EFFECTS OF BIOLOGICAL PHOSPHORUS REMOVAL ON PLANT OPERATIONS AND CAPACITY AT THE NINE SPRINGS WWTP

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In 1997 and 1998 modifications were made to the Nine Springs Wastewater Treatment Plant to convert aerated portions of the activated sludge treatment train to anaerobic and anoxic zones. The plant modifications were made to meet an effluent phosphorus limit of 1.5 mg/l. This limit was in addition to other advanced secondary standards of 2.7 mg/l ammonia nitrogen, 19 mg/l BOD, and 20 mg/l TSS. Modelling performed during facility planing showed that in spite of a 17% reduction in the number of diffusers and removal of 22% of the tank volume from aeration, the plant capacity would not need to be de-rated from its 50 MGD rating, and might actually be rated as high as 57 MGD, based on an analysis of clarifier capacity and aeration/nitrification capacity.

In 2002 the District sponsored a University of Wisconsin research project to investigate simultaneous nitrification/denitrification in the activated sludge processes. One of the District's four plants was operated with very low dissolved oxygen (D.O.) concentrations throughout the tankage in order to achieve this goal. As part of the test the University took profiles of nutrients and D.O. concentrations, then used the results for activated sludge model calibration. In addition, the District took profiles of both the test tanks and control tanks with an off-gas analyzer to evaluate any changes in oxygen transfer efficiencies with the low D.O. mode of operation.

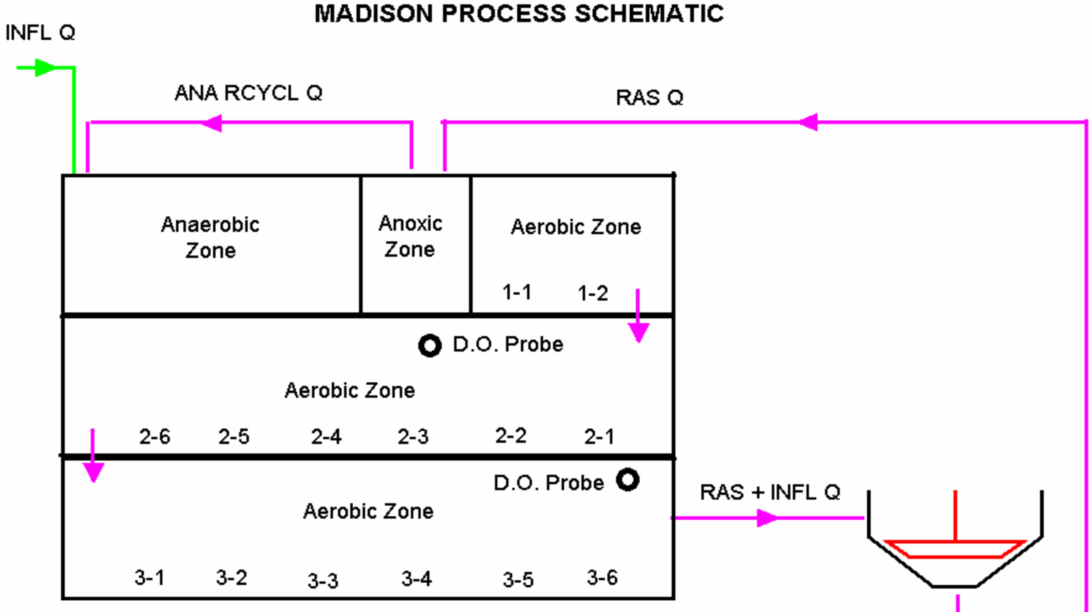
The results of the study not only provided information about simultaneous nitrification/denitrification, but also resulted in a stress test of the District's activated sludge system configuration. The test provided valuable information concerning future plant capacity.

D.O. PROBE CONTROL AND TEST CONFIGURATION

The Nine Springs Wastewater treatment plant is actually operated as four independent plants. Shown in Figure 1 are the configurations of plants 3 and 4 and D.O. probe locations. These two plants have identically sized tanks and layouts, and are the two newest plants placed in service in 1983. The District uses a D.O. control scheme for controlling air flow independently to each pass, and the control system also limits the minimum air flow to a pass. The minimum air flow to the shorter first passes is limited to an average of 1.5 cfm/diffuser because of a higher potential for diffuser plugging in the initial aerated sections. In the second and third passes the minimum air flow is limited to a minimum of 1.1 cfm/diffuser. The setpoint D.O. for the second pass probe was typically set between 1.2 and 1.5 mg/l and was used to control the air flow in both the first and second passes. The setpoint D.O. in the last pass was set at 2.5 mg/l and controlled the air flow in the 3rd pass. Because much the oxygen demand was satisfied in the first two passes, the D.O. concentration tended to typically exceed 7.0 mg/l by the end of the last pass.

For the UW study, the goal was to operate at lower than normal D.O.'s throughout the tankage. It was decided to use Plant 4 as the test plant and plant 3 as the control plant. The test was initiated at the completion of normal diffuser cleaning in Plant 4 in early August, 2002. To achieve low dissolved oxygen concentrations in Plant 4 without removing diffusers, one of the two parallel trains was removed from service and the remaining train received a 50% higher volumetric loading than normal. The operational control was set to keep the D.O. at 0.3 mg/l or lower at the first probe, essentially keeping the air flow at minimum in the first and second pass all the time. A setpoint of 1.0 mg/l was used for the probe at the end of the last pass.

FIGURE 1
MADISON PROCESS SCHEMATIC



Plant 3 & 4 Information
Each plant consists of two 3-pass aeration tank trains and 4 clarifiers
Volume each train: 0.5 MG -- Anaerobic
0.17 MG -- Anoxic
2.33 MG -- Aerobic
3.00 MG -- Total
Volume each clarifier: 1.00 MG

At the end of October, 2002, approximately 2.0 MGD was step fed to the end of pass 2 in the test plant and the influent flow to the first pass was comparably reduced. This was done to try and achieve a higher level of dentrification and was continued until December 3, 2002, when the test was ended.

PERFORMANCE RESULTS

Shown in Table 1 are the plant loading parameters and the effluent results. There was little difference between Plant 3 and Plant 4 effluent except for nitrogen removal during the test. Effluent total phosphorus was equally as good in Plant 4 as Plant 3 and was reliable throughout the test period, even with the step feed. Ammonia removal was not as reliable in Plant 4 as Plant 3, but still met discharge limitation at all times. Nitrate removal was considerably better in Plant 4, as this was one of the goals of the UW research study. The increased nitrate removal was due to simultaneous nitrification/denitrification occurring with the low D.O. concentrations. Nitrification rates were slower in Plant 4 than in Plant 3 where the D.O.'s were higher, but proved to be sufficient to achieve acceptably low ammonia concentrations by the end of the last pass.

TABLE 1

PLANT 3 & 4 LOADING INFORMATION
TEST PERIOD FOR PLANT 4 WAS 9/1/02 TO 12/3/02

Plant 3

	Inf Flow MGD	HRT Hrs	TKN mg/l	BOD mg/l	lbsBOD/ 1000cf
1/1-7/1	11.56	12.46	31.3	117	14.1
9/1-12/3	13.36	10.78	30.4	127	17.6

Plant 4

	Inf Flow MGD	HRT Hrs	TKN mg/l	BOD mg/l	lbsBOD/ 1000cf
1/1-7/1	11.59	12.42	31.3	117	14.1
9/1-12/3*	9.84	7.32	30.4	127	25.9

*One set of tanks removed from service

PLANT 3 & 4 OPERATIONAL DATA

Plant 3

	Sludge Age** Days	MLSS mg/l	MLVSS mg/l	30 Min. SVI	Effluent NH4 mg/l	Effluent NO3 mg/l	Effluent TP mg/l	Effluent TN mg/l	CF of Air/ lb Bod Removed
1/1-7/1	9.5	3145	2363	86	0.04	14.15	0.38	15.31	1183
9/1-12/3	9.8	3325	2437	89	0.08	15.20	0.24	16.33	1144

Plant 4

	Sludge Age** Days	MLSS mg/l	MLVSS mg/l	30 Min. SVI	Effluent NH4 mg/l	Effluent NO3 mg/l	Effluent TP mg/l	Effluent TN mg/l	CF of Air/ lb Bod Removed
1/1-7/1	10.4	2793	2081	82	0.03	14.66	0.42	15.78	1100
9/1-12/3	9.8	4096	3049	121	1.13	10.78	0.21	13.15	673

**Based on total anaerobic, anoxic, aerobic volume

The average hourly D.O. concentrations in Plant 4 during the test period are shown in Figure 2 as a statistical plot. Approximately 50% of the time the D.O. in Plant 4 at the first probe was less than 0.3 mg/l, and less than 0.5 mg/l about 90% of the time. The D.O. at the end of the last pass was less than 1.0 mg/l approximately 70% of the time. This is contrasted to Figure 3 showing typical operation in April and May in Plant 4 prior to the test when the D.O. was less than 1.0 mg/l at the first probe only 10% of the time and D.O.'s at the last pass probe exceeded 7.0 mg/l about 90% of the time.

During the test period, the SVI in Plant 4 averaged 121 using a 2L unstirred settleometer, so the low D.O.'s did not significantly degrade settleability. This was slightly higher than the typical SVI of less than 100, but there were no serious problems with filamentous growth. The Nine Springs plant consistently had filament problems prior to the1997 incorporation of anaerobic zones for phosphorus removal, but has had none since. There have been occasional nuisance scum problems from nocardia and microthrix, but these have not been significant.

The normalized air usage in Plant 4 was approximately 40% less than in Plant 3. This is based on the cubic feet of air used per pound of oxygen demand removed. Successful operation at low D.O.'s resulted in considerable energy savings.

The District's off gas analyzer was used to profile oxygen transfer efficiencies in Plants 3 and 4 before and during the testing. The points at which the measurements were taken are shown in Figure 1 as points 1-1 through 3-6, and the results are shown in Figures 4 through 7. The profiles for alpha (the ratio of dirty water transfer efficiency to clean water transfer efficiency) shown in Figure 5 are typical for the plug flow tanks and Sanitaire fine bubble ceramic discs. The transfer efficiencies are initially low when the primary effluent is introduced. Surfactants in the wastewater initially interfere with the transfer of oxygen to the liquid. As these surfactants are removed the transfer efficiency increases along tank length. The profiles for alpha were similar for both low and high D.O. operation. The profile which was different was the November step feed profile where the introduction of primary effluent at the end of the second pass depressed alpha, similarly to what happens at the head end of the aerated zone.

Shown in Figure 7 are the "bottom line" field transfer efficiencies with D.O. concentration included in the calculation. The weighted transfer efficiency by air flow for the 8/28 Plant 4 profile was 16.64%, while the value for the 7/15 Plant 4 profile was 10.87%. This is nearly a 50% difference in the mass of oxygen transferred from the same quantity of air, due to operation at lower D.O. concentrations.

The District cannot currently load all basins to the level of this test, but the D.O. aeration strategy has been modified as a result of the full scale testing. The 1st pass air flow is never increased greater than minimum. The 2nd pass air flow only controls to greater than minimum if the D.O. at the first probe drops below 0.5 mg/l. The last pass D.O. setpoint is set at 3.0 mg/l to help achieve the effluent D.O. limit, but still exceeds this much of the time because of minimum air flows. The result of the strategy modification is that oxygen supply is first increased in the last pass as loadings increase rather than the first and second passes. This satisfies the increased oxygen demand at a higher transfer efficiency. Prior to biological phosphorus removal the air was always initially increased in the first and second passes to satisfy an increase in oxygen demand. This was done to help prevent filamentous bulking problems. It was estimated the District saved approximately $50,000 in aeration costs in 2003 compared to what aeration costs would have been with previous control settings. Currently, it would be difficult to save additional costs because the lowest blower output matches fairly closely the minimum air flow for diffuser requirements.

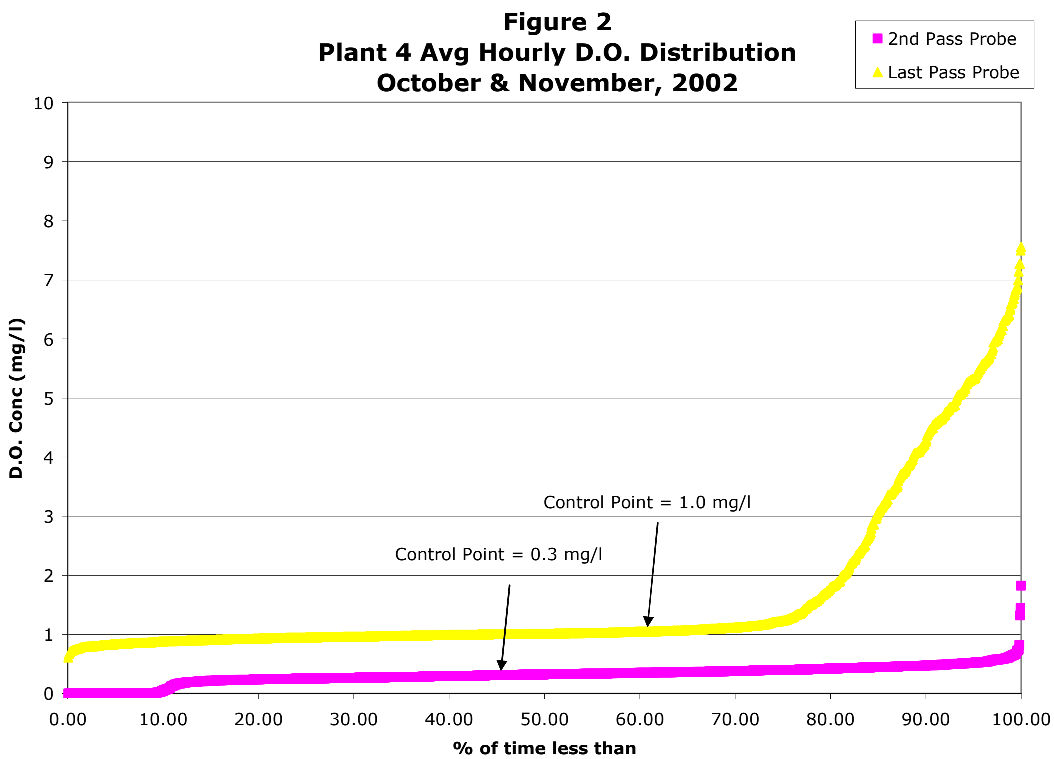


Figure 2
Plant 4 Avg Hourly D.O. Distribution
October & November, 2002
2nd Pass Probe
Last Pass Probe
D.O. Conc (mg/l)
10
9
8
7
6
5
4
3
2
1
0
Control Point = 1.0 mg/l
Control Point = 0.3 mg/l
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
% of time less than

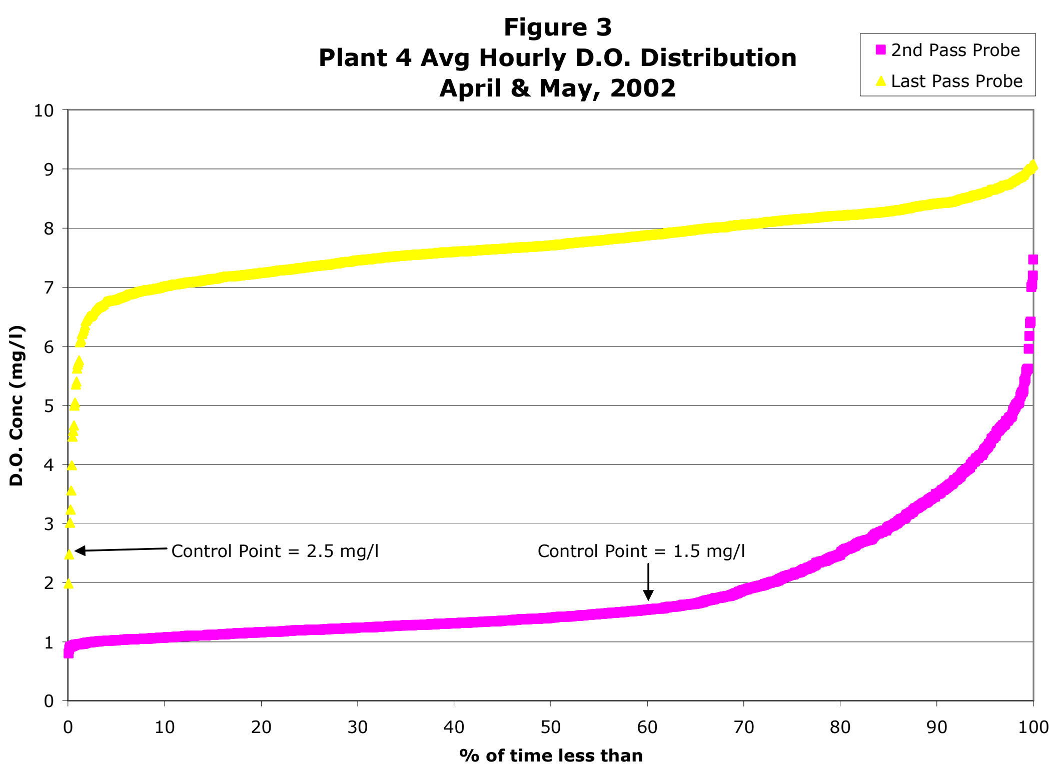


Figure 3
Plant 4 Avg Hourly D.O. Distribution
April & May, 2002
2nd Pass Probe
Last Pass Probe
D.O. Conc (mg/l)
10
9
8
7
6
5
4
3
2
1
0
Control Point = 2.5 mg/l
Control Point = 1.5 mg/l
0
10
20
30
40
50
60
70
80
90
100
% of time less than

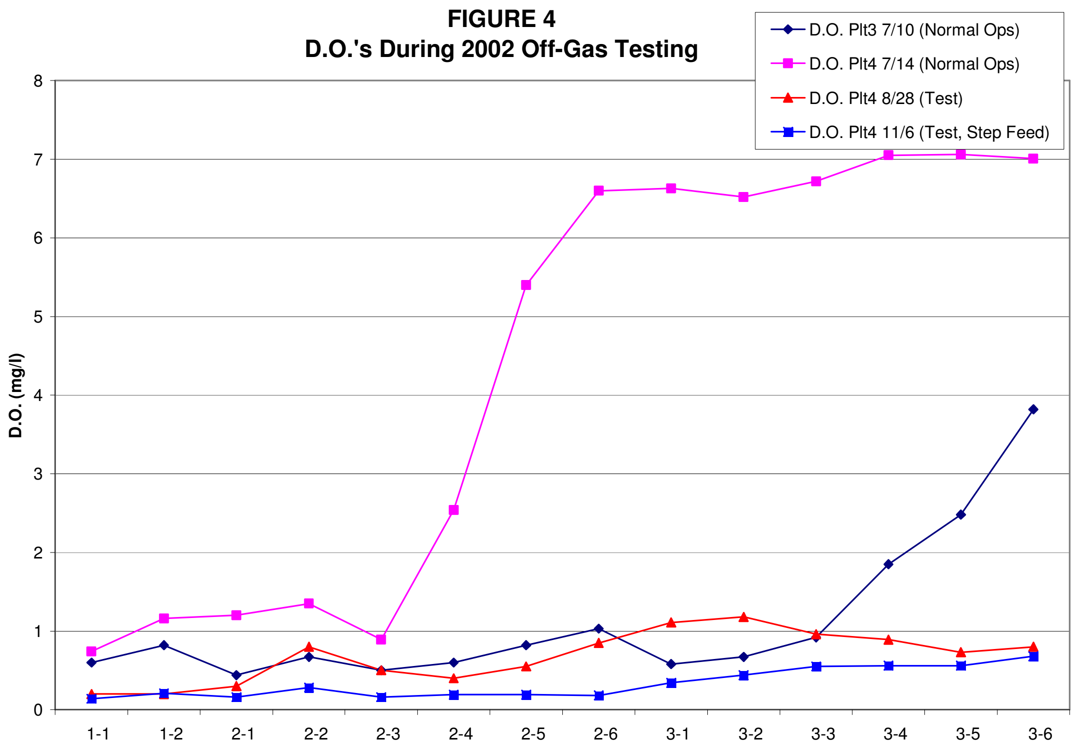


FIGURE 4
D.O.'s During 2002 Off-Gas Testing
D.O. Plt3 7/10 (Normal Ops)
D.O. Plt4 7/14 (Normal Ops)
D.O. Plt4 8/28 (Test)
D.O. Plt4 11/6 (Test, Step Feed)
D.O. (mg/l)
0
1
2
3
4
5
6
7
8
1-1
1-2
2-1
2-2
2-3
2-4
2-5
2-6
3-1
3-2
3-3
3-4
3-5
3-6

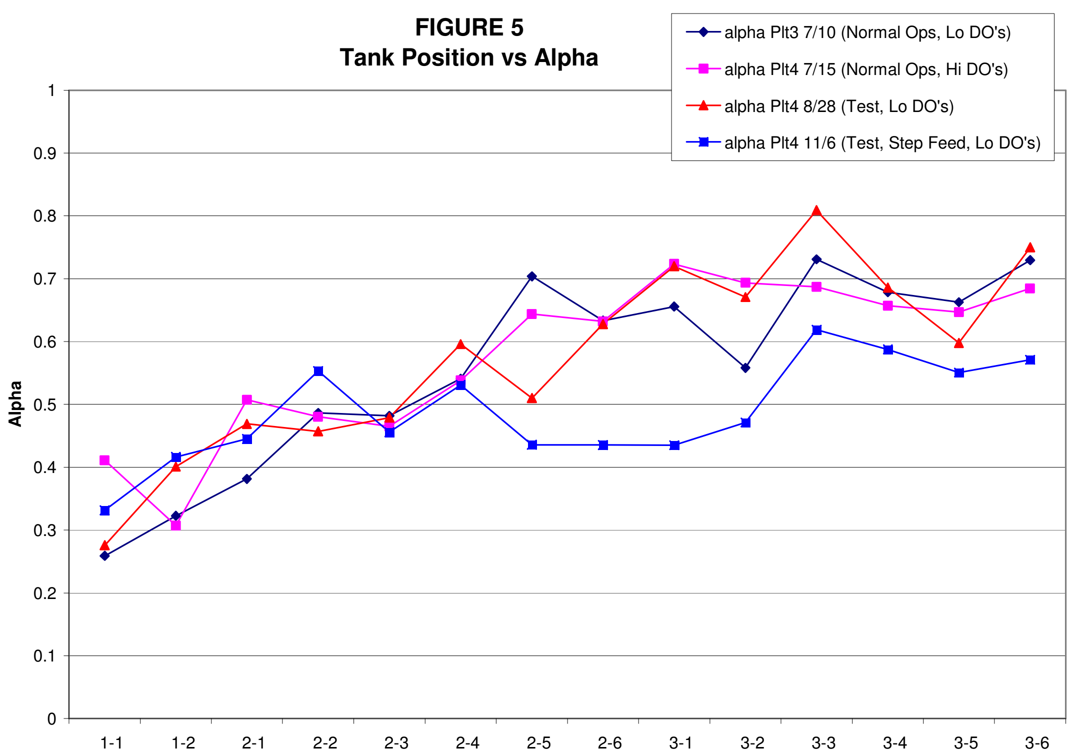


FIGURE 5
Tank Position vs Alpha
alpha Plt3 7/10 (Normal Ops, Lo DO's)
alpha Plt4 7/15 (Normal Ops, Hi DO's)
alpha Plt4 8/28 (Test, Lo DO's)
alpha Plt4 11/6 (Test, Step Feed, Lo DO's)
Alpha
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
1-1
1-2
2-1
2-2
2-3
2-4
2-5
2-6
3-1
3-2
3-3
3-4
3-5
3-6

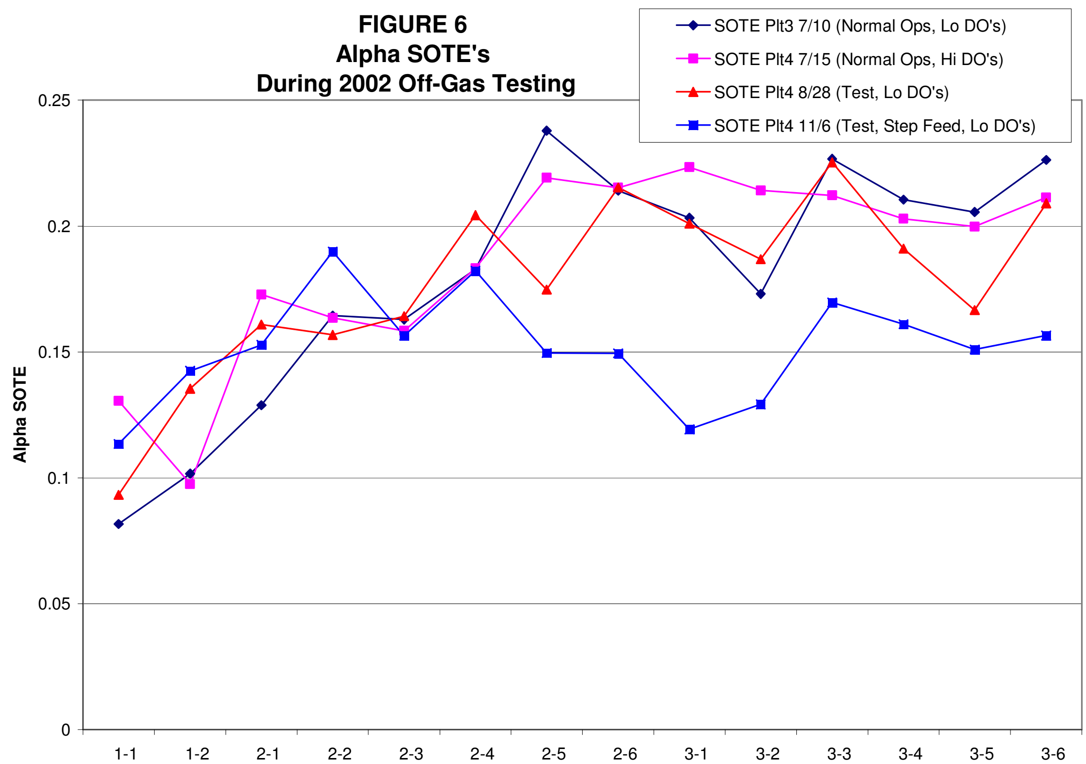


FIGURE 6
Alpha SOTE's
During 2002 Off-Gas Testing
SOTE Plt3 7/10 (Normal Ops, Lo DO's)
SOTE Plt4 7/15 (Normal Ops, Hi DO's)
SOTE Plt4 8/28 (Test, Lo DO's)
SOTE Plt4 11/6 (Test, Step Feed, Lo DO's)
Alpha SOTE
0.25
0.2
0.15
0.1
0.05
0
1-1
1-2
2-1
2-2
2-3
2-4
2-5
2-6
3-1
3-2
3-3
3-4
3-5
3-6

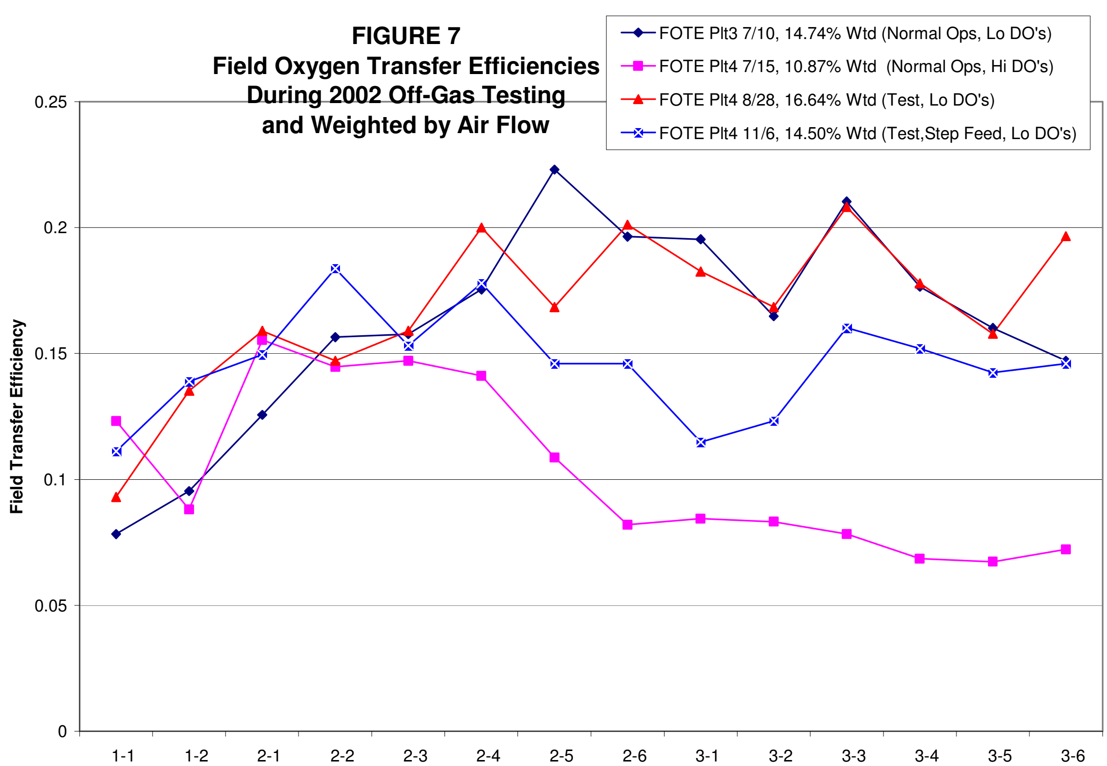


FIGURE 7
Field Oxygen Transfer Efficiencies
During 2002 Off-Gas Testing
and Weighted by Air Flow
FOTE Plt3 7/10, 14.74% Wtd (Normal Ops, Lo DO's)
FOTE Plt4 7/15, 10.87% Wtd (Normal Ops, Hi DO's)
FOTE Plt4 8/28, 16.64% Wtd (Test, Lo DO's)
FOTE Plt4 11/6, 14.50% Wtd (Test,Step Feed, Lo DO's)
Field Transfer Efficiency
0.25
0.2
0.15
0.1
0.05
0
1-1
1-2
2-1
2-2
2-3
2-4
2-5
2-6
3-1
3-2
3-3
3-4
3-5
3-6

COMPARISON TO 1996 FACILITY PLAN RATING

Modelling was performed in the 1996 Facility Plan to estimate plant capacity with the biological phosphorus removal modifications. The rating considered the worst case conditions of clarifier limitations in cold weather conditions (10 deg C), and aeration/nitrification limitations in warm weather (22 deg C). Capacities were determined for a maximum month averge daily flow correlated with an annual average daily flow. For example, a maximum month average daily flow of 56 MGD correlated to an annual average daily flow of 50 MGD, and a maximum monthly daily flow of 63 MGD correlated to an annual average daily flow of 57 MGD. It was determined the plant could be conservatively rated at 50 MGD, but with less of a safety factor could be rated at 57 MGD. Clarifier capacity in cold weather was the limiting condition.

The volumetric loading to Plant 4 during the testing period applied to the whole Nine Springs plant would approximate a flow of 75 MGD to the aeration tanks. This is far greater than the modelled maximum month average daily flow of 56 MGD for a 50 MGD rating. This is encouraging that the plant may be rated greater than 50 MGD, but should not be interpreted that the plant could be rated at 75 MGD. The testing, although carried out with only 1/8 of the plant aeration capacity, used1/4 of the plant clarifier capacity so clarifier limitations were not well tested.

Aeration results were encouraging because high transfer efficiencies were maintained with the higher volumetric loadings, and operation at low D.O.'s maximized field transfer efficiency while nitrification and phosphorus uptake were maintained. Bleed through of ammonia did, though, occur during peak diurnal flow times of the day. Operation at low D.O.'s and higher volumetric loadings may require more sophisticated controls continuously monitoring effluent ammonia. This would provide feedback to the control system so the air flow and D.O. concentration could be increased to increase nitrification rates during higher loading periods.

The plant process control system uses a simplified "process calculator" to provide quick estimates of plant capacity for taking tanks out of service, estimating the effects of process changes, or estimating the effects of high flows. An example of the display for this system is shown in the appendix. The process control system was used to provide a quick estimate of future plant capacity with refined assumptions since the 1997 modifications to the treatment plant. For clarifier estimates the plant control system uses work done by Daigger and Roper, (1985), "The Relationship Between SVI and Activated Sludge Settling Characteristics", JWPCF, **57**, page 859, relating the unstirred settleometer test to maximum clarifier loading using solids flux. Mixed liquor concentrations were estimated based on primary effluent BOD and corrected for temperature. An overall yield and decay coefficient are used based on historical correlation with actual plant data:

$$\text{Est Avg MLVSS} = (Y * Q_{inf} * \text{BOD})/(\text{Total Volume} * (1/\text{Sludge Age} + K_d))$$

Based on data from the last five years, a revised assumption for clarifier evaluation was that the worst case wastewater temperature for the maximum month would be 12 deg C. A sludge age of 10 days was used for ensuring nitrification could be achieved. Also, worst case for the clarifier will occur during a peak hourly flow. Since all of the influent flow is pumped to the plant, the current highest possible flow to the plant is 130 MGD. It did not seem prudent to rate the plant based on this flow since it has only occurred two hours in the last 5 years. Greater than 99.9% of the time in the last 5 years the flow was less than 90 MGD. This is an approximate peak hour to average day ratio of 2.2:1. The ratio of 2.2:1 was used to estimate peak hourly clarifier capacity at increasing future flow rates.

Based on operations during the Plant 4 testing period, transfer efficiencies for estimating aeration capacity were set at alpha SOTE's of 11% in the first pass, 18% in the second pass, and 19% in the final pass. D.O. levels of 0.3mg/l in the first pass, 0.5 in the second pass, and 1.5 in the third pass were used for calculating field transfer efficiencies. A wastewater temperature of 22^0C was used for the warm weather estimates. Aeration capacity should be capable of meeting the normal peak hour requirement in the maximum month. The ratio of the typical daily peak hour to the average daily flow was 1.37:1, based on plant data. Estimated oxygen requirements are calculated in the process control system with an empirical equation using primary effluent BOD, TKN and effluent Nitrate-N concentrations:

$$O_2 \text{ Rqrd} = Q_{inf} * (0.75 * BOD_{inf} + 1.47\ NH_{4inf} + 2.83\ NO_{3effl} + .002 * MLSS * Volume)$$

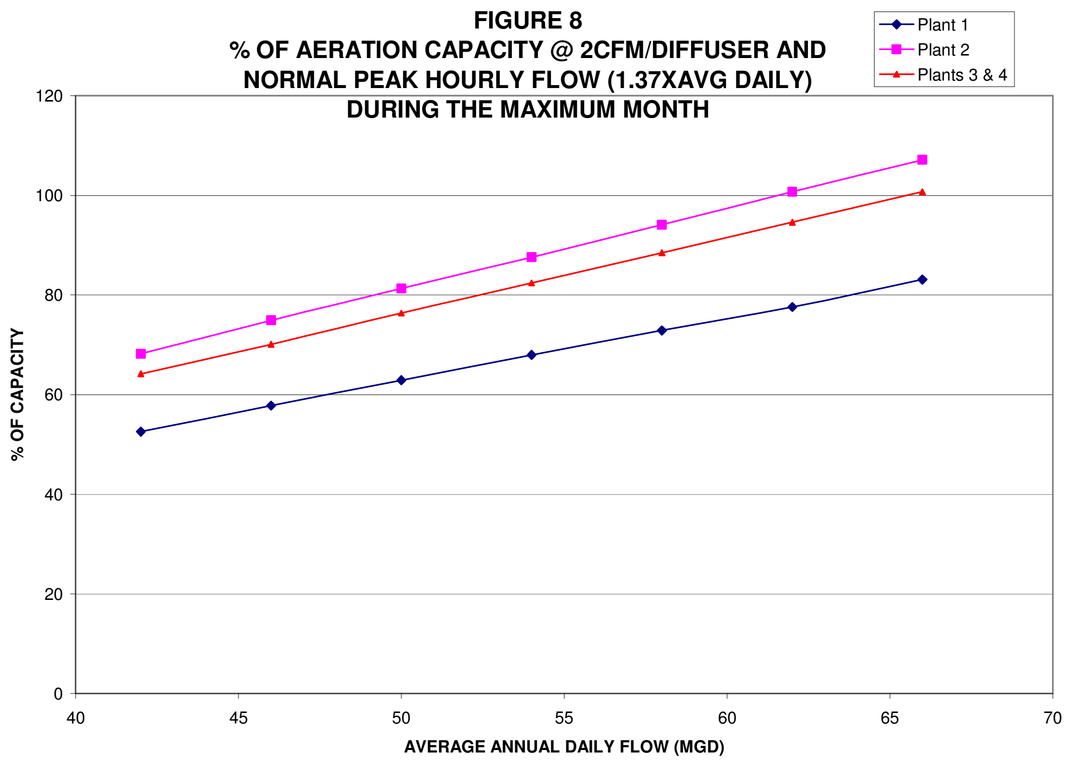
Where O_2 Rqrd is in grams/hr
Q_{inf} is in cubic meters/hour
Concentrations are in mg/l
Volume is in cubic meters

The results from this calculation have been found to correlate fairly well with continuous estimates of pounds of oxygen transferred.

Inputs to the process calculator were made at increasing flow rates. Example outputs from the process control calculator are shown in the appendix. Influent flows were split to the individual plant by aeration tank volume. Clarifier capacity was set at 80% of the output as a safety factor. The results from runs at different flow rates are shown in Figures 8, 9, and 10.

The results seem to confirm that estimates made in the 1996 Facility Plan for plant capacity were quite good. As estimated in the Facility Plan, clarifier capacity, not aeration capacity will probably be the limiting factor. Figures 9 and 10 show clarifier capacity reached at about 58 MGD for an SVI of 100, and approximately 52 MGD for an SVI of 150. Plants 1 & 2 will have the limiting clarifier capacity. Figure 8 shows the aeration capacity being about 62 MGD, with Plant 2 being limiting.

There are other issues which will need to be addressed as the plant approaches maximum capacity. Even though the clarifiers might handle peak hourly flows 99.9% of the time, maximum possible flows will likely wash solids out of the clarifiers and hydraulically the plant may have flow overtopping some of the tanks at flows greater than 130 MGD. These issues will need to be addressed. The testing did show, though, the robustness of the biological nutrient removal system and that phosphorus removal, nitrogen removal, and settling characteristics are not likely to degrade with much higher loadings and operation at lower D.O.'s than previously thought necessary.



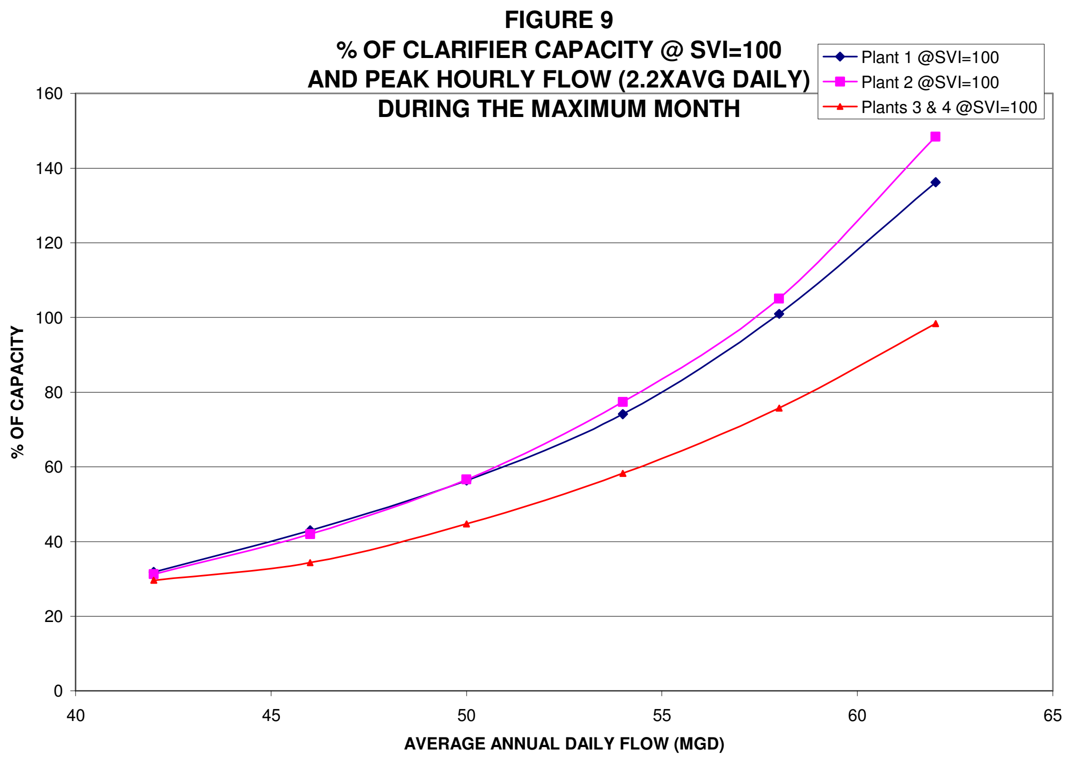


FIGURE 9
% OF CLARIFIER CAPACITY @ SVI=100
AND PEAK HOURLY FLOW (2.2XAVG DAILY)
DURING THE MAXIMUM MONTH
Plant 1 @SVI=100
Plant 2 @SVI=100
Plants 3 & 4 @SVI=100
% OF CAPACITY
AVERAGE ANNUAL DAILY FLOW (MGD)
0
20
40
60
80
100
120
140
160
40
45
50
55
60
65

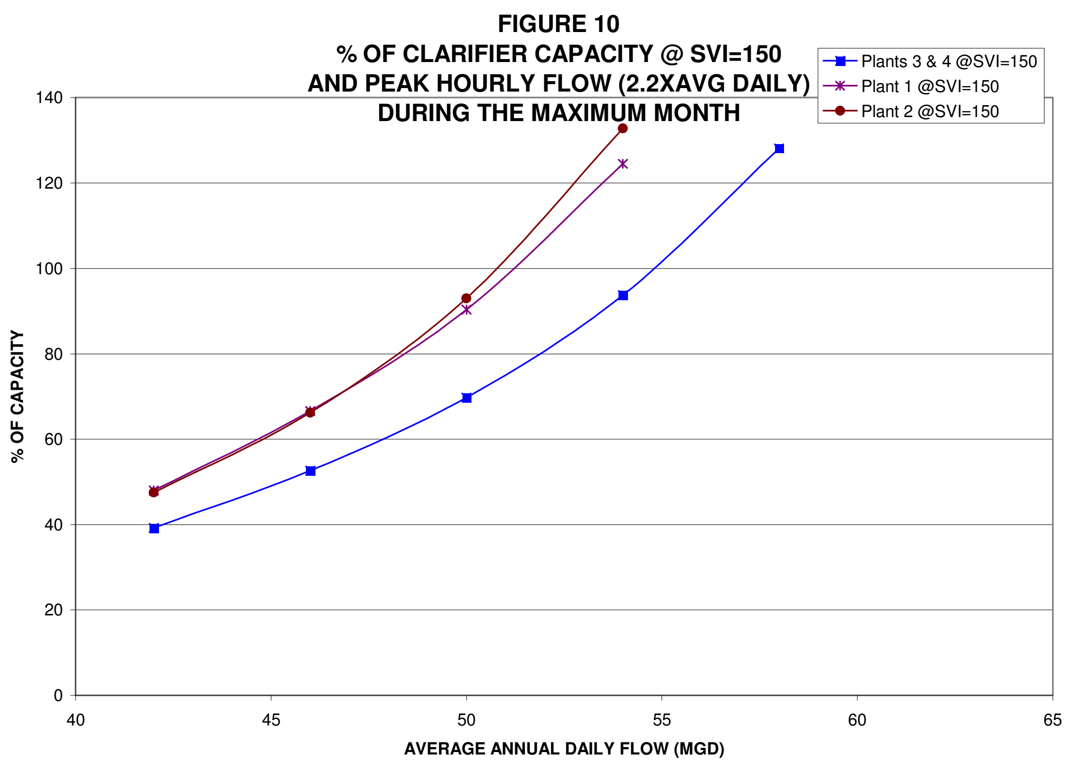


FIGURE 10
% OF CLARIFIER CAPACITY @ SVI=150
AND PEAK HOURLY FLOW (2.2XAVG DAILY)
DURING THE MAXIMUM MONTH
Plants 3 & 4 @SVI=150
Plant 1 @SVI=150
Plant 2 @SVI=150
% OF CAPACITY
AVERAGE ANNUAL DAILY FLOW (MGD)
0
20
40
60
80
100
120
140
40
45
50
55
60
65

DIFFUSER CLEANING AND DISINFECTION CAPACITY

To prevent plugging, the fine bubble ceramic discs have been cleaned at between a two year and five year interval. Plugging has historically occurred mainly in the first pass and has been related to blower power outages and biological fouling in the top few mili-meters of the diffusers. The District monitors the dynamic wet pressures in a single stone in each quadrant and to date there has been no indication that this plugging is occurring any faster than prior to biological phosphorus removal. There were no detectable increases in the pressures in Plant 4 with the high volumetric loadings and low D.O. operation from August to December. It is difficult to determine, though, if the lack of detectable increase will continue for the long term.

An unexpected process result of conversion to biological phosphorus removal has occurred in the ultraviolet disinfection system. The District has had ultraviolet disinfection of effluent since the early 1980's. The system was modified in 1997 from an enclosed vessel system to an open channel system. Both systems were low pressure, low intensity systems with the same size quartz tubes and lamp spacing. Citric acid cleaning was required for the quartz tubes from 1981 through 1996 every three to four weeks. Without the cleanings the effluent fecal coliform counts would quickly go out of compliance.

A phosphoric acid cleaning tank was construction with the new open channel system because it was anticipated the cleaning would continue to be required. Soon after start-up of the biological phosphorus removal system it was discovered the quartz tubes did not seem to require cleaning. It was decided to delay cleaning until fecal coliform numbers started increasing. For the past five years the quartz tubes have only been cleaned in the winter when disinfection is not required. The quartz tube scaling is not occurring to any significant degree when the system is in operation. The mechanism for this is not known. It may be related to other ions, such as calcium and potassium, besides phosphorus being taken up to a higher degree in the process. Unfortunately the change from enclosed vessel to open channel was made at the same time as the change to biological phosphorus removal, so the difference could also be due to some other physical parameters. The flow paced ultraviolet disinfection system has an average power use of between 50 and 60 KW/MGD, including ballast losses and control cabinet ventilation. No chemical or physical cleaning has been required during the disinfection season.

SUMMARY

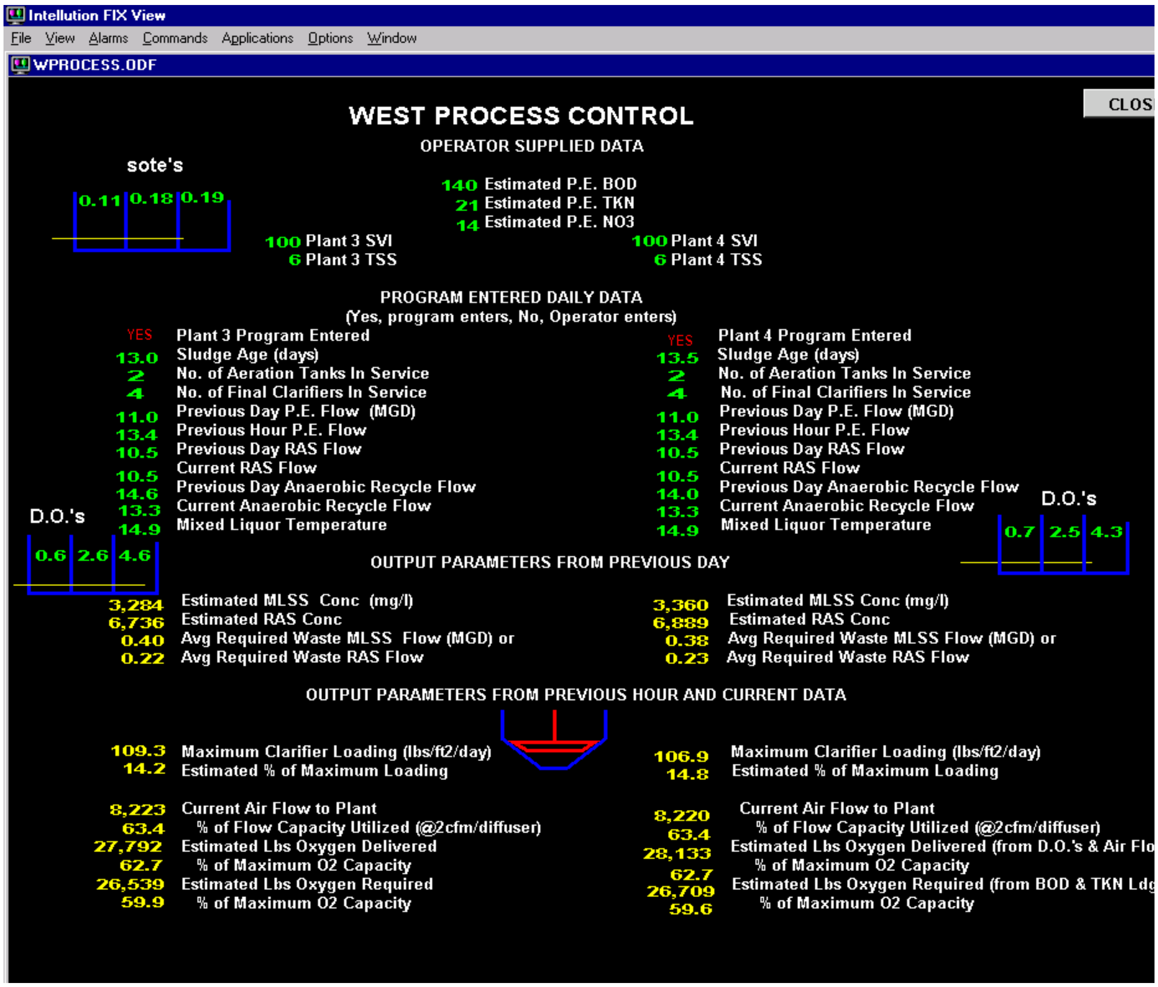
The testing at the Nine Springs plant showed the robustness of the biological nutrient removal system. Phosphorus removal, nitrogen removal, and settling characteristics did not significantly degrade with much higher loadings. Optimistic estimates of future plant capacity made in the 1996 Facility Plan were estimated to be quite good.

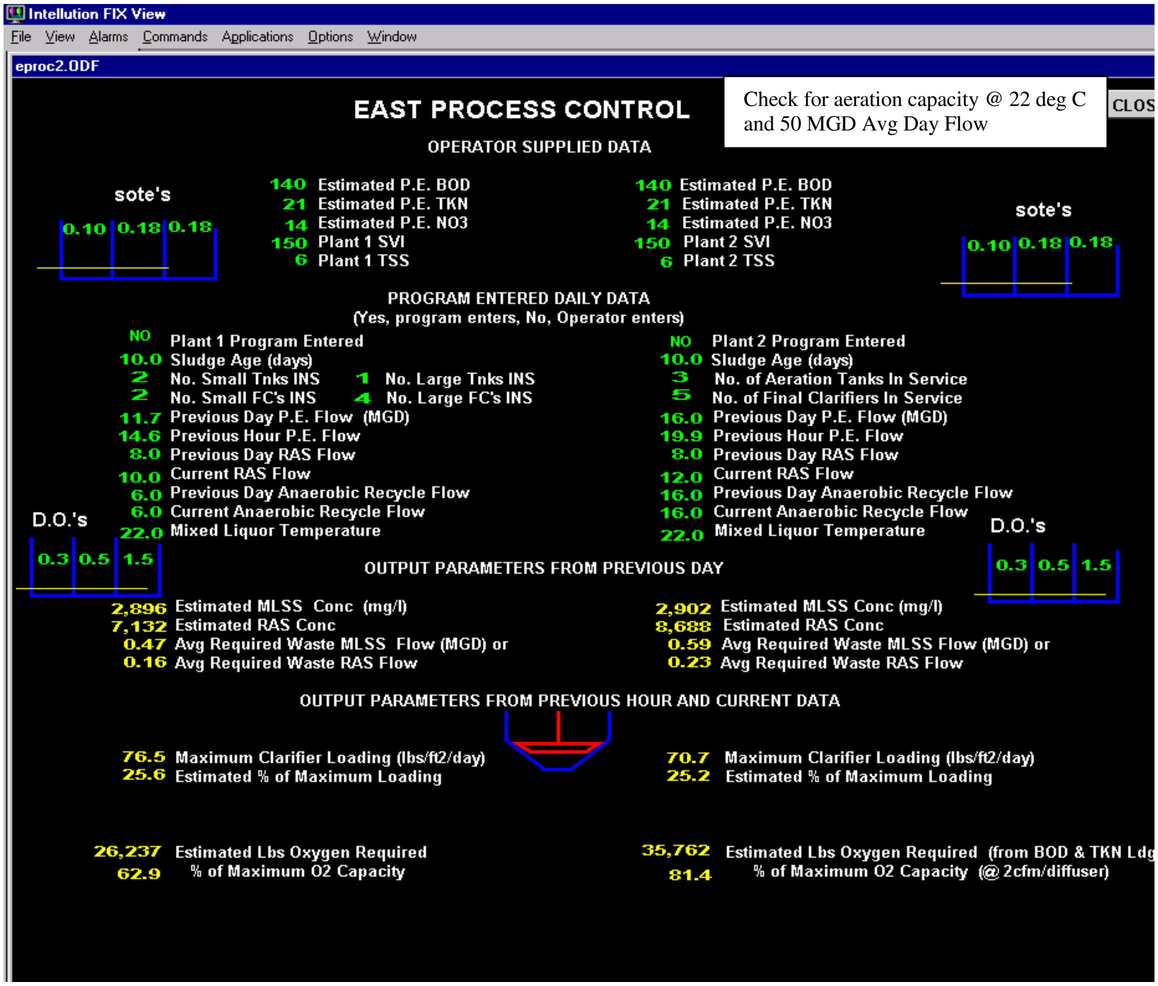
There are other issues which will need to be addressed as the plant approaches maximum capacity. Even though the clarifiers might handle peak hourly flows 99.9% of the time, maximum possible flows will likely wash solids out of the clarifiers and hydraulically the plant may have flow overtopping some of the tanks. These issues will need to be addressed. Long term impact on diffuser plugging and fouling are also a question that will probably only be answered with time, but to date there has been no evidence of increased fouling problems. Another positive aspect of the conversion has been that routine acid cleaning of quartz tubes for ultraviolet disinfection has not been required, and the excellent effluent quality has resulted in low power requirements for UV disinfection.

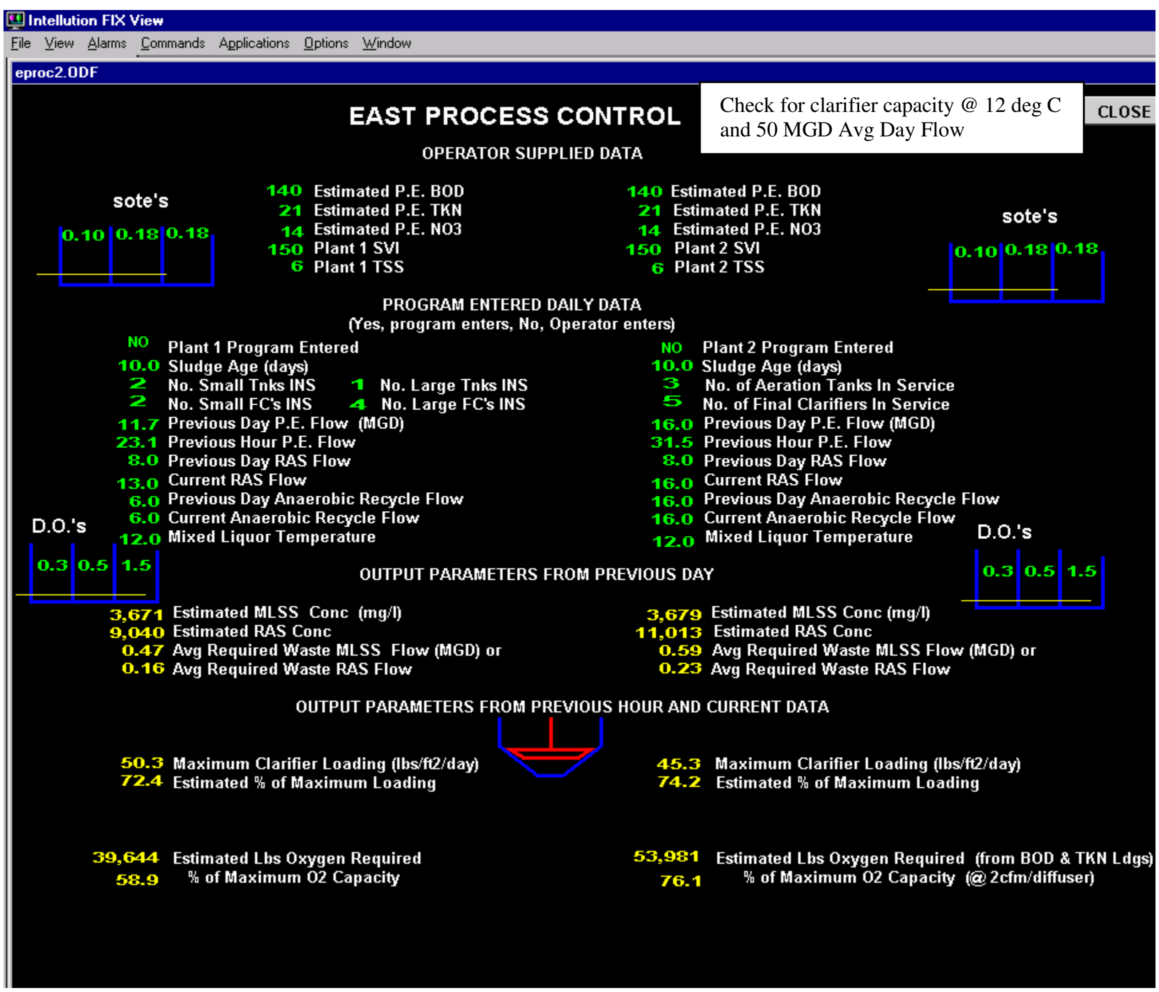
APPENDIX

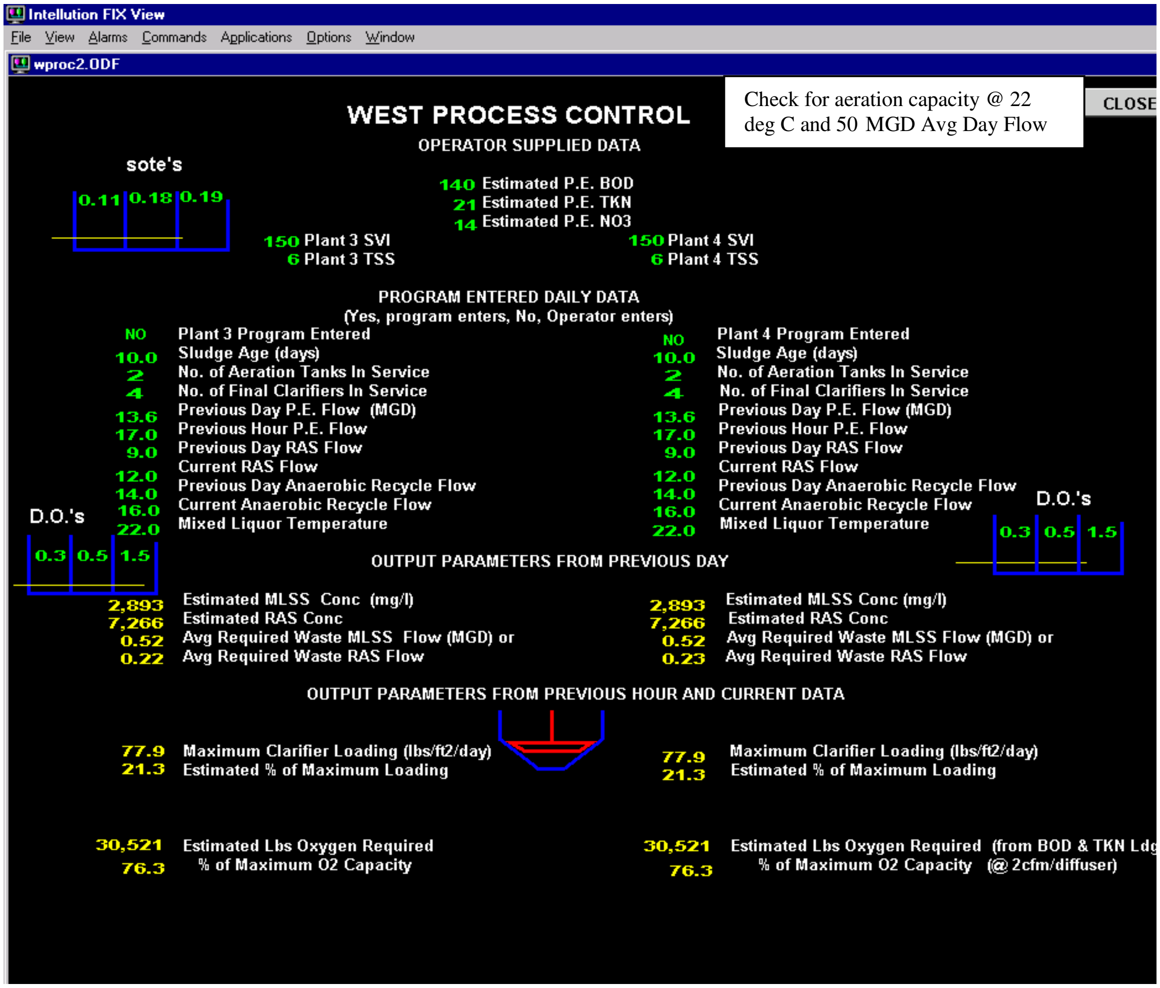
OUTPUTS FROM PLANT CONTROL SYSTEM "PROCESS CALCULATOR"

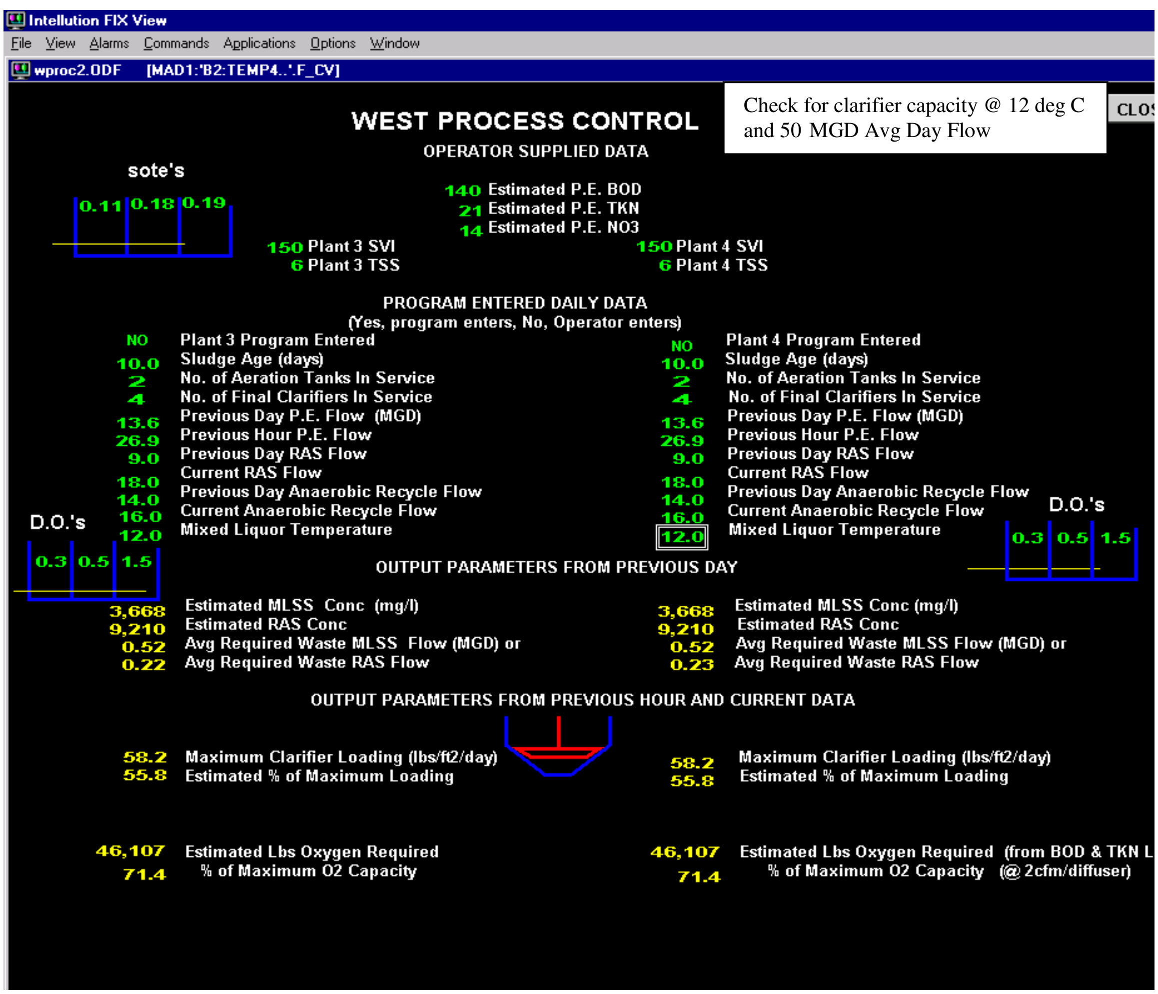
TYPICAL OUTPUT FROM CURRENT DAILY OPERATION IS SHOWN BELOW, FOLLOWED BY EXAMPLE OUTPUTS FOR FUTURE 50 MGD FLOW




Intellution FIX View
File View Alarms Commands Applications Options Window
eproc2.ODF
EAST PROCESS CONTROL
Check for aeration capacity @ 22 deg C and 50 MGD Avg Day Flow
CLOS
OPERATOR SUPPLIED DATA
sote's
0.10 0.18 0.18
140 Estimated P.E. BOD
21 Estimated P.E. TKN
14 Estimated P.E. NO3
150 Plant 1 SVI
6 Plant 1 TSS
140 Estimated P.E. BOD
21 Estimated P.E. TKN
14 Estimated P.E. NO3
150 Plant 2 SVI
6 Plant 2 TSS
sote's
0.10 0.18 0.18
PROGRAM ENTERED DAILY DATA
(Yes, program enters, No, Operator enters)
NO Plant 1 Program Entered
10.0 Sludge Age (days)
2 No. Small Tnks INS
1 No. Large Tnks INS
2 No. Small FC's INS
4 No. Large FC's INS
11.7 Previous Day P.E. Flow (MGD)
14.6 Previous Hour P.E. Flow
8.0 Previous Day RAS Flow
10.0 Current RAS Flow
6.0 Previous Day Anaerobic Recycle Flow
6.0 Current Anaerobic Recycle Flow
22.0 Mixed Liquor Temperature
NO Plant 2 Program Entered
10.0 Sludge Age (days)
3 No. of Aeration Tanks In Service
5 No. of Final Clarifiers In Service
16.0 Previous Day P.E. Flow (MGD)
19.9 Previous Hour P.E. Flow
8.0 Previous Day RAS Flow
12.0 Current RAS Flow
16.0 Previous Day Anaerobic Recycle Flow
16.0 Current Anaerobic Recycle Flow
22.0 Mixed Liquor Temperature
D.O.'s
0.3 0.5 1.5
D.O.'s
0.3 0.5 1.5
OUTPUT PARAMETERS FROM PREVIOUS DAY
2,896 Estimated MLSS Conc (mg/l)
7,132 Estimated RAS Conc
0.47 Avg Required Waste MLSS Flow (MGD) or
0.16 Avg Required Waste RAS Flow
2,902 Estimated MLSS Conc (mg/l)
8,688 Estimated RAS Conc
0.59 Avg Required Waste MLSS Flow (MGD) or
0.23 Avg Required Waste RAS Flow
OUTPUT PARAMETERS FROM PREVIOUS HOUR AND CURRENT DATA
76.5 Maximum Clarifier Loading (lbs/ft2/day)
25.6 Estimated % of Maximum Loading
70.7 Maximum Clarifier Loading (lbs/ft2/day)
25.2 Estimated % of Maximum Loading
26,237 Estimated Lbs Oxygen Required
62.9 % of Maximum O2 Capacity
35,762 Estimated Lbs Oxygen Required (from BOD & TKN Ldg
81.4 % of Maximum O2 Capacity (@ 2cfm/diffuser)


Intellution FIX View
File View Alarms Commands Applications Options Window
eproc2.ODF
EAST PROCESS CONTROL
Check for clarifier capacity @ 12 deg C and 50 MGD Avg Day Flow
CLOSE
OPERATOR SUPPLIED DATA
sote's
0.10 0.18 0.18
140 Estimated P.E. BOD
21 Estimated P.E. TKN
14 Estimated P.E. NO3
150 Plant 1 SVI
6 Plant 1 TSS
140 Estimated P.E. BOD
21 Estimated P.E. TKN
14 Estimated P.E. NO3
150 Plant 2 SVI
6 Plant 2 TSS
sote's
0.10 0.18 0.18
PROGRAM ENTERED DAILY DATA
(Yes, program enters, No, Operator enters)
NO Plant 1 Program Entered
10.0 Sludge Age (days)
2 No. Small Tnks INS
1 No. Large Tnks INS
2 No. Small FC's INS
4 No. Large FC's INS
11.7 Previous Day P.E. Flow (MGD)
23.1 Previous Hour P.E. Flow
8.0 Previous Day RAS Flow
13.0 Current RAS Flow
6.0 Previous Day Anaerobic Recycle Flow
6.0 Current Anaerobic Recycle Flow
12.0 Mixed Liquor Temperature
NO Plant 2 Program Entered
10.0 Sludge Age (days)
3 No. of Aeration Tanks In Service
5 No. of Final Clarifiers In Service
16.0 Previous Day P.E. Flow (MGD)
31.5 Previous Hour P.E. Flow
8.0 Previous Day RAS Flow
16.0 Current RAS Flow
16.0 Previous Day Anaerobic Recycle Flow
16.0 Current Anaerobic Recycle Flow
12.0 Mixed Liquor Temperature
D.O.'s
0.3 0.5 1.5
D.O.'s
0.3 0.5 1.5
OUTPUT PARAMETERS FROM PREVIOUS DAY
3,671 Estimated MLSS Conc (mg/l)
9,040 Estimated RAS Conc
0.47 Avg Required Waste MLSS Flow (MGD) or
0.16 Avg Required Waste RAS Flow
3,679 Estimated MLSS Conc (mg/l)
11,013 Estimated RAS Conc
0.59 Avg Required Waste MLSS Flow (MGD) or
0.23 Avg Required Waste RAS Flow
OUTPUT PARAMETERS FROM PREVIOUS HOUR AND CURRENT DATA
50.3 Maximum Clarifier Loading (lbs/ft2/day)
72.4 Estimated % of Maximum Loading
45.3 Maximum Clarifier Loading (lbs/ft2/day)
74.2 Estimated % of Maximum Loading
39,644 Estimated Lbs Oxygen Required
58.9 % of Maximum O2 Capacity
53,981 Estimated Lbs Oxygen Required (from BOD & TKN Ldgs)
76.1 % of Maximum O2 Capacity (@ 2cfm/diffuser)


Intellution FIX View
File View Alarms Commands Applications Options Window
wproc2.ODF
Check for aeration capacity @ 22 deg C and 50 MGD Avg Day Flow
CLOSE
WEST PROCESS CONTROL
OPERATOR SUPPLIED DATA
sote's
0.11 0.18 0.19
140 Estimated P.E. BOD
21 Estimated P.E. TKN
14 Estimated P.E. NO3
150 Plant 3 SVI
6 Plant 3 TSS
150 Plant 4 SVI
6 Plant 4 TSS
PROGRAM ENTERED DAILY DATA
(Yes, program enters, No, Operator enters)
NO Plant 3 Program Entered
10.0 Sludge Age (days)
2 No. of Aeration Tanks In Service
4 No. of Final Clarifiers In Service
13.6 Previous Day P.E. Flow (MGD)
17.0 Previous Hour P.E. Flow
9.0 Previous Day RAS Flow
12.0 Current RAS Flow
14.0 Previous Day Anaerobic Recycle Flow
16.0 Current Anaerobic Recycle Flow
22.0 Mixed Liquor Temperature
NO Plant 4 Program Entered
10.0 Sludge Age (days)
2 No. of Aeration Tanks In Service
4 No. of Final Clarifiers In Service
13.6 Previous Day P.E. Flow (MGD)
17.0 Previous Hour P.E. Flow
9.0 Previous Day RAS Flow
12.0 Current RAS Flow
14.0 Previous Day Anaerobic Recycle Flow
16.0 Current Anaerobic Recycle Flow
22.0 Mixed Liquor Temperature
D.O.'s
0.3 0.5 1.5
D.O.'s
0.3 0.5 1.5
OUTPUT PARAMETERS FROM PREVIOUS DAY
2,893 Estimated MLSS Conc (mg/l)
7,266 Estimated RAS Conc
0.52 Avg Required Waste MLSS Flow (MGD) or
0.22 Avg Required Waste RAS Flow
2,893 Estimated MLSS Conc (mg/l)
7,266 Estimated RAS Conc
0.52 Avg Required Waste MLSS Flow (MGD) or
0.23 Avg Required Waste RAS Flow
OUTPUT PARAMETERS FROM PREVIOUS HOUR AND CURRENT DATA
77.9 Maximum Clarifier Loading (lbs/ft2/day)
21.3 Estimated % of Maximum Loading
77.9 Maximum Clarifier Loading (lbs/ft2/day)
21.3 Estimated % of Maximum Loading
30,521 Estimated Lbs Oxygen Required
76.3 % of Maximum O2 Capacity
30,521 Estimated Lbs Oxygen Required (from BOD & TKN Ldg
76.3 % of Maximum O2 Capacity (@ 2cfm/diffuser)


Intellution FIX View
File View Alarms Commands Applications Options Window
wproc2.ODF [MAD1:'B2:TEMP4..'.F_CV]
Check for clarifier capacity @ 12 deg C and 50 MGD Avg Day Flow
CLOS
WEST PROCESS CONTROL
OPERATOR SUPPLIED DATA
sote's
0.11 0.18 0.19
140 Estimated P.E. BOD
21 Estimated P.E. TKN
14 Estimated P.E. NO3
150 Plant 3 SVI
6 Plant 3 TSS
150 Plant 4 SVI
6 Plant 4 TSS
PROGRAM ENTERED DAILY DATA
(Yes, program enters, No, Operator enters)
NO Plant 3 Program Entered
10.0 Sludge Age (days)
2 No. of Aeration Tanks In Service
4 No. of Final Clarifiers In Service
13.6 Previous Day P.E. Flow (MGD)
26.9 Previous Hour P.E. Flow
9.0 Previous Day RAS Flow
18.0 Current RAS Flow
14.0 Previous Day Anaerobic Recycle Flow
16.0 Current Anaerobic Recycle Flow
12.0 Mixed Liquor Temperature
NO Plant 4 Program Entered
10.0 Sludge Age (days)
2 No. of Aeration Tanks In Service
4 No. of Final Clarifiers In Service
13.6 Previous Day P.E. Flow (MGD)
26.9 Previous Hour P.E. Flow
9.0 Previous Day RAS Flow
18.0 Current RAS Flow
14.0 Previous Day Anaerobic Recycle Flow
16.0 Current Anaerobic Recycle Flow
12.0 Mixed Liquor Temperature
D.O.'s
0.3 0.5 1.5
D.O.'s
0.3 0.5 1.5
OUTPUT PARAMETERS FROM PREVIOUS DAY
3,668 Estimated MLSS Conc (mg/l)
9,210 Estimated RAS Conc
0.52 Avg Required Waste MLSS Flow (MGD) or
0.22 Avg Required Waste RAS Flow
3,668 Estimated MLSS Conc (mg/l)
9,210 Estimated RAS Conc
0.52 Avg Required Waste MLSS Flow (MGD) or
0.23 Avg Required Waste RAS Flow
OUTPUT PARAMETERS FROM PREVIOUS HOUR AND CURRENT DATA
58.2 Maximum Clarifier Loading (lbs/ft2/day)
55.8 Estimated % of Maximum Loading
58.2 Maximum Clarifier Loading (lbs/ft2/day)
55.8 Estimated % of Maximum Loading
46,107 Estimated Lbs Oxygen Required
71.4 % of Maximum O2 Capacity
46,107 Estimated Lbs Oxygen Required (from BOD & TKN L
71.4 % of Maximum O2 Capacity (@ 2cfm/diffuser)