Nutrient Reduction by Treatment Optimization and Upgrades: Update

BACWA Annual Meeting
15 January 2016

HDR
Brown AND Caldwell

BACWA
BAY AREA
CLEAN WATER
AGENCIES

Agenda

- Watershed Permit Requirements
- Update: Optimization and Upgrade Study
  - Optimization Analysis
  - Sidestream Treatment Reduction
  - Case Studies for Optimization and Upgrades
- 2015 Group Annual Report
- Next Steps

Watershed Permit

CALIFORNIA Water Boards

EDMUND G. BROWN JR.
GOVERNOR

MATTHEW RODRIQUEZ
SECRETARY FOR
ENVIRONMENTAL PROTECTION

San Francisco Bay Regional Water Quality Control Board

ORDER No. R2-2014-0014
NPDES No. CA0038873

WASTE DISCHARGE REQUIREMENTS FOR NUTRIENTS FROM MUNICIPAL WASTEWATER DISCHARGES TO SAN FRANCISCO BAY

The following dischargers are subject to waste discharge requirements (WDRs) set forth in this Order, for the purpose of regulating nutrient discharges to San Francisco Bay and its contiguous bay segments:

Table 1. Discharger Information

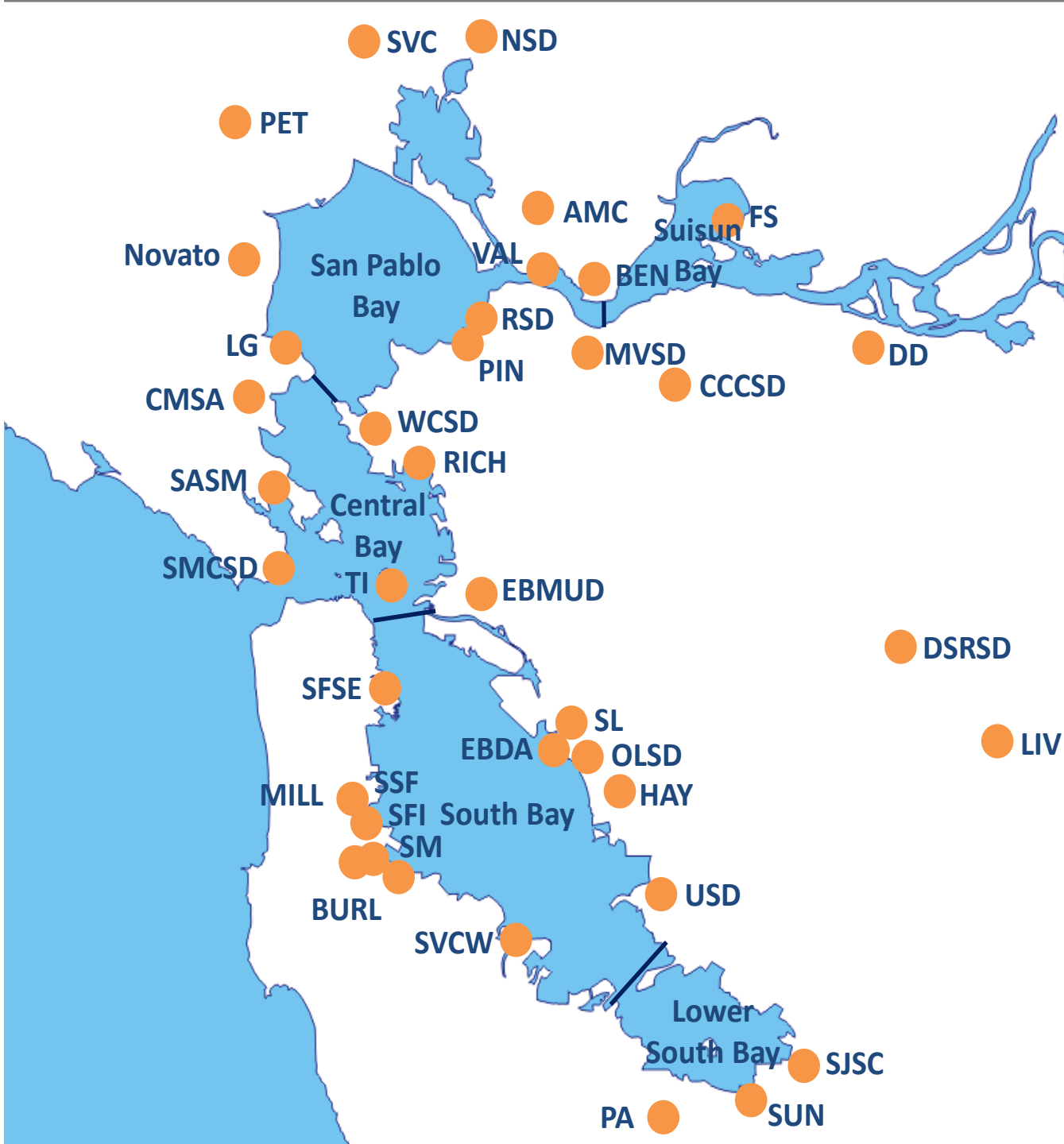
Discharger	Facility Name	Facility Address	Minor/ Major
		151 Mazzetta Court	

April 9, 2014

Watershed Permit Requirements

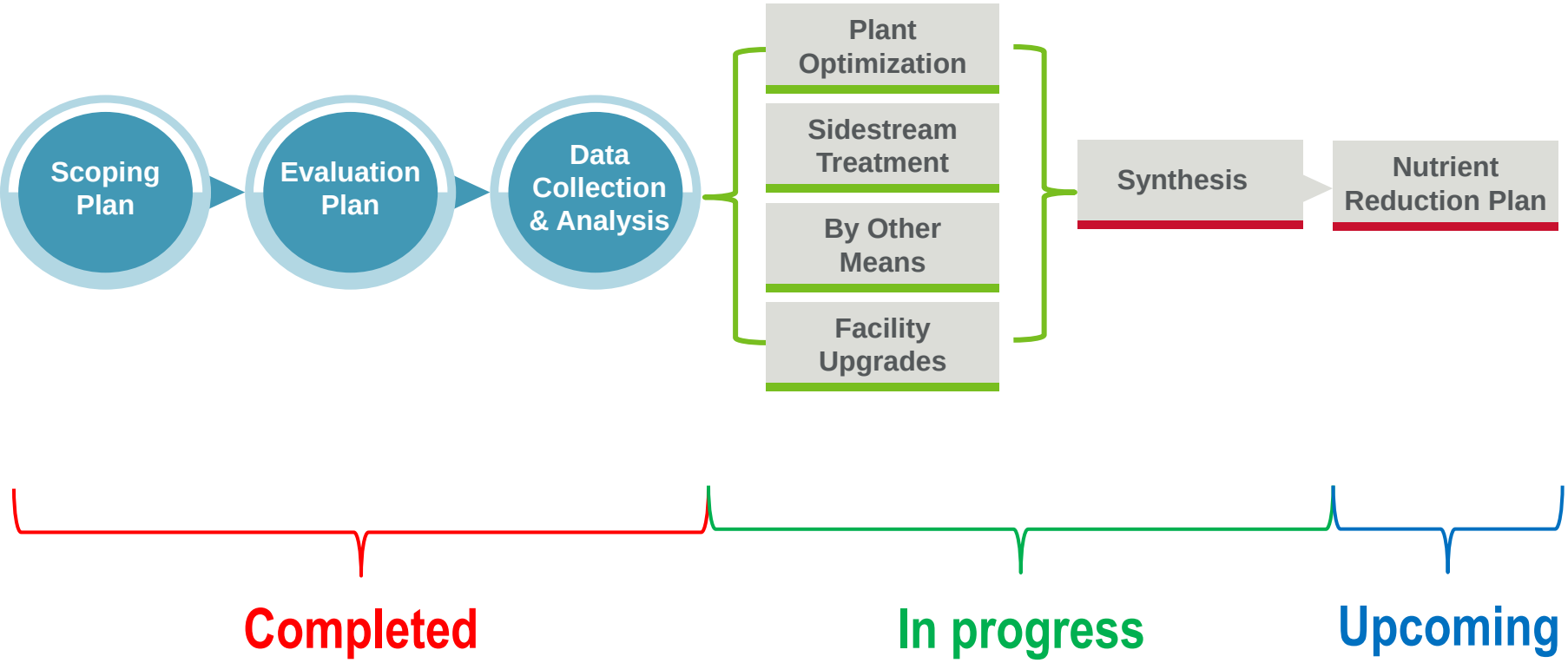
- Issued April 9, 2014 – Regional Water Board Order No. R2-2014-0014
- Requirements:
  - Scoping and Evaluation Plan (Accepted first quarter of 2015)
  - July 2018: Task 1 - Conduct treatment plant optimization and sidestream treatment evaluation for nutrient load reductions (Submittal deadline is July 2018)
  - July 2018: Task 2 - Conduct treatment plant upgrades and analysis of removal by other means for nutrient load reductions (Submittal deadline is July 2018)
  - Annual Reporting (Annual submittal in October from 2015 through 2018)

37 Participating Agencies



Update on Optimization and Upgrades Study

Overview / Status of Study

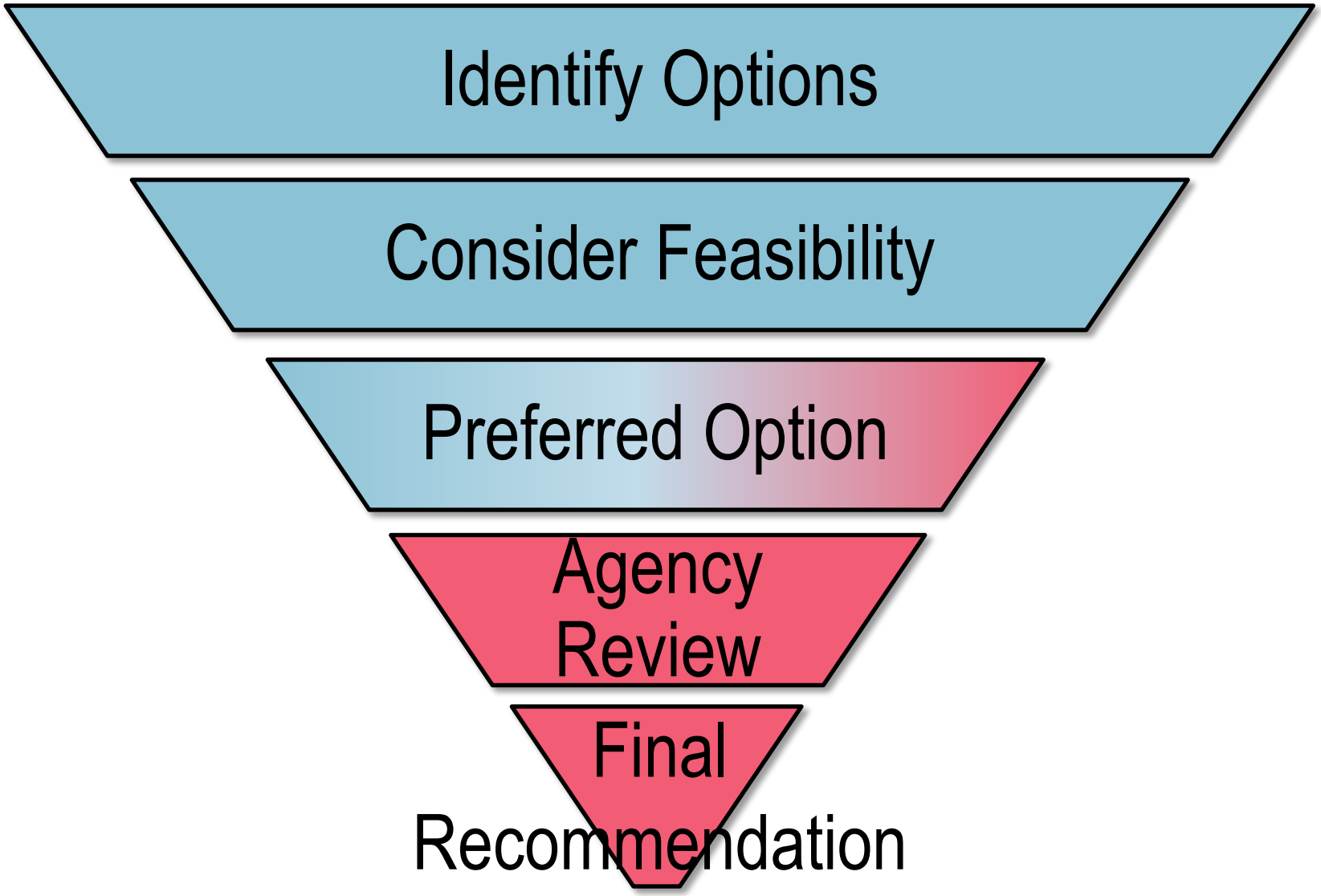


Treatment Levels

Level	Study	Ammonia	TN	TP
Level 1 *	Optimization	--	--	--
Level 2 *	Upgrades	2 mg N/L	15 mg N/L	1.0 mg P/L
Level 3 *	Upgrades	2 mg N/L	6 mg N/L	0.3 mg P/L

* The seasonal impacts will be considered for all three treatment levels:
  - Dry Season = May 1 to September 30
  - Wet Season = October 1 to April 30

Progressive Evaluation



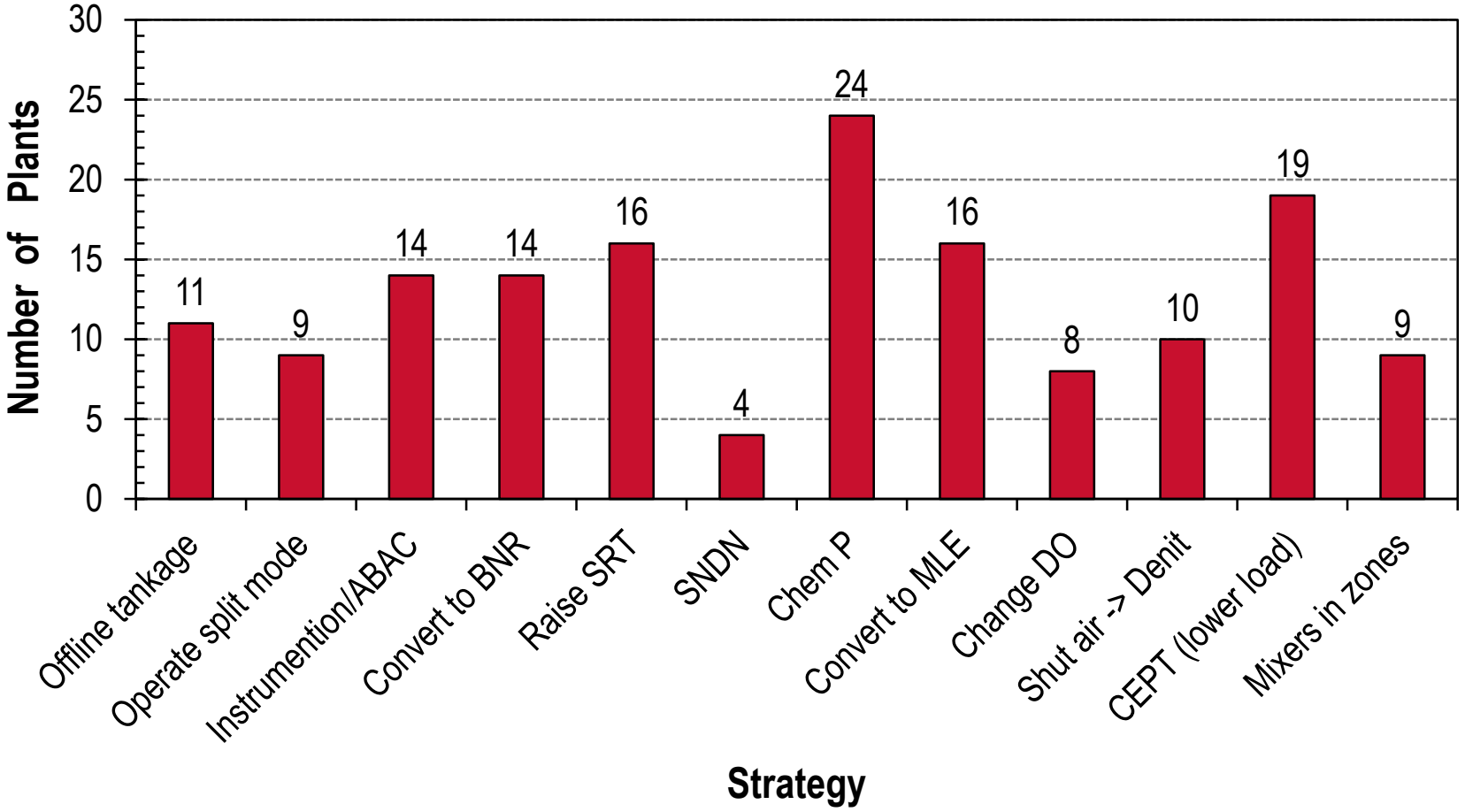
Optimization Analysis




Optimization Concepts

- Use offline tankage
- Operate in split treatment mode
- Modify operational mode (e.g., raise SRT)
- Modify blower set points
- Add chemicals
  - P removal
  - To unlock downstream capacity
- Shut down aeration to create anoxic zones
- Process control instrumentation
- Add internal recycle for denitrification

Potential Optimization Strategies Discussed During Site Visits that are Being Further Explored



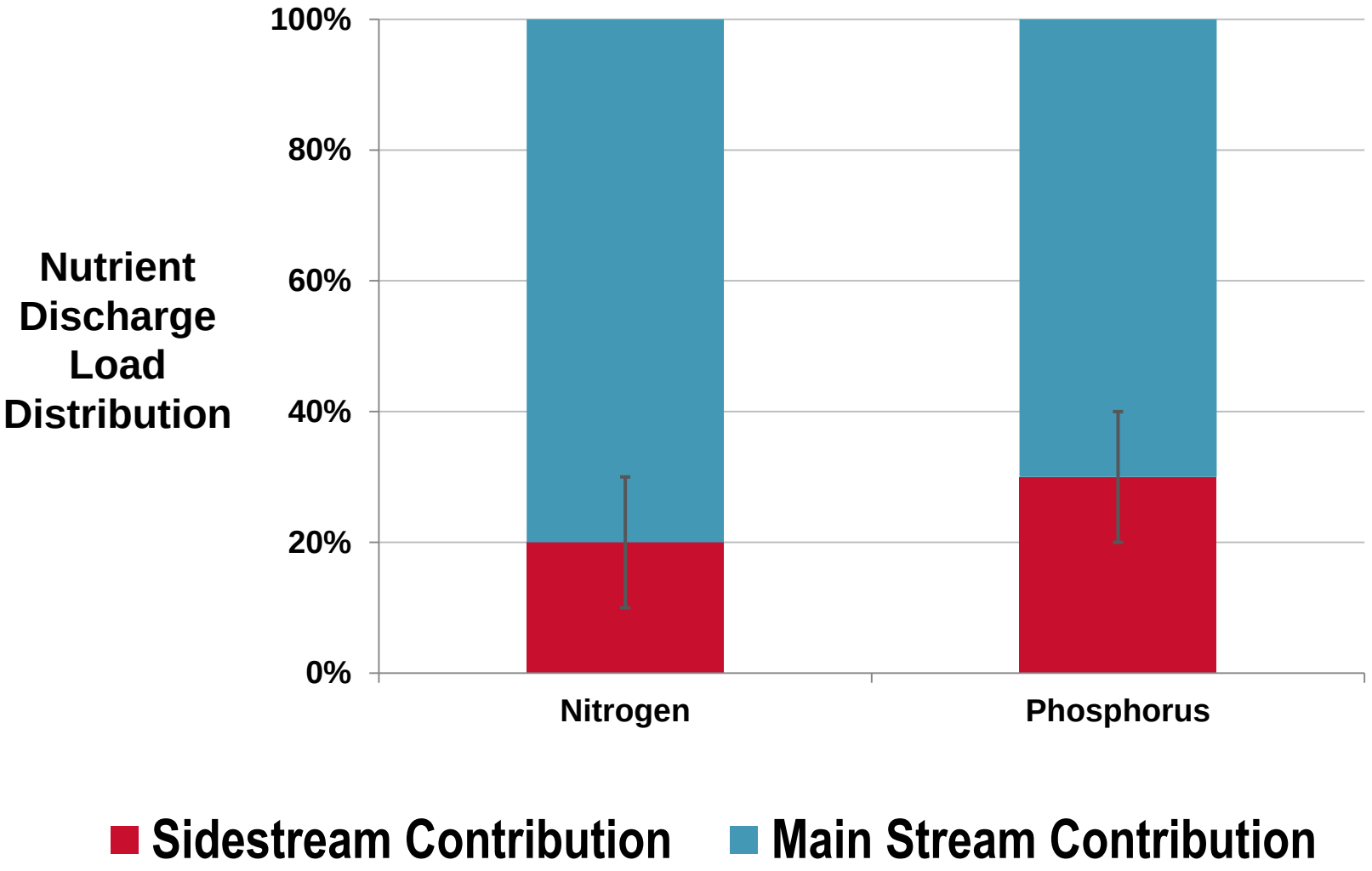
Based on Master Plan Information or Current Flows and 115% Load

Sidestream Treatment Reduction

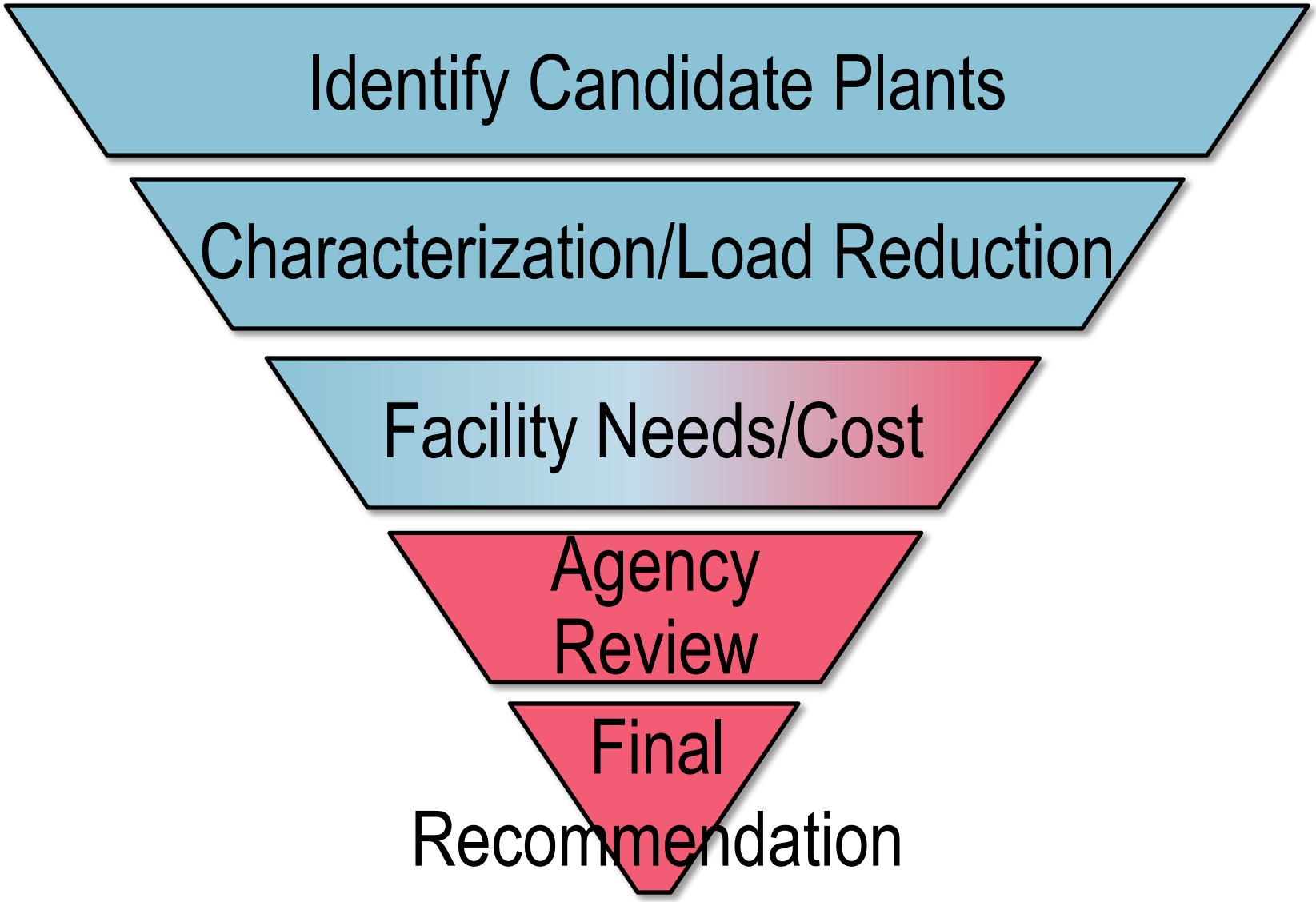
Preliminary Findings




Sidestream Nutrient Load Contributions



Progressive Evaluation



Sidestream Treatment Pilot Test Locations, Technologies, and Status

EBMUD:
Anammox
- Suspended-growth
- Attached-growth

Completed

SFPUC:
Anammox
- Suspended-growth
- Attached-growth
- Biozeolite

Ongoing

DD: CANDO
Ongoing

OLSD: Zeolite anammox
Completed

USD: ANITA™ Mox
Completed

CANDO = Coupled Aerobic-anoxic Nitrous Decomposition Operation process, DD = Delta Diablo, EBMUD = East Bay Municipal Utility District
OLSD = Oro Loma Sanitary District, SFPUC = San Francisco Public Utilities Commission, USD = Union Sanitary District

Pictures of Pilot Testing Systems

CANDO Pilot System at Delta Diablo

ANITA™ Mox Pilot System at USD

Zeolite Anammox Pilot System at Oro Loma

Anammox Pilot System at SFPUC

Anammox Pilot System at EBMUD

Sidestream Treatment Sampling Results (from Plant X)

- Sampling in July 2015
- Funded by EPA Regional Grant
- Loading is typical of national trends
- Bay wide average NH3 is ~810 mg N/L

Parameter	Units	Sample 1 of Plant X	Sample 2 of Plant X	Sample 3 of Plant X
Ammonia	mg N/L	494	395	412
Sol COD	mg/L	430	470	1000
Alkalinity	mg/L	2,700	2,600	2,600
TKN	mg N/L	950	910	600
Total Phosphorus	mg P/L	230	210	190
Orthophosphate	mg P/L	29	36	31
Alkalinity:Ammonia		5.5	6.6	6.3

Preliminary Ammonia Discharge Load Reduction Potential with Sidestream Treatment (based on Current Loading)

Subembayment	Annual Average Daily Discharge, lb N/d*	Preliminary Discharge Reduction Potential with Sidestream Treatment, %**,***
Suisun Bay	9,394	5 – 10
San Pablo Bay	2,906	12 -17
Central Bay	21,978	25 – 35
South Bay	46,042	15 - 20
Lower South Bay	832	0
Total	81,151	15 - 22

* Source: Group Annual Report (November 12, 2016)

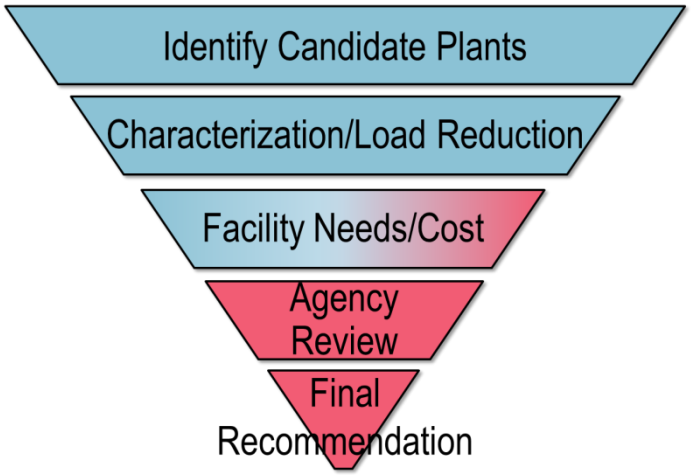
** Based on plants identified as candidates for sidestream treatment to further reduce ammonia discharge loads to the Bay

*** Assumes 85% total nitrogen removal in sidestream treatment reactor

Plant Upgrades

Overview of Plant Upgrades

- Evaluate Master Plan and CIP for future upgrades
- Identify strategies to meet Level 2 and Level 3
- Select appropriate technology
- Determine cost, implementation requirements & plant impacts
- Consider innovative technologies/techniques
- Discuss ideas with plant staff and get feedback

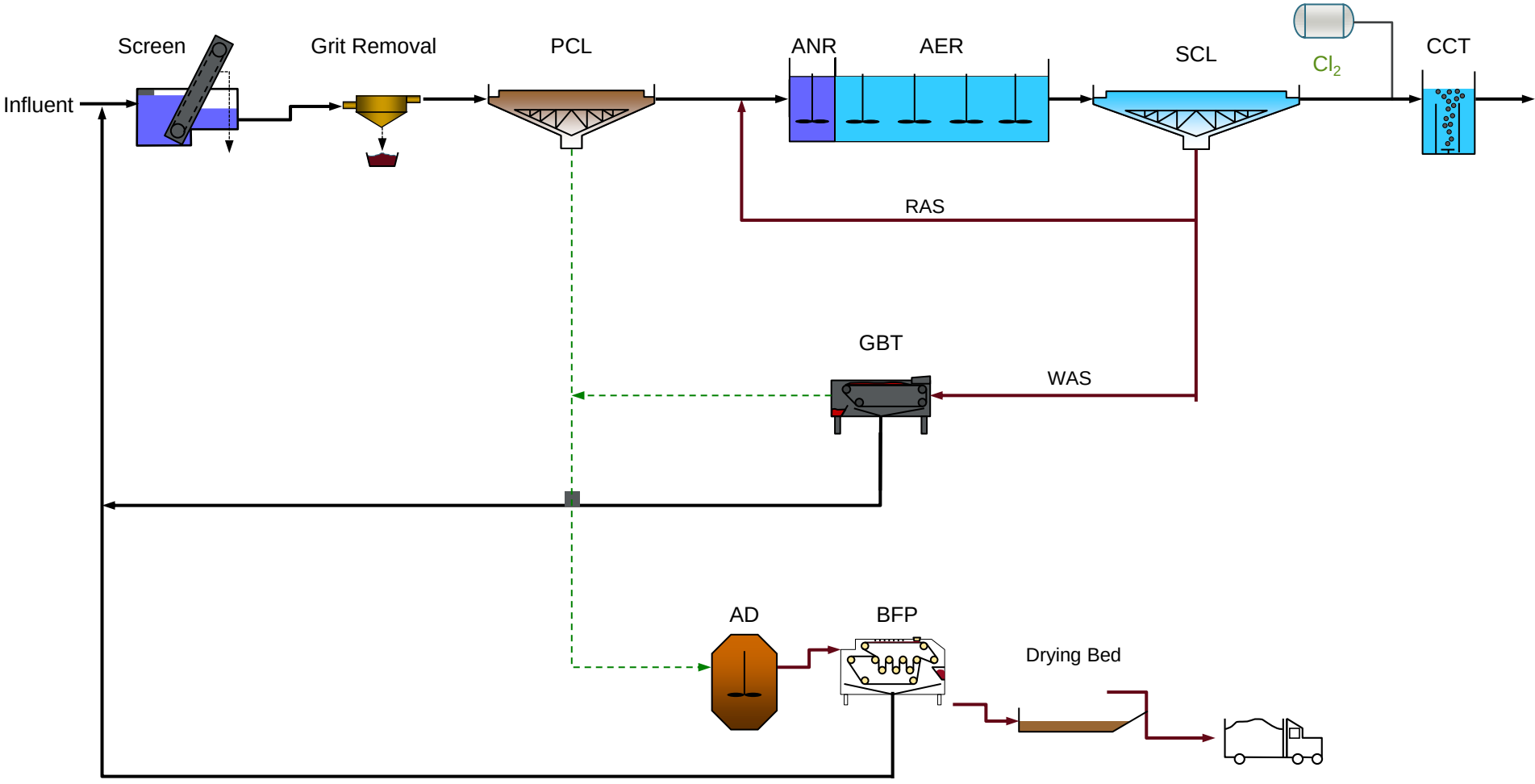


Case Studies

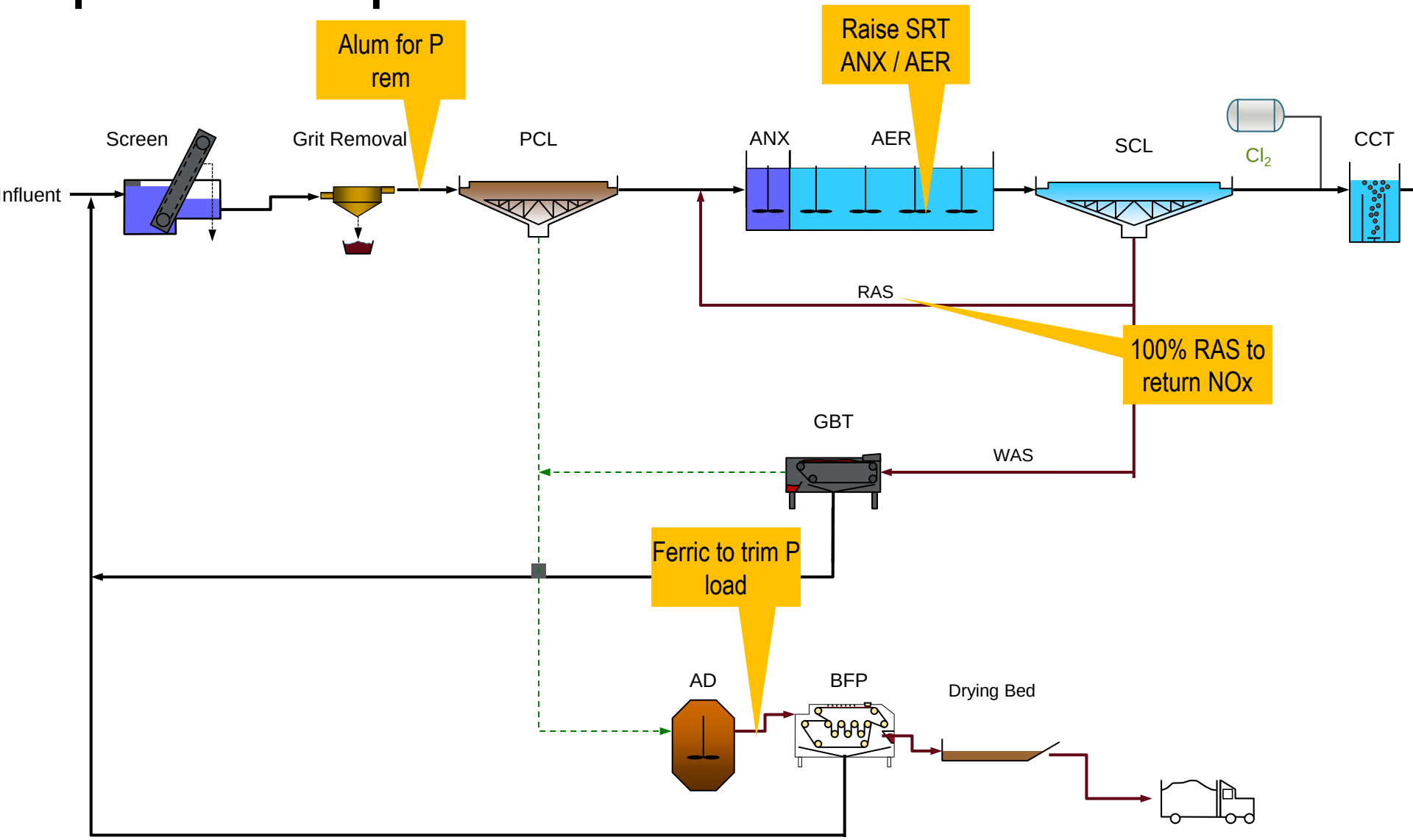
- Oro Loma
- Delta Diablo

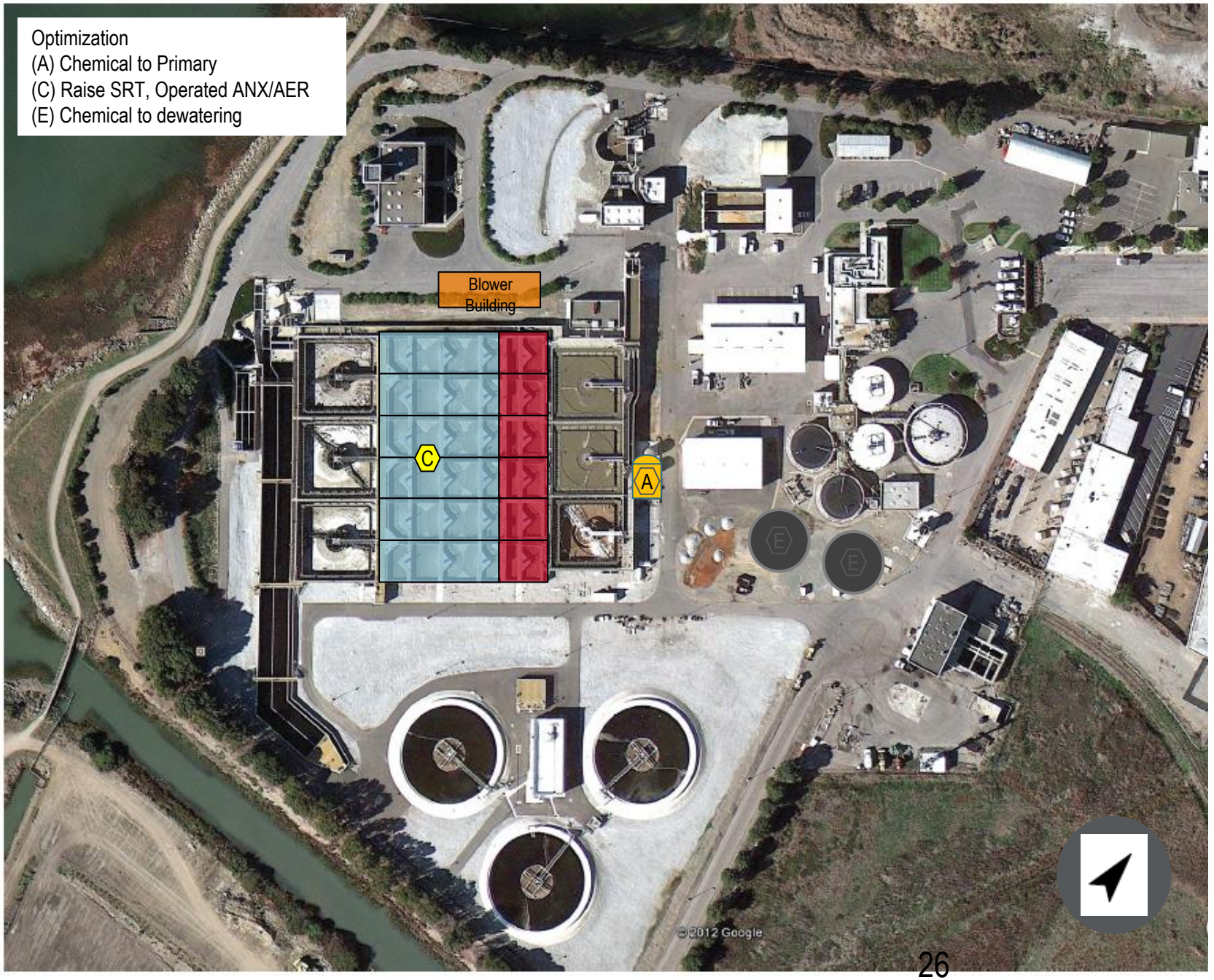
Oro Loma

Process Flow Diagram - Current

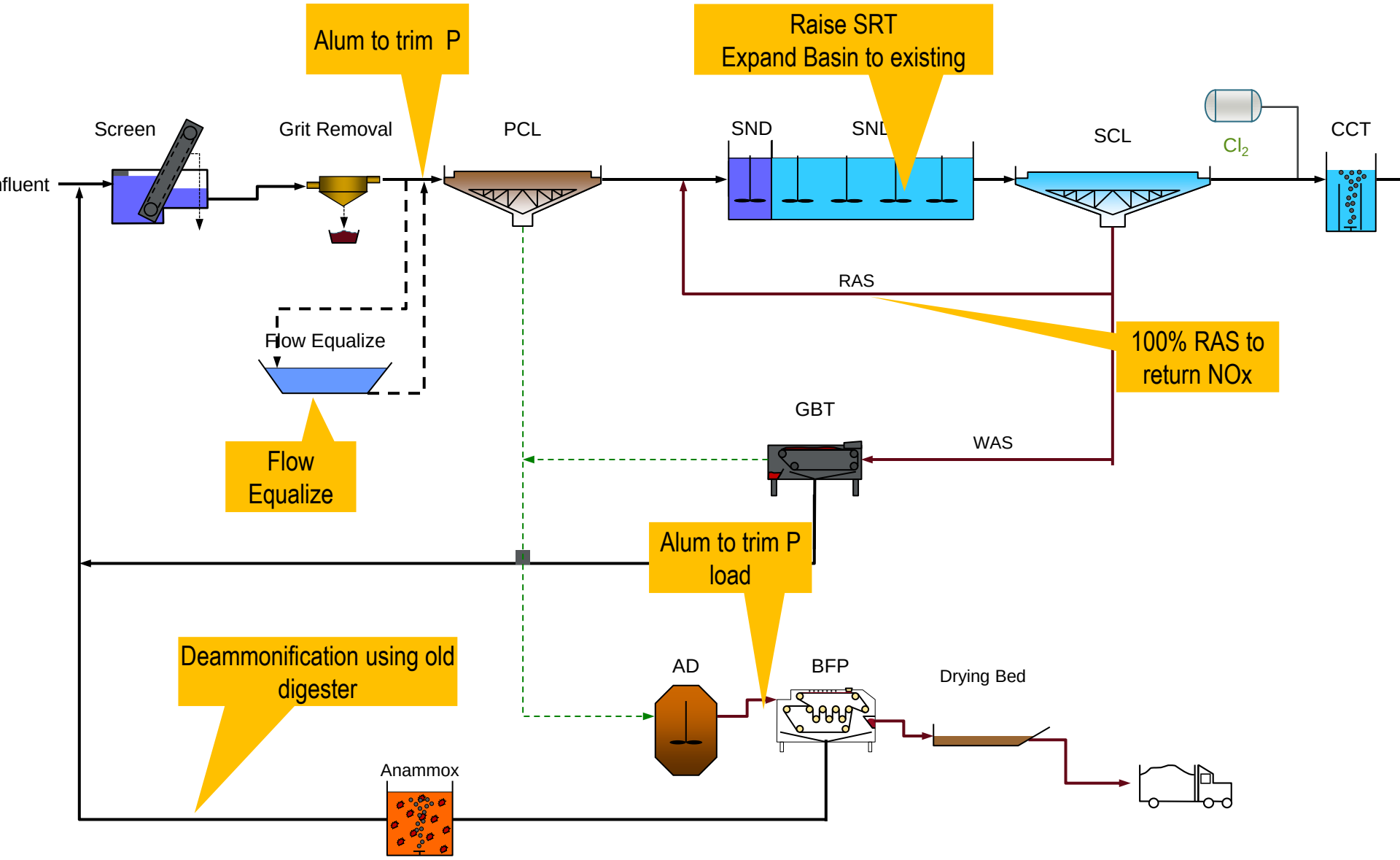


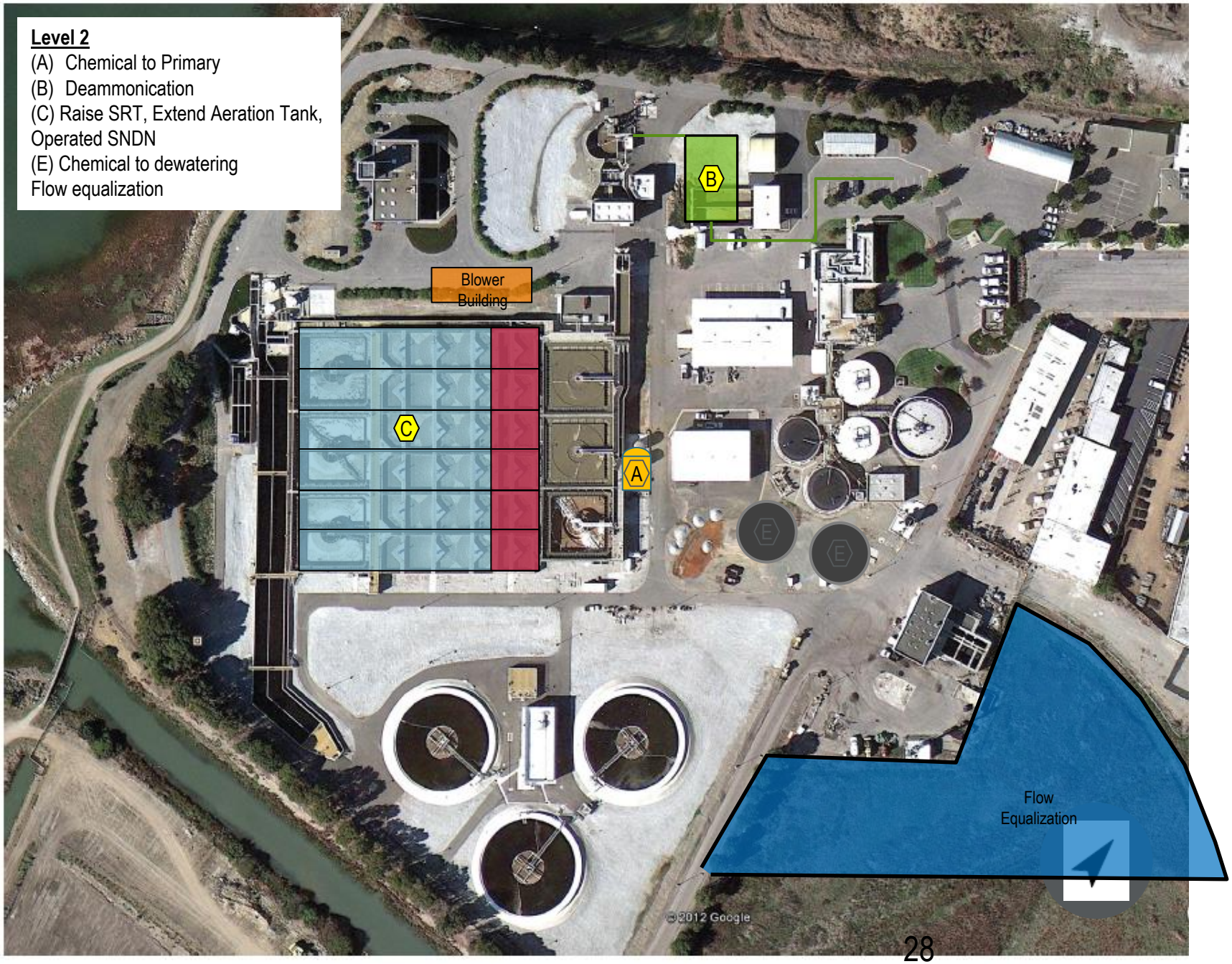
Optimization Options



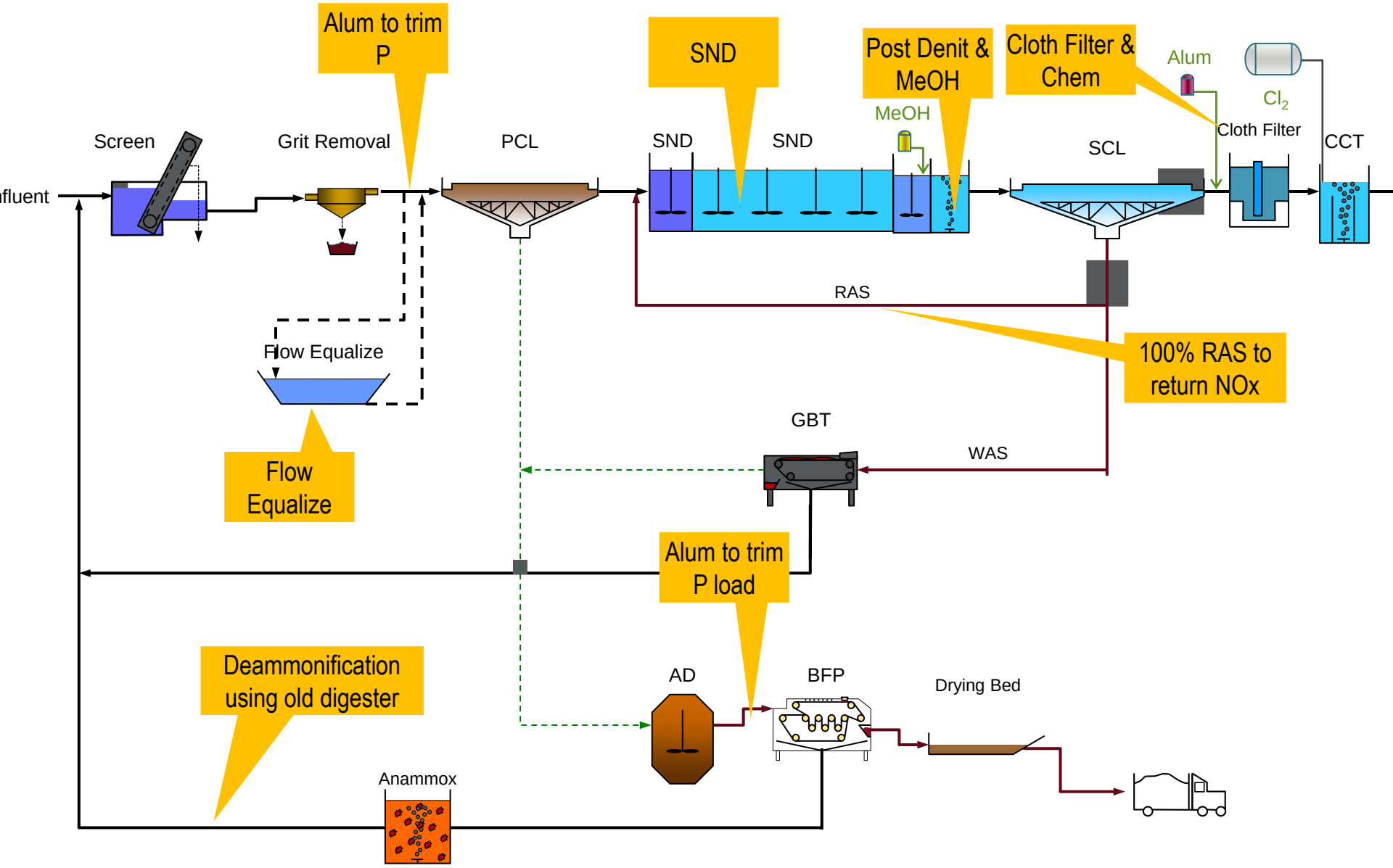

Optimization
(A) Chemical to Primary
(C) Raise SRT, Operated ANX/AER
(E) Chemical to dewatering
Blower Building
C
A
E
E
©2012 Google

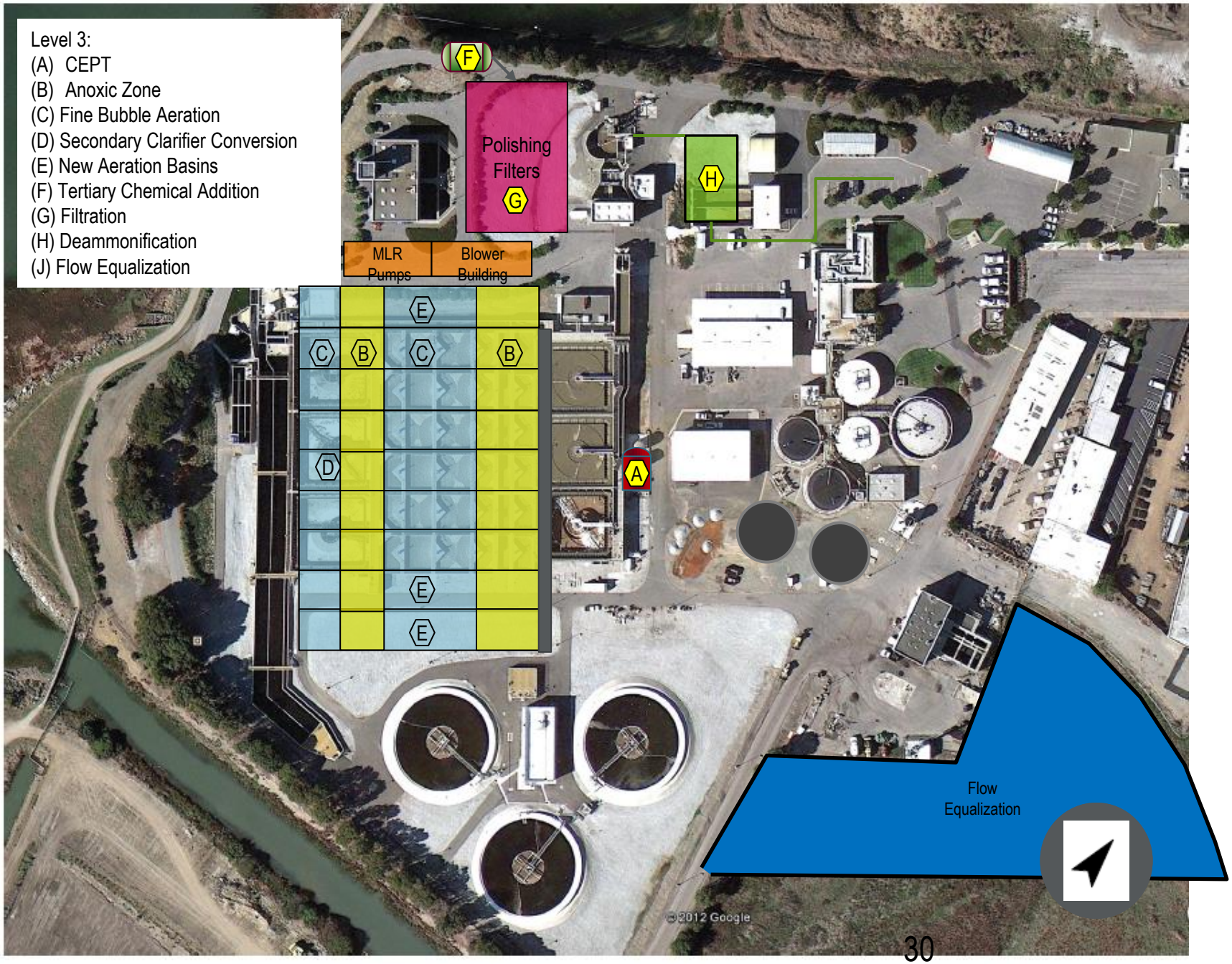
Level 2 – Increase Flow and Load




Level 2
(A) Chemical to Primary
(B) Deammonication
(C) Raise SRT, Extend Aeration Tank, Operated SNDN
(E) Chemical to dewatering
Flow equalization
B
Blower Building
C
A
E
E
Flow Equalization
©2012 Google

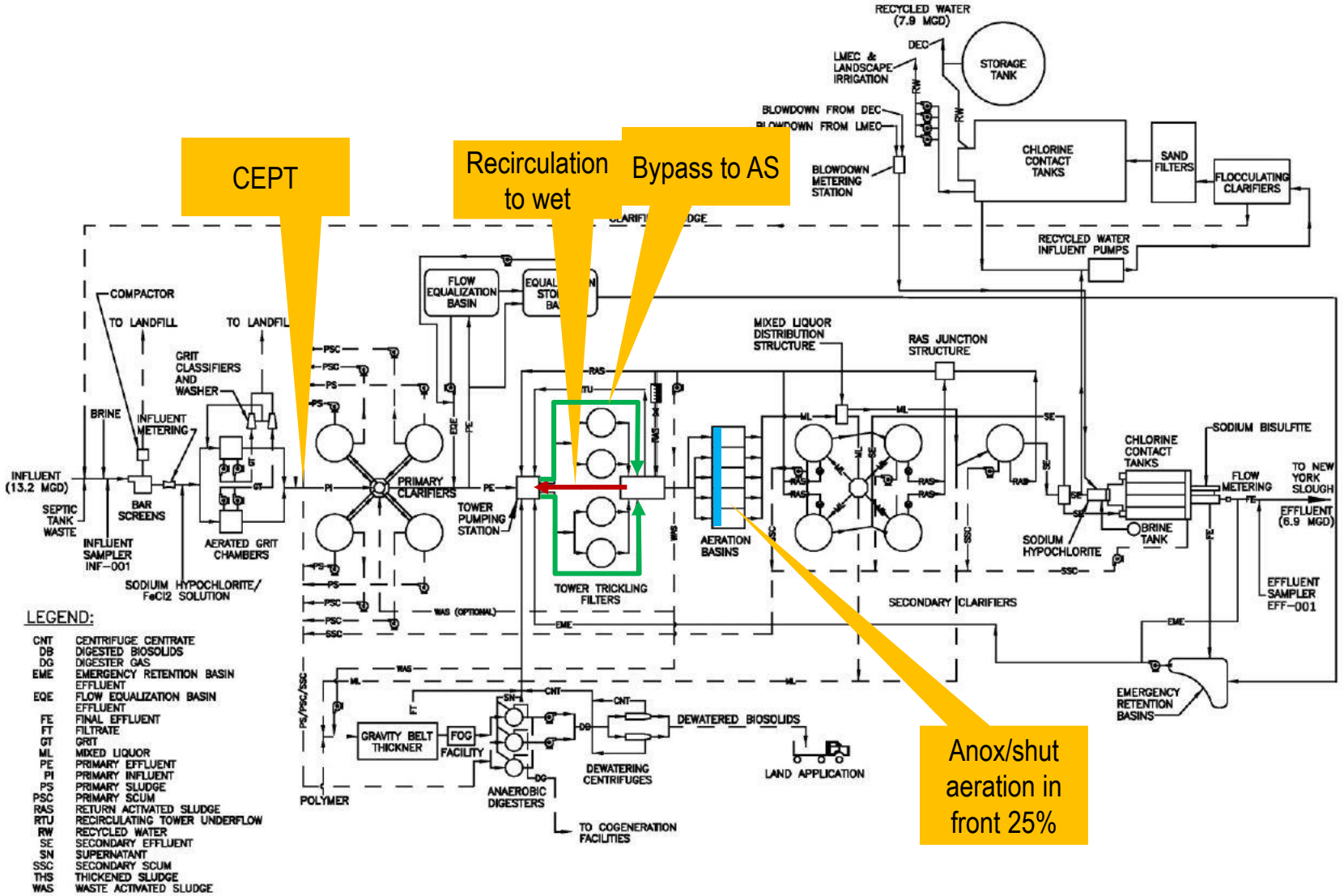
Level 3 – 4 stage Bardenpho, filter, MeOH



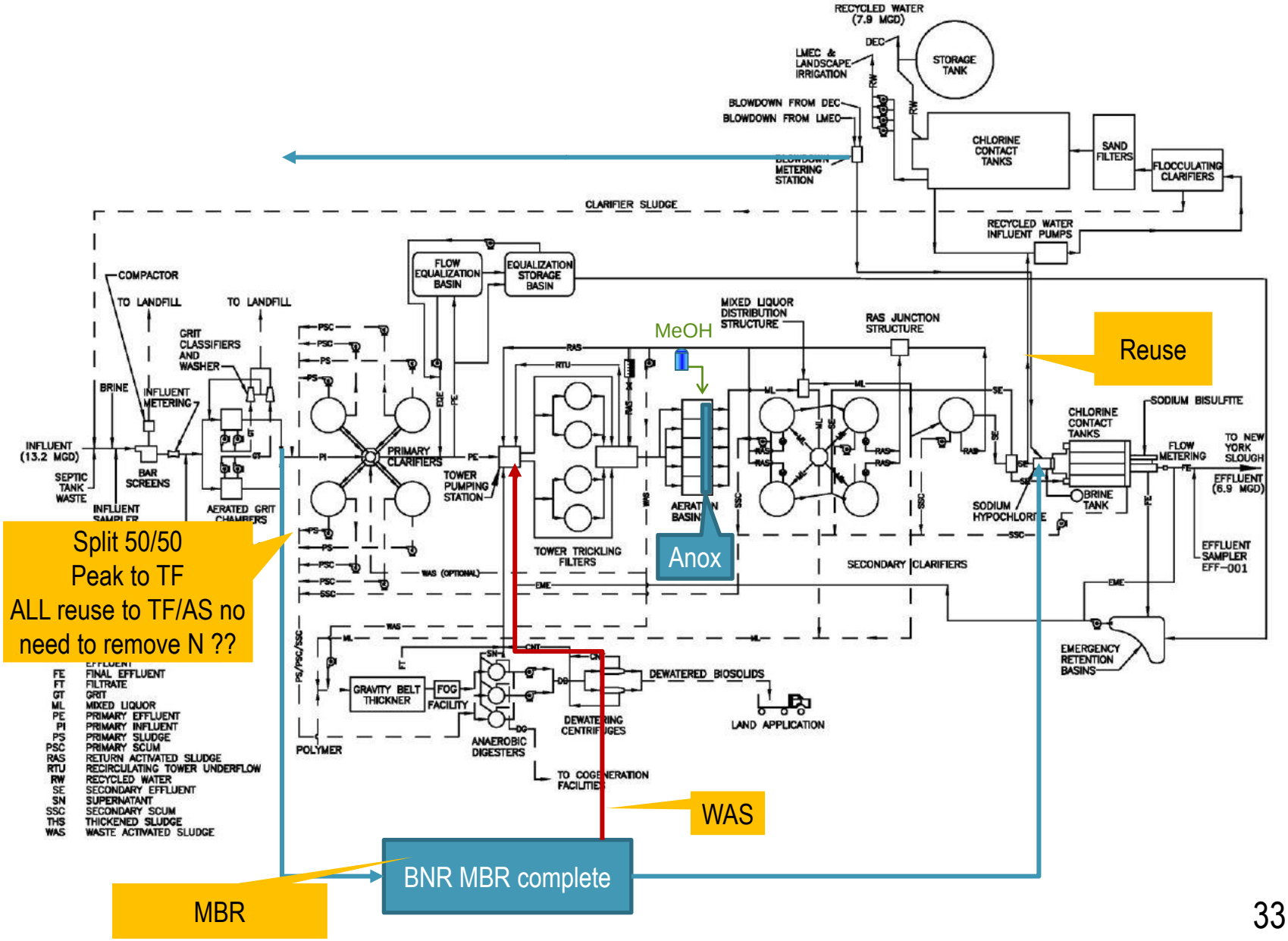

Level 3:
(A) CEPT
(B) Anoxic Zone
(C) Fine Bubble Aeration
(D) Secondary Clarifier Conversion
(E) New Aeration Basins
(F) Tertiary Chemical Addition
(G) Filtration
(H) Deammonification
(J) Flow Equalization
F
Polishing Filters
G
H
MLR Pumps
Blower Building
E
C
B
C
B
D
A
E
E
Flow Equalization
©2012 Google

Delta Diablo

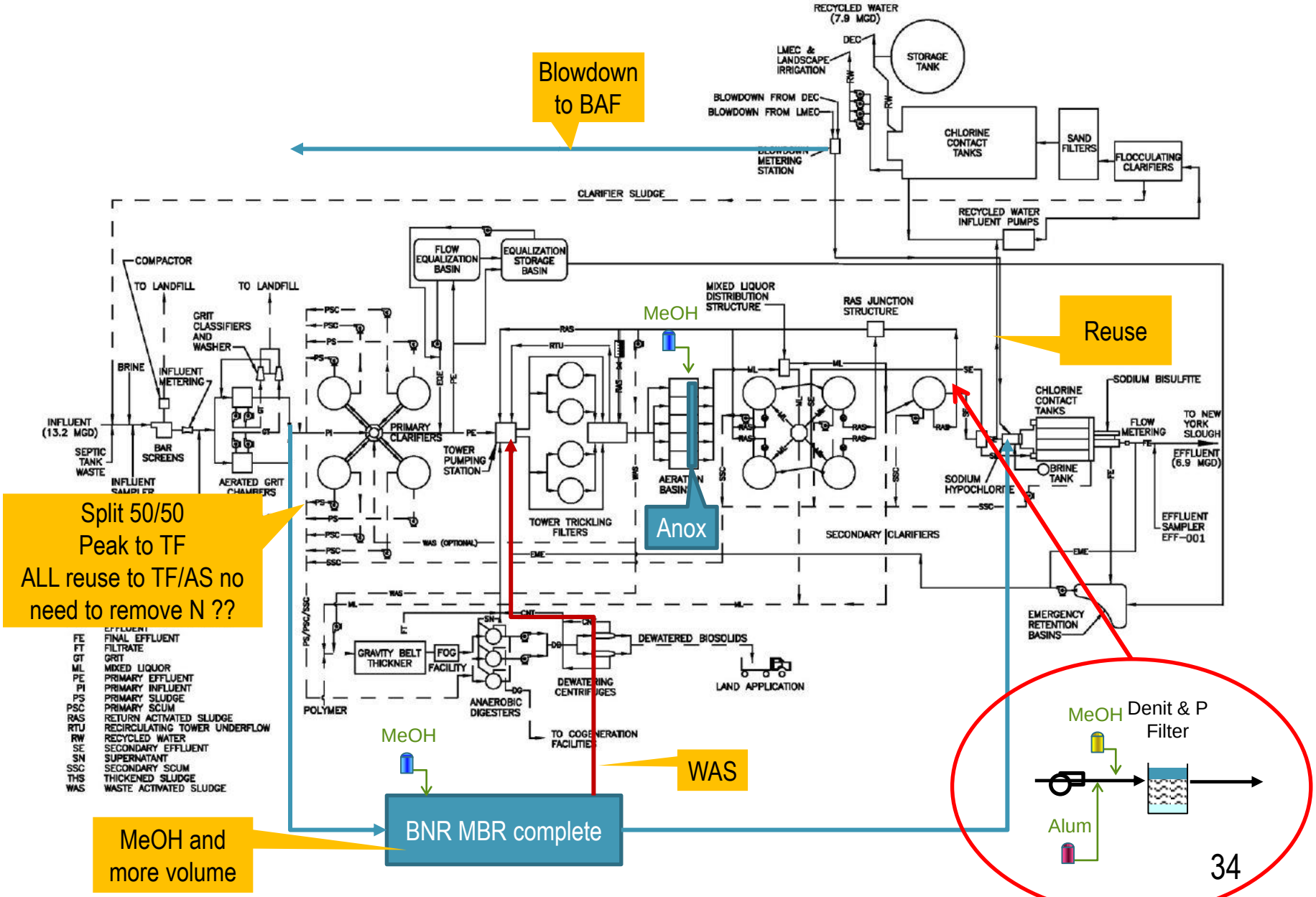
Optimization Options



Level 2 Process Flow Diagram



Level 3 Process Flow Diagram



Level 2 Summer

Level 2 Winter

Level 3 Summer

Level 3 Winter

Cost Calculation

- Estimate Capital and O&M Costs
  - Summer and Winter Season
  - N&P, N, and P removal
- Calculate life cycle cost
- Compare results by plant for unit cost for nutrient removal
  - $/gpd capital
  - $/lb N removed
  - $/lb P removed

Group Annual Report Update

Approach

- Data Sources
  - 13267 Letter Data
  - CIWQS
- Parameters of Interest
  - Flow
  - Total Ammonia
  - TKN
  - NOx
  - Total Nitrogen
  - Orthophosphate
  - Total Phosphorus
- Data Confirmation
- Seasonality
  - Dry Season: May 1 – Sept 30
  - Wet Season: Oct 1 – April 30
- Trend Analysis
  - Method of Least Squares
  - Only Dry Season Considered for Trends

Results - Flows

- Total AA discharge ranged from 421 mgd to just over 450 mgd
  - ADW flows ranged 365 mgd to 399 mgd
- South Bay and Lower South Bay contribute highest flows, >60 %
- Largest dischargers: San Jose, SFPUC Southeast, EBDA and EBMUD
- Flows are either flat or trending downward
  - Water conservation, the drought, and increased diversion for recycled water. San Pablo Bay has the largest portion of recycled water diversion during the dry season, when several plants actually divert all flow and have a zero dry season discharge.

Dry Season Average Flows (mgd)

Subembayment	Permitted Capacity[1]	2012/13	2013/14	2014/15	Trend
Suisun Bay	100	53	52	47	Decreasing
San Pablo Bay	63	16	17	15	None
Central Bay	167	68	65	60	Decreasing
South Bay	261	145	144	139	Decreasing
Lower South Bay	235	117	109	104	Decreasing
Total Discharge to Bay	**826**	**399**	**387**	**365**	Decreasing

Results - Ammonia

- Total AA ammonia ranged from 33,800 kg N/d to 36,900 kg N/d
  - ADW loads ranged from 32,700 kg N/d to 36,600 kg N/d
- Central Bay and South Bay contribute the loads, > 80 %
- Largest contributors SFPUC Southeast, EBMUD, EBDA
- Dry season ammonia loads are flat or increasing
- LSB loads are an order of magnitude lower than other Subembayments, since the dischargers nitrify

Dry Season Average Ammonia (kg N/d)

Subembayment	2012/13	2013/14	2014/15	Trend
Suisun Bay	4,107	4,159	3,967	None
San Pablo Bay	834	895	1,181	Increasing
Central Bay	9,200	10,029	10,154	Increasing
South Bay	18,315	20,281	21,047	Increasing
Lower South Bay	262	177	211	None
Total	**32,718**	**35,541**	**36,560**	Increasing

Total Nitrogen

- Total AA TN ranged from 49,900 kg N/d to 51,600 kg N/d
  - ADW TN ranged from 49,800 kg N/d to 51,400 kg N/d
- Central and South Bay contribute the highest TN loads, >65 percent
- Largest contributor of TN is EBMUD, followed by SFPUC Southeast and EBDA
- Appears to be an upward trend
  - Attributed to increasing loads in the South Bay

Dry Season Average TN (kg N/d)

Subembayment	2012/13	2013/14	2014/15	Trend
Suisun Bay	6,928	6,760	6,177	None
San Pablo Bay	1,549	1,696	1,771	None
Central Bay	11,963	12,510	12,289	None
South Bay	21,706	23,439	24,259	Increasing
Lower South Bay	7,652	7,006	8,044	None
Total	**49,798**	**51,411**	**52,540**	Increasing

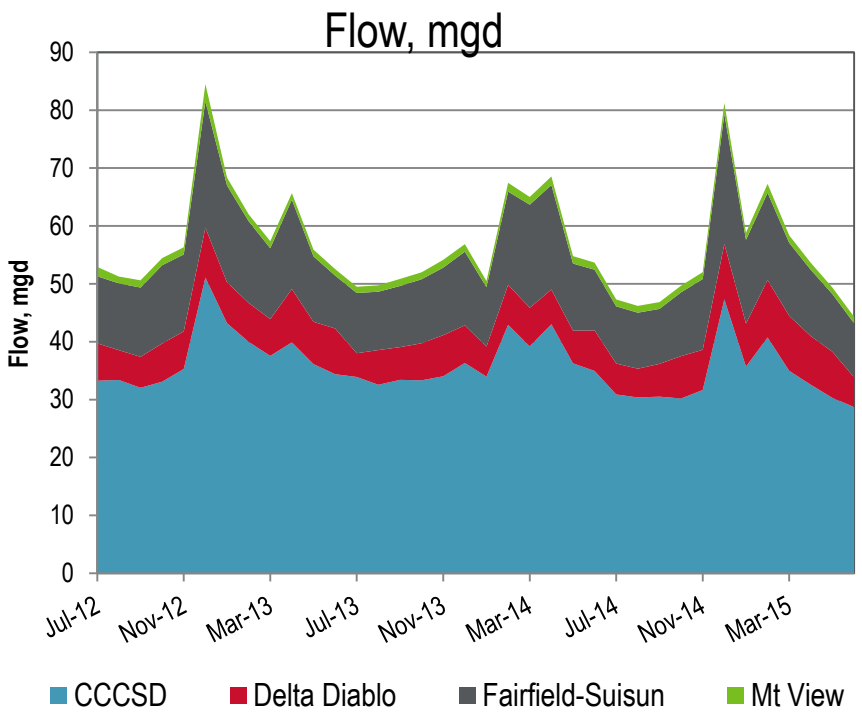
Total Phosphorus

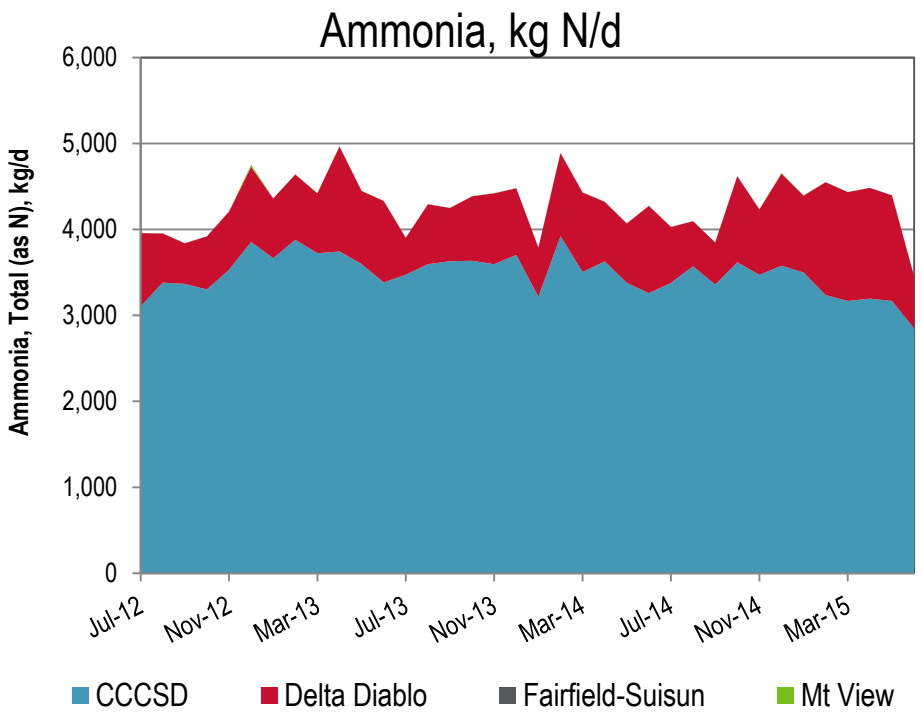
- Total AA TP discharge ranged from 3,500 kg P/d to 3,900 kg P/d
  - ADW TP ranged from 3,200 kg P/d to 3,600 kg P/d
- South Bay contributed the highest TP load
- Largest contributors: EBMUD, followed by EBDA, Palo Alto and San Jose
- Trend is either flat or increasing

Dry Season Average TP (kg P/d)

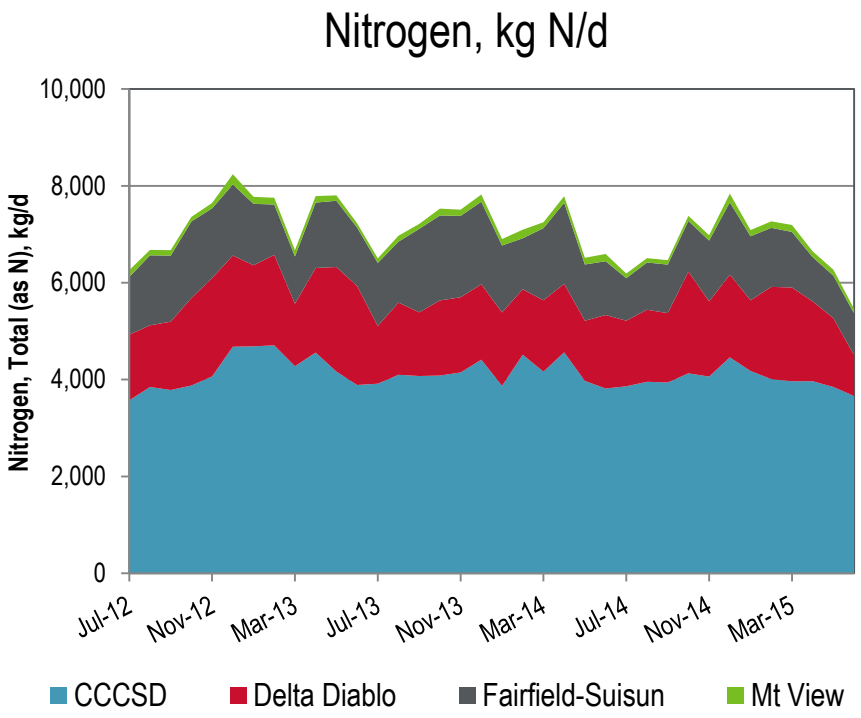
Subembayment	2012/13	2013/14	2014/15	Trend
Suisun Bay	393	360	322	None
San Pablo Bay	233	233	194	None
Central Bay	1,105	825	890	None
South Bay	1,146	1,225	1,214	None
Lower South Bay	717	743	836	Increasing
Total	**3,594**	**3,386**	**3,456**	None

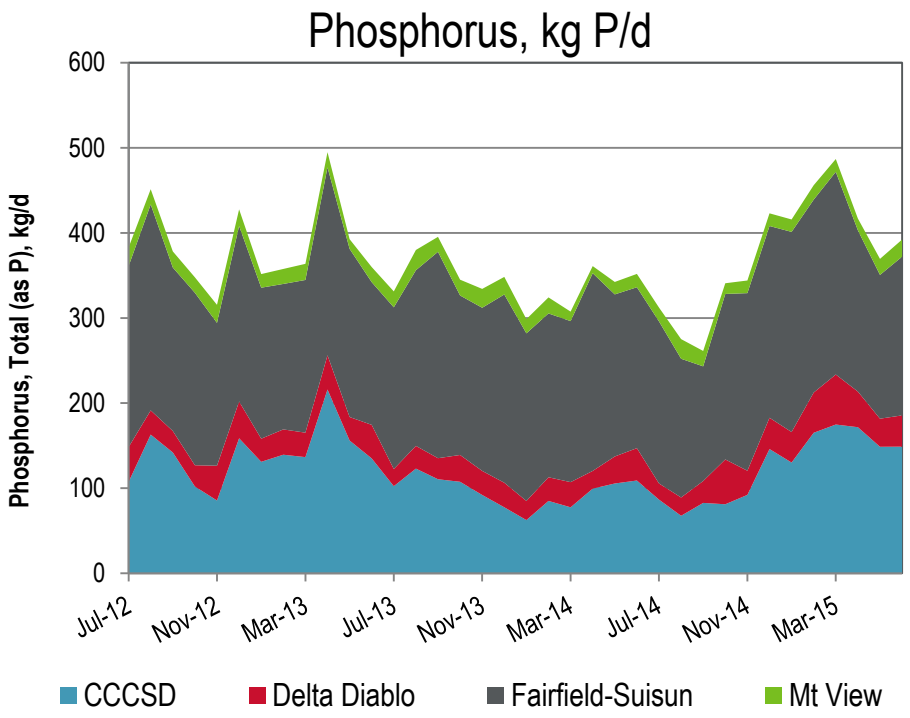
Suisun Bay


Flow, mgd
Flow, mgd
90
80
70
60
50
40
30
20
10
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CCCSD
Delta Diablo
Fairfield-Suisun
Mt View

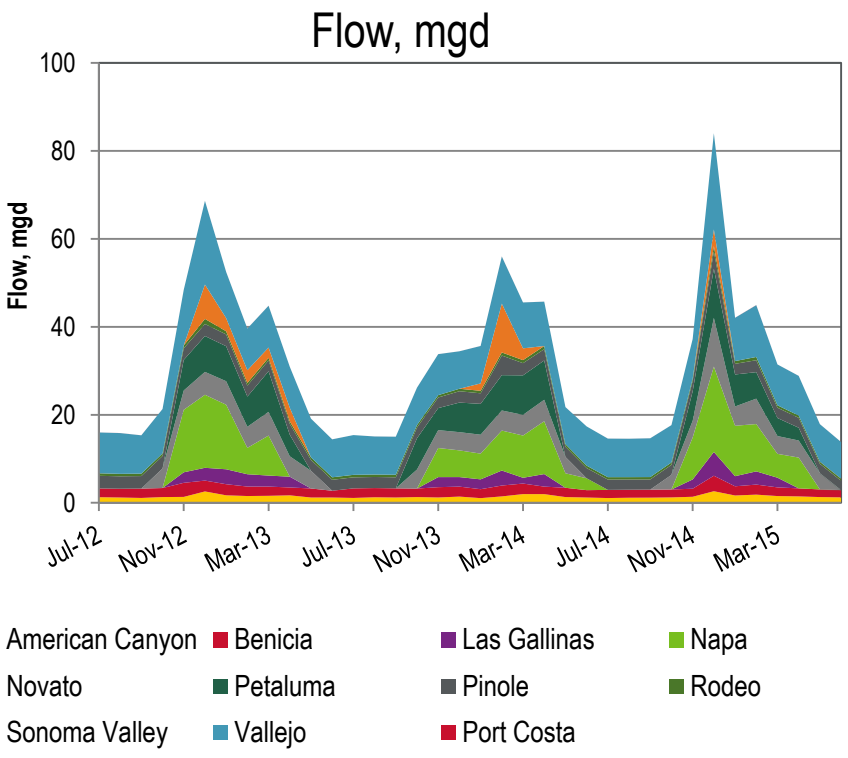

Ammonia, kg N/d
Ammonia, Total (as N), kg/d
6,000
5,000
4,000
3,000
2,000
1,000
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CCCSD
Delta Diablo
Fairfield-Suisun
Mt View

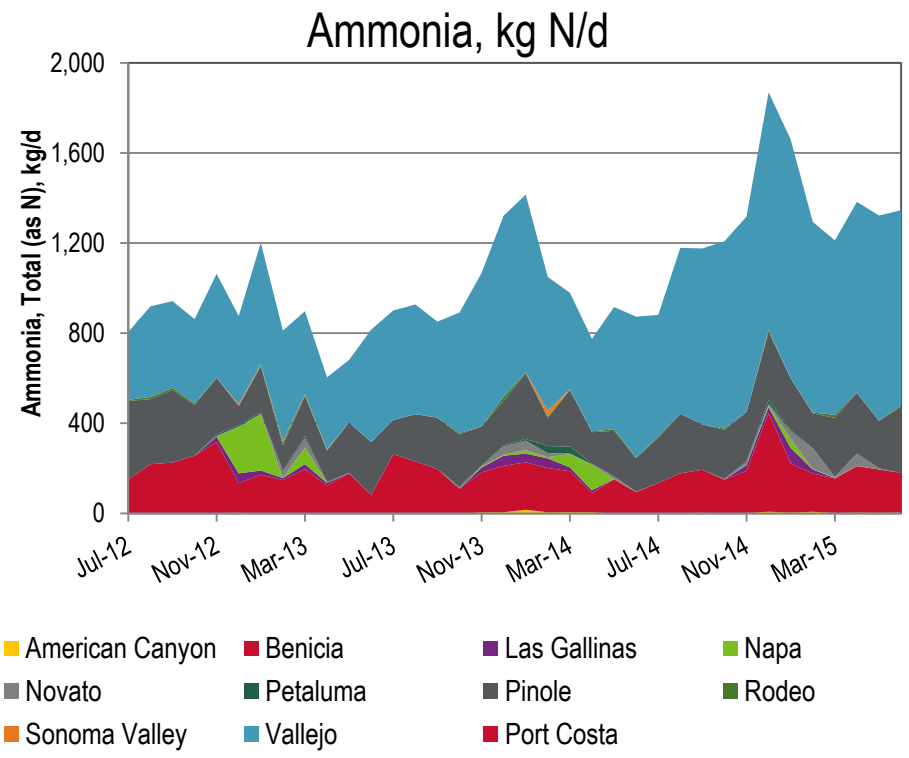
Suisun Bay


Nitrogen, kg N/d
Nitrogen, Total (as N), kg/d
10,000
8,000
6,000
4,000
2,000
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CCCSD
Delta Diablo
Fairfield-Suisun
Mt View

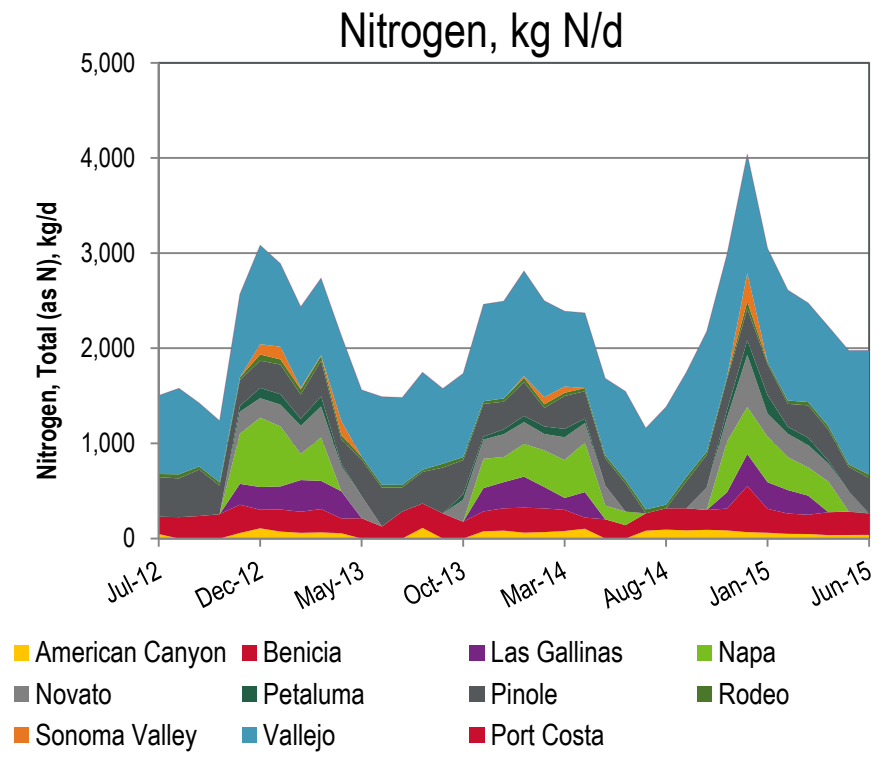

Phosphorus, kg P/d
Phosphorus, Total (as P), kg/d
600
500
400
300
200
100
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CCCSD
Delta Diablo
Fairfield-Suisun
Mt View

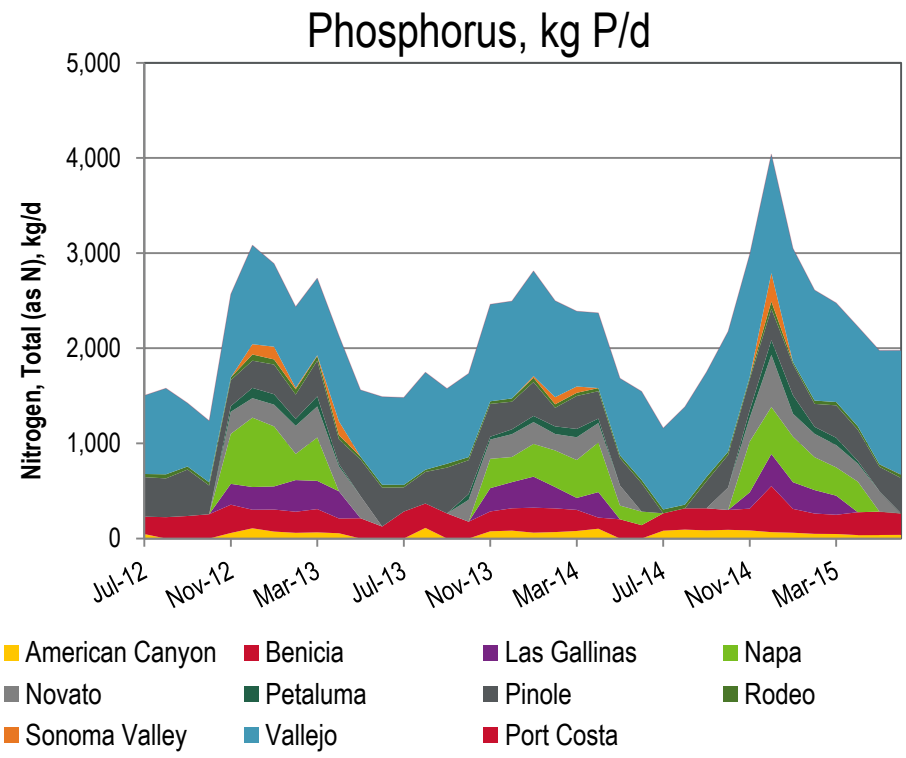
San Pablo Bay



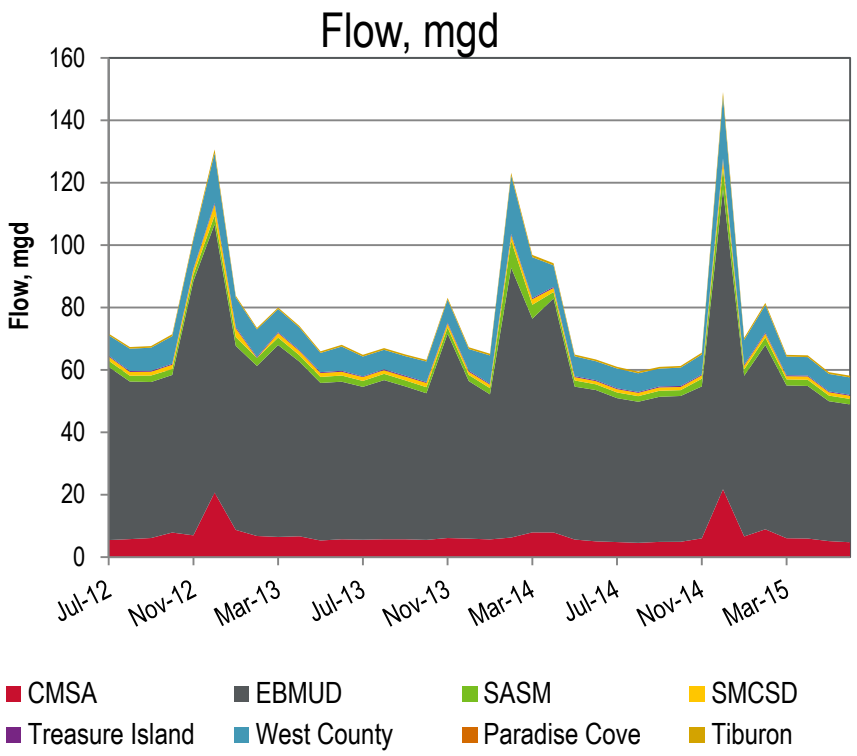


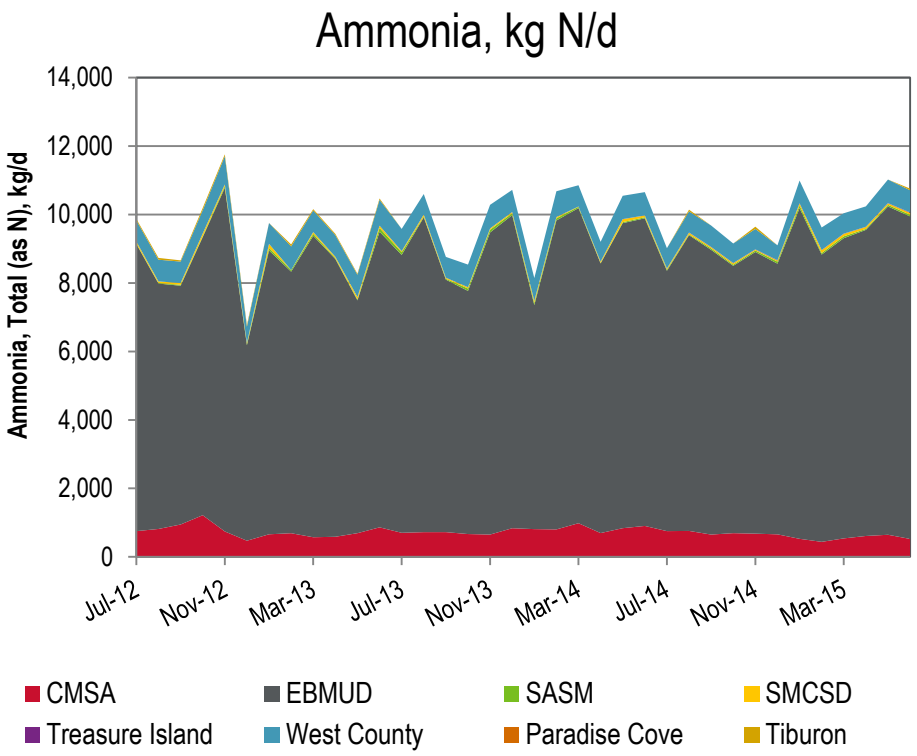
San Pablo Bay



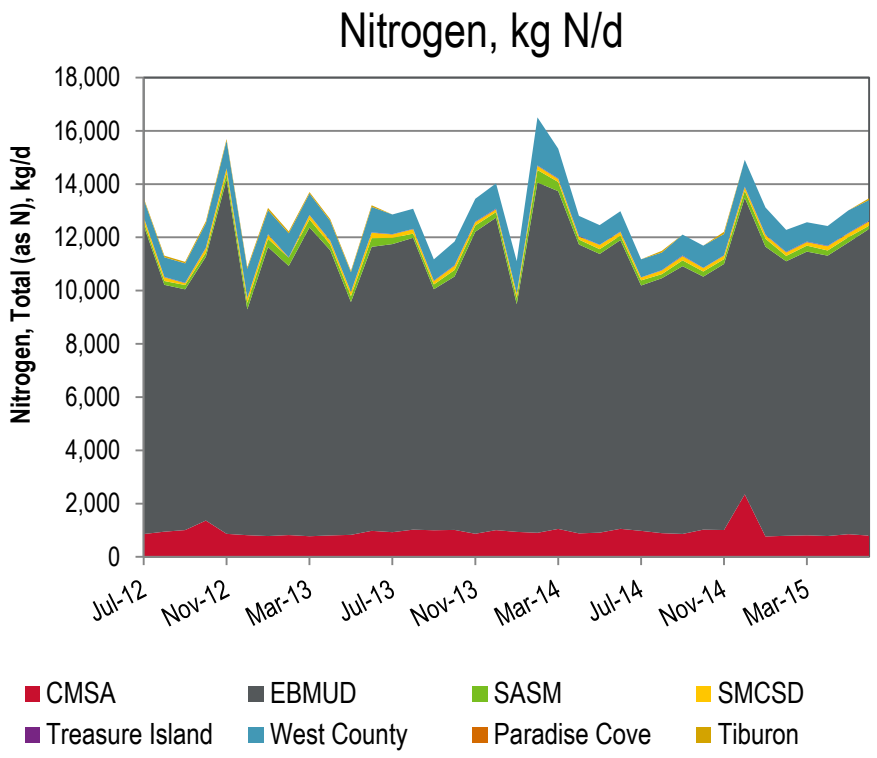


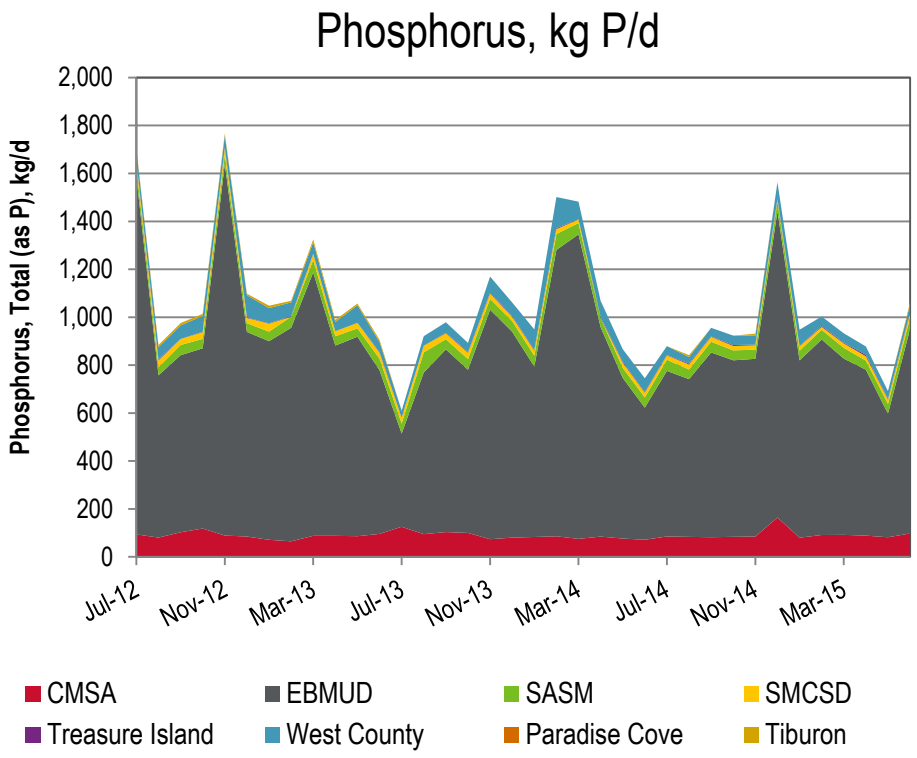
Central Bay


Flow, mgd
Flow, mgd
160
140
120
100
80
60
40
20
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CMSA
EBMUD
SASM
SMCSD
Treasure Island
West County
Paradise Cove
Tiburon

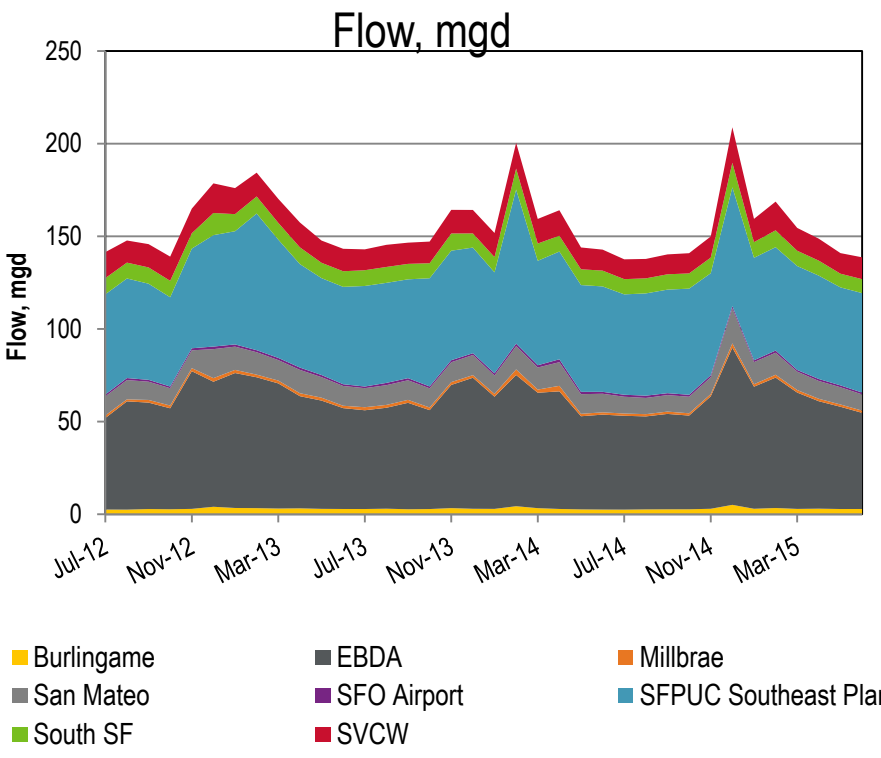

Ammonia, kg N/d
Ammonia, Total (as N), kg/d
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CMSA
EBMUD
SASM
SMCSD
Treasure Island
West County
Paradise Cove
Tiburon

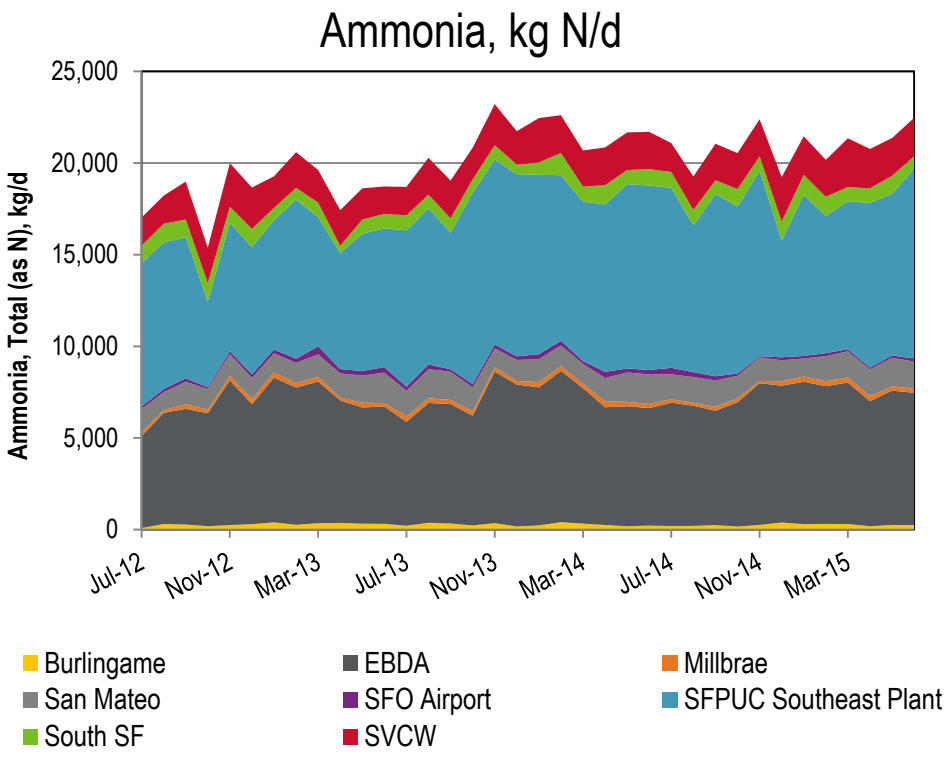
Central Bay


Nitrogen, kg N/d
Nitrogen, Total (as N), kg/d
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CMSA
EBMUD
SASM
SMCSD
Treasure Island
West County
Paradise Cove
Tiburon

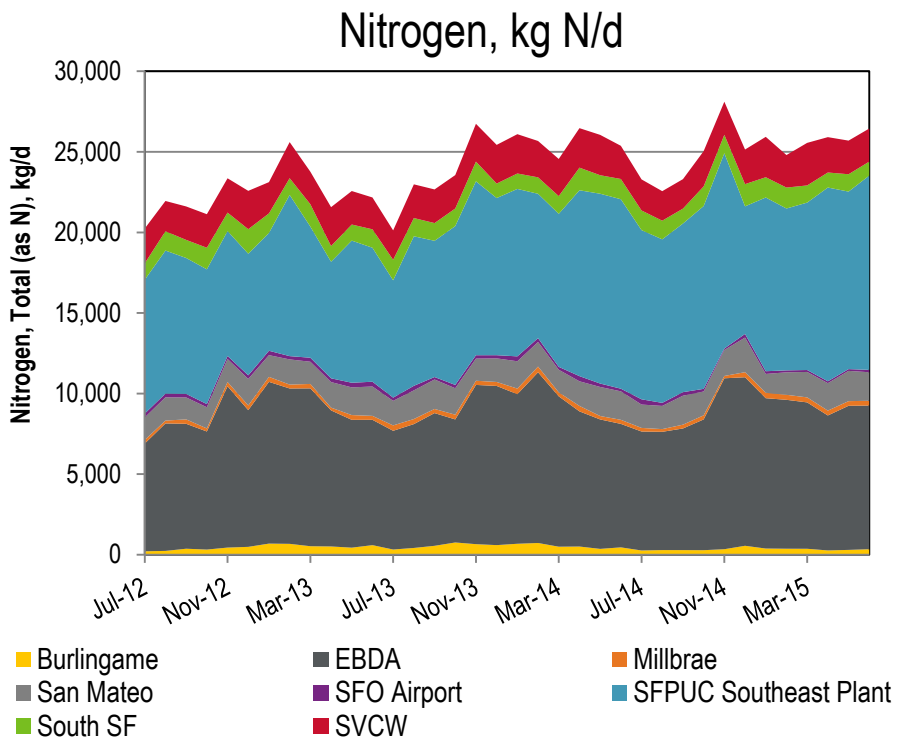

Phosphorus, kg P/d
Phosphorus, Total (as P), kg/d
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
CMSA
EBMUD
SASM
SMCSD
Treasure Island
West County
Paradise Cove
Tiburon

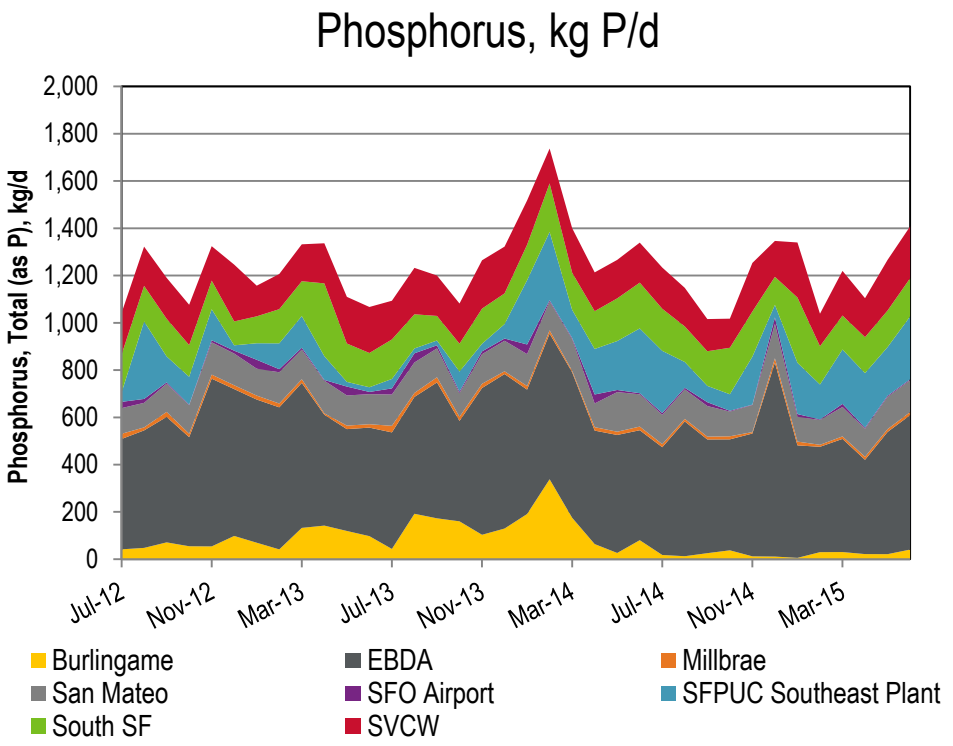
South Bay


Flow, mgd
Flow, mgd
250
200
150
100
50
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
Burlingame
EBDA
Millbrae
San Mateo
SFO Airport
SFPUC Southeast Plant
South SF
SVCW

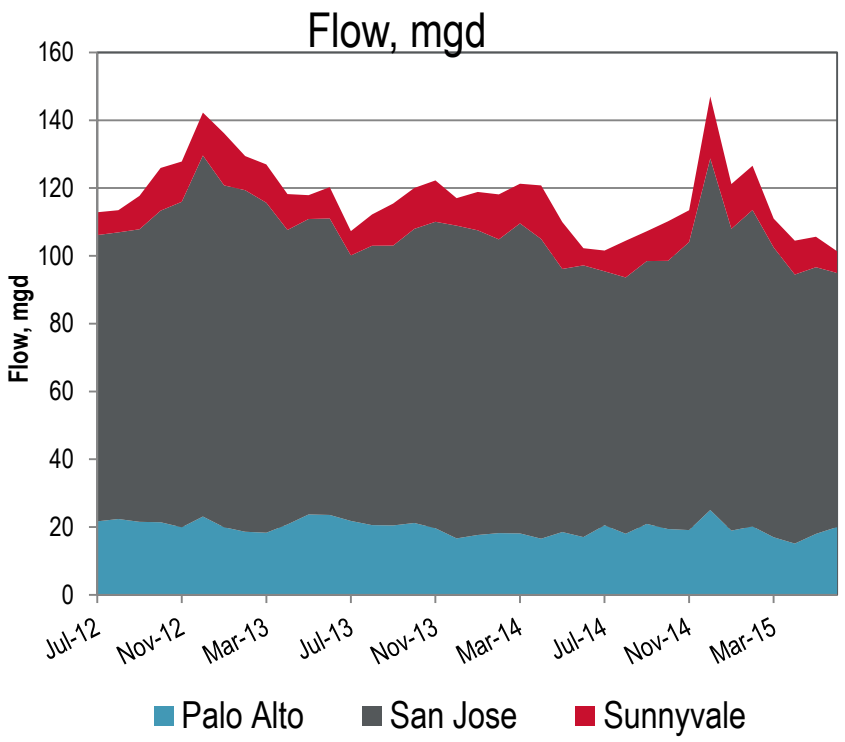

Ammonia, kg N/d
Ammonia, Total (as N), kg/d
25,000
20,000
15,000
10,000
5,000
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
Burlingame
EBDA
Millbrae
San Mateo
SFO Airport
SFPUC Southeast Plant
South SF
SVCW

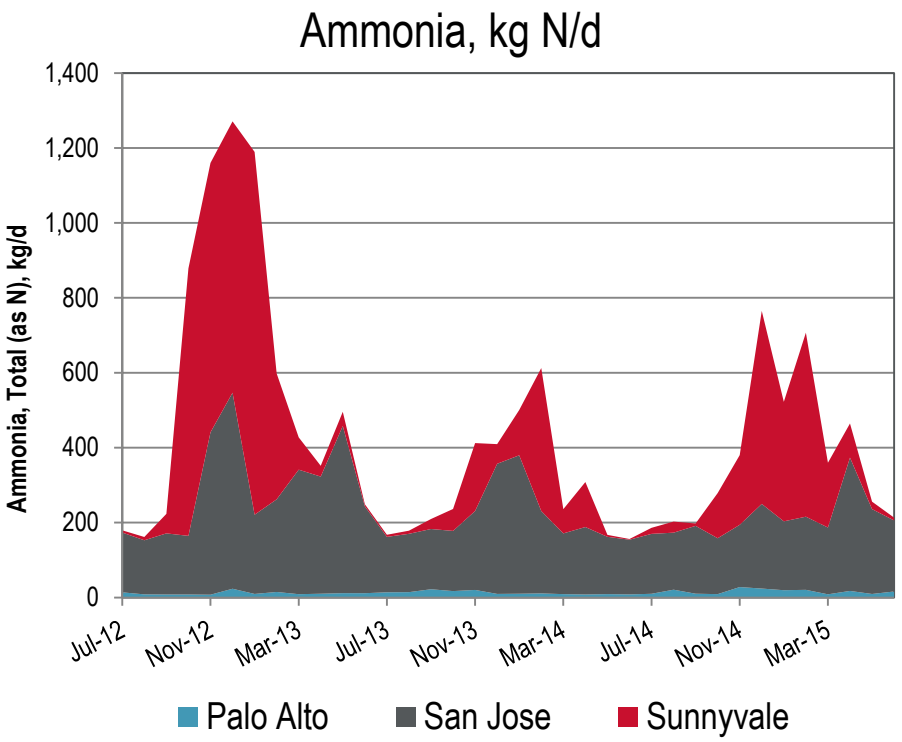
South Bay


Nitrogen, kg N/d
Nitrogen, Total (as N), kg/d
30,000
25,000
20,000
15,000
10,000
5,000
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
Burlingame
EBDA
Millbrae
San Mateo
SFO Airport
SFPUC Southeast Plant
South SF
SVCW

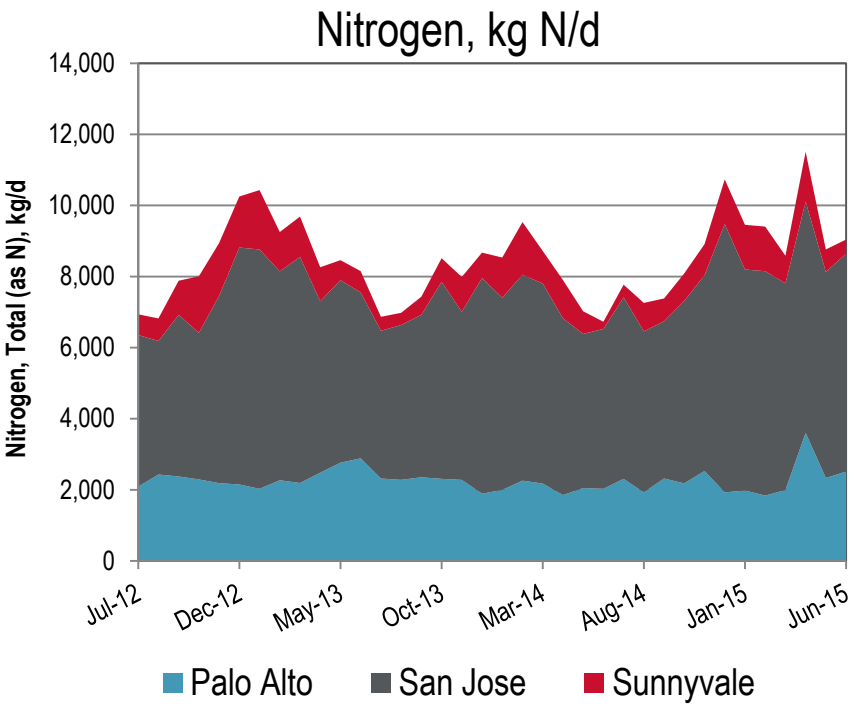

Phosphorus, kg P/d
Phosphorus, Total (as P), kg/d
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Jul-12
Nov-12
Mar-13
Jul-13
Nov-13
Mar-14
Jul-14
Nov-14
Mar-15
Burlingame
EBDA
Millbrae
San Mateo
SFO Airport
SFPUC Southeast Plant
South SF
SVCW

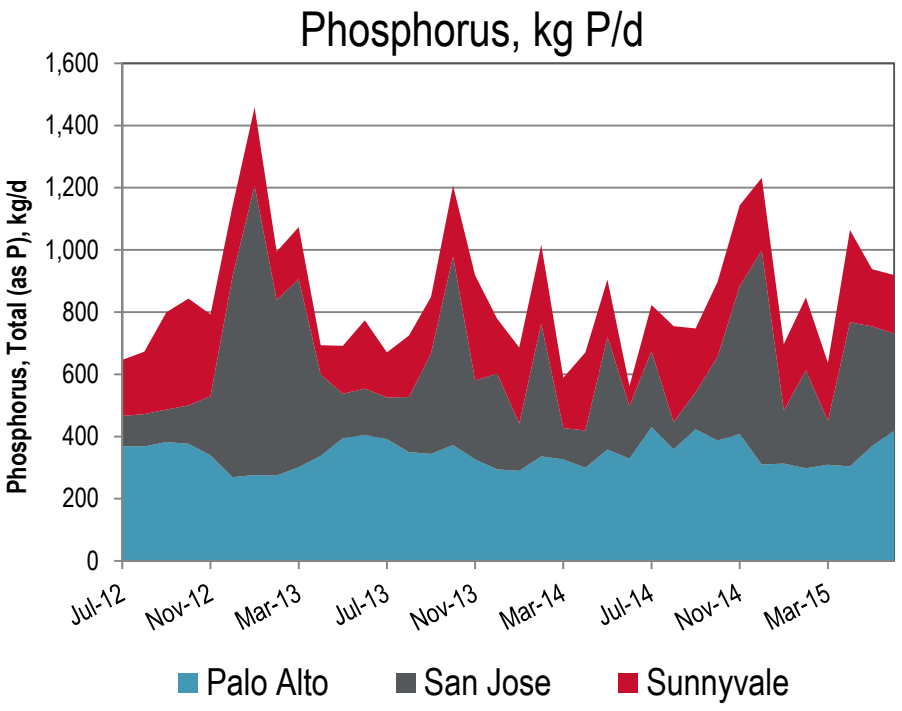
Lower South Bay





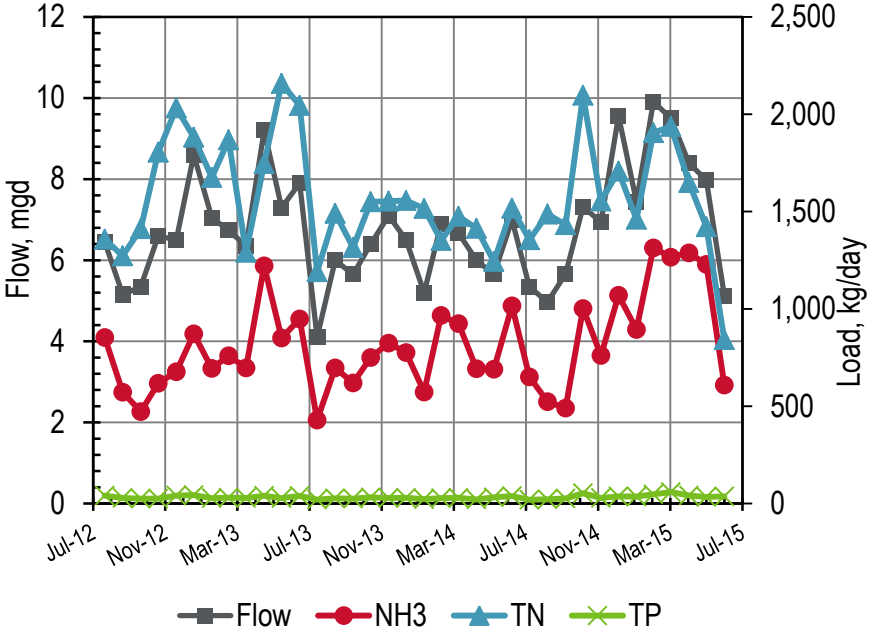
Lower South Bay

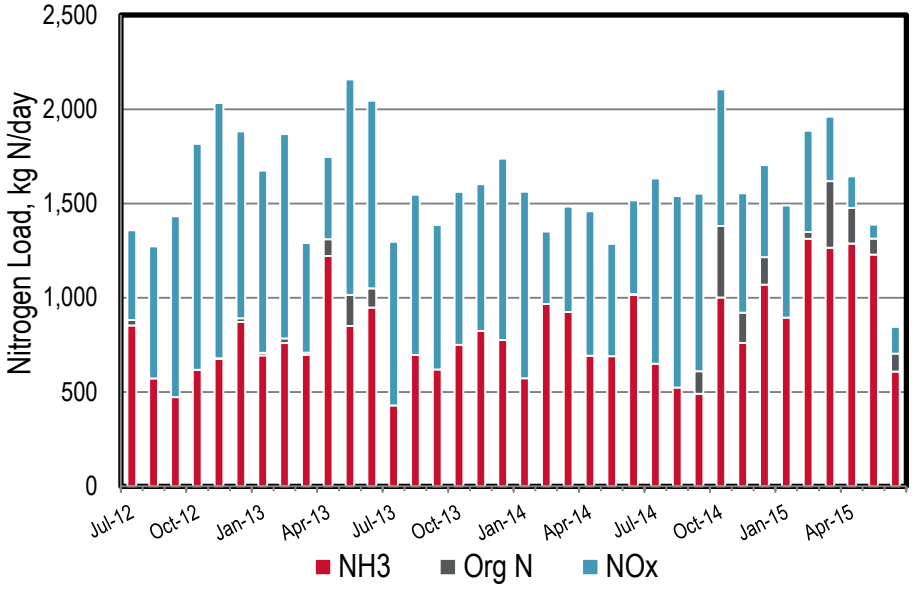


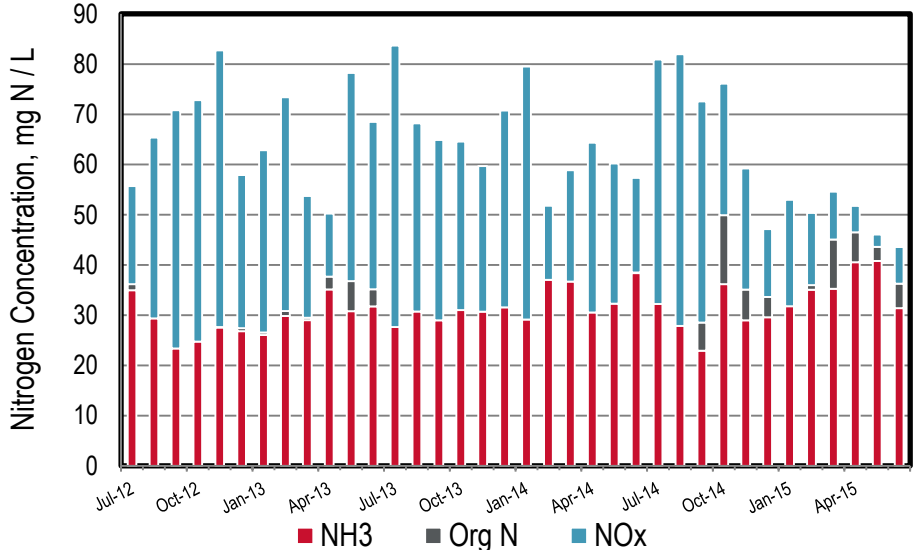


Separate Appendix for Each Discharger

- Brief overview of subembayment, capacity, and treatment
- Observations of data and trends with explanations if known / available
- Nitrogen loads and concentrations
- Phosphorus loads and concentrations







Summary of Total Effluent Loads and Concentrations

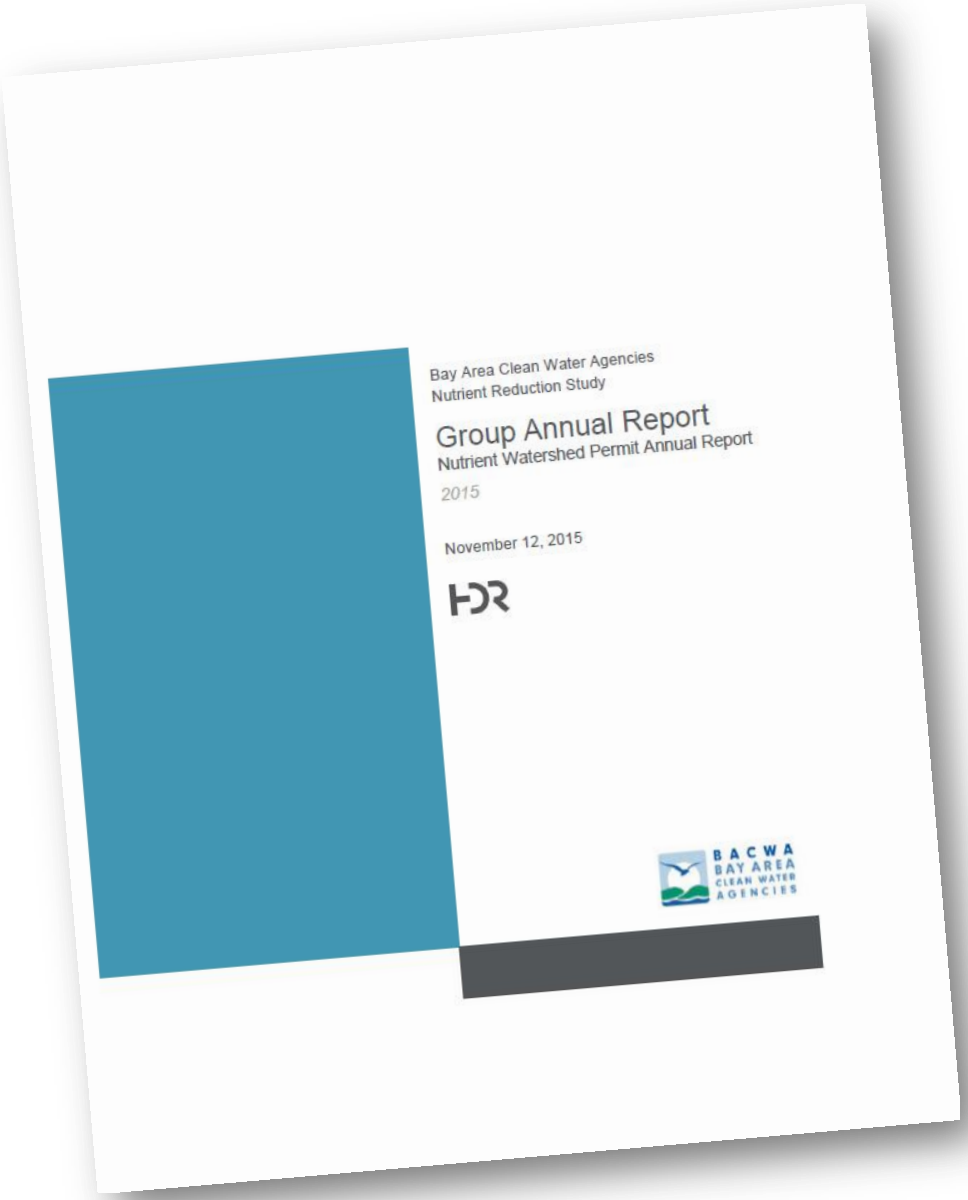
Load

Constituent	2012/13	2013/14	2014/15	Trend	3 Year Average
Flow, mgd	453	434	421	Decreasing	436
Ammonia, kg N/d	33,769	36,629	36,887	Increasing	35,762
TKN, kg N/d	38,212	40,518	41,581	Increasing	40,104
NOx, kg N/d	14,857	14,470	14,169	Decreasing	14,499
TN, kg N/d	53,038	54,928	55,798	Increasing	54,588
Orthophosphate, kg P/d	4,720	4,595	3,074	Decreasing	4,130
TP, kg P/d	3,946	3,761	3,721	None	3,809

Concentration

Constituent	2012/13	2013/14	2014/15	Trend	3 Year Average
Flow, mgd	453	434	421	Decreasing	436
Ammonia, mg N/L	20	22	23	Increasing	22
TKN, mg N/L	22	25	26	Increasing	24
NOx, mg N/L	8.7	8.8	8.9	None	8.8
TN, mg N/L	31	33	35	Increasing	33
Orthophosphate, mg P/L	2.8	2.8	1.9	Decreasing	2.5
TP, mg P/L	2.3	2.3	2.3	None	2.3

2015 Group Annual Report



- Submitted to Water Board in November
- Provided Input:
  - SRP Terminology / Data Reporting
    - Dissolved orthophosphate
  - Recycled Water Data Collection
- Preparing a template to streamline future data collection
- For further consideration: whether to include raw influent trending to avoid misinterpretation of flow and load data

Next Steps

- 2016 Group Annual Report Data Request
- Recycled Water Data Request
- CIP Data Request
- Prepare Draft Optimization and Upgrades Study Report