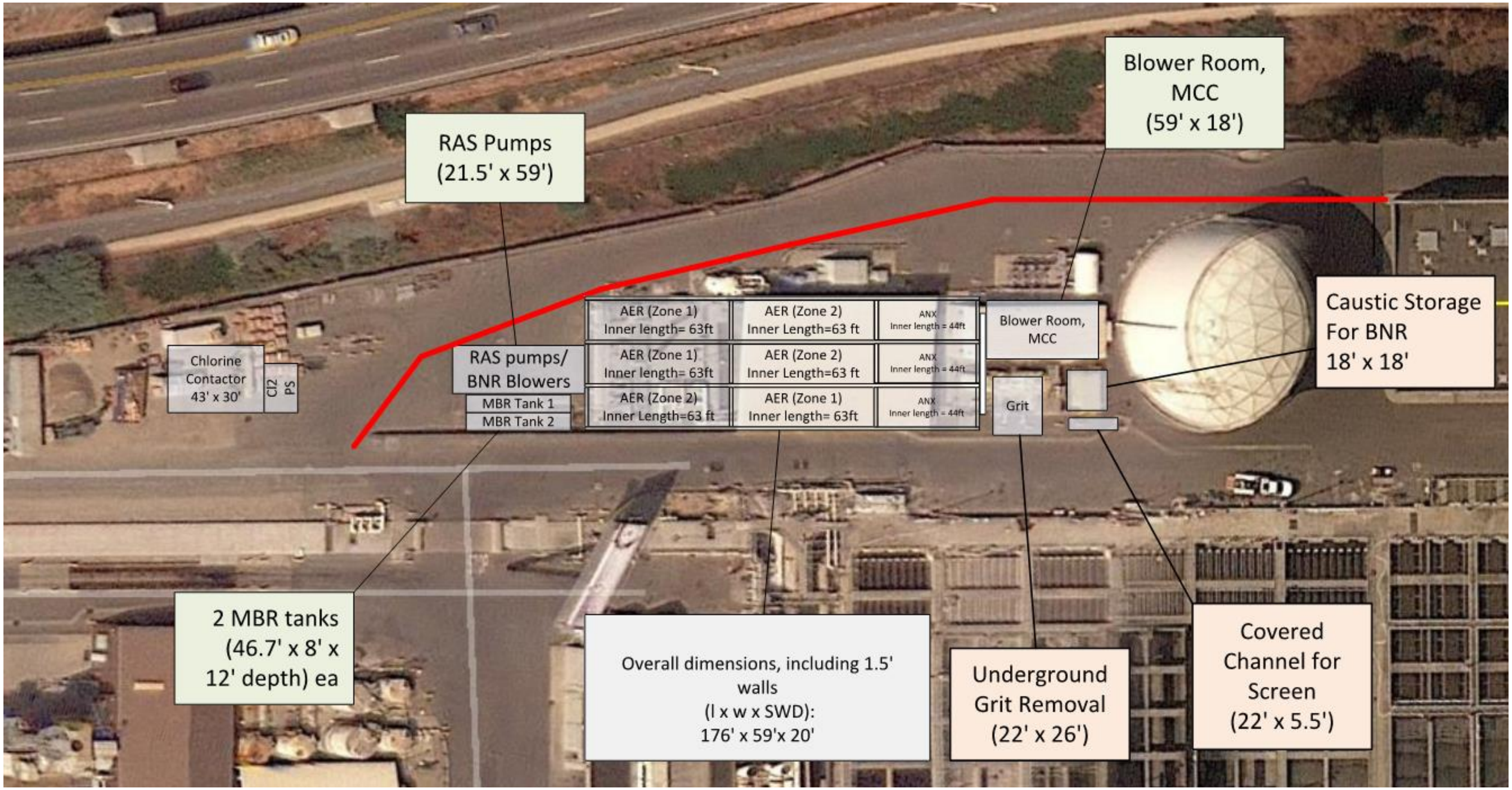
- Add MBR to treat raw wastewater from Adeline Inceptor
  - 1.6 mgd Design Capacity; Annual average: 1.3 mgd
  - 4.4 mgd Design Capacity; Annual average: 3.1 mgd

- Add RO/IX to treat MF effluent from EBRWF
  - 1.6 mgd Design Capacity; Annual average: 1.3 mgd
  - 4.4 mgd Design Capacity; Annual average: 3.1 mgd

Influent Pump Station Location

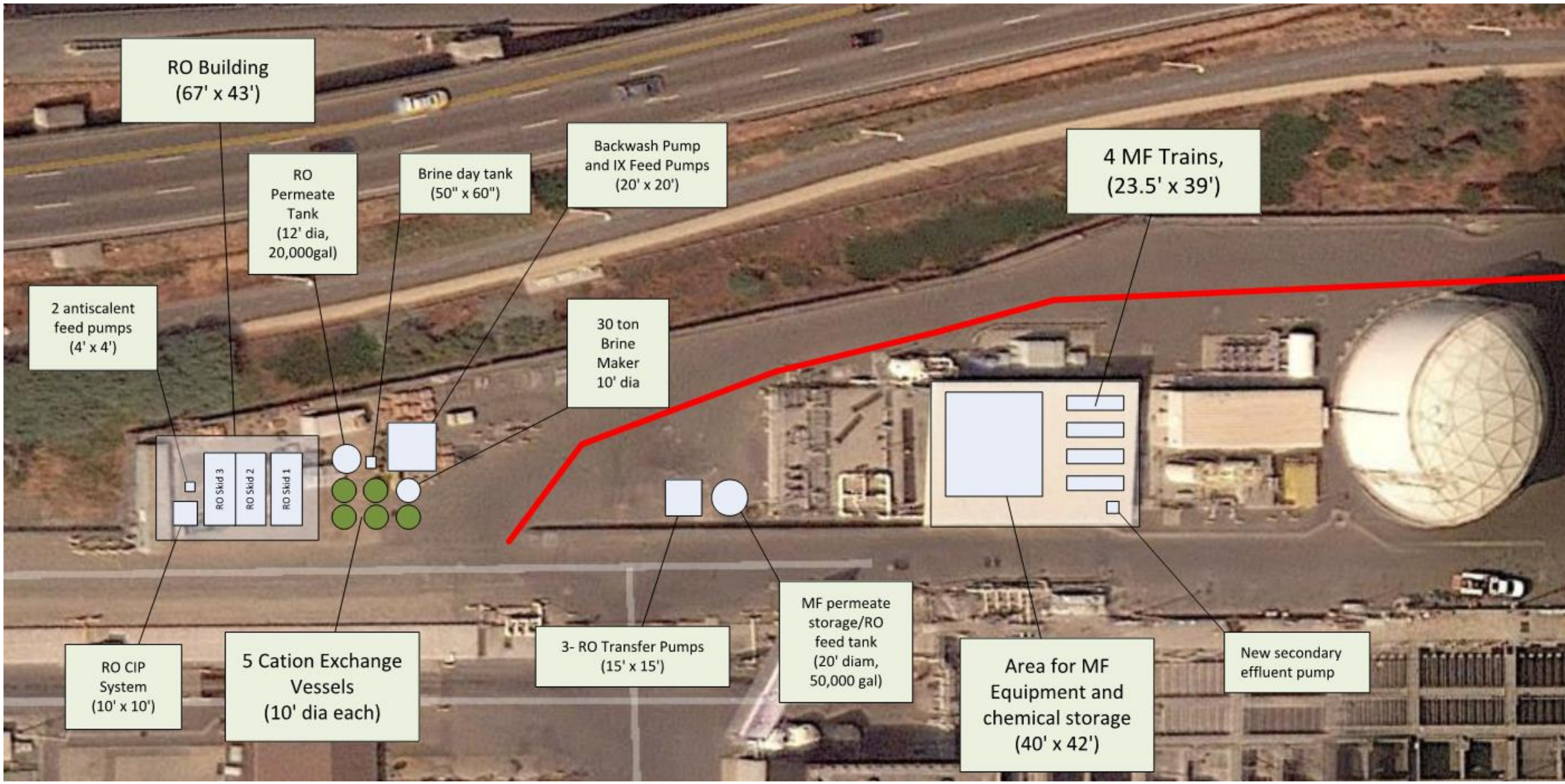
About 1000ft length from Adeline to proposed MBR location

MBR 4.4 MGD



Blower Room, MCC (59' x 18')
RAS Pumps (21.5' x 59')
AER (Zone 1) Inner length= 63ft
AER (Zone 2) Inner Length=63 ft
ANX Inner length = 44ft
AER (Zone 1) Inner length= 63ft
AER (Zone 2) Inner Length=63 ft
ANX Inner length = 44ft
AER (Zone 2) Inner Length=63 ft
AER (Zone 1) Inner length= 63ft
ANX Inner length = 44ft
Blower Room, MCC
Caustic Storage For BNR 18' x 18'
Chlorine Contactor 43' x 30'
Cl2 PS
RAS pumps/ BNR Blowers
MBR Tank 1
MBR Tank 2
Grit
2 MBR tanks (46.7' x 8' x 12' depth) ea
Overall dimensions, including 1.5' walls
(l x w x SWD):
176' x 59'x 20'
Underground Grit Removal (22' x 26')
Covered Channel for Screen (22' x 5.5')

RO/IX 4.4 MGD Layout



Questions?