

201 N. Civic Drive, #115
Walnut Creek, CA 94596-3867
Tel: 925.937.9010
Fax: 925.937.9026

Prepared for: City of Sunnyvale, Sunnyvale, CA

Project Title: Sunnyvale Strategic Infrastructure Plan for the WPCP

Project No: 135083

Technical Memorandum

Subject: Nitrification System Improvements

Date: April 28, 2009

To: Lorrie B. Gervin, P.E., City of Sunnyvale

From: Lloyd Slezak, Project Manager, Brown and Caldwell



Prepared by: _____

Rion Merlo, Ph.D., P.E., Project Engineer, NO. C69030 Exp.06/30/2012



Prepared by: _____

Linda Sawyer, Ph.D., P.E., Project Engineer, NO. C58213 Exp.06/30/2012



Reviewed by: _____

Denny Parker, Ph.D., P.E., Technical Reviewer, NO.C24965 Exp. 12/31/2011

1. EXECUTIVE SUMMARY

City of Sunnyvale Water Pollution Control Plant (WPCP) has been presented with a tentative change in the plant's discharge permit requirements that result in more stringent requirements related to allowable discharge limits for ammonia nitrogen. The existing process has not demonstrated an ability to comply with the new proposed limits. The critical time period where compliance performance may be a concern is in the winter months where a new monthly average limit for ammonia nitrogen is proposed.

The existing process relies primarily on nitrifying fixed growth reactors to remove ammonia from the effluent of the oxidation ponds that are used for conventional secondary treatment. The operational configuration of the existing process has been reviewed and it is estimated that there is additional treatment capacity that may be made available from the process in order to potentially comply with the new proposed requirements. Suggested operational changes to evaluate include:

- Change the optional operating configuration to have DAF clarification treatment precede the nitrifying FGRs.
- Reinstall ventilation blowers on the FGRs that had previously been removed.
- Evaluate whether FGR alkalinity additions may be necessary in the revised configuration.
- Look for opportunities to route ammonia laden recycle streams to the FGRs during the summer months in order to maintain the units' ammonia removal rate capacity.

Also evaluated is an alternative process configuration that would confidently meet proposed new ammonia limits and that would still employ the oxidation ponds as a significant contributor to the overall secondary / nitrification treatment process. The proposed alternative employs a conventional activated sludge process to treat a portion of the untreated primary effluent along with effluent from the oxidation ponds having received the remainder of the primary effluent. This hybrid activated sludge / oxidation pond treatment system has been modeled and is shown to be able to be constructed at the treatment plant site, along with other envisioned upgrades to the existing facility, and able to reliably meet the new proposed ammonia limits. The construction value of the additions to execute the hybrid system is preliminarily estimated at \$30 million.

The significant cost of the hybrid alternative coupled with the estimated potential of the existing system to be improved at much lower cost makes for a recommendation to begin field trials of the existing system modifications at the soonest possible date. Further, it is preliminarily recommended to assume that these modifications will be successful in framing the alternative of rehabilitating the existing plant processes in the Strategic Infrastructure Plan.

2. INTRODUCTION

Brown and Caldwell is developing alternatives to renovate and optimize the existing Water Pollution Control Plant (WPCP) facilities. In addition to confirming or identifying elements that need improvement based on physical condition, Brown and Caldwell has identified processes that may benefit from changes or replacement. This Technical Memorandum discusses recommended improvements to the nitrification process.

2.1 Existing Process Description

The Sunnyvale WPCP uses oxidation ponds for biochemical oxygen demand (BOD) removal, but the ponds do not consistently remove ammonia. The oxidation pond effluent is routed to three Fixed Growth Reactors

(FGRs), which are nitrifying trickling filters that convert ammonia to nitrate. Following the FGRs, the flow is routed to the dissolved air flotation tanks (DAF) for removal of algae solids from the ponds that pass through the FGRs. Total suspended solids (TSS) in the pond effluent ranges from below 50 mg/L to more than 200 mg/L. On average the FGRs reduce the TSS concentration by more than 15 mg/L. A process flow diagram of the current mode of operation is shown in Figure 2-1.

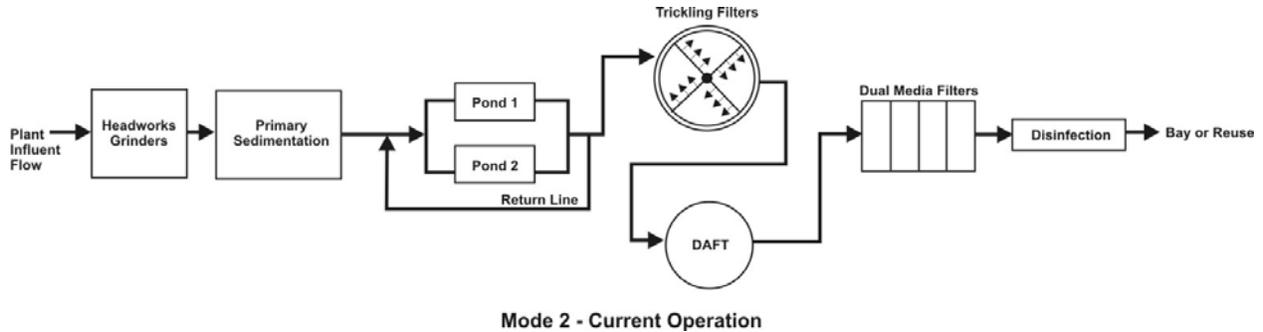


Figure 2-1. Process flow diagram of current mode of operation (Mode II).

The plant also has the flexibility to operate with the DAFs before the FGRs (Mode I). In Mode I operation, the majority of the algae solids are removed before the FGRs. A process flow diagram for Mode I is shown in Figure 2-2.

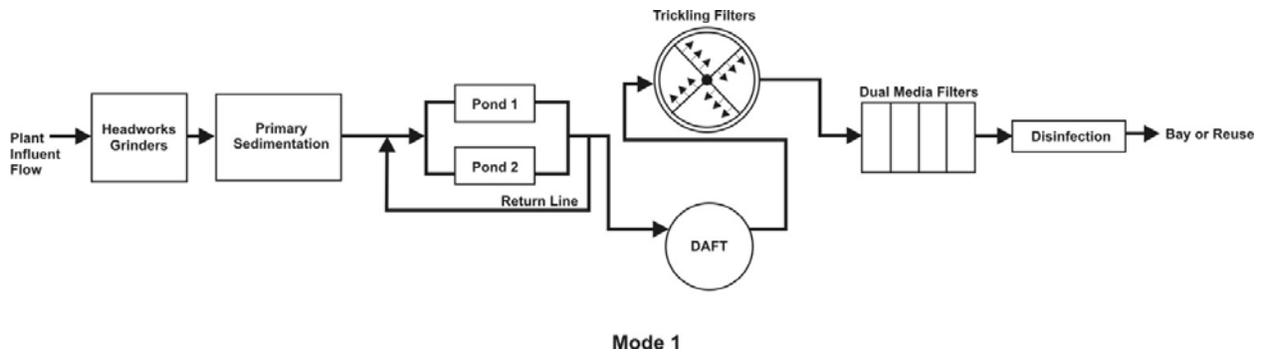


Figure 2-2. Process flow diagram of alternative mode of operation (Mode I).

Design criteria for the FGRs are shown in Table 2-1.

Table 2-1. Fixed Growth Reactor Design Criteria	
Number of Units	3
Diameter	92 feet
Media Depth	19 feet
Media type	Cross-flow
FGR Media Surface Area	42 sq ft/cu ft
<u>FGR Design Hydraulic Loading Rate</u>	1.7 gal/min/sq ft
<u>FGR Design Surface Loading Rate</u>	5,000 sq ft/lb NH ₃ -N oxidized/day (equivalent to 0.98 g/m ² /day, or 3,200 lb/day with 3 FGRs in operation)
<u>Fixed Growth Reactor Pump</u>	
Number of Units	3
Pump Capacity (per unit)	11,000gpm (16 mgd)

2.2 Proposed Ammonia Limits

The NPDES permit for the Sunnyvale WPCP issued in 2003 (Permit number CA0037621) contains effluent limitations for ammonia-nitrogen (NH₃-N) of 2 mg/L monthly average and 5 mg/L daily maximum that apply from June through September. The existing permit does not contain NH₃-N limits for the winter.

Sunnyvale was issued a tentative order by the California Regional Water Quality Control Board, San Francisco Bay Region that includes year-round ammonia-nitrogen limits. The proposed limits are:

Table 2-2. Proposed Effluent NH ₃ -N Limits		
Time Period	Average Monthly Effluent Limitation	Maximum Daily Effluent Limitation
June through September	2.0	5.0
October through May	4.5	18

2.3 Historical Nitrification Performance

NH₃-N in the pond effluent (FGR feed) varies seasonally, as shown on Figure 2-3. During the summer, pond effluent ammonia concentrations are typically quite low (less than 5 mg/L), but during winter the concentrations are much higher.

Plant effluent concentrations are also shown on Figure 2-3. Since little or no ammonia removal occurs downstream of the FGRs, the FGR effluent ammonia-nitrogen concentration should be approximately the same as the plant effluent. Plant effluent ammonia-nitrogen concentrations vary seasonally, with higher concentrations during the winter.

Figure 2-3 shows that the plant effluent has consistently met the proposed maximum daily limit. However, Figure 2-4 shows that the proposed monthly average limit has been exceeded several times in the last five years.

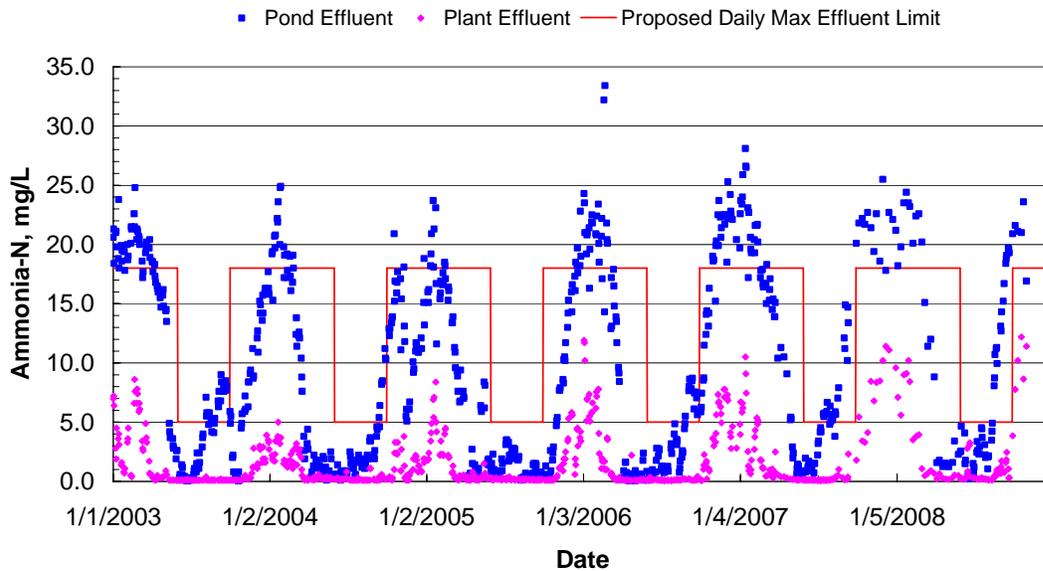


Figure 2-3. FGR Ammonia-Nitrogen Concentrations

Blue dots show FGR feed (pond effluent). Pink dots show the plant effluent after ammonia is removed in the FGRs. The red line shows the proposed daily maximum effluent limit. Since all the plant effluent values (pink) are below the red line, the plant has consistently met the daily maximum limit.

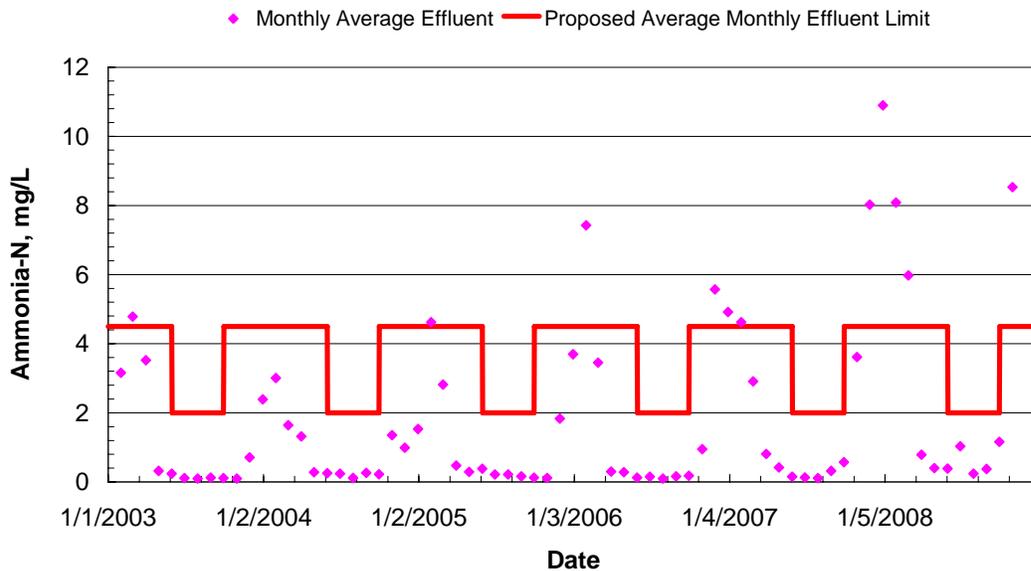


Figure 2-4. Monthly Average Ammonia-Nitrogen Concentrations

Monthly average plant effluent ammonia-nitrogen concentrations are shown as pink dots. The proposed monthly average effluent limit is shown as a red line. The proposed monthly average limit has been exceeded several times in the last five years.

3. FGR PERFORMANCE EVALUATION

The performance of the FGRs was evaluated in more detail to determine whether operational changes will improve performance sufficiently to meet the proposed permit limits.

3.1 Alkalinity

Alkalinity is destroyed by the nitrification reaction (typically 7.1 mg CaCO₃ are consumed per mg ammonia nitrified). Biofilm systems are inhibited in nitrification at levels below 40 mg/L as CaCO₃ (Biesterfeld et al, 2003). To remove 25 mg/L of ammonia, 142 mg/L of alkalinity will be consumed, so an influent alkalinity of around 200 mg/L is needed. Since a main water supply source for the City is the SFPUC which imports high quality (low alkalinity) surface water from the Sierra, it is possible that the alkalinity is low in the pond effluent at critical times when the ammonia is high.

Routine sampling of the primary effluent and pond effluent alkalinity began in March 2009. For four samples taken in March and April 2009, pond effluent alkalinity values were greater than 250 mg/L. Final effluent alkalinity is only measured as part of the acute bioassay, and the data were not available. Recycled water alkalinity is measured. According to Ray Goebel (EOA), recycled water alkalinity ranges from 100 to 160 mg/L. Recycled water is similar to final effluent, but the gaseous chlorine dose is higher. However, recycled water production is mainly during the summer, not during the winter when the pond effluent ammonia levels are high.

Insufficient alkalinity could be limiting nitrification when pond effluent ammonia is high. Further monitoring of alkalinity is recommended, and chemicals should be added to supplement the alkalinity if necessary.

3.2 Air Supply

Each FGR was designed to have four fans. Air entered two ducts and was distributed below the media. According to the Ammonia Removal Enhancement Study – Appendix A (EOA, June 1990), the fans were 5,000 cfm each and were only operated for two years after startup. Plant staff determined that FGR temperatures were depressed by blower operation.

The fans have been removed, and the openings have plywood over them. This may greatly restrict the air supply, which could impact performance, based on our experience with other nitrifying trickling filters. The recommended air rise rate to control stagnation is 4 ft/min. For a 92 ft diameter unit, recommended airflow is 26,600 cfm.

We recommend that the plywood covers be removed now, and that fans be reinstalled during testing.

3.3 Mode of Operation

The plant was designed with the flexibility to operate in either Mode I or Mode II. The plant has always operated in Mode II, with high TSS pond effluent fed to the FGRs.

3.3.1 Mode II Performance

Mode II performance data were analyzed with a fixed film nitrification model (Parker et al., 1989). E_{avg} is the average media effectiveness factor for the FGR, which relates theoretical and experimental zero order nitrification rates. E_{avg} was calculated for times when the effluent ammonia was greater than 5 mg/L, indicating that ammonia was not limiting nitrification (zero order with respect to ammonia). Table 3-1 shows that the results E_{avg} values averaged 0.24, meaning that the FGRs are performing at less than 30 percent of the theoretical maximum nitrification rate. The table also shows that E_{avg} was lowest when TSS was highest.

Time Period	Pond Effluent TSS, mg/L	E _{avg}
1/4/2006 to 2/7/2006	64	0.28
11/5/2007 to 12/4/2007	60	0.23
12/5/2007 to 1/4/2008	113	0.18
1/5/2008 to 2/4/2008	64	0.27

While the data are limited, the two time periods later in the winter have higher E_{avg} values. As shown in Figure 2-3, the FGRs are starved for ammonia during the summer when pond effluent ammonia concentrations are low. The lower E_{avg} early in the season may be due to the biomass slowly building up in the FGRs as pond ammonia levels increase.

A similar analysis was performed on the pilot data from 1974 (). The pilot FGR was fed pond effluent supplemented with ammonia at times, so that ammonia concentrations were greater than 14 mg/L as N for four continuous months. During the last month, E_{avg} was found to be 0.36. Considering that there was a consistent ammonia feed to the pilot FGR and inconsistent feed to the full scale FGR, a slightly higher E_{avg} values than found at full scale would be expected.

To confirm the performance, two increasing pond ammonia periods were modeled assuming an E_{avg} of 0.24. As shown in Figures 3-1 and 3-2, modeled results match the measured plant effluent.

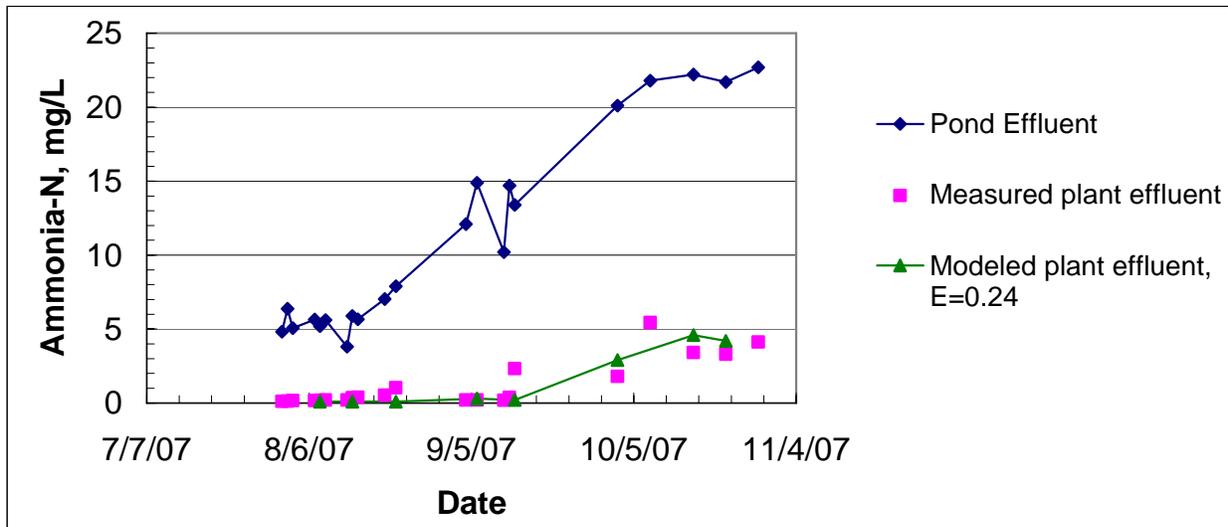


Figure 3-1. Fall 2007 Modeled Performance
 Fall 2007 performance can be modeled using an E_{avg} of 0.24.

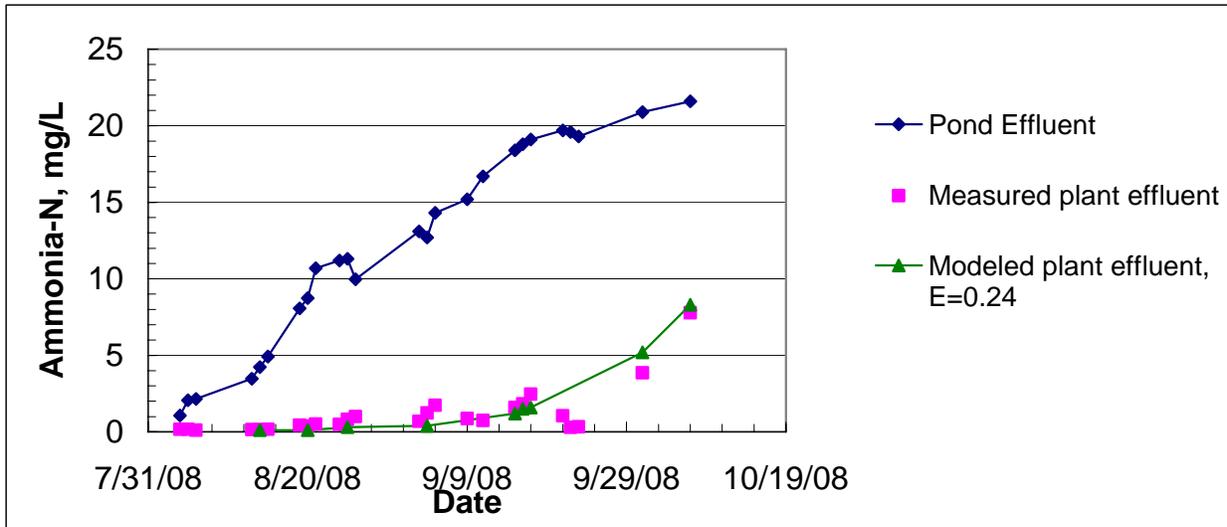


Figure 3-2. Fall 2008 Modeled Performance
 Fall 2008 performance can be modeled using an E_{avg} of 0.24.

Two decreasing pond ammonia periods were also modeled, as shown in Figures 3-3 and 3-4. For both periods, measured performance is better than the model prediction with an E_{avg} of 0.24. Modeling with a higher E_{avg} of 0.36 gives results much closer to measured values. The improved performance later in the season is further indication that the system recovers slowly from the summer starvation by building up biofilm.

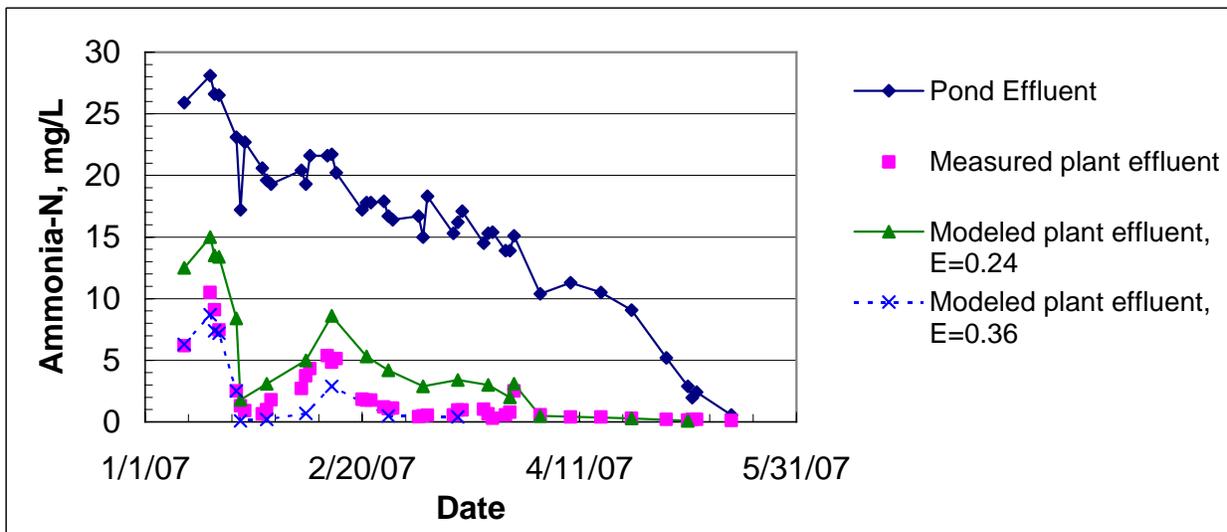


Figure 3-3. Spring 2007 Modeled Performance
 Spring 2007 performance can be modeled using an E_{avg} of 0.36.

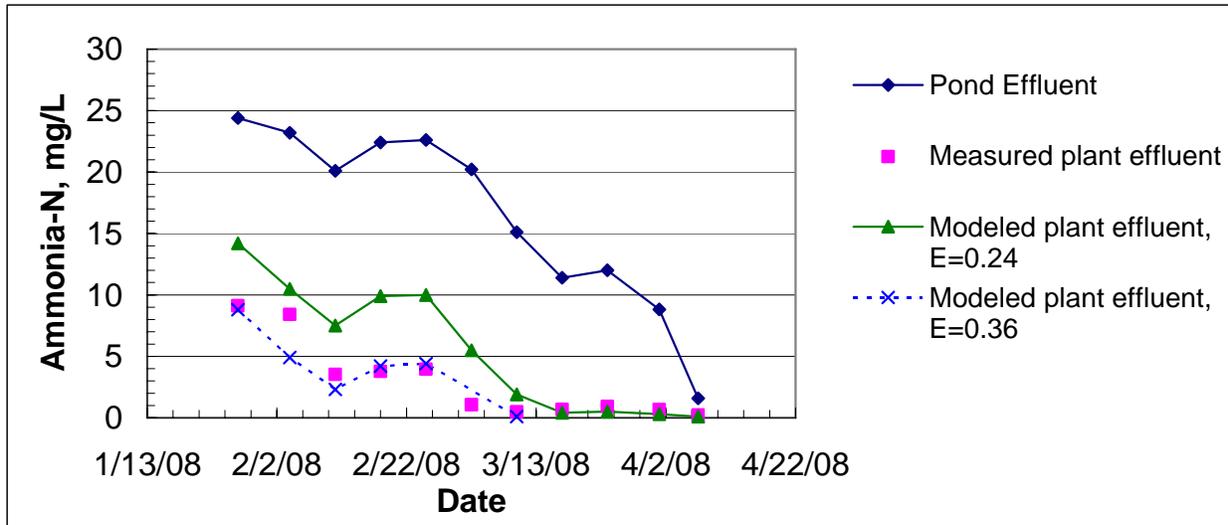


Figure 3-4. Spring 2008 Modeled Performance
 Spring 2007 performance can be modeled using an E_{avg} of 0.36.

3.3.2 Mode I Potential Performance

For nitrifying trickling filters treating activated sludge effluents, Parker et al (1995) found a correlation for E_{avg} based on TSS, temperature, and hydraulic loading rate. High feed TSS correlated with lower E_{avg} values, but the TSS at Sunnyvale is higher than the range the relationship was developed for. This correlation predicts lower E_{avg} values than were found using the Sunnyvale data. This indicates that algae solids have less impact than the activated sludge effluent solids the relationship was developed for. For a TSS of 20 mg/L and increased recirculation to increase the hydraulic loading rate, this correlation predicts E_{avg} values ranging from 0.53 to 0.63. It is reasonable to expect that with algae solids removed, and E_{avg} value of 0.53 or higher is possible for Sunnyvale in Mode I.

To meet permit under the worst conditions (pond ammonia concentration of 32 mg/L and pond effluent flow of 23.5 mgd – equal to the max month flow of 22.4, plus 1.1 mgd of filter backwash), the required E_{avg} is 0.63 with three FGR feed pumps operating. If some of the water can be stored in the ponds when ammonia is highest and the pond effluent flow reduced to 20 mgd, the E_{avg} required would only be 0.54. With the highest pond ammonia of the last 5 years (25 mg/L), an E_{avg} of 0.48 is required. Figure 3-5 shows the predicted performance as a function of pond effluent ammonia at a pond effluent flow of 23.5 mgd for Mode II (E_{avg} of 0.24) and Mode I (E_{avg} ranging from 0.53 to 0.63). Except for the highest historic pond effluent ammonia concentrations, Mode I has good potential to meet permit limits.

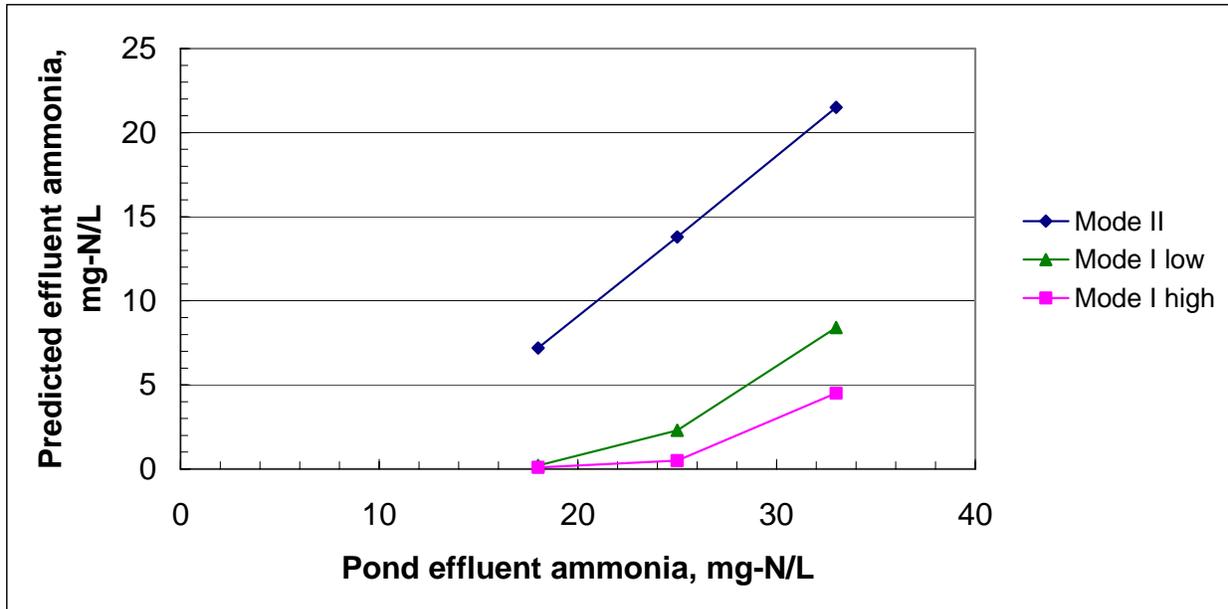


Figure 3-5. Predicted Effluent Ammonia-N as a Function of Pond Effluent Ammonia-N

The higher E_{avg} values expected from Mode I would reduce effluent ammonia to acceptable levels under typical conditions.

While Mode I has the potential to meet permit requirements, field testing is needed to determine the actual E_{avg} value in Mode I.

3.4 Recommendations

Brown and Caldwell’s recent process modeling work at other facilities employing nitrifying trickling filters has shown a relationship between TSS and the observed maximum nitrification rate. Sunnyvale has the capability operate in Mode I, with the DAFs removing algae solids before the FGRs. The analysis showed that changing to Mode I has the potential to achieve permit compliance, but the actual performance in Mode I needs to be tested full-scale.

At first blush, addition of a fourth FGR to add capacity might be a solution. Addition of a fourth FGR would exacerbate the summer starvation problem, and could potentially increase the time required for the biomass to become established each fall and actually cause poorer performance (even lower E_{avg}), especially early in the winter. Under worst case conditions (32 mg/L pond effluent ammonia, 23.5 mgd pond effluent), an E_{avg} of 0.49 is required with a fourth FGR. Because of the slow response time to increasing ammonia levels, a fourth FGR may not be sufficient for permit compliance with the new limits and is not recommended at this time. If mechanical dewatering is added, the filtrate or centrate could be sent to the DAFT rather than the plant influent to increase ammonia to the FGRs during the summer, which would help sustain higher ammonia populations on the FGRs year round.

We recommend that a detailed test plan be developed for the FGRs which will allow the plant staff to confirm that the FGRs can develop additional capacity. The test plan should include:

- Monitor alkalinity and add alkalinity if necessary.
- Remove the plywood covers, and reinstall the fans during testing.
- Consider installing ports to allow sampling with depth in the FGRs.
- Switch to Mode I operation, and test at full-scale for several years.

4. ALTERNATIVE NITRIFICATION PROCESS

This section summarizes the process requirements for nitrification using an alternative process to the FGRs, in this case an activated sludge process. For this alternative, the ponds would be retained and a blend of primary effluent and DAF effluent would be treated with a new activated sludge process.

4.1 Design Basis

An activated sludge process would be used to provide full nitrification of all flow; the FGRs would be abandoned. The process would treat a combination of primary effluent and pond effluent downstream of the DAF. Of the entire influent flow to the activated sludge process, 25 percent would be primary effluent and the remaining 75 percent would be DAF effluent. Feeding the activated sludge process with 25 percent of primary effluent is expected to mitigate sludge bulking. Activated sludge processes treating high ammonia, low BOD wastewaters are prone to poor sludge settleability. Figure 4-1 presents a process flow diagram of this alternative.

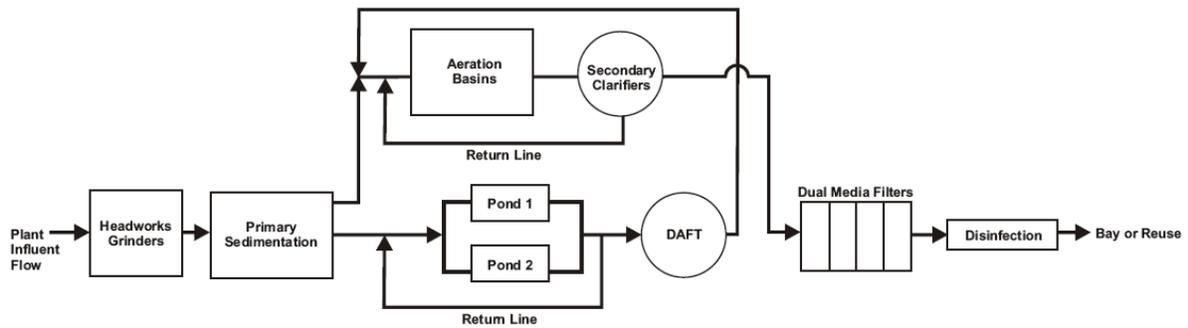


Figure 4-1. Process flow diagram of activated sludge alternative.

Table 4-1 summarizes the assumptions used to size the activated sludge process. The process was sized for maximum month flows and loads. For the DAF effluent, an effluent TSS and BOD concentration of 20 mg/L was assumed, which is considered typical.

Table 4-1. Summary of Influent Flows and Loads for Nitrifying Activated Sludge Process		
Parameter	Units	Value
Primary Effluent ^{1,2}		
Average Flow	mgd	4.18
Maximum Month Flow	mgd	5.60
Maximum Month BOD Loading	lb/d	9,900
Maximum Month TSS Loading	lb/d	6,880
Maximum Month Ammonia Loading	lb-N/d	1,430
DAF Effluent		
Average Flow	mgd	12.5
Maximum Month Flow	mgd	16.8
Maximum Month BOD Loading ³	lb/d	2,800
Maximum Month TSS Loading ³	lb/d	2,800
Maximum Month Ammonia Loading ⁴	lb-N/d	4,700
Minimum Wastewater Temperature ⁵	degrees C	8.8

¹ Assuming a TSS removal of 42 percent and a BOD removal of 22 percent, based on historical data

² Influent loadings, prior to primary clarification, were increased by 20 percent to account for impacts of solids processing recycle streams

³ Assuming a DAF effluent TSS and BOD concentration of 20 mg/L at maximum month flow

⁴ Assuming an ammonia concentration of 33.5 mg-N/L (maximum month value from historical data)

⁵ Minimum month pond temperature

4.2 Conceptual Design

The aeration basin volume requirements for the activated sludge process were determined using the activated sludge computer simulator, BioWin 3 (Envirosim Associates, Ltd., Ontario, Canada). The process was simulated using the influent flows and loads presented in Table 4-1. An anoxic zone, which accounted for 25 percent of the total aeration basin volume, was included to provide partial denitrification. A byproduct of denitrification is alkalinity, which is important in a nitrifying system. The nitrification process destroys alkalinity. If there is insufficient alkalinity, the pH will reduce and could hinder nitrification. Even with the alkalinity addition from denitrification, we assumed that alkalinity addition (e.g. caustic soda) would be required.

A solids retention time (SRT) of 8 days using the mass of solids under aeration was assumed (i.e. solids in the clarifier and in the anoxic zones were not considered). Because of the low wastewater temperature (8.8 degrees C, minimum month), a SRT of 8 days is required to achieve complete nitrification to meet permit requirements and was assumed for the analysis.

Figure 4-2 presents a computer screenshot of the BioWin simulation for the activated sludge process. For the modeling, default modeling parameters were used. An accurately calibrated model requires a 2-week wastewater characterization study to determine characteristics specific to the Sunnyvale wastewater. For this conceptual analysis, default characteristics are sufficient to estimate footprint requirements and planning level construction costs.

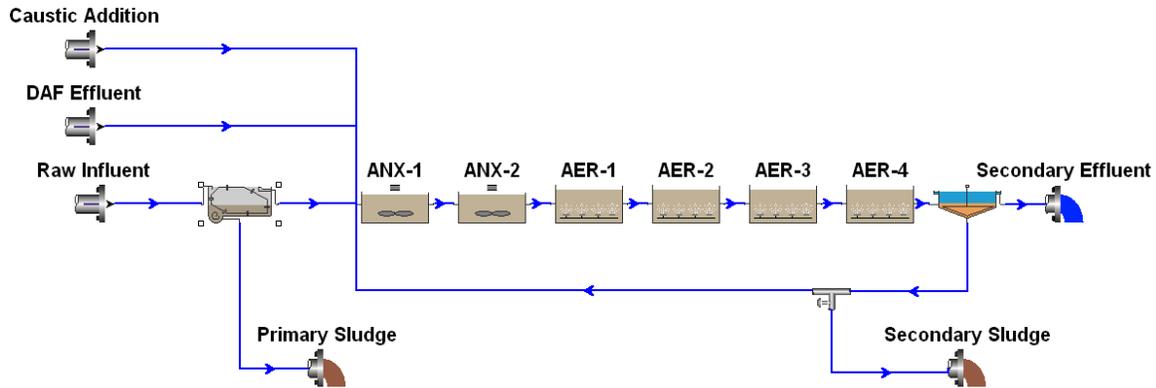


Figure 4-2. Screenshot of the BioWin simulation constructed for the activated sludge alternative.

Steady-state modeling runs were performed to size the aeration basins. The effluent ammonia concentration was predicted to be 0.25 mg-N/L at maximum month loading, which is below permit requirements. At maximum month loading conditions, the mixed liquor suspended solids concentration was limited to 2,000 mg/L by adjusting the aeration basin volume. A maximum concentration of 2,000 mg/L was selected so as not to overload the secondary clarifiers. The modeling results estimate that a total aeration basin volume of 5.87 million gallons (MG) would be required. To minimize footprint requirements, a 30-ft sidewater depth was used to estimate space requirements. A 30-ft sidewater depth will require positive displacement blowers or single stage blowers for the aeration system.

Table 4-2 summarizes the aeration basin requirements for the activated sludge alternative. Table 4-2 also contains information for the secondary clarifiers. The secondary clarifiers were designed assuming a surface overflow rate (SOR) of 940 gallons per square foot per day (gpd/sf) at average flow (16.7 mgd).¹ The clarifiers were sized so that one clarifier could be out of service at average flow conditions for maintenance; all clarifiers are assumed to be in operation at peak flow. Using this design criteria, three circular flocculator secondary clarifiers are required, 106-ft diameter each.

¹ Based on data presented in Parker and Stenquist (1986) Flocculator-Clarifier Performance, *Water Environ. Res.* 58 (3) 214-219.

Table 4-2. Summary Activated Sludge Process for Nitrification		
Parameter	Units	Value
Aeration Basins		
Total Volume	MG	5.87
Number of Basins	---	6
Length, each	ft	145
Width, each	ft	30
Sidewater Depth	ft	30
Secondary Clarifiers		
Number	---	3
Diameter	ft	106
Sidewater Depth	ft	16

Figure 4-3 presents footprint requirements for the activated sludge alternative. New headworks and primary clarifiers would be constructed on the southeast side of the plant. Once the new headworks and primary clarifiers are in operation, the new aeration basins would be constructed where the existing primary clarifiers are located. Two secondary clarifiers would be located south of the aeration basins. The third secondary clarifier would be located south of the anaerobic digesters.



Rehab alternative – add NAS to nitrify pond effluent
 Deeper aeration tanks (6 tanks at 136 ft x 30 ft x 30 ft deep)
 3 clarifiers at 100 ft diameter

4-3. Conceptual layout of the hybrid activated sludge alternative

4.3 Conceptual Cost Estimate

A conceptual cost estimate was performed for the activated sludge alternative. A summary of the cost estimate is provided as Attachment A; the detailed cost estimate is provided as Attachment B. The results of the cost estimate are summarized in Table 4-3. The activated sludge alternative is estimated at \$29.8 million. The estimated cost of the aeration basins and secondary clarifiers is estimated to be \$21.0 million. The remaining \$8.8 million is for site preparation, blower building, pipelines and electrical and instrumentation.

Table 4-3. Summary of Conceptual Cost Estimate for the Activated Sludge Alternative	
Description	Cost
Civil-Demolition	\$3,374,000
Aeration Basins	\$11,835,000
Blower Building	\$1,416,000
Secondary Clarifiers	\$9,230,000
Primary Sludge Pipeline	\$52,000
DAFT Effluent Pipeline	\$445,000
Electrical and Instrumentation	\$3,439,000
Total	\$29,789,000

Cost estimate includes 30-percent construction contingency and mark-ups for labor, materials, equipment and subcontractors.

5. RECOMMENDED IMPROVEMENTS

Considering the relatively high costs of the activated sludge alternative relative to the nominal costs likely necessary for alteration of the FGR mode of operation, we recommend that the City base its planning on continued use of the FGRs for nitrification, while doing a field trial of the FGRs in Mode 1. There would be some nominal upgrades required to ensure success, such as replacing the Fans on the FGRs and providing the ability to add chemicals to supplement the alkalinity of the pond effluent, should that prove necessary.

6. REFERENCES

Biesterfeld, Sidney, Greg Farmer, Phil Russell, Linda Figueroa. “Effect of Alkalinity Type and Concentration on Nitrifying Biofilm Activity.” *Water Environment Research*, Vol. 75, No. 3, May/June 2003, pp. 196-204.

Eisenberg, Olivieri, & Associates (EOA). *City of Sunnyvale Water Pollution Control Plant Ammonia Removal Enhancement Study Final Report*, June 1990.

Parker, Denny, Mike Lutz, Rodney Dahl, and Stephanie Bernkopf. “Enhancing reaction rates in nitrifying trickling filters through biofilm control.” *Journal Water Pollution Control Federation*, Vol. 61, No. 5, May 1989, pp. 618-631.

Parker, Denny, Mike Lutz, Bengt Andersson, and Henrik Aspergren. 1995. “Effect of Operating Variables on Nitrification Rates in Trickling Filters.” *Water Environment Research* 67(7):569.

ATTACHMENT A

Summary Conceptual Estimate Report with Mark-Ups Allocated

**SUMMARY CONCEPTUAL
ESTIMATE REPORT
WITH MARK-UPS
ALLOCATED
STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE**

**CONCEPTUAL LEVEL
COST ESTIMATE**

Project Number: 135083-004
BC Project Manager: Lloyd Sleazak
BC Office: Walnut Creek
Estimate Issue Number: 01
Estimate Original Issue Date: 2009-04-27
Estimate Revision Number: NA
Lead Estimator: Des Orsinelli
Estimate QA/QC Reviewer: Butch Matthews
Estimate QA/QC Date: 2009-04-26

PROCESS LOCATION/AREA INDEX

**1100 - Civil - Demo
1101 - Aeration Basins
1102 - Blower Building
1103 - Clarifiers
1104 - Primary Sludge Pipeline
1105 - DAFT Effluent Pipeline
1106 - Electrical and Instrumentation**

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Description	Total w/ Markups Allocated
--- Base Estimate ---	29,789,378
1100 - Civil - Demo	
02200 - Site Preparation	1,544,436
02300 - Earthwork	11,352
02600 - Drainage & Containment	1,692,080
02610 - Asphltc concrete pavement	15,659
02800 - Site Improvements And Amenities	70,425
02900 - Planting	39,410
1100 - Civil - Demo Total	3,373,362
1101 - Aeration Basins	
01500 - Temporary Facilities & Controls	5,932
01590 - Miscellaneous Equipment Rental without operators	922
02200 - Site Preparation	961,261
02300 - Earthwork	1,932,417
03100 - Concrete Forms & Accessories	1,974,022
03200 - Concrete Reinforcement	1,880,356
03300 - Cast-In-Place Concrete	1,829,526
05500 - Metal Fabrications	435,586
11000 - Equipment	942,079
15010 - Misc. Mechanical	18,567
15050 - Basic Materials & Methods	98,936
15100 - Building Services Piping	86,217
15212 - Stainless Steel Pipe - type 316	1,320,596
15290 - Valves, stainless steel	348,163
1101 - Aeration Basins Total	11,834,580
1102 - Blower Building	
01500 - Temporary Facilities & Controls	20,741
02300 - Earthwork	17,952
02700 - Bases, Ballasts, Pavements & Appurtenances	502
03100 - Concrete Forms & Accessories	8,783
03200 - Concrete Reinforcement	27,710
03300 - Cast-In-Place Concrete	38,299
04050 - Basic Masonry Materials And Methods	33,526
04800 - Masonry Assemblies	166,699
05010 - Misc Metals	39,634
05050 - Basic Metal Materials & Methods	53,196
05100 - Structural Metal Framing	34,796
05300 - Metal Deck	73,696
05400 - Cold-Formed Metal Framing	8,937
07200 - Thermal Protection	5,020
07500 - Membrane Roofing	22,381
07700 - Roof Specialties And Accessories	2,852
08100 - Metal Doors And Frames	8,852
08300 - Specialty Doors	3,079
08500 - Windows	4,715
08700 - Hardware	12,048
11000 - Equipment	394,370
14020 - Material handling	109,154
15050 - Basic Materials & Methods	12,445
15100 - Building Services Piping	11,407
15190 - CARBON STEEL PIPE, WELDED	244,964
15515 - Misc HVAC	37,037
15685 - Louvers	22,877
1102 - Blower Building Total	1,415,671
1103 - Clarifier	
02200 - Site Preparation	716,937
02300 - Earthwork	1,095,346
03100 - Concrete Forms & Accessories	796,546
03200 - Concrete Reinforcement	1,907,246
03300 - Cast-In-Place Concrete	1,167,076
04050 - Basic Masonry Materials And Methods	106
05900 - Metal Restoration & Cleaning	66,446
09020 - Coatings & Paints	50,329
11000 - Equipment	3,163,056
15001 - Pipe, Water Supply	100,944
15010 - Misc. Mechanical	13,507
15030 - Pipe,watr dst,ductl iron	110,396
15031 - DIP Fittings	18,200

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Description	Total w/ Markups Allocated
15100 - Building Services Piping	23,777
1103 - Clarifier Total	9,229,911
1104 - Primary Sludge Pipeline	
01590 - Miscellaneous Equipment Rental without operators	737
02300 - Earthwork	10,311
15030 - Pipe,watr dstr,ductl iron	41,075
1104 - Primary Sludge Pipeline Total	52,124
1105 - DAFT effluent Pipeline	
01590 - Miscellaneous Equipment Rental without operators	1,290
02300 - Earthwork	76,641
15030 - Pipe,watr dstr,ductl iron	366,672
1105 - DAFT effluent Pipeline Total	444,604
1106 - Electrical and Instrumentation	
16000 - Electrical and Instrumentation	3,439,126
1106 - Electrical and Instrumentation Total	3,439,126

ATTACHMENT B

Detailed Conceptual Estimate Report

**DETAILED CONCEPTUAL
ESTIMATE REPORT**

**STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE**

**CONCEPTUAL LEVEL
COST ESTIMATE**

Project Number: 135083-004

BC Project Manager: Lloyd Sleazak

BC Office: Walnut Creek

Estimate Issue Number: 01

Estimate Original Issue Date: 2009-04-27

Estimate Revision Number: NA

Lead Estimator: Des Orsinelli

Estimate QA/QC Reviewer: Butch Matthews

Estimate QA/QC Date: 2009-04-26

PROCESS LOCATION/AREA INDEX

**1100 - Civil - Demo
1101 - Aeration Basins
1102 - Blower Building
1103 - Clarifiers
1104 - Primary Sludge Pipeline
1105 - DAFT Effluent Pipeline
1106 - Electrical and Instrumentation**

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
--- Base Estimate ---					
1100 - Civil - Demo					1,749,428
02200 - Site Preparation					
02220130 - Bldg. Footings And Foundations Demolition					
0440	Bldg. footings and foundations demolition, floors, concrete slab on grade, concrete, rod reinforced, 6" thick, excludes disposal costs and dump fees	12,000.0	SF	8.1	97,228
2500	Bldg. footings and foundations demolition, remove concrete walls, plain concrete, 12" thick, excludes disposal costs and dump fees	28,800.0	SF	24.3	699,543
02220250 - Demolish, Remove Pavement And Curb					
5100	Demolish, remove pavement & curb, remove bituminous driveways, misc fixtures	1,333.0	SY	5.6	7,485
Site Preparation Total					804,256
02300 - Earthwork					
02310100 - Finish Grading					
0100	Fine grading, base or leveling course, large area, 6,000 S.Y. or more	4,500.0	SY	0.8	3,622
02370700 - Synthetic Erosion Control					
1000	Synthetic erosion control, silt fence, polypropylene, 3' high	1,500.0	LF	0.9	1,412
1000	Remove Synthetic erosion control, silt fence, polypropylene, 3' high	1,500.0	LF	0.6	827
Earthwork Total					5,861
02600 - Drainage & Containment					
02630400 - Storm Drainage Manholes, Frames & Covers					
0050	Yard Piping - Storm drain/service water - 4% of net total	1.0	Isum	500,000.0	500,000
0050	Yard Piping - Process - 3% of net total	1.0	Isum	375,000.0	375,000
Drainage & Containment Total					875,000
02610 - Asphalt concrete pavement					
02610 - Asphalt concrete pavement					
0090	Asphaltic conc pavement, and lg paved areas, wearing course, 3" thick	1,000.0	sqyd	7.9	7,940
Asphalt concrete pavement Total					7,940
02800 - Site Improvements And Amenities					
02810300 - Sprinkler Irrigation System					
0900	Underground sprinklers irrigation system, for lawns, residential system, custom, 1-1/2" supply	30,000.0	SF	1.2	36,373
Site Improvements And Amenities Total					36,373
02900 - Planting					
02920400 - Sodding					

STRATEGIC
 INFRASTRUCTURE PLAN
 - WCPC NITRIFICATION
 REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
1000	Sodding, bent grass sod, on level ground, over 6 M.S.F.	30.0	Msf	666.6	19,998
Planting Total					19,998

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
1101 - Aeration Basins					6,054,746
01500 - Temporary Facilities & Controls					
01540750 - Scaffolding					
6610	Scaffolding, steel tubular, heavy duty shoring for elevated slab forms, floor area, rent/month of materials only, to 14'-8" high	69.6	Csf	43.0	2,993
Temporary Facilities & Controls Total					2,993
01590 - Miscellaneous Equipment Rental without operators					
01590400 - General equipment rental without operators					
7030B	Rent trench box, 3000 lbs 6' x 8' - Rent per day	5.0	days	93.0	465
Miscellaneous Equipment Rental without operators Total					465
02200 - Site Preparation					
02250400 - Sheet Piling					
1600	Sheet piling, steel, 27 psf, 20' excavation, drive, extract and salvage, excludes wales	20,000.0	SF	24.6	491,667
Site Preparation Total					491,667
02300 - Earthwork					
02315120 - Backfill, Structural					
4420	[2x] Backfill, structural, common earth, 200 H.P. dozer, 300' haul	16,394.0	L.C.Y.	2.7	43,675
02315310 - Compaction, General					
7000	[6x] Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	14,962.0	E.C.Y.	2.3	35,074
02315424 - Excavating, Bulk Bank Measure					
4400	Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum	39,326.0	B.C.Y.	14.0	551,335
02315492 - Hauling					
0009	[2x] Loading Trucks, F.E. Loader, 3 C.Y.	34,291.0	cuyd	1.9	65,567
4498	[2x] Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 25 min load/wait/unload, 20 CY truck, cycle 20 miles, 45 MPH, no loading equipment	34,291.0	L.C.Y.	6.3	217,129
02315610 - Excavating, Trench					
1000	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering	1,222.0	B.C.Y.	3.7	4,510
02315640 - Utility Bedding					
0100	[2x] Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	1,324.0	L.C.Y.	55.0	72,803
Earthwork Total					990,092
03100 - Concrete Forms & Accessories					

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
03110420 - Forms In Place, Elevated Slabs					
1500	C.I.P. concrete forms, elevated slab, flat plate, plywood, 15' to 20' high ceilings, includes shoring, erecting, bracing, stripping and cleaning	6,960.0	SF	8.4	58,726
03110445 - Forms In Place, Slab On Grade					
3050	C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning	2,384.0	sfca	5.7	13,571
3550	[2x] C.I.P. concrete forms, slab on grade, depressed, edge, wood, 12" to 24" high, 4 use, includes erecting, bracing, stripping and cleaning	2,772.0	LF	13.0	36,058
03110455 - Forms In Place, Walls					
2550	[2x] C.I.P. concrete forms, wall, job built, plywood, 8 to 16' high, 4 use, includes erecting, bracing, stripping and cleaning	92,512.0	sfca	9.3	857,669
03150860 - Waterstop					
0600	[5x] Waterstop, PVC, ribbed, with center bulb, 3/8" thick x 9" wide	6,713.0	LF	9.1	60,948
Concrete Forms & Accessories Total					1,026,971
03200 - Concrete Reinforcement					
03210600 - Reinforcing In Place					
0602	[3x] Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	297,739.5	lb	1.0	308,135
0702	[2x] Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	442,216.5	lb	0.9	386,783
2000	[5x] Reinforcing steel, unload and sort, add to base	403.3	ton	49.9	20,139
2210	[5x] Reinforcing steel, crane cost for handling, average, add	403.3	ton	54.1	21,807
2430	[2x] Reinforcing steel, in place, dowels, deformed, 2' long, #6, A615, grade 60	20,369.5	EA	5.7	116,785
2450	[3x] Reinforcing steel, in place, dowels, deformed, A615, grade 60, longer and heavier, add	46,361.2	lb	2.4	112,224
Concrete Reinforcement Total					965,874
03300 - Cast-In-Place Concrete					
03310220 - Concrete, Ready Mix Normal Weight					
0300	[5x] Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	6,411.3	CY	106.0	679,593
03310700 - Placing Concrete					
1500	Structural concrete, placing, elevated slab, pumped, 6" to 10" thick, includes vibrating, excludes material	171.9	CY	28.4	4,883
4650	[2x] Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material	2,040.0	CY	24.6	50,229
5350	[2x] Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material	4,199.4	CY	38.0	159,380

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
03350300 - Finishing Floors					
0150	[3x] Concrete finishing, floors, manual screed, bull float, manual float, broom finish	34,500.0	SF	0.7	25,499
03350350 - Finishing Walls					
0150	[2x] Concrete finishing, walls, carborundum rub, wet, includes breaking ties and patching voids	4,001.5	SF	2.6	10,577
Cast-In-Place Concrete Total					930,161
05500 - Metal Fabrications					
05520700 - Railing, Pipe					
0220	Railing, pipe, aluminum, dark anodized finish, 3 rails, 3'-6" high, posts @ 5' O.C., 1-1/2" dia, shop fabricated	2,290.0	LF	96.6	221,117
Metal Fabrications Total					221,117
11000 - Equipment					
11010 - Process Equipment					
0060	Diffusers, fine bubble, complete with headers	26,000.0	sf	18.5	481,000
Equipment Total					481,000
15010 - Misc. Mechanical					
15010 - Misc. Mechanical					
0150	Utility stations, complete w/ valve, hose, rack, signage	12.0	each	789.2	9,471
Misc. Mechanical Total					9,471
15050 - Basic Materials & Methods					
15080600 - Piping Insulation					
6900	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 2" iron pipe size	1,000.0	LF	7.7	7,734
7030	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 16" iron pipe size	900.0	LF	25.3	22,754
7060	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 24" iron pipe size	640.0	LF	32.0	20,457
Basic Materials & Methods Total					50,945
15100 - Building Services Piping					
15107420 - Pipe, Copper					
2260	Pipe, copper, tubing, solder, 2" diameter, type L, includes coupling & clevis hanger assembly 10' O.C.	1,000.0	LF	43.8	43,756
Building Services Piping Total					43,756
15212 - Stainless Steel Pipe - type 316					
15212 - Stainless Steel Pipe - type 316					
0160	Pipe, SS, A778, weld, Sched. 10S, type 316L, 6" dia.	480.0	lnft	88.2	42,357

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
0190	Pipe, SS, A778, weld, Sched. 10S, type 316L, 12" dia.	420.0	Inft	227.4	95,496
0220	Pipe, SS, A778, weld, Sched. 10S, type 316L, 18" dia.	510.0	Inft	349.2	178,113
0240	Pipe, SS, A778, weld, Sched. 10S, type 316L, 24" dia.	60.0	Inft	610.7	36,641
0260	Pipe, SS, A778, weld, 5/16", type 316L, 36" dia.	80.0	Inft	1,006.0	80,479
0260	Pipe supports/fittings allowance - 15% of pipe	1.0	lsum	231,000.0	231,000
Stainless Steel Pipe - type 316 Total					664,087
15290 - Valves, stainless steel					
15290 - Valves, stainless steel					
0870	Valves, stainless steel, butterfly, 150 lb., flanged, 6" size	72.0	each	2,446.5	176,147
Valves, stainless steel Total					176,147

CITY OF SUNNYVALE

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
1102 - Blower Building					721,855
01500 - Temporary Facilities & Controls					
01540750 - Scaffolding					
2850	Scaffolding, steel tubular, regular, accessory, plank, rent/mo, 2" x 10" x 16' long	160.0	EA	6.0	960
3250	Scaffolding, steel tubular, heavy duty shoring, frame, rent/mo, 5' high x 2' & 4' wide	960.0	EA	5.0	4,800
3700	Scaffolding, steel tubular, heavy duty shoring, accessory, base plate, rent/mo, 8" x 8"	228.6	EA	1.0	229
3750	Scaffolding, steel tubular, heavy duty shoring, accessory, leveling jack, rent/mo	360.0	EA	2.0	720
9000	Scaffolding assembly and disassembly, OPEN	5,600.0	sqft	0.7	3,888
Temporary Facilities & Controls Total					10,596
02300 - Earthwork					
02315120 - Backfill, Structural					
4420	Backfill, structural, common earth, 200 H.P. dozer, 300' haul	42.3	L.C.Y.	2.7	113
02315310 - Compaction, General					
7500	Compaction, 2 passes, 24" wide, 6" lifts, walk behind, vibrating roller	38.1	E.C.Y.	2.3	86
7520	Compaction, 3 passes, 24" wide, 6" lifts, walk behind, vibrating roller	38.9	E.C.Y.	3.4	132
7540	Compaction, 4 passes, 24" wide, 6" lifts, walk behind, vibrating roller	77.8	E.C.Y.	4.5	352
02315492 - Hauling					
0009	Loading Trucks, F.E. Loader, 3 C.Y.	229.8	cuyd	1.9	439
4498	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 25 min load/wait/unload, 20 CY truck, cycle 20 miles, 45 MPH, no loading equipment	229.8	L.C.Y.	6.3	1,455
02315610 - Excavating, Trench					
0060	[2x] Excavating, trench or continuous footing, common earth, 1/2 C.Y. excavator, 1' to 4' deep, excludes sheeting or dewatering	234.4	B.C.Y.	6.9	1,621
02315640 - Utility Bedding					
0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	90.4	L.C.Y.	55.0	4,973
Earthwork Total					9,171
02700 - Bases, Ballasts, Pavements & Appurtenances					
02775275 - Sidewalks, Driveways, & Patios					
0850	Sidewalks, driveways, and patios, splash block, precast concrete, standard size	20.0	EA	12.8	255
Bases, Ballasts, Pavements & Appurtenances Total					255
03100 - Concrete Forms & Accessories					
03110425 - Forms In Place, Equipment Foundations					
0050	C.I.P. concrete forms, equipment foundations, 2 use, includes erecting, bracing, stripping and cleaning	88.0	sfca	19.6	1,722

CITY OF SUNNYVALE

**STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE**

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
03110445 - Forms In Place, Slab On Grade					
3050	C.I.P. concrete forms, slab on grade, edge, wood, 7" to 12" high, 4 use, includes erecting, bracing, stripping and cleaning	500.0	sfca	5.7	2,846
Concrete Forms & Accessories Total					4,569
03200 - Concrete Reinforcement					
03210600 - Reinforcing In Place					
0602	[4x] Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	12,787.5	lb	1.0	13,234
2000	Reinforcing steel, unload and sort, add to base	6.1	ton	49.9	307
2210	Reinforcing steel, crane cost for handling, average, add	6.1	ton	54.1	332
2420	Reinforcing steel, in place, dowels, deformed, 2' long, #5, A615, grade 60	84.0	EA	4.4	370
Concrete Reinforcement Total					14,243
03300 - Cast-In-Place Concrete					
03310220 - Concrete, Ready Mix Normal Weight					
0300	[3x] Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	128.5	CY	106.0	13,623
03310700 - Placing Concrete					
4650	[3x] Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material	128.5	CY	24.6	3,164
03350300 - Finishing Floors					
0150	Concrete finishing, floors, manual screed, bull float, manual float, broom finish	2,133.3	SF	0.7	1,577
03350350 - Finishing Walls					
0150	Concrete finishing, walls, carborundum rub, wet, includes breaking ties and patching voids	88.0	SF	2.6	233
0750	Concrete finishing, walls, sandblast, heavy penetration	120.0	SF	7.5	897
Cast-In-Place Concrete Total					19,494
04050 - Basic Masonry Materials And Methods					
04070420 - Grouting					
0350	Grout, concrete masonry unit (CMU) cores, 12" thick, 0.422 C.F./S.F., pumped, excludes blockwork	2,800.0	SF	4.9	13,787
04080070 - Anchor Bolts					
0060	Anchor bolts, hooked type, 3/4" diameter x 8" long, includes nut and washer	10.0	EA	5.5	55
04080200 - Reinforcing					
0020	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed horizontally, ASTM A615	1,460.2	lb	1.5	2,205
0060	Masonry reinforcing bars, #5 and #6 reinforcing steel bars, placed vertically, ASTM A615	730.1	lb	1.7	1,220
Basic Masonry Materials And Methods Total					17,267

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
04800 - Masonry Assemblies					
04810100 - Brick Veneer					
2000	Brick veneer masonry, standard brick, select common, running bond, T.L. lots, 6.75/S.F., 4" x 2-2/3" x 8", includes 3% brick and 25% mortar waste, excludes scaffolding, grout and reinforcing	2,800.0	SF	14.8	41,387
04810187 - Concrete Block, High Strength					
0650	Concrete block, high strength, hollow, 5000 psi, 12" x 8" x 16", includes mortar and horizontal joint reinforcing every other course, excludes scaffolding, grout and vertical reinforcing	2,800.0	SF	16.0	44,738
Masonry Assemblies Total					86,124
05010 - Misc Metals					
05010 - Misc Metals					
0020	[2x] Pump mounting base plate, complete w/ anchor bolts, 8 sf	8.0	each	2,528.7	20,230
Misc Metals Total					20,230
05050 - Basic Metal Materials & Methods					
05090340 - Drilling					
0300	Concrete impact drilling, for anchors, up to 4" D, 1/2" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor	140.0	EA	11.5	1,611
0400	Concrete impact drilling, for anchors, up to 4" D, 5/8" dia, in concrete or brick walls and floors, incl bit & layout, excl anchor	84.0	EA	12.0	1,006
05090380 - Expansion Anchors					
8250	Wedge anchor, carbon steel, 1/2" dia x 2-3/4" L, in concrete, brick or stone, excl layout & drilling	140.0	EA	5.0	707
05090540 - Machinery Anchors					
0800	Machinery anchor, heavy duty, 1" dia stud & bolt, incl sleeve, floating base nut, lower stud & coupling nut, fiber plug, connecting stud, washer & nut	24.0	EA	166.0	3,984
05090900 - Welding Structural					
1800	Welding structural steel in field, 3 passes, 0.5 Lb/LF, 3/8" thick, continuous fillet, type 6011	262.5	LF	27.1	7,109
9010	Welding, 5/8" puddle - RSM #05 05 21.90-2010	525.0	each	25.0	13,123
Basic Metal Materials & Methods Total					27,540
05100 - Structural Metal Framing					
05120440 - Lightweight Framing					
0476	Angle framing, structural steel, 3"x3"x3/8", field fabricated, incl cutting & welding	262.5	LF	40.7	10,679
05120520 - Pipe Support Framing					
0200	Pipe support framing, structural, 10.1 to 15 plf, shop fabricated. st stl	1,400.0	lb	5.2	7,214
Structural Metal Framing Total					17,892
05300 - Metal Deck					

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
05310300 - Metal Decking					
0340	Metal decking, steel, cellular units, galvanized, over 15 Sq, 2" D, 16-16 ga	2,100.0	SF	17.8	37,309
Metal Deck Total					37,309
05400 - Cold-Formed Metal Framing					
05420410 - Framing, Joists					
0550	Floor joist, galv CF steel, 12 ga x 12" D, incl joists (2" flange) & fasteners, excl band joists (track), web stiffeners, headers, beams, bridging & bracing, labor, materials only	525.0	LF	7.3	3,859
1550	Floor joist, galv CF steel, 12 ga x 12" D, incl fastening to band joists, beams & headers, excl materials, labor only	17.5	EA	38.5	673
Cold-Formed Metal Framing Total					4,532
07200 - Thermal Protection					
07220700 - Roof Deck Insulation					
0130	Roof Deck Insulation, fiberboard high density, 1-1/2" thick, R3.8	2,100.0	SF	1.2	2,573
Thermal Protection Total					2,573
07500 - Membrane Roofing					
07530350 - Elastomeric Roofing					
0120	Elastomeric Roofing, acrylic rubber, fluid applied, reinforced, 50 mils thick	2,100.0	SF	5.4	11,418
Membrane Roofing Total					11,418
07700 - Roof Specialties And Accessories					
07710400 - Downspouts					
0400	Aluminum downspouts, enameled, 3" x 4", .024" thick	224.0	LF	6.6	1,469
Roof Specialties And Accessories Total					1,469
08100 - Metal Doors And Frames					
08110200 - Commercial Steel Doors					
0100	Doors, hollow metal, commercial, steel, flush, full panel, hollow core, 1-3/8" thick, 20 ga., 3'-0" x 7'-0"	6.0	EA	362.1	2,172
08110250 - Door Frames					
0200	Door frames, steel channels with anchors and bar stops, 8" channel@ 11.5 lb/LF, 6' x 8' door, weighs 275 lb	3.0	EA	778.1	2,334
Metal Doors And Frames Total					4,507
08300 - Specialty Doors					
08360550 - Overhead, Commercial					
2650	Doors, overhead, commercial, stock, steel, heavy duty, sectional, manual, 24 gauge, 10' x 10' high	1.0	EA	1,575.0	1,575
Specialty Doors Total					1,575

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
08500 - Windows					
08520120 - Aluminum Windows					
5000	Windows, aluminum, commercial grade, stock units, sliding, standard glass, 9'-0" x 5'-0" opening, incl. frame and glazing	3.0	EA	802.9	2,409
Windows Total					2,409
08700 - Hardware					
08710300 - Door Closers					
0015	Door hardware, door closer, rack and pinion	6.0	EA	235.6	1,414
08710340 - Doorstops					
0020	Door hardware, doorstops, holder and bumper, floor or wall	6.0	EA	51.4	308
08710520 - Hinges					
0100	Door hardware, hinges, full mortise, average frequency, steel base, USP, 5" x 5"	9.0	pair	41.0	369
08710550 - Kick Plate					
0020	Door hardware, kick plate, stainless steel, 6" high for 3' door	6.0	EA	69.5	417
08710700 - Mortise Lockset					
0020	Door hardware, mortise lockset, commercial, wrought knobs and full escutcheon trim, non-keyed, passage, minimum	6.0	EA	238.5	1,431
08720300 - Weatherstripping, Window					
2300	Weatherstripping, doors, metal frame, spring type, bronze, for 3' x 7' door	6.0	Opng	226.9	1,361
08720800 - Thresholds					
0500	Thresholds, bronze	18.0	LF	48.1	865
Hardware Total					6,166
11000 - Equipment					
11010 - Process Equipment					
0560IK	Aeration Blower 3,200 scfm - 250-hp	4.0	each	49,229.4	196,918
Equipment Total					196,918
14020 - Material handling					
14020 - Material handling					
0290	Crane rail, running track only, 104 lb per yard, 20' piece	100.0	lft	33.5	3,345
0302do	Electric Hoist, trolley and 56-ft monorail, 3 ton - 3-hp hoist, 24' lift, 0.5hp trolley.	1.0	each	51,271.4	51,271
Material handling Total					54,616
15050 - Basic Materials & Methods					
15080600 - Piping Insulation					

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
7060	Insulation, pipe covering (price copper tube one size less than I.P.S.), fiberglass with all service jacket, 1" wall, 24" iron pipe size	200.0	LF	32.0	6,393
Basic Materials & Methods Total					6,393
15100 - Building Services Piping					
15160500 - Storm Area Drains					
5000	Drain, scupper floor, oblique strainer, cast iron, 6" x 7" top, 2", 3" and 4" pipe size	20.0	EA	287.7	5,755
Building Services Piping Total					5,755
15190 - CARBON STEEL PIPE, WELDED					
15190 - Pipe, steel					
0470	Pipe, stl, wldd, sch. 40, (no hgrs incl for 14" dia & up), blk, 18" dia	140.0	lnft	280.2	39,228
0470	Process pipe, small bore allowance	1.0	lsum	20,000.0	20,000
0470	Pipe, service water & floor drain - allowance \$5/sf	1.0	lsum	11,000.0	11,000
0520	Pipe, st, wld, sch. 40, (no hgrs incl for 14" dia & up), bk, 36" dia	70.0	lnft	630.1	44,104
0520	Fittings and Supports, allowance 15% of pipe	1.0	lsum	12,000.0	12,000
CARBON STEEL PIPE, WELDED Total					126,332
15515 - Misc HVAC					
15515 - Misc HVAC					
0010	HVAC heating, cooling allowance, \$10.00/sf	2,100.0	sqft	10.0	21,000
Misc HVAC Total					21,000
15685 - Louvers					
15685 - Louvers					
0360	Louvers, alum, W/scrn, mill fin, accoustical, 48" x 112"	4.0	each	2,876.2	11,505
Louvers Total					11,505

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
1103 - Clarifier					4,689,343
02200 - Site Preparation					
02250400 - Sheet Piling					
1600	Sheet piling, steel, 27 psf, 20' excavation, drive, extract and salvage, excludes wales	14,916.6	SF	24.6	366,700
Site Preparation Total					366,700
02300 - Earthwork					
02315120 - Backfill, Structural					
5420	Backfill, structural, common earth, 300 H.P. dozer, 300' haul	6,749.2	L.C.Y.	1.7	11,639
02315310 - Compaction, General					
7000	[2x] Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	6,017.2	E.C.Y.	2.3	14,106
02315424 - Excavating, Bulk Bank Measure					
4400	[2x] Excavating, bulk bank measure, in sheeting or cofferdam, with all other equipment, minimum	24,936.2	B.C.Y.	14.0	349,596
02315492 - Hauling					
0009	[2x] Loading Trucks, F.E. Loader, 3 C.Y.	24,421.1	cuyd	1.9	46,695
4298	[2x] Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 20 min load/wait/unload, 20 CY truck, cycle 20 miles, 45 MPH, no loading equipment	24,421.1	L.C.Y.	5.7	139,473
Earthwork Total					561,509
03100 - Concrete Forms & Accessories					
03110445 - Forms In Place, Slab On Grade					
3550	C.I.P. concrete forms, slab on grade, depressed, edge, wood, 12" to 24" high, 4 use, includes erecting, bracing, stripping and cleaning	1,998.1	LF	13.0	25,990
03110455 - Forms In Place, Walls					
2550	C.I.P. concrete forms, wall, job built, plywood, 8 to 16' high, 4 use, includes erecting, bracing, stripping and cleaning	39,961.1	sfca	9.3	370,475
03150860 - Waterstop					
0600	[2x] Waterstop, PVC, ribbed, with center bulb, 3/8" thick x 9" wide	1,998.1	LF	9.1	18,141
Concrete Forms & Accessories Total					414,606
03200 - Concrete Reinforcement					
03210600 - Reinforcing In Place					
0502	Reinforcing steel, in place, footings, #4 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	14,772.1	lb	1.0	15,288
0602	[3x] Reinforcing steel, in place, slab on grade, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	538,715.9	lb	1.0	557,526

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
0702	Reinforcing steel, in place, walls, #3 to #7, A615, grade 60, incl labor for accessories, excl material for accessories	192,064.1	lb	0.9	167,988
2000	[2x] Reinforcing steel, unload and sort, add to base	231.9	ton	49.9	11,578
2210	[2x] Reinforcing steel, crane cost for handling, average, add	231.9	ton	54.1	12,537
2430	Reinforcing steel, in place, dowels, deformed, 2' long, #6, A615, grade 60	37,475.4	EA	5.7	214,859
Concrete Reinforcement Total					979,776
03300 - Cast-In-Place Concrete					
03310220 - Concrete, Ready Mix Normal Weight					
0300	[3x] Structural concrete, ready mix, normal weight, 4000 PSI, includes local aggregate, sand, Portland cement and water, delivered, excludes all additives and treatments	4,031.7	CY	106.0	427,361
03310700 - Placing Concrete					
3250	Structural concrete, placing, grade beam, pumped, includes vibrating, excludes material	220.6	CY	25.3	5,573
4650	Structural concrete, placing, slab on grade, pumped, over 6" thick, includes vibrating, excludes material	1,961.1	CY	24.6	48,285
5350	Structural concrete, placing, walls, pumped, 15" thick, includes vibrating, excludes material	1,850.0	CY	38.0	70,215
03350300 - Finishing Floors					
0150	Concrete finishing, floors, manual screed, bull float, manual float, broom finish	26,474.2	SF	0.7	19,567
03350350 - Finishing Walls					
0150	Concrete finishing, walls, carborundum rub, wet, includes breaking ties and patching voids	8,491.7	SF	2.6	22,446
03390200 - Water Curing					
0300	Concrete surface treatment, curing, sprayed membrane compound	14.9	Csf	14.4	214
Cast-In-Place Concrete Total					593,661
04050 - Basic Masonry Materials And Methods					
04080070 - Anchor Bolts					
0060	Anchor bolts, hooked type, 3/4" diameter x 8" long, includes nut and washer	10.0	EA	5.5	55
Basic Masonry Materials And Methods Total					55
05900 - Metal Restoration & Cleaning					
05910500 - Metal Cleaning					
6235	Metal cleaning, steel surface treatment, 2.0 lb sand per S.F., commercial blast, loose scale, fine powder rust (SSPC-SP6)	14,550.0	SF	2.4	34,377
Metal Restoration & Cleaning Total					34,377
09020 - Coatings & Paints					
09020 - Coatings & Paints					
9985	[3x] Coatings & paints, Steel, 6 mils Hi Build Epoxy	43,650.0	sqft	0.6	26,007

CITY OF SUNNYVALE

**STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE**

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
				Coatings & Paints Total	26,007
11000 - Equipment					
11010 - Process Equipment					
0940	Mechanical, clarifier mechanism, 135' dia. w/ bridge, cage, launders, weirs	3.0	each	500,000.0	1,500,000
11040 - Slide gates					
0070	Hydraulic structures, slide gate, self contained, ab & grout, 42" x 42"	3.0	each	6,713.7	20,141
11050 - Sluice gates					
0070	Hydraulic structures, sluice gate, HD, self cont w/crank, 24" x 24"	3.0	each	11,500.7	34,502
11100 - Pumps miscellaneous					
0190	Turbine pump, CI, 250 GPM, 15 HP, 6" discharge	3.0	each	7,892.9	23,679
				Equipment Total	1,578,322
15001 - Pipe, Water Supply					
15001002 - Water Supply, Ductile Iron Pipe					
2180	Water supply distribution piping, ductile iron pipe, cement lined, mechanical joint, no fittings, 18' lengths, 24" diameter, class 50, excludes excavation or backfill	150.0	LF	162.1	24,320
8440	Water supply distribution piping, fitting, 45 degree bend, ductile iron, cement lined, mechanical joint, 24" diameter, class 50 water piping	6.0	EA	4,420.8	26,525
				Pipe, Water Supply Total	50,845
15010 - Misc. Mechanical					
15010 - Misc. Mechanical					
0400	Spray Nozzles, 316 s.s. complete	30.0	each	230.9	6,927
				Misc. Mechanical Total	6,927
15030 - Pipe, water distr, ductl iron					
15030 - Pipe, water distr, ductl iron					
0480B	Piping, water dist, DI, cement lined, 18' L, restrained jt, 48" dia	175.5	lnft	314.4	55,183
				Pipe, water distr, ductl iron Total	55,183
15031 - DIP Fittings					
15031 - DIP Fittings					
0260	Piping, fittings, 45< bend, 6" dia	12.0	each	406.1	4,873
0430	Piping, wall pipe, DI, cement lined, CL 50, 3' L, mech jt, 20" dia	3.0	each	1,131.2	3,394
0440	Piping, wall pipe, DI, cement lined, CL 50, 3' L, mech jt, 6" dia	3.0	each	299.4	898
				DIP Fittings Total	9,165
15100 - Building Services Piping					
15107420 - Pipe, Copper					

STRATEGIC
 INFRASTRUCTURE PLAN
 - WCPC NITRIFICATION
 REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
5389	Pipe, copper, hard temper, cleaned and capped, 1-1/8", type L, ACR tubing, excludes couplings and hangers	300.0	LF	15.3	4,591
	15107460 - Pipe Fittings, Copper				
0520	Tee, copper, wrought, copper x copper, 1-1/4"	30.0	EA	109.2	3,277
2030	Elbow, 90 Deg., copper, copper x copper, 1-1/4", DWV	60.0	EA	72.4	4,344
	Building Services Piping Total				12,212

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
1104 - Primary Sludge Pipeline					26,270
01590 - Miscellaneous Equipment Rental without operators					
01590400 - General equipment rental without operators					
7030B	Rent trench box, 3000 lbs 6' x 8' - Rent per day	4.0	days	93.0	372
Miscellaneous Equipment Rental without operators Total					372
02300 - Earthwork					
02315120 - Backfill, Structural					
4420	Backfill, structural, common earth, 200 H.P. dozer, 300' haul	222.0	L.C.Y.	2.7	591
02315310 - Compaction, General					
7000	[3x] Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	250.0	E.C.Y.	2.3	586
02315492 - Hauling					
0009	Loading Trucks, F.E. Loader, 3 C.Y.	96.0	cuyd	1.9	184
4498	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 25 min load/wait/unload, 20 CY truck, cycle 20 miles, 45 MPH, no loading equipment	96.0	L.C.Y.	6.3	608
02315610 - Excavating, Trench					
1000	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering	254.0	B.C.Y.	3.7	937
02315640 - Utility Bedding					
0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	43.0	L.C.Y.	55.0	2,364
Earthwork Total					5,271
15030 - Pipe,watr dstr,ductl iron					
15030 - Pipe,watr dstr,ductl iron					
0440B	Piping, water dist, DI, cement lined, 18' L, restrained jt, 24" dia	200.0	lnft	103.1	20,627
Pipe,watr dstr,ductl iron Total					20,627

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
1105 - DAFT effluent Pipeline					223,372
01590 - Miscellaneous Equipment Rental without operators					
01590400 - General equipment rental without operators					
7030B	Rent trench box, 3000 lbs 6' x 8' - Rent per day	7.0	days	93.0	651
Miscellaneous Equipment Rental without operators Total					651
02300 - Earthwork					
02315120 - Backfill, Structural					
4420	Backfill, structural, common earth, 200 H.P. dozer, 300' haul	1,930.0	L.C.Y.	2.7	5,142
02315310 - Compaction, General					
7000	[3x] Compaction, around structures and trenches, 2 passes, 18" wide, 6" lifts, walk behind, vibrating plate	2,141.0	E.C.Y.	2.3	5,019
02315492 - Hauling					
0009	Loading Trucks, F.E. Loader, 3 C.Y.	512.0	cuyd	1.9	979
4498	Cycle hauling(wait, load,travel, unload or dump & return) time per cycle, excavated or borrow, loose cubic yards, 25 min load/wait/unload, 20 CY truck, cycle 20 miles, 45 MPH, no loading equipment	512.0	L.C.Y.	6.3	3,242
02315610 - Excavating, Trench					
1000	Excavating, trench or continuous footing, common earth, 1 1/2 C.Y. excavator, 10' to 14' deep, excludes sheeting or dewatering	1,954.0	B.C.Y.	3.7	7,212
02315640 - Utility Bedding					
0100	Fill by borrow and utility bedding, for pipe and conduit, crushed stone, 3/4" to 1/2", excludes compaction	320.0	L.C.Y.	55.0	17,596
Earthwork Total					39,189
15030 - Pipe,watr dstr,ductl iron					
15030 - Pipe,watr dstr,ductl iron					
0460B	Piping, water dist, DI, cement lined, 18' L, restrained jt, 36" dia	985.0	lnft	186.3	183,532
Pipe,watr dstr,ductl iron Total					183,532

STRATEGIC
 INFRASTRUCTURE PLAN
 - WCPC NITRIFICATION
 REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
	1106 - Electrical and Instrumentation				1,950,000
	16000 - Electrical and Instrumentation				
	16000000 - Electrical and Instrumentation				
0001	Electrical and Instrumentation Subcontract - 15% of net	1.0	Isum	1,950,000.0	1,950,000
	Electrical and Instrumentation Total				1,950,000

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Item	Item Description	Qty	Unit	Total \$/Unit	Total Net Cost \$
				Grand Total	15,415,015

STRATEGIC
INFRASTRUCTURE PLAN
- WCPC NITRIFICATION
REHAB ALTERNATIVE

Category	Percent	Amount
--- Base Estimate --- Totals		
Labor	40.23 %	6,201,646
Material	38.61 %	5,951,409
Subcontractor	12.79 %	1,971,000
Equipment	8.37 %	1,290,960
Other		
User		
Net Costs		15,415,015
Labor Mark-up	15.00 %	930,247
Material Mark-up	10.00 %	595,141
Subcontractor Mark-up	5.00 %	98,550
Equipment Mark-up	10.00 %	129,096
Sales tax	9.50 %	688,025
Material Shipping & Handling	2.00 %	56,259
Escalation to Midpoint	12.00 %	1,849,802
Contractor General Conditions	12.00 %	2,371,456
Subtotal		22,133,590
Start-up, training, O & M	2.00 %	
Subtotal		22,133,590
Construction Contingency	30.00 %	6,640,077
Subtotal		28,773,668
Bldg Risk, Liability Auto Ins.	2.00 %	575,473
Subtotal		29,349,141
Bonds	1.50 %	440,237
Subtotal		29,789,378
Total Estimate		29,789,378