October 17th

2003

Special Meeting

KEY LARGO WASTEWATER TREATMENT DISTRICT
POST OFFICE BOX 491; KEY LARGO, FLORIDA 33037
(305) 451-5105

October 17, 2003
Special Meeting

Key Largo Wastewater Treatment District
Board of Commissioner's Meeting Agenda

1:00 PM Friday, October 17, 2003
Key Largo Public Library, 101485 Overseas Highway
Key Largo, Monroe County, Florida

A. Call to Order

B. Pledge of Allegiance

C. Public Comment

D. Additions, Deletions or Corrections to the Agenda

E. Presentations on Vacuum Collection Systems and Advanced Wastewater Treatment Processes

1. Government Services Group, Inc. recommendation
2. Weiler Engineering Corporation recommendation
3. The Haskell Company's recommendation

F. Action Items

1. Approval of a Vacuum Collection System
2. Approval of a Wastewater Treatment Process
3. Approval of the Haskell Company Change Order

G. General Manager's Report

1. Other Items

H. Legal Counsel's Report

I. Engineer's Report

1. Other Items

J. Commissioner's Items

1. Other Items

K. Meeting Adjournment

MEMORANDUM

TO: Key Largo Wastewater Treatment District Board of Commissioners

FROM: Robert E. Sheets, District Manager

CC: Charles L. Sweat, David Miles

SUBJECT: Vacuum Collection System Recommendation for the Key Largo Trailer Village and Key Largo Park

DATE: October 9, 2003

After extensive evaluation and research into the selection of a vacuum system for the Key Largo Wastewater Treatment District (KLWTD), it is Management's recommendation that Airvac be selected as the vendor of choice for the Key Largo Park and the Key Largo Trailer Village projects. The KLWTD Engineer, The Weiler Engineering Corporation (WEC) also supports this conclusion.

Initially, Vendor interviews were conducted with Airvac and Roediger representatives at Brown and Caldwell's office in Miami September 15th, 2003. Following these interviews KLWTD Management reviewed all printed material supplied by the vendors, as well as the recommendations of WEC and the Design-Build Team, the Haskell Company. Staff then visited the installations of Airvac in Longwood, Florida and Roediger in St. Johns County and in each case found viable collection systems with minimal cause for concern. *Please see Table 1 for detail.* In addition, numerous telephone interviews with users of each system were conducted. In every case, for each type of vacuum system, the interviewees were pleased with the results. *Please see Table 2 and associated text for detail.*

As previously mentioned, WEC recommended the use of the Airvac system, primarily due to the proven track record of successful operation within the United States. The Haskell Company, however, recommended the use of the Roediger system based on the qualities of a watertight valve chamber, easy access to the collection sump and corrosion resistant chambers.

It is District Management's opinion that, all things being equal, either vacuum system is capable of providing the necessary service to ensure reliable wastewater collection at a reasonable cost. The District Manager recognizes the fact that there may be higher capital cost associated with an Airvac system. However, given the relative lack of historical operating data pertaining to the Roediger systems in the United States, as compared to the operating data of Airvac in the U.S. dating back for more than 20 years, Airvac should be regarded as the most reliable alternative for the KLWTD. If you have any questions about this recommendation, please do not hesitate to contact me.

Following, please find detail supporting this important decision.

Equipment Evaluation

The Airvac and Roediger vacuum stations each consist of a vacuum tank and a sewage pump and are essentially the same for both systems. The differences may be summarized as follows:

- Airvac utilizes a piston-type valve, which opens when the sewage within the pit reaches a specific level. The valve has a 3" opening, allowing for large solids to pass through the opening without the concern of clogging. Airvac has a sump water capacity of 50 gallons. If more storage is required, deeper sumps can be provided. Airvac also has a traffic-bearing rating of H-20 loading.

- Roediger uses a diaphragm-type valve. The valve opening is much smaller, approximately 2 ¼ ", thus allowing only smaller solids to pass and a greater opportunity for clogging. The valve chamber is water-tight – no water is in sight of the valve, making it easier for maintenance personnel to access and work on the valves. The standard pit is not traffic-bearing H-20; however, a collar can be purchased that will convert the pit to an H-20 traffic-bearing capacity. The sump is reported to have a capacity of 15 gallons.

(Note regarding interchangeability of vacuum valves) The Airvac valve, due to its size, cannot fit within the Roediger chamber but the Roediger valve can; however, fit into the Airvac chamber.

Ease of Maintenance

The prevailing opinion has been that the Roediger valve chamber is easier to access and maintain because it is watertight and ground water unable enter. Also, the sump is easier to access because it is adjacent to the valve chamber and not under or below the chamber as is the Airvac configuration. However, It is staff's opinion that the water that sometimes collects in the chamber of the Airvac pit is not a major concern because it is easily removed with a push of a button. The fact that the sump is under or below the valve chamber on the Airvac is also not of great concern to staff, as there should not be anything to go wrong with the sump assembly. In conclusion, ease of maintenance is probably equal with either Roediger or Airvac.

Operating and Maintenance (O & M) Costs

O & M costs, as supplied by the vendors and provided in the Brown and Caldwell report, states that the yearly O&M costs for Airvac is $45/yr/EDU and Roediger is $25/yr/EDU.

Staff has no dispute with, nor reason to doubt these numbers. However, through the research, evaluation and interview process Staff has come to the conclusion that the differences in cost are negligible and possibly, over the long-term lower in the favor of Airvac.

Table 1
Site Visit Evaluation Summary

Users	Airvac	Roediger	EDU's	Comments
Longwood	X		100	City Manager has enjoyed the Airvac system. The Airvac manufacturer provides excellent service. He has minor and few callouts.
St. John's County		X	80	Utility Director believes the manufacturer has done a good job of providing service. The installation has provided them with quality service. The callouts are minimal.

Table 2
Telephone Interview Evaluation Summary

Users	Airvac	Roediger	EDU's	Comments
City of Sanford	Installed in 1988		460	City of Sanford Utility Manager stated that he really hardly ever thinks about the system at all because it does such a good job that he never has to do anything.
City of Longwood	Installed in 1996		100	City Manager loves their Airvac system.
City of Englewood	Installed in 1996		12,000	Englewood staff and Utility Director believe that the Airvac is a great system. The Airvac manufacturer provides quality service. They have only a few and very minor callouts.
Sarasota	Build out in 2007		Current 565 Build out 12,000	Chose Airvac because there was no Roediger history or data to compare it to.

JEA		X	0	Plan to use Roediger for their Ponte Vedra. Their evaluation over the last year and a half has determined that they will recommend the use of Roediger.
Malden Missouri		X	300	Utility Manager at Malden states that the Roediger system is equivalent to the Airvac and selection was based on the cost

Below please find additional comments received from telephone interviews.

St Johns County The St. John's County Utilities Department selected Roediger for their upscale EDU residential community. Before the County made their selection, they compared the Englewood and City of Sanford's Airvac system. The County made their selection based on the dry valve chamber, which made maintenance easier. The County states they are completely satisfied with their selection. The system has been toured by staff and found to be in good working condition.

Bill Green, P.E., Green and Associates, Malden Missouri Mr. Green designed a comparable system to that of Key Largo with 322 homes or connections in Malden Missouri. Mr. Green conducted a thorough review of both systems by traveling to Germany to review the Roediger system installations. Mr. Green concluded that the Roediger system, collection system and vacuum pumping station, would perform equally to the Airvac system. The Roediger system has been in operation for approximately 13 months. Mr. Green placed the vacuum system out to bid, specifying either Roediger or Airvac because as he said, they are equal as far as he was concerned. Roediger was the low bidder and was awarded the sale. We also spoke to the maintenance supervisor, Mr. Richard Blagg, who had no complaints about the Roediger system. He stated that once or twice per month, he would have callouts to find there was debris stuck in the valve. The debris was from new construction where the system was built; other new construction underway he had no problems with any of the valves.

Terri Tedderman, P.E., Hazen and Sawyer, Sarasota, Florida Hazen and Sawyer designed the Sarasota Area E project using the Airvac system. The system consisted of: 229 valve chambers serving 565 connections. Hazen and Sawyer conducted a review of the Airvac vs. the Roediger system. They concluded that due to the limited domestic Roediger installations, the Airvac system was preferred. The Sarasota collection system construction started in 2000 and to date is serving 526 EDUs. Plan build-out is 12,000 EDUs and will be serviced by Airvac.

Collin Groff - Technical Services Manager for JEA. JEA performed an evaluation of both systems for their planned Ponte Vedra vacuum system, and has recommended Roediger. Their decision to go with Roediger was based on:

- Water-tight valve chamber
- Less moving parts
- Didn't require the vent at the home to make up air (utilized house vent)

City of Longwood. The District's Director of Operations visited the City Manager for the City of Longwood, Mr. Richard Kornblumh, who stated that the City is very pleased with the Airvac collection system and pump station that they had installed in 1996 serving approximately 100 EDUs. Also, went on a field trip with the collection superintendent to visit the actual installation of the pump station as well as a number of vacuum pits. The pump station was in good condition and was operating properly as well as the vacuum pits. That was my first experience administrating how the water would be removed from the valve chamber portion of the pit. The superintendent had a tool that he stuck down into the pit, turned the valve, and the water disappeared immediately.

MEMORANDUM

TO: Key Largo Wastewater Treatment District Board of Commissioners

FROM: Robert E. Sheets, District Manager

CC: Charles L. Sweat, David Miles

SUBJECT: Secondary Treatment Process Selection

DATE: October 9, 2003

After extensive evaluation and research regarding the selection of the wastewater treatment process for the Key Largo Wastewater Treatment District (KLWTD), it is the District Manager's recommendation that the Fluidyne ISAM Sequencing Batch Reactor (SBR), as recommended by the Haskell Corporation and the Design-Build Team, be used for this project. The KLWTD Engineer, Weiler Engineering Corporation (WEC) also supports this conclusion. Please see WEC's letter and completed report dated October 6, 2003.

District staff has spent many hours interviewing engineers and operators across the state inquiring about the Upflow Sludge Blanket Filtration (USBF) and the capabilities of this process to meet Advanced Wastewater Treatment (AWT) Standards. There was no data available that would support the premise that the USBF process would meet AWT. After reviewing the printed materials and interviewing the USBF representative, staff agrees with the District Engineer and the Design-Build Team that the USBF process, as it is designed, will not meet AWT standards. The District Management, Engineer and the Design-Build Team have found no data whatsoever to support the notion that the USBF process in any way could produce AWT (5-5-3-1) quality effluent.

Similarly, staff has also inquired of engineers and operators throughout the State about the SBR process. The results of all inquiries were in agreement that SBR technology has the capacity to meet AWT standards. Furthermore, having managed facilities utilizing the SBR process, District Management concurs that the SBR process, if properly operated, is able to meet regulatory compliance.

The District Manager operates an 850,000 gallon per day AWT SBR Domestic Wastewater Treatment Plant manufactured by Jet-Tek. Major process components of this plant include effluent screening and grit removal, two equal size batch reactor tanks, an equalization tank, chemical feed facilities, dual filters and dual chlorination tanks. While the permit does not require this treatment plant to be operated as AWT it has the capability to fully meet AWT Standards. This treatment plant is located in Osceola County, owned by the Florida Governmental Utility Authority.

The District Manager also operates a 3 million gallon per day Sequencing Batch Reactor (SBR) Domestic Wastewater Treatment Plant. This highly treated effluent is also disposed of by way of a golf course and residential irrigation. The SBR process does an excellent job of treating water to crystal clear polished effluent and could easily be converted to full AWT plant meeting 5-5-3-1 standards.

The ability of the USBF to handle peak flows and heavy loads is questionable. The Director of Operations, on September 23, 2003 visited the Marco Shores USBF installation and witnessed, at normal high flows, a carry over of solids into the effluent. The SBR plant operated by the District Manager has experienced flows of twice the capacity of the plant without affecting the process. SBR is much more capable of handling peak flows and heavy loads than is the USBF. The USBF treatment plant at Marco Shores is not permitted for AWT treatment. It is permitted for public access treatment and the manager believes that it will in fact meet public access reuse criteria. However, it is not believed that even for public access criteria that the plant would consistently meet effluent disposal limits at peak flow conditions.

The SBR system is more complex than the USBF. SBR is a high-tech system and it is operated with a computer. Therefore, the operations staff must be experienced and trained in order to operate this facility properly. With well-trained operators, it will operate and produce consistent effluent that meets high quality standards.

Furthermore, the USBF representative stated that the USBF process produces minimal to no sludge; however no hard data to support this statement is available. From the many years of operating experience at the disposal of the District Manager it is firmly believed that sludge will have to be disposed of eventually. Although, as stated in the Design-Build Team's report, the cost of sludge removal from USBF is probably slightly lower than SBR.

The City of Homestead operates a Fluidyne SBR AWT 6 million gallon per day treatment plant. A telephone interview was conducted with the operator of this treatment plant, who stated that the treatment plant consistently meets his AWT permit requirements. He stated that the treatment plant functions extremely well under heavy loads and he quoted an experience with heavy rains and the fact that the treatment plant exceeded its design capacity 6 MGD, but continued to meet its permitted AWT requirements of 5-5-3-1.

If you have any questions regarding the District Manager's recommendation to select the SBR process, please do not hesitate to contact me.

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October 5, 2003

Charles Sweat
Government Services Group
614 N. Wymore Rd.
Winter Park FL 32789

Mr. Sweat:

WEC has reviewed the vacuum system recommendation presented by The Haskell Company and the vacuum system recommendation by Brown and Caldwell. we have also examined information supplied by both vendors and have checked references. The table below reproduces the Evaluation Summary Table from The Haskell Company with an additional column for comments by WEC.

Evaluation Summary Table with WEC Comments

Item	AirVac	Roediger	WEC Comments
Previous Experience	• Numerous US installations • Florida Keys Installations	• Limited US installations • Approved by JEA and FKAA	• WEC agrees with this assessment but notes that AirVac is being used in the FKAA project and it appears AirVac will also be used in the JEA project. • Two small systems were provided as the only operational Roediger systems in the US. The older of these, the Dunklin County, MO system, has been in operation just over a year. The lack of operating data makes it difficult to assess the performance of the Roediger valves. It is reported that the Dunklin County system experience 1 to 2 failures per month due to debris stuck in the valves. The current Key Largo projects will have more than double the flow of the Dunklin County project, so more frequent failures can be expected. It is noted that the failures were valves stuck open, so no loss of service was experienced and no spills resulted from the failures. It should also be noted that emergency call-outs add a considerable expense to the O&M costs of any system.

Item	AirVac	Roediger	WEC Comments
Equipment	• 50 gallon storage in sump • Traffic bearing lid • Flotation collar • Buried steel bolts • Internal sump breather • Fixed lateral elevation	• 15 gallon storage in sump • Requires traffic bearing collar • Access to sump provided • Adjustable sump elevation • Pulse flow controller	• Greater storage is sump is preferable • Traffic bearing collar provides anti-flotation for Roediger pits • The buried bolts are stainless steel Corrosion has not been a problem with pits installed in Englewood where saline groundwater is encountered • AirVac sump elevation is adjustable by pit type selection. Different pit types provide different lateral elevations • No evidence of the effectiveness of the pulse flow controller was presented
Interchangeability of Vacuum Valves	• Valves do not fit in Roediger Chamber	• Valves fit into AirVac Chamber	• WEC agrees with this assessment but points out that this is an advantage of the AirVac chambers. Once Roediger chambers are installed, there is no choice of valves. Considering that valves were not included in the Key Largo Park bid, WEC suggests that if Roediger is selected, a price for valves must be set with CPI increases only allowed.
Ease of Maintenance	• Access to sump through valve chamber	• Watertight valve chamber • Access to sump from ground surface	• WEC agrees with this assessment of watertightness and ease of access to sump • AirVac manhole covers are standard 24-inch cast iron, single cover. Roediger traffic bearing system requires a 28.75-inch cast iron cover with a 25-inch PE lid located inside the manhole ring-and-cover assemble. Access to the Roediger valve chamber is more difficult • Valves are easily removed for service in both systems. The AirVac upper chamber is drained by removal of a plug with a special tool. Water in the upper chamber drains into the lower sump chamber. The Roediger valve chamber remains dry and is therefore cleaner
Manufacturer Supplied O&M Costs	• $38,300 (850 EDU's) • $45/yr/EDU	• $20,340 (850 EDU's) • $25/yr/EDU	• WEC believes that the annual O&M cost difference for routine service and power between the two vendors will be negligible. • Labor costs for call-outs and unscheduled repairs is difficult to predict for Roediger due to the lack of operating data in the US • Both vendors used a labor rate of $15/hr. Considering that operation of this system will most likely be contracted out, a figure of $45/hr can be expected (includes wages, benefits, overhead and margin)
O&M Costs	• Brown & Caldwell Estimates • $26,300 (850 EDU's) • $31/yr/EDU • $2.57/Month/EDU		• See comments above

Item	AirVac	Roediger	WEC Comments
Ease of Installation	• Not addressed	• Not addressed	• The DN Higgins representative states that installation of the Roediger pits is easier than installation of the AirVac pit, due in part to the anti-flotation collar • United Engineering (contractor at Little Venice) switched to AirVac pits due to ease of installation • Contractor for the JEA project indicates he will use AirVac due in part to ease of installation • WEC believes that the possibility for differential settling of the two pits in the Roediger system exists. The Roediger pits that were installed in Little Venice have been removed. An FKAA representative has stated that they had problems with leakage, possibly due to improper installation or differential settling. According to a Roediger representative at the vendor presentations, pits failed the air test because the air pressure pushed the slip-joint pipes apart. This implies that sufficient compaction was not achieved since motion of the pits or external piping occurred.
Corporate Stability and Financial Capabilities	• Not addressed	• Not addressed	• Dunn and Bradstreet Comprehensive Report of Roediger Pittsburg, Inc. is favorable • Roediger Pittsburg Inc. recently purchased from parent company, Passavant-Roediger • Comprehensive Report for AirVac not provided • AirVac has been in business longer than Roediger Pittsburg and has approximately double the annual sales revenue. AirVac revenue is solely from vacuum system sales. Roediger Pittsburg revenue includes sales of other products

Both products have advantages and disadvantages. Although WEC believes that both systems will work, we are concerned by the lack of operating history for Roediger in the United States. WEC has correspondence from several municipalities that have recently selected AirVac over Roediger for that reason. We are not comfortable recommending a system with so little operating data available. We are also very concerned that proper bedding and compaction around the Roediger pits can not be achieved due to the external piping. This appears to be confirmed based on the reports of the Roediger installations in Little Venice failing the air test. We therefore recommend that AirVac be the supplier of the vacuum system for the Key Largo Wastewater Treatment District.

WEC understands that a financial incentive exists for selecting Roediger. If the Board's decision is to select Roediger, WEC recommends the following actions:

- Roediger provides a fixed price for valves with an annual CPI increase allowed
- Roediger provides a 5-year performance bond to include replacement of valve pits in the event that differential settling causes leakage
- Full time inspection of the installation of the valve pits should be required to ensure proper bedding and compaction of valve pit assemblies

In summary, WEC recommends AirVac based on a proven performance record. We believe the Roediger system will function if care is taken to properly bed the pits, but long-term reliability is unproven.

Sincerely,

Ed Castle, PE

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October 6, 2003

Charles Sweat
Government Services Group
614 N. Wymore Rd.
Winter Park FL 32789

RE: Secondary Treatment Process Selection

Mr. Sweat:

I have reviewed the process recommendation presented by The Haskell Company and the review of the secondary treatment processes prepared by Brown and Caldwell. I have also examined the supporting documentation supplied by the Design/Build team and have conducted some research of the literature and Discharge Monitoring Reports. The table below reproduces the Evaluation Summary Table from The Haskell Company with an additional column for comments by WEC.

Evaluation Summary Table with WEC Comments

Item	USBF	ISAM	WEC Comments
Power Costs	• Continuous Electrical Power Consumption • Costs are Constant	• Intermittent Electrical Power Consumption • Lower Costs with Lower Flows	WEC agrees with this assessment.
Chemical Costs	• Utilizes Ferric Chloride for Phosphorus Removal • Sodium Hypochlorite will be used for Disinfection • Cost Difference is Negligible	• Uses Alum for Phosphorus Removal • Sodium Hypochlorite will be used for Disinfection • Cost Difference is Negligible	WEC understood from the vendor presentation that tab feed of Calcium Hypochlorite will be used in the USBF. However, WEC agrees that the cost difference is negligible
Sludge Handling Costs	• Lower Sludge Production based on Manufacturer's Claims • Sludge Handling Costs Slightly Lower	• Conservative Sludge Production • Higher Costs due to Lower Sludge Age	WEC agrees with this assessment. WEC believes that the cost effectiveness of drying beds should be evaluated.
Process Capabilities	• Expected Total Nitrogen of Less Than 8.0 mg/l • Poor Operational Data	• Expected Total Nitrogen of Less Than 3.0 mg/l • Operational Data Demonstrates Capabilities	WEC believes that both systems need process modifications to achieve <3 mg/l TN (See attached Nitrogen Removal report)
Simplicity of Operation	• Simpler Control System due to Continuous Operation	• More Complex Control due to Intermittent Operation	WEC agrees with this assessment

Item	USBF	ISAM	WEC Comments
Ease of Maintenance	• No Difference Anticipated	• No Difference Anticipated	WEC agrees with this assessment.
Reliability (Permit Compliance)	• Majority of Data Failed Proposed Monthly Effluent Standards	• Majority of Data Passed Proposed Monthly Effluent Standards	WEC believes both systems are capable of passing standards with the exception of TN. Both systems require modifications to meet the TN requirement. (See attached Nitrogen Removal report)
Ability to Handle Peak Flows and Loads	• Flow-through process is prone to Peaking Upsets	• Built-in Equalization Characteristics of SBR/ISAM Process	WEC agrees with this assessment
Reliability	• High Degree of Mechanical Reliability	• High Degree of Process Reliability	WEC believes that the USBF has a higher degree of mechanical reliability due to simplicity of design
Adaptability	• More Complex Control due to Intermittent Operation	• More Complex Control due to Intermittent Operation	WEC believes that the SBR/ISAM has a higher degree of adaptability
Capital Costs	• Not Addressed	• Not Addressed	WEC has been told that the capital costs of the three ISAM plants is $300,000 less than that of the USBFs. Although there is not cost savings to the District on this project, the lower capital costs of the ISAM become a factor for future expansion

Both processes have advantages and disadvantages, but the ability to achieve the required discharge limits is the driving force in the decision-making process. It is WEC's position that the data does not support the claims by either vendor that the effluent will consistently have a total nitrogen concentration of less than 3.0 mg/l without modifications to the processes. With the SBR, the processes can be modified by changes in the operating sequence and possibly the addition of a chemical carbon source. The MLE configuration used by the USBF process would be difficult to modify to achieve additional nitrogen removal without significant changes to the physical configuration of the system.

In summary, WEC concurs with the recommendation of the SBR process due to the low level of effluent total nitrogen required for this project. The flexibility of the SBR process will provide assurance that the process can be operated in a manner that will provide effluent TN concentrations of less than 3.0 mg/l.

Sincerely,

Ed Castle, PE

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Nitrogen Removal

Modified Ludzack Ettinger (MLE) Configuration

The Purestream USBF WWTP uses the MLE configuration for biological nitrogen removal. The literature indicates that the MLE configuration will not achieve the required limit of less than 3 mg/l TN without further treatment. The process is capable of complete nitrification but is not capable of sufficient denitrification to reach the required discharge limit for TN. Performance data from the literature for the MLE configuration is presented below.

- 10 mg/l TN *Cost and Performance Evaluation of BNR Processes, Florida Water Resources Journal, December 1998*
- 7 – 10 mg/l TN *User Guide, ECES Group, LLC CFAS Process Models*
- 6 mg/l NO_x-N *Long Island Sound Nitrogen Removal Training Program, Module 3*

Data from the Discharge Monitoring Reports for Purestream USBF WWTPs in the Florida Keys show that these plants, when operating well, typically discharge effluent with TN concentrations consistent with the TN and NO_x-N ranges from the literature. There is very limited data from the Marco Shores plant showing effluent TN concentrations of less than 3 mg/l.

The MLE process may be capable of meeting the TN limit of <3 mg/l with additional treatment processes. The literature suggests two possible modifications of the MLE configuration to achieve further nitrogen removal: 1.) MLE Configuration with Secondary Anoxic Zone – This configuration requires a second anoxic zone with a methanol (or other carbon source) feed, followed by a final aerobic zone; 2.) MLE Configuration with Denitrifying Filter – In this configuration, the effluent from the secondary clarifier is dosed with methanol and then passed through a deep-bed filtration process where denitrification occurs.

With both of these alternative configurations, a carbon source must be added to allow denitrification to occur. The addition of a carbon source increases operating costs and creates the potential for discharges of CBOD in excess of the permitted 5 mg/l. The MLE Configuration with Secondary Anoxic Zone would be the preferred modification since the final aeration process before clarification would remove any excess CBOD remaining after the denitrification process. This configuration, however, could not easily be incorporated into the Purestream USBF package.

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The MLE Configuration with Denitrifying Filter is somewhat more compatible with the Purestream USBF package. The flow pattern of the Purestream USBF plant is such that the effluent is chlorinated before is leaves the unit. Residual chlorine in the effluent may kill off the attached biofilm in the denitrifying filter. It may be necessary to provide dechlorination of the effluent with sodium bisulfite prior to contact with the denitrification filter, but the sodium bisulfite will increase the chemical oxygen demand in the effluent. This demand will also show up in the effluent CBOD test. The probability of exceeding the CBOD discharge limit of 5 mg/l is increased by the oxygen demand created by the necessary addition of a carbon source and a dechlorination agent.

Sequencing Batch Reactor (SBR)

The Fluidyne ISAM WWTP is a modification of the SBR process. The literature indicates that the SBR process will not achieve the required limit of less than 3 mg/l TN without modifications to the process. Performance data from the literature for the SBR process is presented below.

- 8 mg/l TN *Cost and Performance Evaluation of BNR Processes, Florida Water Resources Journal, December 1998*
- <5 – 8 mg/l TN (based on manufacturers data) *US EPA Wastewater Technology Fact Sheet, Sequencing Batch Reactors*
- 4 – 7 mg/l TN *AWTT Project 1013-01-001 Optimisation of Nitrogen Removal in BNR Plants Using an Industrial Process Control System*

The Fluidyne ISAM process proposed for this project is a modification of the SBR process and may achieve more efficient nitrogen removal due to the anaerobic selector tank and the Surge/Anox/Mix tank. There is limited data (from the Barona plant) that indicates that an effluent TN concentration of less than 3 mg/l can be achieved.

The SBR plant can be modified to achieve higher levels of nitrogen removal by providing for an anoxic mix phase after the aerobic mix phase. Anoxic mixing can be provided by installation of an automated valve on the aspirating jet mixers. If complete oxidation of BOD has occurred in the aerobic mix phase, it will be necessary to add a carbon source such as methanol in the anoxic mix phase. The addition of a carbon source increases operating costs and creates the potential for discharges of CBOD in excess of the permitted 5 mg/l. The excess CBOD could easily be removed in an additional aerobic mix phase after the anoxic mix phase. This will not require any additional equipment. The length of time needed for the additional phases may create a need for larger tank size.

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Conclusion

Both the Fluidyne ISAM and the Purestream USBF have insufficient data to support the claims that the processes will produce effluent with a TN concentration of less than 3 mg/l consistently without modifications. Both the SBR process and the MLE process may be modified to achieve the required additional nitrogen removal. Modifications to both systems would increase the capital and operational costs. The complexity of operation is also increased for both systems.

The most practical modification to the Puresteam USBF plant is installation of a denitrification filter, but this alternative presents the danger of exceeding the CBOD discharge limit due to the need to supply a carbon source and the need to dechlorinate the effluent. Since the flexibility of the SBR process allows for oxidation of excess carbon, the SBR appears to be the better of the two systems under consideration in terms of nitrogen removal.

Cost and Performance Evaluation of BNR Processes

Gerald W. Foess, Paul Steinbrecher, Kenneth Williams, and George S. Garrett

The use of biological nutrient removal (BNR) processes is expected to increase in Florida because of growing concerns about the effects of nitrogen and phosphorus on the stimulation of undesirable aquatic growth in surface waters and the potential adverse health effects of nitrates in groundwater.

In the Florida Keys, degradation and eutrophication of canal and nearshore waters led Monroe County to require all new and expanding wastewater treatment facilities to meet Advanced Wastewater Treatment (AWT) or Best Available Technology (BAT). However, the county lacked the information it needed to determine what discharge limitations could reasonably be imposed under these requirements, given the large number (nearly 300) of wastewater treatment plants with small flows and limited operational oversight. Experience had demonstrated that DEP AWT limits of 3 mg/L for nitrogen and 1 mg/L for phosphorus could be achieved by large plants, but there was no assurance or expectation that such stringent limits could be achieved by small plants. Additionally, no specific BAT standards existed.

A study was commissioned by Monroe County, with support and financial assistance from DEP, to determine BAT effluent limitations for treatment plants with permitted design capacities in the range of 2,000 to 100,000 gpd. The summary provided in this article includes a review and ranking of BNR technologies and proprietary equipment on the market with respect to costs, performance, and other factors. Information was derived from equipment suppliers, DEP and EPA databases, technical literature, and visits to operating facilities.

Small-Flow Nutrient Removal Facilities in the U. S.

Table 1 contains a nationwide list of full-scale facilities in the 2,000 to 100,000 gpd range that are designed to meet total nitrogen or phosphorus limits, as derived from DEP and EPA databases and input from 85 equipment suppliers. The most common phosphorus limit is 1.0 mg/L, ranging from 0.1 to 2.0. The most common nitrogen limit is 10 mg/L, ranging from 3 to 14. Florida has imposed the most stringent nitrogen limits on plants in this size range.

TABLE 1. U.S. WWTPS WITH NUTRIENT REMOVAL PROCESSESCAPACITY $\leq$ 0.1 MGD

Location	*P Removal*	*N Removal*
Arkansas	—	1
Arizona	—	1
California	—	1
Colorado	10	3
Connecticut	—	1
Florida	8	16
Indiana	3	—
Maryland	2	1
Massachusetts	—	2
Michigan	4	5
Minnesota	15	—
New Jersey	8	4
New Mexico	—	3
New York	5	12
Pennsylvania	—	11
TOTAL	55	61

Sources: U. S. EPA Permit Compliance System; FDEP WAFR database; Equipment Suppliers

Site Visits

Nutrient removal systems in the size range of 2,000 to 100,000 gpd are almost universally furnished as pre-engineered, factory- or field-assembled package systems. Approximately 25 systems available on the market were evaluated, followed by visits to 17 operating treatment plants in Florida, New York, New Jersey, and Massachusetts. The plants represented diverse technologies and covered a spectrum of sizes within the range of interest. Information was gathered on plant performance, actual operation and maintenance costs, actual capital costs, and the level of operator staffing. The collected information was subsequently used in the evaluation of alternative systems.

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Nutrient Removal Systems Evaluated

The following biological nitrogen removal systems, which were considered representative of the diverse technologies on the market and applicable to small treatment systems, were selected and evaluated.

1. MLE (2-Stage) Continuous-Flow Suspended-Growth Process
2. 4-Stage Continuous-Flow Suspended-Growth Process
3. 3-Stage Continuous-Flow Suspended-Growth Process
4. 4-Stage Sequencing Batch Reactor (SBR) Suspended-Growth Process

TABLE 2. SELECTED NUTRIENT REMOVAL SYSTEMS

System Description	*Representative Suppliers*	*Achievable Effluent Quality BOD/TSS/TN/P[1] (mg/L)*
1. MLE Process – continuous-flow suspended-growth process with an initial anoxic stage followed by an aerobic stage	Smith and Loveless U. S. Filter/Davco Aeration Industries Zenon Environmental The McNeil Company	10/10/10/2 (5/5/10/1 with filtration)
2. Four-Stage Process – continuous-flow suspended-growth process with alternating anoxic/aerobic/anoxic/aerobic stages	Smith and Loveless U. S. Filter/Davco Zenon Environmental The McNeil Company	10/10/6/2 (5/5/6/1 with filtration)
3. Three-Stage Process – continuous-flow suspended-growth process with alternating aerobic/anoxic/aerobic stages	Smith and Loveless U. S. Filter/Davco Zenon Environmental The McNeil Company	10/10/6/2 (5/5/6/1 with filtration)
4. SBR Suspended-Growth Process – batch process sequenced to simulate the four-stage process	Aqua-Aerobics Purestream, Inc U. S. Filter/Jet Tech Babcock International Fluidyne	10/10/8/2 (5/5/8/1 with filtration)
5. Intermittent-Cycle Process – modified SBR process with continuous influent flow but batch, four-stage, treatment process	Schreiber Corporation Austgen-Biojet Cromaglass Corporation AES	10/10/8/2 (5/5/8/1 with filtration)
6. MLE and Deep-Bed Filtration Process – Alternate 1 followed by attached-growth denitrification filter	U. S. Filter/Davco Purestream, Inc. Aeration Industries	10/5/6/1 (process includes filtration)
7. Submerged Biofilter Process – continuous-flow or intermittent-cycle process using one or more submerged media biofilters with sequential anoxic/aerobic stages	Tetra Technologies, Inc. WWSI Smith and Loveless	20/20/12/2 (5/5/12/1 with filtration)
8. RBC Process – continuous-flow process using RBCs with sequential anoxic/aerobic stages	CMS Group WWSI	20/20/12/2 5/5/12/1 (with filtration)
9. Conventional Secondary Treatment – continuous-flow activated sludge process (no enhanced nutrient removal; included for basis of comparison)	Smith and Loveless U. S. Filter/Davco Aeration Industries Zenon Environmental The McNeil Company	10/10/X/X 5/5/X/X (with filtration)

5. 4-Stage Intermittent-Cycle Suspended-Growth Process
6. MLE Process followed by Deep Bed Filtration Process
7. Submerged Biofilter Process
8. Rotating Biological Contactor (RBC) Process

In each case, the recommended method of phosphorus removal was chemical precipitation. In addition, effluent polishing filtration would be provided in each system, except System 6, which already incorporates the deep bed filtration process for nitrogen removal.

Table 2 presents a description of each system, representative equipment suppliers, and estimated achievable effluent quality. Also included for comparison is a conventional secondary treatment plant (System 9).

Two of the systems identified above (Systems 1 and 6) were determined to be potentially applicable for retrofitting nitrogen removal to existing WWTPs, and evaluated separately. These were identified as (1) System 1R—MLE (2-Stage) Continuous-Flow Suspended-Growth Process, and (2) System 2R—Deep Bed Filtration Process.

The MLE process (System 1R) can be retrofitted to an existing plant by adding an anoxic basin upstream of the existing plant, redirecting the influent flow to this basin, and adding recirculation pumping from the existing aeration basin to the new anoxic basin. Alternatively, an anoxic zone could be created within the existing aeration basin by adding a baffle wall, but that would reduce the capacity of the plant. New chemical feed facilities for phosphorus removal could also be added.

In System 2R, a deep-bed filter would be added downstream of the existing package plant, replacing any existing filtration facilities. New pumping facilities to pump secondary effluent to the deep bed filter would be required, as well as methanol feed facilities and chemical feed facilities for phosphorus removal.

Performance Comparison

As indicated in Table 2, all of the systems are generally considered capable of meeting effluent BOD and TSS concentrations similar to large plants. Achievable effluent nitrogen concentrations range from 6 to 12 mg/L, with the 4-stage and 3-stage processes and the deep-bed filtration process (Systems 2, 3, and 6, respectively) being the most effective. Chemical phosphorus removal in all of the alternative systems is expected to achieve effluent limits of 2 mg/L without filtration and 1 mg/L with filtration.

Achievable permit limits for the MLE retrofit system (System 1R) were considered comparable to the corresponding new-plant MLE system (System 1). Achievable permit limits for the deep-bed filtration retrofit system (System 2R) were also estimated to be similar to those for the corresponding new-plant system (System 6), but with a somewhat lesser N removal capability because the retrofit system did not incorporate an MLE process.

As a result of this performance assessment, DEP provided to Monroe County the following BAT limitations (annual average basis) applicable to new and expanding facilities with permitted design capacities of less than 100,000 gpd (source: DEP correspondence to Monroe County Commissioners dated May 12, 1998):

CBOD	10 mg/L
TSS	10 mg/L
N	10 mg/L
P	1 mg/L

Cost Comparison

Tables 3 and 4 compare costs for the nine new-plant and two retrofit alternatives, respectively, for five different treatment capacities. The cost summary includes the estimated construction cost, annual O&M cost, uniform annual cost, and unit cost ($/1,000 gallons). Uniform annual costs were determined using an interest rate of 6 percent for a 20-year period. The unit cost was determined by dividing the uniform annual cost by the number of 1,000 gallons of wastewater treated per year, at 80 percent capacity utilization.

Construction costs for the new-plant alternatives include all required facilities for a new plant on a new site. Filtration was included for all of the systems except the base case secondary treatment system. In general, the conventional suspended-growth nutrient removal technologies have the lowest construction costs for capacities exceeding approximately 10,000 gpd. The attached-growth processes construction costs are competitive at the smallest system sizes of 4,000 and 10,000 gpd. A generally poor correlation exists between the construction cost of alternatives and nitrogen removal performance.

Table 3. Costs of Nutrient Removal Systems – New Plants

System	Treatment Facility Design Capacity 4,000 (gpd)	10,000 (gpd)	25,000 (gpd)	50,000 (gpd)	100,000 (gpd)
1 MLE					
Construction Cost, $	$ 261,000	$ 311,000	$ 422,000	$ 601,000	$ 874,000
Annual O&M Cost, $/yr	$ 30,400	$ 35,500	$ 49,400	$ 66,600	$ 100,100
Uniform Annual Cost, $/yr	$ 53,200	$ 62,600	$ 86,200	$ 119,000	$ 176,300
Unit Cost, $/1,000 gal	$ 61.8	$ 29.1	$ 16.0	$ 11.1	$ 8.2
2 Four-Stage					
Construction Cost, $	$ 336,000	$ 368,000	$ 475,000	$ 666,000	$ 968,000
Annual O&M Cost, $/yr	$ 52,500	$ 57,600	$ 73,800	$ 95,900	$ 132,300
Uniform Annual Cost, $/yr	$ 81,800	$ 89,700	$ 115,200	$ 154,000	$ 216,700
Unit Cost, $/1,000 gal	$ 95.0	$ 41.7	$ 21.4	$ 14.3	$ 10.1
3 Three-Stage					
Construction Cost, $	$ 291,000	$ 333,000	$ 441,000	$ 627,000	$ 913,000
Annual O&M Cost, $/yr	$ 35,900	$ 41,900	$ 56,400	$ 76,200	$ 115,900
Uniform Annual Cost, $/yr	$ 61,300	$ 70,900	$ 94,800	$ 130,900	$ 195,500
Unit Cost, $/1,000 gal	$ 71.2	$ 32.9	$ 17.6	$ 12.2	$ 9.1
4 SBR					
Construction Cost, $	$ 336,000	$ 381,000	$ 482,000	$ 697,000	$ 966,000
Annual O&M Cost, $/yr	$ 28,000	$ 34,100	$ 49,100	$ 67,600	$ 100,000
Uniform Annual Cost, $/yr	$ 57,300	$ 67,300	$ 91,100	$ 128,400	$ 184,200
Unit Cost, $/1,000 gal	$ 66.5	$ 31.3	$ 16.9	$ 11.9	$ 8.6
5 Intermittent Cycle					
Construction Cost, $	$ 229,000	$ 374,000	$ 584,000	$ 861,000	$ 1,026,000
Annual O&M Cost, $/yr	$ 28,000	$ 34,100	$ 49,100	$ 67,600	$ 100,000
Uniform Annual Cost, $/yr	$ 48,000	$ 66,700	$ 100,000	$ 142,700	$ 189,400
Unit Cost, $/1,000 gal	$ 55.7	$ 31.0	$ 18.6	$ 13.3	$ 8.8
6 MLE + Deep Bed Filtration					
Construction Cost, $	$ 308,000	$ 368,000	$ 486,000	$ 664,000	$ 958,000
Annual O&M Cost, $/yr	$ 36,900	$ 42,700	$ 58,100	$ 75,900	$ 111,400
Uniform Annual Cost, $/yr	$ 63,800	$ 74,800	$ 100,500	$ 133,800	$ 194,900
Unit Cost, $/1,000 gal	$ 74.1	$ 34.7	$ 18.7	$ 12.4	$ 9.1
7 Submerged Biofilters					
Construction Cost, $	$ 247,000	$ 296,000	$ 450,000	$ 847,000	See Note (1)
Annual O&M Cost, $/yr	$ 19,500	$ 24,400	$ 41,100	$ 60,400	See Note (1)
Uniform Annual Cost, $/yr	$ 41,000	$ 50,200	$ 80,300	$ 134,200	See Note (1)
Unit Cost, $/1,000 gal	$ 47.6	$ 23.3	$ 14.9	$ 12.5	See Note (1)
8 RBCs					
Construction Cost, $	$ 263,000	$ 342,000	$ 527,000	$ 868,000	$ 1,092,000
Annual O&M Cost, $/yr	$ 20,400	$ 25,900	$ 43,400	$ 61,500	$ 89,400
Uniform Annual Cost, $/yr	$ 43,300	$ 55,700	$ 89,300	$ 137,200	$ 184,600
Unit Cost, $/1,000 gal	$ 50.3	$ 25.9	$ 16.6	$ 12.7	$ 8.6
9 Baseline – Secondary Treatment					
Construction Cost, $	$ 183,000	$ 223,000	$ 303,000	$ 461,000	$ 671,000
Annual O&M Cost, $/yr	$ 22,000	$ 26,500	$ 39,200	$ 52,100	$ 78,000
Uniform Annual Cost, $/yr	$ 37,900	$ 45,900	$ 65,600	$ 92,300	$ 136,500
Unit Cost, $/1,000 gal	$ 44.0	$ 21.3	$ 12.2	$ 8.6	$ 6.3

Note: (1) Exceeded manufacturer's sizes

Table 4. Cost Summary for Retrofit Systems

	System	System Design Capacity 4,000 (gpd)	10,000 (gpd)	25,000 (gpd)	50,000 (gpd)	100,000 (gpd)
R1	**Anoxic Tank for MLE Upgrade**					
	Construction Cost, $	21,000	24,000	39,000	57,000	80,000
	Annual O&M Cost, $/yr	12,100	12,600	13,400	18,700	21,100
	Uniform Annual Cost, $/yr	13,900	14,700	16,800	23,700	28,100
	Present Worth, $	159,800	168,500	192,700	271,500	322,000
	Unit Cost, $/1,000 gal	16.1	6.8	3.1	2.2	1.3
R2	**Deep Bed Denitrification Filter**					
	Construction Cost, $	109,000	121,000	147,000	163,000	213,000
	Annual O&M Cost, $/yr	17,600	18,200	20,300	24,800	28,600
	Uniform Annual Cost, $/yr	27,100	28,700	33,100	39,000	47,200
	Present Worth, $	310,900	329,800	379,800	447,500	541,000
	Unit Cost, $/1,000 gal	31.5	13.3	6.1	3.6	2.2

For the retrofit alternatives, only the new facilities needed for nitrogen and phosphorus removal are included. Although the deep bed denitrification filter retrofit alternative provides somewhat better nitrogen removal percentage than the MLE retrofit alternative, it is approximately two to four times more costly, depending on capacity.

O&M costs were developed by individually considering operations labor, electricity, maintenance and repairs materials and labor, solids handling and disposal, administration labor, laboratory analytical requirements, and chemical costs. For the retrofit alternatives, only the increase in these costs associated with the addition of nitrogen and phosphorus removal facilities was estimated. Assumptions were as follows:

- Operations labor - labor at $36/hour (includes overhead), with minimum staffing per F.A.C. 62-699.310
- Electricity - $0.10/kW-hr
- Maintenance and repairs materials and labor - 3 percent of capital costs/year
- Solids handling and disposal - liquid haul at $0.17/gal
- Administrative - 5 percent of the sum of the operations labor, electricity, and maintenance and repairs costs
- Laboratory - commercial rates applied to required monitoring parameters in F.A.C. 62-0699.310
- Chemical costs - alum for P removal at $1.80/lb; Symclosene (chlorine) at $2.50/lb; methanol at $0.15/lb

For the new-plant alternatives, the data show that the two attached-growth processes (Systems 7 and 8) have the lowest O&M costs, which was due to lower costs for electricity, solids handling, and laboratory analyses. These processes are also simpler to operate than suspended-growth processes. O&M costs are highest for the four-stage (System 2) and deep-bed filtration (System 6) systems because they are the most complex to operate and maintain. For the same reason, the deep-bed retrofit alternative (System 2R) has higher estimated O&M costs than the MLE retrofit system (System 1R).

On a unit cost basis, the nutrient removal systems with filtration included are approximately 20 to 40% more costly than a conventional secondary treatment system without filtration. For the two lowest new-plant capacities analyzed (4,000 and 10,000 gpd), the attached-growth processes (Systems 7 and 8) appear to have clear life-cycle and unit cost advantages over the other nutrient removal technologies. These alternatives are followed by the intermittent-cycle, MLE, and SBR systems (Systems 5, 1, and 4) in a middle cost range. The highest cost systems in this flow range are the four-stage (System 2) and denitrification filter (System 6) systems. As plant capacity increases to approximately 25,000 gpd or greater, the total cost advantage of the attached-growth systems begins to disappear. The four-stage continuous-flow process (System 2) is consistently more costly than all other technologies across all facility sizes.

For the retrofit alternatives, the annual and unit costs of operating a denitrification filter are nearly twice those of retrofitting and operating an MLE system.

Ranking

Weighted rankings for the seven new treatment plant alternatives and the two plant retrofit alternatives were prepared using five criteria that considered both cost and non-cost factors associated with the ownership, operation, and performance of small-flow nutrient removal treatment plants. The criteria evaluated were unit cost, nitrogen removal performance, process control flexibility, ease of operation, and land requirements. For each criterion, a relative score of 1 (less favorable) to 5 (very favorable) was assigned to each alternative. The raw scores for each criterion were then multiplied by a weighting factor to amplify the rankings of more important criteria relative to those of less important criteria. The results are summarized in Tables 5 and 6 for the new-plant and retrofit systems, respectively.

For the new-plant alternatives, the three-stage system (System 3) was ranked the most favorable based on its moderate costs, process control flexibility, and ease of operation. The MLE and deep-bed filtration systems (Systems 1 and 6, respectively) were ranked second and third, respectively. The SBR and intermittent-cycle systems (Systems 4 and 5, respectively) were ranked in a tie for fourth. The four-stage system (System 2) was ranked fifth, while the attached-growth systems (Systems 7 and 8) were ranked in a tie for sixth.

Among the two retrofit alternatives, the MLE system (System 1R) had the best ranking, primarily due to more favorable unit costs and ease of operation. ■

Table 5. Ranking of Nutrient Removal Alternatives for New WWTPs

No.	System Alternative	Unit Cost	Nitrogen Removal	Process Control Flexibility	Ease of Operation	Land Required	Raw Score	Weighted Score	Ranking
	Weighting Factor	30%	30%	15%	15%	10%		100%	
1	MLE	4	4	3	3	3	17	3.6	2
2	Four-stage	1	5	5	2	3	16	3.2	5
3	Three-stage	3	5	4	3	3	18	3.8	1
4	SBR	3	4	3	3	4	17	3.4	4 (tie)
5	Intermittent Cycle	3	4	3	3	4	17	3.4	4 (tie)
6	MLE + Deep Bed Filtration	2	5	5	2	3	17	3.5	3
7	Submerged Biofilters	3	2	2	4	5	16	2.9	6 (tie)
8	RBC	3	2	2	4	5	16	2.9	6 (tie)
	Total Possible Points						25	5	

Note: Scores: 1 (Less Favorable) to 5 (More Favorable)

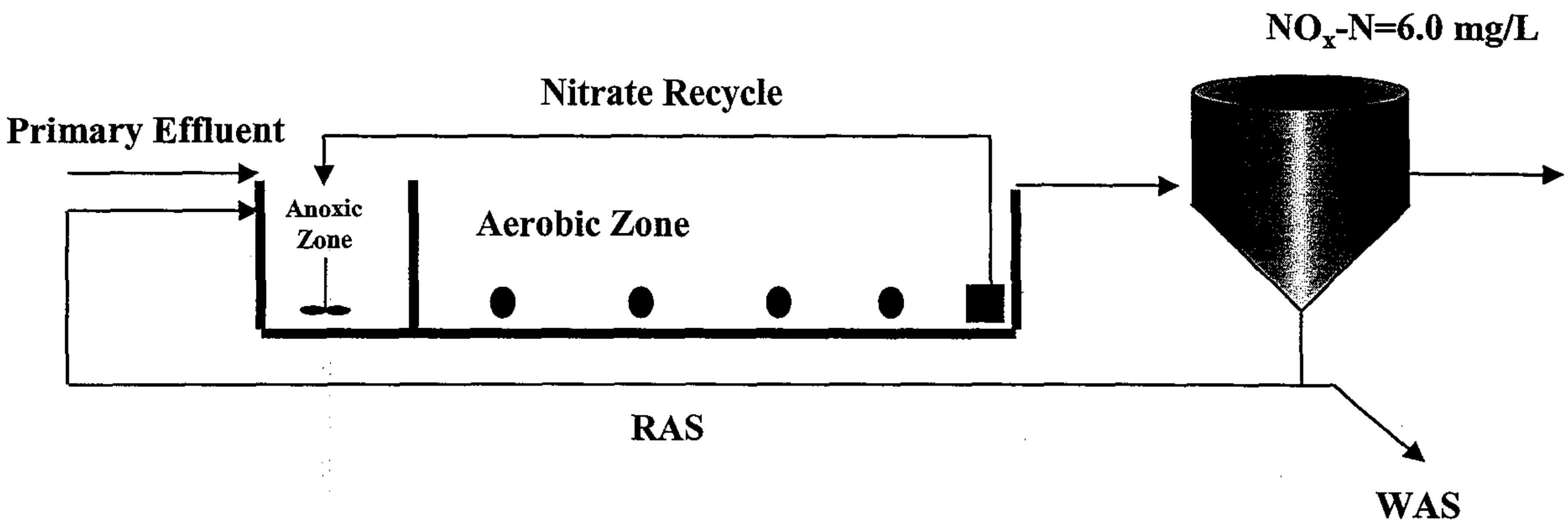
Table 6. Ranking of Retrofit Nutrient Removal Alternatives

No.	System Alternative	Unit Cost	Nitrogen Removal	Process Control Flexibility	Ease of Operation	Land Required	Raw Score	Weighted Score	Ranking
	Weighting Factor	30%	30%	15%	15%	10%		100%	
1	Anoxic Tank, MLE Upgrade	4	4	3	3	3	17	3.6	1
2	Deep-Bed Benite Filter	2	4	3	2	4	15	3.0	2
	Total Possible Points						25	5	

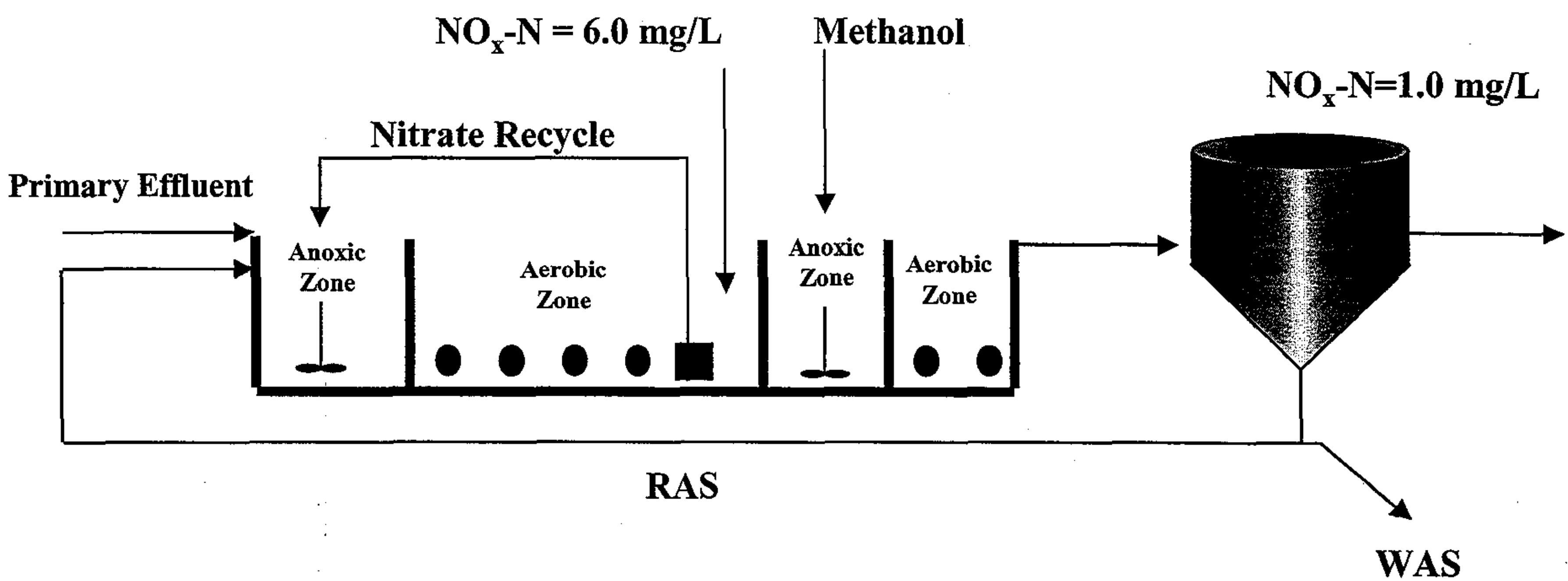
Note: Scores: 1 (Less Favorable) to 5 (More Favorable)

Expected Performance for Various Configurations

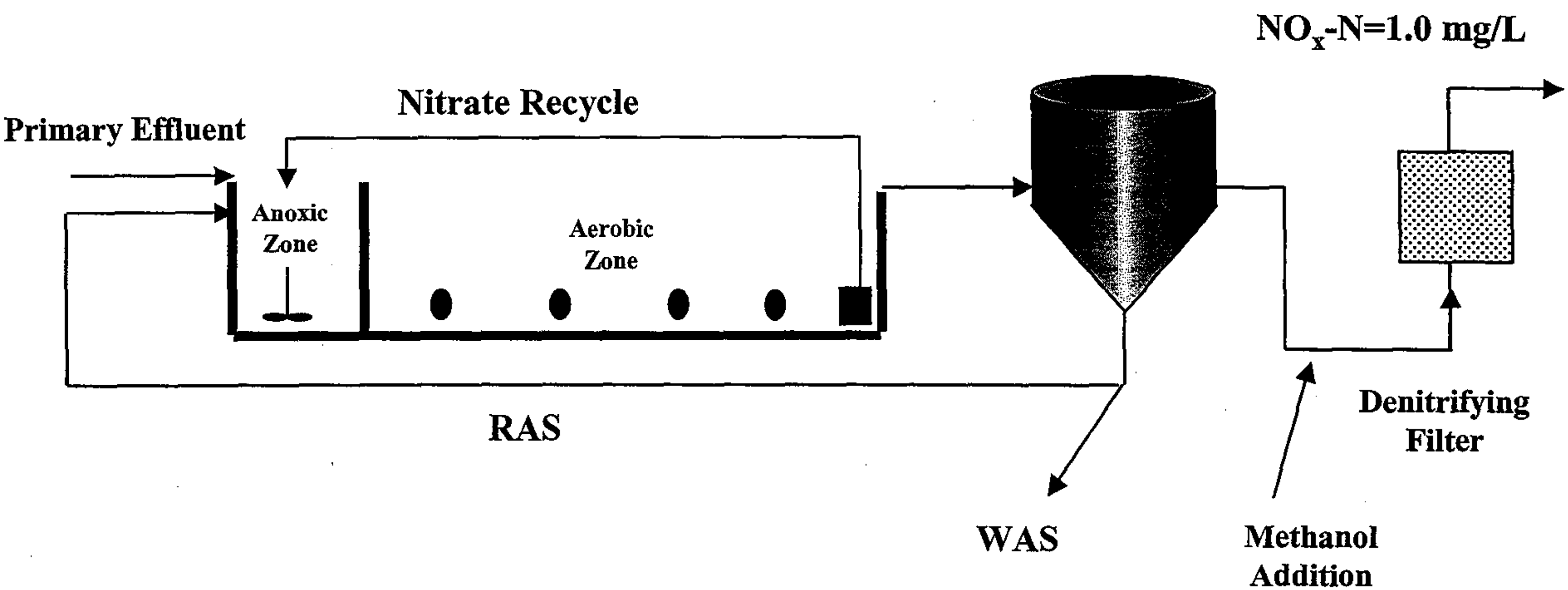
Modified Ludzack-Ettinger (MLE) Configuration



MLE Configuration with Secondary Anoxic Zone



MLE Configuration with Denitrifying Filter



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The process is reliable and well documented; however, it does not provide significant levels of nutrient removal.

3.2 Modified Ludzack-Ettinger Process: This version of the activated sludge process involves sequential anoxic and aerobic stages to provide $CBOD_5$ removal, nitrification and partial denitrification. The Modified Ludzack-Ettinger (MLE) process configuration is very similar to the single stage activated sludge process; however, an anoxic stage is provided upstream of the aerobic stage. Also, a means of returning mixed liquor from the aerobic stage to the anoxic stage is provided. Raw wastewater, RAS, and the mixed liquor return (internal recycle or IR) are directed to the "pre-anoxic" basin to create an environment that promotes denitrification. The internal recycle supplies the bulk of the nitrate that is used by facultative organisms for respiration in the absence of dissolved oxygen, which results in converting the nitrate to nitrogen gas that is released to the atmosphere. The RAS provides the biomass to the anoxic stage to carry out the denitrification process, and to a lesser degree than the internal recycle stream; the RAS provides a level of nitrate return. The influent wastewater provides a source of readily biodegradable organic compounds that increase metabolic rates in the anoxic basin, which, in turn, enhances denitrification rates. The aerobic stage and clarification facilities are immediately downstream of the anoxic stage. The aerobic stage provides $CBOD_5$ removal and nitrification and the clarifiers provide solids separation. The MLE process is simple and reliable and it usually provides excellent $CBOD_5$ and TSS removals and effluent TN concentrations in the 7 to 10 mg/L range.

3.3 3-Stage Biological Nutrient Removal Process: This process is similar to the MLE process with another stage added. In this case an "anaerobic" stage or "fermentation" stage is provided upstream of the anoxic stage in the MLE process and RAS is discharged to the fermentation stage rather than the anoxic stage. This process is generally known as the "A^2/O Process" and it was developed to provide biological nitrogen and phosphorus removal in addition to $CBOD_5$ and TSS removal. The fermentation stage provides "anaerobic pre-conditioning" of the biomass that causes certain microorganisms to release phosphorus in the fermentation stage and subsequently assimilate phosphorus at much higher rates in the aerobic stage, resulting in enhanced phosphorus removal. A small amount of nitrogen is removed in the fermentation stage as a result of the nitrate in the RAS being discharged to a basin that is in an anaerobic state. Subsequent to the fermentation stage, the anoxic, aerobic, and clarification facilities provide the same functions in this process as they do in the MLE process. Typically, this process provides high levels of $CBOD_5$ at TSS removal and effluent TN is usually in the range of 7 to 10 mg/L. Effluent TP concentrations from this process are usually 2 to 3 mg/L without chemical addition.

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EPA

Wastewater Technology Fact Sheet
Sequencing Batch Reactors

DESCRIPTION

The sequencing batch reactor (SBR) is a fill-and-draw activated sludge system for wastewater treatment. In this system, wastewater is added to a single "batch" reactor, treated to remove undesirable components, and then discharged. Equalization, aeration, and clarification can all be achieved using a single batch reactor. To optimize the performance of the system, two or more batch reactors are used in a predetermined sequence of operations. SBR systems have been successfully used to treat both municipal and industrial wastewater. They are uniquely suited for wastewater treatment applications characterized by low or intermittent flow conditions.

Fill-and-draw batch processes similar to the SBR are not a recent development as commonly thought. Between 1914 and 1920, several full-scale fill-and-draw systems were in operation. Interest in SBRs was revived in the late 1950s and early 1960s, with the development of new equipment and technology. Improvements in aeration devices and controls have allowed SBRs to successfully compete with conventional activated sludge systems.

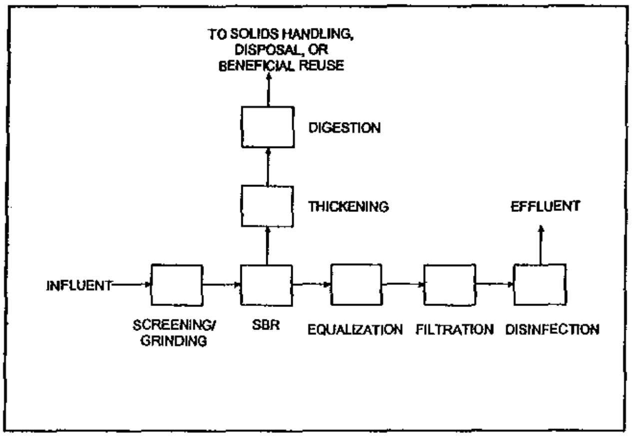
The unit processes of the SBR and conventional activated sludge systems are the same. A 1983 U.S. EPA report, summarized this by stating that "the SBR is no more than an activated sludge system which operates in time rather than in space." The difference between the two technologies is that the SBR performs equalization, biological treatment, and secondary clarification in a single tank using a timed control sequence. This type of reactor does, in some cases, also perform primary clarification. In a conventional activated sludge system, these unit processes would be accomplished by using separate tanks.

A modified version of the SBR is the Intermittent Cycle Extended Aeration System (ICEAS). In the ICEAS system, influent wastewater flows into the reactor on a continuous basis. As such, this is not a true batch reactor, as is the conventional SBR. A baffle wall may be used in the ICEAS to buffer this continuous inflow. The design configurations of the ICEAS and the SBR are otherwise very similar.

Description of a Wastewater Treatment Plant Using an SBR

A typical process flow schematic for a municipal wastewater treatment plant using an SBR is shown in Figure 1. Influent wastewater generally passes through screens and grit removal prior to the SBR. The wastewater then enters a partially filled reactor, containing biomass, which is acclimated to the wastewater constituents during preceding cycles. Once the reactor is full, it behaves like a conventional activated sludge system, but without a continuous influent or effluent flow. The aeration and mixing is discontinued after the biological reactions are complete, the biomass settles, and the treated supernatant is removed. Excess biomass is wasted at any time during the cycle. Frequent wasting results in holding the mass ratio of influent substrate to biomass nearly constant from cycle to cycle. Continuous flow systems hold the mass ratio of influent substrate to biomass constant by adjusting return activated sludge flowrates continually as influent flowrates, characteristics, and settling tank underflow concentrations vary. After the SBR, the "batch" of wastewater may flow to an equalization basin where the wastewater flowrate to additional unit processed can be is controlled at a determined rate. In some cases the wastewater is filtered to remove additional solids and then disinfected.

As illustrated in Figure 1, the solids handling system may consist of a thickener and an aerobic digester. With SBRs there is no need for return activated sludge (RAS) pumps and primary sludge (PS) pumps like those associated with conventional activated sludge systems. With the SBR, there is typically only one sludge to handle. The need for gravity thickeners prior to digestion is determined on a case by case basis depending on the characteristics of the sludge.



Source: Parsons Engineering Science, 1999.

FIGURE 1 PROCESS FLOW DIAGRAM FOR A TYPICAL SBR

An SBR serves as an equalization basin when the vessel is filling with wastewater, enabling the system to tolerate peak flows or peak loads in the influent and to equalize them in the batch reactor. In many conventional activated sludge systems, separate equalization is needed to protects the biological system from peak flows, which may wash out the biomass, or peak loads, which may upset the treatment process.

It should also be noted that primary clarifiers are typically not required for municipal wastewater applications prior to an SBR. In most conventional activated sludge wastewater treatment plants, primary clarifiers are used prior to the biological system. However, primary clarifiers may be recommended by the SBR manufacturer if the total suspended solids (TSS) or biochemical oxygen demand (BOD) are greater than 400 to 500 mg/L. Historic data should be evaluated and the SBR manufacturer consulted to determine whether primary clarifiers or equalization are recommended prior to an SBR for municipal and industrial applications.

Equalization may be required after the SBR, depending on the downstream process. If equalization is *not* used prior to filtration, the filters need to be sized in order to receive the batch of wastewater from the SBR, resulting in a large surface area required for filtration. Sizing filters to accept these "batch" flows is usually not feasible, which is why equalization is used between an SBR and downstream filtration. Separate equalization following the biological system is generally not required for most conventional activated sludge systems, because the flow is on a continuous and more constant basis.

APPLICABILITY

SBRs are typically used at flowrates of 5 MGD or less. The more sophisticated operation required at larger SBR plants tends to discourage the use of these plants for large flowrates.

As these systems have a relatively small footprint, they are useful for areas where the available land is limited. In addition, cycles within the system can be easily modified for nutrient removal in the future, if it becomes necessary. This makes SBRs extremely flexible to adapt to regulatory changes for effluent parameters such as nutrient removal. SBRs are also very cost effective if treatment beyond biological treatment is required, such as filtration.

ADVANTAGES AND DISADVANTAGES

Some advantages and disadvantages of SBRs are listed below:

Advantages

- Equalization, primary clarification (in most cases), biological treatment, and secondary clarification can be achieved in a single reactor vessel.
- Operating flexibility and control.
- Minimal footprint.
- Potential capital cost savings by eliminating clarifiers and other equipment.

Disadvantages

- A higher level of sophistication is required (compared to conventional systems), especially for larger systems, of timing units and controls.
- Higher level of maintenance (compared to conventional systems) associated with more sophisticated controls, automated switches, and automated valves.
- Potential of discharging floating or settled sludge during the DRAW or decant phase with some SBR configurations.
- Potential plugging of aeration devices during selected operating cycles, depending on the aeration system used by the manufacturer.
- Potential requirement for equalization after the SBR, depending on the downstream processes.

DESIGN CRITERIA

For any wastewater treatment plant design, the first step is to determine the anticipated influent characteristics of the wastewater and the effluent requirements for the proposed system. These influent parameters typically include design flow, maximum daily flow BOD_5, TSS, pH, alkalinity, wastewater temperature, total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH_3-N), and total phosphorus (TP). For industrial and domestic wastewater, other site specific parameters may also be required.

The state regulatory agency should be contacted to determine the effluent requirements of the proposed plant. These effluent discharge parameters will be dictated by the state in the National Pollutant Discharge Elimination System (NPDES) permit. The parameters typically permitted for municipal systems are flowrate, BOD_5, TSS, and Fecal Coliform. In addition, many states are moving toward requiring nutrient removal. Therefore, total nitrogen (TN), TKN, NH_3-N, or TP may also be required. It is imperative to establish effluent requirements because they will impact the operating sequence of the SBR. For example, if there is a nutrient requirement and NH_3-N or TKN is required, then nitrification will be necessary. If there is a TN limit, then nitrification and denitrification will be necessary.

Once the influent and effluent characteristics of the system are determined, the engineer will typically consult SBR manufacturers for a recommended design. Based on these parameters, and other site specific parameters such as temperature, key design parameters are selected for the system. An example of these parameters for a wastewater system loading is listed in Table 1.

TABLE 1 KEY DESIGN PARAMETERS FOR A CONVENTIONAL LOAD

	Municipal	Industrial
Food to Mass (F:M)	0.15 - 0.4/day	0.15 - 0.6/day
Treatment Cycle Duration	4.0 hours	4.0 - 24 hours
Typically Low Water Level Mixed Liquor Suspended Solids	2,000-2,500 mg/L	2,000 - 4,000 mg/L
Hydraulic Retention Time	6 - 14 hours	varies

Source: AquaSBR Design Manual, 1995.

Once the key design parameters are determined, the number of cycles per day, number of basins, decant volume, reactor size, and detention times can be calculated. Additionally, the aeration equipment, decanter, and associated piping can then be sized.

Other site specific information is needed to size the aeration equipment, such as site elevation above mean sea level, wastewater temperature, and total dissolved solids concentration.

The operation of an SBR is based on the fill-and-draw principle, which consists of the following five basic steps: Idle, Fill, React, Settle, and Draw. More than one operating strategy is possible during most of these steps. For industrial wastewater applications, treatability studies are typically required to determine the optimum operating sequence. For most municipal wastewater treatment plants, treatability studies are not required to determine the operating sequence because municipal wastewater flowrates and characteristic variations are usually predictable and most municipal designers will follow conservative design approaches.

The Idle step occurs between the Draw and the Fill steps, during which treated effluent is removed and influent wastewater is added. The length of the Idle step varies depending on the influent flowrate and the operating strategy. Equalization is achieved during this step if variable idle times are used. Mixing to condition the biomass and sludge wasting can also be performed during the Idle step, depending on the operating strategy.

Influent wastewater is added to the reactor during the Fill step. The following three variations are used for the Fill step and any or all of them may be used depending on the operating strategy: static fill, mixed fill, and aerated fill. During static fill, influent wastewater is added to the biomass already present in the SBR. Static fill is characterized by no mixing or aeration, meaning that there will be a high substrate (food) concentration when mixing begins. A high food to microorganisms (F:M) ratio creates an environment favorable to floc forming organisms versus filamentous organisms, which provides good settling characteristics for the sludge. Additionally, static fill conditions favor organisms that produce internal storage products during high substrate conditions, a requirement for biological phosphorus removal. Static fill may be compared to using "selector" compartments in a conventional activated sludge system to control the F:M ratio.

Mixed fill is classified by mixing influent organics with the biomass, which initiates biological reactions. During mixed fill, bacteria biologically degrade the organics and use residual oxygen or alternative electron acceptors, such as nitrate-nitrogen. In this environment, denitrification may occur under these anoxic conditions. Denitrification is the biological conversion of nitrate-nitrogen to nitrogen gas. An anoxic condition is defined as an environment in which oxygen is not present and nitrate-nitrogen is used by the microorganisms as the electron acceptor. In a conventional biological nutrient removal (BNR) activated sludge system, mixed fill is comparable to the anoxic zone which is used for denitrification. Anaerobic conditions can also be achieved during the mixed fill phase. After the microorganisms use the nitrate-nitrogen, sulfate becomes the electron acceptor. Anaerobic conditions are characterized by the lack of oxygen and sulfate as the electron acceptor.

Aerated Fill is classified by aerating the contents of the reactor to begin the aerobic reactions completed in the React step. Aerated Fill can reduce the aeration time required in the React step.

The biological reactions are completed in the React step, in which mixed react and aerated react modes are available. During aerated react, the aerobic reactions initialized during aerated fill are completed and nitrification can be achieved. Nitrification is the conversion of ammonia-nitrogen to nitrite-nitrogen and ultimately to nitrate-nitrogen. If the mixed react mode is selected, anoxic conditions can be attained to achieve denitrification. Anaerobic conditions can also be achieved in the mixed react mode for phosphorus removal.

Settle is typically provided under quiescent conditions in the SBR. In some cases, gentle mixing during the initial stages of settling may result in a clearer effluent and a more concentrated settled sludge. In an SBR, there are no influent or effluent currents to interfere with the settling process as in a conventional activated sludge system.

The Draw step uses a decanter to remove the treated effluent, which is the primary distinguishing factor between different SBR manufacturers. In general, there are floating decanters and fixed decanters. Floating decanters offer several advantages over fixed decanters as described in the Tank and Equipment Description Section.

Construction

Construction of SBR systems can typically require a smaller footprint than conventional activated sludge systems because the SBR often eliminates the need for primary clarifiers. The SBR never requires secondary clarifiers. The size of the SBR tanks themselves will be site specific, however the SBR system is advantageous if space is limited at the proposed site. A few case studies are presented in Table 2 to provide general sizing estimates at different flowrates. Sizing of these systems is site specific and these case studies do not reflect every system at that size.

TABLE 2 CASE STUDIES FOR SEVERAL SBR INSTALLATIONS

Flow	Reactors			Blowers	
(MGD)	No.	Size (feet)	Volume (MG)	No.	Size (HP)
0.012	1	18 x 12	0.021	1	15
0.10	2	24 x 24	0:069	3	7.5
1.2	2	80 x 80	0.908	3	125
1.0	2	58 x 58	0.479	3	40
1.4	2	69 x 69	0.678	3	60
1.46	2	78 x 78	0.910	4	40
2.0	2	82 x 82	0.958	3	75
4.25	4	104 x 80	1.556	5	200
5.2	4	87 x 87	1.359	5	125

Note: These case studies and sizing estimates were provided by Aqua-Aerobic Systems, Inc. and are site specific to individual treatment systems.

The actual construction of the SBR tank and equipment may be comparable or simpler than a conventional activated sludge system. For Biological Nutrient Removal (BNR) plants, an SBR eliminates the need for return activated sludge (RAS) pumps and pipes. It may also eliminate the need for internal Mixed Liquor Suspended Solid (MLSS) recirculation, if this is being used in a conventional BNR system to return nitrate-nitrogen.

The control system of an SBR operation is more complex than a conventional activated sludge system and includes automatic switches, automatic valves, and instrumentation. These controls are very sophisticated in larger systems. The SBR manufacturers indicate that most SBR installations in the United States are used for smaller wastewater systems of less than two million gallons per day (MGD) and some references recommend SBRs only for small communities where land is limited. This is not always the case, however, as the largest SBR in the world is currently a 10 MGD system in the United Arab Emirates.

Tank and Equipment Description

The SBR system consists of a tank, aeration and mixing equipment, a decanter, and a control system. The central features of the SBR system include the control unit and the automatic switches and valves that sequence and time the different operations. SBR manufacturers should be consulted for recommendations on tanks and equipment. It is typical to use a complete SBR system recommended and supplied by a single SBR manufacturer. It is possible, however, for an engineer to design an SBR system, as all required tanks, equipment, and controls are available through different manufacturers. This is not typical of SBR installation because of the level of sophistication of the instrumentation and controls associated with these systems.

The SBR tank is typically constructed with steel or concrete. For industrial applications, steel tanks coated for corrosion control are most common while concrete tanks are the most common for municipal treatment of domestic wastewater. For mixing and aeration, jet aeration systems are typical as they allow mixing either with or without aeration, but other aeration and mixing systems are also used. Positive displacement blowers are typically used for SBR design to handle wastewater level variations in the reactor.

As previously mentioned, the decanter is the primary piece of equipment that distinguishes different SBR manufacturers. Types of decanters include floating and fixed. Floating decanters offer the advantage of maintaining the inlet orifice slightly below the water surface to minimize the removal of solids in the effluent removed during the DRAW step. Floating decanters also offer the operating flexibility to vary fill-and-draw volumes. Fixed decanters are built into the side of the basin and can be used if the Settle step is extended. Extending the Settle step minimizes the chance that solids in the wastewater will float over the fixed decanter. In some cases, fixed decanters are less expensive and can be designed to allow the operator to lower or raise the level of the decanter. Fixed decanters do not offer the operating flexibility of the floating decanters.

Health and Safety

Safety should be the primary concern in every design and system operation. A properly designed and operated system will minimize potential health and safety concerns. Manuals such as the Manual of Practice (MOP) No. 8, Design of Municipal Wastewater Treatment Plants, and MOP No. 11, Operation of Municipal Wastewater Treatment Plants should be consulted to minimize these risks. Other appropriate industrial wastewater treatment manuals, federal regulations, and state regulations should also be consulted for the design and operation of wastewater treatment systems.

PERFORMANCE

The performance of SBRs is typically comparable to conventional activated sludge systems and depends on system design and site specific criteria. Depending on their mode of operation, SBRs can achieve good BOD and nutrient removal. For SBRs, the BOD removal efficiency is generally 85 to 95 percent.

SBR manufacturers will typically provide a process guarantee to produce an effluent of less than:

- 10 mg/L BOD
- 10 mg/L TSS
- 5 - 8 mg/L TN
- 1 - 2 mg/L TP

OPERATION AND MAINTENANCE

The SBR typically eliminates the need for separate primary and secondary clarifiers in most municipal systems, which reduces operations and maintenance requirements. In addition, RAS pumps are not required. In conventional biological nutrient removal systems, anoxic basins, anoxic zone mixers, toxic basins, toxic basin aeration equipment, and internal MLSS nitrate-nitrogen recirculation pumps may be necessary. With the SBR, this can be accomplished in one reactor using aeration/mixing equipment, which will minimize operation and maintenance requirements otherwise be needed for clarifiers and pumps.

Since the heart of the SBR system is the controls, automatic valves, and automatic switches, these systems may require more maintenance than a conventional activated sludge system. An increased level of sophistication usually equates to more items that can fail or require maintenance. The level of sophistication may be very advanced in larger SBR wastewater treatment plants requiring a higher level of maintenance on the automatic valves and switches.

Significant operating flexibility is associated with SBR systems. An SBR can be set up to simulate any conventional activated sludge process, including BNR systems. For example, holding times in the Aerated React mode of an SBR can be varied to achieve simulation of a contact stabilization system with a typical hydraulic retention time (HRT) of 3.5 to 7 hours or, on the other end of the spectrum, an extended aeration treatment system with a typical HRT of 18 to 36 hours. For a BNR plant, the aerated react mode (oxic conditions) and the mixed react modes (anoxic conditions) can be alternated to achieve nitrification and denitrification. The mixed fill mode and mixed react mode can be used to achieve denitrification using anoxic conditions. In addition, these modes can ultimately be used to achieve an anaerobic condition where phosphorus removal can occur. Conventional activated sludge systems typically require additional tank volume to achieve such flexibility. SBRs operate in time rather than in space and the number of cycles per day can be varied to control desired effluent limits, offering additional flexibility with an SBR.

COSTS

This section includes some general guidelines as well as some general cost estimates for planning purposes. It should be remembered that capital and construction cost estimates are site-specific.

Budget level cost estimates presented in Table 3 are based on projects that occurred from 1995 to 1998. Budget level costs include such as the blowers, diffusers, electrically operated valves, mixers, sludge pumps, decanters, and the control panel. All costs have been updated to March 1998 costs, using an ENR construction cost index of 5875 from the March 1998 Engineering News Record, rounded off to the nearest thousand dollars.

TABLE 3 SBR EQUIPMENT COSTS BASED ON DIFFERENT PROJECTS

Design Flowrate (MGD)	Budget Level Equipment Costs ($)
0.012	94,000
0.015	137,000
1.0	339,000
1.4	405,000
1.46	405,000
2.0	564,000
4.25	1,170,000

Source: Aqua Aerobics Manufacturer Information, 1998.

In Table 4, provided a range of equipment costs for different design flowrates is provided.

TABLE 4 BUDGET LEVEL EQUIPMENT COSTS BASED ON DIFFERENT FLOW RATES

Design Flowrate (MGD)	Budget Level Equipment Costs ($)
1	150,000 - 350,000
5	459,000 - 730,000
10	1,089,000 - 1,370,000
15	2,200,000
20	2,100,000 - 3,000,000

Note: Budget level cost estimates provided by Babcock King - Wilkinson, L.P., August 1998.

Again the equipment cost items provided do not include the cost for the tanks, sitework, excavation/backfill, installation, contractor's overhead and profit, or legal, administrative, contingency, and engineering services. These items must be included to calculate the overall construction costs of an SBR system. Costs for other treatment processes, such as screening, equalization, filtration, disinfection, or aerobic digestion, may be included if required.

The ranges of construction costs for a complete, installed SBR wastewater treatment system are presented in Table 5. The variances in the estimates are due to the type of sludge handling facilities and the differences in newly constructed plants versus systems that use existing plant facilities. As such, in some cases these estimates include other processes required in an SBR wastewater treatment plant.

TABLE 5 INSTALLED COST PER GALLON OF WASTEWATER TREATED

Design Flowrate (MGD)	Budget Level Equipment Cost ($/gallon)
0.5 - 1.0	1.96 - 5.00
1.1 - 1.5	1.83 - 2.69
1.5 - 2.0	1.65 - 3.29

Note: Installed cost estimates obtained from Aqua-Aerobics Systems, Inc., August 1998.

There is typically an economy of scale associated with construction costs for wastewater treatment, meaning that larger treatment plants can usually be constructed at a lower cost per gallon than smaller systems. The use of common wall construction for larger treatment systems, which can be used for square or rectangular SBR reactors, results in this economy of scale.

Operations and Maintenance (O&M) costs associated with an SBR system may be similar to a conventional activated sludge system. Typical cost items associated with wastewater treatment systems include labor, overhead, supplies, maintenance, operating administration, utilities, chemicals, safety and training, laboratory testing, and solids handling. Labor and maintenance requirements may be reduced in SBRs because clarifiers, clarification equipment, and RAS pumps may not be necessary. On the other hand, the maintenance requirements for the automatic valves and switches that control the sequencing may be more intensive than for a conventional activated sludge system. O&M costs are site specific and may range from $800 to $2,000 dollars per million gallons treated.

REFERENCES

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2. Arora, Madan L. *Technical Evaluation of Sequencing Batch Reactors.* Prepared for U.S. EPA. U.S. EPA Contract No. 68-03-1821.

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11. U.S. EPA. *Innovative and Alternative Technology Assessment Manual,* EPA/430/9-78-009. Cincinnati, Ohio, 1980.

12. U.S. EPA. EPA Design Manual, Summary Report *Sequencing Batch Reactors.* EPA/625/8-86/011, August 1986.

13. Manual of Practice (MOP) No. 8, Design of Municipal Wastewater Treatment Plants,

14. Manual of Practice (MOP) No. 11, Operation of Municipal Wastewater Treatment Plants.

ADDITIONAL INFORMATION

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Memorandum

To: Robert Sheets
Government Services Group, Inc.

Date: October 1, 2003

From: Peter M. Kinsley
The Haskell Company

Subject: Design-Build Wastewater Management System for the Key Largo Trailer Village Area

Issue No. 01-004 – Vacuum Collection System Selection

As requested, The Haskell Company is issuing this memorandum to summarize our recommendations as outlined in our September 30, 2003 letter. In this letter, we recommended the vacuum collection system manufactured by Roediger in lieu of the vacuum collection system manufactured by AirVac.

In summary, we looked at the published materials, conducted interviews, visited installations, checked references and considered cost of both manufactures. In addition, we included an analysis of the operational maintenance and renewal and replacement cost for both manufactures. This evaluation is explained in detail in the Brown and Caldwell letter dated September 29, 2003 which accompanied the above referenced letter and is summarized in the table below.

EVALUATION SUMMARY TABLE

Item	AirVac	Roediger
Previous Experience	• Numerous US installations • Florida Keys Installations	• Limited US installations • Approved by JEA & FKAA
Equipment	• 50 gallon storage in sump • Traffic bearing lid • Flotation Collar • Buried steel bolts • Internal sump breather • Fixed lateral elevation	• 15 gallon storage in sump • Requires traffic bearing collar • Access to sump provided • Adjustable sump elevation • Internal sump breather • Pulse flow controller
Inter-changeability of Vacuum Valves	• Valves do not fit in Roediger chamber	• Valves fit into AirVac chamber
Ease of Maintenance	• Access to sump through valve chamber	• Watertight valve chamber • Access to sump from ground surface

Manufacturer Supplied O&M costs	• $38,300 (850 EDU's) • $45/yr/EDU	• $20,340 (850 EDU's) • $25/yr/EDU
Item	**Brown and Caldwell**	
O&M Costs	• $26,300 (850 EDU's) • $31/yr/EDU • $2.57/Month/EDU	

Some of the benefits of utilizing the Roediger system for these projects are listed here:

- The Roediger valve chamber is watertight allowing ease of access by operational personnel to the vacuum valve for adjustment.

- Collection sump is also easier to access by system operators to remove debris that may inadvertently enter the sewer system.

- Provides corrosion resistant chambers (no buried steel bolts).

cc: Stuart Oppenheim, Brown and Caldwell
Charles Sweats, Government Services Group
Jeff Weiler, Weiler Engineering
Ed Castle, Weiler Engineering
Issue No. 01-004

THE HASKELL COMPANY

AMERICA'S DESIGN-BUILD LEADER®

Peter M. Kinsley
Division Leader - Water

Via Overnight Delivery

September 30, 2003

Re: Design-Build Wastewater Management System for the Key Largo Trailer Village Area
Issue No. 01-004 - Vacuum Collection System Selection

Mr. Robert Sheets
Government Services Group, Inc.
1500 Mahan Drive, Suite 250
Tallahassee, Florida 32308

Dear Mr. Sheets:

In response to your comments regarding our September 24, 2003 letter regarding the above referenced subject, attached, please find the amended review of the vacuum collection systems prepared by The Haskell Company's designer, Brown and Caldwell. Per your request, operation and maintenance cost have been collected, analyzed and included in our study.

As stated in Section 3.8.3 of the Design-Build Agreement, the Key Largo Wastewater Treatment District (KLWTD) is responsible for selecting the vacuum collection system for the above referenced project. To facilitate KLWTD's selection, The Haskell Company conducted vendor presentations and performed a detailed evaluation of the two vacuum collection systems under consideration in order to provide a recommendation.

The vendor presentations were conducted on September 15, 2003 with representatives from the KLWTD, Government Services Group, Weiler Engineering, Brown and Caldwell, DN Higgins, Inc., and The Haskell Company in attendance. In addition, The Haskell Company's designer, Brown and Caldwell, performed a detailed evaluation of the two vacuum collection systems under consideration and provided their recommendation. Finally, to confirm the financial condition of Roediger, we reviewed a D&B report of the organization. I have attached a copy of Brown and Caldwell's evaluation and the D&B report for your review.

Based upon the vendor presentations, subsequent evaluation performed by Brown and Caldwell and the findings of the D&B report, The Haskell Company recommends the vacuum collection system manufactured by Roediger.

If you should have any questions or require any additional information, please contact me directly at 904/357-4868.

Sincerely,

Peter M. Kinsley

Attachments

cc: Stuart Oppenheim, Brown and Caldwell
Charles Sweats, Government Services Group
Jeff Weiler, Weiler Engineering
Ed Castle, Weiler Engineering
Issue No. 01-004

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BROWN AND CALDWELL

September 29, 2003

Mr. Peter Kinsley
Division Leader - Water
The Haskell Company
Haskell Building
Jacksonville, FL 32231-4100

24553.001

Subject: Vacuum System Recommendations Key Largo Trailer Village and Key Largo Park Projects

Dear Mr. Kinsley:

Pursuant to our review of the AirVac® and Roediger® vacuum collections systems, Brown and Caldwell offers our observations and recommendations. We have conducted a review of the vendor supplied printed materials; observed each vendor's installations and checked references. In addition, we conducted vendor interviews, which were attended by the Key Largo Wastewater Treatment District's manager and engineer.

It should be noted that our original proposal for this project was based on the AirVac system. Throughout the negotiation process of developing the project's conceptual design, we refined the project requirements with Roediger. As a result, the entire team has developed a better understanding of their system. The following text summarizes our evaluation and focuses on areas of concern.

1. Prior Experience and References

- Air Vac has several installations within the Untied States, Florida and the Florida Keys. Most recently, AirVac has completed an installation in Stock Island. The project is reported to have 119 valve chambers serving 1200 connections. The Little Venice project is also currently under construction and has 364 valves serving 840 connections. Other installations in Florida include the Englewood / Sarasota area. A reference list is attached to this letter.

- Roediger has a limited number of domestic installations. St John's County, Florida has a system serving approximately 80 EDU's. Another installation in Malden Missouri serves 320 customers. Roediger also reports that the Emerald Bay Resort in the Bahamas currently serves 1760 EDUs at 200gallons /EDUs. The majority of Roediger's installations are found in Europe. A reference list is attached to the letter.

Summary of Reference Checks

The Brown and Caldwell team contacted two facilities that own Roediger installations and one owner who have recently specified Roediger. We contacted one design firm that selected and installed the AirVac System.

A. Bill Young - Director of Utilities, St Johns County

The St John's County Utilities Department selected RoeVac for their exclusive 80 EDU residential community. The county compared the Englewood and Sanford System (Air Vac Systems). The county is satisfied with their selection. The system was selected because of the dry valve chamber, which made maintenance easier. Members of the Brown and Caldwell team have conducted a site investigation and have found the system to be in sound working condition.

B. Colin Groff -Technical Services Manager JEA

JEA performed an evaluation of both systems for their planned Ponte Vedra vacuum sewer system and recommended Roediger. The decision to go with Roediger was based on:

- Water tight valve chamber
- Less moving parts
- Didn't require the vent at the home for make-up air (utilized house vents)

C. Bill Green P.E. - Green and Associates, Malden Missouri

Mr. Green designed a comparable system to that of Key Largo with 300+ connections in Malden, Missouri. Mr. Green conducted a through review of both systems by traveling to Germany to review the Roediger system installations. Mr. Green concluded that the Roediger systems (collection system and vacuum pumping station) would perform equivalently to the AirVac system. The system was designed for either Roediger or AirVac. All six bids received included Roediger as the named supplier of the vacuum system. They received adequate assistance and cooperation during the design, construction and start-up of the system from Roediger. The Roediger system has been in operation for 1-½ years with an average of 2 service calls per month

D. Dan Burden P.E. – Hazen and Sawyer, Sarasota, Florida

Mr. Burden designed the Sarasota Area-E project utilizing the AirVac system. The system consisted of 229 valve chambers serving 565 connections. Mr. Burden conducted a review of the AirVac vs. Roediger systems. Mr. Burden concluded that due to the limited domestic Roediger installations the AirVac system was preferred.

Site Visits

The Haskell Team has visited the St Johns County's Roediger system. It was reported that the system was operating as designed. The Haskell team has also visited the Little Venice (Marathon) and the Ocean Reef's AirVac vacuum system projects. We have observed and also discussed the installation with the contractors involved with these projects. We have become familiar with the installation on both systems.

2. Equipment Evaluation

There are several differences between the AirVac and Roediger vacuum valve and valve pit/chambers. The collection mains and the vacuum pumping station (VPS), which consists of the central vacuum tank, vacuum and the sewage pumps, are virtually the same for both systems.

- AirVac utilized a piston-type valve, which opens when the sewage within the pit reaches a specific level. The valve is equipped with an internal sump breather. The valve is approximately 18 inches in height and it has a 3-inch opening. The pit sump varies in depth depending on the gravity lateral elevation needed. It is reported that the sump has a capacity of 50 gallons. If more storage is required, deeper sumps can be provided. The AirVac pit is equipped with a lid that has traffic bearing rating for an H-20 loading. The pit is assembled with stainless steel screws, which secure the upper valve chamber to the lower sump. The stainless steel screws also secure an anti-flotation collar.

- Roediger uses a diaphragm-type valve, which is 7 1/4 inches tall. The valve is equipped with a sump breather. The valve is equipped with a pulse flow controller that controls the air to liquid ratio into the system. The valve chamber is watertight. An external traffic collar is required to obtain the H-20 traffic bearing capacity. The sewage collection sump is adjacent to the valve chamber and also has an access lid with a traffic-bearing collar. The sump is reported to have a capacity of 15 gallons. The inlet elevation on the sump can be adjusted.

3. Interchangeability of Vacuum Valves

AirVac, due to its size, cannot fit within the Roediger valve chamber. The Roediger valve can however fit into the AirVac chamber. We have collected no evidence where the vacuum valves have been used in the other manufacturer's chamber.

The vacuum collection system is designed in such a way as to use either manufactures pits/chambers. For example, an AirVac chamber and a Roediger chamber could be installed on the same main line. The District should however only utilize one manufacturer for the entire project to obtain the economy of scale and have one point of responsibility and warranty. However, if a new neighborhood were to be added to the existing system either supplier could be used.

4. **Ease of Maintenance**

The Roediger valve chamber is easier to access because it is watertight and thus does not fill with water when the groundwater table is high. The sump is easier to access because it is adjacent to the valve chamber and not below the valve chamber as in the AirVac configuration. Roediger has stated that the mean time between service calls on any particular valve would be approximately 10 years. Their data indicates a longer period between calls. AirVac recommends one hour/yr/valve when calculating system-operating costs. There was no way to verify either manufactures claims.

5. **Operating and Maintenance (O&M) Costs**

AirVac and Roediger provided operational and maintenance costs information for vacuum collection system. These costs are based on the current collection systems configuration and anticipated operational conditions. These conditions may change as design progresses. The values presented here should only be considered as order-of-magnitude cost estimates. The discrepancy in the methodology used to develop the cost estimates makes any conclusions regarding the annual O&M costs between the two systems difficult.

The total O&M costs reported by both manufacturers are as follows:

- AirVac $38,300 ($45/yr/EDU)
- Roediger $20,340 ($25/yr/EDU)

Due to the wide variation of costs supplied by each manufactures, BC reviewed the basis of their O&M costs.

The AirVac and Roediger estimates are included as an attachment to this letter. Both used 277 valve chambers to serve 850 EDUs and a labor cost of $15/ hour. They did not use the same methods of determining their O&M costs. Some of the differences are highlighted here:

- The AirVac annual O&M costs are based on inspection of the valve each year (@ 0.5 hrs/valve), rebuilding the valve controller every 7 years (@ 1.0 hrs/valve) and rebuilding the valve every 10 years (@ 1.75 hrs/valve).

    1. The annual O&M renewal and replacement cost for the vacuum / pumping station is $5,400.

    2. The annual power cost of the VPS is estimated as $18,700. (Based on $1.75/edu plus $75/month).

- The Roediger annual maintenance costs are based on inspection of the valve each year (@ 0.2 hrs/valve), rebuilding the valve controller every 5 years (@ 1.25 hrs/valve) and rebuilding the valve every 10 years (@ 0.85 hrs/valve).

1. The annual O&M renewal and replacement cost for the VPS is $5,758.

2. The annual power cost of the collection system is estimated as $3,020. (Based on $0.055/ kWh.).

After analysis of the O&M Costs prepared for by AirVac and Roediger, we determined the following:

1. The vacuum/pumping station O&M cost for both manufacturers should be nearly the same due to the similarity of the system.

   The method of calculating power costs should be based on an estimate of kilowatt-hours based on anticipated run time of equipment. The actual cost of power in the Key Largo is more realistically approximated at $ 0.075 / kWh. The actual VPS O&M cost should be in the range of $ 4,800 /year or $5.64/EDU /year. This is based on annual power usage of 63,700 kWh for the VPS and controls.

2. The manufactures agree on the inspection interval of 1 year and the valve overhaul interval of 10 years. AirVac states rebuild controller every 5 years but uses a 7-year interval for renewal and replacement cost estimates. Roediger uses the 5-year interval for its estimate.

3. The manufacturer's estimate of vacuum valve O & M varied significantly. AirVac used a labor estimate of 1.4 hours /valve/ year. Roediger used 0.6 hours / valve.

4. Brown and Caldwell, based on our understanding of the system operation, estimate the annual O&M and R&R cost for the collection system and VPS to be on the order of magnitude of the following:

a. Vacuum Station Operation and Maintenance	$12,800
b. Vacuum Station Renewal & Replacement	$6,000
c. Collection Chamber O&M and R&R	$7,500
	$26,300/yr
	$30.94/yr/EDU
	$2.57/Month/EDU

We based our O&M and R&R costs on the following:

- One inspection of each valve chamber each year
- Two unscheduled service calls / month
- Replacement of valve and VPS equipment as recommended by manufacturer
- Power required to operate VPS at ADF at power cost of $0.075/kWh

The following table summarizes the evaluation:

EVALUATION SUMMARY TABLE

Item	AirVac	Roediger
Previous Experience	• Numerous US installations • Florida Keys Installations	• Limited US installations • Approved by JEA & FKAA
Equipment	• 50 gallon storage in sump • Traffic bearing lid • Flotation Collar • Buried steel bolts • Internal sump breather • Fixed lateral elevation	• 15 gallon storage in sump • Requires traffic bearing collar • Access to sump provided • Adjustable sump elevation • Internal sump breather • Pulse flow controller
Inter-changeability of Vacuum Valves	• Valves do not fit in Roediger chamber	• Valves fit into AirVac chamber
Ease of Maintenance	• Access to sump through valve chamber	• Watertight valve chamber • Access to sump from ground surface

Based on this review it is Brown and Caldwell's opinion that the Roediger vacuum system will accomplish the specified requirements for the Key Largo Trailer Village and Key Largo Park projects. Some of the benefits of utilizing this system for these projects are listed here:

- The Roediger valve chamber is watertight allowing ease of access by operational personnel to the vacuum valve for adjustment.

- Collection sump is also easier to access by system operators to remove debris that may inadvertently enter the sewer system.

- Provides corrosion resistant chambers (no buried steel bolts)

For the above reasons, Brown and Caldwell recommend the use of the Roediger system. It should be noted that both vendors made detailed presentations to the District's Engineer and Manager as well as the Haskell Design Build Team during these presentations; both manufacturers expressed their interest in supporting the District's needs.

We trust that the information will assist the Key Largo Wastewater Treatment District Board in its decision.

Very truly yours,

BROWN AND CALDWELL

Joseph S. Paterniti, P.E, D.E.E.
Collection System Project Engineer

Attachments:

Cc: Charles Sweat, GAC
Jeff Weiler, WEC

ROEVAC® Vacuum Sewer System

List of Reference Plants

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
GERMANY							
Community Aholming	Isarau	D – BAY	94527	Aholming	220	1994	
Community Aholming	Kühmoos	D – BAY	94527	Aholming	50	1994	
Community Aholming	Tabertshausen	D – BAY	94527	Aholming	180	1994	
Community Bad Aibling	Berbling	D – BAY	83043	Bad Aibling	58	1996	
Community Balzhausen		D – BAY	86483	Balzhausen	64	1989	
Community Demling		D – BAY	85098	Demling	150	1998	
Community Edling		D – BAY	83533	Edling	80	1989	
Community Geltendorf	Walleshausen	D – BAY	82269	Walleshausen	120	1997	
Community Geisling Pfatter		D – BAY	93102	Geisling	200	2001	
Haindl Papier-Fabrik		D – BAY	86956	Schongau	40	1993	
Community Höchstädt		D – BAY	89420	Höchstädt	400	1994	
Community Illkofen		D – BAY	93092	Illkofen	100	1998	
Community Karlshuld	VS 6	D – BAY	86668	Karlshuld	300	1990	
Community Karlshuld	VS 7	D – BAY	86668	Karlshuld	200	1989	
Community Karlshuld	VS 8	D – BAY	86668	Karlshuld	400	1990	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
City of Kelheim	Schiffsentwässerung	D – BAY	93309	Kelheim	3 pistols	1990	ship services
City of Kolbermoor	Pullach	D – BAY	83505	Kolbermoor	70	1992	Water protection a.
Community Langeringen	Gennach	D – BAY	86853	Gennach	140	1994	
City of Neuötting	Alzgern	D – BAY	84524	Neuötting	120	1993	
City of Neuötting	Roja	D – BAY	84524	Neuötting	30	1993	
Community Niederwinkling		D – BAY	94559	Niederwinkling	30	1998	
City of Regensburg	Sallermühle	D – BAY	93057	Regensburg	12	1995	Water protection
Community Reit im Winkel		D – BAY	83242	Reit im Winkl	12	1995	
Community Stephansposching	Michaelsbuch	D – BAY	94569	Stephansposching	140	1993	
Community Straßkirchen	Schambach	D – BAY	94342	Straßkirchen	140	1998	
Markt Tüßling	VS I + VS II	D – BAY	84577	Tüßling	800	1997	
Gem. Uffenheim-Langensteinach	Langensteinach	D – BAY	97215	Uffenheim	15	1996	industry
Waldmünchen	Ast	D – BAY	93449	Waldmünchen	63	2000	
Community Wallersdorf	Moosfürth	D – BAY	94522	Wallersdorf	60	1997	
City of Miltenberg	Miltenberg	D – BAY	63897	Miltenberg	16	1999	Compact Station

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Siedlergemeinschaft	HOKA 3	D – BER	13629	Berlin	157	1997	
Community Wernsdorf/Ziegenhals		D – BER	15537	Niederlehne	214	1997	
Community Alt-Schadow		D – BRA	15910	Alt Schadow	130	1993	
Community Alt-Tucheband		D – BRA	15306	Alt Tucheband	128	1998	
Community Brusendorf		D – BRA	15749	Brusendorf	244	1996	
Community Genshagen	Brandenburg Park	D – BRA	14974	Genshagen	124	1993	
Community Jänschwalde		D – BRA	03197	Jänschwalde	332	1994	
Community Ketzin	1. BA	D – BRA	14669	Ketzin	270	1996	
Community Leibsch		D – BRA	15910	Leibsch	154	1993	
City of Lieberose	BA 1 und BA 2	D – BRA	15868	Lieberose	500	1995	
Community Neu- Lübbenau		D – BRA	15910	Neu -Lübbenau	150	1993	
Community Rangsdorf		D – BRA	15834	Rangsdorf	373	1995	
Community Schlepzig		D – BRA	15910	Schlepzig	304	1994	
Community Zeust		D – BRA	15848	Zeust	34	1989	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Community Hagenbach	Hagenbach	D – BWB	76767	Hagenbach	8	1973	
Community Dettenheim	Altdettenheim	D – BWB	76706	Dettenheim	15	1989	
Community Dettenheim	Rußheim	D – BWB	76706	Dettenheim	8	1991	
Community Graben–Neudorf	Graben–Neudorf I	D – BWB	76676	Graben–Neudorf	4	1990	
Community Graben–Neudorf	Graben–Neudorf II	D – BWB	76676	Graben–Neudorf	8	1991	
Community Gaienhofen	Möösle	D – BWB	78343	Gaienhofen	40	1993	
Community Iffezheim		D – BWB	76473	Iffezheim	22		
Community Kronau		D – BWB	76709	Kronau	6	1990	
Community Malsch		D – BWB	76316	Malsch	60	1993	
City of Mannheim	Straßenheim	D – BWB	63133	Mannheim	32	1994/1999	
City of Viernheim	Neuzenlache	D – BWB	68519	Viernheim	60	1998	
Community Gottmadingen	Murbach	D – BWB	78244	Gottmadingen	30	2000	Compact Station
City of BürCity of		D – HES	63297	BürCity of	7	1993	
City of BürCity of	Boxheimerhof	D – HES	63297	BürCity of	16	1996	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Community Börzow	Gostorf	D – MVP	23738	Gostorf	100	1994	
Community Börzow		D – MVP	19294	Gostorf	82	1994	
Community Redewisch		D – MVP	23946	Redewisch	110	1994	
Community Neuenkirchen		D – MVP	17392	Neuenkirchen	42	1997	
Community Neu–Gülze	Neu Gülze I	D – MVP	19258	Neu–Gülze	105	2000	
City of Moers	Steinbrückenstr.	D – NRW	47441	Moers	20	1995	
City of Moers	Schwafheim	D – NRW	47441	Moers	35	1998	
City of Neukirchen	Vluyn	D – NRW	47506	Neukirchen	116	1989	
City of Wermeldkirchen	Stumpf/Koeckersweg	D – NRW	42929	Wermelskirchen	134	1998	
Community Baddeckenstedt		D – NS	38271	Baddeckenstedt	60	1996	
City of Bergen	Becklingen	D – NS	29303	Bergen	91	1994	
City of Bergen	Bleckmar	D – NS	29303	Bergen	142	1989	
City of Bergen	Donsen	D – NS	29303	Bergen	46	1993	
City of Bergen	Niendorf	D – NS	29303	Bergen	55	1991	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
City of Bergen	Wardböhmen	D – NS	29303	Bergen	92	1992	
City of Bergen	Hassel	D – NS	29303	Bergen	70	1996	
City of Buxtehude	Neuland	D – NS	21614	Buxtehude	25	1992	
Community Klein Meckelsen	Marschhorst	D – NS	27419	Klein Meckelsen	20	1994	
City of Langenhagen	Schulenburg	D – NS	30855	Langenhagen	30	1992	
Community Oberndorf	Am Dobrock	D – NS	21787	Oberndorf - SG	34	1994	
City of Sulingen	Klein Lessen	D – NS	27233	Sulingen	30	1991	
City of Sulingen	Landwehr	D – NS	27233	Sulingen	35	1992	
City of Sulingen	Stehlen	D – NS	27233	Sulingen	25	1990	
Community Stadland	Schwei	D – NS	26936	Stadland	30	1996	
Community Wathlingen	Adelheitsdorf	D – NS	29339	Wathlingen	140	1993	
City of Winsen	Bannetze	D – NS	29308	Winsen/Aller	100	1994	
City of Winsen	Thören	D – NS	29308	Winsen/Aller	400	1994	
Community Stroit	Stroit	D – NS	37574	Stroit	100	2000	
Community Neuhofen	Neuhofen	D – RLP	67141	Neuhofen	4	1978	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Community Böhl-Iggelheim		D – RLP	67459	Böhl - Iggelheim	260	1990	
City of Otter	Waldsee	D – RLP	67166	City of Otter	98	1995	Recreation Area
Eich	Eicher See	D – RLP	67575	Eich	660	1998	Flooding Area
Bad Elster	Heißenstein	D – SAC	08645	Bad Elster	15	2001	Healing water protection zone / Vacuum station type 140
Bischofswerda	Belmsdorf	D – SAC	01877	Bischofswerda	12	1998	Incline
Deutschneudorf	Deutschneudorf	D – SAC	09548	Deutschneudorf	100	1998	Vacuum station inside the mountain
Eilenburg	Hainichen	D – SAC	04838	Eilenburg	79	2000	Vacuum station underground
Görlitz	Alt-Weinhübel	D – SAC	02827	Görlitz	41	2001	Water protection A.
Gräfenhain	Gräfenhain	D – SAC	01936	Gräfenhain	83	2000	Rocky ground,
Großenhain	Walkdamm	D – SAC	01558	Großenhain	7	1999	narrow street
Hirschfelde	Drausendorf	D – SAC	02788	Hirschfelde	60	1997	Mining area – unstable ground
Leipzig/Markkleeberg	Cospuden	D – SAC	04229	Leipzig	8	2000	4 house connection chambers in operation / Vacuum station type 360

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Löbnitz	Löbnitz	D – SAC	04509	Löbnitz	51	2001	Still without Vacuum Station
Markranstädt	Quesitz	D – SAC	04420	Quesitz	99	1997 + 1999	Water protection A.
Morgenröthe - Rautenkranz	Morgenröthe	D – SAC	08262	Morgenröthe	60	1997 + 1999	
Neuhausen	Neuwernsdorf	D – SAC	09544	Neuwernsdorf	77	1996	Water protection A.
Neuhausen	Heidersdorf	D – SAC	09526	Heidersdorf	120	1997	
Audenhain	Niederaudenhain	D – SAC	04834	Audenhain	90	1995	
Audenhain	Oberaudenhain	D – SAC	04834	Audenhain	135	1995	
Rammenau	Rammenau 2 VS	D – SAC	01877	Rammenau	222	1999	High water table
Rochlitz	Zaßnitz	D – SAC	09366	Rochlitz	100	1997	
Schlunzig		D – SAC	08138	Schlunzig	84	1997	
Thallwitz	Nischwitz	D – SAC	04808	Thallwitz	33	1996	Water protection A.
Thallwitz	Kollau	D – SAC	04808	Thallwitz	30	1995	
Chemie AG Bitterfeld	Chemie Park	D – SAH	06749	Bitterfeld	approx. 80	1994	Industrial Area
Braunsbedra	Schortau	D – SAH	06242	Braunsbedra	90	1999	
Göddeckenrode	Göddeckenrode	D – SAH	38835	Göddeckenrode	60	1995	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
City of Halle	Dölau	D – SAH	06114	Halle	250	1994	
City of Halle	Lettin 1	D – SAH	06114	Halle	110	1994	
City of Halle	Lettin 2	D – SAH	06114	Halle	250	1995	
Community Hohengöhren		D – SAH	39524	Hohengöhren	120	1994	
Community Hohenweiden	Hohenweiden	D – SAH	06179	Hohenweiden	168	1997	
Community Holleben	Benkendorf	D – SAH	06179	Holleben	50	1994	
Community Miesterhorst		D – SAH	39639	Miesterhorst	188	1994	
City of Naumburg	Schellsitz	D – SAH	06618	Naumburg	64	1997	Flooding Area
Verwaltungsgemeinschaft (VG) Schmerzbach	Burgkemnitz	D – SAH	06774	Plodda	192	1995	
(VG) Schmerzbach	Gossa	D – SAH	06774	Plodda	169	1993	
(VG) Schmerzbach	Gröbern	D – SAH	06774	Plodda	194	1994	
(VG) Schmerzbach	Krina	D – SAH	06774	Plodda	212	1994	
(VG) Schmerzbach	Plodda	D – SAH	06774	Plodda	146	1993	
(VG) Schmerzbach	Rösa	D – SAH	06774	Plodda	188	1995	
(VG) Schmerzbach	Brösa	D – SAH	06744	Plodda	40	1995	
(VG) Schmerzbach	Schlaitz	D – SAH	06774	Plodda	276	1993	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
(VG) Schmerzbach	Schmerz	D – SAH	06774	Plodda	89	1995	
(VG) Schmerzbach	Hohenlubast	D – SAH	06774	Plodda	39	1996	
(VG) Schmerzbach	Schköna	D – SAH	06774	Plodda	109	1996	
(VG) Schmerzbach	Schwemsal	D – SAH	06774	Plodda	150	1996	
Community Solpke		D – SAH	39638	Solpke	182	1994	
City of Wettin	Zaschwitz	D – SAH	06198	Wettin	40	1996	
City of Aken	Kühren	D – SAH	06385	Kühren	95	2001	
Möhlau	Möhlau	D – SAH	06791	Möhlau	4	2001	2001, Water Protection A.
Community Daldorf		D – SH	24635	Daldorf	120	1996	
Community Fargau-Pratjau		D – SH	24256	Fargau	80	1991	
Community Kalübbe		D – SH	24326	Kalübbe	155	1990	
Community Kayhude		D – SH	28863	Kayhude	165	1987	
Community Neuendeich		D – SH	25436	Neuendeich	160	1992/1993	
Community Neukirchen		D – SH	25927	Neukirchen	140	1992	
Community Nordstrand		D – SH	25845	Nordstrand	350	1998/1999	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Community Pellworm		D – SH	25849	Pellworm	80	1996	
Community Risum - Lindholm		D – SH	25920	Risum-Lindholm	1.000	1987	
Community Schmalensee		D – SH	24638	Schmalensee	180	1990	
AUSTRIA							
City of Gerasdorf	Föhrenhain	A	2201	Gerasdorf	700	1998	
City of Gerasdorf	Kappellerfeld I + II	A	2201	Gerasdorf	1.000	1991	
City of Gerasdorf	Seyring	A	2201	Gerasdorf	600	1990	
Ebreichsdorf	EHZ - Weigelsdorf	A		Ebreichsdorf	450	1998	
City of Rust	See-Ufer	A	7021	Rust	100	1990	
Leopoldsdorf / Nähe Marchfeld	Zuckerfabrik	A		Leopoldsdorf	20		
City of Vienna	"Old Danube"	A		Vienna	200	1992	Recreation Area
Wörth a.d. Lafnitz	Bez. Hartberg	A		Wörth a.d. Leitha	150	1997	
City of Salzburg	Liefering	A		Salzburg	140	1999	
City of Salzburg	Moosstrasse	A		Salzburg	170	1999	
Mining	Whole community	A	6343	Mining	300	2001	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Pottendorf	Settlement Eisteich	A		Pottendorf	70	2000	
City of Baden	Haidhofteich	A		Baden	70	2000	
CZECH REPUBLIC							
Karlovice		CZ		Karlovice	150	1998/99	
Kostomlaty		CZ		Kostomlaty	120	1997	
Prerov n.L.		CZ		Prerov	200	1997/1998	
Tri Dvory		CZ		Tri Dvory	300	1997/1999	
Hradistko		CZ		Hradistko	125	1998/1999	
Postrelmov		CZ		Postrelmov	600	2000	
Otice		CZ		Otice	320	2001	
Sudkov		CZ		Sudkov	250	2001/2002	
Obora		CZ		Obora	100	2001	
Bedimost		CZ		Bedimost	320	2002	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
POLAND							
Community Blonie		PL	05-870	Blonie	150	1997	
Community Krokowa	Karwienski Blota I	PL		Karwienski Blota	220	2000	
Community Krokowa	Karwienski Blota II	PL		Karwienski Blota	220	2000	
Community Krokowa	Debki	PL		Debki	100	2001	
Community Kedzierzyn-Kozle		PL		Kedzierzyn-Kozle	90	1999	
Community Lagow		PL		Lagow	270	2001	
Community Piaseczno	Gloskow I A	PL		Piaseczno	90	1999	
Community Piaseczno	Gloskow II B	PL		Piaseczno		2000	
Community Piaseczno	Gloskow III C	PL		Piaseczno		2000	
Community Piaseczno	Gloskow IV D	PL		Piaseczno		2000	
Community Piaseczno	Chyliczki	PL		Piaseczno	300	2000	
Community Piaseczno	Zalesie Gorne B	PL		Piaseczno	510	2001	
Community Piaseczno	Zalesie Gorne C	PL		Piaseczno	220	2001	
Community Wiazownica VS C		PL		Wiazownica	900	1999	
Community Wiazownica VS B		PL		Wiazownica		2000	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Community Wiazownica VS A		PL		Wiazownica		2002	
Community Wiazownica VS D		PL		Wiazownica		2002	
Community Celestinow VS B		PL		Celestinow		2001	
Community Wieliszew	Janowek I	PL		Wiesliszew	100	2000	
Community Wieliszew	Janowek II	PL		Wiesliszew	100	2000	
Community Wieliszew	Krubin	PL		Wiesliszew	100	2000	
Community Dygowo	Dygowo	PL		Dygowo	350	2000	
Community Zukowka	Zukowka	PL		Zukowka	40	2001	
Community Malbork	Lasowice	PL		Lasowice	45	under construction	
Trzesn	Trzesn	PL		Trzesn	200	under construction	

BOTSWANA

Shoshong	Shoshong Village	BW		Shoshong District	500	2002/under construction	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
GREECE							
Potidea	Chalkidiki	GR		Potidea	180	2002	
Sarti	Chalkidiki	GR		Sarti	110	under construction	
HUNGARY							
Community Dany		H	2118	Dany	550	1997	
ITALY							
Piombino	Parco Turistico	I		Piombino (LI)	15	2001	
Ostia (Roma)	Stagni di Ostia	I		Canale della Lingua	410	2002 under construction	
NETHERLANDS							
Community Amstelveen		NL		Amstelveen	40	2000	
Community Bedum		NL		Bedum	35	2001	
Community Gramsbergen		NL		Gramsbergen	45	2001	
Community Houten		NL		Houten	26	2001	

Community	Village Area	Country	Code	Address	N° of Valves	Operation	Speciality
Community Oirschot		NL		Oirschot	120	2001	
Community Venhuizen		NL		Venhuizen	112	2002	
MALAYSIA							
Langkawi	Langkawi Lagoon	MY		Langkawi Lagoon Resort	26	2002	
Kerian	Kerian Valley	MY		Perak Darul Ridzuan	120	2002	
SPAIN							
Puerto de Tarragona	Plataforma Logística	E		Tarragona	10	1999	
Orilla dell'Azarbe (MU)	Orilla dell'Azarbe	E		Murcia	366	2002	
UNITED KINGDOM							
ISIS REACH	Belvedere	UK		London	12	2001	Operating comp.: Thames Water

ROEVAC

Annual Cost for Vacuum Sewer System (Key Largo KLTV + KLP)

Project:	Key Largo, FL	Proposal # 0023060

Total Vacuum Sewer Cost

Monthly Vacuum Station Costs	$ 1.54	per month per EDU
Monthly Vacuum Sewer Network Costs	$ 0.46	per month per EDU
Total Monthly Vacuum Sewer Costs	$ 1.99	per month per EDU
	$ 36.17	per million gallons
Annual Vacuum Station Costs	$ 18.47	per year per EDU
Annual Vacuum Sewer Network Costs	$ 5.46	per year per EDU
Total Annual Vacuum Sewer Costs	$ 23.93	per year per EDU
	$ 434.00	per million gallons

Vacuum Station

1. Operation, Maintenance and Repair Cost

a) Energy Cost

Vacuum Pumps

Actual suction capacity			467 am³/h	
Average running time of vacuum pumps			10.1 hr / day	
Average daily power consumption			113 kWh / day	
Annual running time			3,688 hr / year	
Annual average power consumption vacuum pumps			37,123 kWh	
Nominal motor power	11.2 kW	(15.0 hp)	Efficiency:	90%
Brake motor power	10.1 kW	(13.5 hp)		

Sewage Pumps

Average running time sewage pumps			6 hr / day	
Average daily power consumption			31 kWh / day	
Annual running time			2,231 hr / year	
Annual average power consumption sewage pumps			11,229 kWh	
Nominal motor power	5.6 kW	(7.5 hp)	Efficiency:	90%
Brake motor power	5.0 kW	(6.8 hp)		

Control Panel

	18.0 kWh / day
Annual average power consumption control panel	6,570 kWh

Total Energy Cost

Total annual energy consumption		54,922 kWh
Total annual energy cost	(when using $ 0.055 /kWh)	$ 3,020 per year
Annual energy cost per EDU		$ 3.55 per year per EDU

ROEVAC

b) Routine Inspection and Preventive Maintenance Cost

Labor Cost:	$ 15 per hour			
		5.0	hours per week	
		7.0	hours per month	(monthly service schedule)
		24.0	hours per year	(annual service)
Parts (oil, air filter, etc.)		$ 484.0	per year	

Total annual cost	$ 4,999 per year
Annual cost per per EDU	$ 5.88 per year per EDU

c) Non predictive Maintenance / Repair Cost (Labor & Parts)

Total annual cost are approximately :	$ 1,920 per year
Annual cost per EDU	$ 2.26 per year per EDU

2. Re-investment Cost for Vacuum Station Equipment

	Approx. annual costs	Expected life time
Vacuum pumps	$ 2.157	17 years
Sewage pumps	$ 1.465	15 years
Vacuum tank	$ 1,061	20 years
Control panel	$ 956	20 years
Misc. equipment	$ 119	15 years
Total costs:	$ 5,758 per year	
Annual cost per EDU	$ 6.77 per year per EDU	

ROEVAC

Vacuum Sewer Network

Operation, Maintenance and Repair Cost

# House connections:	850	
# Collection chambers:	277	
# Interface valve units:	277	
Labor costs:	$ 15	

1. Service Calls

Average MTBSC interface valves	40	years
Average MTBSC controllers	30	years
Service time interface valves	0.85	hours
Service time controller	1.25	hours
Total service time:	17	hours
Total labor costs:	**$ 261**	per year

MTBSC = Mean Time Between Service Calls
Note: Service time includes **traveling time** to defect valve unit and repairing it onsite or offsite.

2. Routine / Preventive Maintenance & Material Repair:

a) Interface Valve

Diaphragm overhaul interval:	5	years
Diaphragm overhaul time:	0.1	hours
Diaphragm:	$ 25	
Valve overhaul interval:	10	years
Valve overhaul time:	0.15	hours
Valve overhaul kit:	$ 50	
Costs:	**$ 1,458**	per year

b) Controller

Controller overhaul interval:	10	years
Controller overhaul time	0.5	hours
Controller overaul kit:	$ 45	
Costs:	**$ 1,454**	per year

c) Collection Chamber

Preventive inspection per chamber:	1	per year
Inspection time:	0.2	hours
Costs:	**$ 831**	per year

d) Miscellaneous

Parts:		$ 263	per year
Labor:	25 hours	$ 375	hours per year

Total Annual Cost:	$ 4,643	per year
Total Annual Cost per EDU	$ 5.46	per year per EDU

Mean Time Between Service Calls for Roevac Valve Unit

			service per year			
Project	**Date of Installation**	**# valves**	**controller [%]**	**valves [%]**	**unit [%]**	**MTBSC for unit [year]**
Edling	1989	80	9.5	0	9.5	10.6
Buxtehude, Germany	1990	140	5.2	0.4	5.2	17.9
Gemshagen, Germany	1993	84	1.2	0	1.2	84
Leibsch	1993	150	0.4	0	0.4	225
Aholming	1993	450	2	0.1	2	46.6
Neu-Luebbenau	1993	150	0.2	0	0.2	450

Key Largo Trailer Village

Connections 470

EDU's 567

ANNUAL O&M ESTIMATE

Initial Condition

VPS sized for KLTV & KLP

LABOR						
Item	Labor effort		Quantity		Annual Labor	
Vacuum Station	300 hrs/yr/station	x	1 station	=	300	hrs/yr
Piping	60 hrs/yr/system	x	1 system	=	60	hrs/yr
Valves	1.4 hrs/yr/valve	x	187 valves	=	262	hrs/yr
					622	hrs/yr
				x	$15	/hr
					$9,330	/yr
				ROUND TO:	$9,300	/yr

POWER								
Item	Unit cost		EDU		Duration		Annual Power	
Vacuum Station								
Flat rate	$75.00 /mo	x			12 mo		$900	/yr
Consumption	$1.75 /mo/EDU	x	567 EDU	x	12 mo	=	$11,907	/yr
							$12,807	
						ROUND TO:	$12,800	/yr

EQUIPMENT REPLACEMENT								
Item	Replacement cost		Useful life		Quantity		Annual R&R	
VACUUM STATION								
Vacuum Pumps	$15,800 /ea	/	15 years	x	3 pumps	=	$3,160	/yr
Sewage Pumps	$7,000 /ea	/	15 years	x	2 pumps	=	$933	/yr
Collection Tank	$10,200 /ea	/	15 years	x	1 ea	=	$680	/yr
Control Panel	$10,000 /ea	/	20 years	x	1 ea	=	$500	/yr
Misc. Equip	$2,000 /ea	/	15 years	x	1 ea	=	$133	/yr
							$5,407	/yr
						ROUND TO:	$5,400	/yr
VACUUM VALVES								
Vacuum Valves	$20.00 /ea	/	10 years	x	187 valves	=	$374	/yr
Controller	$40.00 /ea	/	7 years	x	187 valves	=	$1,069	/yr
Misc. Parts	$20.00 /ea	/	10 years	x	187 valves	=	$374	/yr
							$1,817	/yr
						ROUND TO:	$1,800	/yr

SUMMARY		
LABOR	$9,300	/yr
POWER	$12,800	/yr
EQUIPMENT REPLACEMENT (STATION)	$5,400	/yr
EQUIPMENT REPLACEMENT (VALVES)	$1,800	/yr
	$29,300	/yr
# EDU's	567	
COST PER EDU	$52	/yr/EDU

Adding Key Largo Park

Connections 283
EDU's 283

ANNUAL O&M ESTIMATE
Future Extension
incremental increase in O&M

LABOR							
Item	Labor effort		Quantity				Annual Labor
Vacuum Station	300 hrs/yr/station	x	0 station	*already included in KLTV & KLP*	=		0 hrs/yr
Piping	20 hrs/yr/system	x	1 system		=		20 hrs/yr
Valves	1.4 hrs/yr/valve	x	90 valves		=		126 hrs/yr
							146 hrs/yr
					x		$15 /hr
							$2,190 /yr
						ROUND TO:	$2,200 /yr

POWER								
Item	Unit cost		EDU		Duration			Annual Power
Vacuum Station								
Flat rate	$75.00 /mo	x			*already included in KLTV & KLP*			$0 /yr
Consumption	$1.75 /mo/EDU	x	283 EDU	x	12 mo	=		$5,943 /yr
								$5,943
							ROUND TO:	$5,900 /yr

EQUIPMENT REPLACEMENT								
Item	Replacement cost		Useful life		Quantity			Annual R&R
VACUUM STATION					*already included in KLTV & KLP*			
Vacuum Pumps	$15,800 /ea	/	15 years	x	0 pumps	=		$0 /yr
Sewage Pumps	$7,000 /ea	/	15 years	x	0 pumps	=		$0 /yr
Collection Tank	$10,200 /ea	/	15 years	x	0 ea	=		$0 /yr
Control Panel	$10,000 /ea	/	20 years	x	0 ea	=		$0 /yr
Misc. Equip	$2,000 /ea	/	15 years	x	0 ea	=		$0 /yr
								$0 /yr
							ROUND TO:	$0 /yr
VACUUM VALVES								
Vacuum Valves	$20.00 /ea	/	10 years	x	90 valves	=		$180 /yr
Controller	$40.00 /ea	/	7 years	x	90 valves	=		$514 /yr
Misc. Parts	$20.00 /ea	/	10 years	x	90 valves	=		$180 /yr
								$874 /yr
							ROUND TO:	$900 /yr

SUMMARY	
LABOR	$2,200 /yr
POWER	$5,900 /yr
EQUIPMENT REPLACEMENT (STATION)	$0 /yr
EQUIPMENT REPLACEMENT (VALVES)	$900 /yr
	$9,000 /yr
# EDU's	283
COST PER EDU	$32 /yr/EDU

Labor required for rebuild

The following chart shows the labor effort required to rebuild the AIRVAC controller and valve.

Item	Maintenance Interval	Personnel Required	Labor ** (hours)
Physical Inspection	Every year	1 man	0.50 hrs
Controller Rebuild Sanitize Rebuild QC tests	Every 5 yrs	1 man	0.25 hrs 0.50 hrs 0.25 hrs 1.00 hrs
Valve Rebuild Sanitize Inspect * Rebuild QC testing	Every 10 yrs	1 man	0.25 hrs 0.25 hrs 1.00 hrs 0.25 hrs 1.75 hrs

* inspect for other wear/defects
** per valve

MTBSC - EPA Study (systems from 1979 to 1989)

Data gathered by EPA and presented in their 1990 Alternative Wastewater Collection Systems manual (EPA/625/1-91/024) indicates a MTBSC of between 6 and 22.5 years (MTBSC = # valves/# service calls/yr). Stated another way, 4 to 16 service calls per year per 100 valves are required.

	Year operational	# valves	# service calls/yr	MTBSC (yrs)
Westmoreland, TN	1979	490	48	10.2
Ohio Co, WV	1984	200	24	8.3
Lake Chatauqua, NY	1986	900	40	22.5
Central Boaz, WV	1988	180	30	6.0
Whitehouse, TN	1988	260	24	10.8
		2030	166	12.2

MTBSC – AIRVAC Data (systems from 1988 to 1999)

The more recent systems have experienced fewer problems than the older systems. Component improvements and design advancements have led to this improved reliability. AIRVAC gathered information from several recently constructed systems (data shown below). The result was a MTBSC ranging from 8.0 to 21.8 years.

	Year operational	# valves	# service calls/yr	MTBSC (yrs)
Lake Manitou, IN	1988	435	20	21.8
Adams Lake, IN	1992	209	26	8.0
Tri-Lakes, IN	1994	540	36	15.0
Reedville, VA	1996	87	10	8.7
		1271	92	13.8

D&B Comprehensive Report

ATTN: **Sara Guthrie**

Report Printed: SEP 23 2003

Overview

BUSINESS SUMMARY

ROEDIGER PITTSBURGH, INC.
(FOREIGN PARENT IS PASSAVANT-ROEDIGER UMWELTTECHNIK GMBH, AARBERGEN, GERMANY.)
3812 Route 8
Allison Park, PA 15101

D&B D-U-N-S Number: 09-332-9928

This is a **single (subsidiary)** location.

Web site:	www.roediger.com
Telephone:	412 487-6010
Fax:	412 487-6005
Chief executive:	DR MARCUS ROEDIGER, PRESIDENT
Year started:	1978
Employs:	47
Financial statement date:	DEC 31 2001
Sales F:	$6,941,989
Net worth F:	$2,079,937
History:	CLEAR
Financing:	SECURED
Financial condition:	GOOD
SIC:	3589 3542 3531
Line of business:	Mfg service industry machinery, mfg machine tools-forming, mfg construction machinery

Credit Score Class: 2

Moderate risk of severe payment delinquency over next 12 months

Financial Stress Class: 1

Low risk of severe financial stress over the next 12 months

12-Month D&B PAYDEX®: 66

When weighted by dollar amount, payments to suppliers average 19 days beyond terms.

D&B Rating:	**3A2**
Financial strength:	3A is **$1 to 10 million.**
Composite credit appraisal:	2 is **good.**

EXECUTIVE SUMMARY

The **Financial Stress Class of 1** for this company shows that during the previous year, firms with this classification had a failure rate of 0.49% (49 per 10,000), which is lower than the national average.

The **Credit Score class of 2** for this company shows that during the previous year, 4.7% of the firms with this classification paid one or more bills severely delinquent, which is lower than the national average.

Predictive Scores	This Business	Comments
Financial Stress Class	1	Failure Rate lower than the national average
Financial Stress Score	1478	Highest Risk: 1,001; Lowest Risk: 1,850
Credit Score Class	2	Probability of Severely Delinquent Payment is lower than the national average.

Other Key Indicators		
PAYDEX Scores	19 days beyond terms	Pays more slowly than the average for its industry of 14 days beyond terms
Industry Median	14 days beyond terms	
Operations	Profitable	
Present management control	25 years	
UCC Filings	UCC filing(s) are reported for this business	
Public Filings	No record of open Suit(s), Lien(s), or Judgment(s) in the D&B database	
Financing	Is secured	
History	Is clear	

CREDIT CAPACITY SUMMARY

D&B Rating: **3A2**

Financial strength: 3A indicates **$1 to 10 million.**

Composite credit appraisal: 2 is **good.**

This credit rating was assigned because of D&B's assessment of the company's financial ratios and its cash flow. For more information, see the D&B Rating Key.

Sales:	$6,941,989	**Payment Activity:**	
# of Employees Total:	47	(based on 63 experiences)	
As of 12/31/01		**Average High Credit:**	$3,845
Worth:	$2,079,937	**Highest Credit:**	$40,000
Working Capital:	$1,882,325	**Total Highest Credit:**	$231,700

Note: The Worth amount in this section may have been adjusted by D&B to reflect typical deductions, such as certain intangible assets.

Jump to:

Overview | Payments | Public Filings | History & Operations | Banking & Finance

Scores

FINANCIAL STRESS SUMMARY

The Financial Stress Summary Model predicts the likelihood of a firm ceasing business without paying all creditors in full, or reorganization or obtaining relief from creditors under state/federal law over the next 12 months. Scores were calculated using a statistically valid model derived from D&B's extensive data files.

Financial Stress Class: 1

Low risk of severe financial stress, such as a bankruptcy, over the next 12 months.

Incidence of Financial Stress

Among Businesses with this Classification:	0.49% (49 per 10,000)
National Average	1.40% (140 per 10,000)

Financial Stress National Percentile: 76 (Highest Risk: 1; Lowest Risk: 100)

Financial Stress Score: 1478 (Highest Risk: 1,001; Lowest Risk: 1,850)

The Financial Stress Class of this business is based on the following factors:

- No record of open suit(s), lien(s), or judgement(s) in the D&B files.
- 43% of trade experiences indicate slow payment(s) are present.
- Change in Net Worth suggests lower risk of financial stress.
- Financial Statement is more than 12 months old.
- Change in Quick Ratio suggests lower risk of financial stress.

Notes:

- The Financial Stress Class indicates that this firm shares some of the same business and financial characteristics of other companies with this classification. It does not mean the firm will necessarily experience financial stress.
- The Incidence of Financial Stress shows the percentage of firms in a given Class that discontinued operations over the past year with loss to creditors. The Incidence of Financial Stress - National Average represents the national failure rate and is provided for comparative purposes.
- The Financial Stress National Percentile reflects the relative ranking of a company among all scorable companies in D&B's file.
- The Financial Stress Score offers a more precise measure of the level of risk than the Class and Percentile. It is especially helpful to customers using a scorecard approach to determining overall business performance.
- All Financial Stress Class, Percentile, Score and Incidence statistics are based on 2002.

Norms	National %
This Business	76
Region: **MIDDLE ATLANTIC**	60
Industry: **MANUFACTURING**	49
Employee Range: **20-99**	59
Years in Business: **11-25**	73

This business has a Financial Stress Percentile that shows:

- Lower risk than other companies in the same region.
- Lower risk than other companies in the same industry.
- Lower risk than other companies in the same employee size range.
- Lower risk than other companies with a comparable number of years in business.

CREDIT SCORE CLASS SUMMARY

The Credit Score class predicts the likelihood of a firm paying in a severely delinquent manner (90+ Days Past Terms) over the next twelve months. It was calculated using statistically valid models and the most recent payment information in D&B's files.

Credit Score Class: 2

Moderate risk of severe payment delinquency over next 12 months.

Incidence of Delinquent Payment

Among Companies with this Classification: 4.70%

Credit Score Percentile: 85 (Highest Risk: 1; Lowest Risk: 100)

The Credit Score Class of this business is based on the following factors:

- Control age or date entered in D&B files indicates lower risk.
- No record of open suit(s), lien(s), or judgments(s) in the D&B files.
- Business does not own facilities.
- Quick ratio is 1.2.

Notes:

- The Incidence of Delinquent Payment is the percentage of companies with this classification that were reported 90 days past due or more by creditors. The calculation of this value is based on an inquiry weighted sample.
- The Percentile ranks this firm relative to other businesses. For example, a firm in the 80th percentile has a lower risk of paying in a severely delinquent manner than 79% of all scorable companies in D&B's files.

Norms	National %
This Business	85
Region: **MIDDLE ATLANTIC**	43
Industry: **MANUFACTURING**	53
Employee Range: **20-99**	60
Years in Business: **11-25**	61

This business has a Credit Score Percentile that shows:

- Lower risk than other companies in the same region.
- Lower risk than other companies in the same industry.
- Lower risk than other companies in the same employee size range.
- Lower risk than other companies with a comparable number of years in business.

Jump to:

Overview | Scores | Public Filings | History & Operations | Banking & Finance

Payments

PAYMENT TRENDS

Total Payment Experiences in D&B's 63

File:		**Current PAYDEX is:**	**66**	equal to 19 days beyond terms
Payments Within Terms: (not dollar weighted)	75%	**Industry Median is:**	**71**	equal to 14 days beyond terms
Total Placed For Collection:	0	**Payment Trend currently is:**		**unchanged,** compared to payments three months ago
Average Highest Credit:	$3,845			
Largest High Credit:	$40,000			
Highest Now Owing:	$40,000			
Highest Past Due:	$15,000			

Indications of slowness can be the result of dispute over merchandise, skipped invoices, etc. Accounts are sometimes placed for collection even though the existence or amount of the debt is disputed.

PAYDEX Scores

Shows the D&B PAYDEX scores as calculated on the most recent 3 months and 12 months of payment experiences.

The D&B PAYDEX is a unique, dollar weighted indicator of payment performance based on up to payment experiences as reported to D&B by trade references. A detailed explanation of how to read and interpret PAYDEX scores can be found at the end of this report.

3-Month D&B PAYDEX: 65
When weighted by dollar amount, payments to suppliers average 19 days beyond terms.

Based on payments collected over last 3 months.

12-Month D&B PAYDEX: 66
When weighted by dollar amount, payments to suppliers average 19 days beyond terms.

Based on payments collected over last 12 months.

PAYDEX Yearly Trend

12 Month PAYDEX Scores Comparison to Industry

	10/02	11/02	12/02	1/03	2/03	3/03	4/03	5/03	6/03	7/03	8/03	9/03
This Business	UN	UN	UN	UN	UN	UN	67	67	67	67	67	66
Industry Quartiles												
Upper			76			76			76			77
Median			71			71			71			71
Lower			65			65			66			65

- Current PAYDEX for this Business is 66, or equal to 19 days beyond terms
- The 12-month high is **67**, or equal to 18 days beyond terms
- The 12-month low is **unavailable**

PAYDEX Comparison to Industry

Shows PAYDEX scores of this Business compared to the Primary Industry from each of the last four quarters. The Primary Industry is Mfg service industry machinery, mfg machine tools-forming, mfg construction machinery, based on SIC code 3589.

Quarterly PAYDEX Scores Comparison to Industry

Previous Year

	9/01	12/01	3/02	6/02
This Business	UN	UN	UN	UN
Industry Quartiles				
Upper	75	75	75	76
Median	69	69	70	70
Lower	64	65	63	65

Current Year

	9/02	12/02	3/03	6/03
This Business	UN	UN	UN	67
Industry Quartiles				
Upper	77	76	76	76
Median	71	71	71	71
Lower	65	65	65	66

- Current **PAYDEX** for this Business is **66**, or equal to 19 days beyond terms
- The present industry **median score** is **71**, or equal to 14 days beyond terms.

- Industry upper quartile represents the performance of the payers in the 75th percentile
- Industry lower quartile represents the performance of the payers in the 25th percentile

Payment Habits

For all payment experiences within a given amount of credit extended, shows the percent that this Business paid within terms. Provides number of experiences used to calculate the percentage, and the total dollar value of the credit extended.

Dollar Range Comparisons:

$ Credit Extended	**# Payment Experiences**	**$ Total Dollar Amount**	**% of Payments Within Terms**
OVER $100,000	0	$0	0
$50,000 - 99,999	0	$0	0
$15,000 - 49,999	5	$115,000	24
$5,000 - 14,999	11	$85,000	52
$1,000 - 4,999	11	$21,500	60
Under $1,000	33	$9,200	75

Payment experiences reflect how bills are met in relation to the terms granted. In some instances, payment beyond terms can be the result of disputes over merchandise, skipped invoices, etc.

PAYMENT SUMMARY

The Payment Summary section reflects payment information in D&B's file as of the date of this report.

There are 63 payment experiences in D&B's file for the most recent 12 months, with 50 experiences reported during the last three month period.

Below is an overview of the company's dollar-weighted payments, segmented by its suppliers' primary industries:

	Total Rcv'd (#)	**Total Dollar Amts ($)**	**Largest High Credit ($)**	**Within Terms (%)**	**Days Slow (%) <31**	**31-60**	**61-90**	**90>**
Top industries:								
Trucking non-local	7	2,550	1,000	61	39	0	0	0
Whol metal	6	85,000	40,000	53	47	0	0	0

Nonclassified	5	4,350	2,500	77	23	0	0	0
Whol plastic material	4	3,350	2,500	91	9	0	0	0
Whol industrial suppl	3	16,500	15,000	3	97	0	0	0
Misc business credit	3	12,500	7,500	100	0	0	0	0
Whol electrical equip	3	8,500	5,000	59	26	15	0	0
Mfg pumping equipment	2	40,000	30,000	0	75	25	0	0
Mfg inorganic chemcls	2	25,000	15,000	0	100	0	0	0
Mfg process controls	2	7,750	7,500	52	0	48	0	0
Whol industrial equip	2	2,750	2,500	0	100	0	0	0
Data processing svcs	2	850	750	88	6	6	0	0
Paper mill	2	1,000	500	50	50	0	0	0
Mfg paint/allied prdt	2	500	250	100	0	0	0	0
Mfg ball/roll bearing	1	10,000	10,000	100	0	0	0	0
Mfg fluid power pumps	1	5,000	5,000	0	100	0	0	0
Mfg motors/generators	1	2,500	2,500	100	0	0	0	0
Whol nondurable goods	1	500	500	100	0	0	0	0
Arrange cargo transpt	1	500	500	100	0	0	0	0
Mfg cleaning products	1	250	250	0	100	0	0	0
Mfg plastic foam prdt	1	250	250	0	100	0	0	0
Mfg power handtools	1	250	250	50	50	0	0	0
Mfg metal stampings	1	250	250	100	0	0	0	0
Ret misc merchandise	1	250	250	100	0	0	0	0
Air courier service	1	100	100	100	0	0	0	0
Whol misc profsn eqpt	1	100	100	100	0	0	0	0
Whol office supplies	1	50	50	100	0	0	0	0
Telephone communictns	1	50	50	100	0	0	0	0
Ret-direct selling	1	50	50	100	0	0	0	0
Short-trm busn credit	1	0	0	0	0	0	0	0
Truck rental/leasing	1	0	0	0	0	0	0	0
Other payment categories:								
Cash experiences	0	0	0					
Payment record unknown	1	1,000	1,000					
Unfavorable comments	0	0	0					
Placed for collections:								
With D&B	0	0	0					
Other	0	N/A	0					
Total in D&B's file	63		40,000					

The highest **Now Owes** on file is $40,000 The highest **Past Due** on file is $15,000

Accounts are sometimes placed for collection even though the existence or amount of the debt is disputed. Indications of slowness can be result of dispute over merchandise, skipped invoices, etc.

PAYMENT DETAILS

Detailed payment history

Date Reported (mm/yy)	Paying Record	High Credit ($)	Now Owes ($)	Past Due ($)	Selling Terms	Last Sale Within (months)
09/03	Ppt	2,500	0	0		4-5 mos

	Ppt	500	500	0		1 mo
	Ppt	50	50	0		1 mo
08/03	Ppt	10,000	0	0	N30	6-12 mos
	Ppt	10,000	7,500	0	N30	1 mo
	Ppt	5,000	0	0		1 mo
	Ppt	2,500	2,500	0		1 mo
	Ppt	2,500	2,500	0		1 mo
	Ppt	2,500	1,000	0	Lease Agreemnt	1 mo
	Ppt	2,500	2,500	0	N30	1 mo
	Ppt	750	500	0		1 mo
	Ppt	500	500	0	Regular terms	1 mo
	Ppt	500	0	0		4-5 mos
	Ppt	500	100	0		1 mo
	Ppt	250	0	0		2-3 mos
	Ppt	250	0	0		6-12 mos
	Ppt	250	0	0		6-12 mos
	Ppt	250	100	0		1 mo
	Ppt	100	100	0		1 mo
	Ppt	50	0	0	N30	2-3 mos
	Ppt	50	0	0	N30	6-12 mos
	Ppt-Slow 30	40,000	40,000	15,000	1/2 10 N30	1 mo
	Ppt-Slow 30	15,000	0	0	N30	2-3 mos
	Ppt-Slow 30	5,000	5,000	5,000		1 mo
	Ppt-Slow 30	500	100	0		1 mo
	Ppt-Slow 30	250	250	0		1 mo
	Ppt-Slow 60	7,500	0	0		6-12 mos
	Slow 5	10,000	5,000		1 10 N30	
	Slow 5	500	0	0		6-12 mos
	Slow 15	15,000	0	0		6-12 mos
	Slow 15	15,000	7,500	250	N30	1 mo
	Slow 15	10,000	10,000	2,500		1 mo
	Slow 15	1,000	0	0		2-3 mos
	Slow 30	30,000	30,000	15,000		1 mo
	Slow 30	5,000	5,000	1,000		1 mo
	Slow 30	2,500	2,500	1,000		1 mo
	Slow 30	250	250	250		
	Slow 30-60	2,500	2,500	1,000		1 mo
	Slow 30-60	100	0	0		6-12 mos
07/03	Ppt	500	250	0		1 mo
	Ppt	250	0	0	N30	6-12 mos
	Ppt	250	0	0		2-3 mos
	Ppt	100				4-5 mos
	Ppt	100	100	0		1 mo
	Slow 5	1,000	0	0	N30	4-5 mos
	Slow 30	250	0	0		4-5 mos
06/03	Ppt	5,000	5,000	0	N30	1 mo
	Ppt	250	0	0		6-12 mos
	Ppt	100	0	0	N30	6-12 mos
	Slow 60	10,000	0	0	N30	6-12 mos
04/03	Ppt-Slow 30	100	0	0	1 10 N30	6-12 mos

03/03	Ppt	100	0	0		6-12 mos
	Ppt	0	0	0		6-12 mos
12/02	Ppt	7,500	1,000		Lease Agreemnt	
	Slow 5-30	250	0	0		6-12 mos
10/02	Ppt	250	0	0	N30	6-12 mos
	Slow 30	1,000	0	0		6-12 mos
09/02	Ppt	500	0	0		6-12 mos
08/02	Ppt-Slow 30	1,000	0	0		2-3 mos
	Slow 30	500	0	0		6-12 mos
07/02	Slow 5	0	0	0		6-12 mos
06/02	Ppt	100	0	0		6-12 mos
05/02	(063)	1,000	0			6-12 mos

Payments Detail Key: red = 30 or more days beyond terms

Payment experiences reflect how bills are met in relation to the terms granted. In some instances payment beyond terms can be the result of disputes over merchandise, skipped invoices etc.

Each experience shown is from a separate supplier. Updated trade experiences replace those previously reported.

Jump to:

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Public Filings

PUBLIC FILINGS

The following data includes both open and closed filings found in D&B's database on the subject company.

Record Type	# of Records	Most Recent Filing Date
Bankruptcy Proceedings	0	-
Judgments	1	06/13/2000
Liens	0	-
Suits	0	-
UCC's	6	02/07/2000

The following Public Filing data is for information purposes only and is not the official record. Certified copies can only be obtained from the official source.

JUDGMENTS

Judgment award:	**$735**
Status:	**Satisfied**
CASE NO.:	2000la4903
Judgment type:	Judgment
Against:	Roediger Pitts Inc
In favor of:	Yellow Freight System
Where filed:	JOHNSON COUNTY DISTRICT COURT, OLATHE, KS
Date status attained:	08/10/2000
Date entered:	06/13/2000
Latest Info Collected:	04/30/2001

UCC FILINGS

Collateral:	Specified Negotiable instruments including proceeds and products - All Accounts receivable including proceeds and products - All Inventory including proceeds and products - All Account(s) including proceeds and products - and OTHERS
Type:	Original
Sec. party:	DOLLAR BANK FSB, PITTSBURGH, PA
Debtor:	ROEDIGER PITTSBURGH INC
Filing number:	23821501
Filed with:	SECRETARY OF STATE/UCC DIVISION, HARRISBURG, PA
Date filed:	12/22/1994
Latest Info Received:	12/29/1994

Type:	Continuation
Sec. party:	DOLLAR BANK FSB, PITTSBURGH, PA
Debtor:	ROEDIGER PITTSBURGH INC
Filing number:	30781580
Filed with:	SECRETARY OF STATE/UCC DIVISION, HARRISBURG, PA
Date filed:	10/01/1999
Latest Info Received:	10/05/1999
Original UCC filed date:	12/22/1994
Original filing no.:	23821501

Collateral:	All Machinery - All Equipment - Specified Computer equipment
Type:	Original
Sec. party:	TECHNOLOGY DEVELOPMENT & EDUCATION CORP, PITTSBURGH, PA
Debtor:	ROEDIGER PITTSBURGH INC
Filing number:	24171386
Filed with:	SECRETARY OF STATE/UCC DIVISION, HARRISBURG, PA
Date filed:	04/11/1995
Latest Info Received:	04/17/1995

Collateral:	Leased Computer equipment - Leased Equipment
Type:	Original
Sec. party:	DOLLAR BANK LEASING CORP, PITTSBURGH, PA
Debtor:	ROEDIGER PITTSBURGH INC
Filing number:	31250719
Filed with:	SECRETARY OF STATE/UCC DIVISION, HARRISBURG, PA
Date filed:	02/07/2000
Latest Info Received:	03/13/2000

Collateral:	Leased Fixtures
Type:	Original
Sec. party:	DOLLAR BANK LEASING CORP, PITTSBURGH, PA
Debtor:	ROEDIGER PITTSBURGH INC
Filing number:	25751331
Filed with:	SECRETARY OF STATE/UCC DIVISION, HARRISBURG, PA
Date filed:	08/12/1996
Latest Info Received:	08/15/1996

Collateral:	Leased Computer equipment
Type:	Original
Sec. party:	DOLLAR BANK LEASING CORP, PITTSBURGH, PA
Debtor:	ROEDIGER PITTSBURGH INC
Filing number:	24060266
Filed with:	SECRETARY OF STATE/UCC DIVISION, HARRISBURG, PA
Date filed:	03/07/1995
Latest Info Received:	03/13/1995

The public record items contained in this report may have been paid, terminated, vacated or released prior to the date this report was printed.

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History & Operations

HISTORY

The following information was reported **08/11/2003**:

Officer(s):	DR MARCUS ROEDIGER, PRESIDENT HUGH W NEVIN JR, SECRETARY JAMES RUBINO, VICE PRESIDENT-CHIEF FINANCIAL OFFICER
DIRECTOR(S):	THE OFFICER(S)

Business started 1978 by the parent company. 100% of capital stock is owned by the parent company.

DR MARCUS ROEDIGER born 1956. 1997 to present active here. Prior to 1997 employed Roediger Anlagenbau GmbH, Hanau, Gemany.

HUGH W NEVIN JR born 1946. 1968 graduated from Harvard University with a BA degree and from Harvard Law School in 1974 with a JD Degree. Admitted to the Bar in 1974. Currently active as an attorney with the law firm Adler, Cohen & Grigsby, Pittsburgh, PA.

JAMES RUBINO born 1954. 1976 graduated from Indiana University of Pennsylvania. 1990-present active here. 1989-90 employed by Robroy Industries, Verona, PA. 1982-89 employed by Midland Ross Corp/American Electric, Pittsburgh, PA. 1980-82 employed by Ampco Pittsburgh Co, Pittsburgh, PA. 1976-80 employed by Campbell Barge Line Inc, Charleroi, PA.

CORPORATE FAMILY

For more details on the Corporate Family, use D&B's Global Family Linkage product.

COMING SOON!
Easily order Business Information Reports on international family members through the Corporate Family section.

Parent:

Passavant-Roediger Umwelttechnik Gmbh	Aarbergen, Germany	DUNS # 31-419-1458

Affiliates (International):*(Affiliated companies share the same parent company as this business.)*

PASSAVANT-ROEDIGER CONTROLS GmbH	AARBERGEN, GERMANY	DUNS # 31-578-7171
PASSAVANT-ROEDIGER PRODUCTS GmbH	AARBERGEN, GERMANY	DUNS # 34-413-6804
PASSAVANT-ROEDIGER SERVICE GmbH	AARBERGEN, GERMANY	DUNS # 34-422-1564
PASSAVANT-ROEDIGER-ANLAGENBAU GmbH	HANAU, GERMANY	DUNS # 31-590-3422
PRV Gesellschaft fuer Vermoegensverwaltung, Immobilien und Dienstleistung mbH	AARBERGEN, GERMANY	DUNS # 32-651-6978
ROEDIGER VAKUUM- und HAUSTECHNIK GmbH	HANAU, GERMANY	DUNS # 31-590-3414
Schlosser-Pfeiffer GmbH	AARBERGEN, GERMANY	DUNS # 31-500-8938

BUSINESS REGISTRATION

CORPORATE AND BUSINESS REGISTRATIONS REPORTED BY THE SECRETARY OF STATE OR OTHER OFFICIAL SOURCE AS OF MAR 07 2003:

The following data is for informational purposes only and is not an official record. Certified copies may be obtained from the Pennsylvania Department of State.

Registered Name: ROEDIGER PITTSBURGH, INC.

Business type:	CORPORATION
Corporation type:	PROFIT
Date incorporated:	JUL 28 1978
State of incorporation:	PENNSYLVANIA
Filing date:	JUL 28 1978
Registration ID:	0672306
Duration:	PERPETUAL
Status:	ACTIVE
Where filed:	SECRETARY OF STATE/CORPORATIONS DIVISION, HARRISBURG, PA
Principals:	DAVID A GIBSON, CHIEF EXECUTIVE OFFICER HUGH W NEVIN JR, SECRETARY A JAMES RUBINO, TREASURER NORMAN W TESLIK, VICE PRESIDENT

OPERATIONS

08/11/2003

Description: Foreign parent is Passavant-Roediger Umwelttechnik Gmbh, Aarbergen, Germany. Foreign parent DUNS number is 31-419-1458.

Manufactures service industry machinery, specializing in sewage or water treatment equipment (100%). Manufactures metal forming type machine tools. Manufactures construction machinery or equipment.

Terms are net 30 days. Has 150 account(s).

Nonseasonal.

Employees: 47 which includes officer(s).

Facilities: Rents 60,000 sq. ft. in a two story brick building.

Location: Suburban business section on well traveled highway.

SIC & NAICS

SIC:

Based on information in our file, D&B has assigned this company an extended 8-digit SIC. D&B's use of 8-digit SICs enables us to be more specific to a company's operations than if we use the standard 4-digit code.

The 4-digit SIC numbers link to the description

NAICS:

333319	Other Commercial and Service Industry Machinery Manufacturing
333513	Machine Tool (Metal Forming Types) Manufacturing
333120	Construction Machinery Manufacturing

on the Occupational Safety & Health Administration (OSHA) Web site. Links open in a new browser window.

35890300	Sewage and water treatment equipment
35420000	Machine tools, metal forming type
35310000	Construction machinery

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Banking & Finance

KEY BUSINESS RATIOS

Statement date: DEC 31 2001
Based on this number of establishments: 21

Industry Norms based on 21 establishments

	This Business	Industry Median	Industry Quartile
Profitability			
Return on Sales	3.8	3.8	2
Return on Net Worth	12.6	12.7	3
Short-Term Solvency			
Current Ratio	1.7	1.7	2
Quick Ratio	1.2	1.0	2
Efficiency			
Assets Sales	82.9	55.9	4
Sales / Net Working Capital	3.7	5.3	3
Utilization			
Total Liabs / Net Worth	176.7	118.9	3

FINANCE

04/04/2003

Three-year statement comparative:

	Fiscal Dec 31 1999	Fiscal Dec 31 2000	Fiscal Dec 31 2001
Current Assets	3,084,754	2,738,390	4,758,880
Current Liabs	1,307,719	1,539,069	2,876,555
Current Ratio	2.36	1.78	1.65
Working Capital	1,777,035	1,199,321	1,882,325
Other Assets	1,029,418	1,067,456	996,759
Net Worth	2,269,702	1,818,174	2,079,937
Sales	6,943,859	6,894,780	6,941,989

Long Term Liab	536,751	448,603	799,147
Net Profit (Loss)	275,910	273,472	261,763

Fiscal statement dated DEC 31 2001:

Assets		**Liabilities**	
Cash	120,919	Accts Pay	530,745
Accts Rec	3,431,726	Notes Pay	750,000
Inventory	939,294	Affiliate Rec	84,145
Notes Rec	246,750	Taxes	64,907
Prepaid	20,191	L.T. Liab-(1yr)	116,504
		Commissions	226,560
		Interco Charges	44,730
		Other Curr Liabs	1,058,964
Curr Assets	**$ 4,758,880**	**Curr Liabs**	**$ 2,876,555**
Fixt & Equip	996,759	L.T. Liab-Other	799,147
		Corp Equity	2,079,937
Total Assets	**$ 5,755,639**	**Total**	**$ 5,755,639**

From JAN 01 2001 to DEC 31 2001 annual sales $6,941,989; cost of goods sold $4,451,812. Gross profit $2,490,177. Net income $261,763.

Submitted JUN 18 2002 by Jim Rubino, . Extent of audit, if any, not indicated.

Fixed assets shown net less $1,485,026 depreciation.

On APR 04 2003 James Rubino, Vice President, deferred financial statement.

CUSTOMER SERVICE

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THE HASKELL COMPANY
AMERICA'S DESIGN-BUILD LEADER®

Memorandum

To: Robert Sheets
Government Services Group, Inc.

Date: October 8, 2003

From: Peter M. Kinsley
The Haskell Company

Subject: Design-Build Wastewater Management System for the Key Largo Trailer Village Area

Issue No. 01-003 – Secondary Treatment Process Selection

As requested, The Haskell Company is issuing this memorandum to summarize our recommendations as outlined in our October 3, 2003 letter. In this letter, we recommended the ISAM Sequencing Batch Reactor (SBR) developed by Fluidyne Corporation be utilized for this project in lieu of the USBF activated sludge process developed by Purestream for the secondary treatment process. In summary, we looked at the published and vendor supplied materials, conducted interviews with references and considered both cost and non-cost factors related to both processes.

EVALUATION SUMMARY TABLE

Item	USBF	ISAM
Power Costs	• Continuous Electrical Power Consumption • Costs are Constant	• Intermittent Electrical Power Consumption • Lower Cost with Lower Flows
Chemical Costs	• Utilizes Ferric Chloride for Phosphorus Removal • Sodium Hypochlorite will be Used for Disinfection • Cost Difference is Negligible	• Uses Alum for Phosphorus Removal • Sodium Hypochlorite will be Used for Disinfection • Cost Difference is Negligible
Sludge Handling Costs	• Lower Sludge Production based on Manufacturers Claims • Sludge Handling Costs Slightly Lower	• Conservative Sludge Production • Higher Costs due to Lower Sludge Age
Process Capabilities	• Expected Total Nitrogen of Less Than 8.0 mg/l • Poor Operational Data	• Expected Total Nitrogen of Less Than 3.0 mg/l • Operational Data Demonstrates Capabilities
Simplicity of Operation	• Simpler Control System due to Continuous Operation	• More Complex Control due to Intermittent Operation

Ease of Maintenance	• No Difference Anticipated	• No Difference Anticipated
Reliability (permit compliance)	• Majority of Data Failed Proposed Monthly Effluent Standards	• Majority of Data Passed Proposed Monthly Effluent Standards
Ability to Handle Peak Flows and Loads	• Flow-through Process is Prone to Peaking Upsets	• Built-in Equalization Characteristic of SBR/ISAM Process
Reliability	• High-degree of Mechanical Reliability • Redundant Equipment	• Slightly Less Degree of Mechanical Reliability due to Start/Stop Operation • Redundant Equipment
Adaptability	• Difficult to Modify Process (i.e. adding a carbon source, adding a secondary anoxic process)	• Easier to Modify Process (i.e. adding a carbon source, implementing additional anoxic sequences)

Some of the benefits of utilizing the ISAM process for this project are listed here:

- The ISAM has the ability to equalize peak flows and loads
- The ISAM has the ability to accommodate widely varying flows and loads due to intermittent flows
- The ISAM process cycles can be modified to achieve the required total nitrogen levels

cc: Stuart Oppenheim, Brown and Caldwell
Charles Sweats, Government Services Group
Jeff Weiler, Weiler Engineering
Ed Castle, Weiler Engineering
Issue No. 01-003

THE HASKELL COMPANY
AMERICA'S DESIGN-BUILD LEADER®

Peter M. Kinsley
Division Leader - Water

Via Overnight Delivery

October 3, 2003

Re: Design-Build Wastewater Management System for the Key Largo Trailer Village Area
Issue No. 01-003 - Secondary Treatment Process Selection

Mr. Robert Sheets
Government Services Group, Inc.
1500 Mahan Drive, Suite 250
Tallahassee, Florida 32308

Dear Mr. Sheets:

In response to your comments regarding our September 24, 2003 letter regarding the above referenced subject, attached, please find the amended review of the secondary treatment processes prepared by The Haskell Company's designer, Brown and Caldwell. Per your request, additional performance data has been collected, analyzed and included in our study. In addition, operating and maintenance costs have been developed for both secondary treatment processes.

As stated in Section 3.8.3 of the Design-Build Agreement, the Key Largo Wastewater Treatment District (KLWTD) is responsible for selecting the secondary treatment process for the above referenced project. To facilitate KLWTD's selection, The Haskell Company conducted vendor presentations and performed a detailed evaluation of the two secondary treatment processes under consideration in order to provide a recommendation.

The vendor presentations were conducted on September 15, 2003 with representatives from the KLWTD, Government Services Group, Weiler Engineering, Brown and Caldwell, DN Higgins, Inc., and The Haskell Company in attendance. In addition, The Haskell Company's designer, Brown and Caldwell performed a detailed evaluation of the two secondary treatment processes under consideration and provided their recommendation. I have attached a copy of their report for your review.

Based upon the vendor presentations and the subsequent evaluation performed by Brown and Caldwell, The Haskell Company recommends the ISAM Sequencing Batch Reactor (SBR) manufactured by Fluidyne Corporation for the secondary treatment process. The proof of performance this system and manufacturer provides leaves The Haskell Company confident in our guarantee to provide plant effluent meeting the requirements of Advanced Wastewater Treatment (AWT).

HASKELL BUILDING•JACKSONVILLE, FLORIDA 32231-4100•904/791-4500 FAX 791-4699

If you should have any questions or require any additional information, please contact me directly at 904/357-4868.

Sincerely,

Peter M. Kinsley

Attachment

cc: Stuart Oppenheim, Brown and Caldwell
Charles Sweats, Government Services Group
Jeff Weiler, Weiler Engineering
Ed Castle, Weiler Engineering
Issue No. 01-003

1060 Maitland Center Commons, Suite 402
Maitland, Florida 32751

Tel: (407) 661-9500
Fax: (407) 661-9599

October 3, 2003

BROWN AND CALDWELL

Mr. Pete Kinsley
The Haskell Company
111 Riverside Avenue
Jacksonville, Florida 32231

22/24533

Subject: Key Largo
Selection of Activated Sludge Process

Dear Mr. Kinsley:

The selected advanced wastewater treatment plant (AWWTP) must be capable of treating influent wastewater to a level compatible with groundwater disposal. Based on previously presented information, the design influent and effluent wastewater characteristics will be as follows:

- Average daily flow 0.122 mgd
- Maximum month average flow 0.183 mgd
- Biochemical Oxygen Demand (BOD_5) 250 mg/l
- Total Suspended Solids (TSS) 250 mg/l
- Total Nitrogen (TN) 40 mg/l
- Total Phosphorus (TP) 8 mg/l
- Total Alkalinity (as $CaCO_3$) 150 mg/l

The effluent requirements are as follows:

Required Parameter	Annual Average	Monthly Average	Weekly Average
Biochemical Oxygen Demand (BOD_5)	Less than 5 mg/l	Less than 6.25 mg/l	Less than 7.5 mg/l
Total Suspended Solids (TSS)	Less than 5 mg/l	Less than 6.25 mg/l	Less than 7.5 mg/l
Total Nitrogen (TN)	Less than 3 mg/l	Less than 3.75 mg/l	Less than 4.5 mg/l
Total Phosphorus (TP)	Less than 1 mg/l	Less than 1.25 mg/l	Less than 2.0 mg/l

In addition, the biosolids hauled offsite should meet Class B Stabilization requirements to avoid additional hauling costs.

The treatment facility will consist of a vacuum pumping station, a raw wastewater screening process, an activated sludge process, a filtration system, a disinfection process and effluent disposal. Ancillary systems will include a sludge stabilization process, an odor control system, an emergency power system and facility controls.

In the RFP, two systems were identified for the project, the Sequencing Batch Reactor (SBR) and the Upflow Sludge Blanket Filter (USBF). The selection of the process will be based on the following economic factors:

- Power Costs
- Chemical Costs
- Sludge Handling Costs

Non-economic factors will include the following:

- Process Capabilities
- Simplicity of operation
- Ease of maintenance
- Reliability (permit compliance)
- Ability to handle peak flows and loads
- Reliability
- Adaptability

Sequencing Batch Reactor (SBR)

The SBR system is a variation of the activated sludge process. The SBR acts as an aeration basin and secondary clarifier within a single reactor. The SBR process operates in a single reactor basin to accomplish both biological treatment and solids-liquid separation. A minimum of two SBR basins must be provided so that one basin processes wastewater, while the other receives wastewater. The system can be designed to operate as a process to remove nitrogen and phosphorus. To remove nitrogen, ammonia is oxidized under aerobic conditions, and then nitrate is reduced through respiration under low oxygen (anoxic) conditions. A sequence of aerated and non-aerated mixing is used to provide aerobic and anoxic process conditions. This combination of conditions enables nitrification and denitrification to occur in the same basin.

Principles of Operation: The SBR utilizes a simple repeated time-based sequence, which incorporates the following phases as shown in Figure 1.

- **Mixed-fill phase**, influent entering, anoxic for denitrification, mixed tankage.

- **React-fill phase**, influent entering, alternating aerobic and anoxic conditions for reduction of organics and nitrification/denitrification, mixed tankage.

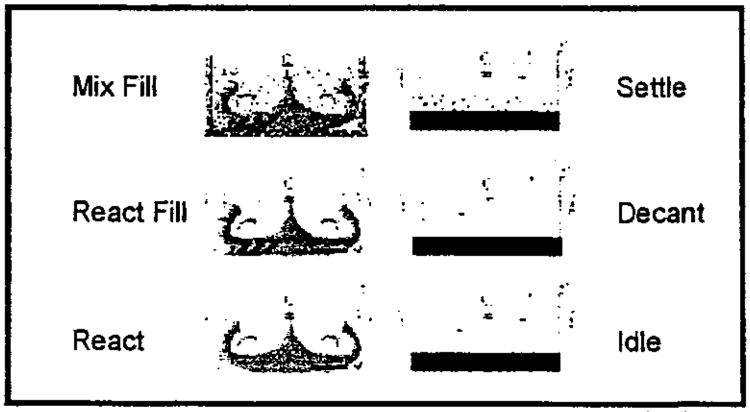
- **React phase,** alternating aerobic and anoxic conditions for polishing of organics and nitrification/denitrification, mixed tankage.

- **Settle phase** for solid-liquid separation, unaerated, unmixed for undisturbed settling.

- **Decant phase** for removal of treated effluent, unmixed, unaerated. Treated effluent supernatant is decanted using a moving weir decanter. After decanting, the liquid level returns to the bottom liquid level. Surplus solids are wasted in order to maintain the SRT and mixed liquor suspended solids (MLSS) at the desired concentration.

- **Idle time,** which is the time after a cycle is complete, prior to the beginning of the next cycle. This can be based on a timer and/or wastewater flow.

Figure 1. Six Phases of the Standard SBR Process.



Completion of these six operations in the sequence described above constitutes a single cycle, which is then repeated. During the period of a cycle, the liquid level inside the reactor basin rises from a set bottom liquid level in response to a varying influent wastewater flow rate. At the end of a cycle, the liquid level returns to the set bottom liquid level.

The SBR process tolerates variable hydraulic loads very well. Mixed liquor solids cannot be washed out by hydraulic surges since effluent withdrawal is typically accomplished in a separate phase following the termination of flow to each reactor. It also tolerates variable organic loads. Each influent liquid batch is diluted/mixed with the remaining reactor contents from the previous cycle.

In order to drive the denitrification phase to completion thus achieving a total nitrogen concentration less than 3.0 mg/l, a sufficient carbon source must be available. In a standard SBR process, aerobic bacteria deplete the available carbon source during aeration phases. In many instances, insufficient carbon supplies do not allow the nitrate to be removed during the denitrification phase. Three potential options are available to drive denitrification down to the required level:

1. Provide a supplemental carbon source – This is not viewed as a good option since the carbon source (i.e. sodium acetate) would need to be fed intermittently at the right time in the process cycle.
2. Carbon source provided through endogenous respiration – Once readily degradable carbon sources are depleted, the microorganisms feed on residual from dead cells. This requires a larger volume to achieve, or in the case of an SBR, more time from each cycle.

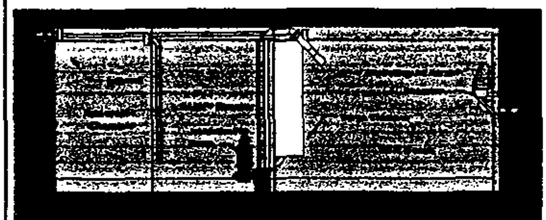
3. Provide a modified SBR process – Improvements have been made to SBRs allowing a separate denitrification basin to be provided. This improves the process kinetics since there is more of a driving force towards full denitrification. Also, more food (carbon source) becomes available from the SBR tank during endogenous respiration under aerobic conditions than under anaerobic/anoxic conditions.

For the Key Largo project, a process developed by Fluidyne called the ISAM (Integrated Surge Anoxic Mix) has been evaluated. The system components as well as a description of each of the operating phases are shown on Figure 2. For purposes of this evaluation, the following design parameters are proposed:

Secondary Treatment using ISAM	
No. of Trains	3
SBR	
Sidewater Depth: min, max (ft)	8, 10.8
SRT (days)	22
MLSS (mg/l)	3,000
Volume, total (MGal)	0.102
Avg. HDT (hrs)	13.3
Oxygen Requirement (lb/d)	819
As Clarifier	
Surface Area, each (ft^2)	420
Overflow rate (gpd/sf)	145
ISAM Reactor	
Sidewater Depth: min, max (ft)	2.5, 10.8
Working Volume, total (MGal)	.039
Anaerobic Chamber	
Working Volume, total (MGal)	.034
Sludge Production	139
Quantity (lb/day)	139
Volume (gpd)	418
Concentration (% Solids)	4.0
Equipment Requirements	
Motive/Aeration Pumps	1 per basin at 15 HP each
Operating Time (hours)	42 total per day
Power Draw (HP)	12.5
Power Usage (kw-hrs/day) at Design Average Daily Flow	392

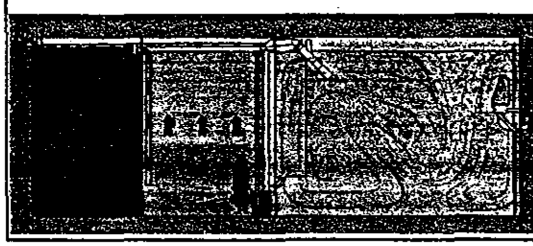
Figure 1: ISAM SBR

ISAM™ Sequencing Batch Reactor
with Anaerobic Selector and Sludge Reduction System
System Components

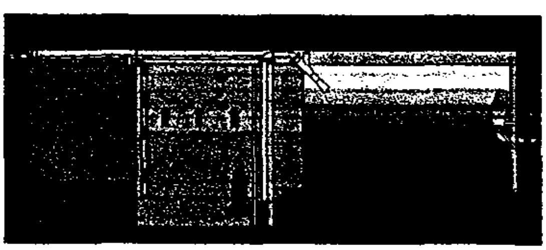


1. Fill Phase: When the level in the SAM™ reactor reaches a predetermined set point, the motive liquid pump is started. SBR basin is filled and mixed. A variable percentage of the pumped flow is recycled to the Anaerobic Chamber where heavier solids settle. Recycle flow is varied to maintain desired MLSS concentration in SBR. Solids in Anaerobic Chamber are digested.

2. Interact Phase: When the level in the SBR basin reaches TWL, mixed liquor overflows the Surge Chamber weir, and is returned to the SAM™ reactor through the Surge Jet to mix the SAM™ reactor. A variable percentage of the pumped flow is recycled to the Anaerobic Chamber where heavier solids settle. Recycle flow is varied to maintain desired MLSS concentration in SBR. Aeration is cycled on and off to provide required aeration. Scum is removed from SBR basin. Solids in Anaerobic Chamber are digested.



3. Settle Phase: When the SAM™ reactor reaches a predetermined level, aeration is discontinued, and the SBR basin settles under perfect quiescent conditions. Solids in Anaerobic Chamber are digested.



4. Decant Phase: When the Settle time value is reached, the decant valve is opened and treated effluent is withdrawn from the upper portion of the reactor.

Upflow Sludge Blanket Filter (USBF)

The USBF system is a flow-through activated sludge system. This process combines aeration, nitrification, denitrification, clarification and sludge stabilization into one compact reactor.

Principles of Operation: The flow from the preliminary treatment process enters the anoxic compartment, where it mixes with the activated sludge recycled from the bottom of the clarifier. The anoxic effluent then flows into the bioreactor's aerobic compartment. After aeration, the mixed liquor enters the bottom of the clarifier, where sludge flocculates and water is separated by an upflow movement. The mixed liquor then must flow through the sludge blanket, which acts as a filter. The effluent then flows to the effluent filters. Activated sludge collected at the bottom of the clarifier is recycled back to the anoxic chamber via air lift pumps. Return rates are fixed, which does make for simplicity of operation. Sludge is wasted in the system, although like other similar high sludge age (SRT) systems, the waste sludge is fairly well stabilized prior to wasting.

The operating SRT of the USBF process is approximately 23 days. Sludge holding or digestion is estimated to require approximately 20 days, thereby providing very stable biosolids for disposal. The USBF process considered for this project will meet the following design requirements:

Secondary Treatment using USBF	
No. of Trains	3
Reactor	
Sidewater Depth (ft)	12
SRT (days)	22.3
MLSS (mg/l)	6,000
Aeration Volume, total (MGal)	0.184
Anoxic Volume, total (MGal)	0.038
Oxygen Requirement (lb/d)	606
Secondary Clarifiers	
Type	Upflow
Total Surface Area (ft^2)	932
Sidewater Depth (ft)	12
Overflow rate at Design Flow (gpd/sf)	196
WAS (lb/d)	199
Aerobic Digester (MGal)	0.032
Equipment Requirements	
Anoxic Mixers	2 per basin at 1.9 HP each
Operating Time	continuous
Blowers	2 per basin at 10 HP each
Power Draw (HP)	11 per basin
Power Usage (kw-hrs/day) at Average Daily Flow	590

Process Capabilities Review

It is a fundamental requirement that the plant meet the stringent advanced wastewater treatment effluent requirements. During prior reviews of this process, Brown and Caldwell has expressed concern over the ability of the USBF to achieve a total nitrogen level of less than 3.0 mg/l. Since the activated sludge process is critical to the success of the facility, a process guarantee will be required. As such, the concern over the strict nitrogen limit has been addressed by Fluidyne through the offering of the ISAM process, but has not been addressed by Purestream through process modifications or additional unit processes. Suggestions have been given by Brown and Caldwell such as the addition of a denitrification filter, however, these additions have not been offered formally, or been supported with operational data.

References and operational data were provided to Brown and Caldwell by both process suppliers. Based on our discussions with the references, both processes have been successful in the application that the process operates. Both companies have a good track record of providing the necessary training and after-the-sale support. None of the references had anything negative to say about either process, and both processes had minor problems after construction that were quickly resolved by the process company. With this said, it must be noted that several of the Fluidyne references were operating facilities that had to meet comparable effluent limits (5 mg/l BOD, 5 mg/l TSS, 3 mg/l TN and 1 mg/l TP) required by a current FDEP operating permit. None of the USBF references operated under these conditions. The Marco Shores facility, which was presented as the most comparable facility to that proposed for Key Largo had a permitted effluent quality requirement of 25 mg/l BOD, 5 mg/l TSS and 12 mg/l NO3 (TN includes NO3). Information provided by Randazza Enterprises and those obtained from other sources regarding the Purestream USBF process are included as Appendix A; Information provided by TSC-Jacobs and those obtained from other sources regarding the Fluidyne ISAM process are included as Appendix B.

Economic Comparison of Secondary Treatment Alternatives

In order to objectively evaluate each process, operational economic information related to each process was estimated. These components of the costs associated with treating wastewater are as follows:

Power Costs: Both processes depend on electrical power to provide mixing and aeration to the activated sludge process. The USBF process relies on blowers to provide aeration, and submersible mixers to keep the contents of the anoxic zone in suspension. The ISAM process relies on submersible pumps to provide both the motive force for mixing and aeration through the use of jet aeration. For both processes, an aerobic sludge digester will be provided along with the associated aeration system, which will contain blowers for delivering oxygen. $0.07 per kilowatt-hour was assumed for the price of commercial electricity.

Chemical Costs: Both processes rely on chemicals for portions of the treatment process. Specifically, sodium hypochlorite is proposed for disinfection of the final effluent. Alum (aluminum sulfate) is proposed by Fluidyne for the removal of phosphorus. The USBF utilizes ferric chloride for the removal of phosphorus, but the difference in cost was assumed to be negligible. For purposes of estimating chemical usage costs, the ratio of 2.5 parts alum to 1 part phosphorus was utilized, and the quantities were adjusted to account for the chemical compositions and concentration of commercial alum. The cost of alum was assumed to be $0.40 per pound delivered to Key Largo in 55-gallon drums.

Sludge Handling Costs: Various microorganisms utilize the dissolved and particulate biological wastes contained in domestic wastewater as a food source. The microorganisms degrade these wastewater components through aerobic and anaerobic respiration. The energy provided by this respiration provides intracellular energy for these microorganisms for cell growth and maintenance. In order to maintain a healthy biomass (referred to as mixed liquor), solids must be removed on a periodic basis, or two things can occur. First, as food becomes scarce due to the buildup of mixed liquor solids, microorganisms die thus reducing the concentration of viable microorganisms. In the event of increased loading due to higher flows such as what may occur over a weekend, insufficient "live" biomass causes insufficient treatment to occur. Second, the ability of "old" sludge to settle becomes much less due to the increase in solids, and eventually, solids are lost in the effluent. In addition, a certain component of wastewater solids is inert, and if solids are not wasted from the process, then the inert solids build up until wash out of solids into the effluent occurs. Sludge production is an expected part of wastewater treatment. Sludge hauling costs were assumed to be $0.20 per gallon of sludge, and the concentration that could be achieved through either process was assumed to be 1.5 percent solids.

Operational Cost Component	**USBF**	**ISAM**
Power Cost for Treatment	$18,931	$12,003
Power Cost for Sludge Digestion	$4,573	$4,573
Annual Sodium Hypochlorite	$8,500	$8,500
Alum	$4,460	$4,460
Sludge Handling	$85,112	$96,891
Total Estimated Operating Costs	**$121,575**	**$126,427**

It should be noted that sludge handling costs were estimated on what Brown and Caldwell believes to be conservative sludge generation values. Based on claims by the USBF representative, the sludge age used for estimating the USBF sludge quantities was higher than the ISAM sludge age (35 versus 25 days). Based on the inherent difficulty in estimating these types of operational costs, the two processes are viewed to be the same on an economical basis. Additional detail on the development of operational costs is included in Appendix C.

Non-Economic Comparison of Secondary Treatment Alternatives

Due to the importance of the activated sludge process to the success of the overall system, non-cost factors were also considered in the evaluation of each process. These factors are as follows:

Process Capabilities: As discussed previously, both processes are capable of achieving a high-quality effluent. Based on our review of the supplied process information and operating data, the modified SBR process proposed by Fluidyne appears to have a better ability to achieve the total nitrogen limits under design loading conditions. Information obtained on both processes is included in the appendices. The operational data for the USBF, the SBR and the ISAM process is summarized in the following table along with a comparison of the data to the actual performance required on a monthly and annual basis:

Process	Facility	Permitted Flow (MGD)	Annual TN Averages		Monthly TN Averages		TN Data Range	
			Best Annual TN Average	Percent Exceeding 3.0 mg/l	Best Monthly TN Average	Percent Exceeding 3.75 mg/l	Minimum	Maximum
USBF	Oceanside Marina	0.02	38.0	100%	23.1	100%	23.1	71.60
USBF	Marathon Marina	0.025	22.6	100%	15.4	100%	15.4	31.10
USBF	Ziggie's	0.006	8.0	100%	2.2	81%	2.2	29.30
USBF	Islander	0.006	7.4	100%	2.3	95%	1.7	22.50
USBF	Island Tiki	0.012	6.0	100%	0.2	81%	0.1	77.00
USBF	Marco Shores	0.3	3.1	100%	3.1	0%	2.1	3.50
SBR	Blacksford	1	2.9	0%	1.5	38%	0.99	5.80
SBR	Hilliard	0.32	4.9	100%	1.7	17%	1.7	21.00
SBR	Bartow	4	3.1	100%	2.8	36%	2.76	4.30
ISAM	Barona	0.75	1.6	0%	0.59	0%	0.21	5.41

Several issues should be noted concerning the data supplied by the manufacturers. Only four months of data was supplied for the Oceanside Marina USBF and the Marathon Marina USBF. Only four weeks of data was supplied for the Marco Shores USBF. Of the data provided, only the ISAM plant located at Barona Casino in California demonstrated the ability to consistently achieve the effluent requirements for at least a one-year period.

Simplicity of operation: Since the USBF process is a flow-through system, the controls for this process are simpler. However, based on conversations with operators of the Fluidyne systems (SBR and ISAM), the PLC-based control system utilized by the ISAM process has not shown to be burdensome on the operators of the existing facilities. The main suggestions taken from the references of the SBR systems are to have backup PLC's so that the operators never have to run the facility in a manual mode. Besides monitoring, the operator should not have to make adjustments to either system.

Ease of maintenance: Both processes utilize electrical equipment. The USBF process has two submersible mixers per train, and the SBR has one submersible pump per train. The SBR system has several automatic valves, whereas the USBF has two blowers per train. Based on the amount of equipment, the required maintenance effort will likely be comparable for both facilities.

Reliability (permit compliance): With the exception of the TN requirement, both processes have demonstrated the ability to meet permit conditions. However, the USBF process does not have any facilities operating under the same permit conditions as those required by the Key Largo facility. Therefore, the USBF has not demonstrated the ability to meet the permit conditions proposed for the Key Largo facility. As noted earlier, the only process with data demonstrating the ability to achieve the anticipated effluent requirements is the ISAM system from Fluidyne.

Ability to handle peak flows and loads: Based on discussions with the Marco Shores USBF reference, the only problem that was recently encountered was high pumping flows affecting the effluent quality due to pin floc. The pumping rate is currently 500 gpm while the average daily flow to each basin is 50 gpm. This problem was resolved by placing a second train in service which lowered the peaking factor from 10:1 down to 5:1. However, an equalization basin should be considered where a USBF plant experiences high peak flows. A 5:1 peaking factor is still fairly high, however, the SBR process is not affected by peak flows due to its inherent ability to equalize flows.

Each of the wastewater treatment alternatives was compared in terms of reliability, adaptability, regulatory compliance, environmental factors, and operation as described below.

Reliability. The reliability of each alternative can generally be described as the ability to continuously operate for extended periods, under varying conditions, and with minimal downtime due to major maintenance and repairs. Reliability examines the ability of the process to produce consistent quality effluent under varying load conditions, whether the proposed systems have the redundancy to permit routine maintenance, and the capability to either operate or bypass systems during a power failure or major maintenance operations.

The USBF is an extremely simple system to operate and maintain and adequate redundancy is provided.. It can produce consistent effluent quality although insufficient data is available to make a definitive conclusion regarding the total nitrogen limit. However, there does remain a concern regarding its ability to meet effluent limits at peak flow conditions, due to the stability and integrity of the sludge blanket under peak surge inflow conditions.

The SBR system is more complex than the USBF. Automation is provided so that the fill, draw, decant sequence can be performed. The system, when operated by experienced and trained operators is capable of producing a consistent effluent. It is able to function very well under varying loads, since it is designed as an equalization system.

Although the USBF would rank higher based on reliability, this issue is mitigated since there will be three SBR trains.

Adaptability. Each alternative is evaluated based on its ability to accommodate additional capacity expansion and/or process changes to meet effluent discharge limits. These changes may be dictated by regulatory changes, changes in development patterns or densities, or policy changes. Alternatives that have extensive site requirements or that require extensive process changes or additions will be penalized in the rankings for this category. Since both process suppliers propose three small trains, much of the future adaptability is lost with either system.

Process Recommendations

Based on a review of available information and data, Brown and Caldwell believes that both Fluidyne and Purestream provide a high-quality treatment process capable of achieving high-quality effluent. However, due to the extreme effluent quality required for the effluent method proposed, Brown and Caldwell recommends that the Fluidyne ISAM process be utilized for the Key Largo project. The following reasons are given in support of this recommendation:

- Fluidyne has a proven track record for meeting permit requirements similar to those required by Key Largo

- Fluidyne has demonstrated success in providing processes in the same general size range as proposed

- Brown and Caldwell views the ISAM process as having more flexibility than the USBF process due to its ability to equalize flows and loadings without the need for an equalization basin

- The ISAM process has demonstrated the ability to achieve the low levels of total nitrogen that will be required on this project.

In our opinion, the Fluidyne ISAM process is a better process for this application than the Purestream USBF process.

Thank you for the opportunity to work with you on this very important project for Key Largo. Please let me know if you have any questions.

Very truly yours,

BROWN AND CALDWELL

Ted Hortenstine, P.E.
Office Leader

Cc: John Bratby, BC
Stu Oppenheim, BC

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APPENDIX A

Brown and Caldwell
Secondary Treatment Process Selection
October 3, 2003

USBF/Purestream References:

Marco Shores – Conversation with Jeff Potcet on Tuesday, September 23, 2003

Plant is permitted for 25 mg/l BOD, 5 mg/l TSS and 12 mg/l NOx with no formal TN or NH3 limit. He has been able to achieve low TN levels, and he does believe that he could meet a 3.0 mg/l TN limit. The plant is currently operating at 60,000 gpd. He was able to run one train, but the peak flow due to a pumping rate of 500 gpm forced him to bring a second train into service. The plant has only been online since July 27, 2003, so no sludge has been wasted since it takes a while to develop a sludge blanket in the clarifier. He has had good response from Purestream when problems arise. He was not a proponent of the USBF process, but he has changed his opinion based on his experience with the process.

RANDAZZA ENTERPRISES, INC.
Manufacturers Representative
Wastewater Treatment Systems & Chemicals

September 20, 2003

Mr. Ted Hortenstine, P.E
Brown & Caldwell
1060 Maitland Center Commons
Suite 402
Orlando, Florida 32751

Reference: Your request for additional information regarding Key Largo Project.

Dear Ted:

In response to your letter dated September 16, 2003 requesting additional information, please find the following:

Item #1:
References and Contacts of the Three (3) USBF Wastewater Treatment Plants listed in the package for your review are as follows:

Project: ***Marco Shores, USBF AWT 300,000 GPD***
Contact: ***Mr. Jeff Poteet, Chief Operator, WWTPS Florida Water Services,***
Florida Water Services Corporation
960 N. Collier Blvd.
Marco Island, FL 31145
Tel: 239 825 9003

1. *The USBF 300,000 GPD, AWT Designed, Marco Shores Wastewater Treatment Plant, has officially been in operation for approximately Two (2) months.*
2. *The plant is permitted for Reuse with the Effluent to be used on the Marco Shores new multimillion dollar Golf Course. The USBF AWT Wastewater Treatment Plant is a "Poured in Place Concrete System" composed of Four (4) 75,000 GPD Systems/Trains.*
3. *As of this writing, only One (1) of Four (4) 75,000 GPD Systems/Trains are in operation.*

Project: ***Islander Resort***
Contact: ***Mr. Jim Hand***
Hand Utilities Inc.
P.O. Box 971745
Miami, FL 33197
Tel: 305 495 3250

1. *This 65,000 GPD BAT Dual Designed USBF has been in operation for almost Three (3) years operating at extremely low flows. As of the last few months, the Islander is finally reaching half of the plant's capacity with Influent flows between .020 and .028 MGD.*

8824 Van Fleet Road • Riverview, Florida 33569 • Tel: (813) 677 0041 • (813) 677 3359 • Fax: (813) 677 0413

2. *In spite of the extremely low flows, the USBF at the Islander Resort has always met all the BAT Effluent Parameters.*
3. *During a period of about Six (6) months, while the Resort was completely closed for renovation, supplemental food, in the form of "Agricultural Grade Molasses" was added to the WWTP in order to provide food to obtain the Total Nitrogen Results required.*

Project: ***Ziggies Restaurant***
Contact: ***Mr. Jim Hand***
Hand Utilities Inc.
P.O. Box 971745
Miami, FL 33197
Tel: 305 495 3250

1. *This USBF 6,000 GPD BAT Dual Designed USBF has been in operation for almost Three (3) years operating at extremely low flows during the "off season" and also with extremely high BOD/TSS during peak season.*
2. *During the "off season" flows range between 800 GPD and 1,500 GPD and in "peak season" between 1,500 and 2,500 GPD.*
3. *This plant has always met its BAT required Effluent Parameters.*

Item #2: Permits, included in folder.

Item #3: Process description, included in folder.

Item #4: Operational Data, included in folder.

Item #5: Guarantee, included in folder.

Item #6: Discuss Process Modifications Required to achieve 5-5-3-1

There would be no process modifications required to achieve the treatment requirements. *The portion of our warranty covering modification(s) of the equipment, as deemed necessary, until the process performance is met, is included merely for the project owner's protection. We do not expect the process to fail in meeting the treatment requirements. We have never been in the situation where process wouldn't meet requirements and modifications had to be made.*

Theoretically, *some modifications that could be made, if deemed necessary, to achieve a required nitrogen removal are addition of an influent flow equalization tank; better control of blower operating speed and air flow provided; and supplemental chemical addition.*

As you can see from the Marco Shores Report dated from 9-1-03 thru 9-17-03 the required Effluent BOD/TSS and Total Nitrogen has already been achieved in less than Two (2) months after startup.

RANDAZZA ENTERPRISES, INC.
Manufacturers Representative
Wastewater Treatment Systems & Chemicals

If you have any questions or need more information, please let me know.

Sincerely,

Nos Espin
President
Randazza Enterprises, Inc.

8824 Van Fleet Road • Riverview, Florida 33569 • Tel: (813) 677 0041 • (813) 677 3359 • Fax: (813) 677 0413

Department of Environmental Protection

Jeb Bush
Governor

South District
P.O. Box 2549
Fort Myers, Florida 33902-2549

David B. Struhs
Secretary

STATE OF FLORIDA
DOMESTIC WASTEWATER FACILITY PERMIT

PERMITTEE:

Florida Water Services Corp.

RESPONSIBLE AUTHORITY:

Mr. Ying C. Lee, P.E.
Vice President, Engineering Services
P.O. Box 609520
Orlando, FL 32860-9520
(407) 598-4213

PERMIT NUMBER: FLA014174
PA FILE NUMBER: FLA014174-002-DW2P
ISSUANCE DATE: September 14, 1999
REVISED DATE: January 11, 2002
EXPIRATION DATE: September 13, 2004

FACILITY:

Marco Shores WWTP
100 Mainsail Drive
Marco Island, FL
Collier County
Latitude: 26° 00' 00" N Longitude: 81° 40' 01" W

This permit is issued under the provisions of Chapter 403, Florida Statutes, and applicable rules of the Florida Administrative Code. The above named permittee is hereby authorized to construct and operate the facilities shown on the application and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows:

TREATMENT FACILITIES:

Operate an existing 0.090 mgd annual average daily flow (AADF) contact stabilization domestic wastewater treatment plant (WWTP) consisting of a surge tank, a bar screen, two contact zones, two reaeration zones, two clarifiers, a chlorine contact chamber, and an aerobic digester. Construct and operate a new 0.30 mgd (TMADF) USBF modified activated sludge domestic wastewater treatment plant consisting of two manual fine screens, two anoxic zones, four aeration zones, four clarifiers, two tertiary filters with associated chemical feed facilities, two chlorine contact chambers, effluent pump station, and an aerobic digester/holding tank. The existing WWTP will be abandoned after the new plant is placed into service.

REUSE:

Land Application: An existing off-site rapid infiltration basin system (R-001) located approximately at latitude 26° 00' 03" N, longitude 81° 41' 30" W. System R-001 also consists of the two on-site ponds that will be abandoned after the new WWTP is placed into service. R-001 has an existing permitted capacity of 0.090 mgd annual average daily flow (AADF) from the existing Marco Shores WWTP and 0.30 mgd AADF for the proposed Marco Shores WWTP. R-001 has a total permitted capacity of 3.5 mgd (0.30 mgd AADF credited to the Marco Shores WWTP and 3.2 mgd AADF credited to the existing Marco Island WWTP).

Land Application: Substantial modifications to an existing 0.3 mgd annual average daily flow (AADF) permitted capacity slow-rate public access (R-002) consisting of the Marco Shores Golf Course. The Marco Shores reuse system is supplemented with reclaimed water from the Marco Island WWTP.

IN ACCORDANCE WITH: The limitations, monitoring requirements and other conditions set forth in Pages 1 through 25 of this permit.

Department of Environmental Protection

South District
P.O. Box 2549
Fort Myers, Florida 33902-2549

Jeb Bush
Governor

David B. Struhs
Secretary

STATE OF FLORIDA
DOMESTIC WASTEWATER FACILITY PERMIT

PERMITTEE:

S&H, Inc.

PERMIT NUMBER:	FLA187607
PA FILE NUMBER:	FLA187607-001-DW3P
ISSUANCE DATE:	September 27, 2000
EXPIRATION DATE:	September 26, 2005

RESPONSIBLE AUTHORITY:

Mr. C. David Curry
President
P.O. Box 126
Fort Smith, AR 72902

(501) 785-0844

FACILITY:

Islander Motel WWTP
Overseas Highway, Mile Marker 82.1
Islamorada, FL 33036
Monroe County
Latitude: 24° 55' 14" N Longitude: 80° 37' 49" W

This permit is issued under the provisions of Chapter 403, Florida Statutes, and applicable rules of the Florida Administrative Code. The above named permittee is hereby authorized to construct and operate the facilities shown on the application and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows:

TREATMENT FACILITIES:

Construct and operate a 0.065 MGD maximum month average daily flow, MMADF, modified conventional activated sludge process domestic wastewater treatment plant designed to exceed secondary treatment standards and provide Best Available Technology, (BAT), treatment standards utilizing the upflow sludge blanket filtration technology, USBF. BAT treatment standards are 10 mg/l CBOD, 10 mg/l TSS, 10 mg/l Total N and 1 mg/l Total P. The treatment plant consists of a welded steel rectangular tank structure divided into eight major sections identified as follows: an anoxic compartment, two aeration compartments, two prism clarifiers, a sludge storage compartment and dual chlorine contact chambers. Ancillary support equipment and piping include fine bubble diffusers, sludge air lift pumps, effluent troughs, dual blower assemblies with motors and controls, blower and motor housings, chemical dosing equipment, and all internal piping, valves and accessory equipment. Additionally, a surge tank with blower- motor assembly for hydraulic and BOD load cushioning. Install ancillary piping and support equipment to integrate the surge tank with the treatment process. An auxiliary generator for pump station back up in case of a power failure is to be provided to assure Class III power reliability.

PERMITTEE:	**S&H, Inc.** **P.O. Box 126** **Fort Smith, AR 72902**	**PERMIT NUMBER:** **PA FILE NUMBER:**	**FLA187607** **FLA18607-001-DW3P**

EFFLUENT DISPOSAL:

Underground Injection: Construct and operate a 0.065 mgd MADF permitted capacity underground injection well system U-001 consisting of 3 Class V underground injection wells permitted under Department permit numbers 166426-001-UC, 166426-002-UC and 166426-003-UC discharging to Class G-III ground water. Underground injection well system U-001 is located approximately at latitude 24° 55' 14" N, longitude 80° 37' 49" W.

IN ACCORDANCE WITH: The limitations, monitoring requirements and other conditions set forth in Pages 1 through 21of this permit.

Jeb Bush
Governor

South District
P.O. Box 2549
Fort Myers, Florida 33902-2549

David B. Struhs
Secretary

STATE OF FLORIDA
DOMESTIC WASTEWATER FACILITY PERMIT

PERMITTEE:
Ziggie's Conch Restaurant
Wendy Kurfist-Cioffi, President
Security Storage, LLP
P.O. Box 360101
Phone (305) 393-1002
Islamorada, FL. 33036

PERMIT NUMBER: FLA186945-001-DW4P
ISSUANCE DATE: September 29, 2000
EXPIRATION DATE: September 28, 2005

FACILITY:

Ziggie's Conch Restaurant
Overseas Highway, MM 83
Islamorada, FL. 33036
Monroe County
Latitude: 24° 55' 55" N   Longitude: 80° 37' 14" W

This permit is issued under the provisions of Chapter 403, Florida Statutes, and applicable rules of the Florida Administrative Code. The above named permittee is hereby authorized to construct and operate the facilities shown on the application and other documents attached hereto or on file with the Department and made a part hereof and specifically described as follows:

TREATMENT FACILITIES:

To construct and operate a 0.006 MGD, based upon three month average daily flow, TMADF, extended aeration process domestic wastewater treatment facility with Best Available Technology (BAT) treatment requirements for the removal of nutrients and more stringent levels of treatment for CBOD and TSS. BAT treatment standards are 10 mg/l CBOD, 10 mg/l TSS, 10 mg/l Total N and 1 mg/l Total P. The treatment facility will consist of the following process units: Surge tank, anoxic zone, aeration, final settling, disinfection and sludge digestion with effluent discharge to two Class V injection wells. The collection system for this project shall be constructed with authorization from a separate permit.

EFFLUENT DISPOSAL:

Underground Injection: A new 0.006 mgd TMADF permitted capacity underground injection well system U-001 consisting of 2 Class V underground injection wells permitted under Department permit numbers —145645-001-UC and —145645-002-UC discharging to Class G-III ground water. These wells will be drilled to at least 90 feet and cased to a minimum of 60 feet. Underground injection well system —U-001 is located approximately at latitude 24° 55' 55" N, longitude 80° 37' 14" W.

IN ACCORDANCE WITH: The limitations, monitoring requirements and other conditions set forth in Pages 1 through 21 of this permit.

DESCRIPTION OF THE USBF PROCESS

The USBF process is a modification of conventional activated sludge that incorporates an anoxic selector zone and an upflow sludge blanket clarifier. The USBF process may be designed for 1) carbonaceous (BOD) removal 2) BOD removal and nitrification 3) BOD removal nitrification, and denitrification and 4) BOD removal, nitrification/denitrification and phosphorous removal. For carbonaceous removal, the anoxic zone serves as a "selector zone" that conditions the mixed liquor to improve settleability and to control filamentous organism growth.

For nitrification, denitrification and phosphorous removal designs, the anoxic zone provides the necessary conditions for dissimilarity nitrate reduction and phosphorous removal by "luxury uptake". In this process, ammonia nitrogen is oxidized to nitrite and then to nitrate by Nitrosomonas and Nitrobacter bacteria, respectfully in the aeration zone. The nitrate is then recycled to the anoxic zone where the nitrate is reduced by dissimilarity nitrate reduction. In this reaction, the incoming BOD serves as the carbon source or electron donor for the reduction of nitrate to elemental nitrogen. The phosphorous removal mechanism in this process is the same as that employed in the Phostrip and modified Bardenflow processes. In the USBF process, fermentation of soluble BOD occurs in the anaerobic or anoxic zone. The fermentation products are selectively used or assimilated by a special group of microorganisms that are capable of storing phosphorous. During the aerobic stage of treatment, soluble phosphorous is taken up by the population of the phosphorous storing bacteria (Acinetabacter) that was developed in the anoxic zone. The assimilated phosphorous is then removed from the system as excess biomass or waste sludge. The amount and rate of phosphorous removal depends primarily on the BOD/P ratio of the influent wastewater.

Process Design

The Purestream / Ecofluid LLC Design Program for the USBF process is based on the Lawrence and McCarty kinetic models for BOD removal, nitrification and denitrification (the nomenclature as shown in the USBF guide is somewhat different than our standard U.S. texts). The process model equations along with the kinetic coefficients and related critical design parameters are presented in the attached USBF guide. The USBF process is capable of removal of BOD to less than 5 mg/l, TSS removal to less 10 mg/l, without filtration total nitrogen removal to less than 1.0 mg/l and total phosphorous removal to a range of 0.5 to 2.0 mg/l.

Higher levels of phosphorous removal down to 0.2 to 0.5 mg/l can be achieved by metal salt addition to the aeration zone immediately prior to the mixed liquor entering the clarifier. A number of metal salts may be used including Alum ($Al_2(SO_4)_3.14H_2O$), Sodium Aluminate ($Na_2O.Al_2O_3$), Ferric Chloride ($FeCl_3$), Ferrous Chloride ($FeCl_2$), Ferrous Sulfate ($FeSO_4.\&H_2O$) or Ferric Sulfate ($Fe_2(SO_4)_3$).

Since the bulk of phosphorous removed (over 80%) in the USBF process is accomplished by biological uptake, the small polish dosages of a metal salt coagulant does not significantly increase sludge production. For example, removal of phosphorous by $FeSO_4$ is given by the two following reactions:

Phosphorous Precipitation

$$3FeSO_4 + 2PO_4^{-3} \longrightarrow Fe_3(PO_4)_2 + 3SO_4^{-2}$$

Alkalinity Reduction and Hydroxide Precipitation

$$Fe^{+++} + 3HCO^{-3} \longrightarrow Fe(OH)_3$$

According to the above two reactions, removal of 2 mg/l of PO_4^{-3}, would theoretically produce 6 mg/l of additional sludge. In actual practice, a value of 5 mg/l of sludge per mg/l of PO_4^{-3} removed provides a conservative design value. For an influent wastewater having 240 mg/l of incoming BOD and a sludge yield of 0.6 lbs TSS/lb BOD removal, and the use of $FeSO_4$ to remove 2 mg/l of PO_4^{-3}, the total increase in sludge production would be about 7%.

The USBF process utilizes a unique patented upflow sludge blanket clarifier. The upflow blanket clarifier utilizes a trapezoidal shape where the mixed liquor enters the bottom of the clarifier thorough a specially designed baffel where hydraulically induced flocculation occurs. The trapezoidal clarifier shape provides for a steadily increasing surface area from the bottom to the top of the clarifier. This permits a gradually decreasing vertical velocity gradient within the clarifier. The "top surface area" clarifier overflow rate is 150 to 250 gpd/ft² at average daily design flow. The clarifier is normally designed for a daily peak flow rate of 3 times the average flow ratio which translates to a peak "top surface" clarifier overflow rate of 450 to 750 gpd/ft which is very conservative. The clarifier also includes a unique baffel arrangement to allow sludge withdrawal at the bottom of the clarifier. The sludge withdrawal design also incorporates the internal recycle between the aerobic and anoxic zone. The normal design recycle/sludge withdrawal rate is 4 times the average daily flow. This high sludge withdrawal rate from the clarifier bottom creates a downward velocity gradient within the clarifier that significantly improve the hydraulic efficiency of the clarifier compared to a conventional clarifier.

The internal recycle between the aeration zone and the anoxic zone provides recycle BOD that is required for endogenously supported nitrate reduction. This internal recycle of mixed liquor also provides for recycle of phosphorous removal organisms developed in the anoxic zone that are then carried into the aeration zone for phosphorous uptake. The recycle ratio is established based on the influent BOD/total phosphorous/ammonia nitrogen ratio. The recycle ratio of 4.0 provides for a 25% - 35% safety factor for domestic wastewater. Higher recycle rates (up to 24:1) are used in conjunction with extreme wastewater conditions such as would be found in hog manure or cattle waste.

The major process design parameters for this process depends on 1) wastewater strength and biodegradability 2) wastewater temperature, influent and effluent BOD, N, and P concentration. Typical HRT's for the aeration zone range from 6 to 30 hrs. The HRT's for the anoxic zone typically range from 1 to 2 hrs for a selector zone used for carbonaceous removal and 2-8 hrs for biological phosphorous removal and denitrification. The design SRT is controlled by the temperature dependent nitrification and BOD removal kinetics and the design effluent NH_4-N requirements. The operating SRT is normally maintained at 50% to 100% greater than the design SRT at a operating temperature to provide a safety factor and to accommodate changes in influent wastewater characteristics. (Please note that SRT is both a design parameter and a process control parameter).

Operational Parameters

The dissolved oxygen (D.O.) concentration should be maintained at 2.0 to 4.0 mg/l in the aeration zone, and less than 0.5 mg/l in the anoxic zone. Under influent loading conditions less than the design values, the HRT in both the aeration zone and in the anoxic zone will be greater than the design value. Under these conditions, the mixed liquor volatile solids concentration in the system will normally be reduced to meet the process requirements. The D.O. may be maintained at optimum levels by reducing air supply. The increased HRT in the anoxic zone permits more time for exertion of D.O. demand and production of anoxic conditions needed for fermentation.

The operating SRT is controlled by controlling the sludge wasting rate. SRT is normally calculated based on aeration zone volume and MLVSS concentration since BOD removal and nitrification kinetics controls the aeration zone volume. Provision is made in the Purestream / Ecofluid design for measurement of both the internal recycle and sludge wasting. The operating SRT of the USBF process may be increased significantly above the design requirements without sacrificing effluent quality since the "anoxic selector" zone conditions the mixed liquor solids and the upflow sludge blanket clarifier provides a "filtration/flocculation" mechanism to prevent the discharge of pin-point floc normally associated with high SRT systems.

Alkalinity and pH

If the influent wastewater is not properly buffered it is necessary to add alkalinity to the influent wastewater for the USBF process designed for nitrification and denitrification. The nitrification reaction consumes 7.1 mg/l of alkalinity as $CaCO_3$ for each mg/l of ammonia nitrogen oxidized. The denitrification reaction produces 3.57 mg/l of hydroxide alkalinity as $CaCO_3$ for each mg/l of nitrate- nitrogen reduced.. For an influent wastewater having 40 mg/l of NH_4-N, the total alkalinity should be 150-200 mg/l to insure adequate buffering. The pH of the system should always be maintained between 7.0 to 8.5 S.U. by the addition of alkalinity when required.

Mechanical Design, Redundancy and Mechanical Reliability

The standard P/E design for the USBF process provides for 100% redundancy in total aeration blower capacity. The final clarifiers are integral to the modular system design and have no moving parts. Since recycle is accomplished by air lift pumps, this also provides for 100% redundancy in internal recycle and sludge wasting capacity. The P/E design also includes single or multiple clarifiers, and single or multiple chlorination facilities where required. Duplex chemical pumps are provided for alkalinity control, metal salt addition for residual phosphorous removal and nutrient addition when required. Sludge holding tanks or sludge digesters are not aerated due to the stability and sludge age of the wasted sludge. If local requirements call for an aerated sludge digester, P/E designs for duplex blowers to provide 100% redundancy. The P/E digester design provides for either gravity overflow through a "T" pipe (standard) or air lift decanting of the supernatant.

Nitrification and Denitrification

Nitrogen is removed by the nitrification and denitrification processes. Nitrification is autotropic and all Purestream/Ecofluid LLC integrated bioreactors are designed for complete nitrification of ammonia to NO_3 (please see Metcalf & Eddy, Third Edition, Chapter 11-6).

Denitrification, however, is heterotropic and requires a carbon source. Conventional plants' "separate sludge denitrification" requires that carbon is added, typically in the form of methanol. This adds to operating costs, and if used in excess, to increased effluent BOD_5 content. USBF technology's "single-sludge denitrification" approach uses an endogenous carbon source to maintain the denitrifiers. Influent is combined with nitrified mixed liquor in the anoxic compartment providing the carbon source needed for denitrification. Relatively high mixed liquor recycle rates are employed and sufficient denitrification retention times provided.

Total nitrogen reduction (N_T) is a subject of not only providing sufficient anoxic volume for denitrification and keeping temperature above a certain minimum, but also a function of Recycled Activated Sludge (RAS) flow rate. The efficiency of N_T reduction is expressed as follows:

$$\eta = (1 - 1/(1 + n)) \times 100$$

Where n = RAS flow multiple of average flow Q.

The following are typical efficiencies and RAS flow multiples used / required:

	n	η (%)
Domestic	2	66
	3	75
	4	80
Slaughterhouse Wastewater	14	93
Hog Manure	29	97

Phosphorous Reduction

USBF technology delivers not only high efficiency of organic matter reduction, but also increased efficiency of phosphorous removal. Two processes, biological and chemical precipitation are employed with advantage.

The mechanics of biological phosphorous removal, known as "Luxury Uptake", is due to exposure of activated sludge to alternating oxic and anoxic conditions. Under these conditions, the cells store more energy in the form of phosphorous than needed for their survival. If strictly oxic conditions are maintained during subsequent clarification, phosphorous will be retained by the cells and will eventually be removed with the excess sludge. Unlike most other methods of clarification, these conditions are maintained by the USBF clarification process, and biological phosphorous reduction to less than 3 mg/l are readily achievable.

The basic reaction involved in the precipitation of phosphorous with iron is as follows:

$$Fe^{+3} + H_n(PO_4)^{n-3} \Leftrightarrow FePO_4 + nH^+$$

In the case of iron, 1 mole will precipitate 1 mole of phosphate. The advantage of the process is its low chemical consumption, close to stochiometric, and consequently, the reduction of ballast sludge production. Followed by microfiltration, reductions to 0.5 mg/l are possible.

If yet further reduction of phosphorous is required, ferric sulfate precipitation after the bioreator followed by microfiltration must be used.

ENVIRONMENTAL LABORATORIES, INC.
307 Coolidge Avenue, Lehigh Acres, Florida 33936 Tel:(941) 369-8477 Fax: (941) 369-3367

MARCO SHORES USBF WWTP
Attention: Mr. Jeff Poteet, Chief Operator

Group: Domestic
Monitoring Period: From:7/29 To: 8/29/03

Date	INF TSS	EFF TSS	% Efficiency	INF CBOD	EFF CBOD	% Efficiency	EFF NO3
7/29/2003	79	0.5	99.4	100	2.6	97.4	2.8
8/13/2003	160	0.5	99.7	170	2.5	98.5	2.5
8/27/2003	35	1.4	96.0	50	2.6	94.8	2.8

	INF TKN	EFF TKN	% Efficiency	INF Ammonia	EFF Ammonia	% Efficiency
7/29/2003	41	0.4	99.0	Not Sampled		
8/13/2003	32	1	96.9	28	0.049	99.8
8/27/2003	29	0.74	97.4	29	0.049	99.8

	Daily Grab TSS	Daily Grab Fecal
8/11/2003	2.1	<1U
8/12/2003	3.3	<1U
8/13/2003	1.9	<1U
8/14/2003	0.7	<1U

	Daily Grab TSS	Daily Grab Fecal
8/18/2003	0.5	<1U
8/19/2003	0.5	<1U
8/20/2003	0.5	<1U
8/21/2003	1.1	<1U

	Daily Grab TSS	Daily Grab Fecal
8/26/2003	0.2	<1U
8/27/2003	0.1	<1U
8/28/2003	0.8	<1U
8/29/2003	1.6	<1U

ENVIRONMENTAL LABORATORIES, INC.

307 Coolidge Avenue, Lehigh Acres, Florida 33936 **Tel: (941) 369-8477** **Fax: (941) 369-3367**

MARCO SHORES USBF WWTP
Attention: Mr. Jeff Poteet, Chief Operator

Group: Domestic
Monitoring Period: From 9/1 **To: 9/17/03**

Date	INF TSS	EFF TSS	% Efficiency	INF CBOD	EFF CBOD	% Efficiency	EFF NO3
9/10/2003	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	1.5

	INF TKN	EFF TKN	% Efficiency	INF Ammonia	EFF Ammonia	% Efficiency
9/10/2003	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

	Flow (MGD)	Daily Grab TSS	Daily Grab Fecal		Flow (MGD)	Daily Grab TSS	Daily Grab Fecal		Flow (MGD)	Daily Grab TSS	Daily Grab Fecal
9/1/2003	0.062	1.8	1 U	9/8/2003	0.063	2.6	1 U	9/15/2003	0.061	2.1	1 U
9/2/2003	0.065	1.5	1 U	9/9/2003	0.059	0.78	1 U	9/16/2003	0.063	2.2	1 U
9/3/2003	0.060	1.2	1 U	9/10/2003	0.067	1.8	1 U	9/17/2003	0.066	2.1	1 U
9/4/2003	0.069	2	1 U	9/11/2003	0.063	0.89	1 U				

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

EDEP LIMITS (REPLACES MOR FORM)

PERMITTEE NAME: S & H Inc.
MAILING ADDRESS: PO Box 126
Ft. Smith, AR 72902

FACILITY: ISLANDER MOTEL
LOCATION: MM 82.1 Overseas Highway
Islamorada, Florida 33036

ATT'N:

PERMIT NUMBER: FLA187607-001-DW3P
EXPIRATION DATE: 9/27/05
MONITORING PERIOD: From: 8/1 To: 8/31/03
LIMIT: FINAL
CLASS SIZE: MINOR
GROUP: DOMESTIC
FACILITY ID: FLA187607
DISCHARGE POINT NUMBER: U001
PLANT SIZE/TREATMENT TYPE: Category I, Class C
TYPE OF EFFLUENT DISPOSAL: Two Class V injection wells
*** NO DISCHARGE [ ]***

Please read instructions before completing this form.

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sampl Type
STORET CODE MON. SITE No.		Average	Maximum	Units	Minimum	Average	Maximum	Units			
FLOW	Sample Measurement	.012	.017	(03)	*************	***************	*************				
50050 FLOW-1 MONTHLY AVERAGE	Permit Requirement	REPORT MONTHL Y AVG.	0.065 MGD (MMADF)	MGD	*************	***************	*************	********		daily, 5/wk	Elapsed time meters
CBOD5, INFLUENT	Sample Measurement	**********	*************	********	40.5	188	159	(19)			
80082 G INF-1 INFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Every 2 Wks	GRAI
TSS, INFLUENT	Sample Measurement	**********	*************	*********	62	256	107	(19)			
00530 G INF-1 INFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Every 2 Wks	GRAI
CBOD5, EFFLUENT	Sample Measurement	**********	*************	********	2.2	2.6	3	(19)			
80082 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Every 2 Wks	GRAI
TSS, EFFLUENT	Sample Measurement	**********	********	*********	2.4	2.8	3.4	(19)			
00530 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Every 2 Wks	GRAI

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here): (Attach additional sheets if necessary.)

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

NAME/TITLE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT (Type or Print)	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE NO.	DATE (YY/MM/D
Jim Hand		(305)455-2250	03/8/31

DEP Form 62-620.910 (10), effective November 29, 1994 -1-

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

FDEP LIMITS (REPLACES MOR FORM)

PERMITTEE NAME: S & H Inc.
MAILING ADDRESS: PO Box 126
Ft. Smith, AR 72902

FACILITY: ISLANDER MOTEL
LOCATION: MM 82.1 Overseas Highway
Islamorada, Florida 33036

ATTN:

PERMIT NUMBER: FLA187607-001-DW3P EXPIRATION DATE: 9/27/05
MONITORING PERIOD: From: 8/1 To: 8/31/03
LIMIT: FINAL
CLASS SIZE: MINOR GROUP: DOMESTIC
FACILITY ID: FLA187607
DISCHARGE POINT NUMBER: U001
PLANT SIZE/TREATMENT TYPE: Category I, Class C
TYPE OF EFFLUENT DISPOSAL: Two Class V injection wells
*** NO DISCHARGE [ ] ***

Please read instructions before completing this form.

Parameter	[redacted]	Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
STORET CODE MON. SITE No.		Average	Maximum	Units	Minimum	Average	Maximum	Units			
COLIFORM, FECAL	Sample Measurement	**********	*************	*********	<1			(13)			
31616 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	REPORT DAILY MINIMUM	***************	REPORT DAILY MAX	#/100 mL		Every 2 Weeks	GRAB
pH	Sample Measurement	**********	*************	*********	7.0	****************	7.2	(12)			
00400 1 EFA-1 MINIMUM/MAXIMUM	Permit Requirement	**********	*************	*********	6.0 MINIMUM	***************	8.5 DAILY MAX	SU		DAILY, 5/WK	GRAB
CHLORINE, TOTAL RESIDUAL	Sample Measurement	**********	*************	*********	1.0	****************	***********	(19)			
50060 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	0.5 MINIMUM	****************	***********	mg/L		DAILY, 5/WK	GRAB
NITROGEN, TOTAL (as N)	Sample Measurement	**********	*************	*********		****************	8.1	(19)			
00600 1 EFA-1	Permit Requirement	**********	*************	*********	REPORT	****************	REPORT	mg/L		Every 2 Weeks	GRAB
PHOSPHORUS, TOTAL (as P)	Sample Measurement	**********	*************	*********	0.2	****************	0.3	(19)			
00665 1 EFA-1	Permit Requirement	*********	*************	********	REPORT	****************	REPORT	mg/l		Every 2 Weeks	GRAB

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here): (Attach additional sheets if necessary.)

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NAME/TITLE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT (Type or Print)	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE NO.	DATE (YY/MM/DD)
Jim Hand		(386)485-2250	2003/8/31

DEP Form 62-620.910(10), effective November 29, 1994

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

FDEP LIMITS (REPLACES MOR FORM)

PERMITTEE NAME: Ziggie's Conch Restaurant
MAILING ADDRESS: P.O. Box 360101
Islamorada, Fl. 33036

PERMIT NUMBER: FLA186945-001-DW3P
EXPIRATION DATE: 9/28/05
MONITORING PERIOD: From: 8/1 To: 8/31/03
LIMIT: FINAL
CLASS SIZE: MINOR
GROUP: DOMESTIC
FACILITY ID: FLA186945
DISCHARGE POINT NUMBER: U001
PLANT SIZE/TREATMENT TYPE: Category I, Class C
TYPE OF EFFLUENT DISPOSAL: Two Class V injection wells
*** NO DISCHARGE [ ]***

FACILITY: ZIGGIE'S CONCH RESTAURANT
LOCATION: Overseas Hwy., MM 83
Islamorada, Florida 33036

ATT'N:

Please read instructions before completing this form.

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	San Ty
STORET CODE MON. SITE No.		Average	Maximum	Units	Minimum	Average	Maximum	Units			
FLOW	Sample Measurement	.001	.002	(03)	*************	***************	************				
50050 FLOW-1 MONTHLY AVERAGE	Permit Requirement	REPORT MONTHL Y AVG.	0.006 MGD (MMADF)	MGD	*************	***************	************	********		daily, 5/wk	Elap time mete
CBOD5, INFLUENT	Sample Measurement	**********	************	********			449	(19)			
80082 G INF-1 INFLUENT GROSS VALUE	Permit Requirement	**********	************	*********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Monthly	GR
TSS, INFLUENT	Sample Measurement	**********	*************	*********			140	(19)			
00530 G INF-1 INFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Monthly	GR
CBOD5, EFFLUENT	Sample Measurement	**********	*************	********			2	(19)			
80082 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Monthly	GR
TSS, EFFLUENT	Sample Measurement	**********	********	*********			2.4	(19)			
00530 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	********	MONTHLY MINIMUM	MONTHLY AVERAGE	MONTHLY MAXIMUM	mg/L		Monthly	GR

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here): (Attach additional sheets if necessary.)

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NAME/TITLE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT (Type or Print)	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE NO.	DATE (YY/MM
Jim Hand		(305)495-3250	03/8/31

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

FDEP LIMITS (REPLACES MOR FORM)

PERMITTEE NAME: Ziggie's Conch Restayrant
MAILING ADDRESS: P.O. Box 360101
Islamorada, Fl 33036

FACILITY: ZIGGIE'S CONCH RESTAURANT
LOCATION: Overseas Hwy., MM 83
Islamorada, Florida 33036

ATT'N:

PERMIT NUMBER: FLA186945-001-DW3P EXPIRATION DATE: 9/28/05
MONITORING PERIOD: From: 8/1 To: 8/31/03
LIMIT: FINAL
CLASS SIZE: MINOR GROUP: DOMESTIC
FACILITY ID: FLA186945
DISCHARGE POINT NUMBER: U001
PLANT SIZE/TREATMENT TYPE: Category I, Class C
TYPE OF EFFLUENT DISPOSAL: Two Class V injection wells
*** NO DISCHARGE [ ] ***

Please read instructions before completing this form.

Parameter		Quantity or Loading			Quality or Concentration				No. Ex.	Frequency of Analysis	Sample Type
STORET CODE MON. SITE No.		Average	Maximum	Units	Minimum	Average	Maximum	Units			
COLIFORM, FECAL	Sample Measurement	**********	*************	*********	<1		<1	(13)			
31616 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	REPORT DAILY MINIMUM	***************	REPORT DAILY MAX	#/100 mL		Monthly	GRAB
pH	Sample Measurement	**********	*************	*********	6.9	***************	7.1	(12)			
00400 1 EFA-1 MINIMUM/MAXIMUM	Permit Requirement	**********	*************	*********	6.0 MINIMUM	***************	8.5 DAILY MAX	SU		DAILY, 5/WK	GRAB
CHLORINE, TOTAL RESIDUAL	Sample Measurement	**********	*************	*********	1.2	***************	************	(19)			
50060 1 EFA-1 EFFLUENT GROSS VALUE	Permit Requirement	**********	*************	*********	0.5 MINIMUM	***************	************	mg/L		DAILY, 5/WK	GRAB
NITROGEN, TOTAL (as N)	Sample Measurement	**********	*************	*********		***************	3.4	(19)			
00600 1 EFA-1	Permit Requirement	**********	*************	*********	REPORT	***************	REPORT	mg/L		Monthly	GRAB
PHOSPHORUS, TOTAL (as P)	Sample Measurement	**********	*************	*********		***************	0.1	(19)			
00665 1 EFA-1	Permit Requirement	*********	*************	********	REPORT	***************	REPORT	mg/l		Monthly	GRAB

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here): (Attach additional sheets if necessary.)

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

NAME/TITLE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT (Type or Print)	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE NO.	DATE (YY/MM/DD)
Jim Hand		(305)495-3350	2003/8/31

PURESTREAM inc.
P.O. Box 68 Florence, KY 41022-0068 Phone (606) 371-9898 Fax (606) 371-3577

September 18, 2003

USBF Process Warranty

Project: Key largo Park & Trailer Center

PURESTREAM, INC., (PSI) warrants that the equipment supplied by PSI shall be capable of producing treated effluent with a monthly average BOD_5 concentration of ≤ 5 mg/l; Total Suspended Solids concentration of ≤ 5 mg/l; Total Nitrogen concentration of ≤ 3 mg/l; and Total Phosphorus of ≤ 1 mg/l, provided that:

1. The equipment must be installed, operated and maintained in accordance with PSI drawings and instructions and the O&M manual.

2. Tests shall be conducted not less than sixty days nor more than six months from initial operation of the equipment. TESTING EXPENSE SHALL BE BY OTHERS.

3. PSI must be notified in advance of testing to determine the existence of suitable biological activity. PSI shall be given the opportunity to witness all tests. The laboratory performing sampling and analyses must be mutually acceptable to the Project Engineer and PSI.

4. Influent into the PSI supplied equipment must have the following characteristics during the testing period:

Average influent BOD concentration — mg/l 250
Average influent suspended solids concentration — mg/l 250
Daily average wastewater flow rate per. — MGD 0.183
Minimum temperature of influent waste water — °C. 20
Maximum instantaneous peak wastewater flow — GPM 382
Maximum grease — mg/l 50
pH range to equipment — 6 - 7.5
Maximum pH change per hour — 0.20
Average influent TKN concentration — mg/l 40
Average influent phosphate (PO4 -P) concentration — mg/l 12

5. Wastewater analysis shall be performed in accordance with applicable articles of the current edition of the "Standard Method for Examination of Waste and Wastewater". Samples shall be flow proportional, twenty - four hour composites taken at the equipment influent and effluent.

purestream inc.
P.O. Box 68 Florence, KY 41022-0068 Phone (606) 371-9898 Fax (606) 371-3577

6. Performance evaluation shall be based on the arithmetic average of not less than seven nor more than thirty consecutive influent and effluent composite samples.

7. This process warranty shall be deemed fulfilled if the effluent requirements as stated above are met regardless of influent characteristics. If effluent requirements are not met and influent characteristics are not as specified in paragraph #4, up to two additional tests may be conducted at no expense to PSI. After a total of three such tests with influent characteristics not as specified, this process warranty shall be deemed fulfilled.

8. If the PSI supplied equipment does not meet the standards of performance warranted and the wastewater characteristics are within the limits of Paragraph #4, PSI shall be notified in writing and shall within 10 days after said notification conduct a seven to thirty day performance test as deemed necessary by PSI at no expense to the owner. Sample analyses to be at PSI expense.

9. If the PSI supplied equipment does not meet the standard of performance warranted and the influent parameters of Paragraph #4 are met, after no more than two such test periods, PSI shall modify the equipment as deemed necessary by PSI until the process performances are met.

10. Inhibiting compounds in the influent exceeding the limits on the attached the list will constitute a voidance of this warranty.

11. This process warranty shall be in force for a period of twelve (12) months from date of start up.

FOR PURESTREAM, INC.	ACCEPTED BY:
BY:____________________	BY ____________________
DATE:__________________	DATE __________________

Best Available Technology Effluent Data for Monroe County Wastewater Treatment Plants

FACILITY: Ziggie's Conch Restaurant

Permitted Capacity 0.006 MGD TMADF Process: USBF

Month-Year	MADF (MGD)	Flow on sample date	TSS mg/L single sample	TSS mg/L annual average	CBOD mg/L single sample	CBOD mg/L annual average	TN mg/L single sample	TN mg/L annual average	TP mg/L single sample	TP mg/L annual average
October-01	0.001	0.001	6.0		6.0		13.1		5.9	
November-01	0.001	0.001	3.0		4.0		9.2		7.2	
December-01	0.001	0.002	6.0		6.0		2.8		0.2	
January-02	0.002	0.001	2.0		6.0		2.7		0.1	
February-02	0.002	0.002	4.0		4.0		29.3		0.2	
March-02	0.002	0.002	32.0		2.0		11.0		0.8	
April-02	0.002	0.001	1.0		2.0		6.0		0.6	
May-02	0.001	0.001	22.0		2.7		11.0		0.3	
June-02	0.001	0.001	4.2		2.0		7.7		1.1	
July-02	0.001	0.001	1.0		2.0		11.5		0.4	
August-02	0.001	0.001	1.0		3.5		6.7		0.2	
September-02	0.001	0.001	3.2	7.1	3.7	3.7	8.9	10.0	0.6	1.5
October-02	0.001	0.001	4.4	4.4	2.0	3.3	13.1	10.0	0.7	1.0
November-02	0.001	0.001	6.0	7.2	3.2	3.2	6.4	9.8	0.3	0.3
December-02	0.001	0.001	1.8	6.9	2.0	2.9	14.2	10.7	0.4	0.5
January-03	0.001	0.001	3.8	7.0	2.4	2.4	9.8	11.3	0.4	0.5
February-03	0.001	0.002	5.8	7.2	3.0	2.5	2.9	9.1	0.3	0.5
March-03	0.001	0.001	25.0	6.6	4.1	2.7	7.5	8.8	0.5	0.5
April-03	0.001	0.001	2.0	6.7	2.0	2.7	6.2	8.8	0.2	0.4
May-03	0.001	0.001	4.6	5.2	2.2	2.7	2.2	8.1	0.6	0.5
June-03	0.001	0.001	2.0	5.1	2.0	2.7	6.7	8.0	0.9	0.5
Feb. 18, 2002							35.1		0.6	
Sep. 3, 2002							31.9		1.0	
Feb. 27, 2003							9.1		0.6	

Best Available Technology Effluent Data for Monroe County Wastewater Treatment Plants										
FACILITY: Key West Oceanside Marina										
Permitted Capacity 0.020 MGD MMADF Process: USBF										
		Flow on	TSS mg/L		CBOD mg/L		TN mg/L		TP mg/L	
Month-Year	MADF (MGD)	sample date	single sample	annual average	single sample	annual average	single sample	annual average	single sample	annual average
Jan-03	startup end of month									
Feb-03	0.002	0.003	39.3		20.6					
		0.001	38.0		19.7					
		0.002	10.4		15.7					
		0.002	16.4		12.9		71.6		8.63	
Mar-03	0.002	0.001	9.2		17.6					
		0.001	2.6		8.7					
		0.002	5.6		20.2		23.1		5.74	
		0.002	4.0		8.6					
Apr-03	0.001	0.002	2.4		2.1					
		0.001	3.4		2.2					
		0.001	2.8		1.7		29.7		5.04	
		0.002	3.2		2.5					
May-03	0.003	0.002	3.6		5.1					
		0.002	4.0		2.2		27.4		6.74	
		0.001	8.4		2.0					
		0.004	4.8		2.0					

FACILITY: Marathon Marina

Permitted Capacity 0.025 MGD AADF Process: USBF

Month-Year	monthly average flow	Flow on sample date	TSS mg/l. single sample	TSS mg/l. annual average	CBOD mg/L single sample	CBOD mg/L annual average	TN mg/l. single sample	TN mg/l. annual average	TP mg/L single sample	TP mg/L annual average
March-03	0.001	0.001	3.8		8.7		31.1		0.36	
		0.001	27.3		18.4					
		0.001	7.2		18.5					
April-03	0.001	0.001	8.8		8.1		26.8		0.92	
		0.001	28		17.3					
		0.001	31.6		19.7					
		0.001	7		12.6					
May-03	0.001	0.001	9.8		9.7		17.2		0.89	
		0.001	22.3		9					
		1.000	7		12.3					
		0.001	17.2		2.3					
June-03	0.001	0.001	2.6		12		15.4		1.19	
		0.001	13.2		5.3					
		0.001	19.7		16.6					

Best Available Technology Effluent Data for Monroe County Wastewater Treatment Plants

FACILITY: The Islander Resort

Permitted Capacity 0.06 MGD TMADF Process USBF

Month-Year	MADF (MGD)	Flow on sample date	TSS mg/L		CBOD mg/L		TN mg/L		TP mg/L	
			single sample	annual average	single sample	annual average	single sample	annual average	single sample	annual average
January-02	0.003	0.004	4.00		3.00		9.00		0.700	
February-02	0.004	0.004	3.60		2.90		11.50		1.100	
		0.006	1.60		<2		9.00		0.900	
March-02	0.004	0.004	3.60		<2		21.80		1.100	
		0.005	1.00		2.70		9.00		0.900	
April-02	0.004	0.007	<1		<2		4.30		0.010	
		0.004	4.40		2.61		5.50		0.430	
May-02	0.004	0.004	1.00		2.80		9.40		0.100	
		0.003	6.40		3.10		17.20		1.800	
June-02	0.004	0.005	15.20		3.60		2.20		0.760	
		0.007	13.00		3.60		16.60		0.630	
July-02	0.004	0.005	3.80		2.00		9.40		0.900	
		0.004	8.40		4.60		10.40		0.300	
		0.003	23.40		7.40		22.50		0.300	
Aug. 02	0.003	0.005	1.00		2.00		7.20		0.600	
		0.002	5.00		4.30		6.00		0.600	
Sept. 02	0.005	0.001	4.60		2.00		12.40		0.960	
		0.001	1.50		2.00		4.20		0.300	
October-02	0.001	0.001	1.00		2.00		13.10		0.500	
		0.001	1.00		2.00		21.00		0.360	
November-02	0.001	0.001	1.00		2.00		2.96		0.580	
		0.001	1.00		2.00		10.60		0.01	
December-02	0.003	0.001	1.00		2.00		4.48		0.56	
		0.001	4.00	**4.60**	2.00	**2.50**	10.20	**9.53**	0.17	**0.62**
Jan-03	0.004	0.002	1.00		2.00		3.57		0.90	
		0.004	2.00	**4.40**	2.00	**2.50**	15.20	**9.80**	0.20	**0.61**
Feb-03	0.007	0.004	1.00		2.20		2.40		0.16	
		0.006	7.80	**4.71**	3.20	**2.79**	2.30	**9.76**	0.30	**0.54**
March-03	0.008	0.008	2.00		2.00		3.04		0.80	
		0.007	1.00	**1.00**	2.00	**2.73**	7.30	**8.94**	0.50	**0.51**
April-03	0.01	0.008	15.60		4.60		5.50		1.10	
		0.008	1.20	**1.20**	2.00	**2.78**	5.80	**9.00**	0.30	**0.55**
May-03	0.01	0.009	4.20		2.00		1.70		0.70	
		0.012	1.00	**4.87**	2.00	**2.70**	7.40	**8.30**	0.90	**0.54**
Jun-03	0.013	0.017	4.80		2.80		5.60		0.10	
		0.013	1.20	**3.980**	2.00	**2.60**	9.40	**8.15**	0.90	**0.520**
July-03	0.012	0.011	2.40		2.00		6.80		1.20	
		0.01	3.00	**2.89**	2.00	**2.30**	11.20	**7.47**	0.24	**0.539**
Feb. 18	0.004	0.012					30.90		1.600	
Sept. 3		0.005					80.40		1.200	
27-Feb							18.2		0.72	

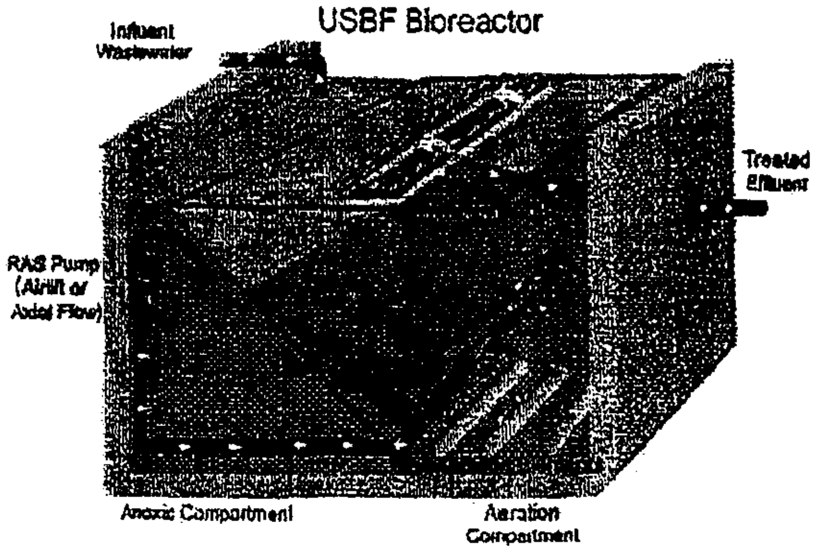
Best Available Technology Effluent Data for Monroe County Wastewater Treatment Plants

FACILITY: The Island Tiki Bar

Permitted Capacity 0.012 MGD TMADF Process USBF

Month-Year	MADF (MGD)	Flow on sample date	TSS mg/L		CBOD mg/L		TN mg/L		TP mg/L	
			single sample	annual average	single sample	annual average	single sample	annual average	single sample	annual average
November-01	0.002	0.008	0.8		2.5		13.80		0.120	
December-01	0.001	0.001	28.0		1.2		9.93		0.230	
January-02	0.001	0.002	11.4		11.8		12.30		0.340	
		0.001	14.0		9.7				0.343	
		0.001	18.8						0.338	
		0.001	24.0		28.2				1.190	
		0.002	41.0		12.3				3.320	
February-02	0.002	0.002	102.8		26.8		77.00		3.310	
		0.004	34.0		13.8				1.160	
		0.001	11.9		9.4				1.250	
		0.002	9.6		13.1				1.830	
March-02	0.002	0.001	10.6		18.6		4.73		1.170	
		0.002	6.3		8.5				0.469	
		0.002	3.7		9.8				1.450	
		0.002	4.6		6.4				0.528	
April-02	0.002	0.001	3.6		13.1		3.37		0.528	
		0.002	1.3		9.8				0.321	
		0.001	1.9		8.6				0.300	
		0.002	4.6		7.9				0.311	
May-02	0.002	0.002	7.8		8.4		2.27		0.260	
		0.001	5.4		6.6		2.01		0.230	
		0.002	2.3		6.6		1.33		0.250	
		0.001	3.7		9.7		0.63		0.320	
		0.001	5.4		7.7		1.84		0.330	
June-02	0.002	0.002	2.5		3.1		0.1		0.363	
		0.003	5.1		11.0		0.5		0.755	
		0.002	5.4		10.0		0.3		0.772	
		0.002	6.4		8.2		0.1		0.116	
July-02	0.002	0.002	4.9		8.8		3.6			
			3.0		7.1					
			2.7		7.5					
August-02	0.001	0.001	2.9		6.2		7.3		0.540	
September-02	0.001	0.001	7.8		4.1		6.1		0.160	
October-02	0.001	0.000	13.4	**12.1**	11.4	**9.9**	7.6	**8.1**	0.430	**0.7**
November-02	0.001	0.001	11.2	**12.4**	3.5	**9.9**	23.3	**8.2**	0.270	**0.8**
December-02	0.001	0.001	9.0	**12.1**	5.0	**10.0**	37.8	**10.1**	0.170	**0.8**
January-03	0.001	0.001	6.6	**11.1**	8.1	**9.6**	5.3	**9.3**	0.3	**0.7**
February-03	0.002	0.001	4.60	**5.4**	9.10	**7.9**	6.70	**6.05**	0.30	**0.445**
Mar-03	0.002	0.02	10	**5.5**	13.3	**8.1**	5.22	**6.07**	0.26	**0.349**
April-03	0.002	0.002	10.2	**6.2**	4.8	**7.6**	5.8	**6.2**	0.141	**0.3**
May-03	0.002	0.001	9.8	**6.8**	7.2	**7.6**	7.5	**7.8**	0.250	**0.3**
June-03	0.002	0.001	6.7	**7.3**	4.0	**7.2**	8.9	**10.4**	6.760	**0.9**
July-03	0.002	0.001	8.4	**8.4**	8.4	**7.1**	6.7	**10.7**	0.490	**0.8**
February-03							3.87		0.280	

PROCESS DESCRIPTION



Introduction

The USBF process is a modification of the conventional activated sludge process that incorporates an anoxic selector zone and an upflow sludge blanket clarifier. The USBF process may be designed for:

- Carbonaceous (BOD) removal
- BOD removal and nitrification
- BOD removal, nitrification, and denitrification
- BOD removal, nitrification/denitrification and phosphorus removal

For carbonaceous removal, the anoxic zone serves as a "selector zone" that conditions the mixed liquor to improve settleability and to control filamentous organism growth.

For nitrification, denitrification and phosphorus removal designs, the anoxic zone provides the necessary conditions for dissimilarity nitrate reduction and phosphorus removal by "luxury uptake". In this process, Nitrosomonas and Nitrobacter bacteria, oxidize ammonia nitrogen to nitrite and then to nitrate respectively in the aeration zone. The nitrate is then recycled to the anoxic zone where it is reduced by dissimilarity nitrate reduction. In this reaction, the incoming BOD serves as the carbon source or electron donor for the reduction of nitrate to elemental nitrogen.

The phosphorus removal mechanism in this process is the same as that employed in the Phostrip and modified Bardenpho processes. In the USBF process, fermentation of soluble BOD occurs in the anaerobic or anoxic zone. The fermentation products are selectively used or assimilated by a special group of microorganisms that are capable of storing phosphorus. Soluble phosphorus is taken up by the population of the phosphorus-storing bacteria (Acinetabacter) developed in the anoxic zone during the aerobic stage of treatment. The assimilated phosphorus is then removed from the system as excess biomass or waste sludge. The amount and rate of phosphorus removal depends primarily on the BOD/P ratio of the influent wastewater.

Process Design

The Ecofluid Design Program for the USBF process is based on the Lawrence and McCarty kinetic models for BOD removal, nitrification and denitrification.

The USBF process is capable of removal of BOD_5 to less than 5 mg/l, TSS removal to less than 10 mg/l without filtration, total nitrogen removal to less than 1.0 mg/l and total phosphorus removal to a range of 0.5 to 2.0 mg/l. Higher levels of phosphorus removal down to 0.2 to 0.5 mg/l can be achieved by metal salt addition to the aeration zone immediately prior to the mixed liquor entering the clarifier. A number of metal salts may be used including Alum ($Al_2(SO_4)_3.14H_2O$), Sodium Aluminate ($Na_2O.Al_2O_3$), Ferric Chloride ($FeCl_3$), Ferrous Chloride ($FeCl_2$), Ferrous Sulphate ($FeSO_4$.& H_2O) or Ferric Sulphate ($Fe_2(SO_4)_3$). Since the bulk of phosphorus (over 80%) in the USBF process is accomplished by biological uptake, the small polish dosages of a metal salt coagulant do not significantly increase sludge production.

For example, removal of phosphorus by $FeSO_4$ is given by the two following reactions:

Phosphorus Precipitation $3FeSO_4 + 2PO_4^{-3} \longrightarrow Fe3\ (PO4)_2 + 3SO4^{-2}$

Alkalinity Reduction and Hydroxide Precipitation $Fe{+}{+}{+} + 3HCO^{-3} \longrightarrow Fe(OH)_3$

According to the above two reactions, removal of 2 mg/l of PO_4^{-3}, would theoretically produce 6 mg/l of additional sludge. In actual practice, a value of 5 mg/l of sludge per mg/l of PO_4^{-3} removed provides a conservative design value. For an influent wastewater having 240 mg/l of incoming BOD and a sludge yield of 0.6 lbs TSS/lb BOD removal, and the use of $FeSO_4$ to remove 2 mg/l of PO_4^{-3}, the total increase in sludge production would be about 7%.

The USBF process utilizes a unique patented upflow sludge blanket clarifier. The upflow blanket clarifier utilizes a trapezoidal shape where the mixed liquor enters the bottom of the clarifier through a specially designed baffle where hydraulically induced flocculation occurs. The trapezoidal clarifier shape provides for a steadily increasing surface area from the bottom to the top of the clarifier. This permits a gradually decreasing vertical velocity gradient within the clarifier. The "top surface area" clarifier overflow rate is 150 to 250 gpd/ft^2 (6 to 10 $m^3/d/m^2$) at average daily design flow. The clarifier is typically designed for a daily peak flow rate of 3 times the average flow ratio which translates to a peak "top surface" clarifier overflow rate of 450 to 750 gpd/ft^2 (18 to 31 $m^3/d/m^2$) which is very conservative.

The clarifier also includes a unique baffle arrangement to allow sludge withdrawal at the bottom of the clarifier. The sludge withdrawal design also incorporates the internal recycle between the aerobic and anoxic zone. The normal design recycle/sludge withdrawal rate is 4 times the average daily flow. This high sludge withdrawal rate from the clarifier bottom creates a downward velocity gradient within the clarifier that significantly improves the hydraulic efficiency of the clarifier compared to conventional clarifier.

The internal recycle between the aeration zone and the anoxic zone provides BOD recycle that is required for endogenously supported nitrate reduction. This internal recycle of mixed liquor also provides for recycle of phosphorus removal organisms developed in the anoxic zone that are then carried into the aeration zone for phosphorus uptake. The recycle ratio is established based on the influent BOD/total phosphorus/ammonia nitrogen ratio. The recycle ratio of 4 provides for a 25% - 35% safety factor for domestic wastewater.

The major process design parameters for this process depend on (1) wastewater strength and biodegradability (2) wastewater temperature, influent and effluent BOD, N, and P concentrations. Typical HRT's for the aeration zone range from 6 to 30 hrs. The HRT's for the anoxic zone typically range from 1 to 2 hrs for a selector zone used for carbonaceous removal and 2-8 hrs for biological phosphorus removal and denitrification.

The design SRT is controlled by the temperature dependent nitrification and BOD removal kinetics and the design effluent N-NH_4 requirements. The operating SRT is normally maintained at 50% to 100% greater than the design SRT at an operating temperature to provide a safety factor and to accommodate changes in influent wastewater characteristics. (Please note that SRT is both a design parameter and a process control parameter).

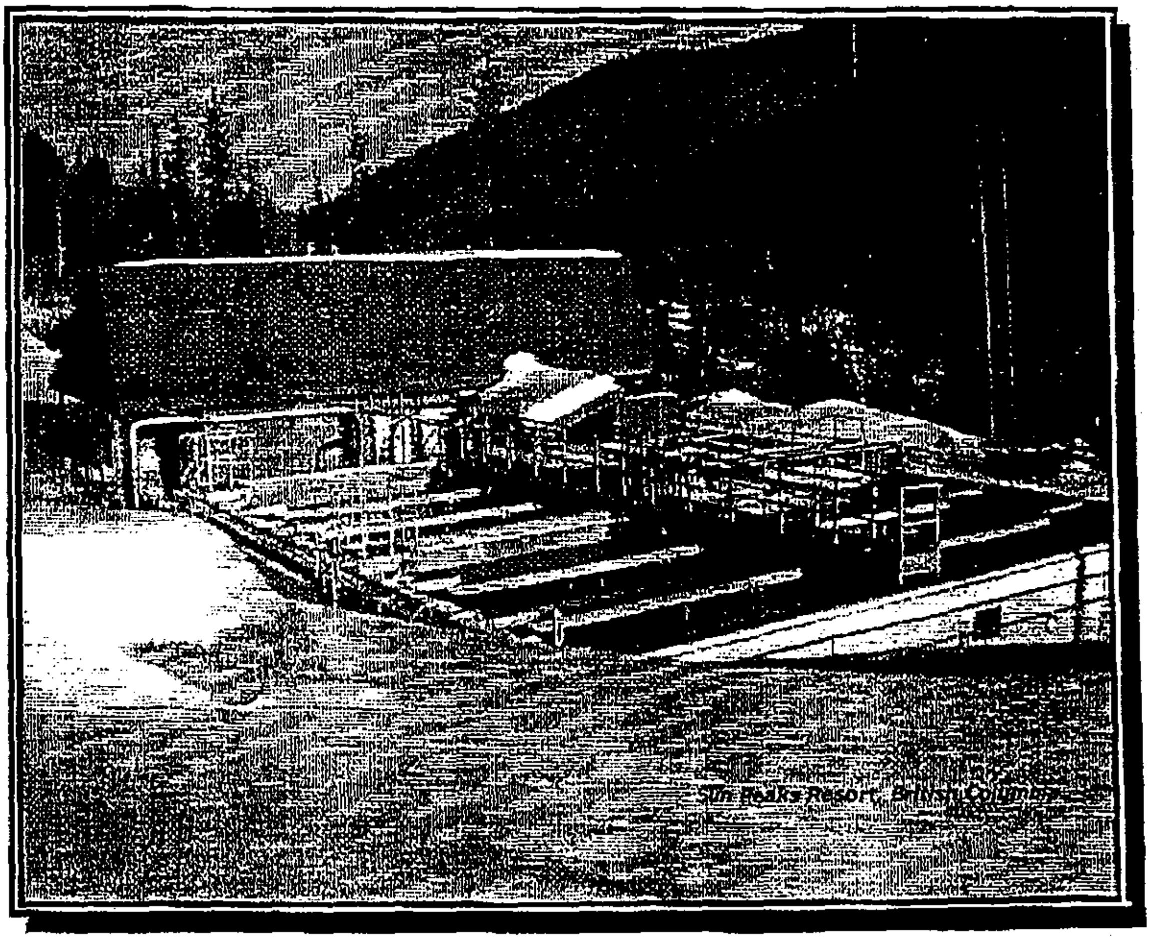
Operating Parameters

The dissolved oxygen (DO) concentration should be maintained at 2.0 to 4.0 mg/l in the aeration zone, and less than 0.2 mg/l in the anoxic zone. Under influent loading conditions less than the design values, the HRT in both the aeration zone and in the anoxic zone will be greater than the design value. Under these conditions, the mixed liquor volatile solids concentration in the system will normally be reduced to meet the process requirements. The DO may be maintained at optimum levels by reducing air supply. The increased HRT in the anoxic zone permits more time for exertion of DO demand and production of anoxic conditions needed for fermentation. The operating SRT is controlled by the sludge-wasting rate. SRT is normally calculated based on aeration zone volume and MLVSS concentration since BOD removal and nitrification kinetics control the aeration zone volume.

Provision is made in the Ecofluid design for measurement of both the internal recycle and sludge wasting. The operating SRT of the USBF process may be increased significantly above the design requirements without sacrificing effluent quality since the "anoxic selector" zone conditions the mixed liquor solids and the USBF clarifier provides a "filtration/flocculation" mechanism to prevent discharge of pin-point floc normally associated with high SRT systems. Alkalinity and pH If the influent wastewater is not properly buffered, it is necessary to add alkalinity for nitrification and denitrification. The nitrification reaction consumes 7.1 mg/l of alkalinity as $CaCO_3$ for each mg/l of ammonia nitrogen oxidized. The denitrification reaction produces 3.57 mg/l of hydroxide alkalinity as $CaCO_3$ for each mg/l of nitrate-nitrogen reduced. For an influent wastewater having 40 mg/l of NH_4-N, the total alkalinity should be 150-200 mg/l to insure adequate buffering. The pH of the system should always be maintained between 7.5 to 8.5 S.U. by the addition of alkalinity when required.

Ecofluid Systems Inc.

Advanced Biological Wastewater Treatment Technology



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FEATURES AND BENEFITS

Introduction

Ecofluid USBF process is the result of over forty years of research, development, and testing and practical experience. It is a modification of conventional activated sludge process that incorporates an anoxic selector zone and an Upflow Sludge Blanket Filtration clarifier in one integrated bioreactor vessel. This compact, modular system takes up significantly less space and contains few moving parts. The result is an efficient, highly affordable wastewater treatment plant with low maintenance and operating costs. USBF technology has no inherent capacity limits and is used in a wide range of applications. Plants serving the domestic and municipal sectors designed for treating industrial, food processing and agricultural wastewater are in successful operation around the world. Ecofluid has established an impressive international reputation for its USBF process. Elegantly designed, simple and highly cost-effective, it is making a significant impact on the wastewater treatment industry. In a 1995 report to United Nations Industrial Development Organization, Dr. Lawrence K. Wang called it "state-of the-art…an important environmental engineering process revolution."

Features

The proprietary USBF technology incorporates three innovative features that increase efficiency and reduce costs:

Upflow Sludge Blanket Filtration Clarifier

Sedimentation is the most commonly used separation technique today. Its low specific rate of separation makes it slow and inefficient promulgating the need for large tanks and other equipment. USBF technology has a substantially higher specific rate of separation using a prism or cone shaped clarifier. Unlike conventional clarifiers, the influent enters at the bottom and flows upwards. As the cross sectional area increases, the upflow velocity decreases and the activated sludge flocs form a sludge blanket. Influent to the clarifier must flow through the sludge blanket, which acts as a filter removing suspended particles with settling velocities too low to be removed by settling alone.

High Sludge Concentration

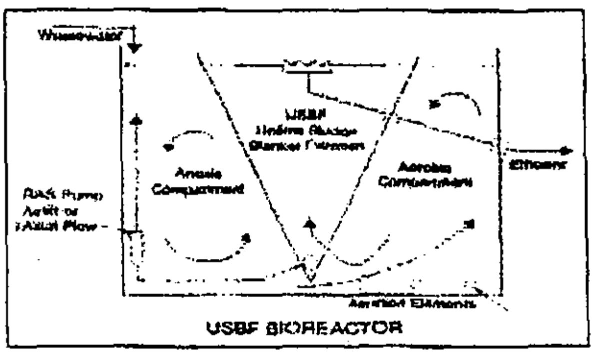
Most traditional plants operate at low or medium sludge concentrations. USBF plants operate at high concentrations, enhancing the efficiency of upflow sludge blanket filtration and creating conditions that increase the number of microbial cells searching for "food" - organic matter in the incoming wastewater. By keeping the biomass hungry or "superactivated," the nutrient-deficient microbial cells "feed" on wider range of available organic material, including some previously considered non-biodegradable.

All Processes Integrated into One Reactor

Most conventional technologies carry out aeration, nitrification, denitrification, and clarification and sludge stabilization in a number of dedicated vessels. By contrast, USBF technology can carry out all these processes inside one compact bioreactor, substantially reducing equipment size and costs.

Process

The operation of a USBF plant is simple and self-regulating. Wastewater enters the anoxic compartment of the bioreactor where it mixes with activated sludge recycled from the bottom of the clarifier. Agitated and moved in a plug flow manner, the mixed liquor eventually underflows into the bioreactor's aerobic compartment. After aeration, a stream of the mixed liquor enters the bottom of the clarifier where sludge flocs and water are separated by upflow sludge blanket filtration. After separation, clear water overflows into a collection trough and is discharged from the system. To complete the internal circulation loop, activated sludge collecting at the bottom of the clarifier is recycled back into the bioreactor's anoxic compartment.



Benefits

Reduced capital cost
Single integrated bioreactor concept reduces auxiliary equipment and built-up land requirements.

Reduced operating and maintenance costs
The compact design, minimal moving parts, modular construction and self-regulating hydraulics result in reduced supervision requirements contributing to lower operating and maintenance costs.

High treatment efficiency
Treatment includes biological reduction of nitrogen and phosphorus with reductions of BOD_5 and TSS to less than 10 mg/l.

Stabilized sludge with less excess
Low microbial loading produces significantly less excess sludge and extends its age. After heat treatment for pathogens (in some cases directly) the stabilized sludge may be used as fertilizer.

No odour
Aerobic conditions throughout the bioreactor and extended sludge age dramatically reduce the potential for odour. Plants can be located in the vicinity of populated areas without any ill effect.

Hydraulic flexibility

The clarifier's prism or cone shape allows other treatment processes to take place around it and facilitates superior hydraulic flexibility. USBF technology accommodates high peak flows and flow swings in a self-regulating manner the higher the flow, the higher sludge flocs rise and the larger the filtration area becomes.

Modular and flexible design

Modularity of design ensures that plants meeting current needs can be quickly expanded if and when growth demands. A variety of construction materials are used and plant components can even be retrofitted into existing tanks.

Improved sludge dewatering

Extended sludge age improves its structure and mechanical dewatering characteristics.

No primary clarification

USBF technology does not require primary clarification. For larger units, screening and grit removal is all that is required prior to biological treatment.

Patented and proven

Literally hundreds of plants in operation worldwide

PROCESS DESCRIPTION*

Introduction

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- BOD removal, nitrification/denitrification and phosphorus removal

For carbonaceous removal, the anoxic zone serves as a "selector zone" that conditions the mixed liquor to improve settleability and to control filamentous organism growth.

For nitrification, denitrification and phosphorus removal designs, the anoxic zone provides the necessary conditions for dissimilarity nitrate reduction and phosphorus removal by "luxury uptake". In this process, Nitrosomonas and Nitrobacter bacteria, oxidize ammonia nitrogen to nitrite and then to nitrate respectively in the aeration zone. The nitrate is then recycled to the anoxic zone where it is reduced by dissimilarity nitrate reduction. In this reaction, the incoming BOD serves as the carbon source or electron donor for the reduction of nitrate to elemental nitrogen. The phosphorus removal mechanism in this process is the same as that employed in the Phostrip and modified Bardenpho processes. In the USBF process, fermentation of soluble BOD occurs in the anaerobic or anoxic zone. The fermentation products are selectively used or assimilated by a special group of microorganisms that are capable of storing phosphorus. Soluble phosphorus is taken up by the population of the phosphorus-storing bacteria (Acinetabacter) developed in the anoxic zone during the aerobic stage of treatment. The assimilated phosphorus is then removed from the system as excess biomass or waste sludge. The amount and rate of phosphorus removal depends primarily on the BOD/P ratio of the influent wastewater.

Process Design

The Ecofluid Design Program for the USBF process is based on the Lawrence and McCarty kinetic models for BOD removal, nitrification and denitrification. The USBF process is capable of removal of BOD_5 to less than 5 mg/l, TSS removal to less than 10 mg/l without filtration, total nitrogen removal to less than 1.0 mg/l and total phosphorus removal to a range of 0.5 to 2.0 mg/l.

Higher levels of phosphorus removal down to 0.2 to 0.5 mg/l can be achieved by metal salt addition to the aeration zone immediately prior to the mixed liquor entering the clarifier. A number of metal salts may be used including Alum ($Al_2(SO_4)_3.14H_2O$), Sodium Aluminate ($Na_2O.Al_2O_3$), Ferric Chloride ($FeCl_3$), Ferrous Chloride ($FeCl_2$), Ferrous Sulphate ($FeSO_4$& H_2O) or Ferric Sulphate ($Fe_2(SO_4)_3$).

Since the bulk of phosphotus (over 80%) in the USBF process is accomplished by biological uptake, the small polish dosages of a metal salt coagulant do not significantly increase sludge production.
For example, removal of phosphorus by $FeSO_4$ is given as by the two following reactions:

Phosphorus Precipitation
$3FeSO_4 + 2PO_4^{-3} \longrightarrow Fe_3(PO_4)_2 + 3SO_4^{-3}$

Alkalinity Reduction and Hydroxide Precipitation
$Fe^{+++} + 3HCO^{-3} \longrightarrow Fe(OH)_3$

According to the above two reactions, removal of 2 mg/l of PO_4^{-3}, would theoretically produce 6 mg/l of additional sludge. In actual practice, a value of 5 mg/l of sludge per mg/l of PO_4^{-3} removed provides a conservative design value. For an influent wastewater having 240 mg/l of incoming BOD and a sludge yield of 0.6 lbs TSS/lb BOD removal, and the use of $FeSO_4$ to remove 2 mg/l of PO_4^{-3}, the total increase in sludge production would be about 7%.

The USBF process utilizes a unique patented upflow sludge blanket clarifier. The upflow blanket clarifier utilizes a trapezoidal shape where the mixed liquor enters the bottom of the clarifier through a specially designed baffle where hydraulically induced flocculation occurs. The trapezoidal clarifier shape provides for a steadily increasing surface area from the bottom to the top of the clarifier. This permits a gradually decreasing vertical velocity gradient within the clarifier. The "top surface area" clarifier overflow rate is 150 to 250 gpd/ft^2 (6 to 10 m^3/d/m^2) at average daily design flow. The clarifier is typically designed for a daily peak flow rate of 3 times the average flow ratio which translates to a peak "top surface" clarifier overflow rate of 450 to 750 gpd/ft^2 (18 to 31 m^3/d/m^2) which is very conservative. The clarifier also includes a unique baffle arrangement to allow sludge withdrawal at the bottom of the clarifier. The sludge withdrawal design also incorporates the internal recycle between the aerobic and anoxic zone. The normal design recycle/sludge withdrawal rate is 4 times the average daily flow. This high sludge withdrawal rate from the clarifier bottom creates a downward velocity gradient within the clarifier that significantly improves the hydraulic efficiency of the clarifier compared to conventional clarifier.

The internal recycle between the aeration zone and the anoxic zone provides BOD recycle that is required for endogenously supported nitrate reduction. This internal recycle of mixed liquor also provides for recycle of phosphorus removal organisms developed in the anoxic zone that are then carried into the aeration zone for phosphorus uptake. The recycle ratio is established based on the influent BOD/total phosphorus/ammonia nitrogen ratio. The recycle ratio of 4 provides for a 25% - 35% safety factor for domestic wastewater.

The major process design parameters for this process depend on (1) wastewater strength and biodegradability (2) wastewater temperature, influent and effluent BOD, N, and P concentrations. Typical HRT's for the aeration zone range from 6 to 30 hrs. The HRT's for the anoxic zone typically range from 1 to 2 hrs for a selector zone used for carbonaceous removal and 2-8 hrs for biological phosphorus removal and denitrification. The design SRT is controlled by the temperature dependent nitrification and BOD removal kinetics and the design effluent N-NH_3 requirements. The operating SRT is normally maintained at 50% to 100% greater than the design SRT at an operating temperature to provide a safety factor and to accommodate changes in influent wastewater characteristics. (Please note that SRT is both a design parameter and a process control parameter).

Operating Parameters

The dissolved oxygen (DO) concentration should be maintained at 2.0 to 4.0 mg/l in the aeration zone, and less than 0.2 mg/l in the anoxic zone. Under influent loading conditions less than the design values, the HRT in both the aeration zone and in the anoxic zone will be greater than the design value. Under these conditions, the mixed liquor volatile solids concentration in the system will normally be reduced to meet the process requirements. The DO may be maintained at optimum levels by reducing air supply. The increased HRT in the anoxic zone permits more time for exertion of DO demand and production of anoxic conditions needed for fermentation.

The operating SRT is controlled by the sludge-wasting rate. SRT is normally calculated based on aeration zone volume and MLVSS concentration since BOD removal and nitrification kinetics control the aeration zone volume. Provision is made in the Ecofluid design for measurement of both the internal recycle and sludge wasting. The operating SRT of the USBF process may be increased significantly above the design requirements without sacrificing effluent quality since the "anoxic selector" zone conditions the mixed liquor solids and the USBF clarifier provides a "filtration/flocculation" mechanism to prevent discharge of pin-point floc normally associated with high SRT systems.

Alkalinity and pH

If the influent wastewater is not properly buffered, it is necessary to add alkalinity for nitrification and denitrification. The nitrification reaction consumes 7.1 mg/l of alkalinity as $CaCO_3$ for each mg/l of ammonia nitrogen oxidized. The denitrification reaction produces 3.57 mg/l of hydroxide alkalinity as $CaCO_3$ for each mg/l of nitrate-nitrogen reduced. For an influent wastewater having 40 mg/l of NH_4-N, the total alkalinity should be 150-200 mg/l to insure adequate buffering. The pH of the system should always be maintained between 7.5 to 8.5 S.U. by the addition of alkalinity when required.

COMPARISON WITH SBR*

General Considerations

Both the Sequencing Batch Reactor (SBR) and the Upflow Sludge Blanket Filter (USBF™) are modifications of the Activated Sludge Process. The SBR was developed in the U.S. in the late 1960's and became widely used during the 1980's and 1990's. The process concepts incorporated into the patented USBF process were developed both in Europe and the U.S. in the 1970's. Various forms of the USBF process concepts including "anoxic selector zones", and "upflow blanket clarifiers" have been used worldwide for the last 25 years.

Both the SBR and USBF processes are fully capable of treating municipal wastewater to meet the U.S. and International Standards of secondary wastewater treatment, (30 mg/l BOD, 30 mg/l TSS); advanced secondary treatment, (10 mg/l BOD, 10 mg/l TSS and 1 mg/l NH_4-N) and tertiary treatment (10 mg/l BOD, 10 mg/l TSS and 1.5 mg/l total nitrogen) standards.

Both processes are designed using the same basic biological treatment kinetics for carbonaceous removal, nitrification and denitrification. JMS has developed and refined kinetic design models for both processes based on the approach of Lawrence and McCarty, which is incorporated into U.S. Textbooks in Sanitary Engineering and in the USEPA Design Manuals for Wastewater Treatment and Nutrient Control. A complete description of the kinetic process design models and a detailed description of each process can be found elsewhere. This evaluation will present a comparison of the two processes including:

- Design loading considerations
- Performance and operating parameters
- Power requirements
- Modular design considerations and mechanical component design
- Cost factors

Each of these is discussed in the following sections.

Design Loading

Table 1: Comparison of major loading parameters

Parameters	USBF™	SBR
F/M	0.01 to >1.0	0.01 to >1.0
MLVSS (mg/l)	4,000 - 6,000	2,000 - 4,000
Hydraulic loading (average to peak ratio)	1 to 6	1 to 4
SVI	80 - 120	250 - 350
SRT days	5 - 70	5 - 50

The USBF process has been used in Europe under low F/M ratios (0.01 to 0.05) or in the "super-aeration mode" to achieve very low removal of BOD and refractory COD when necessary. In the US, the F/M loadings are increased for municipal waste to the 0.1 to 0.3 ranges for BOD removal for municipal sewage and to over 1.0 for high rate treatment of high strength industrial waste.

Design loadings (F/M's) for the SBR system are generally less due to the larger aeration requirements since air is only supplied during a portion of the total SBR cycle time thus increasing installed aeration HP. Because of the patented and unique Sludge Blanket Clarification Concept of the USBF and the incorporation of an "Anoxic Selector Zone", the operating Sludge Volume Index (SVI ml/g) for this process is much lower than for the SBR. This is a critical factor in the overall performance of this process.

Both processes respond well to peak to average hydraulic loading. The USBF process addresses increased hydraulic loading by first producing a faster settling mixed liquor due to the lower SVI and secondly, by the unique sloping sidewall clarifier that allows the sludge blanket to rise automatically increasing the surface settling area and by inter-particle flocculation in the upflow clarifier. The SBR addresses increased hydraulic loading by a djustment of the settling cycle time.

Performance and Operating Parameters

Table 2: Typical removal efficiency of the USBF and SBR system.

Parameters	USBF	SBR
BOD removal (mg/l)	<5	<5
Nitrification (mg/l)	<0.5	<1.0
Denitrification (mg/l)	<1.5	<1.5
TSS (mg/l)	<5.0	<10.0

Data available to support removal efficiencies based on the state-of-the-art kinetic design concepts.

A major feature of USBF is the combined advantage of an anoxic zone prior to the aeration zone for "conditioning" the mixed liquor prior to the upflow solids contacting the flocculating clarifier. The anoxic zone reduces or eliminates filamentous sludge and provides a very low (80-120 ml/g) SVI. The anoxic zone operates in this fashion for BOD removal and BOD removal plus nitrification. For denitrification, the anoxic zone is increased in HRT and utilizes the endogenous carbon in the wastewater as the electron donor for denitrification. In the SBR process, a separate carbon source (commonly methanol) is normally added for denitrification. Unless methanol addition is closely controlled, over dosing can lead to the discharge of excessive BOD. The USBF process can reliably remove TSS to a slightly lower level (5 mg/l) than SBR (10 mg/l) due to the better conditioned mixed liquor suspended solids (MLSS).

Power Requirements

From a process standpoint, USBF and SBR require the same amount of oxygen for BOD removal and nitrification in accordance with accepted kinetic theory. Both processes take advantage of the Nitrate Oxygen returned (2/3 of oxygen required for nitrification) during denitrification.

The USBF process requires less installed HP than SBR because the SBR process must provide the same amount of oxygen in a shorter period of time (i.e. during the aerated fill cycle) and the aerated react cycle. The installed HP for a SBR is typically 30 to 50% higher than for the USBF process under the same influent and effluent design conditions. The aeration efficiency of fine or coarse bubble aeration is also greater for USBF than SBR since SBR average aeration depth is lower due to decanting up to 30% of the aeration tank volume, which thereby lowers aeration depth by 30%. At 30% decant, the average aeration efficiency of an SBR system is 85% of that achieved by a USBF system.

Modular Design Considerations and Mechanical Component Design

The USBF design is a continuous flow system incorporating the aeration zone, clarifier and anoxic zone into a single tank. The only mechanical equipment required is a blower for aeration and airlifting return sludge (in larger plants, a low HP axial pump is used for sludge return). Waste sludge can be taken off the air lifted sludge return line unless prohibited by head considerations.

The SBR system is normally a two-tank design and in addition to the aeration requirements requires decanting by pumping from each tank. SBR's are also normally equipped with separate sludge wasting pumps. In order to meet mechanical reliability requirements, duplicate decant and waste sludge pumps are required for each separate SBR tank. From a mechanical standpoint, the USBF system is much simpler and requires much less rotating equipment. This provides a significant advantage to USBF in:

- Original equipment cost
- Maintenance cost
- Operational simplicity

For example, airlift pumps rarely fail compared to mechanical pumping systems.

Although there are no size limitations on USBF or SBR systems, the USBF single tank design better lends itself to higher capacity system design than SBR. Dual tank SBR systems have generally been limited to 0.5 to 1.0 mgpd (1,900 to 3,800 m^3/d) volumes per tank due to decant pumping requirements. In standard SBR systems, the decant rate is 7 to 15 times the average design flow. Over 98% of SBR systems installed in the U.S. are under 1.0 mgpd (3,800 m^3/d) whereas, USBF single tank systems have been installed with up to 4.0 mgpd (15,000 m^3/d) capacity.

Cost Factors

The capital cost of biological treatment processes are summarized below:

- The cost of constructed tankage to provide the required Hydraulic Residence Time (HRT) to meet the process kinetic requirements. (These requirements are the same for both processes).
- The cost of clarification tankage.
- The cost of the mechanical support equipment, including pumps, blowers, internal piping and decanting devices.
- Site, civil works and land area requirements.
- System control equipment.
- Electrical supply and equipment.

The USBF and SBR processes require the same basic tankage for the biological processes since they are based on the same biological kinetics. The USBF is a single tank system and the SBR is a dual tank system. The mechanical requirements for SBR system designs are much greater than for USBF systems because of the requirements for decant pumping and waste sludge pumping with duplicate units for each. Clarification tankage is incorporated into the single tank design for USBF and into the dual tank design for SBR's. The installed HP requirements for the SBR form of treatment is much greater (30 - 50%) than for the USBF as previously discussed. The electrical requirements including total power and power distribution is a first power function of installed HP and is greater for SBR than USBF due to the greater number and spatial distribution of electrical motors in the SBR system.

Both USBF and SBR are compact treatment systems compared to conventional activated sludge or the oxidation ditch form of treatment. The site and civil works for these forms of treatment are much less than for conventional secondary or advanced secondary treatment. In terms of land area required, the USBF system requires approximately 60-80% of the land area of the SBR system depending on layout.

Summary

The following is a summary analysis of the SBR and USBF processes.

1. Both USBF and SBR processes are proven in the U. S. and throughout Europe to reliably meet all current standards for BOD removal, nitrification and denitrification down to an effluent BOD level of <5.0 mg/l, TSS of 5-10 mg/l, NH_4-N of 1.0 mg/l and a total nitrogen of less than 1.5 mg/l. (Extensive operating data are available to document the above).
2. The USBF process requires less installed HP than the SBR process.
3. The USBF process has fewer mechanical components than SBR and therefore is simpler.
4. The USBF process with anoxic zone treatment of mixed liquor produces an inherently more stable mixed liquor, lower operating SVI's and slightly higher removal efficiency for TSS.
5. The USBF system is more flexible in retrofitting existing plants than the SBR because of the unique single tank upflow clarifier concept and design of the USBF™.
6. The USBF has a smaller land area requirement ("footprint") than SBR.
7. USBF electrical and mechanical requirements are 20-40% less than the SBR form of treatment.
8. Based on total process requirements including tankage, mechanical support equipment, power requirements, electrical, controls, site work and land area required, the USBF system has a significant cost advantage over conventional activated sludge, the oxidation ditch form of activated sludge and SBR's for treatment system sizes ranging from 1.0 to 50 mgpd (3,800 to 190,000 m^3/d).

*Contains excerpts from the original texts of the Process Description and SBR Comparison prepared by Mr. John M. Smith of J.M. Smith & Associates of Cincinnati, Ohio (513 231-6800). Mr. Smith has 17 years experience in wastewater treatment research and process design for US EPA office of Research and Development plus 18 years as an independent consultant.

NUTRIENT REDUCTION

Nitrogen

Nitrogen is removed by nitrification and denitrification processes. Nitrification is autotropic and all USBF integrated bioreactors are designed for complete nitrification of ammonia to NO_3. Denitrification however, is heterotropic and requires a carbon source. Conventional plants' "separate-sludge denitrification" requires that carbon be added, typically in the form of methanol. This adds to operating costs, and if used in excess, it increases effluent BOD_5 content.

USBF technology "single-sludge denitrification" approach uses an endogenous carbon source to maintain the denitrifiers. Influent is combined with nitrified mixed liquor in the anoxic compartment providing the carbon source needed for denitrification. Relatively high (3 to 4 times average daily flow) nitrified mixed liquor recycle rates are employed and sufficient denitrification retention times provided. Total nitrogen reduction to below 10 mg/l is achievable.

Phosphorus

USBF technology delivers not only high efficiency of organic matter reduction, but also increased efficiency of phosphorus removal. Three processes, biological uptake, simultaneous precipitation and chemical precipitation followed by microfiltration can be employed with advantages.

The mechanics of biological phosphorus uptake, known as "luxury uptake", is due to exposure of activated sludge to alternating oxide and anoxic conditions. Under the conditions, the cells store more energy in the form of phosphorus than needed for their survival. If strictly oxide conditions are maintained during subsequent clarification, phosphorus will be retained by the cells and will eventually be removed with the excess sludge. Unlike most other methods of clarification, the USBF clarifier maintains these conditions. Biological phosphorus reduction to less than 2 mg/l is achievable[1].

For firther phosphorus reduction, chemical precipitation followed by filtration is used. In most domestic wastewater phosphorus is present in three forms, orthophosphate, polyphosphate and organic phosphorus. Polyphosphate and organic phosphorus cannot be readily precipitated however, during the biological treatment they are converted to orthophosphate, which can. Since the bulk of phosphorus reduction (up to 80%) is accomplished by biological uptake, the small polishing dosage of metal salt precipitant does not significantly increase sludge production.

Typically, aluminum sulfate, ferrous sulfate or other metal salts are used as precipitants. Chemical dosing and precipitation typically takes place in a dedicated system following biological treatment. However, in the USBF process chemicals are advantageously dosed into an anoxic compartment and precipitation, coagulation and flocculation take place within the USBF bioreactor. Continuous sludge circulation and mixing within the bioreactor ensure efficient precipitation with an additional benefit of increased efficiency of the USBF clarifier.

[1] Sludge decant return from storage or dewatering to bioreactors if such is the case must be chemically treated as anoxic conditions during quiescent periods will cause phosphorus release.

Divalent ferrous sulfate has some additional advantage[3]. Since the anoxic conditions prevent oxidation of divalent ions to trivalent and the subsequent formation of ferric hydroxide, more of Fe ions are available to react with orthophosphate. The advantage is reduced chemical consumption (close to stochiometric) and reduction of ballast sludge production.[3] Reduction of total phosphorus by simultaneous precipitation to less than 0.5 mg/l is readily achievable. Reduction of total phosphorus to less than 0.1 mg/l is eminently possible but may require additional flash mixing and precipitation prior to filtration.

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[2] Caution must be exercised if coagulation/flocculation and filtration is followed by UV disinfection.

[3] By contrast, dosing compounds containing divalent Fe ions within oxide conditions allows their oxidation to trivalent and subsequent hydrolysis. Since both take place faster than mixing and precipitation, the result is formation of ballast ferric hydroxide and increased chemicals consumption.

APPENDIX B

Brown and Caldwell
Secondary Treatment Process Selection
October 3, 2003

Fluidyne References:

Blacksford – Conversation with Robert Parks on September 22, 2003

He likes the Fluidyne over the other SBR manufacturers. User friendly, easy to operate, but the operator must pay attention to the process. Denite is a little tricky since it is accomplished in one basin. They have a DO monitor, and do use DO control. Toughest part is getting that last little bit of nitrate out. Good support from manufacturer and rep during construction and startup. Level control is easier to control, but you have to pay attention to which phase the plant is in during sampling. Recommend having spare parts such as plc, power supply, control modules, valve actuators, etc. Also, keep the program on a laptop.

Hilliard – Conversation with David Thompson on September 22, 2003

Month of July 2,2,1.7 TN, 0.03 TP. In April, his numbers were bad due to mechanical problems (high I/I, flows of .45 to .5 MGD). Need to stay up on process control testing to keep process meeting the tight effluent requirements. Fluidyne integrated a Chemscan unit into the control algorithm to control blower and pump run times. Set up so that the operator can change set points remotely. No odor problems except for the aerobic digester when they let the AD decant. They haul about 60 cy sludge with 13 to 18% dry solids every 3 weeks. They use a tile underdrain system (gravity). They use alum for phosphorus removal. The facility is right next to homes, and they have not had any odor complaints since the facility started up. They had startup problems due to faulty valves, but Fluidyne resolved the issues in a timely fashion. Fluidyne has assisted him with programming on line; this has been real helpful.

TSC-JACOBS

September 18, 2003

Mr. Ted Hortenstine, P.E.
Brown and Caldwell
1060 Maitland Center Commons
Suite 402
Maitland, FL 32751

Transmit Via Fax: 407-661-9599

Reference: Key Largo WWTP

Dear Ted:

Thank you for the time you gave us Monday to present the Fluidyne information to your team. See below my response to your questions. In response to your bullet number six, I have attached a few paragraphs from Fluidyne, which discusses nitrification, denitrificaiton and phosphorous removal specifically at Key Largo.

Reference: Blacks Ford WWTP
1310-100 Roberts Road
Jacksonville, FL 32259
Contact: Robbie Parks
Phone: 904-260-5562 x 3

- Operating Permit Information: TSS = 6 mg/l; TN = 3 mg/l; BOD = 6 mg/l; TP = N/A; Capacity = 1 MGD; Effluent Disposal – Wetlands
- Nitrogen removal is achieved biologically. There is no requirement for phosphorus removal.
- Operational data will be forwarded upon receipt.
- Process guarantee: See attached!
- To achieve phosphorus removal, Blacks Ford could add an Alum feed system to feed alum into the equalization tank downstream of the SBR tank before filtration.

Reference: City of Hilliard WWTP
2756 Ruby Drive
Hilliard, FL 32046
Contact: David Thompson
Phone: 904-845-2711

- Operating Permit Information: TSS = 5 mg/l; TN = 3 mg/l; BOD = 5 mg/l; TP = 0.5 mg/l; Capacity = 0.32 MGD; Effluent Disposal – Artificial Wetland

- Nitrogen removal is achieved biologically. Phosphorus is removed with alum addition.
- Operational Data to be forwarded upon receipt.
- Process guarantee: See Attached!

Reference: **City of Macclenny**
798 Honeymill Road
Macclenny, FL 32063
Contact: Richard Harris
Phone: 904-259-4491

- Operating Permit Information: TSS = 6.25 mg/l TN = 2.5 mg/l
  BOD = 6.25 mg/l TP = N/A
  Capacity = 1.3 MGD
  Effluent Disposal – Spray Field/Perculation Ponds
- Nitrogen removal is achieved biologically. There is no requirement for phosphorus removal.
- Operational Data: See Attached
- Process guarantee: See Attached!
- To achieve phosphorus removal, Macclenny could add an alum feed system to feed alum into the equalization tank upstream of the filters.

I hope that this information is sufficient to meet your requirements and I will forward the operational data upon receipt. We look forward to working with you on this project.

Sincerely,

TSC-JACOBS

John A. Verscharen

John A. Verscharen, P.E.
JAV/jqr

Cc: Stu Oppenheim, Fax (305) 418-4924
Glen Calltharp, Fax (941) 342-9765

FLUIDYNE

Sequencing Batch Reactors Hydro-Grit™ - Grit Separators
Jet Aeration / Mixing Surge Anoxic Mix (SAM)™

2816 West First Street
Cedar Falls, Iowa 50613

Tel. 319-266-9967
Fax 319-277-6034

Fluidyne Corporation warrants that its ISAM™ system is capable of producing an average effluent quality less than or equal to 5 mg/l BOD5, 5 mg/l TSS, 3 mg/l TN, and 1 mg/l P. This effluent quality is contingent upon the plant being properly started up, maintained and operated, the flow and loads to the plant being within the design range, and the influent consisting of non toxic and readily biodegradable wastewater.

Chemical types and dose rates must be adequate to convert any soluble phosphorus to insoluble phosphorus. For purposes of this guarantee any data points collected during plant start up, acclimation, upset, or any out of design condition shall be excluded.

For purposes of determining compliance with this guarantee, a one week performance validation test will be performed after start-up and biological acclimation. If for any reason compliance is not met during this test period, Fluidyne may make process modifications or recommend operating changes to achieve compliance.

Process Description for Nitrification, Denitrification and Phosphorous removal utilizing the Fluidyne ISAM Technology at the Key Largo WWTP

All Fluidyne ISAM™ packaged sequencing batch reactor system are designed to achieve advanced treatment standards, even if such standards are not required by a particular facility. No special modifications are required to meet the permitted standards for the Key Largo facility. Each flow train will consist of three chambers; the anaerobic conditioning/digester chamber, the SAM™ flow equalization chamber, and the SBR.

For each flow train in the Key Largo design, the design flow (maximum month average daily design flow) is 61,000 gallons per day, and the annual average daily flow is 40,667 gallons per day. The volume of the anaerobic conditioning/digester chamber is 33,929 gallons. Assuming the upper 50% of the chamber is the influent conditioning zone, the raw wastewater will be retained in the chamber for approximately 7 to 10 hours. During that period, the majority of the influent BOD will be converted to volatile fatty acids (soluble BOD). During any operating cycle, one full batch (8,796 gallons) will enter the SAM™ chamber from the anaerobic conditioning/digester chamber. Each batch will contain approximately 3 pounds of total Kjeldahl nitrogen (organic nitrogen plus ammonia). During the fill and interact periods, the motive liquid/fill pump will operate at 1,232 GPM. The 3 pounds of TKN will be fed to the SBR where nitrosomonas and nitrobacter bacteria in the biomass will convert the ammonia nitrogen to nitrite (NO_2), and then to nitrate (NO_3). During the interact period, the motive liquid flow will cause 1,232 GPM to be recycled from the SBR to the SAM™ chamber, where it will be mixed with the incoming conditioned influent, under anoxic conditions (no dissolved oxygen available). Under the anoxic conditions, the bacteria in the recycled mixed liquor will convert the nitrates to nitrogen gas, water, and carbon dioxide. For this conversion, called denitrification to occur, a supply of soluble carbon is required in the ratio of three parts of carbon to one part nitrate. The influent wastewater received during the interact period, plus the residual wastewater in the SAM™ chamber will contain between 18 and 23 pounds of soluble BOD. This is over twice as much soluble carbon as that required to convert the 3 pounds of nitrates.

Since the wastewater must be nitrified in the SBR before denitrification can take place, the rate at which the nitrified mixed liquor is recycled to the anoxic zone is critical to achieving very low effluent total nitrogen concentrations. Competitive processes recycle nitrified mixed liquor at a rate of 3 to 5 times the influent flow rate. The ISAM™ process proposed for Key Largo will recycle nitrified mixed liquor at a minimum of 12 times the peak hourly influent flow, and 29 to 42 times the daily influent flow rate. In fact, at the maximum month average daily design flow, the system will recycle the entire content of the SBR over 4 times. Effluent total nitrogen concentrations will be well below the permitted effluent concentration. Effluent ammonia concentrations are projected to be 0.19 mg/l.

Phosphorous removal will be accomplished by precipitation. A chemical containing aluminum or iron ions will be fed in to the decant stream to produce an insoluble phosphate precipitate, which will either settle in the effluent equalization basin, or trapped in the effluent filters. The ISAM™ controller will activate the chemical feeder at the same time the decant valve is opened.

Again, the ISAM™ packaged sequencing batch reactor process is designed to achieve advanced treatment standards with regard to nitrogen without any modifications, or special operating procedures. The addition of the chemical precipitation feature for phosphorous removal, guarantees that the proposed system will easily and reliably meet the required standards.

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Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G030762
Date/Time Received: 5/5/03 12:40

Lab Code: G030762-01
Client Sample ID:
Site: Influent
Matrix: Water

Date/Time Sampled: 5/5/03 9:00
Sampled By: Richard & Walter
Shipping Method: AEL Pickup

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	140	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	96	mg/L		G

G DOH certification #[illegible], Compqap #200005 (AEL-Gainesville)

Lab Code: G030762-02
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 5/5/03 9:00
Sampled By: Richard & Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	3.4	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #[illegible], Compqap #200005 (AEL-Gainesville)

Lab Code: G030762-03
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 5/5/03 9:00
Sampled By: Richard & Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	0.81	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	1.8	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	0.99	mg/L		T

T DOH certification #[illegible], Compqap #990174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP
Report No.: G030802
Date/Time Received: 5/12/03 11:55

Lab Code: G030802-01
Date/Time Sampled: 5/12/03 9:00
Client Sample ID:
Site: Influent
Sampled By: Richard & Walter
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	200	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	150	mg/L		G

G DOH certification #E82620, Compqap #200006 (AEL-Gainesville)

Lab Code: G030802-02
Date/Time Sampled: 5/12/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Richard & Walter
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.7	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Compqap #200006 (AEL-Gainesville)

Lab Code: G030802-03
Date/Time Sampled: 5/12/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Richard & Walter
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	5	0.020	0.10	3.6	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	3.7	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	0.10	mg/L	I	T

I The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.
T DOH certification #E84089, Compqap #980174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G030843
Date/Time Received: 5/19/03 12:30

Lab Code: G030843-01
Client Sample ID:
Site: Influent
Matrix: Water

Date/Time Sampled: 5/19/03 9:00
Sampled By: Nate/Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	150	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	220	mg/L		G

G DOH certification #E82620, Comp. #200005 (AEL-Gainesville)

Lab Code: G030843-02
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 5/19/03 9:00
Sampled By: Nate/Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.0	mg/L O2	U	G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Comp. #200005 (AEL-Gainesville)

Lab Code: G030843-03
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 5/19/03 9:00
Sampled By: Nate/Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	0.020	mg/L	U	T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	0.050	mg/L	U	T
Total Organic Nitrogen	1	0.050	0.050	0.050	mg/L	U	T

U The compound was analyzed for but not detected.
T DOH certification #E84589, Comp. #800174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP
Report No.: G030895
Date/Time Received: 5/28/03 14:00

Lab Code: G030895-01
Date/Time Sampled: 5/28/03 9:00
Client Sample ID:
Site: Influent
Sampled By: Walter and Richard
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	120	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	200	mg/L		G

G DOH certification #E82620, Compqap 0200008 (AEL-Gainesville)

Lab Code: G030895-02
Date/Time Sampled: 5/28/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Walter and Richard
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.0	mg/L O2	U	G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Compqap #200008 (AEL-Gainesville)

Lab Code: G030895-03
Date/Time Sampled: 5/28/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Walter and Richard
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	0.020	mg/L	U	T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	0.050	mg/L	U	T
Total Organic Nitrogen	1	0.050	0.050	0.050	mg/L	U	T

U The compound was analyzed for but not detected.
T DOH certification #E84589, Compqap #990174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny **Report No.:** G030919
Project Name: WWTP **Date/Time Received:** 8/2/03 14:25

Lab Code: G030919-01 **Date/Time Sampled:** 8/2/03 9:00
Client Sample ID:
Site: Effluent **Sampled By:** Walter and Richard
Matrix: Water **Shipping Method:** AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Unionized Ammonia (as N)	1	0.00067	0.00067	0.030	mg/L		T

T DOH certification #E84589, Company #030174 (AEL-Tampa)

Lab Code: G030919-02 **Date/Time Sampled:** 8/2/03 9:00
Client Sample ID:
Site: Effluent **Sampled By:** Walter and Richard
Matrix: Water **Shipping Method:** AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Nitrate + Nitrite (as N)	5	0.050	0.25	0.25	mg/L	U	G
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	1.6	mg/L		T
Total Nitrogen	5	0.050	0.25	1.8	mg/L		G
Total Phosphorus (as P)	1	0.050	0.050	2.9	mg/L		T

U The compound was analyzed for but not detected.
G DOH certification #E82620, Company #200005 (AEL-Gainesville)
T DOH certification #E84589, Company #030174 (AEL-Tampa)

Lab Code: G030919-03 **Date/Time Sampled:** 8/2/03 9:00
Client Sample ID:
Site: Effluent **Sampled By:** Walter and Richard
Matrix: Water **Shipping Method:** AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Nitrate (as N)	5	0.050	0.25	0.25	mg/L	U	G
Nitrite (as N)	5	0.050	0.25	0.25	mg/L	U	G
Ortho-phosphate (as P)	10	0.050	0.50	2.8	mg/L		G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Company #200005 (AEL-Gainesville)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G030920
Date/Time Received: 6/2/03 14:25

Lab Code: G030920-01
Client Sample ID:
Site: Influent
Matrix: Water

Date/Time Sampled: 6/2/03 9:00
Sampled By: Walter and Richard
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	180	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	160	mg/L		G

G DOH certification #E82620, Comquap #200006 (AEL-Gainesville)

Lab Code: G030920-02
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 6/2/03 9:00
Sampled By: Walter and Richard
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	3.3	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Comquap #200006 (AEL-Gainesville)

Lab Code: G030920-03
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 6/2/03 9:00
Sampled By: Walter and Richard
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	0.89	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	1.7	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	0.81	mg/L		T

T DOH certification #E84589, Comquap #990174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny **Report No.:** G030977
Project Name: WWTP **Date/Time Received:** 6/9/03 13:20

Lab Code: G030977-01 **Date/Time Sampled:** 6/9/03 9:00
Client Sample ID:
Site: Influent **Sampled By:** Nate/Walter/Richard
Matrix: Water **Shipping Method:** AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	120	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	150	mg/L		G

G DOH certification #E82620, Company #20000S (AEL-Gainesville)

Lab Code: G030977-02 **Date/Time Sampled:** 6/9/03 9:00
Client Sample ID:
Site: Effluent **Sampled By:** Nate/Walter/Richard
Matrix: Water **Shipping Method:** AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.0	mg/L O2	U	G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Company #20000S (AEL-Gainesville)

Lab Code: G030977-03 **Date/Time Sampled:** 6/9/03 9:00
Client Sample ID:
Site: Effluent **Sampled By:** Nate/Walter/Richard
Matrix: Water **Shipping Method:** AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	0.020	mg/L	U	T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	0.61	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	0.61	mg/L		T

U The compound was analyzed for but not detected.
T DOH certification #E84589, Company #880174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G031023
Date/Time Received: 6/16/03 12:00

Lab Code: G031023-01
Client Sample ID:
Site: Influent
Matrix: Water

Date/Time Sampled: 6/16/03 9:00
Sampled By:
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	73	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	72	mg/L		G

G DOH certification #E82620, Comqap #200005 (AEL-Gainesville)

Lab Code: G031023-02
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 6/16/03 9:00
Sampled By:
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.1	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Comqap #200005 (AEL-Gainesville)

Lab Code: G031023-03
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 6/16/03 9:00
Sampled By:
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	1.3	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	1.8	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	0.32	mg/L		T

T DOH certification #E84589, Comqap #980174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G031070
Date/Time Received: 6/23/03 11:40

Lab Code: G031070-01
Client Sample ID:
Site: Influent
Matrix: Water

Date/Time Sampled: 6/23/03 9:00
Sampled By: Richard & Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	71	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	240	mg/L		G

G DOH certification #E82620, Compqap #200005 (AEL-Gainesville)

Lab Code: G031070-02
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 6/23/03 9:00
Sampled By: Richard & Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	3.0	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Compqap #200005 (AEL-Gainesville)

Lab Code: G031070-03
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 6/23/03 9:00
Sampled By: Richard & Walter
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	1.9	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	2.5	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	0.56	mg/L		T

T DOH certification #E84589, Compqap #980174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP
Report No.: G031128
Date/Time Received: 6/30/03 12:40

Lab Code: G031128-01
Date/Time Sampled: 6/30/03 9:00
Client Sample ID:
Site: Influent
Sampled By: Walter and Richard
Matrix: Water
Shipping Method: AEL Pickup

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	99	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	68	mg/L		G

G DOH certification #E82620, Comqap #200005 (AEL-Gainesville)

Lab Code: G031128-02
Date/Time Sampled: 6/30/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Walter and Richard
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.2	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Comqap #200005 (AEL-Gainesville)

Lab Code: G031128-03
Date/Time Sampled: 6/30/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Walter and Richard
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	0.020	mg/L	U	T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	1.3	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	1.3	mg/L		T

U The compound was analyzed for but not detected.
T DOH certification #E84589, Comqap #940174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G031172
Date/Time Received: 7/7/03 13:10

Lab Code: G031172-01
Date/Time Sampled: 7/7/03 9:00
Client Sample ID:
Site: Influent
Sampled By: Walter & Nate
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	48	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	60	mg/L		G

G DOH certification #E82620, Comqap #C00005 (AEL-Gainesville)

Lab Code: G031172-02
Date/Time Sampled: 7/7/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Walter & Nate
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	3.1	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	5.4	mg/L		G

G DOH certification #E82620, Comqap #C00005 (AEL-Gainesville)

Lab Code: G031172-03
Date/Time Sampled: 7/7/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Walter & Nate
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	1.9	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	4.1	mg/L		T
Total Organic Nitrogen	1	0.050	0.050	2.2	mg/L		T

T DOH certification #E84589, Comqap #980174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G031235
Date/Time Received: 7/14/03 11:30

Lab Code: G031235-01
Date/Time Sampled: 7/14/03 9:00
Client Sample ID:
Site: Influent
Sampled By: Richard & Walter
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	79	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	120	mg/L		G

G DOH certification #E82620, Comquap #200005 (AEL-Gainesville)

Lab Code: G031235-02
Date/Time Sampled: 7/14/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Richard & Walter
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.9	mg/L O2		G
Total Suspended Solids (TSS)	1	4.0	4.0	4.0	mg/L	U	G

U The compound was analyzed for but not detected.
G DOH certification #E82620, Comquap #200005 (AEL-Gainesville)

Lab Code: G031235-03
Date/Time Sampled: 7/14/03 9:00
Client Sample ID:
Site: Effluent
Sampled By: Richard & Walter
Matrix: Water
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	1	0.020	0.020	1.5	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.050	0.050	1.9	mg/L		T
Total Organic Nitrogen	1	0.000	0.050	0.40	mg/L		T

T DOH certification #E84589, Comquap #880174 (AEL-Tampa)

Advanced Environmental Laboratories, Inc.

Analytical Report

Client: City Of Macclenny
Project Name: WWTP

Report No.: G031339
Date/Time Received: 7/23/03 11:50

Lab Code: G031339-01
Client Sample ID:
Site: Influent
Matrix: Water

Date/Time Sampled: 7/28/03 9:00
Sampled By: Walter Sloan
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	120	mg/L O2		G
Total Suspended Solids (TSS)	1	2.0	2.0	270	mg/L		G

G DOH certification #E82620, CompQAP #980005 (AEL-Gainesville)

Lab Code: G031339-02
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 7/28/03 9:00
Sampled By: Walter Sloan
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
CBOD (5-day)	1	2.0	2.0	2.8	mg/L O2		G
Total Suspended Solids (TSS)	1	2.0	2.0	2.2	mg/L		G

G DOH certification #E82620, CompQAP #980005 (AEL-Gainesville)

Lab Code: G031339-03
Client Sample ID:
Site: Effluent
Matrix: Water

Date/Time Sampled: 7/28/03 9:00
Sampled By: Walter Sloan
Shipping Method: AEL Pick-up

Miscellaneous Analytes

Analytes:	Dilution	MDL	Adjusted Reporting Limit	Results	Units	Qualifier(s)	Certification Indicator
Ammonia (as N)	5	0.020	0.10	0.17	mg/L		T
Total Kjeldahl Nitrogen (as N)	1	0.034	0.034	0.61	mg/L	J4	T
Total Organic Nitrogen	1	0.050	0.050	0.44	mg/L		T

J4 The sample matrix interfered with the ability to make an accurate determination.
T DOH certification #E84589, CompQAP #980174 (AEL-Tampa)

BLACKS FORD WWTF

Effluent Quality Compliance Summary

01/01/03 through 08/31/03

Week of:	Eff Flow	Eff BOD	Eff TSS	Eff Total Nitrogen	Eff TKN	Eff NO2+NO3	Eff Fecal Coli	Eff Ammonia	Eff Total Phos	Inf BOD	Inf TSS	Inf NH3
01/04/03	0.565											
01/11/03	0.531	< 2.0	1.0	2.23	0.83	1.40	2	0.110	2.59	146	80	
01/18/03	0.513											
01/25/03	0.470	< 1.0	1.0	1.32	0.78	0.54	2	0.180	1.34	171	142	
02/01/03	0.502											
02/08/03	0.435	< 2.0	< 1.0	1.90	0.75	1.15	2	0.050	1.38	180	164	60
02/15/03	0.482											
02/22/03	0.540	< 2.0	1.0	1.17	1.11	0.06	2	0.440	3.70	201	198	53
03/01/03	0.484											
03/08/03	0.495	< 2.0	4.0	2.08	1.19	0.87	2	0.050	5.80	184	148	
03/15/03	0.614											
03/22/03	0.527	< 2.0	1.0	5.80	1.00	4.80	66	0.210	4.00	146	75	53
03/29/03	0.608	< 1.0	1.0	5.58	0.97	4.61	2	0.080	3.32	201	142	58
04/05/03	0.560	< 1.0	1.0	2.87	0.65	2.22	2	0.220	1.81	231	198	55
04/12/03	0.611	< 2.0	< 1.0	4.78	1.00	3.78	2	0.050	3.34	206	124	44
04/19/03	0.665	< 2.0	1.0	5.78	1.01	4.77	2	0.140	2.92	216	166	48
04/26/03	0.646	< 1.0	1.0	1.83	0.88	0.95	2	0.170	2.05	226	180	70
05/03/03	0.832	< 2.0	< 1.0	4.56	0.92	3.64	2	0.130	0.50	186	126	
05/10/03	0.647	< 2.0	< 1.0	3.07	0.96	2.11	2	0.110	0.70	167	156	48
05/17/03	0.692	< 2.0	1.0	3.92	0.94	2.98	2	0.070	1.65	151	108	
05/24/03	0.720	< 1.0	< 1.0	1.66	0.93	0.73	4	0.060	2.55	184	190	
05/31/03	1.070	< 1.0	< 1.0	2.75	0.89	1.86	2	0.110	2.65	197	143	63
06/07/03	0.788	< 2.0	< 1.0	1.39	1.00	0.39	2	0.020	5.51	187	220	60
06/14/03	0.698	< 2.0	< 1.0	1.45	1.08	0.38	2	0.660	2.94	162	108	55
06/21/03	0.804	< 1.0	1.0	0.99	0.75	0.24	2	0.150	1.43	167	136	65
06/28/03	0.901	< 2.0	1.0	1.54	1.07	0.47	1	0.130	3.10	176	177	
07/05/03	0.724	< 1.0	1.0	2.46	1.07	1.38	2	0.200	2.42	160	118	
07/12/03	1.018	< 2.0	1.0	4.16	1.00	3.16	2	0.130	2.68	140	88	
07/19/03	0.720	< 2.0	1.0	3.45	1.75	1.70	2	0.890	4.13	124	78	
07/26/03	0.716	2.0	1.0	4.56	1.00	3.56	2	0.110	3.57	175	152	
08/02/03	0.782	2.0	1.0	2.65	1.08	1.57	1	0.150	4.54	189	126	48
08/09/03	0.681	2.0	1.0	4.84	1.08	3.76	2	0.160	3.15	178	165	
08/16/03	1.245	< 2.0	1.0	3.23	0.84	2.39	2	0.070	3.05	206	172	
08/23/03	0.879	2.0	1.0	4.48	0.88	3.51	2	0.120	2.73	174	104	
08/30/03	0.844	< 2.0	1.0	4.75	1.06	3.69	1	0.240	2.59	175	88	
Averages:	0.678	1.58	1.00	3.15	0.98	2.16	4.2	0.175	2.86	180	139	83.2

TOWN OF HILLIARD

A Florida Municipality

FAX TRANSMITTAL SHEET

TO: John Verschoren **FAX NO.** (813) 889-0777

FROM: David Thompson **DATE:** 09/19/03

TOWN OF HILLIARD
POST OFFICE BOX 249
15879 WEST COUNTY ROAD 108
HILLIARD, FLORIDA 32046
PHONE: (904) 845-3555 FAX: (904) 845-1221

NUMBER OF PAGES (Including This Transmittal Sheet): 9

MESSAGE: Here is the info you requested. As you will see we have taken a few hits. But overall we are maintaining compliance. Let me know if you need anything else.

DEPARTMENT OF ENVIRONMENTAL PROTECTION DISCHARGE MONITORING REPORT - PART A

When completed mail this report to: Department of Environmental Protection, Wastewater Compliance Evaluation Section, M.S. 3551, 2600 Blair Stone Road, Tallahassee, FL 32399-2400

PERMITTEE NAME: Town of Hilliard
MAILING ADDRESS: Town of Hilliard
P.O. Box 249
Hilliard, FL 32046

FACILITY: Hilliard WWTF
LOCATION: 2765 Ruby Drive
Hilliard, Florida 32046
COUNTY: Nassau

PERMIT NUMBER: FL0043079

LIMIT: FINAL
CLASS SIZE: Minor
MONITORING GROUP NUMBER: D001
MONITORING GROUP DESC: Including Influent
NO DISCHARGE FROM SITE:
MONITORING PERIOD - From: 1-Jul-03 To: 31-Jul-03

REPORT: Monthly
GROUP: Domestic

FOR INCLUSION ON ALL SUBMISSIONS

Parameter		Quantity or Loading		Units	Quality or Concentration			Units	No. Ex.	Frequency of Analysis	Sample Type
Flow	Sample Measurement	0.285		mgd					0		
[illegible]											
Flow	Sample Measurement	0.305		mgd					0		
[illegible]											
Percent Capacity (TMADF/ Permitted Capacity)x100	Sample Measurement		pcts						0		
[illegible]											
CBOD5	Sample Measurement					144.5			0	3/month	
[illegible]											
TSS	Sample Measurement					100.0			0	3/month	
[illegible]											

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein; and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment.

NAME/TITLE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	SIGNATURE OF PRINCIPAL EXECUTIVE OFFICER OR AUTHORIZED AGENT	TELEPHONE NO.	DATE (YY/MM/DD)
David Buchanan, Mayor		(904)845-3555	

COMMENT AND EXPLANATION OF ANY VIOLATIONS (Reference all attachments here):

Version 25 June 2003

FACILITY NAME: Town of Hilliard Regional WWTP

DISCHARGE MONITORING REPORT - PART A (Continued)
PERMIT NUMBER: FLA0043079 Monitoring Group Number: D001
MONITORING PERIOD--From: 1-Jul-03 To: 31-Jul-03

FOR TREATMENT WHICH DID NOT INCLUDE THE CONSTRUCTED WETLAND - FIRST PAGE

Parameter		Quantity or Loading		Units	Quality or Concentration			Units	No Ex	Frequency of Analysis	Sample Type
$CBOD_5$	Sample Measurement					4			0	3/month	
[redacted]											
$CBOD_5$	Sample Measurement					2.0	1		0	3/month	
[redacted]											
Solids, Total Suspended (TSS)	Sample Measurement					4.9			3	3/month	
[redacted]											
Solids, Total Suspended (TSS)	Sample Measurement					2.0	2.9		0	3/month	
[redacted]											
Nitrogen, Total (as N)	Sample Measurement					4.5			0	3/month	
[redacted]											
Nitrogen, Total (as N)	Sample Measurement					1.7	2.5		0	3/month	
[redacted]											
Phosphorous, Total (as P)	Sample Measurement					0.13			0	3/month	
[redacted]											
Phosphorous, Total (as P)	Sample Measurement					0.00	0.04		0	3/month	
[redacted]											
Coliform, Fecal	Sample Measurement					2			0	3/month	
[redacted]											
Coliform, Fecal	Sample Measurement					1.0	1.4		0	3/month	
[redacted]											
Total Residual Chlorine (For Disinfection)	Sample Measurement				0.8				0		
[redacted]											

DISCHARGE MONITORING REPORT - PART A (Continued)

FACILITY NAME: Town of Hilliard Regional WWTP

PERMIT NUMBER: FLA004079 Monitoring Group Number: D001

MONITORING PERIOD- From: 1-Jul-03 To: 31-Jul-03

FOR TREATMENT WHICH DID NOT INCLUDE THE CONSTRUCTED WETLAND - SECOND PAGE

Parameter		Quantity or Loading		Units	Quality or Concentration			Units	No Ex.	Frequency of Analysis	Sample Type
Total Residual Chlorine (For Dechlorination)	Sample Measurement						<0.01		0		grab
	[illegible]										
Oxygen, Dissolved (DO)	Sample Measurement				[illegible]				0	2/month	
	[illegible]										
Specific Conductance	Sample Measurement						548.0			2/month	
	[illegible]										
Color	Sample Measurement						10		0	2/month	
	[illegible]										
Phosphate, Ortho (as P)	Sample Measurement						0.4		0	2/month	
	[illegible]										
Nitrogen, Kjeldahl, Total (as N)	Sample Measurement						0.6		0	2/month	
	[illegible]										
Nitrogen, Nitrate, Total (as N)	Sample Measurement						1.2		0	2/month	
	[illegible]										
Nitrogen, Ammonia, Total (as N)	Sample Measurement					0.02	0.04		0	2/month	
	[illegible]										
pH	Sample Measurement				4.7		7		0		
	[illegible]										
Temperature (C) Water	Sample Measurement						28.5		0	2/month	
	[illegible]										
Ammonia, Unionized*	Sample Measurement					0.0175334			0	2/month	
	[illegible]										

*Unionized Ammonia calculation based on Total Ammonia Nitrogen, Temperature and pH at time of sample collection at EFA-3.

Version 26 June 2003

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DISCHARGE MONITORING REPORT - PART A (Continued)

FACILITY NAME: Town of Hilliard Regional WWTP

PERMIT NUMBER: FLA0043079 Monitoring Group Number: 0001

MONITORING PERIOD–From: 1-Jul-03 To: 31-Jul-03

FOR TREATMENT WHICH DID NOT INCLUDE THE CONSTRUCTED WETLAND - THIRD PAGE

Parameter		Quantity or Loading		Units	Quality or Concentration			Units	No Ex.	Frequency of Analysis	Sample Type
$CBOD_5$	Sample Measurement					3.3			0	2/month	
[illegible]											
$CBOD_5$	Sample Measurement					2.0			0	2/month	
[illegible]											
Solids, Total Suspended (TSS)	Sample Measurement					3.6				2/month	
[illegible]											
Solids, Total Suspended (TSS)	Sample Measurement					2.0			0	2/month	
[illegible]											
Phosphorus, Total (as P)	Sample Measurement					0.22			1	2/month	
[illegible]											
Phosphorus, Total (as P)	Sample Measurement					0.025			0	2/month	
[illegible]											
pH*	Sample Measurement				6.787		6.54		0	2/month	
[illegible]											

*pH sample to be collected at the same time as the monthly CBOD, TSS, and Total Phosphorous grab samples at EFA-3

DAILY SAMPLE RESULTS-PART B

Permit Number: FL0049070

Monitoring Period/From 1-Jul-03 To. 31-Jul-03

FOR INCLUSION ON ALL SUBMISSIONS

	Flow (mgd)	CBOD5 (mg/L)	TSS (mg/L)
Code	50050	80082	00530
Mon. Site	EFA-3	INF-1	INF-6
1	0.264	150	150
2	0.342		
3	0.286		
4	0.274		
5	0.259		
6	0.239		
7	0.230		
8	0.252		
9	0.254		
10	0.263		
11	0.281		
12	0.239		
13	0.239		
14	0.241		
15	0.344		
16	0.324	110.0	150.0
17	0.308		
18	0.351		
19	0.307		
20	0.307		
21	0.309		
22	0.338		
23	0.328		
24	0.369		
25	0.321		
26	0.344		
27	0.344		
28	0.345		
29	0.328		
30	0.338	54	[illegible]
31	0.388		
Avg.	0.303	104.7	[illegible]
Max	0.388	110	[illegible]
Min	0.239	64	140

PLANT STAFFING:

Day Shift Operator	Class:	C-6586	Steve Wingate
Evening Shift Operator	Class:		
Night Shift Operator	Class:		
Lead Operator	Class:	B-10158	David Thompson

DAILY SAMPLE RESULTS-PART B

Permit Number: FL0043079

Monitoring Period: 1-Jul-03 To: 31-Jul-03

Facility: Hilliard WWTF

County: Nassau

FOR TREATMENT WHICH DID NOT INCLUDE THE CONSTRUCTED WETLAND- FIRST DAILY PAGE

	CBOD5 (mg/L) Every 2 wks 8-Hr. FPC	TSS (mg/L) Every 2 wks 8-Hr. FPC	Nitrogen Total (as N) (mg/L)	Phosphorous Total (as P) mg/L Every 2 wks 8-Hr. FPC	Fecal Coliform (#/100mL)	TRC (For Chlorination) (mg/L)	TRC (For Dechlor.) (mg/L)	Oxygen Dissolved (DO) (mg/L)	Specific Conductance (UMHO/CM)	Color (PT-CO)
Code	80082	00530	00600	00665	74055	50060	50060	00300	00095	08080
Mon. Site	EFA-1	EFA-1	EFA-1	EFA-1	EFA-1	EFA-2	EFD-1	EFA-1	EFA-1	EFA-1
1	2.0	2.0	0.84	0.02		1.5	<0.01			
2					1.0	2.4	<0.01			
3						1.7	<0.01			
4						1.7	<0.01			
5										
6										
7						1.6	<0.01			
8						0.8	<0.01			
9						0.9	<0.01			
10						1.1	<0.01			
11						1.2	<0.01			
12										
13										
14						1	<0.01			
15						1.4	<0.01			
16	2.0	2.0	2.8	0.04		0.9	<0.01			
17					1.0	0.4	<0.01			10.0
18						1.1	<0.01			
19										
20										
21						0.9	<0.01			
22						0.8	<0.01			
23						0.9	<0.01			
24						1	<0.01			
25						1	<0.01			
26										
27										
28						1.1	<0.01			
29						0.8	<0.01			
30	3.0	3	2.5	0.05		0.8	<0.01			
31					1.0	0.8	<0.01	6.4	548	10.0
Avg.	2.0	2.0	1.72	0.030	1.0	1.15	#DIV/0!	6.400	548.000	10.000
Max	3.0	2.0	2.6	0.04	1	2.40	#DIV/0!	6.400	548.000	10.000
Min	2.000	2.000	0.840	0.020	1.0	0.80	0.00	6.400	548.000	10.000

PLANT STAFFING:

Day Shift Operator	Class:	C-4888	Steve Wingate
Evening Shift Operator	Class:		
Night Shift Operator	Class:		
Lead Operator	Class:	B-10138	David Thompson

Version 25 June 2003

DAILY SAMPLE RESULTS-PART B

Permit Number: FL0040679 | Facility: [illegible]
Monitoring Period: [illegible] To [illegible] | County: [illegible]

FOR TREATMENT WHICH DID NOT INCLUDE THE CONSTRUCTED WETLAND-FIRST DAILY PAGE

	Phosphate Ortho (as P) (mg/L)	TKN (mg/L)	Nitrogen Nitrate, Total (as N) (mg/L)	pH (S.U.) 5 days per week	Temperature (Deg. C)	Nitrogen Ammonia [illegible] (mg/L)	CBOD5 (mg/L) [illegible]	TSS (mg/L) Monthly [illegible]	Phosphorus Total (as P) (mg/L) [illegible]	pH (S.U.) [illegible]
Code	70507	[illegible]	[illegible]	[illegible]	00010	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mon. Site	EFA-1	EFA-1	EFA-1	EFA-1	EFA-1	EFA-1	EFA-1	EFA-1	EFA-1	EFA-1
1				[illegible]						
2				6.70						
3				[illegible]						
4				[illegible]						
5										
6										
7				[illegible]						
8				7						
9				[illegible]						
10				6.90						
11				7						
12										
13										
14				6.80						
15				7.00						
16				[illegible]						
17	0.39	[illegible]	[illegible]	[illegible]		[illegible]	2.0	[illegible]	[illegible]	
18				7						
19										
20										
21				7.00						
22				[illegible]						
23				[illegible]						
24				[illegible]						
25				[illegible]						
26										
27										
28				[illegible]						
29				[illegible]						
30				[illegible]						
31	0.12	0.6	1.2	[illegible]	26.6	[illegible]	2	[illegible]	[illegible]	[illegible]
Avg.	[illegible]	0.6	1.20	[illegible]	[illegible]	[illegible]	2.00	2.000	[illegible]	[illegible]
Max	0.4	[illegible]	[illegible]	7.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Min	[illegible]	0.600	1.200	[illegible]	[illegible]	0.02	2.00	[illegible]	[illegible]	[illegible]

PLANT STAFFING
Day Shift Operator — Class: [illegible] — [illegible]
Evening Shift Operator — Class:
Night Shift Operator — Class:
Lead Operator — Class: [illegible] — [illegible]

Version 25 June 2003

ANNUAL AVERAGE CALCULATION SHEET							
MONTH/YR	FLOW	CBOD	TSS	Total - N	Total -P	FECAL	unionized amm.
Aug-02	0.225	2.7	2.7	3.40	0.180	1.0	0.00012
Sep-02	0.276	3.0	2.0	2.95	0.106	1.0	0.00098
Oct-02	0.288	2.3	5.3	2.90	0.400	1.0	0.00015
Nov-02	0.260	2.0	2.0	3.60	0.100	1.0	0.00037
Dec-02	0.330	2.0	3.0	3.00	0.050	7.0	0.00036
Jan-03	0.298	2.5	2.0	3.28	0.035	1.7	0.00220
Feb-03	0.308	2.5	2.0	3.10	0.020	1.0	0.00740
Mar-03	0.379	2.5	4.5	8.60	0.110	1.0	0.04600
Apr-03	0.278	21.0	27.5	21.00	0.975	1.0	0.15000
May-03	0.269	2.7	4.3	3.10	0.110	2.7	0.00124
Jun-03	0.235	2.6	2.0	2.20	0.040	1.0	0.00160
Jul-03	0.303	2.0	2.0	1.70	0.030	1.0	0.0000665
Annual Average	0.286	4.0	4.9	4.8	0.18	2	0.0175395
3 Month Average	0.268						

BAKONA CASINO - LAKESIDE, CA JULY 21

Influent						Mixed Liquor		Effluent								
Date	BOD	TSS	TKN	NH3	grease/oil	MLSS	grease/oil	BOD	TSS	NH3	NO3	NO2	TKN	Total Coliform	Fecal Coliform	grease/oil
11/29/00	1216	353	60	34.4	17.5	2470	9.0	3.9	2.4	ND	.63	ND		<2	<2	
12/6/00	1314	1180	103	38.2	197			3.6	ND	ND	.51	ND	.53	<2	<2	2.4
12/13/00	1600	2490	122	48	1100		88.7	4.8	ND	ND	.19	ND	.95	<2	<2	48
12/20/00	830	324	107	40.9	209		20.8	2.0	ND	.11	2.03	ND	1.3	220	14	1.3
12/27/00	842	486	104	47.5	173		9.2	4.2	ND	ND	.23	ND	1.5	<2	<2	ND
1/3/01	>1600	1530	97.3	36.8	243		12.5	5.2	ND	ND	.40	ND	2.0	<2	<2	
1/10/10	890	724	128	55.0	87.3		4.2	4.7	3.2	ND	2.75	ND	.86	<2	<2	
1/17/01	768	256	100	34.4	87.7		2.4	3.3	ND	ND	.55	ND	1.38	50	<2	
1/24/01	>1600	1350	108	40.4	215		8.0	9.4	7.2	ND	.70	ND	.89	<2	<2	
1/31/01	816	184	50.5	34.4	72.6			3.7	4.0	ND	.61	ND	.67	<2	<2	
2/7/01	814	381	84	83.4	102			8.2	ND	.18	.95	ND	1.9	8	<2	ND
2/14/01	1462	526	103	35.3	99.5			3.9	1.0	ND	.45	ND	2.8	<2	<2	5.1
2/21/01	1200	280	20.5	12.3	124	3530	9.8	3.7	1.2	ND	ND	ND	.41	<2	<2	2.5
2/28/01	1298	455	98.2	34	163			3.4	ND	ND	.18	ND	1.7	<2	<2	ND
3/7/01	700	459	66.8	31.7	119			4.7	ND	ND	.4	ND	.99	<2	<2	6.6
3/14/01	976	879	48.5	27.8	245		8.5/13.9	3.4	ND	ND	.59	ND	1.31	<2	<2	3.6
3/21/01	802	489	93.8	37.9	130		/14.6	3.7	5.6	ND	0.18	ND	0.73	<2	<2	
3/28/01	1070	191	82	12.7	189			ND	ND	ND	1.66	ND	0.90	<2	<2	4.9
4/4/01	742	307	88.4	26.5	140			2.2	ND	0.10	1.76	ND	3.65	<2	<2	13.1
4/11/01	>1600	1480	94.1	51.2				2.4	1.1	ND	2.4	ND	0.86	<2	<2	1
4/18/01	1970	624	106	51.4	105		15.5/12.6	3.8	2.0	0.37	0.87	ND	1.3	<2	<2	9.4
4/25/01	1677	498	72.7	27.5	103		17.8/19.8	2.5	ND	ND	0.20	ND	1.1	<2	<2	ND
5/2/01	817	348	95.4	45.5	78.3		12.9/17.6	ND	ND	ND	1.22	ND	0.74	<2	<2	ND
5/9/01	1853	964	88.6	35.6	132		11.8/4.6	2.3	1.3	ND	1.24	ND	0.77	<2	<2	3.2
5/16/01	1340	360	66.8	40.1	117		10.0/6.1	ND	ND	ND	0.87	ND	0.68	>1600	188	ND
5/17/01														>1600	900	
5/18/01														>1600	>1600	
5/23/01	>2400	836	69.9	36.8	278		16.8/8.1	3.6	<1	ND	0.52	ND	1.04	<2	<2	1.5
5/30/01	812	203	14.9	10.4	98.5		9.7/8.9	2.2	1.0	ND	0.22	ND	0.65	<2	<2	1.5
6/6/01	718	257	89.7	32.8	85.1		28.0/13.8	2.5	ND	ND	0.34	ND	0.86	<2	<2	ND
6/13/01	1550	1060	88.8	61.4	108		7.4/13.4	3.3	1.3	ND	0.36	ND	1.09	<2	<2	ND
6/20/01	805	191	35.6	16.3	87.5		10.2/8.9	4.7	1.0	ND	.88	ND	.88	<2	<2	4.8
6/27/01	1760	851	87.4	40.4	120		10.3/10.5	3.9	ND	ND	0.12	ND	0.91	<2	<2	ND
7/5/01	1048	446	68.4	16.0	99.6		12.3/15.2	2.8	ND	ND	1.28	ND	0.91	<2	<2	4.9
7/11/01	1140	851	82.1	31.6	121		7.6/10.8	2.3	ND	ND	0.63	ND	0.88	<2	<2	8.9
7/18/01														<2	<2	

INFLUENT

CERTIFIED LABORATORY RESULTS

EFFLUENT

DATE	BOD	TSS	NH3	TKN	G & O	BOD	TSS	NH3	NO3	NO2	TKN	TOTAL C	FECAL C	G & O
09/12/2001	1880	582	42.7	82.9	220	2.8	ND	ND	0.28	ND	0.94	<2	<2	ND
09/19/2001	1160	284	14.2	44.9	108	2.8	ND	ND	0.21	ND	1.36	<2	<2	4
09/26/2001	1580	628	44.3	91	108	3.3	ND	ND	0.15	ND	0.79	<2	<2	2
10/03/2001	1420	528	47.8	87.5	98.5	2.2	ND	ND	0.13	ND	0.82	<2	<2	ND
10/10/2001	815	211	48.9	63.3	63.7	2.2	3.3	ND	0.12	ND	0.13	<2	<2	3.4
10/17/2001	220	388	84.8	84	100	2.1	ND	ND	ND	ND	1.2	<2	<2	3
10/24/2001	1180	270	36.1	81	102	2.3	ND	ND	0.06	ND	0.52	<2	<2	ND
10/31/2001	795	320	39.8	97.3	76.7	3	ND	ND	0.08	ND	0.35	<2	<2	7.2
11/07/2001	888	198	10.7	37.2	73.8	3.1	ND	ND	ND	ND	0.21	<2	<2	ND
11/14/2001	881	158	12.6	48.4	86	2.3	ND	1.11	ND	ND	0.88	<2	<2	ND
11/21/2001	699	288	35.5	88.1	312	3	ND	ND	ND	ND	1.1	<2	<2	3.4
11/28/2001	877	948	31.7	82	21.3	3.4	ND	ND	ND	ND	0.8	<2	<2	ND
					Avg	2.9	0.28	0.009	0.033	0	0.80	<2	<2	1.93

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FLUIDYNE REFERENCE LIST

ISAM™/ SAM™ WASTEWATER TREATMENT PLANTS

FACILITY/OPERATOR	TELEPHONE	FLOW (MGD)	TYPE
CONO CHRISTIAN SCHOOL WALKER, IA Andrew Belz	319-448-4395	0.025	School
BACARDI-MARTINI TORONTO, ONTARIO Alan Dyck	905-451-6100	0.070	Distillery
BARONA, CALIFORNIA Larry McThompson	619-328-3968	0.750	Casino
CHAPMAN'S ICE CREAM MARKDALE, ONTARIO Charlie Rheaume	519-986-3131	0.132	Dairy
CORDAVALLE, CA William Marcum	831-915-5408	0.030	Golf Course
EL PASO, AR Scott Kamph	501-227-7001	0.0025	Store
GRANDHAVEN, MI Chuck Larsen.	616-842-6355	0.0025	Power Plant
INGHAM LAKE, IA Jim Sundae	712-867-4170	0.008	Camp
JOHN WOOD SCHOOL, IN Mark Keyes	219-650-5309	0.008	School
LAKE AND FOREST CLUB BROWNSVILLE, IN Steve Lawrence	812-522-5351	0.040	Development
LIBERTY SCHOOL SPANGLE, WASHINGTON John Galow	509-622-2888	0.025	School

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ISAM™/ SAM™ WASTEWATER TREATMENT PLANTS

Facility/Operator	Telephone	Flow (MGD)	TYPE
MCCAIN FOODS, ALBERTA John Fair	403-269-5311	0.020	Factory
MULGRAVE, NOVA SCOTIA Steve Wheller	902-478-4137	0.090	Municipal
PALM VALLEY, AZ Larry Johnson	623-935-3005	4.1	Municipal
POPLAR SPRINGS, VA Howard Foer	540-738-4600	0.012	Municipal
ST. PETERS, NS Tom Madden	305-258-7891	0.15	Municipal
SOUND OF THE SEA, NC Don O'Mara	252-247-9167	0.040	Municipal
SUNDANCE, AZ Arthur Faiello	623-393-9630	1.20	Municipal
VOLUSIA COUNTY, FL Bill Gilley	904-943-4905	0.008	Washwater

FLUIDYNE SAM™ / ISAM™ PROJECTS

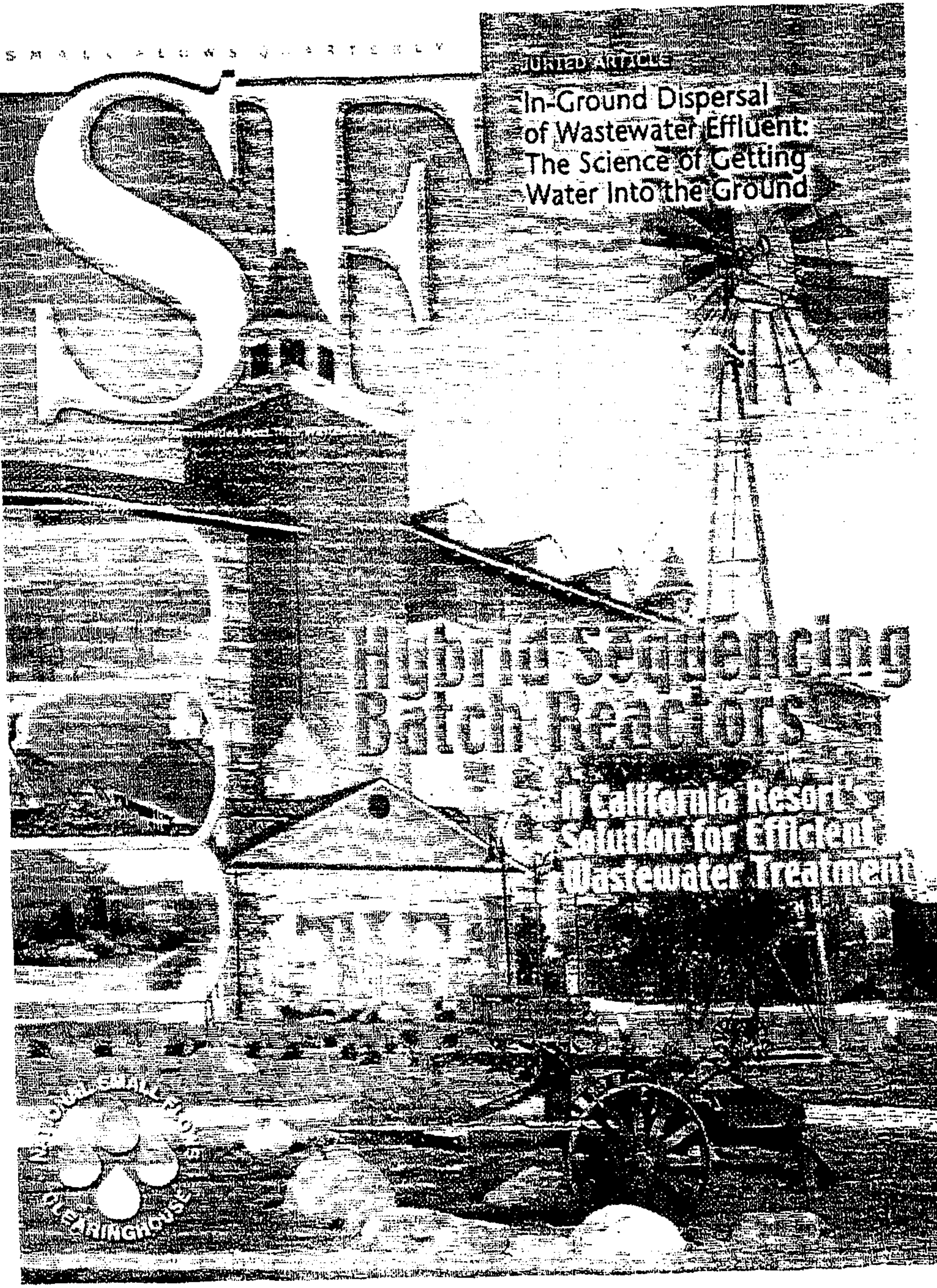
PROJECT NAME	ENGINEER	TYPE	# OF TANKS	GPD FLOW	WASTEWATER
Alum Springs, VA	Dewberry & Davis	ISAM™	1	40,000	Domestic
Baca Grande, CO	Sear-Brown	ISAM™	2	150,000	Domestic
Bacardi-Martini, London, Ontario	Fluidyne Corporation	SAM™	1	40,000	Beverage
Barona, CA	PERC	SAM™	2	750,000	Casino/Resort
Bauxite, AR	NRS	ISAM™	2	150,000	Domestic
Chapman's Ice Cream-Markdale, ONT	DJ Peach	ISAM™	1	100,000	Dairy
Cono-Christian School-Walker, IA	Fluidyne Corporation	ISAM™	1	25,000	Domestic
Cordavelle, CA	PERC	ISAM™	1	30,000	Domestic
El Mirage, AZ-Phase	PERC	ISAM™	4	3,600,000	Domestic
El Paso, AR	Fluidyne Corporation	ISAM™	1	2,500	Domestic
Firebag, Alberta	Reid Crother	ISAM™	2	40,000	Domestic
Fogo Island, Newfoundland	BAE Newplan	ISAM™	1	6,000	Domestic
Fork Union, VA	Berkley-Howell	ISAM™	2	100,000	Domestic
Frontier Ranch, CO	Fluidyne Corporation	ISAM™	1	12,000	Domestic
Grand Haven, MI	Fluidyne Corporation	ISAM™	1	2,500	Domestic
Highlands Camp-Allenspark, CO	TEC	ISAM™	2	20,000	Domestic
Hill Mobile Home Park-Culpepper, VA	PM Brooks	ISAM™	1	5,000	Domestic
Ingham Bible Camp-Okoboji, IA	Fluidyne Corporation	ISAM™	1	8,000	Domestic
John Wood School-Merrillville, IA	Commonwealth Eng.	ISAM™	1	10,000	Domestic
Kona Village, HI	GMP	ISAM™	2	50,000	Domestic
Lake & Forest Club-Brownsville, IN	Sieco	ISAM™	2	25,000	Domestic
Lamoni, IA	V & K	ISAM™	2	500,000	Domestic
Liberty School, Spangler, WA	T,D & H Inc.	ISAM™	1	20,000	Domestic
McCain Foods-Coaldale, Alberta	Geomatrix	SAM™	1	20,000	Domestic
Meyers Bakery, AR	Garver	ISAM™	2	25,000	Domestic
Millipore - Jaffrey, NH	Capaccio	ISAM™	2	37,000	Industrial

FLUIDYNE SAM™ / ISAM™ PROJECTS

PROJECT NAME	ENGINEER	TYPE	# OF TANKS	GPD FLOW	WASTEWATER
Mt. Ashland Ski Area-Ashland, OR	JBR Environmental	ISAM™	1	20,000	Ski Resort
Mulgrave, Nova Scotia	Strait Engineering	ISAM™	2	90,000	Domestic
Palm Valley, AZ	PACE	ISAM™	2	4,100,000	Domestic
Poplar Springs, VA	PM Brooks	ISAM™	1	10,000	Domestic
Rancho Viejo, NM	PACE	ISAM™	1	40,000	Domestic
San Pasqual, CA	PERC	ISAM™	1	40,000	Casino
Six O Five Mobile Home Park, VA	PM Brooks	ISAM™	1	40,000	Domestic
Sound of the Sea, NC	Wojek Engineering	ISAM™	1	40,000	Domestic
South Dade Landfill-South Dade, FL	IT Group	SAM™	2	320,000	Leachate
South Slopes, Ontario	RCA	ISAM™	2	60,000	Domestic
St. Peters, Nova Scotia	Strait Engineering	ISAM™	2	240,000	Domestic
St. Philips, Newfoundland	BAE Newplan	ISAM™	1	100,000	Domestic
Sundance, AZ	PACE	ISAM™	2	1,200,000	Domestic
USA Embassy - Nigeria	BL Harbert	ISAM™	1	6,000	Domestic
Volusia County, FL-Septage Facility	Mills Engineering	ISAM™	1	2,000	Septage
Woodleaf, CA	Fluidyne Corporation	ISAM™	1	25,000	Domestic

SAM™ = Surge/Anoxic Mix ISAM™ = Integrated Surge/Anoxic Mix

SMALL FLOWS QUARTERLY



Hybrid Sequencing Batch Reactors (SBR) Offer an Efficient Wastewater Treatment

CONTRIBUTING WRITERS

Michael Lahlou, E.I.T. and James Matthews, P.E.

Batch processes are not a new or innovative wastewater treatment technology, since the first reported fill/draw systems are at least a century old. The sequencing batch reactor (SBR) process has been successfully applied to more than 1,300 plants in the U.S., Canada, and Europe within the last 25 years. In particular, the number of SBR plants in North America is growing rapidly. Many of these facilities have been constructed for small communities, producing less than 1.0 million gallons per day (mgd) of wastewater, although larger plants (up to 230 mgd in Dublin, Ireland) have used SBR technology with similar effluent quality results.

Both municipal and industrial wastewater has been successfully treated in SBR systems. A general overview of SBR reactor systems and the technology is presented here, along with a discussion of the additional enhancements of a hybrid SBR designed by Pacific Advanced Civil Engineering, Inc. (PACE) and constructed by Pacific Environmental Resources Corporation, Inc. (PERC). A real-world application using the PACE/PERC design is evaluated.

History and Evaluation of SBRs

The use of batch processes for treating wastewater is not a recent development; batch processes have been in development and use since the turn of the century. However, facility design moved to continuous flow or "conventional" systems after 1920 due to the high degree of operator attention and automation required for SBRs. The clogging of air diffusers caused by periodic settling of sludge on the air diffusion systems in SBRs also increased the complexity of their operation.

In the early 1960s, interest was revived in batch systems with the development of new technology and equipment, most significantly the micro processor. In addition, improvements in aeration devices and control systems have allowed the development of the "fill-and-draw" systems to their present level of efficiency and now enable SBRs to successfully compete with, and in most cases outperform, conventional activated sludge systems.

The biological and physical unit processes involved in the SBR and conventional activated-sludge systems

Benefits of Using SBR Treatment

- a higher degree of operational flexibility with respect to effluent quality and dissolved oxygen (DO) controlled aeration system;
- complete quiescent settling for improved total suspended solids (TSS) removal;
- effluent quality meets current and anticipated future nitrogen requirements for surface discharge;
- no separate clarifiers;
- proven treatment process;
- capacity upgrades and phasing do not require modification or interruption of current treatment process;
- a high degree of automation reduces operational staff requirements;
- significantly smaller footprint requires less site work and yard plumbing;
- lower initial capital cost; and
- power consumption is typically less than that of a conventional plant with substantial power savings at lower flows (i.e., greater turn-down capability).

Limitations of SBR Systems

Limitations of SBRs are generally related to the education of the operating staff and do not focus on the process elements. Therefore, SBRs often require:

- a higher level of control sophistication,
- knowledgeable operators,
- some retraining of existing operations staff, and
- two or more basins or a pre-equalization tank for process operation and redundancy.

A series of blowers supply air to the hybrid sequencing batch reactor at Barona Valley Ranch Resort and Casino in Lakeside, California. Photo courtesy of Michael Lahlou.

are essentially the same. Aeration and sedimentation/clarification are performed in both systems. However, there is one important difference. The processes in the conventional plant are carried out simultaneously in separate tanks; whereas, in the SBR process, treatment takes place sequentially in a common "reactor" tank.

The reactor in an SBR system has five basic operating modes. Listed sequentially in the treatment process, they are 1) fill, 2) react, 3) settle, 4) draw, and 5) idle. These modes of the SBR are controlled by time to achieve the effluent quality and treatment capacity objectives.

A major advantage of the SBR system compared to the conventional system is its flexibility to adapt and modify reactor conditions through time controls or dissolved oxygen settings during the operational phases. The computer controls allow the operator the ability to change the effective size/volume of the aeration, anoxic, and clarification processes to achieve effluent goals. This allows SBR facilities to adapt to changing influent loading conditions and consistently maintain the objective effluent water quality. A description of the different modes follows (see Figure 1 above and Figure 2 on page 16).

Fill Mode

The purpose of the fill operation is to add substrate (raw wastewater or primary effluent) to the reactor. The time allocated to the fill mode is variable and depends on the influent flow rate. Typically, SBRs are designed to have a minimum fill time that corresponds to the peak hour flow (PHF) rate of the facility. Aeration and mixing are typically cycled on and off during fill to provide a substantial amount of substrate reduction, nitrification, and denitrification.

React Mode

Air is introduced periodically to the process to allow the microorganisms to breathe and consume waste products. The purpose of the react mode is to complete the reactions that were initiated during fill. The SBR tank is isolated from receiving any new substrate while in react, usually through an influent control valve. The remaining raw influent wastewater is directed to the next SBR in series while the first SBR completes react, settle, and draw. As with fill mode, performance considerations might require alternating periods of high and low dissolved oxygen (DO) concentrations.

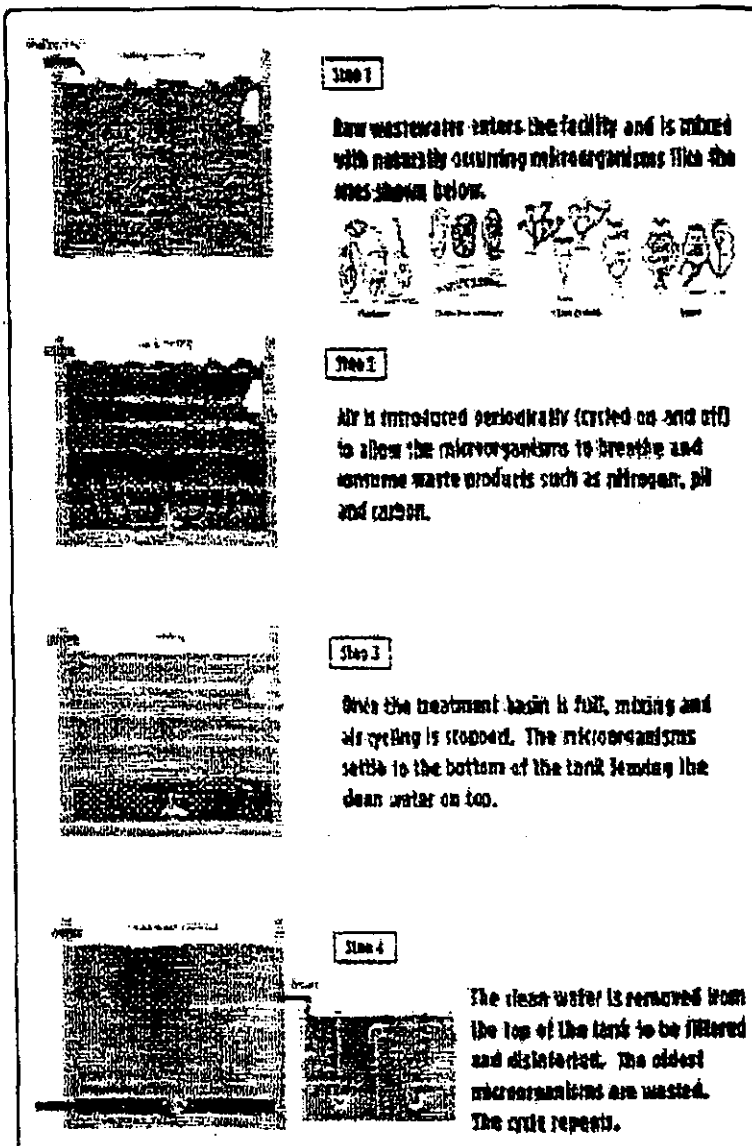


Figure 1 Typical SBR Operation for One Cycle

Settle Mode

All aeration and mixing is terminated during the settle and draw modes, and the reactor tank is allowed to dissipate all hydraulic energy developed due to the mixing operations. The purpose of settle mode is to allow solids separation to occur, which provides a clarified supernatant to be discharged as effluent.

In an SBR, this process is normally much more efficient than in a continuous flow system because the influent flow to the reactor is zero; therefore, the effective clarification overflow rate is zero gallons per day per square foot (i.e., the reactor is allowed to settle in a completely quiescent environment). The SBR has the ability to provide optimum settling conditions and eliminate hydraulic influences.

Draw Mode

The purpose of draw mode is to remove clarified or treated water from the reactor. Many types of decant mechanisms are in current use, the most popular being floating or adjustable weirs. The decanting rate can be controlled by automatic valves in a gravity system or by pumping.

Idle Mode

The purpose of idle mode in a multi-tank system is to provide "park" or stand-by time for the SBR just completing its batch cycle while waiting for the other SBR reactor to complete its fill mode. Idle is not a necessary phase and can be eliminated if variable volume batches are included in the design of the system. Length of time in idle is determined by the flow rate of wastewater into the plant.

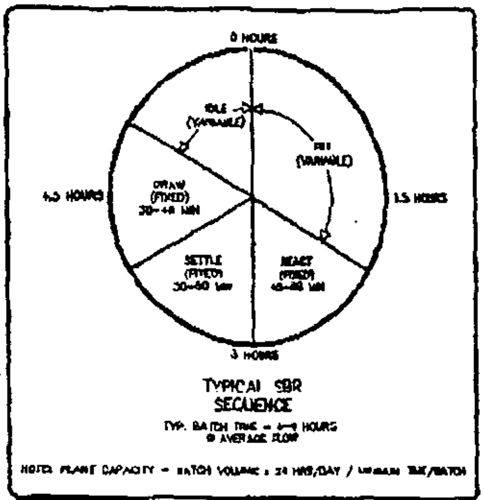


Figure 2 Typical SBR Cycle per Batch

A key element in understanding the SBR process and operation is that a reactor is never completely emptied during the batch process. Typically, 25 percent of the volume of the tank is decanted during the draw phase, retaining nearly 100 percent of the activated sludge within the tank. The advantage is that this establishes a population of microorganisms uniquely suited to treating the waste water without the need for a return activated sludge (RAS) pump station. The microorganisms are subject to high and low oxygen and to high and low food availability during the process. This operating condition in the SBR develops a population of organisms that are very efficient at treating site-specific wastewater constituents.

Sludge wasting is another important step in the SBR operation that greatly affects performance and effluent water quality. It is not included as one of the five basic basin modes because wasting strategies differ between SBR designs. Sludge wasting usually occurs during the settle or draw phases and depends upon the desired sludge age and process requirements.

Description and Advantages of a Hybrid SBR

Many significant advantages have been identified for application of a conventional SBR process; however, new hybrid designs have improved the benefits of this system and the potential applications. The hybrid SBR combines the advantages of the batch process with a conventional anoxic prereactor. This hybrid design adds the prereactor as an additional facility element in the system. The prereactor may be configured to act as a surge basin (e.g., Fluidyne Surge Anoxic Mix) or as a high F/M Bio-Selector (e.g., Austgen Biojet ICEAS). The major advantage of the hybrid configuration is in the aeration system sizing and bio-nutrient removal capacity. Air is cycled on and off with conventional SBRs during fill and react modes to create aerobic and anoxic conditions within one reactor tank. Since the same tank is used for clarification (i.e., settle and draw), the aeration time available per day is described by the following equation:

Aeration Time (per day) =
1,440 min/day –
batches/day x
(Settle Time + Draw Time + Anoxic Time)

This amount of time equates to about 8–9 hours/day of aeration in most SBR designs. If the design process is required to nitrify and denitrify, then the oxygen requirement is the same as conventional nitrification/denitrification in a biological nutrient removal facility. The oxygen demand must be delivered in one third of the time; therefore, conventional SBRs would typically have two to three times the installed horsepower for aeration, which leads to higher capital investment in mechanical and electrical equipment.

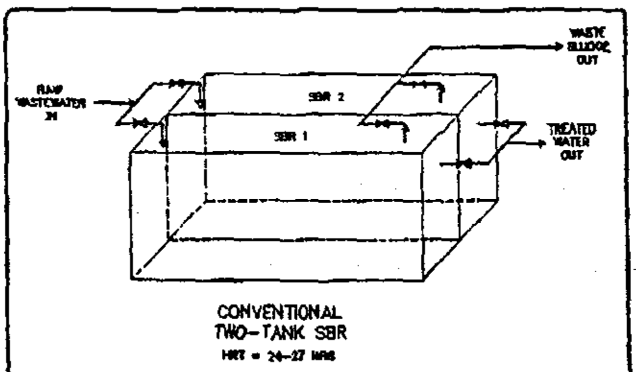


Figure 3 Conventional Process Schematic

Mixed-liquor suspended solids (MLSS) in the hybrid design are recycled back from the SBR to the anoxic prereactor for denitrification. This allows the SBR reactor to remain fully aerobic, and simultaneous nitrification (in the SBR) and denitrification (in the anoxic prereactor) can occur, reducing the installed aeration horsepower requirement. In addition, the denitrification kinetics are increased substantially, as the recycled, nitrified MLSS is contacted with raw wastewater, constituting a high carbon source, in a smaller, completely mixed reactor. This condition ensures that the process is not carbon limited and eliminates the need for chemical addition (e.g., methanol or acetate) to meet stringent total nitrogen limits imposed for some facility discharge permits. The figures below present the process schematics for both the conventional and hybrid SBR designs. As can be seen from the figures, the footprint and operation are only slightly different, while performance is greatly enhanced.

Application of a Hybrid SBR

Barona Valley Ranch Resort and Casino is located just outside of the City of San Diego, in Lakeside, California. It is one of the largest Indian-owned and operated casino facilities in California and began operation in 1994. The complex has undergone considerable expansion since that time and has required the tribe to invest in wastewater infrastructure to support its very successful enterprise. In 1999, Barona broke ground on a massive expansion that included a 400-room resort hotel, an 18-hole championship golf course, an events center, and a new 300,000-square-foot casino. Barona retained PACE and PERC as a design/build team to determine the best course of action for their waste-

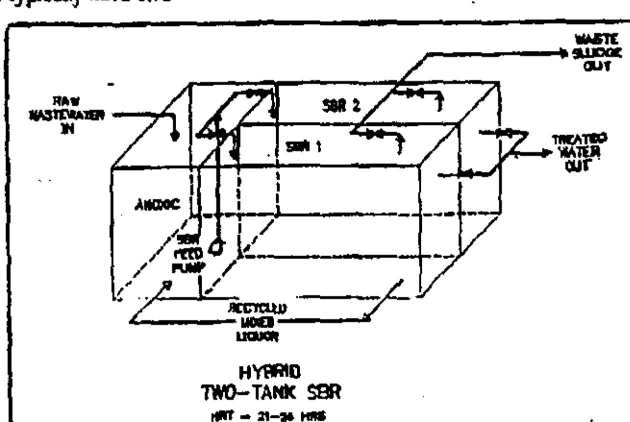


Figure 4 Hybrid Process Schematic

Table 1 Description of the Influent and Effluent Parameters for the Barona WRF

Parameter	Design		2-Year Actual	
	Influent	*Effluent*	*Influent*	*Effluent*
Flow (mgd)	0.375	0.375	0.150	0.150
BOD (mg/L)	700	< 5	1250	< 3
TSS (mg/L)	300	< 5	450	< 1
NH_3 (mg/L)	50	< 1	65	< 1
TN (mg/L)	NA	< 5	NA	< 7
Turbidity (ntu)	NA	< 2	NA	0.37
Total Coliform (mpn/100 ml)	NA	<2.2 Mean <23 Max	NA	Non-Detect 8 Maximum

water treatment needs. PACE and PERC conducted extensive meetings with the Barona Band of Mission Indians to obtain information concerning the following utility needs: 1) financial issues, 2) future growth possibilities, 3) land use, 4) aesthetic impacts, 5) water quality, and 6) environmental concerns. Determining the best design alternative to meet Barona's need for compliance with tough California regulations involved analyzing two treatment technologies that provide nitrogen removal: oxidation ditch and SBR. The feasibility evaluation focused on cost of construction, anticipated effluent quality, and cost of operations and maintenance.

The results from the comparison of these two alternatives indicated that the SBR, specifically the hybrid SBR, offered advantages in terms of construction costs, land required, ease of expansion, and operational flexibility that made it the most viable treatment alternative. The treatment facility that was designed consisted of a 0.375-mgd, two-tank SBR and a dedicated, variable-volume, anoxic pre-reactor that serves as a front-end hydraulic surge tank and biological selector, as well as a high-rate denitrification reactor, tertiary filtration, medium-pressure ultraviolet disinfection, and a two-stage aerobic sludge digestion process. The facility is expandable up to 1.2 mgd with the addition of two more reactor tanks to meet future needs. The plant design was developed with control and mechanical buildings directly above the underground tanks to confine and mitigate potential noise and odors. PACE and PERC's innovative hybrid SBR design allowed for accelerated construction and delivery of the project. The design/build contract was signed in February of 1999, with project completion and start-up of the turnkey design/build water reclamation facility (WRF) in January 2000 (11 months).

Design Parameters

The design of the facility was based on having to treat extremely strong commercial wastes with varying concentrations of BOD, TSS, and ammonia. A preliminary site analysis conducted by PACE indicated that the average BOD, TSS, and ammonia were 700 mg/L, 300 mg/L, and 50 mg/L respectively. As the project progressed, modifications to the sewer collection system and waste disposal operations increased the BOD to 1200–1500 mg/L average, with increases for ammonia up to 80 mg/L. Most of these increases can be attributed to fats, oils, and grease (FOG), which average 250 mg/L in the incoming waste stream and additional casino customers gained by the new casino expansion. PACE and PERC were confident that the hybrid SBR design would have the flexibility to treat the additional loading.

The facility has been operating for two and half years, and the effluent water quality has consistently exceeded the design specifications. Effluent BOD, TSS, and total nitrogen have been averaging less than 3 mg/L, less than 1 mg/L, and less than 2 mg/L, respectively. Although the facility averages less than half (150,000 gpd) of the design flow, only one of the two SBR reactors and the anoxic pre-reactor are on-line. The other SBR reactor has been idle since start-up. Table 1 provides a summary of influent and effluent design parameters along with two year actual influent and effluent averages.

Operations Program and Training

As part of the design/build contract, PACE and PERC provided a 2-week start-up and 6-month training and operations program that provided operators with the analytical tools and training to operate the new facility in compliance with the design specifications. This portion of the contract includes training in mechanical equipment service, electrical/control panel troubleshooting, biological treatment processes, laboratory analysis, sludge digestion and processing, and system operation.

The educated staff operators were able to operate the plant more efficiently and provide preventive maintenance, thereby significantly reducing overhead costs. This properly run facility was able to use less power, produce less sludge, and provide higher quality water without additional expense. PACE and PERC provided educational experiences that allowed Barona's staff to operate the plant at a high quality level with minimum supervision.

Conclusion

The Barona Hybrid SBR wastewater treatment facility, two years after the treatment plant startup, has consistently outperformed its design parameters while treating wastewater in excess of its design loading concentrations. The flexibility of the hybrid SBR design ensures achievement of excellent performance results under widely varying hydraulic and organic loading conditions. In addition, compared to conventional design, the design resulted in a more cost-effective and significantly reduced land requirement.

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Activated Sludge System with High Effluent Quality and Minimal Sludge Production.

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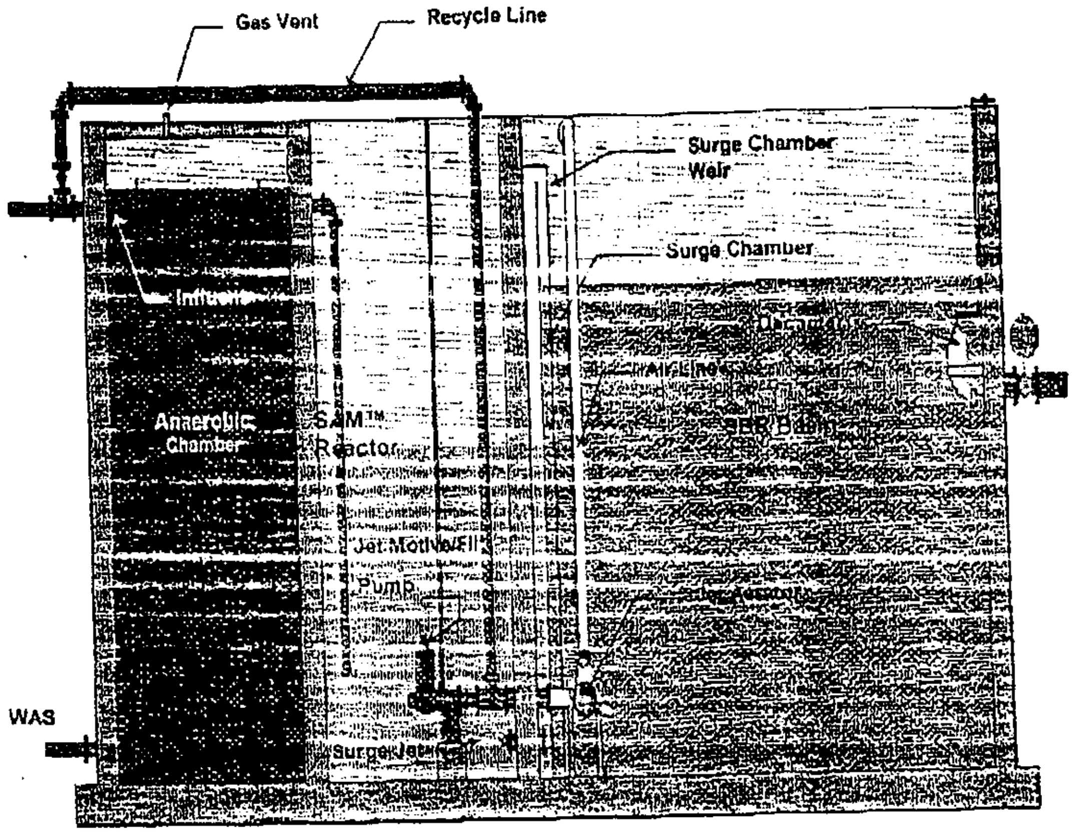
ABSTRACT
The paper describes the ISAM™ process of activated sludge treatment. This is a version of the activated sludge process which has been developed in the USA and is capable of producing tertiary quality effluents with minimal sludge production. The system is particularly suited to small works as a package plant. The system is based on a sequencing batch reactor with fixed decanter and jet aeration. By the use of anaerobic and anoxic zones a very stable and efficient system is achieved. Sludge is broken down both aerobically and anaerobically. Case studies from three operating plants are presented.

INTRODUCTION
A major problem with activated sludge plant operation is disposal of the waste activated sludge generated in the process. This sludge is low in solids content, (0.5% to 1%), is difficult to thicken, and may become malodorous if not aerated. Options to reduce sludge production usually involve reducing the sludge loading so that solids are burned off by aerobic digestion. This results in a large plant size and incurs high energy costs for aeration. In addition the low F: M ratio may result in a poor-settling sludge, with consequent loss of solids in the effluent. Particular difficulties have occurred with package activated sludge plants, some claims by manufacturers of low desludging frequencies have proved to be over optimistic.[1] In particular these plants have suffered problems of loss of solids during peaks in flow.
The following paper describes the ISAM™ process, which has been developed to overcome problems encountered with conventional package activated sludge plants.

DESCRIPTION OF THE ISAM™ PROCESS.
The basis of the ISAM™ process is a single cell sequencing batch reactor. (SBR) In this the sewage is treated batchwise, with aeration being followed by a period of quiescent settlement. Key components of the SBR are shown in figure 1 They are

1. The decanter
2. The jet aerator
3. The SAM™ tank
4. The surge chamber and surge chamber weir
5. The anaerobic chamber
6. The recycle line

Figure 1 Components of the ISAM™ System



1. Decanter

The treated effluent is removed by a novel fixed decanter, with no moving parts in the tank. When the tank is being mixed, the decanter is sealed by an air seal. This prevents mixed liquor entering the decanter. After the settlement period is complete an air relief valve is opened and allows effluent into the decanter. The outlet valve opens and the treated effluent is discharged. ,The decant is terminated just before the lip of the decanter to prevent any scum being drawn into the effluent. At the end of the decant the outlet valve and air relief valve are closed. This seals the air in the decanter to prevent ingress of mixed liquor

2. Aeration

Aeration and mixing are provided by a jet aerator[2], but this is installed in a novel way. The jet aerator is an efficient aeration and mixing device .In operation mixed liquor is pumped through a venturi jet. Air is entrained in the jet and is sheared into small bubbles in the jet. The stream of mixed liquor and bubbles is forced into the aeration tank where mixing and aeration take place. This system of aeration is very efficient and the efficiency is not significantly reduced in dirty water conditions. (Alpha factor effects are minimal.) This compares favourably with fine bubble diffusers where oxygen transfer efficiency in sewage may be less than half of that in clean water. In the configuration used in this process the jet motive pump is also used to transfer mixed liquor into the SBR.

3. *SAM™ tank.*
The SAM ™ tank functions as both a balancing tank and an anoxic zone. It is located before the SBR tank and receives the incoming flow. When the level in the SAM tank reaches a preset level the jet aerator motive pump starts and transfers the accumulated feed to the SBR tank via the jet aerator.

4. *Surge chamber and surge chamber weir*
This is located at top water level in the SBR tank, and is connected to the SAM™ tank via the surge jet. When the SBR tank is full, the contents overflow via the surge chamber and surge jet into the SAM™ tank. This causes very intense mixing in the SAM™ tank

5. *Anaerobic chamber.*
This is simple tank with inlet and outlet baffles and an overflow leading to the SAM™ tank. The hydraulic retention period is several hours. A connection for removal of waste sludge is provided at the bottom of the tank.

6. *Recycle Line.*
A recycle line is provided to divert some of the flow from the jet motive pump to the anaerobic tank. The proportion of the flow bled off is fixed and is set on start up.

OPERATION OF THE ISAM™ SYSTEM.
Crude sewage enters the anaerobic chamber. Solids settle in the chamber and the settled sewage enters the SAM™ reactor. This is an unaerated chamber, which will contain some activated sludge. The level in the chamber rises and at a pre-set level the combined jet motive and fill pump starts and transfers the mixture from the SAM™ tank to the aeration tank via the jet aerator. When the aeration tank is filled the mixed liquor overflows the surge weir and returns to the SAM™ tank via the surge jet. This causes intense mixing in the SAM tank, which then functions as an anoxic zone. The mixed liquor is then subjected to alternating periods of aerobic and anaerobic conditions. After a pre-set period, the pump is stopped and the mixed liquor in the aeration tank is allowed to settle. Settlement takes place in totally quiescent conditions. At the end of the settlement period the supernatant effluent is removed by the decanter. During the settlement and decanting periods the SAM™ tank acts as a balancing tank. Since it contains activated sludge from the previous cycle, the contents are subjected to denitrification and high floc loadings. When the aerator is operating, a small amount of mixed liquor is diverted at a controlled rate to the inlet of the anaerobic chamber. These solids settle within the anaerobic chamber. In this chamber some decomposition of the solids takes place to give simpler, soluble compounds such as fatty acids. The mixed liquor flow from the recycle line acts as a form of elutriation, flushing solublised material from the anaerobic chamber to be degraded in the aerobic reactor.
The net result of the above is as follows.

1. The activated sludge is subjected to periods of high floc loading, inhibiting the growth of filamentous organisms and giving a well settling sludge.
2. The system is ideal for denitrification, which prevents rising sludge and reduces energy costs by recovery of oxygen.
3. The destruction of sludge solids results in a very low sludge yield.

4. The presence of readily biodegradable COD in the anaerobic tank effluent and the anaerobic/anoxic periods in the SAM™ tank favour the growth of organisms responsible for biological phosphorus removal.
5. Any scum which forms in the aeration tank overflows the surge weir and is mixed in the SAM™ tank. It is either broken down aerobically in the react phases or is transferred to the anaerobic tank for degradation or removal.
6. Settlement takes place in totally quiescent conditions. There is no danger of solids being scoured from the plant during high flow events.

In its simplest form the ISAM™ process consists of a single tank package plant. The only moving part is the jet motive/fill pump, which is a conventional submersible pump mounted on rails. Two pumps are provided on a duty/standby basis.

There are over 130 SBR plants throughout the world which employ the fixed decanter and jet aerators. At present there are about 10 plants employing the ISAM™ technology. Case studies from 3 are given below.

CASE STUDY 1 CONO CHRISTIAN SCHOOL, WALKER, IOWA USA

This installation was started up in the winter of 1998. It consists of a single package unit treatment plant measuring 9.75m long by 2.6m wide by 3.2m high. The unit is placed on a concrete slab and covered by a simple timber framed building. In winter the building is heated sufficiently to maintain the temperature just above freezing. Design and operating parameters for the plant are shown in table 1.

Table 1 Cono Christian School ISAM™ plant Design Parameters.

Parameter	Value	Units
Population served	200	Residents
Average Flow	19	M^3/d
Maximum flow	95	M^3/d
Feed BOD	200	Mg/l
Feed TSS	200	Mg/l
Feed ammonia	30	MgN/l

The performance parameters for the plant for the first 18 months of operation are shown in table 2

Table 2 Cono Christian School ISAM™ Plant Operating results

Parameter	Value	Units
Effluent cBOD	3	Mg/l
Effluent TSS	3	Mg/l
Effluent Ammonia N	<1	MgN/l

All of these values are less than the permit values, which are 25mg/l for BOD, 30mg/l for TSS and 3 mgN/l for ammonia.

The only moving parts in the plant are two 6 kW jet aerators, which are operated on a duty/standby basis.

The plant was started up in December 1998. The plant operated for 18 months before desludging was necessary. In June 2000, 9.5m^3 of sludge were removed from the plant. This had a total solids content of 11.93% and only 29.74% was volatile. This is equivalent to an operating period of about 540 days. The daily sludge production is equivalent to17.6 litres or 2.1kgds/d. The long term average flow to the plant was 22.8 m^3/d. Sludge production from a similar, conventional plant would be expected to be10 to 14 kgd.s./d. This would have a volume of between 200l and 1400l depending upon solids content.

The most recent information from the plant was received in November 2001. Effluent quality continued to comply with permit values and no further sludge had been removed.

CASE STUDY 2 JOHN WOOD SCHOOL MERRILLVILLE, INDIANA USA

This plant was started up in August 1999. This consists of a single package treatment plant, 6.25m long by 2.44m wide and 3.5m high. It is buried in the ground to the top of the unit. There is no other protection from the severe winters, where temperatures can fall as low as -25°C. The plant treats the sewage from a population of between 400 and 500 students and staff who attend during the working day only. (5 days per week, 8 to 10 hours per day). The design average flow is 25 m^3/d. On weekdays over 50% of the flow arrives between 11:00 hrs and 14:00 hrs.

The consent conditions are shown in table 3

Table 3 John Wood School Permit Conditions

Parameter	Monthly Average	Weekly Average
CBOD	10mg/l	15mg/l
TSS	10mg/l	15mg/l
Ammonia Summer	1.2mgN/l	2.9mgN/l
Ammonia Winter	1.3mgN/l	3.1mgN/l

The operating results for the period between the end of August 2000 and May 2001 (33 results) showed that there were no individual samples which exceeded the weekly average limits. The overall average effluent TSS was 7.4 and the ammonia 0.76mg/l. The plant operated with a mixed liquor TSS of between 2051mg/l and 5099 mg/l (average 3293mg/l).

During the early months of operation it was noted that there was some "bleed through" of nitrogen into the effluent. This was due to the large proportion of flow entering the plant in the middle of the day. The operational regime was altered using simple time clocks to optimise treatment during the high load periods.

During the first year of operation no sludge was removed from the plant.

CASE STUDY 3 SEPTAGE PRETREATMENT PLANT, VOLUSIA COUNTY, FLORIDA USA

This is a plant designed to pre treat septic tank waste before discharge to an existing treatment facility. The design parameters are:

Table 4, Volusa County, Septage Pre-treatment Plant Design Parameters.

Parameter	Value	Units
Average Flow	8	M^3/d
CBOD	3200	Mg/l
TSS	700	Mg/l
Required Effluent cBOD	180	Mg/l
Required Effluent TSS	220	Mg/l

In the first year of operation the plant produced an effluent well within its design capability. The average of the analytical results is shown in table 5.

Table 5 Actual Operating Data for Volusia County Septage Pre-treatment Plant.

Parameter	Influent	Effluent	Units
CBOD	3879	7	Mg/l
TSS	506	4.1	Mg/l

VISUAL AMENITY

All of the plants described are prefabricated and delivered to site complete. They can either be buried in the ground (as at John Wood School) or installed in a suitable small building. In some cases the building is indistinguishable from others on the development.

FURTHER DEVELOPMENTS

So far the ISAM™ process has been successfully applied to small package installations in the USA. Further development of the process is underway to apply it to larger installations, both in new build plants and as retrofit to existing installations. This includes developments for reducing sludge production from existing activated sludge plants.

CONCLUSIONS

The ISAM™ process is a novel process employing a modified anaerobic stage providing optimal operating conditions for the activated sludge process. In particular the process is capable of producing an effluent of consistently high quality, with very low sludge production. The equipment is very simple and is easily maintained. This makes it ideal for package plant as it can be prefabricated and can be hidden underground or within suitable buildings.

The process is adaptable for a range of sizes and will be applied in new installations as well as being retrofitted to existing plants.

REFERENCES

1 CIWEM. Handbook of UK Wastewater Practice, Activated Sludge Treatment CIWEM 1997,p131

2 Water Pollution Control Federation and American Society of Civil Engineers Manual of Practice FD-13 Aeration WPCF/ASCE 1988, p30

United States Environmental Protection Agency | Office of Water Washington, D.C. | EPA 832-F-99-073 September 1999

EPA

Wastewater Technology Fact Sheet
Sequencing Batch Reactors

DESCRIPTION

The sequencing batch reactor (SBR) is a fill-and-draw activated sludge system for wastewater treatment. In this system, wastewater is added to a single "batch" reactor, treated to remove undesirable components, and then discharged. Equalization, aeration, and clarification can all be achieved using a single batch reactor. To optimize the performance of the system, two or more batch reactors are used in a predetermined sequence of operations. SBR systems have been successfully used to treat both municipal and industrial wastewater. They are uniquely suited for wastewater treatment applications characterized by low or intermittent flow conditions.

Fill-and-draw batch processes similar to the SBR are not a recent development as commonly thought. Between 1914 and 1920, several full-scale fill-and-draw systems were in operation. Interest in SBRs was revived in the late 1950s and early 1960s, with the development of new equipment and technology. Improvements in aeration devices and controls have allowed SBRs to successfully compete with conventional activated sludge systems.

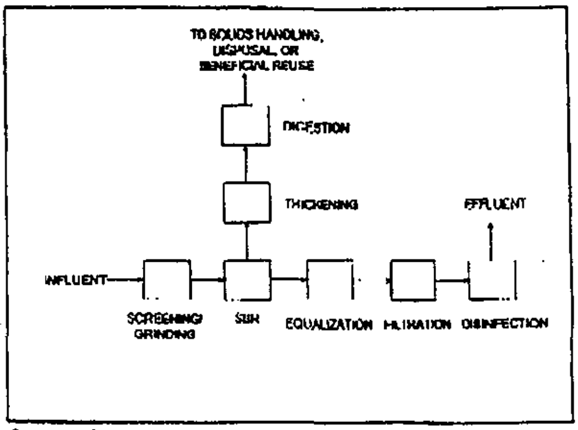
The unit processes of the SBR and conventional activated sludge systems are the same. A 1983 U.S. EPA report, summarized this by stating that "the SBR is no more than an activated sludge system which operates in time rather than in space." The difference between the two technologies is that the SBR performs equalization, biological treatment, and secondary clarification in a single tank using a timed control sequence. This type of reactor does, in some cases, also perform primary clarification. In a conventional activated sludge system, these unit processes would be accomplished by using separate tanks.

A modified version of the SBR is the Intermittent Cycle Extended Aeration System (ICEAS). In the ICEAS system, influent wastewater flows into the reactor on a continuous basis. As such, this is not a true batch reactor, as is the conventional SBR. A baffle wall may be used in the ICEAS to buffer this continuous inflow. The design configurations of the ICEAS and the SBR are otherwise very similar.

Description of a Wastewater Treatment Plant Using an SBR

A typical process flow schematic for a municipal wastewater treatment plant using an SBR is shown in Figure 1. Influent wastewater generally passes through screens and grit removal prior to the SBR. The wastewater then enters a partially filled reactor, containing biomass, which is acclimated to the wastewater constituents during preceding cycles. Once the reactor is full, it behaves like a conventional activated sludge system, but without a continuous influent or effluent flow. The aeration and mixing is discontinued after the biological reactions are complete, the biomass settles, and the treated supernatant is removed. Excess biomass is wasted at any time during the cycle. Frequent wasting results in holding the mass ratio of influent substrate to biomass nearly constant from cycle to cycle. Continuous flow systems hold the mass ratio of influent substrate to biomass constant by adjusting return activated sludge flowrates continually as influent flowrates, characteristics, and settling tank underflow concentrations vary. After the SBR, the "batch" of wastewater may flow to an equalization basin where the wastewater flowrate to additional unit processed can be is controlled at a determined rate. In some cases the wastewater is filtered to remove additional solids and then disinfected.

As illustrated in Figure 1, the solids handling system may consist of a thickener and an aerobic digester. With SBRs there is no need for return activated sludge (RAS) pumps and primary sludge (PS) pumps like those associated with conventional activated sludge systems. With the SBR, there is typically only one sludge to handle. The need for gravity thickeners prior to digestion is determined



Source: Parsons Engineering Science, 1999.

FIGURE 1 PROCESS FLOW DIAGRAM FOR A TYPICAL SBR

on a case by case basis depending on the characteristics of the sludge.

An SBR serves as an equalization basin when the vessel is filling with wastewater, enabling the system to tolerate peak flows or peak loads in the influent and to equalize them in the batch reactor. In many conventional activated sludge systems, separate equalization is needed to protects the biological system from peak flows, which may wash out the biomass, or peak loads, which may upset the treatment process.

It should also be noted that primary clarifiers are typically not required for municipal wastewater applications prior to an SBR. In most conventional activated sludge wastewater treatment plants, primary clarifiers are used prior to the biological system. However, primary clarifiers may be recommended by the SBR manufacturer if the total suspended solids (TSS) or biochemical oxygen demand (BOD) are greater than 400 to 500 mg/L. Historic data should be evaluated and the SBR manufacturer consulted to determine whether primary clarifiers or equalization are recommended prior to an SBR for municipal and industrial applications.

Equalization may be required after the SBR, depending on the downstream process. If equalization is *not* used prior to filtration, the filters need to be sized in order to receive the batch of wastewater from the SBR, resulting in a large surface area required for filtration. Sizing filters to accept these "batch" flows is usually not feasible, which is why equalization is used between an SBR and downstream filtration. Separate equalization following the biological system is generally not required for most conventional activated sludge systems, because the flow is on a continuous and more constant basis.

APPLICABILITY

SBRs are typically used at flowrates of 5 MGD or less. The more sophisticated operation required at larger SBR plants tends to discourage the use of these plants for large flowrates.

As these systems have a relatively small footprint, they are useful for areas where the available land is limited. In addition, cycles within the system can be easily modified for nutrient removal in the future, if it becomes necessary. This makes SBRs extremely flexible to adapt to regulatory changes for effluent parameters such as nutrient removal. SBRs are also very cost effective if treatment beyond biological treatment is required, such as filtration.

ADVANTAGES AND DISADVANTAGES

Some advantages and disadvantages of SBRs are listed below:

Advantages

- Equalization, primary clarification (in most cases), biological treatment, and secondary clarification can be achieved in a single reactor vessel.
- Operating flexibility and control.
- Minimal footprint.
- Potential capital cost savings by eliminating clarifiers and other equipment.

Disadvantages

- A higher level of sophistication is required (compared to conventional systems), especially for larger systems, of timing units and controls.
- Higher level of maintenance (compared to conventional systems) associated with more sophisticated controls, automated switches, and automated valves.
- Potential of discharging floating or settled sludge during the DRAW or decant phase with some SBR configurations.
- Potential plugging of aeration devices during selected operating cycles, depending on the aeration system used by the manufacturer.
- Potential requirement for equalization after the SBR, depending on the downstream processes.

DESIGN CRITERIA

For any wastewater treatment plant design, the first step is to determine the anticipated influent characteristics of the wastewater and the effluent requirements for the proposed system. These influent parameters typically include design flow, maximum daily flow BOD_5, TSS, pH, alkalinity, wastewater temperature, total Kjeldahl nitrogen (TKN), ammonia-nitrogen (NH_3-N), and total phosphorus (TP). For industrial and domestic wastewater, other site specific parameters may also be required.

The state regulatory agency should be contacted to determine the effluent requirements of the proposed plant. These effluent discharge parameters will be dictated by the state in the National Pollutant Discharge Elimination System (NPDES) permit. The parameters typically permitted for municipal systems are flowrate, BOD_5, TSS, and Fecal Coliform. In addition, many states are moving toward requiring nutrient removal. Therefore, total nitrogen (TN), TKN, NH_3-N, or TP may also be required. It is imperative to establish effluent requirements because they will impact the operating sequence of the SBR. For example, if there is a nutrient requirement and NH_3-N or TKN is required, then nitrification will be necessary. If there is a TN limit, then nitrification and denitrification will be necessary.

Once the influent and effluent characteristics of the system are determined, the engineer will typically consult SBR manufacturers for a recommended design. Based on these parameters, and other site specific parameters such as temperature, key design parameters are selected for the system. An example of these parameters for a wastewater system loading is listed in Table 1.

TABLE 1 KEY DESIGN PARAMETERS FOR A CONVENTIONAL LOAD

	Municipal	Industrial
Food to Mass (F:M)	0.15 - 0.4/day	0.15 - 0.6/day
Treatment Cycle Duration	4.0 hours	4.0 - 24 hours
Typically Low Water Level Mixed Liquor Suspended Solids	2,000-2,500 mg/L	2,000 - 4,000 mg/L
Hydraulic Retention Time	6 - 14 hours	varies

Source: AquaSBR Design Manual, 1995.

Once the key design parameters are determined, the number of cycles per day, number of basins, decant volume, reactor size, and detention times can be calculated. Additionally, the aeration equipment, decanter, and associated piping can then be sized.

Other site specific information is needed to size the aeration equipment, such as site elevation above mean sea level, wastewater temperature, and total dissolved solids concentration.

The operation of an SBR is based on the fill-and-draw principle, which consists of the following five basic steps: Idle, Fill, React, Settle, and Draw. More than one operating strategy is possible during most of these steps. For industrial wastewater applications, treatability studies are typically required to determine the optimum operating sequence. For most municipal wastewater treatment plants, treatability studies are not required to determine the operating sequence because municipal wastewater flowrates and characteristic variations are usually predictable and most municipal designers will follow conservative design approaches.

The Idle step occurs between the Draw and the Fill steps, during which treated effluent is removed and influent wastewater is added. The length of the Idle step varies depending on the influent flowrate and the operating strategy. Equalization is achieved during this step if variable idle times are used. Mixing to condition the biomass and sludge wasting can also be performed during the Idle step, depending on the operating strategy.

Influent wastewater is added to the reactor during the Fill step. The following three variations are used for the Fill step and any or all of them may be used depending on the operating strategy: static fill, mixed fill, and aerated fill. During static fill, influent wastewater is added to the biomass already present in the SBR. Static fill is characterized by no mixing or aeration, meaning that there will be a high substrate (food) concentration when mixing begins. A high food to microorganisms (F:M) ratio creates an environment favorable to floc forming organisms versus filamentous organisms, which provides good settling characteristics for the sludge. Additionally, static fill conditions favor organisms that produce internal storage products during high substrate conditions, a requirement for biological phosphorus removal. Static fill may be compared to using "selector" compartments in a conventional activated sludge system to control the F:M ratio.

Mixed fill is classified by mixing influent organics with the biomass, which initiates biological reactions. During mixed fill, bacteria biologically degrade the organics and use residual oxygen or alternative electron acceptors, such as nitrate-nitrogen. In this environment, denitrification may occur under these anoxic conditions. Denitrification is the biological conversion of nitrate-nitrogen to nitrogen gas. An anoxic condition is defined as an environment in which oxygen is not present and nitrate-nitrogen is used by the microorganisms as the electron acceptor. In a conventional biological nutrient removal (BNR) activated sludge system, mixed fill is comparable to the anoxic zone which is used for denitrification. Anaerobic conditions can also be achieved during the mixed fill phase. After the microorganisms use the nitrate-nitrogen, sulfate becomes the electron acceptor. Anaerobic conditions are characterized by the lack of oxygen and sulfate as the electron acceptor.

Aerated Fill is classified by aerating the contents of the reactor to begin the aerobic reactions completed in the React step. Aerated Fill can reduce the aeration time required in the React step.

The biological reactions are completed in the React step, in which mixed react and aerated react modes are available. During aerated react, the aerobic reactions initialized during aerated fill are completed and nitrification can be achieved. Nitrification is the conversion of ammonia-nitrogen to nitrite-nitrogen and ultimately to nitrate-nitrogen. If the mixed react mode is selected, anoxic conditions can be attained to achieve denitrification. Anaerobic conditions can also be achieved in the mixed react mode for phosphorus removal.

Settle is typically provided under quiescent conditions in the SBR. In some cases, gentle mixing during the initial stages of settling may result in a clearer effluent and a more concentrated settled sludge. In an SBR, there are no influent or effluent currents to interfere with the settling process as in a conventional activated sludge system.

The Draw step uses a decanter to remove the treated effluent, which is the primary distinguishing factor between different SBR manufacturers. In general, there are floating decanters and fixed decanters. Floating decanters offer several advantages over fixed decanters as described in the Tank and Equipment Description Section.

Construction

Construction of SBR systems can typically require a smaller footprint than conventional activated sludge systems because the SBR often eliminates the need for primary clarifiers. The SBR never requires secondary clarifiers. The size of the SBR tanks themselves will be site specific, however the SBR system is advantageous if space is limited at the proposed site. A few case studies are presented in Table 2 to provide general sizing estimates at different flowrates. Sizing of these systems is site specific and these case studies do not reflect every system at that size.

TABLE 2 CASE STUDIES FOR SEVERAL SBR INSTALLATIONS

Flow	Reactors			Blowers	
(MGD)	No.	Size (feet)	Volume (MG)	No.	Size (HP)
0.012	1	18 x 12	0.021	1	15
0.10	2	24 x 24	0.069	3	7.5
1.2	2	80 x 80	0.908	3	125
1.0	2	58 x 58	0.479	3	40
1.4	2	69 x 69	0.678	3	60
1.46	2	78 x 78	0.910	4	40
2.0	2	82 x 82	0.958	3	75
4.25	4	104 x 80	1.556	5	200
5.2	4	87 x 87	1.359	5	125

Note: These case studies and sizing estimates were provided by Aqua-Aerobic Systems, Inc. and are site specific to individual treatment systems.

The actual construction of the SBR tank and equipment may be comparable or simpler than a conventional activated sludge system. For Biological Nutrient Removal (BNR) plants, an SBR eliminates the need for return activated sludge (RAS) pumps and pipes. It may also eliminate the need for internal Mixed Liquor Suspended Solid (MLSS) recirculation, if this is being used in a conventional BNR system to return nitrate-nitrogen.

The control system of an SBR operation is more complex than a conventional activated sludge system and includes automatic switches, automatic valves, and instrumentation. These controls are very sophisticated in larger systems. The SBR manufacturers indicate that most SBR installations in the United States are used for smaller wastewater systems of less than two million gallons per day (MGD) and some references recommend SBRs only for small communities where land is limited. This is not always the case, however, as the largest SBR in the world is currently a 10 MGD system in the United Arab Emirates.

Tank and Equipment Description

The SBR system consists of a tank, aeration and mixing equipment, a decanter, and a control system. The central features of the SBR system include the control unit and the automatic switches and valves that sequence and time the different operations. SBR manufacturers should be consulted for recommendations on tanks and equipment. It is typical to use a complete SBR system recommended and supplied by a single SBR manufacturer. It is possible, however, for an engineer to design an SBR system, as all required tanks, equipment, and controls are available through different manufacturers. This is not typical of SBR installation because of the level of sophistication of the instrumentation and controls associated with these systems.

The SBR tank is typically constructed with steel or concrete. For industrial applications, steel tanks coated for corrosion control are most common while concrete tanks are the most common for municipal treatment of domestic wastewater. For mixing and aeration, jet aeration systems are typical as they allow mixing either with or without aeration, but other aeration and mixing systems are also used. Positive displacement blowers are typically used for SBR design to handle wastewater level variations in the reactor.

As previously mentioned, the decanter is the primary piece of equipment that distinguishes different SBR manufacturers. Types of decanters include floating and fixed. Floating decanters offer the advantage of maintaining the inlet orifice slightly below the water surface to minimize the removal of solids in the effluent removed during the DRAW step. Floating decanters also offer the operating flexibility to vary fill-and-draw volumes. Fixed decanters are built into the side of the basin and can be used if the Settle step is extended. Extending the Settle step minimizes the chance that solids in the wastewater will float over the fixed decanter. In some cases, fixed decanters are less expensive and can be designed to allow the operator to lower or raise the level of the decanter. Fixed decanters do not offer the operating flexibility of the floating decanters.

Health and Safety

Safety should be the primary concern in every design and system operation. A properly designed and operated system will minimize potential health and safety concerns. Manuals such as the Manual of Practice (MOP) No. 8, Design of Municipal Wastewater Treatment Plants, and MOP No. 11, Operation of Municipal Wastewater Treatment Plants should be consulted to minimize these risks. Other appropriate industrial wastewater treatment manuals, federal regulations, and state regulations should also be consulted for the design and operation of wastewater treatment systems.

PERFORMANCE

The performance of SBRs is typically comparable to conventional activated sludge systems and depends on system design and site specific criteria. Depending on their mode of operation, SBRs can achieve good BOD and nutrient removal. For SBRs, the BOD removal efficiency is generally 85 to 95 percent.

SBR manufacturers will typically provide a process guarantee to produce an effluent of less than:

- 10 mg/L BOD
- 10 mg/L TSS
- 5 - 8 mg/L TN
- 1 - 2 mg/L TP

OPERATION AND MAINTENANCE

The SBR typically eliminates the need for separate primary and secondary clarifiers in most municipal systems, which reduces operations and maintenance requirements. In addition, RAS pumps are not required. In conventional biological nutrient removal systems, anoxic basins, anoxic zone mixers, toxic basins, toxic basin aeration equipment, and internal MLSS nitrate-nitrogen recirculation pumps may be necessary. With the SBR, this can be accomplished in one reactor using aeration/mixing equipment, which will minimize operation and maintenance requirements otherwise be needed for clarifiers and pumps.

Since the heart of the SBR system is the controls, automatic valves, and automatic switches, these systems may require more maintenance than a conventional activated sludge system. An increased level of sophistication usually equates to more items that can fail or require maintenance. The level of sophistication may be very advanced in larger SBR wastewater treatment plants requiring a higher level of maintenance on the automatic valves and switches.

Significant operating flexibility is associated with SBR systems. An SBR can be set up to simulate any conventional activated sludge process, including BNR systems. For example, holding times in the Aerated React mode of an SBR can be varied to achieve simulation of a contact stabilization system with a typical hydraulic retention time (HRT) of 3.5 to 7 hours or, on the other end of the spectrum, an extended aeration treatment system with a typical HRT of 18 to 36 hours. For a BNR plant, the aerated react mode (oxic conditions) and the mixed react modes (anoxic conditions) can be alternated to achieve nitrification and denitrification. The mixed fill mode and mixed react mode can be used to achieve denitrification using anoxic conditions. In addition, these modes can ultimately be used to achieve an anaerobic condition where phosphorus removal can occur. Conventional activated sludge systems typically require additional tank volume to achieve such flexibility. SBRs operate in time rather than in space and the number of cycles per day can be varied to control desired effluent limits, offering additional flexibility with an SBR.

COSTS

This section includes some general guidelines as well as some general cost estimates for planning purposes. It should be remembered that capital and construction cost estimates are site-specific.

Budget level cost estimates presented in Table 3 are based on projects that occurred from 1995 to 1998. Budget level costs include such as the blowers, diffusers, electrically operated valves, mixers, sludge pumps, decanters, and the control panel. All costs have been updated to March 1998 costs, using an ENR construction cost index of 5875 from the March 1998 Engineering News Record, rounded off to the nearest thousand dollars.

TABLE 3 SBR EQUIPMENT COSTS BASED ON DIFFERENT PROJECTS

Design Flowrate (MGD)	Budget Level Equipment Costs ($)
0.012	94,000
0.015	137,000
1.0	339,000
1.4	405,000
1.46	405,000
2.0	564,000
4.25	1,170,000

Source: Aqua Aerobics Manufacturer Information, 1998.

In Table 4, provided a range of equipment costs for different design flowrates is provided.

TABLE 4 BUDGET LEVEL EQUIPMENT COSTS BASED ON DIFFERENT FLOW RATES

Design Flowrate (MGD)	Budget Level Equipment Costs ($)
1	150,000 - 350,000
5	459,000 - 730,000
10	1,089,000 - 1,370,000
15	2,200,000
20	2,100,000 - 3,000,000

Note: Budget level cost estimates provided by Babcock King - Wilkinson, L.P., August 1998.

Again the equipment cost items provided do not include the cost for the tanks, sitework, excavation/backfill, installation, contractor's overhead and profit, or legal, administrative, contingency, and engineering services. These items must be included to calculate the overall construction costs of an SBR system. Costs for other treatment processes, such as screening, equalization, filtration, disinfection, or aerobic digestion, may be included if required.

The ranges of construction costs for a complete, installed SBR wastewater treatment system are presented in Table 5. The variances in the estimates are due to the type of sludge handling facilities and the differences in newly constructed plants versus systems that use existing plant facilities. As such, in some cases these estimates include other processes required in an SBR wastewater treatment plant.

TABLE 5 INSTALLED COST PER GALLON OF WASTEWATER TREATED

Design Flowrate (MGD)	Budget Level Equipment Cost ($/gallon)
0.5 - 1.0	1.96 - 5.00
1.1 - 1.5	1.83 - 2.69
1.5 - 2.0	1.65 - 3.29

Note: Installed cost estimates obtained from Aqua-Aerobics Systems, Inc., August 1998.

There is typically an economy of scale associated with construction costs for wastewater treatment, meaning that larger treatment plants can usually be constructed at a lower cost per gallon than smaller systems. The use of common wall construction for larger treatment systems, which can be used for square or rectangular SBR reactors, results in this economy of scale.

Operations and Maintenance (O&M) costs associated with an SBR system may be similar to a conventional activated sludge system. Typical cost items associated with wastewater treatment systems include labor, overhead, supplies, maintenance, operating administration, utilities, chemicals, safety and training, laboratory testing, and solids handling. Labor and maintenance requirements may be reduced in SBRs because clarifiers, clarification equipment, and RAS pumps may not be necessary. On the other hand, the maintenance requirements for the automatic valves and switches that control the sequencing may be more intensive than for a conventional activated sludge system. O&M costs are site specific and may range from $800 to $2,000 dollars per million gallons treated.

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12. U.S. EPA. EPA Design Manual, Summary Report *Sequencing Batch Reactors.* EPA/625/8-86/011, August 1986.

13. Manual of Practice (MOP) No. 8, Design of Municipal Wastewater Treatment Plants,

14. Manual of Practice (MOP) No. 11, Operation of Municipal Wastewater Treatment Plants.

ADDITIONAL INFORMATION

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Stockbridge, GA 30281

Gary Hooder, Operator
Martinsburg WWTP
133 East Allegheny
Martinsburg, PA 16662-1112

Mitchell Meadows, Lead Operator
1300 Recker Highway
Auburndale, FL 33823

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Antrim TWP
P.O. Box 130
Greencastle, PA 17225

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Blountstown WWTP
125 West Central Avenue
Blountstown, FL 32424

For more information contact:

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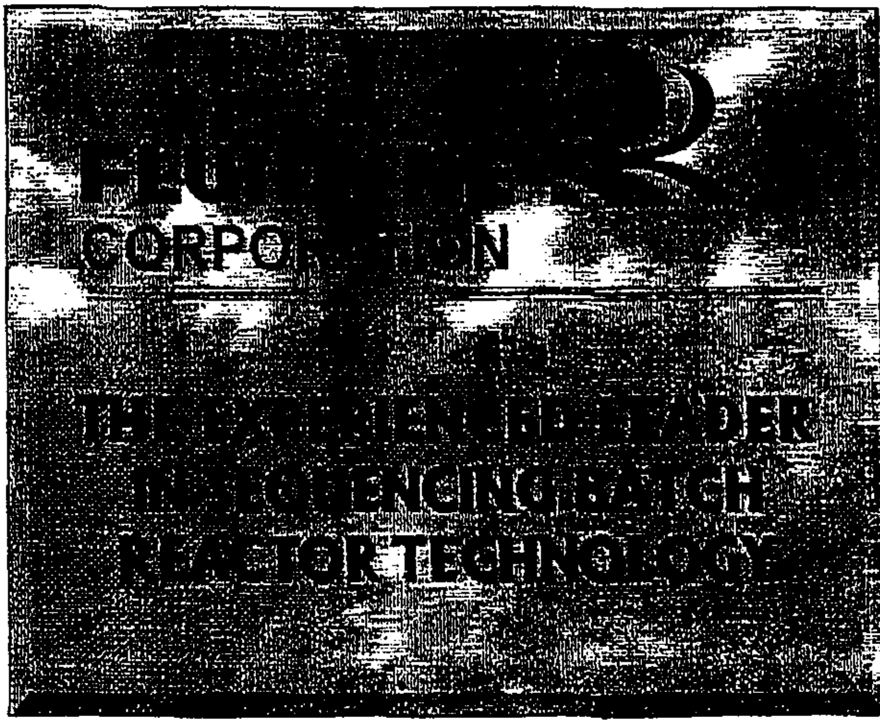
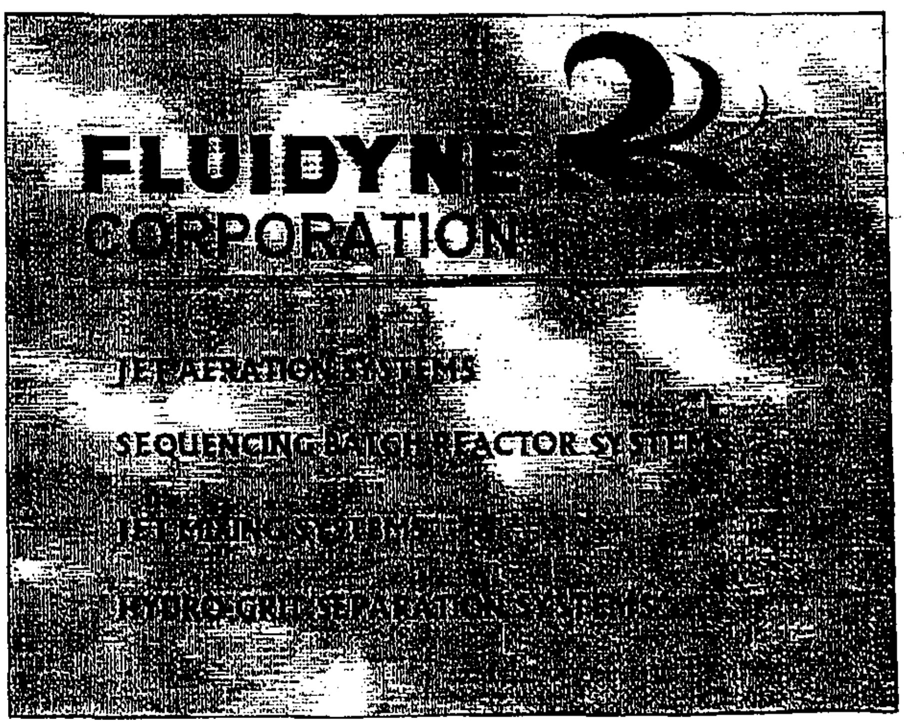
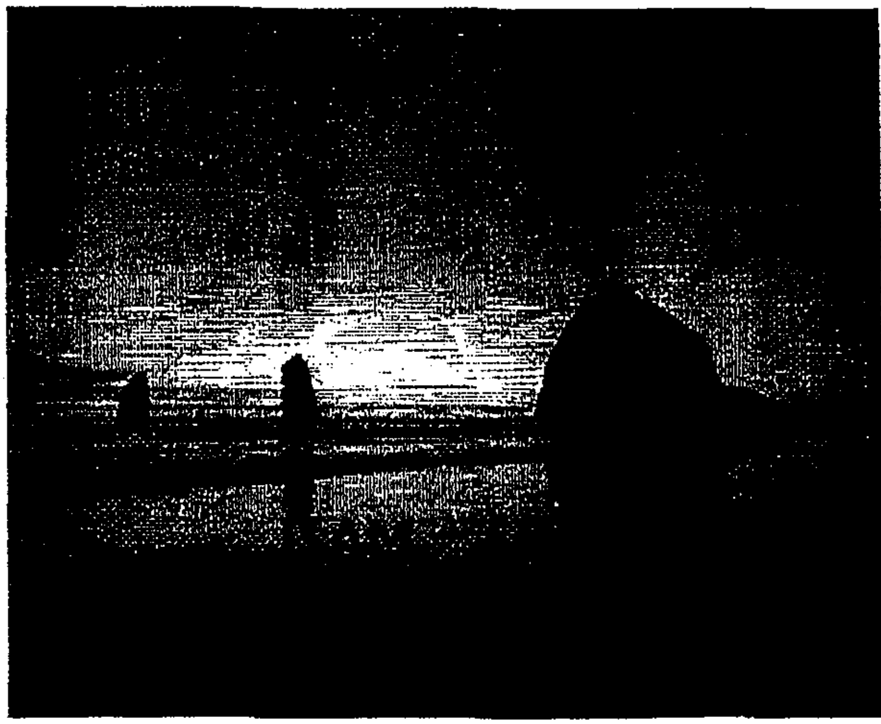
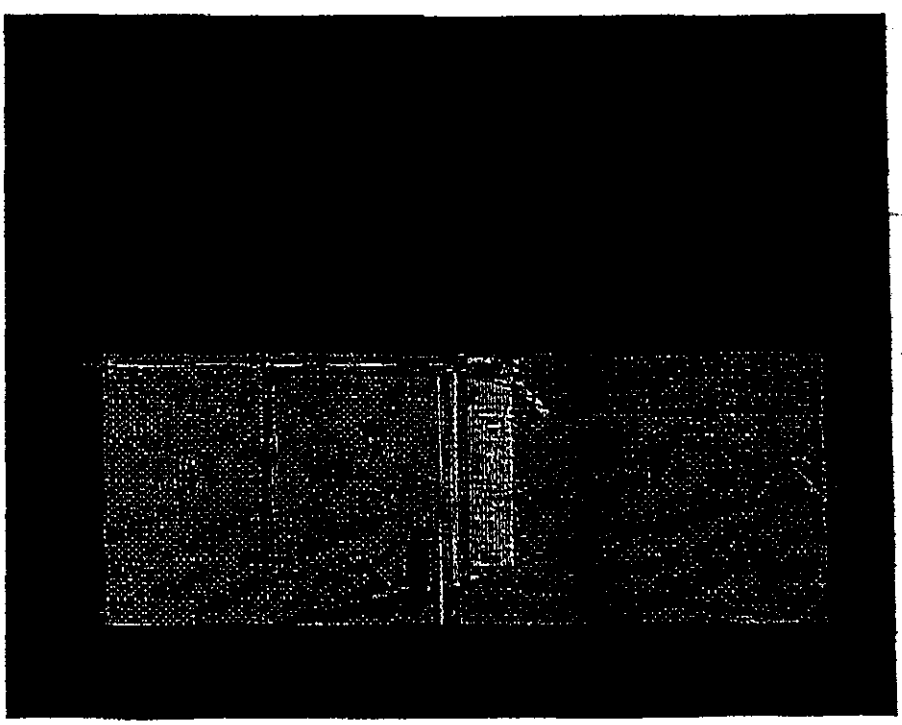
U.S. EPA
Mail Code 4204
401 M St., S.W.
Washington, D.C., 20460

OWM MTB
excellence in compliance through optimal technical solutions
MUNICIPAL TECHNOLOGY BRANCH


CORPORATION
REACTOR TECHNOLOGY


FLUIDYNE
CORPORATION
SEQUENCING BATCH REACTOR SYSTEMS





ISAM™ Sequencing Batch Reactor

Fill Phase: When the level in the SAM™ reactor reaches a preset [illegible] set point, the motive liquid pump is started. SBR basin is filled and mixed. A [illegible] percentage of the pumped flow is recycled to the Anaerobic Chamber where heavier solids settle. Recycle flow is [illegible] to maintain desired MLSS concentration in SBR. Solids in Anaerobic Chamber are digested.

ISAM™ Sequencing Batch Reactor

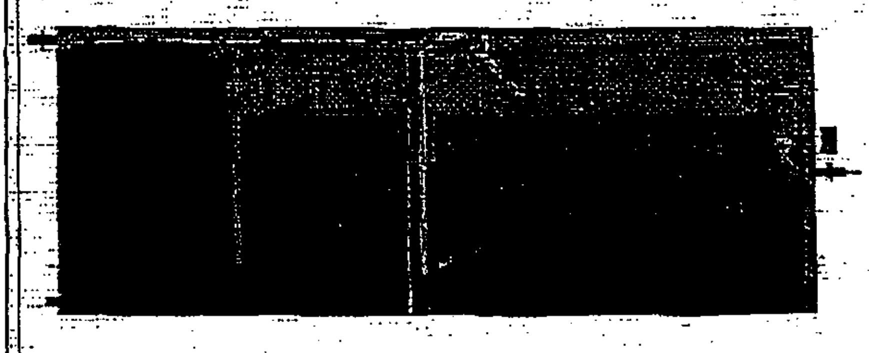
[illegible] Phase: When the level in the SBR basin reaches [illegible] overflows the [illegible] chamber weir, and is returned to the SAM™ reactor through the [illegible] the SAM™ reactor. A settable percentage of the pumped flow is recycled to the Anaerobic Chamber where heavier solids settle. Recycle flow is [illegible] to maintain desired MLSS concentration in SBR. [illegible] and off to provide [illegible] aeration. Sludge is removed from SBR [illegible] Anaerobic Chamber are digested.

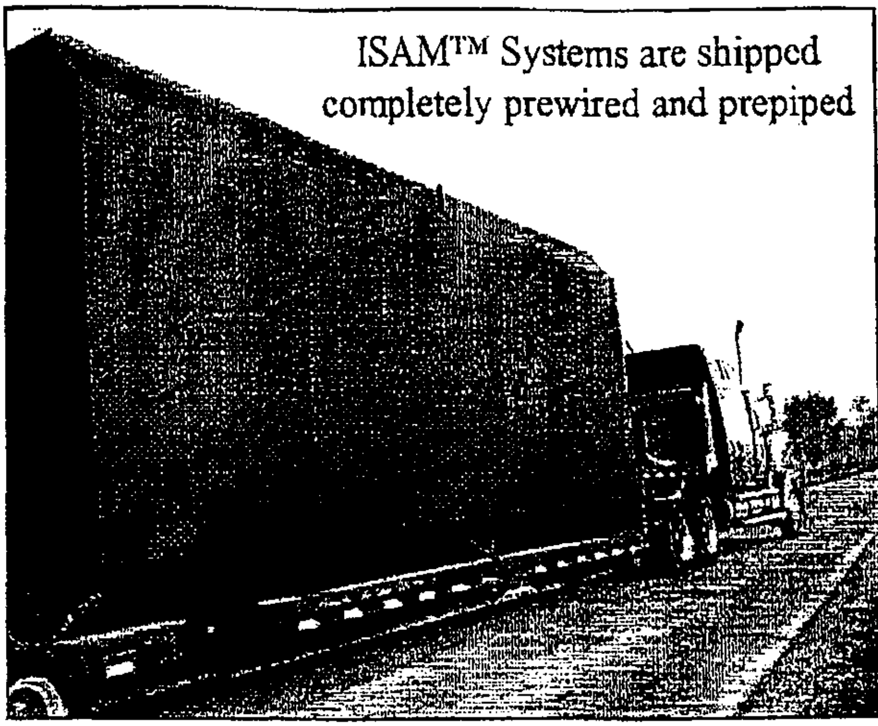
ISAM™ Sequencing Batch Reactor

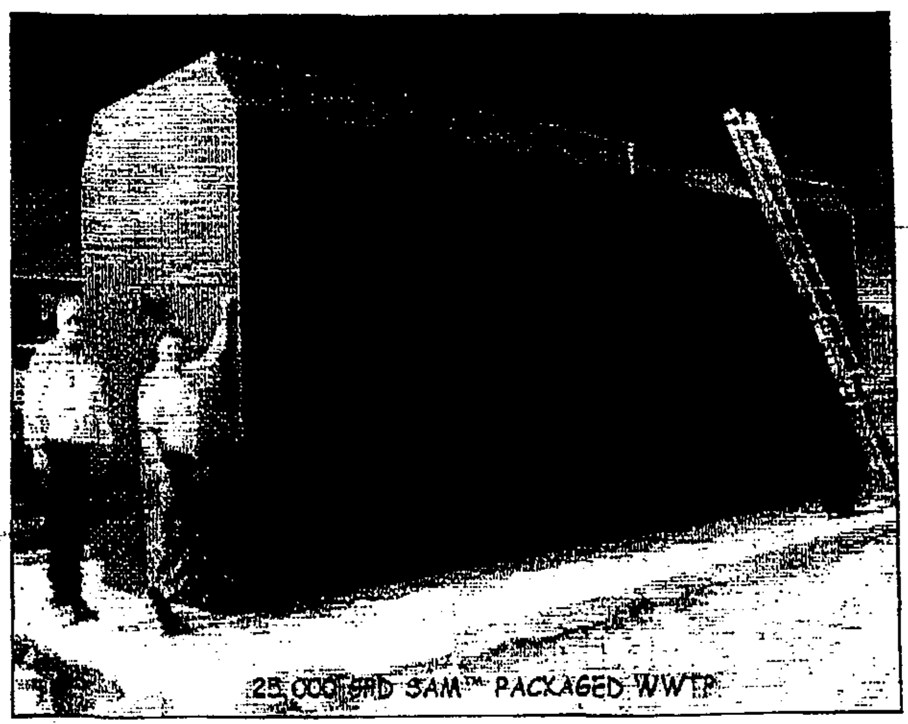
Settle Phase: When the SAM™ reactor reaches a preselected level, aeration is discontinued, and the SBR basin settles under perfect quiescent conditions. Solids in Anaerobic Chamber are digested.

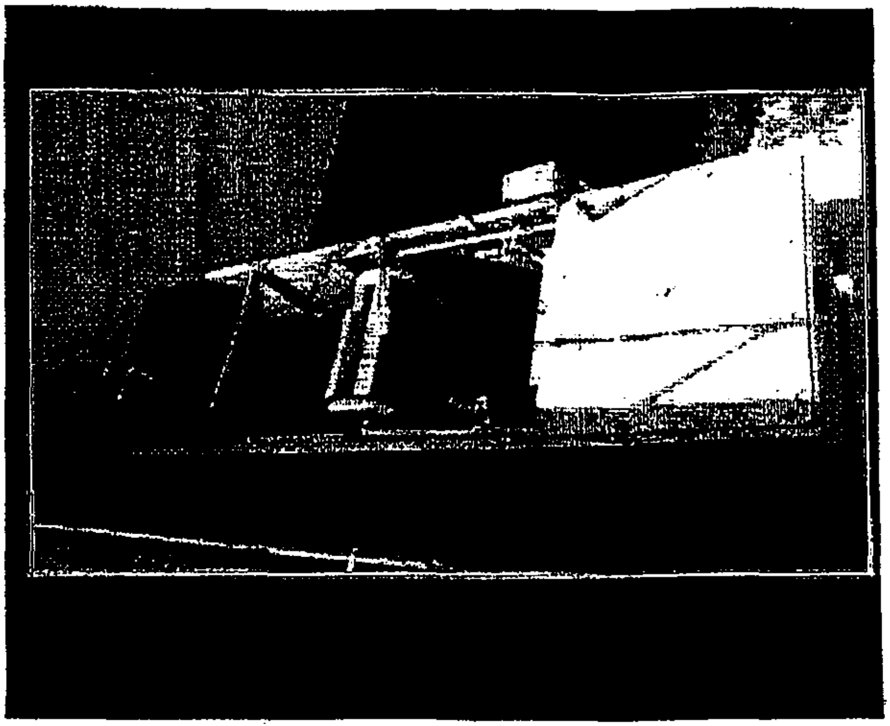
ISAM™ Sequencing Batch Reactor

Decant Phase: When the Settle time value is reached, the decant valve is opened and treated effluent is withdrawn from the upper portion of the reactor.




ISAM™ Systems are shipped
completely prewired and prepiped


25,000 GPD SAM™ PACKAGED WWTP



WASTEWATER TREATMENT FACILITY
VOLUSIA COUNTY SOLID WASTE TRANSFER STATION
PRE-TREATMENT SYSTEM

Parameter	Design Influent (mg/L)	Design Effluent (mg/L)	Actual Effluent (mg/L)
$CBOD_5$	3,200	180	4.1
TSS	700	220	7.0

Parameter	Monthly Avg.	Weekly Avg	Actual
$CBOD_5$	10.0 mg/l	15.0 mg/l	< 5.0 mg/l
TSS	10.0 mg/l	15.0 mg/l	< 5.0 mg/l
Ammonia Nitrogen			
Summer	1.2 mg/l	2.9 mg/l	< 1.0 mg/l
Interim Winter	1.6 mg/l	2.4 mg/l	< 1.0 mg/l
Final Winter	1.3 mg/l	3.1 mg/l	< 1.0 mg/l

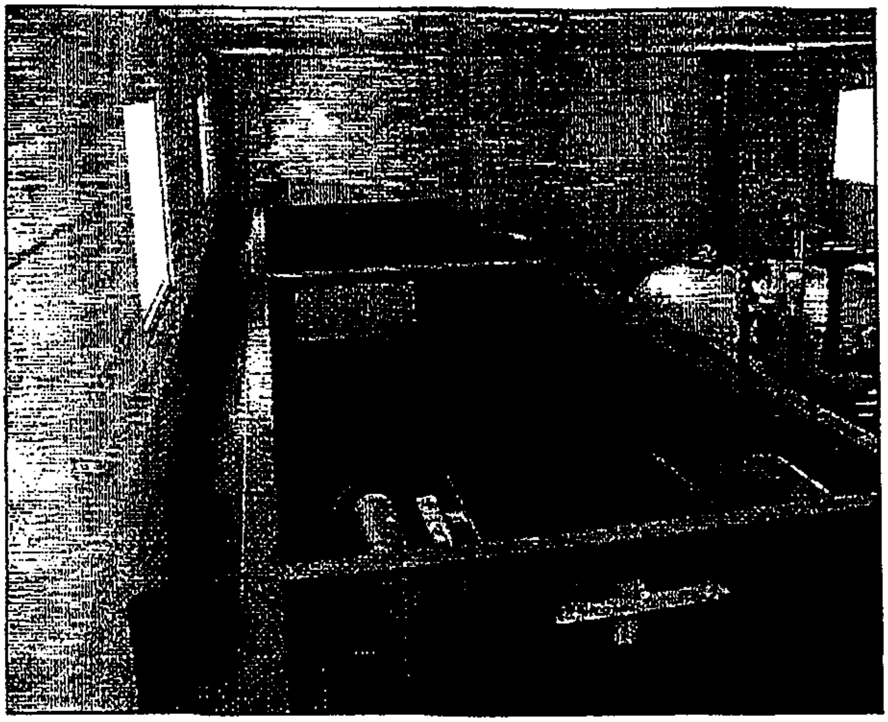
BARONA, CA SAM™ SBR

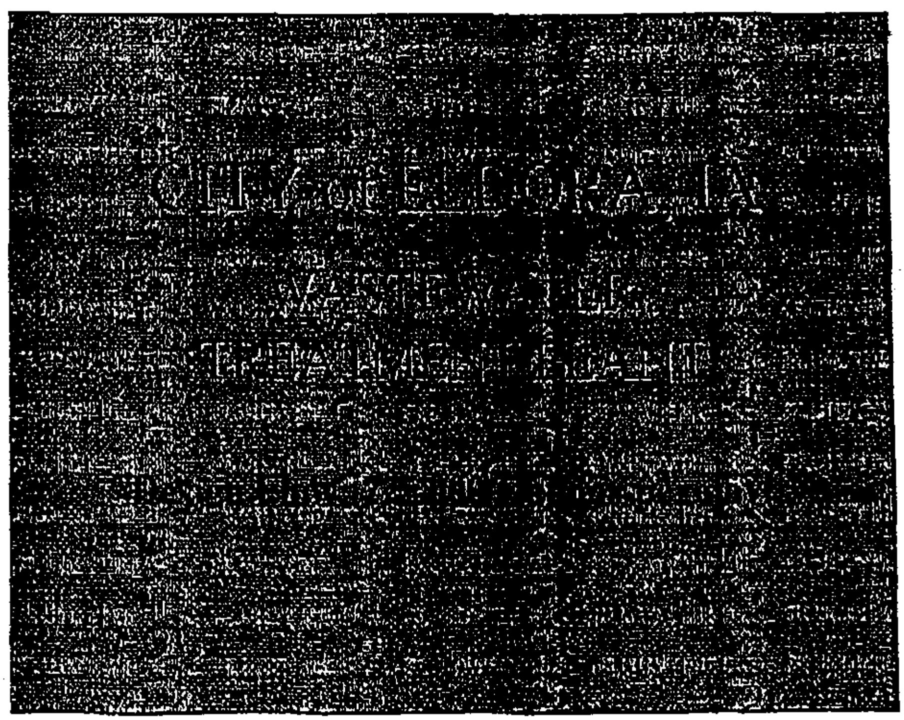
INFLUENT

Date	BOD	TSS	TKN	NH_3	FOG
4/12/00	1,540	770		15	262
[illegible]	1,000	261		50	
[illegible]	1,800	1,452		72	
[illegible]	884	288		47	
[illegible]	834	347		42	
[illegible]	1,102	704		48	
[illegible]	288	333	106	68	120
8/16/00	1,340	533	111	42	179
[illegible]	1,500	387	102	34	257
[illegible]	800	312	109	78	138
10/4/00	1,014	797	88	38	252
[illegible]	1,100	487	111	71	178
11/8/00	1,320	1,130	117	52	121
11/22/00	3,000	606	88	47	280
[illegible]	1,314	1,180	103	38	197
[illegible]	380	324	107	41	209
[illegible]	4,000	1,500	97	37	243
[illegible]	700	208	100	34	38
[illegible]	818	184	51	34	73
[illegible]	1,428	328	103	35	100
[illegible]	1,298	486	98	34	183
[illegible]	978	570	40	28	245
[illegible]	1,070	191	82	13	169
[illegible]	1,600	1,400	84	31	
AVERAGE	1,176	641	98	43	184

EFFLUENT

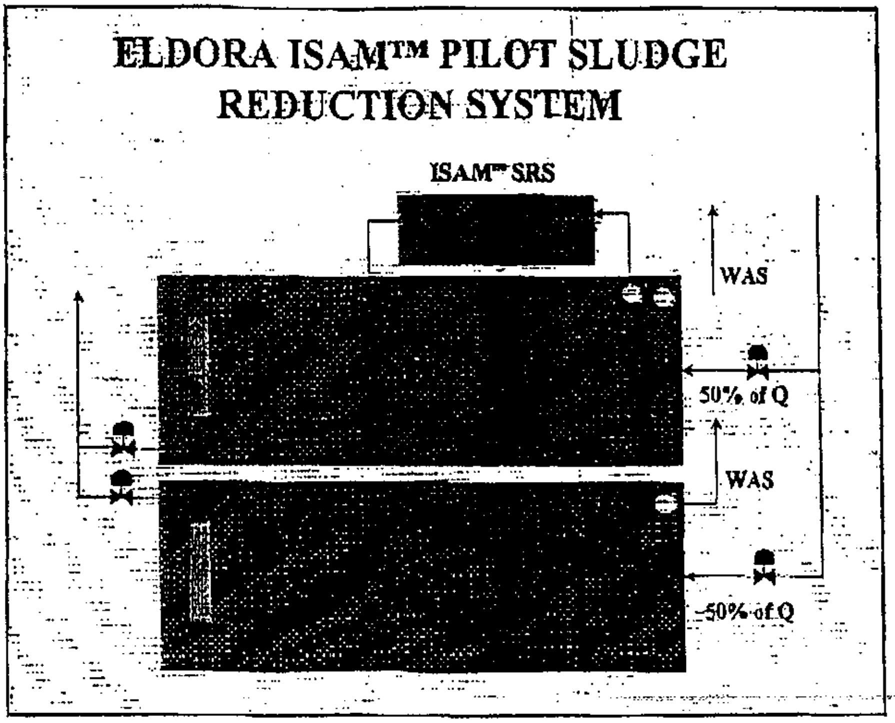
Date	BOD	TSS	NH_3	NO_3	NO_2	TN	COD
4/12/00	5.00	ND	0.20	1.40	0.02	[illegible]	[illegible]
[illegible]	15.00	17.00	0.70	1.00		[illegible]	[illegible]
[illegible]	6.00	3.00	0.80	1.30		[illegible]	[illegible]
[illegible]	1.00	1.00	0.30			[illegible]	[illegible]
[illegible]	4.00	4.00	0.10	1.50		[illegible]	[illegible]
[illegible]	6.00	2.00		1.60	ND	[illegible]	[illegible]
[illegible]	5.00	1.00	0.20	0.20	ND	[illegible]	[illegible]
8/16/00	4.00	2.00	ND	0.20	ND	1.80	[illegible]
[illegible]	6.00	1.00	ND	0.60	ND	[illegible]	[illegible]
[illegible]	7.00	ND	ND	0.90	ND	[illegible]	[illegible]
10/4/00	10.00	ND	ND	0.80	ND	ND	[illegible]
[illegible]	10.00	ND	0.30	2.20	ND	1.70	[illegible]
11/8/00	2.00	2.00		1.30	0.02	[illegible]	ND
11/22/00	5.00	ND	ND	3.00	0.14	[illegible]	[illegible]
[illegible]	3.00	ND	ND	0.19	ND	[illegible]	[illegible]
[illegible]	2.90	ND	0.11	2.03	ND	[illegible]	[illegible]
[illegible]	6.20	ND	ND	0.40	ND	[illegible]	[illegible]
[illegible]	3.30	ND	ND	0.86	ND	[illegible]	[illegible]
[illegible]	3.70	4.00	ND	0.01	ND	[illegible]	[illegible]
[illegible]	3.80	1.00	ND	0.45	ND	[illegible]	[illegible]
[illegible]	3.40	ND	ND	0.16	ND	[illegible]	[illegible]
[illegible]	3.40	ND	ND	0.50	ND	[illegible]	[illegible]
[illegible]	ND	ND	ND	1.00	ND	[illegible]	[illegible]
[illegible]	2.40	1.10	ND	2.40	ND	[illegible]	[illegible]
AVERAGE	5.20	1.83	0.12	1.23	0.01	[illegible]	[illegible]

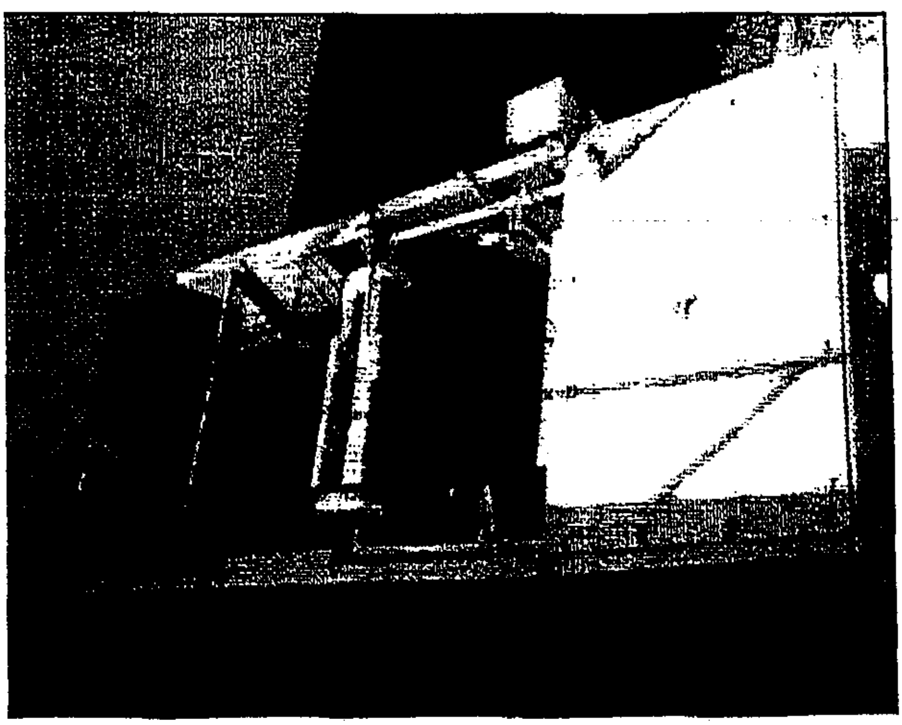



CITY of ELDORA, IA
WASTEWATER
TREATMENT PLANT

City of Eldora : SBR SLUDGE PRODUCTION

Date	Gallons Treated	Waste Activated Sludge, GPD			(WAS/Gal)
	GPD	I	II	I + II	%
30	144,000	1,000	800	1,800	1.25
29	252,000	1,500	2,000	3,500	1.39
28	180,000	1,500	1,200	2,700	1.50
27	180,000	1,100	1,200	2,300	1.28
26	180,000	1,800	1,200	3,000	1.67
25	180,000	1,300	2,000	3,300	1.83
24	180,000	200	1,600	1,800	1.00
23	180,000	1,400	2,400	3,800	2.11
22	180,000	2,200	2,700	4,900	2.72
21	180,000	1,600	2,700	4,300	2.38
20	216,000	2,400	2,800	5,200	2.41
19	216,000	2,400	3,000	5,400	2.50
18	144,000	1,600	1,800	3,400	2.36
17	216,000	200	2,700	2,900	1.34
16	144,000	1,600	1,800	3,400	2.36
15	180,000	2,400	1,120	3,520	1.96
14	180,000	1,600	2,400	4,000	2.22
13	216,000	2,500	2,300	4,800	2.22
12	288,000	3,600	2,800	6,400	2.22
11	252,000	3,600	2,100	5,700	2.26
10	288,000	3,600	2,800	6,400	2.22
9	288,000	3,600	2,800	6,400	2.22
9	324,000	3,600	3,500	7,100	2.19
7	288,000	3,600	2,800	6,400	2.22
6	288,000	360	3,000	3,360	1.17
5	288,000	4,000	2,800	6,800	2.36
4	288,000	400	3,600	4,000	1.39
3	252,000	4,400	3,000	7,400	2.94
2	252,000	3,300	4,000	7,300	2.90
1	288,000	440	3,500	3,940	1.37
TOTAL	**6,732,000**	**62,800**	**72,420**	**135,220**	**59.97**
AVERAGE	**224,400**	**2,093**	**2,414**	**4,507**	**2.00**

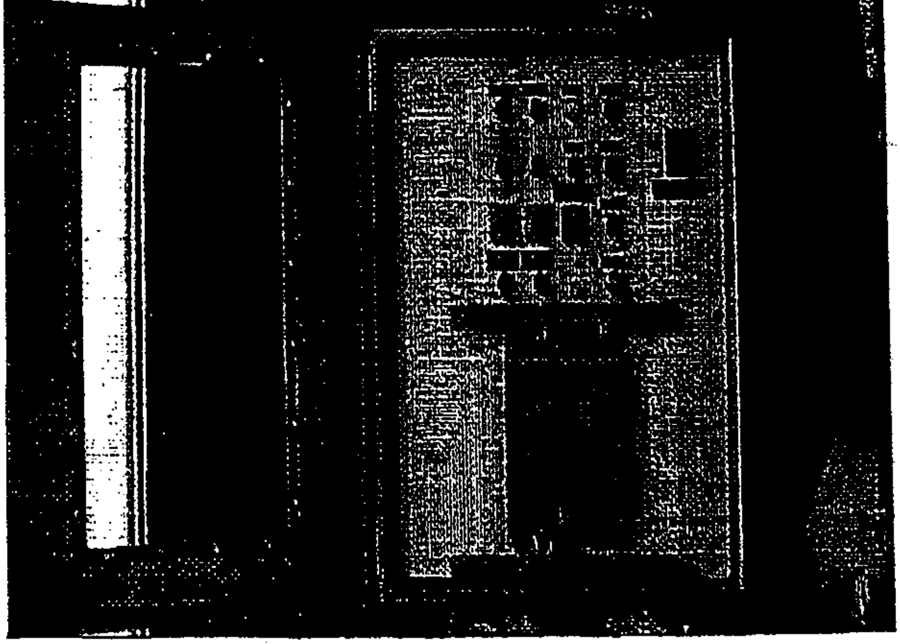

ELDORA ISAM™ PILOT SLUDGE REDUCTION SYSTEM
ISAM™ SRS
WAS
50% of Q
WAS
50% of Q



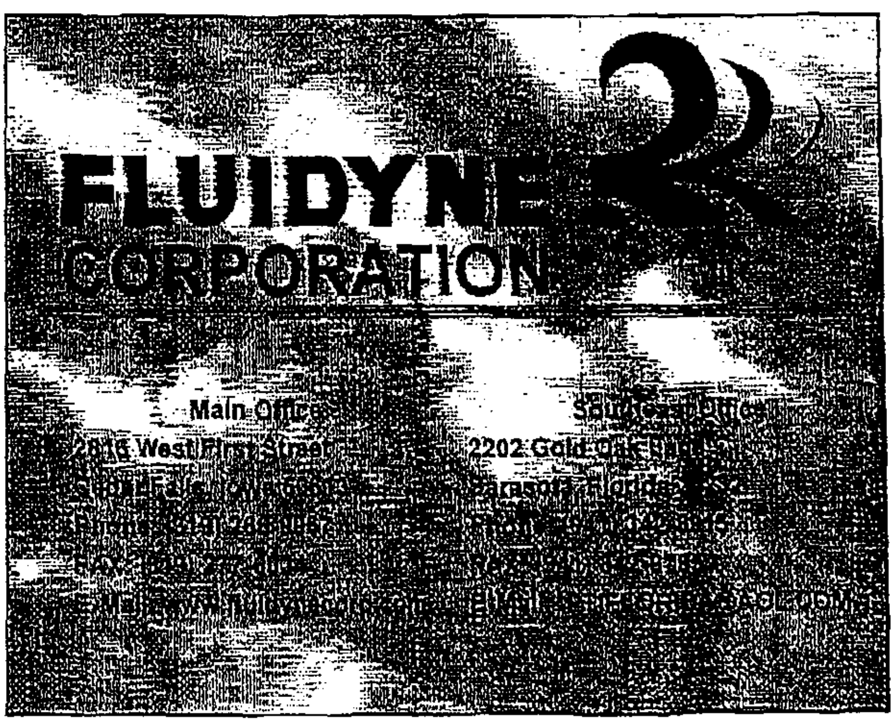
ELDORA SLUDGE WASTED WITH ISAM™ PILOT UNIT

DATE	SBR 1 WAS (gpd)	SBR 2 WAS (gpd)	SBR 1 MLSS (lbs.)	SBR 2 MLSS (lbs.)
08/14/1999	900	1800	1862	2031
08/15/1999	500	2000		
08/16/1999	300	1200		
08/17/1999	300	1200	2188	2356
08/18/1999	400	1200		
08/19/1999	300	1200	2331	2442
08/20/1999	300	1600		
08/21/1999	300	1200	2398	2700
08/22/1999	300	1600		
08/23/1999	300	1800		
08/24/1999	400	2400	2965	2525
08/25/1999	1600	1800		
08/26/1999	900	1800	2734	2689
AVERAGE	*523*	*1600*	*2413*	*2457*

ISAM™ CONTROL PANEL

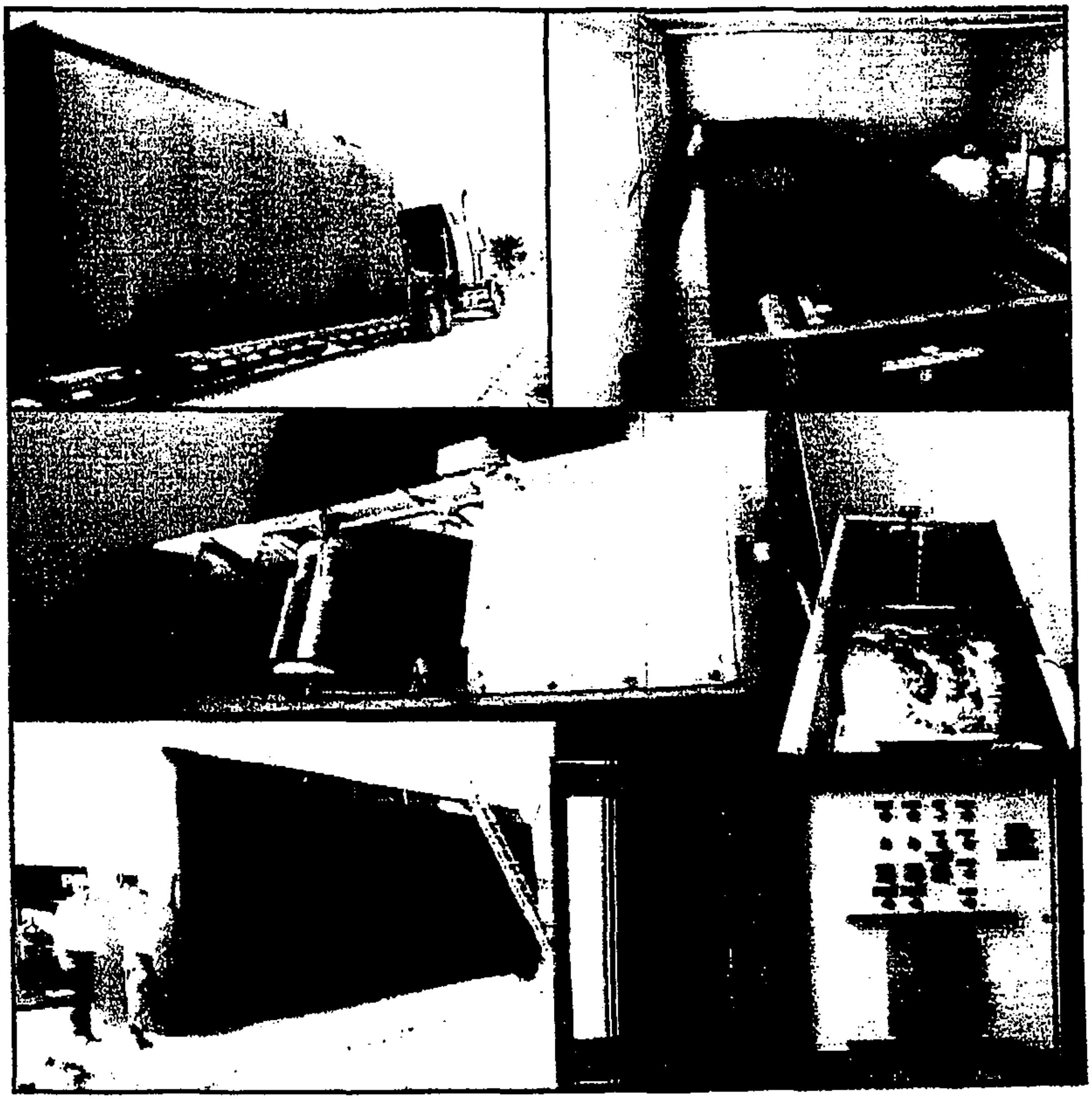



Jet Aspirator Nozzles


FLUIDYNE
CORPORATION
Main Office

FLUIDYNE CORPORATION

THE EXPERIENCED LEADER IN SEQUENCING BATCH REACTOR TECHNOLOGY



ISAM™

SEQUENCING BATCH REACTOR PROCESS

FLUIDYNE CORPORATION

THE EXPERIENCED LEADER IN SEQUENCING BATCH REACTOR TECHNOLOGY

TRUST FLUIDYNE'S EXPERIENCE

The Fluidyne ISAM™ Sequencing Batch Reactor (SBR) system incorporates the latest technology and two decades of experience in providing the most reliable system with the highest effluent quality. Fluidyne SBR systems have operated around the World and won numerous awards including the 1997 USEPA Grand Award for the best operated and maintained WWTP in the Nation in the Large, Non-Discharging (water reclamation) category for the Bartow, Florida plant. Fluidyne SBRs consistently provide better than 10/10/5/1 (BOD5/TSS/N/TP) effluent quality. The Bartow plant has consistently produced better than 3/3/3/1 effluent quality.

A TOTALLY NEW CONCEPT IN SBR DESIGN

The Fluidyne ISAM™ Sequencing Batch Reactor system is a single train SBR system which incorporates a constant level anaerobic selector chamber, followed by a surge/anoxic/mix (SAM™) tank , and one or more SBR basins.

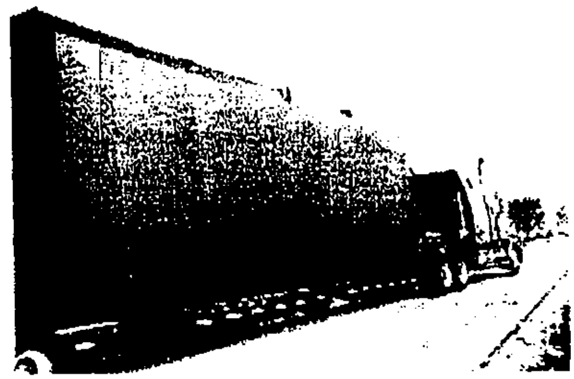
In operation, all influent flow enters the anaerobic basin where influent solids are allowed to settle much like a primary clarifier. Elimination of primary solids in the anaerobic basin allows for much smaller SBR basins at equivalent SRT than conventional SBRs. The anaerobic selector also creates soluble carbon as a food source for biological nutrient removal through anaerobic conversion of settleable BOD to soluble BOD.

The influent then flows to the SAM™ surge basin, or influent equalization basin. The surge basin provides flow and nutrient equalization to optimize treatment at the full range of flows and loadings.

Several unique feature of the Fluidyne ISAM™ SBR include odor control and scum skimming. Mixed liquor is maintained in the SAM™ tank to immediately react with incoming flow from the anaerobic chamber to suppress odors and initiate and accelerate carbon and nitrogen reactions. Mixed liquor is recycled from the top of the SBR tank effectively removing scum by use of proprietary flow and scum control system. In addition, nitrates are recycled to the SAM™ tank for effective and rapid denitrification. Denitrification reactions are accelerated in the presence of the unreacted carbon from the raw sewage entering the SAM™ tank. Aeration and energy requirements are reduced as nitrates are fully reduced to nitrogen gas in the SAM™ tank.

FLUIDYNE PREPACKAGED SBRS

The Fluidyne prepackaged ISAM™ SBR is available for average influent flows from 1,000 GPD to 50,000 GPD. Each unit is shipped complete; prewired and prepiped.



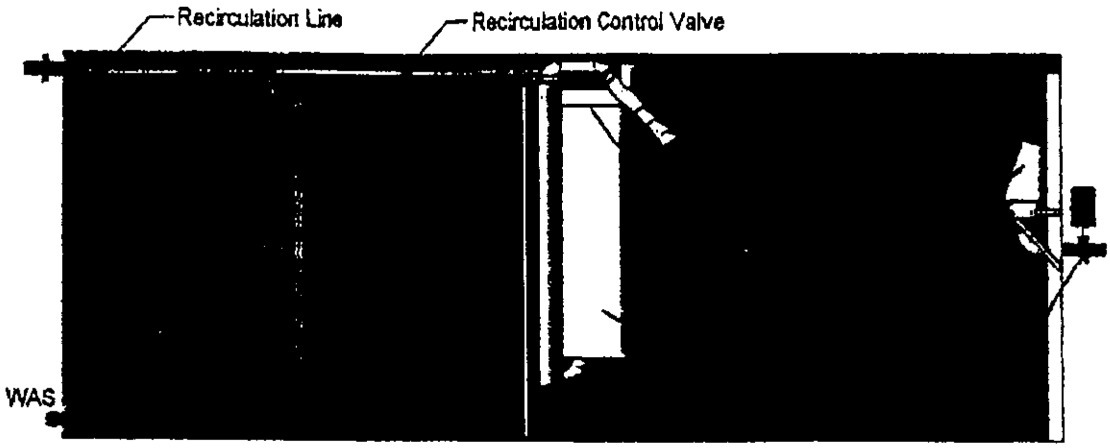
100% ON-LINE STANDBY EQUIPMENT

Fluidyne's prepackaged ISAM™ SBRs are furnished with spare mixing/fill pump and aerator assembly installed for 100% redundancy.

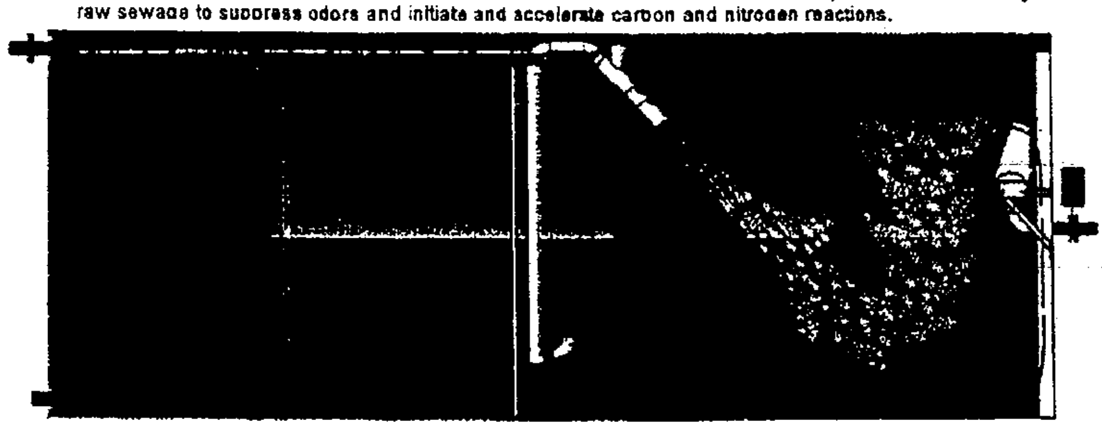
REDUCES WASTE SLUDGE BY 75%

The Fluidyne ISAM™ Sequencing Batch Reactor incorporates an anaerobic selector chamber with the SAM™ SBR. The anaerobic selector not only provides consistent phosphorous removal by subjecting the recirculated biomass to anaerobic conditions, forcing the release of phosphorous, but also creates soluble carbon as a food source for phosphorous removal through anaerobic conversion of settleable BOD to soluble BOD. Additionally, anaerobic sludge digestion occurs in the anaerobic selector chamber, reducing waste solids production by up to 75% for the entire secondary process.

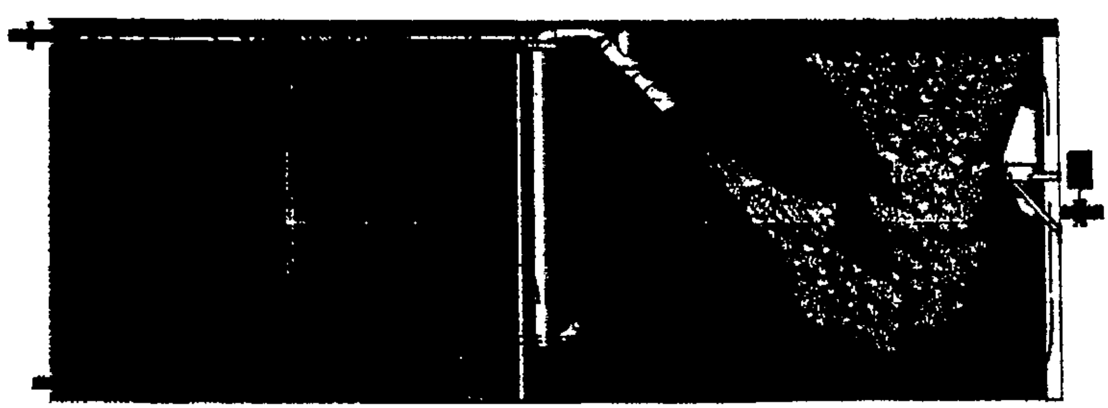
FLUIDYNE CORPORATION



System Components: Influent flow enters the Anaerobic Chamber where influent solids settle much like a primary clarifier. Settable BOD is converted to soluble BOD. The influent then flows to the SAM™ Reactor. Mixed liquor is maintained in the SAM™ Reactor to immediately react with incoming raw sewage to suppress odors and initiate and accelerate carbon and nitrogen reactions.

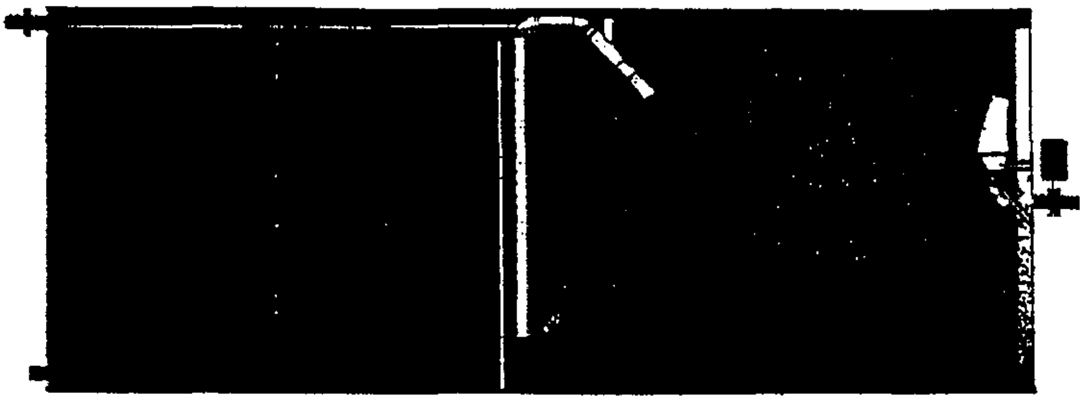


Fill Phase: When the level in the SAM™ Reactor reaches a predetermined set point, the motive liquid pump is started. SBR basin is filled and mixed. A variable percentage of the pumped flow is recycled to the Anaerobic Chamber where heavier solids settle. Recycle flow is varied to maintain desired MLSS concentration in SBR. Solids in Anaerobic Chamber are digested.

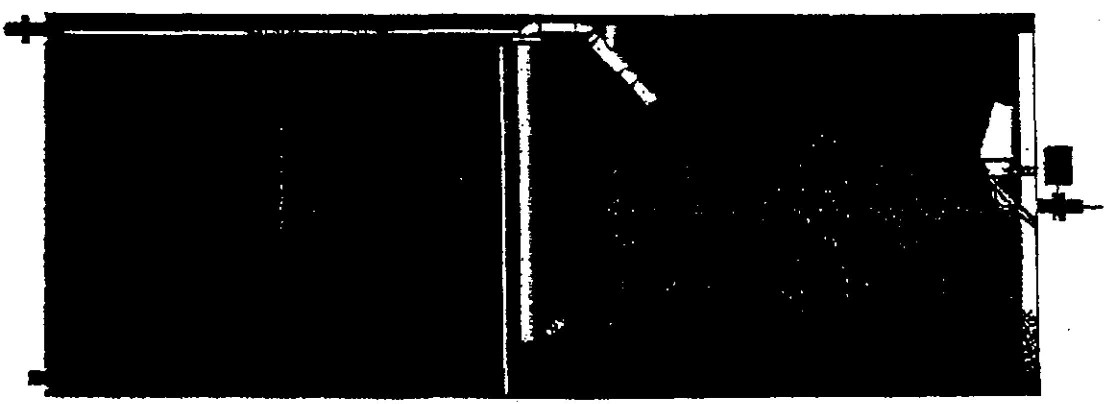


Interact Phase: When the level in the SBR basin reaches TWL, mixed liquor overflows the Surge Chamber weir, and is returned to the SAM™ Reactor through the Surge Jet to mix the SAM™ Reactor. A variable percentage of the pumped flow is recycled to the Anaerobic Chamber where heavier solids settle. Recycle flow is varied to maintain desired MLSS concentration in SBR. Aeration is cycled on and off to provide required aeration. Scum is removed from SBR basin. Solids in Anaerobic Chamber are digested.

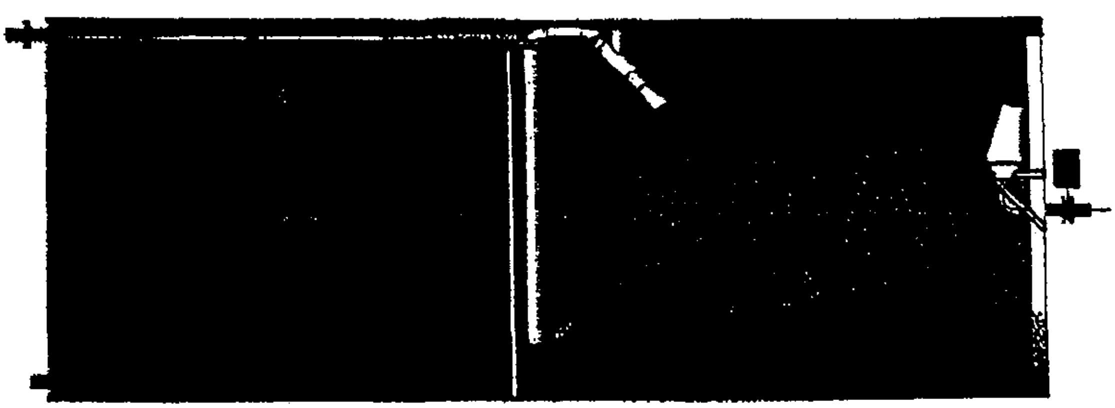
FLUIDYNE CORPORATION



Settle Phase: When the SAM™ reactor reaches a predetermined level, aeration is discontinued, and the SBR basin settles under perfect quiescent conditions. Solids in Anaerobic Chamber are digested.



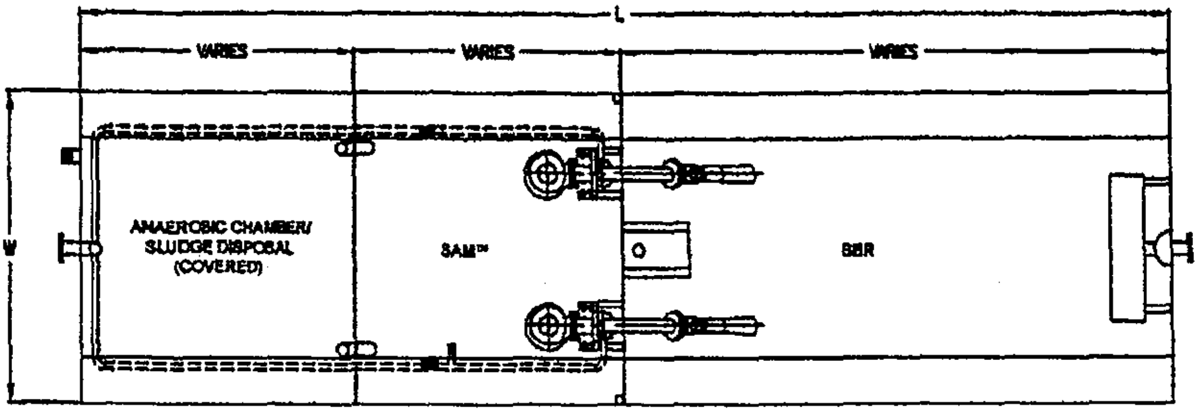
Decant Phase: When the Settle time value is reached, the decant valve is opened and treated effluent is withdrawn from the upper portion of the reactor.

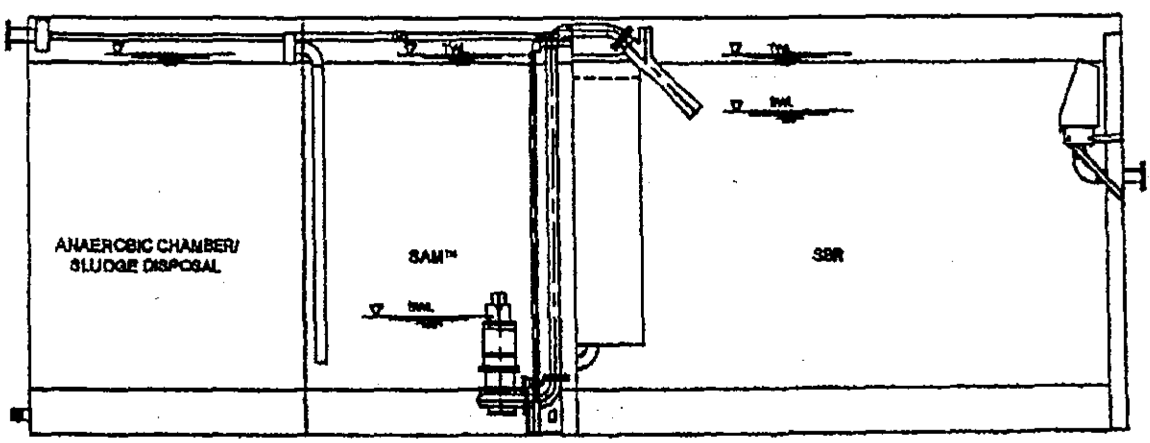


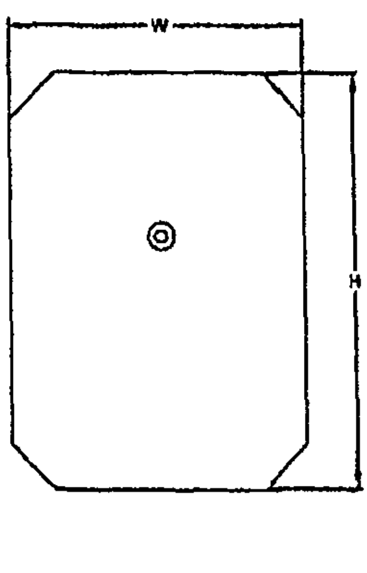
Filled Decant Phase: If SAM™ Reactor reaches TWL before decant phase ends, during peak hourly influent flows, influent overflows the overflow chamber, and is diffused at into the settled sludge at extremely low velocities.

FLUIDYNE CORPORATION

PREPACKAGED ISAM™ SEQUENCING BATCH REACTOR SYSTEMS







MODEL	W	L	H	HP*
ISAM™ 05	8.5	16	9.5	5
ISAM™ 10	8.5	24	9.5	5
ISAM™ 15	8.5	24	11.5	5
ISAM™ 20	8.5	32	11.5	5
ISAM™ 25	8.5	40	11.5	7.5
ISAM™ 30	11.9	32	11.5	7.5
ISAM™ 40	11.9	46	11.5	10
ISAM™ 50	11.9	56	11.5	10

* EACH PUMP (ONE IS STANDBY)

FLUIDYNE
CORPORATION

THE EXPERIENCED LEADER IN SEQUENCING BATCH REACTOR TECHNOLOGY

The Fluidyne ISAM™ SBR system provides the following benefits,

1. Ability to handle highly variable flows and loading associated with the small flow plants. The ISAM™ is more flexible than continuous flow plants. Regardless of flows or loading, aeration and mixing can automatically be adjusted to optimize power and prohibit filamentous growth.

2. At high flows, solids cannot wash out as with extended aeration plants as the ISAM™ system has quiescent settle and decant.

3. ISAM™ facilities are easily expandable by adding a new tank. The additional tank does not require major changes in controls; only a new tank and associated equipment.

4. ISAM™ provides a small footprint with no digesters, secondary clarifiers, RAS piping and pumping.

5. ISAM™ produces the highest quality effluent. Typical Fluidyne ISAM™ facilities are achieving less than 10 mg/l BOD and TSS, less than 1 mg/l NH_3-N, less than 5 mg/l total N, and less than 2 mg/l phosphorous.

6. Easy to operate and maintain as mechanical equipment is minimized with no chasing of sludge associated with extended aeration plants.

7. Use of self-aspirating jet aerators eliminate blowers and blower accessories.

8. Built in sludge reduction system using the Anaerobic Conditioner/Trash Trap significantly reduces sludge handling and hauling costs.

9. 100% stand-by aerator is included with the system to allow continuous operation with one unit out of service.

10. Built in flow equalization is provided in the ISAM™ reactor to handle peak hours.

11. Automatic scum skimming prior to effluent discharge provides highest quality effluent.

12. Exceptional after sales service by Fluidyne technicians. Fluidyne employees have been granted over 40 patents in wastewater and water treatment technology and equipment.

13. Reduced operation and maintenance costs as power usage is controlled through the Fluidyne control panel.

14. Installed cost is lower as the system comes with the in-basin equipment pre-installed

15. The Anaerobic Conditioner/Trash Trap is covered and raw wastewater reacts immediately with mixed liquor in an aerated environment, there are no odor concerns.

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Fluidyne Canada
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ISAM™ SBR with Aspirating Jet Aeration System

Design Calculations For

Key Largo, Florida

Sep. 12, 2003

I. DESIGN CONDITIONS:

Design flow	=	0.183	MGD
Peak daily flow	=	0.461	MGD (Assumed)
Peak hourly flow	=	320	GPM
Influent BOD_5	=	250	mg/l
	=	382	lbs./day
Effluent BOD_5	=	30	mg/l
Influent TSS	=	250	mg/l
Removal in anaerobic chamber	=	65%	
TSS to SBR	=	88	mg/l
Effluent TSS	=	10	mg/l
Influent TKN	=	40	mg/l
	=	61	lbs./day
Effluent NH_3-N	=	1	mg/l
Effluent total N	=	3	mg/l
Design MLSS (Full reactor)	=	3,000	mg/l
Design F:M	=	0.09	
SRT (SBR)	=	15	days
SRT (SBR plus SAM))	=	22	days
Elevation	=	20	ft. MSL
Average barometric pressure	=	14.68	psia

II. BASIN DESIGN:

SBR basin	=	3		
Length	=	30	ft.	0 in.
Width	=	14	ft.	0 in.
TWL	=	10	ft.	10 in.
BWL	=	8	ft.	0 in.
Volume	=	101,788	Gallons	
Retention time	=	13.3	hrs.	

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SAM™ reactor basin	=	3	
Length	=	15 ft.	0 in.
Width	=	14 ft.	0 in.
Maximum SWD	=	10 ft.	10 in.
Minimum SWD	=	2 ft.	6 in.
Working volume	=	39,113	Gallons
Anaerobic chamber	=	3	
Length	=	10 ft.	0 in.
Width	=	14 ft.	0 in.
SWD	=	10 ft.	10 in.
Volume	=	33,929	Gallons

III. OXYGEN REQUIREMENT:

lbs. O_2 / lb. BOD_5 removed	=	1.40
lbs. O_2 / lb. TKN oxidized	=	4.6
lbs. O_2 recovered/ lb. NO_3 denitrified	=	1.84
Actual Oxygen Required	=	594 lbs./day

Actual to Standard Oxygen Conversion Formula:

$$SOR = \frac{AOR}{\alpha\theta^{(T-20)}\left\{\frac{\beta C_{SMID} - C_L}{C_S\left[1+\frac{0.5\,(D)}{34}\right]}\right\}}$$

Where:

α	=	0.85	β	=	0.95
T	=	20 °C	θ	=	1.024
C_S	=	9.09	C_L	=	1.0 mg/l

C_{SMID} = Oxygen saturation concentration at 50 % depth at site elevation and temperature.

C_{SMID} = 10.53 mg/l

Therefore:

Standard Oxygen Required = 819 lbs./day

IV. PROCESS DESIGN

Cycle time at design flow	=	3.46 hrs.
Fill time	=	0.12 hrs.
Interact time (Maximum)	=	2.23 hrs.

Interact time (Design)	=	1.90 hrs.
Settle time	=	0.75 hrs.
Decant time	=	0.37 hrs.
Total cycle time	=	3.46 hrs.
Total aeration time	=	2.02 hrs./cycle
	=	42 hrs./day
SOR for aeration design	=	19.5 lbs./hr.
Aspirating jets per basin	=	2
BHp required per aspirator	=	6.09
Aspirator model	=	SAA 7.5 /2

VI. PUMP CALCULATIONS:

Jet motive/fill pump:

Pumps per basin	=	1
Flow per pump	=	1,232 GPM
Total pump head	=	31 ft.
Assumed pump efficiency	=	77 %
BHp per pump	=	12.5
Pump motor Hp	=	15

VII. DECANTER SIZING:

Cycles per day	=	20.80
Batch size	=	8,796 Gallons
Decant flow	=	400 GPM

VIII. SUMMARY:

Design Standard Oxygen Required	=	819 lbs./day
Avg. BHp for 24 hrs. @ design SOR	=	22
Power usage	=	393 KWH/day

IX. SLUDGE PRODUCTION CALCULATIONS:

Inert accumulation	=	0.23 lbs./lb. BOD_5 removed
VSS production	=	0.47 lbs./lb. BOD_5 removed
Total sludge yield	=	0.70 lbs./lb. BOD_5 removed
Anaerobic volatile sludge reduction	=	60%
Waste sludge concentration	>	4%
Sludge production	=	139 lbs. day
	=	418 GPD
Sludge storage	=	31 days

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X. NITRIFICATION/DENITRIFICATION

Minimum mixed liquor temperature	=	15 °C
Mixed liquor dissolved oxygen	=	1.0 mg/l
Alkalinity required for nitrification	=	196 mg/l
Alkalinity recovered, denitrification	=	74 mg/l
Net influent alkalinity required	=	123 mg/l
Max. nitrifier growth rate	=	0.204 $days^{-1}$
Minimum SRT required for nitrification	=	4.89 days
Actual SRT (SBR)	=	14.70 days
Kn, half velocity constant	=	0.40 mg/l
Des. growth rate for heterotrophs/nitrifier	=	0.068
Projected effluent soluble NH_3-N	=	0.20 mg/l
Specific utilization rate	=	0.21 lbs BOD_5/lb MLVSS
MLVSS required for BOD & NH_3 removal	=	1,778 lbs.
MLVSS	=	2,100 mg/l
Tank volume req. for BOD & NH_3 remove	=	0.102 MG
Denitrification rate	=	0.047 g/g/day
MLVSS required for denitrification	=	795 lbs.
Tank volume required for NO_3 removal	=	0.045 MG
Total tank volume required	=	0.1469 MG
Total tank volume provided	=	0.1527 MG

Barona Casino Wastewater Treatment Plant
Performance Data

Month	NO3 (mg/l)	TKN (mg/l)	TN (mg/l)	Monthly Avg (mg/l)
Nov-00	0.51	0.53	1.04	
	0.19	0.95	1.14	
	2.03	1.3	3.33	
	0.23	1.5	1.73	1.81
Dec-00	0.4	2	2.4	
	2.75	0.98	3.73	
	0.55	1.38	1.93	
	0.7	0.89	1.59	2.4125
1-Jan	0.61	0.67	1.28	
	0.95	1.9	2.85	
	0.45	2.6	3.05	
	0	0.41	0.41	1.8975
1-Feb	0.16	1.7	1.86	
	0.4	0.99	1.39	
	0.59	1.31	1.9	
	0.18	0.73	0.91	1.515
1-Mar	1.66	0.9	2.56	
	1.76	3.65	5.41	
	2.4	0.96	3.36	
	0.87	1.3	2.17	3.375
1-Apr	0.2	1.1	1.3	
	1.22	0.74	1.96	
	1.24	0.77	2.01	
	0.87	0.68	1.55	1.705
1-May	0.52	1.04	1.56	
	0.22	0.65	0.87	
	0.34	0.66	1	
	0.36	1.09	1.45	1.22
1-Jun	0.86	0.86	1.72	
	0.12	0.91	1.03	
	1.26	0.91	2.17	
	0.53	0.58	1.11	1.5075

APPENDIX C

Brown and Caldwell
Secondary Treatment Process Selection
October 3, 2003

Operational Cost Component		USBF		ISAM
Power Cost for Treatment:	$	18,931	$	12,003
Power Cost for Sludge Digestion	$	4,573	$	4,573
Annual Sodium Hypochlorite Cost	$	8,500	$	8,500
Annual Alum Cost	$	4,460	$	4,460
Sludge Handling Cost	$	85,112	$	96,891
Annual Operationing Cost	**$**	**121,575**	**$**	**126,427**

	USBF		ISAM	
Power Cost for Treatment:				
Anoxic Mixer Power (2 @ 1.9 HP)	3.8		0	
Blower Power (HP)	10		0	
Aeration Pump Power (HP)	0		15	
Operating Time (hr/day)	24		14	
Power Usage per Train	247		157	
No. of Trains	3		3	
Total Power Usage	741		470	
Annual Power Cost		$ 18,931		$ 12,003
Power Cost for Sludge Digestion				
No. of Digesters	1		1	
Blower Power (HP)	10		10	
Operating Time (hr/day)	24		24	
Power Usage per Train (kWH)	178.968		178.968	
Annual Power Cost		$ 4,573		$ 4,573
Chemical Cost				
Annual Sodium Hypochlorite Cost		$ 8,500		$ 8,500
Annual Alum Cost		$ 4,460		$ 4,460
Chemical Sludge				
Production (lb sludge/lb alum)	0.44		0.44	
Alum Feed Rate (lb alum/day	30.5		30.5	
Sludge Produced (lb/day)	13.42		13.42	
Solids Concentration of Sludge	1.5%		1.5%	
Sludge Volume	107		107	

Sludge Handling Cost				
Max Sludge Yield (mg VSS/mg BOD)	0.58		0.6	
Endogenous Decay Coefficient (1/day)	0.06		0.06	
Sludge Retention Time (days)	35		25	
Influent Flow (MGD)	0.183		0.183	
Influent BOD (mg/l)	250		250	
Influent TSS (mg/l)	250		250	
Influent VSS (mg/l) Assumed	210		210	
Volatile Suspended Solids (mg/l)	71.38770968		91.5732	
Non-Volatile Suspended Solids (mg/l)	61.0488		61.0488	
Waste Activated Sludge (lb/day)	132.4365097		152.622	
Solids Content of Sludge	1.5%		1.5%	
Quantity of Biosolids (gpd)	1058.645161		1220	
Quantity of Alum Sludge (gpd)	107		107	
Daily Hauling Costs		$ 233		$ 265
Annual Hauling Costs		$ 85,112		$ 96,891
Sludge Handling at 25% Flow				
Max Sludge Yield (mg VSS/mg BOD)	0.55		0.55	
Endogenous Decay Coefficient (1/day)	0.06		0.06	
Sludge Retention Time (days)	45		40	
Influent Flow (MGD)	0.04575		0.04575	
Influent BOD (mg/l)	250		250	
Influent TSS (mg/l)	250		250	

Influent VSS (mg/l) Assumed	210			210		
Volatile Suspended Solids (mg/l)	14.17940878			15.43053309		
Non-Volatile Suspended Solids (mg/l)	15.2622			15.2622		
Waste Activated Sludge (lb/day)	29.44160878			30.69273309		
Solids Content of Sludge	1.5%			1.5%		
Quantity of Solids (gpd)	235.3445946			245.3455882		
Daily Hauling Costs at $0.20 per gal		$	47		$	49
Annual Hauling Costs		$	17,180		$	17,910
Sludge Handling at 50% Flow						
Max Sludge Yield (mg VSS/mg BOD)	0.57			0.58		
Endogenous Decay Coefficient (1/day)	0.06			0.06		
Sludge Retention Time (days)	40			32		
Influent Flow (MGD)	0.0915			0.0915		
Influent BOD (mg/l)	250			250		
Influent TSS (mg/l)	250			250		
Influent VSS (mg/l) Assumed	210			210		
Volatile Suspended Solids (mg/l)	31.98328676			37.89416096		
Non-Volatile Suspended Solids (mg/l)	30.5244			30.5244		
Waste Activated Sludge (lb/day)	62.50768676			68.41856096		
Solids Content of Sludge	1%			1%		
Quantity of Solids (gpd)	749.4926471			820.3664384		
Daily Hauling Costs at $0.20 per gal		$	150		$	164
Annual Hauling Costs		$	54,713		$	59,887

MEMORANDUM TO THE BOARD

TO: KEY LARGO WASTEWATER DISTRICT BOARD OF COMMISSIONERS

CC: CHARLES SWEAT, DAVID MILES

FROM: ROBERT SHEETS, DISTRICT MANAGER

SUBJECT: PROPOSED CHANGES TO THE HASKELL SCOPE OF SERVICE

DATE: OCTOBER 10, 2003

The Key Largo Trailer Village (KLTV) and Key Largo Park (KLP) wastewater projects were originally developed by the Florida Keys Aqueduct Authority around two separate FEMA funding sources for "unmet needs". Upon the Key Largo Wastewater Treatment District's (KLWTD's) assumption of responsibilities for these projects, and after careful deliberation, the Board awarded a design-build contract for the KLTV collection system and treatment plant, to the Haskell Company. Concurrently, the Higgins Corporation, a partner to Haskell in the KLTV, was independently contracted for constructing the portion of the KLP designed by Boyle Engineering. The Weiler Engineering Corporation (WEC) was contracted to be the KLWTD consulting engineer, with a scope of service that authorized WEC to provide additional engineer of record services for the balance of the KLP.

As these projects near realization, it is becoming increasingly clear that diligence requires both the KLP and KLTV be consolidated under one design-build team contract. This strategic change will create a sole source of responsibility, through one project guarantor, to better ensure the successful completion of both wastewater projects.

For review and consideration of the KLWTD Board is a summary of the Haskell Company "Change Proposal #1", which increases the scope of services to include engineering services for the KLP. The change is reflected by an increase of $80,332 in associated engineering fees. Please reference amendment #1 to the WEC scope of services as outlined in Work Authorization WEC 03-02 for KLP.

District Management recommends approval of "Change Proposal #1" to the Haskell Company Contract. Approval will allow Brown & Caldwell, of the Haskell Company Design-Build Team, to become engineer of record for the KLP. If you have any questions or require further clarification, please do not hesitate to contact me.

Peter M. Kinsley
Division Leader - Water

October 9, 2003

Re: Wastewater Management System For The Key Largo Trailer Village Area
Key Largo, Florida
Issue No. 02-001 – Key Largo Park Design and Construction

Mr. Robert Sheets
Government Services Group, Inc.
1500 Mahan Drive
Suite 250
Tallahassee, Florida 32308

Dear Mr. Sheets:

The purpose of this letter is to reiterate The Haskell Company's commitment to providing Design-Build services for the Key Largo Park project under the terms and conditions of the Key Largo Trailer Village project. We are pleased to offer the Key Largo Wastewater Treatment District (KLWTD) a single source of responsibility for the overall project with The Haskell Company serving as Project Guarantor with engineering and construction being performed by our team members Brown and Caldwell and DN Higgins, Inc.

As your are aware, The Haskell Company provided three alternate prices in Change Proposal No. 1 dated September 16, 2003. Per your request and in response to concerns regarding the manner in which vacant lots are serviced, The Haskell Company designed and priced three scenarios for consideration by KLWTD. Change Proposal No. 1 describes the alternatives in detail and are as follows:

<u>Alternate A</u>
Service to All Occupied Lots in Key Largo Park and Sunset Waterways
$2,528,423.00

<u>Alternate B</u>
Service to All Occupied Lots in Key Largo Park and Sunset Waterways and Access without Valve Pits for All Unoccupied Lots in Key Largo Park and Sunset Waterways
$2,933,694.00

<u>Alternate C</u>
Service to All Occupied and Unoccupied Lots in Key Largo Park and Sunset Waterways
$3,331,328.00

With regard to vacant lots, The Haskell Company acknowledges that additional study must be performed before completing design and determining final construction cost. We are prepared to support the process with design and cost commentary as KLWTD collects information and establishes utility policy.

Change Proposal No. 1 will be performed in a two-phase manner. The design will proceed and final construction cost will be determined once the drawings reach 60 percent. In order for the KLWTD to release The Haskell Company for design, please find the attached Brown and Caldwell schedule of values and scope of work. The design proposal value of $80,332.00 is included in all three alternate prices provided in Change Proposal No. 1. With regard to future construction cost, the pricing provided in Change Proposal No. 1 will serve as the basis with reasonable escalation allowed.

Should you have any questions or require further information, please do not hesitate to contact me at (904) 357-4868.

Sincerely,

Peter M. Kinsley

Enclosures

cc: Issue No. 02-001
Mr. Stuart Oppenheim, Brown and Caldwell
Mr. Walt Messer, DN Higgins, Inc.

BROWN AND CALDWELL

Mr. Pete Kinsley
Division Leader – Water
The Haskell Company
111Riverside Avenue
Jacksonville, Florida 32231-4100

24533.001/1

Subject: Key Largo Park Collection System Redesign Services

Dear Mr. Kinsley:

In response to your request, Brown and Caldwell is pleased to provide you with scope and compensation details for the Key Largo Park Collection System Redesign. As you know, Brown and Caldwell has already developed three value engineering concepts for the Key Largo Park Collection System. Incorporating the value engineering concepts will require a complete redesign of the existing system. As such, Brown and Caldwell will become the Engineer of Record for the entire project.

In addition to the anticipated Redesign Services, we understand that consulting services are requested to address policy scenarios, as they may impact the District's design and construction costs.

Schedule of Values

The following table presents the schedule of values for the proposed services.

Task No.	Task Name	Cost
4A	Concept Design Submittal	$12,519.00
9A	60 Percent Design Submittal	$27,753.00
10A	90 Percent Design Submittal	$20,664.00
11A	100 Percent Design Submittal	$7,271.00
14A	Construction Phase Services	$12,125.00
	Total	**$80,332.00**

For each Park scenario that Brown and Caldwell is requested to evaluate, we propose a fee of $1,800.00

The above costs are based upon the following assumptions:

- Scenario B Park layout was used as presented to the District Board.
- Surveying has already been completed and will be provided to Brown and Caldwell. In addition, field surveying layout of the collection system and, as-

built locations and elevations of the collection system will be provided by others.
- Geotechnical work has already been completed and the report(s) will be provided to Brown and Caldwell.
- All necessary documentation will be provided to Brown and Caldwell from Boyle Engineering Corporation through the District.

Scope of Work

The Scope of Work for each of the Tasks identified in the Schedule of Values is presented in Exhibit A.

Brown and Caldwell is pleased and excited to provide these additional services to the Haskell Company and the Key Largo Wastewater Treatment District. If you have any questions, please call me.

Yours truly,

Stuart Oppenheim
Project Manager

Cc: Mr. Joe Paterniti, Miami
Mr. Ted Hortenstine, Orlando

Enclosure: Exhibit A

Key Largo Park Collection System Redesign Services

EXHIBIT A

SCOPE OF WORK

TASK 4A – Concept Review Submittal

Objective: To provide a basis of understanding of what will be incorporated into the completed project.

Activities:

4.1 Concept Review Submittal Report

Principal elements to be included in the Basis of Design Report include:

- Project Description
- Design Data
- Basis of Design Standards
- Project Master Schedule and Design Period Schedule
- Geotechnical Investigation Reports
- Design Drawing List
- Technical Specifications List
- Preliminary Collection System Layout

4.2 Submit Documents

Submit 7 Copies of Draft and Final Concept Review Submittal

Products:

1. Completed draft and final concept review submittal

TASK 9A – PARK COLLECTION SYSTEM 60% DESIGN DEVELOPMENT PROGRESS SUBMITTAL

Objective: To prepare the Park Collection System 60% Design Development Submittal

Activities:

9.1 Prepare Park Collection System Design Development Progress Submittal

- Park Collection System Plan And Profiles
- Park Collection System Details specific to the Park Project
- Park Collection System Specifications specific to the Park Project.

Based on Scenario B (Vacuum mains in front of all lots, no pits for vacant lots) it is estimated that at least 26 new drawings will be required,

9.2 Submit Documents

Submit Seven copies of the documents a set of reproducible, and a CD will be provided.

Products:

1. Product from this task is the Park Collection System 60% Design Development Progress Submittal.

TASK 10A – PARK COLLECTION SYSTEM PRE-FINAL DESIGN SUBMITTAL (90%)

Objective: To prepare Park Collection System pre-final Design Submittal (90%)

Activities:

10.1 Prepare Park Collection System Pre-Final Design Submittal

- Park Collection System Plan And Profiles
- Park Collection System Details
- Park Collection System Specifications

10.2 Submit Documents

Seven copies of the documents a set of reproducible, and a CD will be provided.

Products:

1. Product from this task is the Park Collection System Pre-Final Design Submittal.

TASK 11A – PARK COLLECTION SYSTEM FINAL DESIGN

Objective: To prepare Park Collection System Final Design Documents

Activities:

11.1 Preparation of Park Collection System plans and specifications.

- Park Collection System Plan and Profiles
- Park Collection System Details
- Park Collection System Specifications

Products

1. Product from this task is the final Park Collection System design submittal.

TASK 14 – PARK COLLECTION SYSTEM CONSTRUCTION PHASE SERVICES

Objective: To provide construction Phase Services for the Park Collection System in support of The Haskell Company.

Activities:

14.1 Office Engineering Services

Provide office engineering services to include consulting with and advising THC on resolutions of problems due to actual field conditions encountered; and reviewing shop drawings and submittals for compliance with design concepts. It has been assumed that submittal reviews will be conducted as part of the Key Largo Trailer Village project's scope of work.

14.2 Field Engineering Support Services

- Make periodic visits to project site at intervals appropriate to various stages of construction to observe the quality of the executed work. This scope of work is based on 20 site visits.
- Coordinate with State, County, and City Agencies for construction in their jurisdictions.
- Review shop drawings

- Resolve design related construction problems.
- Make necessary interpretations and clarifications of Contract Documents.
- Witness testing
- Provide substantial completion inspection walk-through of the project with THC and KLWWTP.
- Prepare and certify record drawings.

Products:

1. Meeting and site visit notes.
2. Record drawings

ADDITIONAL SERVICES – EVALUATE SCENARIOS

Objective: In response to District policy proposals, provide Engineer's opinion of the associated design and cost impacts upon the collection system.

Activities:

The District recognizes that certain policy issues remain to be resolved. Some of these policy issues or scenarios can have a significant impact upon the project's engineering and construction cost. Brown and Caldwell will respond to questions posed by the District by assessing the policy impacts through the development of engineering and construction cost opinions. This Task will be considered an Additional Service and will be based on the number of scenarios that are requested for evaluation.

Products:

1. Products from this Task will be a schedule of estimated material quantities and marked-up drawings that identify the scenario's collection system.

Key Largo Wastewater Treatment District

Guest Sign In Sheet

Friday, October 17, 2003

****Please Print****

Name & Company	E mail	Phone
1. Dos Espal	Boocznr@AOL.com	813 6770041
2. Terry Zaudtke CPH	tzaudtke@cphengineers.com	407-425-0452
3. John Verschacca TSC Jacobs	John@TSCJacobs.com	813-888-5006
4. GLEN CALLTHARP FLUIDYNE	ptiflorida@aol.com	941-342-8915
5. Robert E Burk	rootssar@ecit.com	451-4894
6. Gaile Jelinek		4512504
7. BILL BROOKMAN MCHD	william-brookman@doh.state.fl.us	853-1901
8. WALT MESSER / D.N. HIGGINS	DNHIGGINSKEYWEST@AOL.COM	305-797-1036
9. Tom Evans / Tom Evans Environmental / Roevac	te@tomevans.com	451-2031
10. Thomas M. Dillon	largosunset@hotmail.com	852-1996
11. JOE PATERNITI Brown & Caldwell	jpaterniti@browncald.com	3054184090
12. Stuart Oppenheim Brown and Caldwell	soppenheim@browncald.com	"
13. William English The Haskell Company	wtenglis@thehaskellco.com	904-791-8110
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17.		
18.		
19.		
20. Steve Gibbs, Charles Fishburn, Tom Evans		

Key Largo Wastewater Treatment District
Board of Commissioner's Meeting Agenda

1:00 PM Friday, October 17, 2003
Key Largo Public Library, 101485 Overseas Highway
Key Largo, Monroe County, Florida

A. Call to Order

B. Pledge of Allegiance

C. Public Comment

D. Additions, Deletions or Corrections to the Agenda

E. Presentations on Vacuum Collection Systems and Advanced Wastewater Treatment Processes

1. Government Services Group, Inc. recommendation
2. Weiler Engineering Corporation recommendation
3. The Haskell Company's recommendation

F. Action Items

1. Approval of a Vacuum Collection System
2. Approval of a Wastewater Treatment Process
3. Approval of the Haskell Company Change Order

G. General Manager's Report

1. Other Items

H. Legal Counsel's Report

I. Engineer's Report

1. Other Items

J. Commissioner's Items

1. Other Items

K. Meeting Adjournment

Wastewater Management System for the Key Largo Trailer Village Area

Introduction

- Project History
- Introduction of Participants
  - John Bratby, Brown and Caldwell
  - Terry Zaudtke, CPH Engineers
  - Glen Calltharp, Fluidyne Corporation

Wastewater Management System for the Key Largo Trailer Village Area

Operating Requirements

Based on State Regulations:

- Effluent disposal – shallow gravity drainage well
- Rules 62-520 and 62-600, F.A.C.
- Effluent requirements at 0.122 mgd flow

Treatment Parameter	Maximum Annual Average	Maximum Monthly Average	Maximum Weekly Average
Total Suspended Solids	<5.0 mg/l	<6.25 mg/l	<7.5 mg/l
Carbonaceous Biological Oxygen Demand (CBOD)	<5.0 mg/l	<6.25 mg/l	<7.5 mg/l
Total Nitrogen (TN)	<3.0 mg/l	<3.75 mg/l	<4.5 mg/l
Total Phosphorus (TP)	<1.0 mg/l	<1.25 mg/l	<1.5 mg/l

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Available Processes

Activated sludge processes with nitrogen removal capabilities:

Process	Lower Design Point (TN)	Upper Design Point (TN)	Drawback
Modified Ludzak-Ettinger (MLE)	5	8	Dependent on Internal Recycle
Step Feed	5	8	Flow-split Control
Sequencing Batch Reactor	5	8	Complex Operation/Control
Bio-denitro	5	8	Complex Operation/Control
Nitrox	5	8	Potential Ammonia Bleed-through
Single Sludge Post-Anoxic	3	12	Large Anoxic Volume or Methanol/Acetate Usage
4-Stage Bardenpho	3	5	Complex Operation/Control
Oxidation Ditch	8	12	Large Ditch Volume
Sym-Bio - SNDN	3	8	Complex Operation/Control and Potential Sludge Bulking
Orbal - SNDN	3	8	Complex Operation/Control and Potential Sludge Bulking

- Grady, Daigger, and Lim, Biological Wastewater Treatment, 2nd Edition, Chapter 11: Biological Nutrient Removal, 1999
- Metcalf and Eddy, Wastewater Treatment and Reuse, 4th Edition, Chapter 8: Suspended Growth Biological Treatment Processes, 2003

Wastewater Management System for the Key Largo Trailer Village Area

Modified Processes for Small Facilities

Modified activated sludge processes with the capability to meet 5,5,3,1 in small facilities:

Process	Lower Design Point (TN)	Upper Design Point (TN)	Drawback
Modified Ludzak-Ettinger (MLE)	3	5	Addition of Denitrification Filter Required
Sequencing Batch Reactor	3	5	Larger Volume or Separate Anoxic Zone
Membrane Bio-Reactor	3	5	Combined 3 or 4-Stage BNR with Low-Pressure Membrane

Note: Based on field research during evaluation process

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DN Higgins General Contractors

RFP Requirement

Requested to review two processes:

- Sequencing Batch Reactor (SBR)
- Upflow Sludge Blanket Filter (USBF)

Consideration of MBR was not requested:

- Suitable process
- Produces high quality effluent
- Barrier to microorganisms and viruses

Sequencing Batch Reactor (SBR)

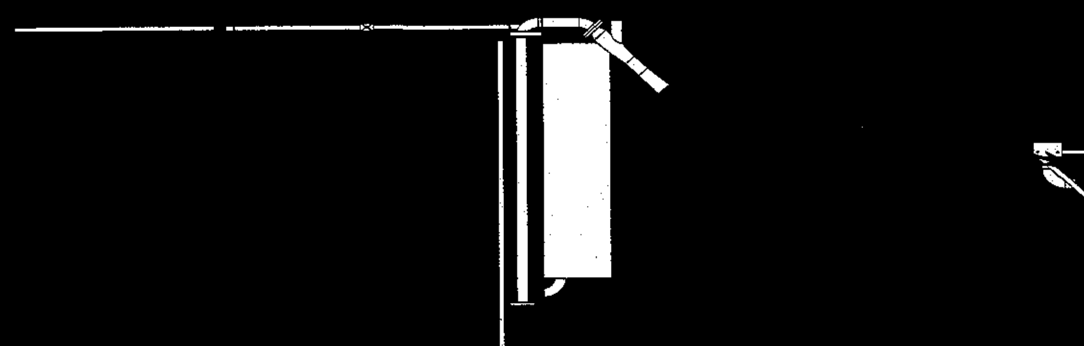
Overview:

- Mixed opinions – SBR achieving 5,5,3,1
- Considered modified SBR
  - Enhanced nitrogen removal
  - Achieved through additional anoxic cycle(s)
  - Or, separate anoxic zone
- Fluidyne proposed ISAM

Integrated Surge Anoxic Mix (ISAM)

Process description:

- Anaerobic chamber – allows fermentation of organic compounds to increase soluble BOD
- SAM reactor – equalizes flow during fill phase and serves as anoxic zone during react phase
- SBR basin – ammonia oxidized, BOD removed
- Aeration / mixing achieved via motive pump and aspirator



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Wastewater Management System for the Key Largo Trailer Village Area

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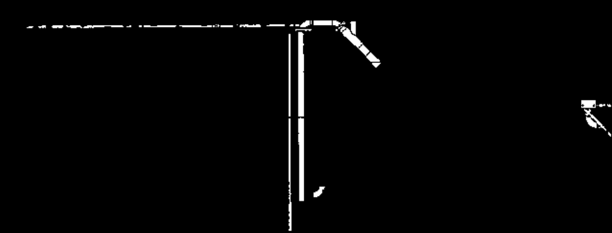
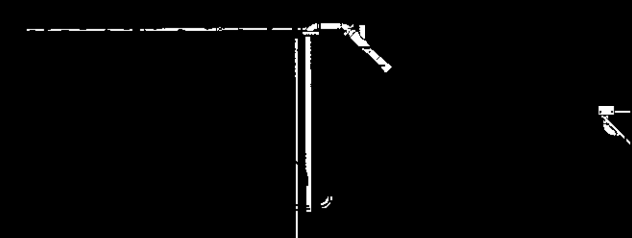
Integrated Surge Anoxic Mix (ISAM)

Operation:

1. Fill Phase:

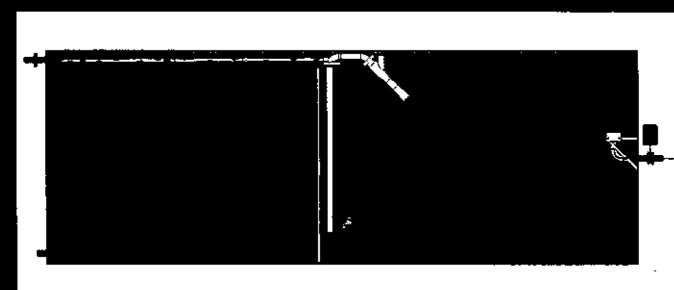


2. Interact Phase:



3. Settle Phase:

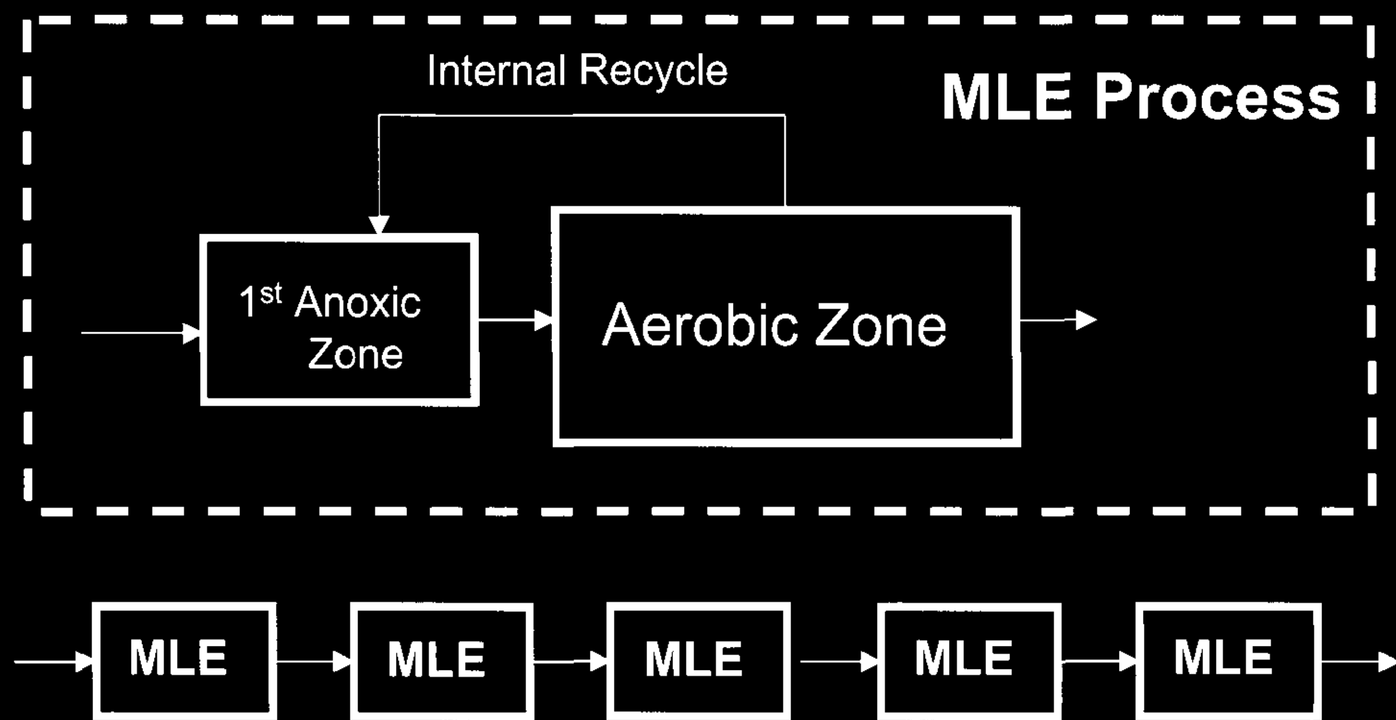
4. Decant Phase:



ISAM Process

Process Simulates:

- Multiple MLE Processes



Wastewater Management System for the Key Largo Trailer Village Area

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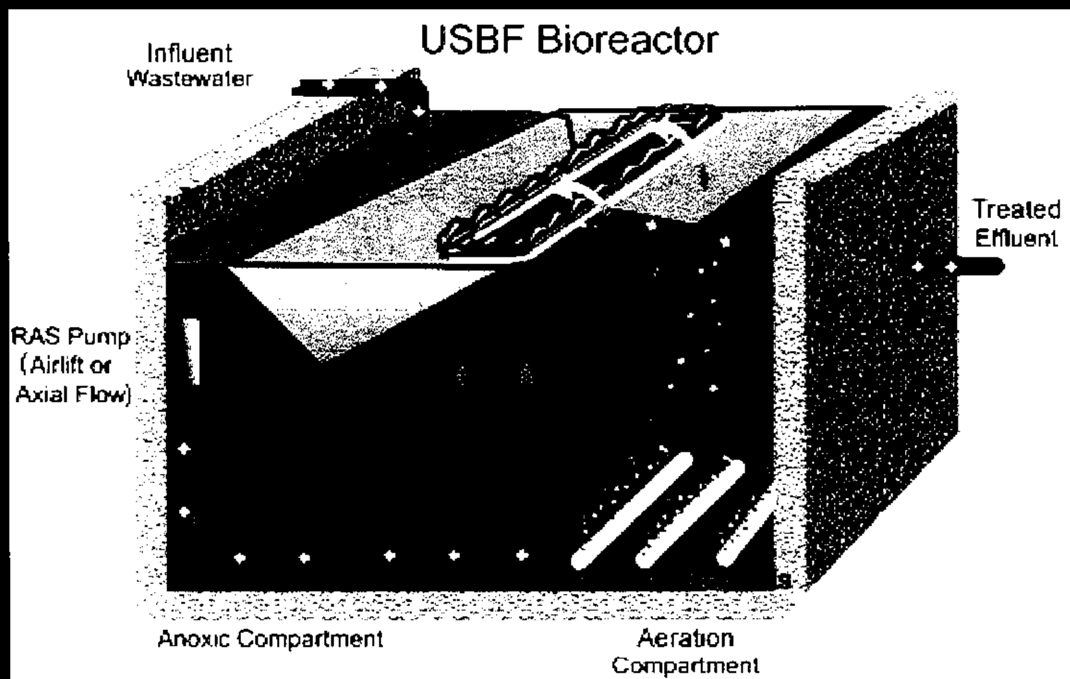
Upflow Sludge Blanket Filter (USBF)

Process description:

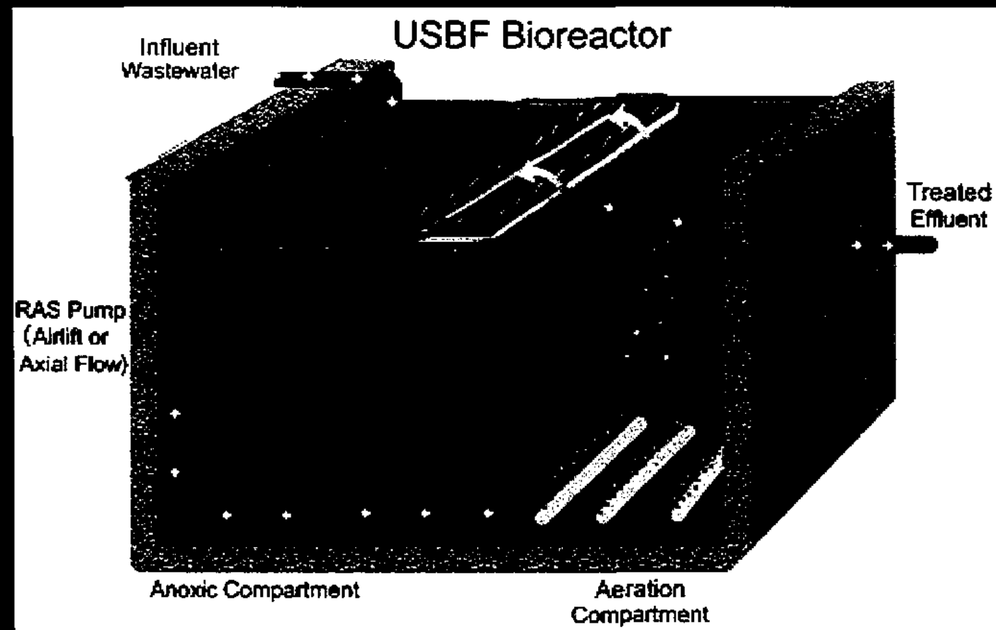
- Modified MLE process
- Sludge blanket serves as small 2nd anoxic zone
- Upflow Sludge Blanket Filter (USBF)



Wastewater Management System for the Key Largo Trailer Village Area

Upflow Sludge Blanket Filter (USBF)

Operation:



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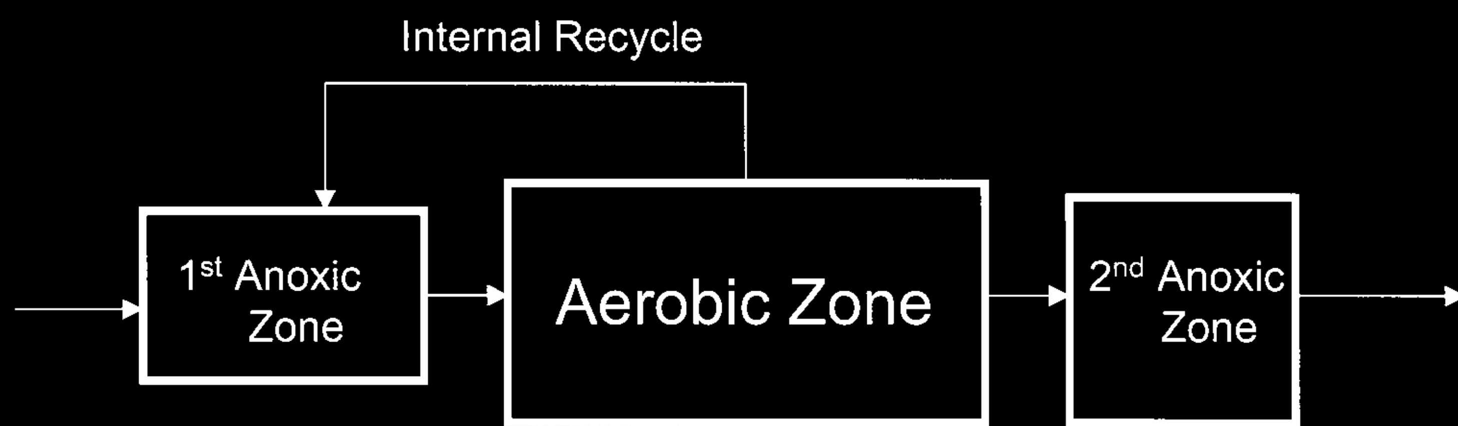
- Anoxic Zone: nitrate removed
- Aeration Zone: ammonia oxidized, BOD removed
- RAS Recycle: returns nitrate to anoxic zone
- Sludge Blanket: achieves settling / partial denite

USBF Process

Process Simulates:

- an MLE Process
- followed by a 2nd Anoxic Zone0



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Evaluation Process

- Information request letter was sent
- Information received
- Processes were evaluated
- References were confirmed
- Site visits were made
- Operational costs were compared
- Performance data was compiled
  - Compared to regulatory requirements
  - Reconciled operational problems

Sludge Generation - Common to Both

Three components after steady state is reached:

- Inert solids input
- Cell growth through BOD removal (Exogenous Respiration)
- Cell Death/Lysis (Endogenous Respiration)

Flow = 0.122 MGD
Inert Solids = 50 mg/l

Plant Accumulation = 41 lb/day

Inert Solids = 10 mg/l

Inert is roughly 20% of the total (250 mg/l)

Wastewater Management
System for the Key Largo
Trailer Village Area

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Inert Sludge Generation

Volume of Sludge:

- Best case – 2% solids without thickening

$$\text{Volume} = \frac{41\ \text{lb/day}}{0.02\ \text{lb Solids/lb Sludge}} \quad \frac{\text{gallon}}{7.4805\ \text{lb}}$$

= 274 gallons of liquid sludge at 2%

= 137 gallons at 50% flow

= 68 gallons at 25% flow

Minimum! A Day!

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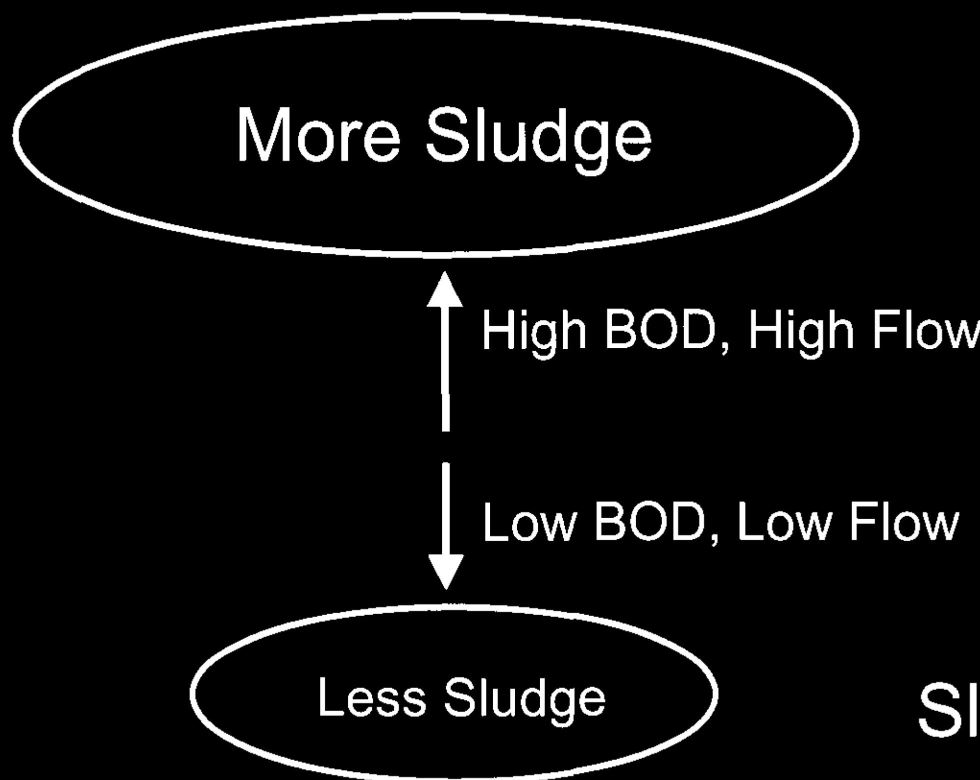
Additional Sludge Generation

Volume of generated sludge:

- Depends on sludge age and organic loading



Sludge Does Happen!

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USBF

- Numerous facilities around US
- Multiple facilities in the Keys
- Marco Shores – comparable facility
  - Insufficient data to verify treatment capability (4 Weeks)
  - Problems associated with peak flows
  - Otherwise, a nice facility

Process	Facility	Permitted Flow (MGD)	Annual TN Averages		Monthly TN Averages		TN Data Range	
			Best Annual TN Average	Percent Exceeding 3.0 mg/l	Best Monthly TN Average	Percent Exceeding 3.75 mg/l	Minimum	Maximum
USBF	Oceanside Marina	0.02	NA	NA	23.1	100%	23.1	71.60
USBF	Marathon Marina	0.025	NA	NA	15.4	100%	15.4	31.10
USBF	Ziggie's	0.006	8.0	100%	2.2	81%	2.2	29.30
USBF	Islander	0.006	7.4	100%	2.3	95%	1.7	22.50
USBF	Island Tiki	0.012	6.0	100%	0.2	81%	0.1	77.00
USBF	Marco Shores	0.3	NA	NA	3.1	0%	2.1	3.50

Wastewater Management System for the Key Largo Trailer Village Area

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USBF

Advantages:

- Minimal moving equipment
- Ease of operation
- Continuous operation

Disadvantages:

- Limited ability to handle peak flows / loadings
- Limited flexibility to achieve <8.0 mg / l TN
- No facility operating under 5,5,3,1 permit

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ISAM

- Numerous facilities around US
- Multiple SBR facilities in Florida
- Barona Casino – comparable facility
  - Sufficient data to verify treatment capability (1+ Years)
  - Confirmed ability to handle peaks

Process	Facility	Permitted Flow (MGD)	Annual TN Averages		Monthly TN Averages		TN Data Range	
			Best Annual TN Average	Percent Exceeding 3.0 mg/l	Best Monthly TN Average	Percent Exceeding 3.75 mg/l	Minimum	Maximum
SBR	Blacksford	1	2.9	0%	1.5	38%	0.99	5.80
SBR	Hilliard	0.32	4.9	100%	1.7	17%	1.7	21.00
SBR	Bartow	4	3.1	100%	2.8	36%	2.76	4.30
ISAM	Barona	0.75	1.6	0%	0.59	0%	0.21	5.41

Note: Hilliard Annual Average would be 2.9 mg/l if Plant Upset had not Occurred during March and April of 2003

ISAM

Advantages:

- Flexibility to achieve <3.0 mg / l
- Confirmed ability to accommodate peaks
- Fluidyne SBRs operating under 5,5,3,1 permit

Disadvantages:

- More complex operations
- Less mechanical reliability (Starts/Stops vs. Cont.)

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ISAM vs. USBF

Operational Comparison:

Process	Facility	Permitted Flow (MGD)	Annual TN Averages		Monthly TN Averages		TN Data Range	
			Best Annual TN Average	Percent Exceeding 3.0 mg/l	Best Monthly TN Average	Percent Exceeding 3.75 mg/l	Minimum	Maximum
USBF	Oceanside Marina	0.02	NA	NA	23.1	100%	23.1	71.60
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ISAM	Barona	0.75	1.6	0%	0.59	0%	0.21	5.41

Note: Hilliard Annual Average would be 2.9 mg/l if Plant Upset had not Occurred during March and April of 2003

Wastewater Management System for the Key Largo Trailer Village Area

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USBF vs. ISAM

Operational Costs:

- ISAM vs. SBR power savings due to nitrate usage
- ISAM power cost less during lower flows
- USBF sludge handling costs lowered based on manufacturer's claims

Operational Cost Component	USBF	ISAM
Power Cost for Treatment:	$ 18,931	$ 12,003
Power Cost for Sludge Digestion	$ 4,573	$ 4,573
Annual Sodium Hypochlorite Cost	$ 8,500	$ 8,500
Annual Alum Cost	$ 4,460	$ 4,460
Sludge Handling Cost	$ 85,112	$ 96,891
Annual Operationing Cost	**$ 121,575**	**$ 126,427**

USBF vs. ISAM

Overall Comparison:

Item	USBF	ISAM
Power Costs	• Continuous electrical power consumption	• Intermittent electrical power consumption
Chemical Costs	• Costs are consent • Utilizes ferric chloride phosphorus removal • Sodium hypochlorite will be used for disinfection	• Lower cost with lower flows • Uses Alum for Phosphorus Removal • Sodium Hypochlorite will be used for disinfection
Sludge Handling Costs	• Cost difference is negligible • Lower sludge production based on manufacturer's claims	• Cost difference is negligible • Conservative sludge production
Process Capabilities	• Sludge handling costs slightly lower • Expected total nitrogen of less than 8.0 mg/l • Poor operational data	• Higher costs due to lower sludge age • Expected total nitrogen of less than 3.0 mg/l • Operational data demonstrates capabilities

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USBF vs. ISAM (continued)

Overall Comparison:

Item	USBF	ISAM
Simplicity of Operation	• Simpler control system due to continuous operation	• More complex control due to intermittent operation
Ease of Maintenance	• No difference anticipated	• No difference anticipated
Reliability (permit compliance)	• Majority of data failed proposed monthly effluent standards	• Majority of data passed proposed monthly effluent standards
Ability to Handle Peak Flows	• Flow-through process is prone to peaking upsets	• Built-in equalization characteristic of SBR/ISAM process
Reliability	• High-degree of mechanical reliability	• Slightly less degree of mechanical reliability due to start/stop operation
Adaptability	• Redundant equipment • Difficult to modify process (i.e. adding a carbon source, adding a secondary anoxic process)	• Redundant equipment • Easier to modify process (i.e. adding a carbon source, implementing additional anoxic sequences)

USBF vs. ISAM (continued)

Brown and Caldwell

Recommends the ISAM process

- Greater flexibility to reduce nitrogen levels
- Sludge generation differences – negligible
- Operational cost differences – negligible
- Fluidyne – strong, successful track record in Florida

Wastewater Management System for the Key Largo Trailer Village Area

KLWTD Engineer's Recommendations

Wastewater Treatment Plant Recommendation

WEC recommends SBR technology as the secondary treatment process for the Key Largo Trailer Village projects because:

- Both systems provide good secondary treatment.
- Both Systems need additional treatment to meet Total Nitrogen requirements.
- SBR modification can be achieved by adding cycles to the existing design.
- USBF modification is more complex and requires structural changes.
- Fluidyne SBR in Barona demonstrates ability to achieve AWT.

Wastewater Management System for the Key Largo Trailer Village Area

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KLWTD Manager Recommendations

Secondary Treatment Process

- Initial interview of SBR and USBF vendors and review of vendor provided literature

- Site Visits to Florida SBR and USBF Systems

  - Marco Shores (Purestream USBF) Observation of solids carryover at normal high flows and no demonstrated ability to meet AWT standards.

  - City of Bartow (Fluidyne SBR) Observed the operation at flow below design capacity, however the plant was able to produce near AWT results.

  - Poinciana (Jet-Tek SBR) Observed the ability to reliably treat at high flows, as well as, produce AWT quality effluent.

KLWTD Manager Recommendations

Secondary Treatment Process

Phone Interviews with operators of USBFs and SBRs

- City of Homestead (Jet-Tek SBR) Permitted and operated in compliance as an AWT plant.
- City of Bartow (Fluidyne SBR) While not required to operate as AWT, Bartow produces near AWT effluent.
- City of Eustis (Purestream USBF) The City has purchased a USBF plant to place in service in 2004. Eustis is not required to produce AWT quality effluent.

- *No information has been produced that indicates the USBF process will produce AWT results without additional treatment appurtenances.*

Wastewater Management System for the Key Largo Trailer Village Area

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KLWTD Manager Recommendations

Secondary Treatment Process

It is Management's recommendation that, given the operational data available, SBR be selected as the most reliable alternative for the KLWTD to achieve AWT results and maintain future regulatory compliance.

Wastewater Management System for the Key Largo Trailer Village Area

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Break

(10 minutes)

Wastewater Management System for the Key Largo Trailer Village Area

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Technical Presentation by Vendors

USBF

Wastewater Management System for the Key Largo Trailer Village Area

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Technical Presentation by Vendors

SBR

Wastewater Management System for the Key Largo Trailer Village Area

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Q & A

Questions and Answers by the Board

Wastewater Management System for the Key Largo Trailer Village Area

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Break
(10 minutes)

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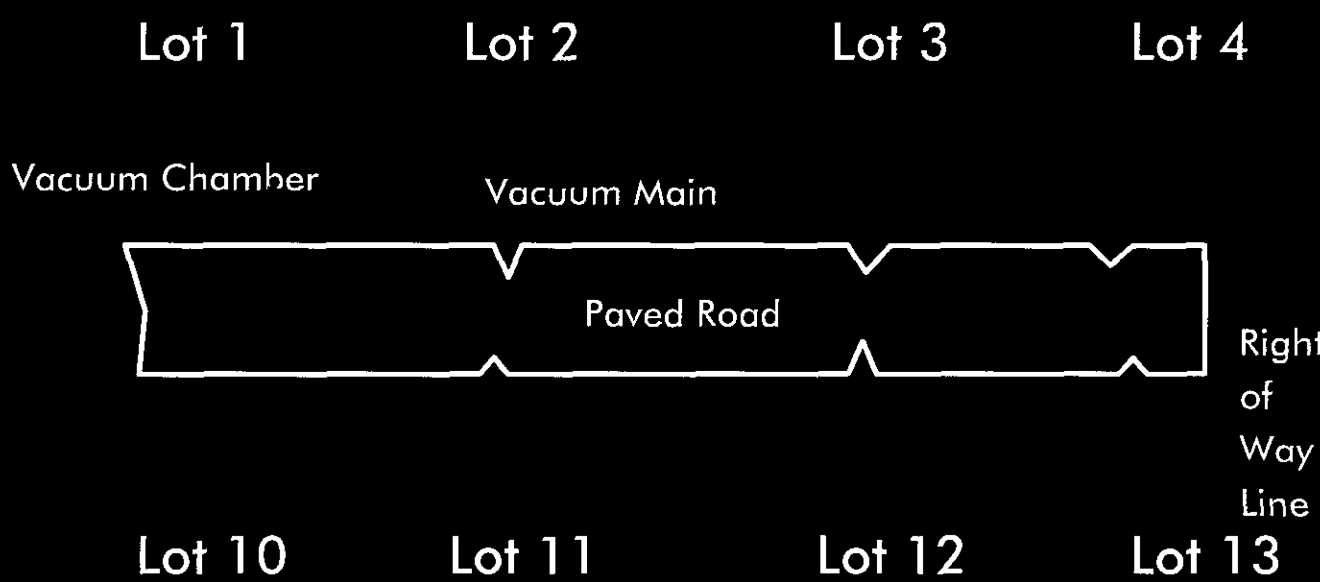
Function of Vacuum Collection System



System consists of gravity sewer lateral, vacuum pit, vacuum main, and vacuum pump station.

Wastewater Management System for the Key Largo Trailer Village Area

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Why Use Vacuum Collection System?

- **Minimal rock excavation and dewatering =**
  Lower Construction Cost (Saves $)

- **Less corrective work associated with deep excavations typical of gravity systems =**
  Lower Construction Cost (Saves $)

- **Closed system reduces infiltration / inflow =**
  Lower Wet Weather Flows (Saves Plant Capacity)

Wastewater Management System for the Key Largo Trailer Village Area

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Roe-Vac vs. Air-Vac

- **Both vendors are well qualified**
  - Numerous installations = demonstrated experience
- **Both have verifiable prior experience**
  - BC contacted equipment users and conducted site visits
- **Vendors presented equipment**
- **Both vendors will provide the required system and we believe both systems will perform as specified**

Wastewater Management System for the Key Largo Trailer Village Area

Roe-Vac / Air-Vac Technical Comparison

	Roe-Vac	Air-Vac
System Layout	Same	Same
VPS	Same	Same
Valve Access	Water tight	Not water tight
Sump Storage	15 gallons +/-	50 gallons +/-
Sump Access	Easy	Involved
Sump Construction	Not corrosive	Medium corrosive

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Wastewater Management System for the Key Largo Trailer Village Area

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Roe-Vac / Air-Vac Company Comparison

	Roe-Vac	Air-Vac
System Warranty	12 months	12 months
Financial Strength	Good	Good
Installation Requirements	• Requires qualified installer • Pit installation requires greater care and verification (included)	• Requires qualified installer
Capital Costs	Lower capital costs	Higher capital costs
O&M Costs	Similar to Air-Vac (annual valve inspections)	Similar to Roe-Vac (annual valve inspections)

Recommendation

- Roe-Vac is recommended due to the following:
  - Lower capital cost
  - Reduced costs per customer
  - Watertight valve chamber (O&M)
  - Easier access into sump (O&M)
  - Non-corrosive construction (O&M)

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KLWTD Engineer's Recommendations

Vacuum Collection System

WEC recommends AirVac as the supplier of the vacuum system for the Key Largo Park and Key Largo Trailer Village projects because:

- AirVac has a proven performance history.
- AirVac vacuum pit assembly allows for compaction of bedding material.
- AirVac is less prone to failure.

Wastewater Management System for the Key Largo Trailer Village Area

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KLWTD Engineer's Recommendations

Vacuum Collection System

If the Board chooses Roediger, WEC recommends the following be required:

- A fixed price for valves with an annual CPI increase allowed.
- A 5-year performance bond to include replacement of valve pits.
- Full time inspection to ensure proper bedding and compaction.

Wastewater Management System for the Key Largo Trailer Village Area

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KLWTD Manager Recommendations

Vacuum Collection System

- Initial interview of Roevac and Airvac vendors and review of vendor provided literature

- Site Visits to Florida Airvac and Roevac Systems

  - City of Longwood, 100 EDUs (Airvac) – vacuum system in good working order, no complaints.

  - St. Johns County, 80 EDUs (Roevac) vacuum system in good working order, no complaints.

KLWTD Manager Recommendations

Vacuum Collection System

Telephone interviews with Airvac and Roevac users

- City of Sanford, Airvac since 1988 – 460 EDUs
- City of Longwood, Airvac since 1996 – 100 EDUs
- City of Englewood, Airvac since 1996 – 12,000 EDUs
- Sarasota County, Airvac since 2000 – 565 EDUs (current) and 12,000 EDUs expected at build out in 2007
- Jacksonville Electric Authority (JEA) - Created specifications around the design of Roevac for 300 EDU system
- Malden Missouri, Roevac since 2002 – 300 EDUs

In each instance, the users of Airvac and Roevac have been pleased with the results, regard the system maintenance as minimal and stand by their selection.

KLWTD Manager Recommendations

Vacuum Collection System

Airvac

Pros

- 50 gallon sump
- Piston Valve
- Single unit installation
- Multiple U.S. and Florida systems
- Traffic bearing collar

Cons

- 123 moving parts
- Requires vent on private property
- Non water tight valve Chamber
- Sump is difficult to access

GSG

THE WEILER ENGINEERING CORPORATION

BROWN AND CALDWELL

KLWTD Manager Recommendations

Vacuum Collection System

Roevac

Pros

- Water tight valve chamber
- No vent required on private property
- 5 moving parts
- Easy access to sump

Cons

- Only 2 small installations in U.S.
- Diaphragm valve
- 15 gallon sump
- Separate parts make pit more difficult to install

KLWTD Manager Recommendations

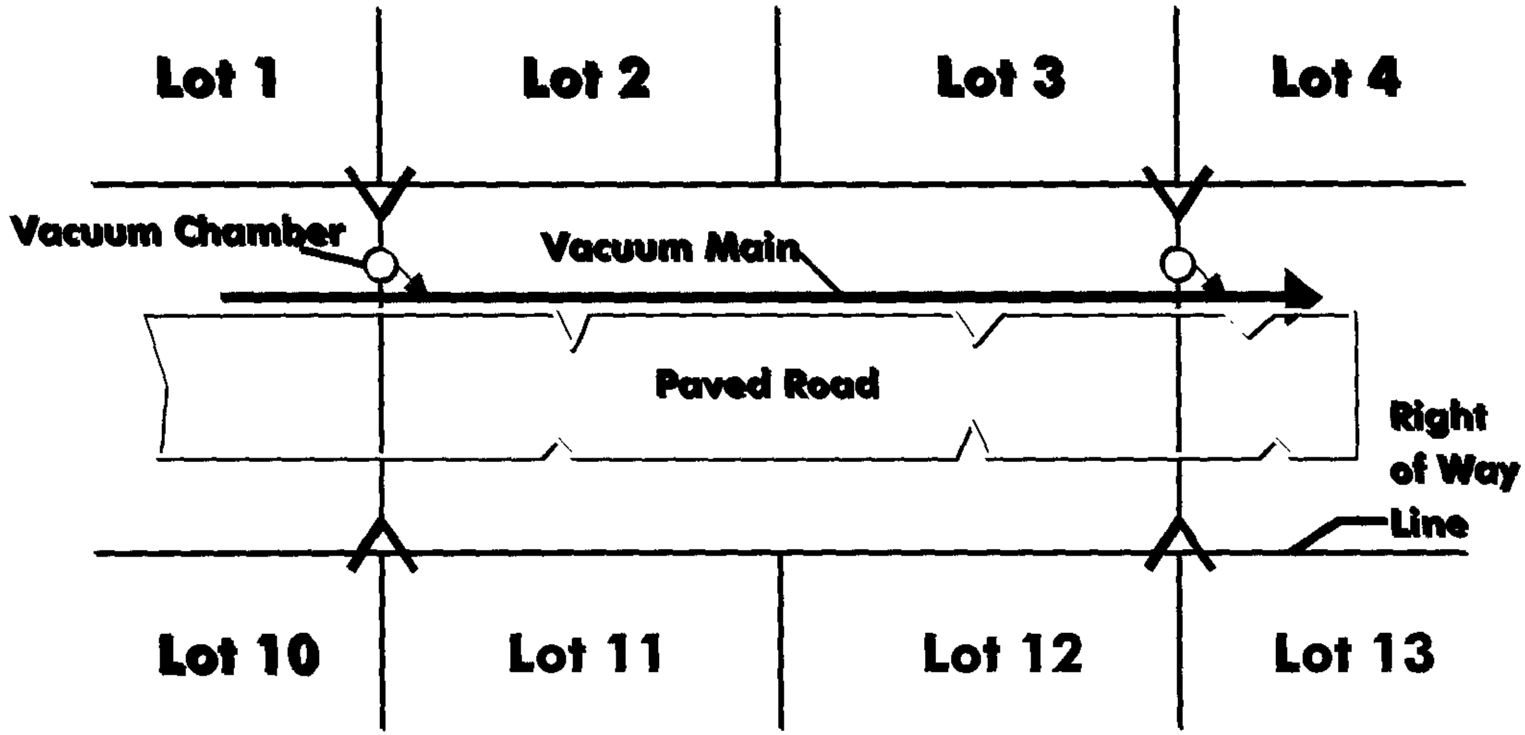
Vacuum Collection System

- Either vacuum system is capable of providing wastewater collection at a reasonable cost.
- Multiple Airvac systems operating in U.S. for 20+ years.
- Few Roevac systems operating in U.S. for 3+ years.

Given the quantity of operational data available, Management believes Airvac should be regarded as the most reliable alternative for the KLWTD.

Joe's Slides (6)

Function of Vacuum Collection System



System consists of gravity sewer lateral, vacuum pit, vacuum main, and vacuum pump station.

Why Use Vacuum Collection System?

- **Minimal rock excavation and dewatering =**
  Lower Construction Cost (Saves $'s)

- **Closed system reduces infiltration / inflow =**
  Lower Wet Weather Flows (Saves Plant Capacity)

Air-Vac vs. Roe-Vac

- **Both vendors are well qualified**
  - Numerous installations = demonstrated experience
- **Both verifiable have prior experience**
  - BC contacted equipment users and
  - conducted site visits
- **Vendors presented equipment**
- **Both vendors will provide the required system and we believe both systems will perform as specified**

Air-Vac / Roe-Vac
Company Comparison

	Air-Vac	Roe-Vac
System Warranty	12 months	12 months
Installation requirements	• Requires qualified installer	• Requires qualified installer • Pit installation requires greater care and verification (Included)
Capital Costs	Higher capital costs	Lower capital costs
O&M Costs	Similar to Roe-Vac (annual valve inspections)	Similar to Air-Vac (annual valve inspections)

Recommendation

- Roe-Vac is recommended because:
  - Lower capital cost
    ($150,000 investment)
  - Reduced costs per customer
    ($212 / customer)
  - Watertight valve chamber (O&M)
  - Easier access into sump (O&M)

Ted's Slides (22)

Operating Requirements

Based on State Regulations:

- Effluent disposal – shallow gravity drainage well
- Rules 62-520 and 62-600, F.A.C.
- Effluent requirements at 0.122 mgd flow

Treatment Parameter	Maximum Annual Average	Maximum Monthly Average	Maximum Weekly Average
Total Suspended Solids	<5.0 mg/l	<6.25 mg/l	<7.5 mg/l
Carbonaceous Biological Oxygen Demand (CBOD)	<5.0 mg/l	<6.25 mg/l	<7.5 mg/l
Total Nitrogen (TN)	<3.0 mg/l	<3.75 mg/l	<4.5 mg/l
Total Phosphorus (TP)	<1.0 mg/l	<1.25 mg/l	<1.5 mg/l

Available Processes

Activated sludge processes with nitrogen removal capabilities:

Process	Lower Design Point (TN)	Upper Design Point (TN)	Drawback
Modified Ludzak-Ettinger (MLE)	5	8	Dependent on Internal Recycle
Step Feed	5	8	Flow-split Control
Sequencing Batch Reactor	5	8	Complex Operation/Control
Bio-denitro	5	8	Complex Operation/Control
Nitrox	5	8	Potential Ammonia Bleed-through
Single Sludge Post-Anoxic	3	12	Large Anoxic Volume or Methanol/Acetate Usage
4-Stage Bardenpho	3	5	Complex Operation/Control
Oxidation Ditch	8	12	Large Ditch Volume
Sym-Bio - SNDN	3	8	Complex Operation/Control and Potential Sludge Bulking
Orbal - SNDN	3	8	Complex Operation/Control and Potential Sludge Bulking

- Grady, Daigger, and Lim, Biological Wastewater Treatment, 2nd Edition, Chapter 11: Biological Nutrient Removal, 1999
- Metcalf and Eddy, Wastewater Treatment and Reuse, 4th Edition, Chapter 8: Suspended Growth Biological Treatment Processes, 2003

Modified Processes for Small Facilities

Modified activated sludge processes with the capability to meet 5,5,3,1 in small facilities:

Process	Lower Design Point (TN)	Upper Design Point (TN)	Drawback
Modified Ludzak-Ettinger (MLE)	3	5	Addition of Denitrification Filter Required
Sequencing Batch Reactor	3	5	Larger Volume or Separate Anoxic Zone
Membrane Bio-Reactor	3	5	Combined 3 or 4-Stage BNR with Low-Pressure Membrane

Note: Based on field research during evaluation process

RFP Requirement

Requested to review two processes:

- Sequencing Batch Reactor (SBR)
- Upflow Sludge Blanket Filter (USBF)

Consideration of MBR was not requested:

- Suitable process
- Produces high quality effluent
- Barrier to microorganisms and viruses

Sequencing Batch Reactor (SBR)

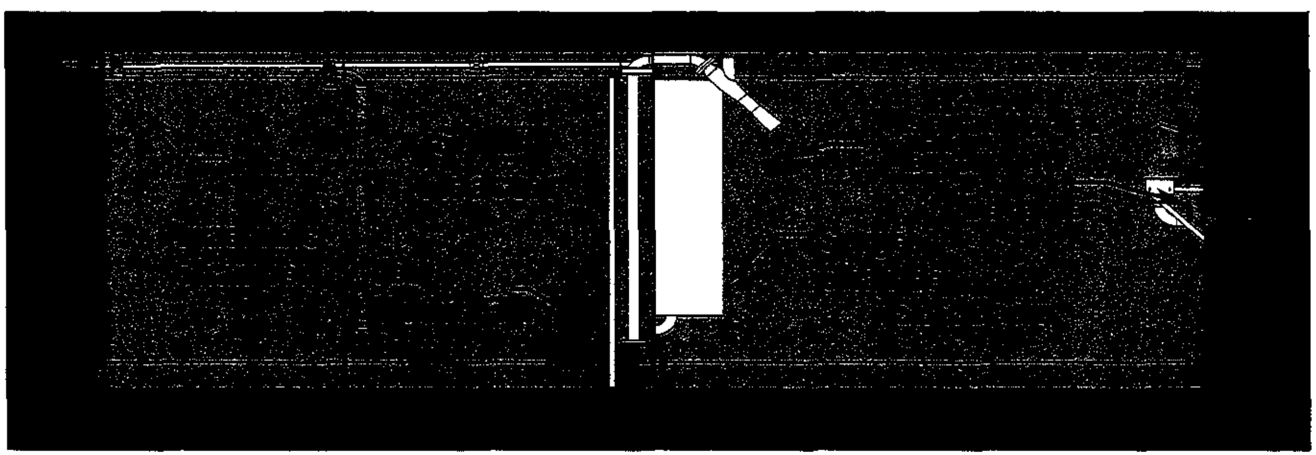
Overview:

- Mixed opinions – SBR achieving 5,5,3,1
- Considered modified SBR
  - Enhanced nitrogen removal
  - Achieved through additional anoxic cycle(s)
  - Or, separate anoxic zone
- Fluidyne proposed ISAM

Integrated Surge Anoxic Mix (ISAM)

Process description:

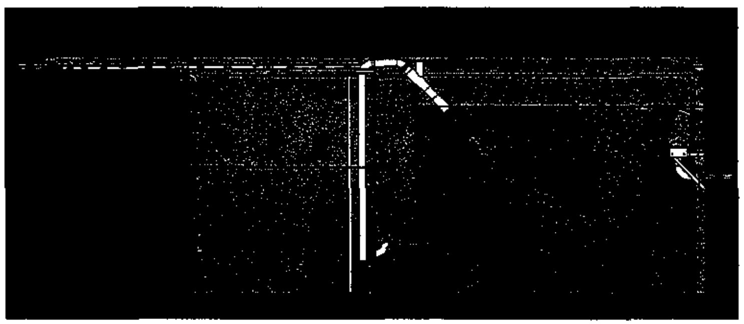
- Anaerobic chamber – allows fermentation of organic compounds to increase soluble BOD
- SAM reactor – equalizes flow during fill phase and serves as anoxic zone during react phase
- SBR basin – ammonia oxidized, BOD removed
- Aeration / mixing achieved via motive pump and aspirator



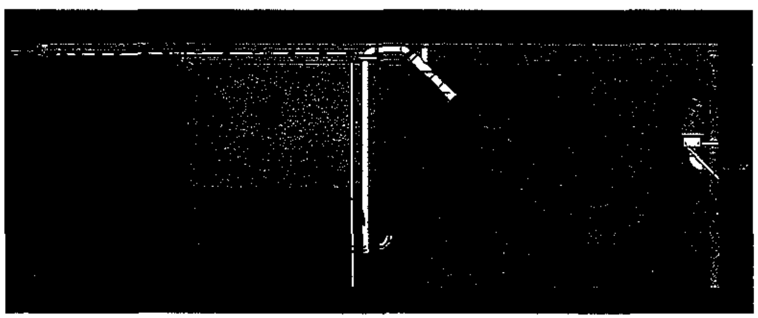
Integrated Surge Anoxic Mix (ISAM)

Operation:

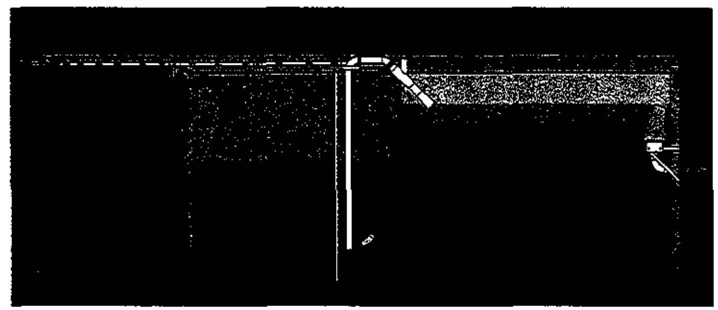
1. Fill Phase:



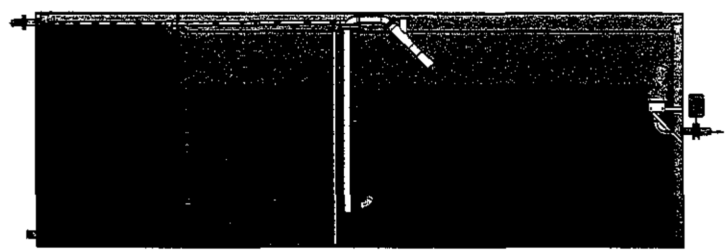
2. Interact Phase:



3. Settle Phase:



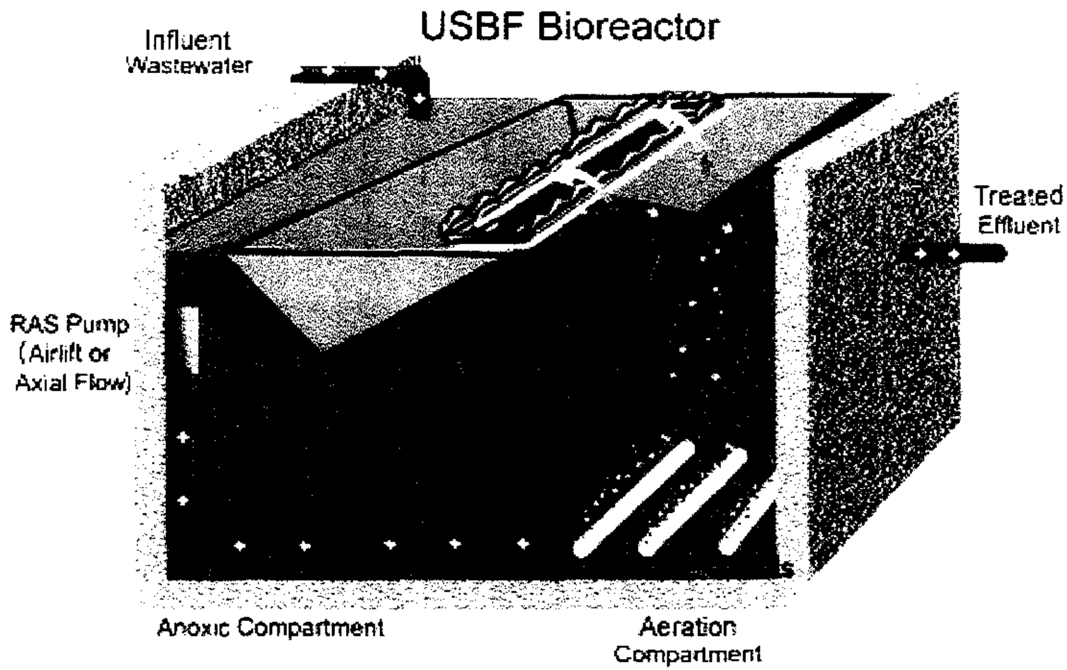
4. Decant Phase:



Upflow Sludge Blanket Filter (USBF)

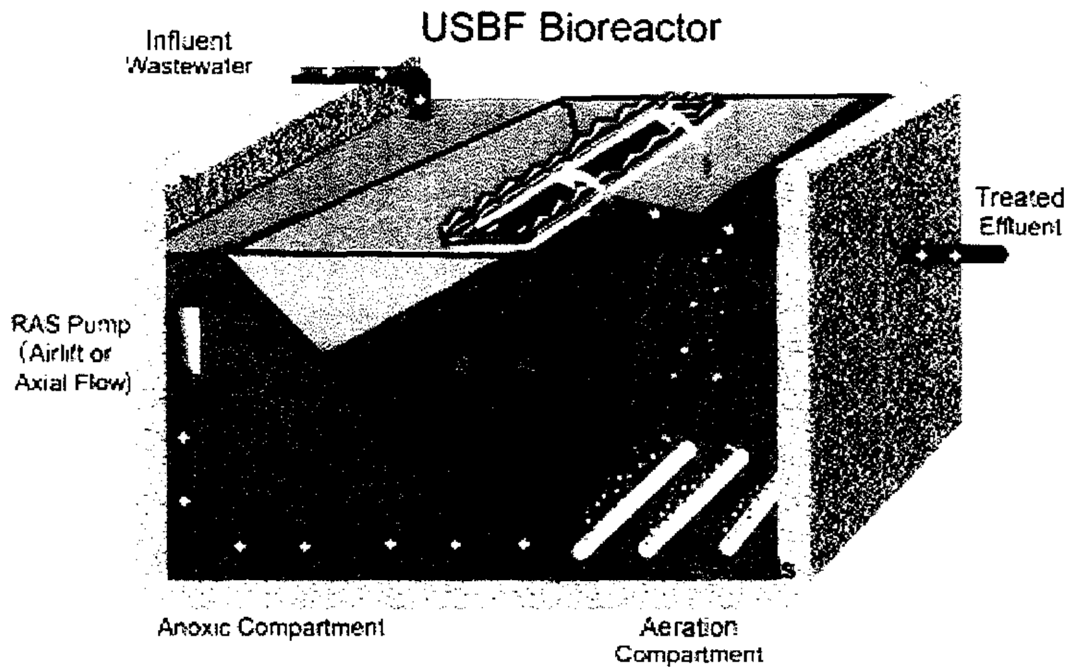
Process description:

- Modified MLE process
- Sludge blanket serves as small 2nd anoxic zone
- Upflow Sludge Blanket Filter (USBF)



Upflow Sludge Blanket Filter (USBF)

Operation:



1. Anoxic Zone: nitrate removed
2. Aeration Zone: ammonia oxidized, BOD removed
3. RAS Recycle: returns nitrate to anoxic zone
4. Sludge Blanket: achieves settling / partial denite

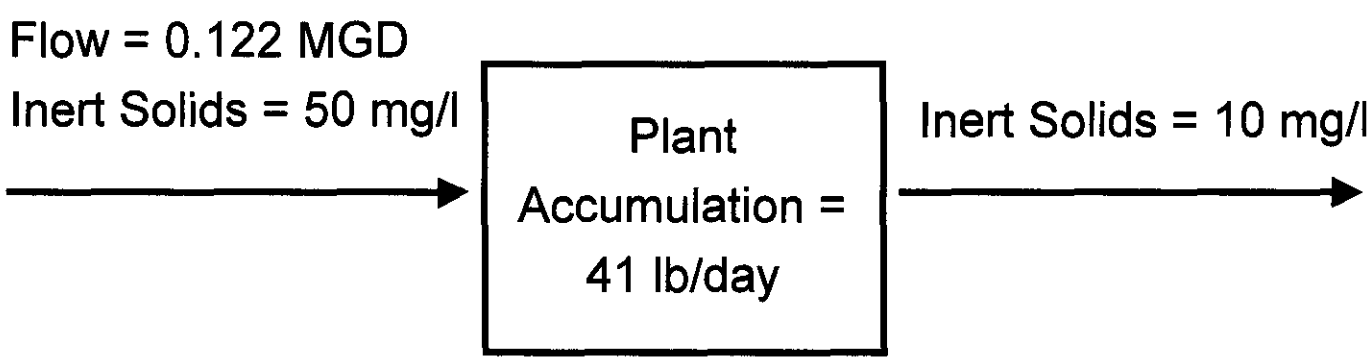
Evaluation Process

- Information request letter was sent
- Information received
- Processes were evaluated
- References were confirmed
- Site visits were made
- Operational costs were compared
- Performance data was compiled
  - Compared to regulatory requirements
  - Reconciled operational problems

Sludge Generation – Common to Both

Three components after steady state is reached:

1. Inert solids input
2. Cell growth through BOD removal (Exogenous Respiration)
3. Cell Death/Lysis (Endogenous Respiration)



Inert is roughly 20% of
the total (250 mg/l)

Inert Sludge Generation

Volume of Sludge:

1. Best case – 2% solids without thickening

$$\text{Volume} = \frac{41 \text{ lb/day}}{0.02 \text{ lb Solids/lb Sludge}} \left| \frac{\text{gallon}}{7.4805 \text{ lb}} \right.$$

= 274 gallons of liquid sludge at 2%

= 137 gallons at 50% flow

= 68 gallons at 25% flow

Minimum! A Day!

Inert Sludge Generation

Volume of Sludge:

1. Best case – 2% solids without thickening

$$\text{Volume} = \frac{41 \text{ lb/day}}{0.02 \text{ lb Solids/lb Sludge}} \cdot \frac{\text{gallon}}{7.4805 \text{ lb}}$$

= 274 gallons of liquid sludge at 2%

= 137 gallons at 50% flow

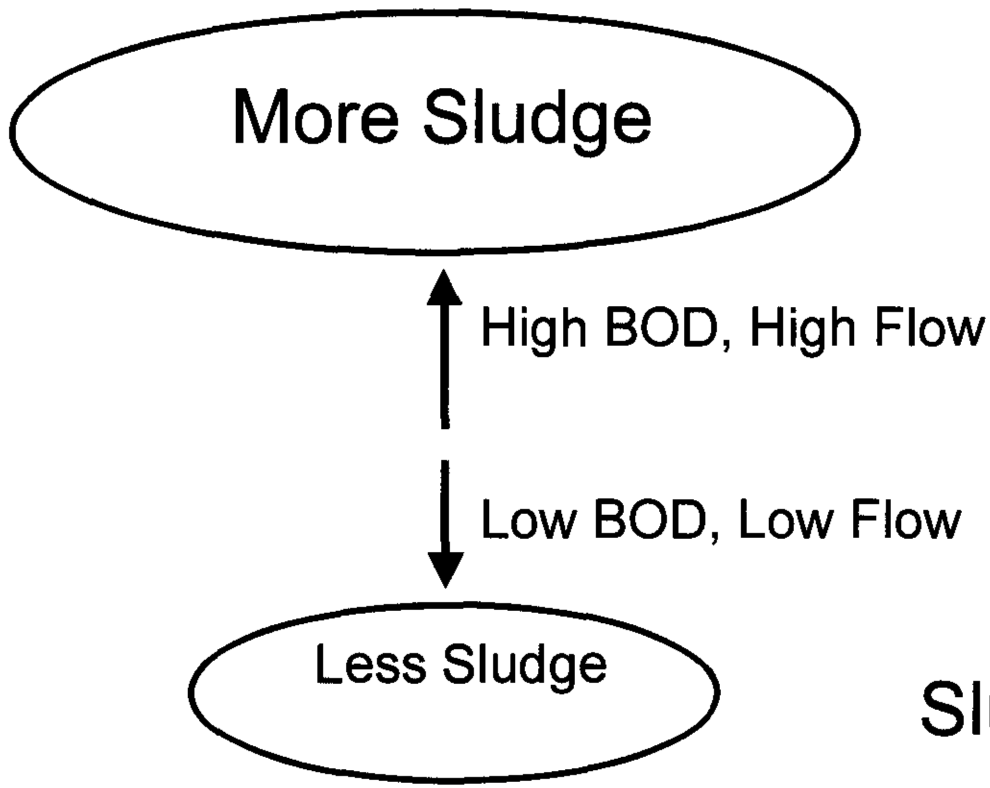
= 68 gallons at 25% flow

Minimum! A Day!

Additional Sludge Generation

Volume of generated sludge:

1. Depends on sludge age and organic loading



Sludge Does Happen!

USBF

- Numerous facilities around US
- Multiple facilities in the keys
- Marco shores – comparable facility
  - Insufficient data to verify treatment capability (4 Weeks)
  - Problems associated with peak flows
  - Otherwise, a nice facility

Process	Facility	Permitted Flow (MGD)	Annual TN Averages		Monthly TN Averages		TN Data Range	
			Best Annual TN Average	Percent Exceeding 3.0 mg/l	Best Monthly TN Average	Percent Exceeding 3.75 mg/l	Minimum	Maximum
USBF	Oceanside Marina	0.02	NA	NA	23.1	100%	23.1	71.60
USBF	Marathon Marina	0.025	NA	NA	15.4	100%	15.4	31.10
USBF	Ziggie's	0.006	8.0	100%	2.2	81%	2.2	29.30
USBF	Islander	0.006	7.4	100%	2.3	95%	1.7	22.50
USBF	Island Tiki	0.012	6.0	100%	0.2	81%	0.1	77.00
USBF	Marco Shores	0.3	NA	NA	3.1	0%	2.1	3.50

USBF

Advantages:

- Minimal moving equipment
- Ease of operation
- Continuous operation

Disadvantages:

- Limited ability to handle peak flows / loadings
- Limited flexibility to achieve <8.0 mg/l TN
- No facility operating under 5,5,3,1 permit

ISAM

- Numerous facilities around US
- Multiple SBR facilities in Florida
- Barona casino – comparable facility
  - Sufficient data to verify treatment capability (1+ Years)
  - Confirmed ability to handle peaks

Process	Facility	Permitted Flow (MGD)	Annual TN Averages		Monthly TN Averages		TN Data Range	
			Best Annual TN Average	Percent Exceeding 3.0 mg/l	Best Monthly TN Average	Percent Exceeding 3.75 mg/l	Minimum	Maximum
SBR	Blacksford	1	2.9	0%	1.5	38%	0.99	5.80
[redacted]								
SBR	Hilliard	0.32	4.9	100%	1.7	17%	1.7	21.00
[redacted]								
SBR	Bartow	4	3.1	100%	2.8	36%	2.76	4.30
[redacted]								
ISAM	Barona	0.75	1.6	0%	0.59	0%	0.21	5.41

Note: Hilliard Annual Average would be 2.9 mg/l if Plant Upset had not Occurred during March and April of 2003

ISAM

Advantages:

- Flexibility to achieve <3.0 mg/l
- Confirmed ability to accommodate peaks
- Fluidyne SBRs operating under 5,5,3,1 permit

Disadvantages:

- More complex operations
- Less mechanical reliability (Starts/Stops vs. Cont.)

ISAM

Operational Comparison:

Process	Facility	Permitted Flow (MGD)	Annual TN Averages: Best Annual TN Average	Annual TN Averages: Percent Exceeding 3.0 mg/l	Monthly TN Averages: Best Monthly TN Average	Monthly TN Averages: Percent Exceeding 3.75 mg/l	TN Data Range: Minimum	TN Data Range: Maximum
USBF	Oceanside Marina	0.02	NA	NA	23.1	100%	23.1	71.60
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SBR	Bartow	4	3.1	100%	2.8	36%	2.76	4.30
ISAM	Barona	0.75	1.6	0%	0.59	0%	0.21	5.41

Note: Hilliard Annual Average would be 2.9 mg/l if Plant Upset had not Occurred during March and April of 2003

USBF vs. ISAM

Operational Costs:

- ISAM vs. SBR power savings due to nitrate usage
- ISAM power cost less during lower flows
- USBF sludge handling costs lowered based on manufacturer's claims

Operational Cost Component	USBF	ISAM
Power Cost for Treatment:	$ 18,931	$ 12,003
Power Cost for Sludge Digestion	$ 4,573	$ 4,573
Annual Sodium Hypochlorite Cost	$ 8,500	$ 8,500
Annual Alum Cost	$ 4,460	$ 4,460
Sludge Handling Cost	$ 85,112	$ 96,891
Annual Operationing Cost	**$ 121,575**	**$ 126,427**

USBF vs. ISAM

Overall Comparison:

Item	USBF	ISAM
Power Costs	• Continuous electrical power consumption	• Intermittent electrical power consumption
Chemical Costs	• Costs are consent • Utilizes ferric chloride phosphorus removal • Sodium hypochlorite will be used for disinfection	• Lower cost with lower flows • Uses Alum for Phosphorus Removal • Sodium Hypochlorite will be used for disinfection
Sludge Handling Costs	• Cost difference is negligible • Lower sludge production based on manufacturer's claims	• Cost difference is negligible • Conservative sludge production
Process Capabilities	• Sludge handling costs slightly lower • Expected total nitrogen of less than 8.0 mg/l • Poor operational data	• Higher costs due to lower sludge age • Expected total nitrogen of less than 3.0 mg/l • Operational data demonstrates capabilities

USBF vs. ISAM continued

Overall Comparison:

Item	USBF	ISAM
Simplicity of Operation	• Simpler control system due to continuous operation	• More complex control due to intermittent operation
Ease of Maintenance	• No difference anticipated	• No difference anticipated
Reliability (permit compliance)	• Majority of data failed proposed monthly effluent standards	• Majority of data passed proposed monthly effluent standards
Ability to Handle Peak Flows	• Flow-through process is prone to peaking upsets	• Built-in equalization characteristic of SBR/ISAM process
Reliability	• High-degree of mechanical reliability	• Slightly less degree of mechanical reliability due to start/stop operation
Adaptability	• Redundant equipment • Difficult to modify process (i.e. adding a carbon source, adding a secondary anoxic process)	• Redundant equipment • Easier to modify process (i.e. adding a carbon source, implementing additional anoxic sequences)

USBF vs. ISAM

Brown and Caldwell:

Recommends the ISAM process

- Greater flexibility to reduce nitrogen levels
- Sludge generation differences – negligible
- Operational cost differences – negligible
- Fluidyne – strong, successful track record in Florida

KEY LARGO STORMWATER DISTRICT SPECIAL MEETING
OCTOBER 11, 2003

TENTATIVE PRESENTATION OUTLINE	TIME LIMIT
I. Introduction	1:00-1:15
A. History	
B. Introduction of Participants	
II. Presentation of Vacuum collection System (Haskell)	1:15-1:40
A. Function of Vacuum collection systems	
B. Pro and Cons of Airvac vs. Roevac	
C. Recommendations	
III. Presentation and evaluation of WWTP (Haskell)	1:40-2:10
A. History of treatment process in Florida	
B. Permit requirements for advanced wastewater treatment (AWT	
C. General description of SBR and USBF treatment process	
D. How evaluation was conducted	
1. Research conducted	
2. References checked	
3. Site visits	
4. Cost comparisons	
5. Use of performance data	
E. Evaluation results	2:10-2:30
1. USBF	
a. History	
b. Performance Data	
c. O & M Cost	
d. Meets AWT standards	
e. Pros and Cons of the process	
2. SBR	2:30-2:50
a. History	
b. Performance Date	
c. O & M Cost	
d. Meets AWT standards	
e. Pros and Cons of the Process	
BREAK (10 MINUTES)	
IV. Summary comparison of USBF versus SBR	3:00-3:20
A. AWT Standards	
B. O & M Costs (Labor, Chemical, Sludge removal and etc.)	
C. Odor control	
D. Additional requirements to meet AWT	

TENTATIVE PRESENTATION OUTLINE	**TIME LIMIT**
VI. Presentation Recommendation by District Manager	
A. Airvac versus Roevac	**3:40:3:50**
B. USBR versus SBR	
VII. Technical Presentation by Vendors	
A. USBF	**3:50-4:05**

(Presentation will be limited to no more than 15 mins and will be designed to focus on the technical aspects of the process and any other facts or figures relevant to the evaluation and recommendations)

B. SBR	**4:05-4:20**

(Presentation will be limited to no more than 15 mins and will be designed to focus on the technical aspects of the process and any other facts or figures relevant to the evaluation and recommendations)

IIIV. Questions and answers by the Board	**OPEN**

Charles L. Sweat
Director of Operations
Biography

Charles L. Sweat, Vice President of Government Services Group and Director of Operations for the Florida Governmental Utility Authority (FGUA), has nearly 40 years of professional water/wastewater experience, ranging from operations and customer service to upper level administration. Prior to joining Government Services Group, he served for more than five years as the President of Southern States Utilities which, at that time, was Florida's largest private water/wastewater utility.

Mr. Sweat is a licensed water and wastewater plant operator whose vast process knowledge includes lime softening, reverse osmosis, contact stabilization, extended aeration, trickling filters and sequencing batch reactor (SBR). He has extensive experience with low-pressure sewer systems. During his operational tenure, he has been responsible for the planning, design and construction of over a dozen major facility expansions. It has been estimated that over the tenure of his career, Mr. Sweat has personally supervised the installation of more than 6,000 miles of pipe to serve Florida customers. Mr. Sweat was also an early pioneer and staunch advocate of the use and benefits of reclaimed water, and his involvement can be traced back to some of the first systems to employ such methods.

Mr. Sweat is a native Florida High School graduate, and attended Seminole Community College and Rollins College in Winter Park, Florida.

Mr. Sweat is certified in Risk Assessment Methodologies for Water Utilities (RAM-W) and was named Project Manager for the EPA mandated Vulnerability Assessments for the ten FGUA water treatment facilities. Also to his credit is the development of numerous Disaster Recovery and Emergency Response Plans, for water and wastewater systems throughout Florida.

Mr. Sweat served as chairman for the Region 11 Operator's Association in 1980, Chairman of the AWWA Small Meters Committee in 1992 and President of the Florida Water Works Association in 2000. He is currently a

Director on the Executive Committee for the Sun Trust Bank, a position he has held for more than 11 years.

R. Jeff Weiler, PE **President**

Mr. Weiler is a Professional Engineer registered in the State of Florida. He is the President of The Weiler Engineering Corporation specializing in residential, commercial and municipal engineering projects throughout Southwest Florida and has more than eleven years experience working in the Florida Keys.

Mr. Weiler graduated from Colorado State University in 1987 with a Bachelor of Science (BS) Degree in Civil Engineering and a minor in mathematics and is a registered Professional Engineer.

Mr. Weiler has over twenty (20) years of experience in various types of engineering, construction and surveying projects and offers specialized knowledge and proven ability in:

• Design, permitting and construction management and administration for Water Distribution and Sewage Treatment, Collection and Transmission systems.

• Design, permitting and construction administration for numerous stormwater management facilities throughout southwest Florida and the Florida Keys.

• Road, Highway and Drainage Design for municipal and private projects.

• Value Engineering and Cost estimating for private and public works projects.

• Site and Project Planning, Design, and Permitting of a variety of projects ranging from residential and mixed use subdivisions to large shopping and office centers.

• Design and permitting of individual on-site wastewater treatment units including conventional and aerobic systems.

• Structural design and permitting of residential and commercial structures to assure compliance with Standard and South Florida building codes.

• Surveying, Platting and Mapping for subdivisions, highway and engineering projects.

• Boat Ramp Design and Permitting.

• Dredge and Fill Design and Permitting.

• Design of marine facilities including docks, ramps, shelters and accessory structures.

Mr. Weiler has a long and strong track record of understanding the client's needs and managing personnel to attain project goals.

Notable projects Mr. Weiler has served as Principal or Engineer in Charge and has been responsible for include:

• Key West Resort Utilities – General Consultant
• Monroe County Wastewater Project
• Monroe County Detention Facility
• Villages at Hawk's Cay
• Indies Island Utilities
• Boy Scouts of America / SEABASE
• Mangrove Marina

Ed Castle, PE **Project Manager**

Mr. Castle has over (17) seventeen years experience in administration, supervision and laboratory services relating to water pollution control in Florida and has worked with WEC since 1998. He is licensed as a Florida Class A Wastewater Treatment Plant Operator with a Bachelor of Science Degree in Chemical Engineering from the University of Kentucky with emphasis on water pollution control and is a Register Professional Engineer in the State of Florida.

Mr. Castle is experienced in staff supervision, budget management and capital improvement projects.

Mr. Castle has specialized knowledge and proven ability in areas such as:

- Construction management and administration of multiple wastewater treatment plant operations.
- Administration and technical support of wastewater treatment plants, sanitary sewer collection systems and storm sewer systems.
- Operation and maintenance of privately and publicly owned wastewater treatment plants and individual home aerobic treatment units.
- Wastewater residuals management.
- Operation of sludge and sewage transfer stations.
- Wastewater and stormwater utility elevations and underground utility construction inspects.
- Facilities ranging from individual home units to 127 MGD.
- Sampling and analysis of water, wastewater, groundwater and surface water samples.

In addition, Mr. Castle has experience and a strong working relationship with regulatory agencies, local governmental agencies and environmental groups in the Florida Keys. Has worked closely with the Department of Environmental Protection, the US EPA, NOAA, Monroe County, the City of Key West, the US Navy and the Department of Health regarding wastewater and environmental issues.

Notable projects Mr. Castle has been involved in include:

- Key West Resort Utility
- Monroe County Wastewater Project
- Key Colony Beach
- City of Key West Wastewater Treatment Plant
- Duck Key Wastewater Treatment Plant
- City of Hollywood Wastewater Treatment Plant
- Jupiter Wastewater Treatment Plant
- Martin County Wastewater Treatment Facilities
- Stewart County Wastewater Treatment Plant
- 250 Package Plants throughout the Florida Keys

PETER M. KINSLEY
DIVISION LEADER – WATER
CIVIL GROUP

CREDENTIALS	Kinsley's experience includes lead management and direction of major projects in excess of $80 million, with an extensive knowledge of civil, structural, architectural, MEP systems and instrumentation. During his professional career, he has managed an array of projects, including water treatment, educational and telecommunication facilities.
RESPONSIBILITIES	As leader of the Water/Wastewater Division, Kinsley is responsible for developing design-build project opportunities and markets as well as the strategic planning and financial performance of the division. He establishes relationships with engineering firms and specialty subcontractors for the pursuit and delivery of water and wastewater projects. He provides oversight for all phases of project delivery including client relations, estimating, procurement, scheduling, contract administration, staffing, project controls and construction coordination. Kinsley has full authority to commit company resources as required for the successful delivery of every project.
RELEVANT PROJECT EXAMPLES	**Key Largo Wastewater Management System**, Key Largo Wastewater Treatment District, Key Largo, Florida, $7.9 Million **Hollywood WTF**, Hollywood Florida, $5.34 Million **Glades Road Water Treatment Plant**, Boca Raton, Florida, $7.96 Million **Jupiter Island Reverse Osmosis Water Treatment Plant**, Hobe Sound, Florida, $4.67 Million **JEA Plant Consolidation Highlands Water Treatment Plant Improvements**, Jacksonville, Florida $7.74 Million **JEA Cecil Commerce Center Water Treatment Plant**, Jacksonville, Florida, $10.9 Million **Allentown Business School**, Allentown, PA – $12 Million – 12 Months – Design/Build Delivery **Sprint PCS Call Center**, Orlando, FL – $8.5 Million – 13 weeks – Design/Assist Delivery **Town Creek Water Treatment Plant**, Macon, GA – $80 Million – 36 Months – Traditional Delivery **Reservoir Intake Pump Station**, Macon, GA – $4 Million – 12 months – Traditional Delivery
EDUCATION	Master of Science in Civil Engineering Virginia Polytechnic University, 1995 Bachelor of Science in Civil Engineering Vanderbilt University, 1992
REGISTRATIONS / LICENSES/TRAINING	OSHA 30-Hour Training Course in Construction Safety & Health Competent Person Training in Scaffolding and Excavation
PROFESSIONAL AFFILIATIONS	Design Build Institute of America
YEARS OF EXPERIENCE	10

Regional Process Engineer

John R. Bratby, Ph.D., P.E., DEE

Experience Summary

Dr. John Bratby has 30 years of experience in the areas of design, research and teaching. He has worked as chief process design engineer; carried out on-site research; and presented training courses for numerous treatment plants. He has functioned as senior process design engineer for numerous wastewater treatment plants, and water reclamation facilities.

Randolph Park WRF, Pima County, Tucson, Arizona
Senior Process Design Engineer. Process design of the 3.5 mgd Randolph Park WWTP, Pima County, Tucson, AZ. The plant comprises a 3.5 mgd membrane bioreactor plant. Separate process designs were carried out for two potential membrane equipment suppliers (Zenon and Kubota).

Water Resource Center, Las Vegas Valley Water District (LVVWD), Las Vegas, Nevada
Senior Process Engineer. Process design and preparation of conceptual Basis of Design for the water reclamation plant (10 mgd). Processes include preliminary treatment, equalization, activated sludge with nitrification-denitrification, secondary sedimentation, filtration, UV disinfection and odor control.

Mason Farm WWTP, Orange Water and Sewer Authority, Carrboro, North Carolina
Senior Process Design Engineer. Extensive sampling and simulation modeling of the 8 mgd biological phosphorus removal plant. The plant currently operates under the patented OWASA process. Conducted evaluation of the impacts of removing the trickling filters from the process train.

91st Avenue Wastewater Treatment Plant, Phoenix, Arizona
Senior Process Engineer. Process Engineer for design of methanol system. Evaluation of DAF thickeners and delineation of upgrades and testing program required.

Big Creek WRP and Little River WPCP, Fulton County, Georgia
Senior Process Engineer. Extensive sampling and process modeling of these two biological P removal plants for interim capacity improvements and future plant expansions. Big Creek currently rated at 24 mgd and Little River 1.5 mgd.

Gilbert WRF, Gilbert, Arizona
Senior Process Engineer. Process design of the Gilbert WRF expansion to 12.1 mgd. Evaluated additional reactors, anoxic zones, secondary clarifiers and aeration requirements to meet future flows and loads, and Arizona reuse standards.

Assignment
Process Design Expert

Education
Ph.D., Environmental Engineering, University of Cape Town, 1976
M.S., Environmental Engineering, University of Cape Town, 1973
B.S., Civil Engineering, Loughborough University, England, 1970

Registration
Professional Engineer, 33607, Colorado, 1995
Professional Engineer, Sanitary, 26020, Arizona, 1992
Professional Engineer 13136, New Mexico, 1995
Professional Engineer 40067, Minnesota, 2000
Professional Engineer PE 900098, District of Columbia, 2000
Diplomat, American Academy of Environmental Engineers, 92-20052, 1993

Training/Certification
Arizona Department of Environmental Quality, Certified Operator, Water Treatment Plant, Wastewater Treatment Plant, Grade 4 (both); Operator ID 05940

Experience
30 years

Joined Firm
1997

Relevant Expertise
Nitrification-Denitrification
Biological Phosphorus Removal
Effluent Polishing
Process Simulation Modeling
Aeration
Sludge Thickening
Sludge Handling
Membrane Technology
Filtration
Coagulation and Flocculation
Water Sludge processing
Disinfection

Employee Information:
Stuart Oppenheim, P.E.
Vice President
Brown and Caldwell

Project Title: *Design Project Manager*

Experience: *BC - 17 yrs. Others - 11 yrs.*

Education:
M.C.E., Sanitary Engineering, 1975
B.S., Civil Engineering, 1974

Professional Registration:
Professional Engineer, FL(in process), IL, WA, TX

Applicable Work Experience:
Oppenheim is experienced in the design and management of various wastewater collection and treatment system projects including numerous small and large secondary treatment plant designs and sludge dewatering projects. He has also been actively involved in a number of reclaimed water and odor control projects.

- **El Paso Water Utilities, Haskell R. Street Wastewater Treatment Plant, El Paso, Texas**
  Project Manager. Upgrade of a 24-mgd plant to provide nitrification including a new air activated sludge process that comprises converting an existing high purity oxygen basin into an anoxic selector. Other facets of the project consist of a remodeled grit system, new plant water system a new mixed sludge pumping and blending system and odor control.

- **El Paso Water Utilities, Eastside Water Reclamation Plant Predesign, El Paso, Texas**
  Project Manager. Developed predesign study for a new 1.0 mgd water reclamation plant. Evaluated secondary processes, including SBR and IMB. Project included evaluation of each plant process, together with screens and disinfection. Evaluated deep well injection for the plant's effluent.

- **Waste Water Treatment Plant, Fabens, Texas**
  Technical Reviewer. Replaced an existing .375 mgd plant with a new 1.2 mgd facility plant which will use Sequox nitrification / denitrification process. Also, includes new screens, 4V disinfection, sludge treatment and dewatering.

- **North District Plant, Miami-Dade Peak Flow Management Project, Miami, Florida**
  Project Manager. Assembly of existing capacity, management, operation and maintenance (CMOM) programs into a summary document that meets the requirements contained in the U.S. Environmental Protection Agency's proposed National Pollutant Discharge Elimination System Regulation 40 CFR 22.42.e Municipal Sanitary Sewer Systems - Capacity, Management, Operation and Maintenance Programs.

- **Carkeek Transfer/CSO Facility Plan and Design, Municipality of Metropolitan Seattle, Washington**
  Lead Project Engineer. Responsible for planning the Storm Weather Treatment Plant and Transfer System. An 8.4 mgd two-stage high head pumping station with a discharge pressure of 280 feet located within a City of Seattle park. Odor control, noise abatement, aesthetics and public involvement were integral parts of the design. The project also included the modification of an existing primary treatment plant to operate as an intermittently operated storm weather plant.

- **El Paso Water Utilities, Bustamante Wastewater Treatment Plant Expansion, El Paso, Texas**
  Project Manager. Multi-phased enlargement of El Paso's largest wastewater treatment plant. The first two phases are under construction, and include a new 88 mgd headworks (influent lift station, mechanical screening and grit removal system modifications). The second contract consists of a new 2 million gallon anaerobic digester and control building.

- **Renton Regional Water Reclamation Plant, Municipality of Metropolitan Seattle, Seattle, Washington**
  Enlargement III, Liquid Stream Contract Manager. Led the design of this $56 million expansion from 72 mgd to 108 mgd. This 50 percent expansion was accomplished by adding only 25 percent more tankage. The project included headworks expansion, new aeration basins, sedimentation and major odor control facilities.

Employee Information:
Joseph Paterniti, P.E., DEE
Practice Leader
Brown and Caldwell

Project Title: *Collection System Design Lead & Effluent Disposal Design Lead*

Experience: *BC - 3 yrs.* *Others - 20 yrs.*

Education:
B.S., Civil Engineering, 1984

Professional Registration:
Professional Engineer, FL

Applicable Work Experience:
Paterniti has over 23 years of water and wastewater municipal consulting experience and has been highly effective in providing numerous clients with cost-saving solutions for environmental problems and issues. His experience includes coordinating large-team efforts to successfully complete designs and obtain local and state permits to mitigate adverse environmental impacts. He has provided construction, administration and management for numerous facility expansions and improvement projects for Florida utilities and public works departments.

- Surface Water Treatment Plant, Hillsborough County, Florida
  Project Engineer. Provided peer review of the Tampa Bay Water, 66 mgd surface water treatment plant. The review included an evaluation of the engineering plans and report to confirm that the public health, safety and welfare was protected and sound engineering practices were being utilized. Results of the review were presented to the Hillsborough County Commission.

- **Wastewater Treatment Plant, Effluent Reuse System, Lehigh Utilities, Florida**
  Project Manager. Selected most cost-effective reuse main route. Designed, permitted and implemented 3.5 miles of 20-inch diameter reuse effluent transmission main. The selected route included 4 aerial canal crossings and a jack and bore county roadway crossing. Designed, permitted and implemented the 100 Hp variable speed irrigation pumping facility to apply reuse effluent to the 90-acre public golf course. This design included modifications to the existing golf course irrigation system.

- **Contract Administration and Construction Management**
  Project Manager. Construction management services included: reviewing contractor submittals, conducting pre-construction and progress meetings, and coordinated resident engineer activities to ensure quality control and conformance to contract specifications. Provided construction, administration and management for the following utility and public work expansions and improvements.

- City of Miramar, Water Treatment Plant Phase I Expansion and Access Road
- North Key Largo, Utilities Odor Control System
- City of Sunrise, Water and Forcemain Projects
- City of Sarasota, Water Treatment Plant Improvements
- City of Sarasota, Raw Water Wells
- City of Sarasota, Elevate Storage Tank
- Lehigh Utilities, Wastewater Reuse and Golf Course Irrigation Modifications
- Lehigh Utilities, Wastewater Treatment Plant Expansion
- Plantation Utilities, Reverse Osmosis Treatment Plant Expansion
- Plantation Utilities, Reverse Osmosis Water Supply Wells and Transmission Main
- Charlotte County, Water Mains and Deep Injection Well
- City of Punta Gorda, Water Treatment Plant and Finish Water Storage Tank

Employee Information:
Charles Hortenstine, P.E.
Senior Project Manager
Brown and Caldwell

Project Title: *Treatment Plant Design Lead*

Experience: *BC - 2 yrs.* *Others - 16 yrs.*

Education:
B.S., Chemical Engineering, 1984

Professional Registration:
Professional Engineer, FL

Applicable Work Experience:
Hortenstine has over 18 years of experience in the field of environmental engineering. He has been involved with many important wastewater treatment projects in the State of Florida. His project experience includes wastewater plant design, permitting, and construction; and, treatment process testing, evaluation and modifications.

- **2.25 MGD Wastewater Treatment Plant, City of Edgewater, Florida**
  Project Manager. The project included the design, permitting, bidding and construction of a 2.25 MGD advanced wastewater treatment plant.

- **Phase I Expansion of the Iron Bridge Water Pollution Control Facility, City of Orlando, Florida**
  Project Engineer. The project consisted of developing plans and specifications for a portion of the Phase I expansion of the Iron Bridge Water Pollution Control Facility including flow diversion, pretreatment, and odor control for the initial 12 MGD expansion. For the second 12 MGD expansion, Mr. Hortenstine prepared plans and specifications for the pretreatment system for this facility.

- **Pembroke Pines East Wastewater Treatment Plant, The Haskell Company, Pembroke Pines, Florida**
  Project Manager. The City of Pembroke Pines has contracted with a design build firm, The Haskell Company, to provide engineering contracting services for several City projects. Brown and Caldwell has been retained to provide the design and permitting of the 12 mgd wastewater treatment plant and disposal facilities.

- **City of Orlando Water Conserv II Master Pump Station and Flow Equalization, City of Orlando, Florida**
  Project Manager. Mr. Hortenstine is currently serving as project manager on the Master Pump Station and Flow Equalization Project for the Orlando Conserv II Water Reclamation Facility. Mr. Hortenstine is responsible for developing the conceptual process modifications and control scenarios for this project. The project will consist of a pump station capable of pumping in excess of 60 MGD, one 3.5 MG flow equalization basin, a flow equalization pumping station and all associated yard piping, electrical and instrumentation modifications.

- **3.0 MGD Expansion of Existing 4.5 MGD WWTP, City of New Port Richey, Florida**
  Project Manager. The project consisted of the design, permitting, bidding and construction management of a pretreatment system, odor control system, RAS system, filtration system expansion, chlorine contact/dechlorination system, non-potable water pumping system and post-aeration system which utilized both mechanical aeration and a liquid oxygen feed system.

- **1.0 MGD Expansion of the Existing Wastewater Treatment Facility, City of Wildwood, Florida**
  Project Manager. The expansion included the conversion of the existing activated sludge system to Phased Isolation Ditch technology. The project also included a new pretreatment system, an additional clarifier, a new chlorine feed system, an aerobic sludge digester, a sludge dewatering system and an administration/maintenance building.

Employee Information:

Walter Messer
Vice President
Florida Senior Project Manager
Douglas N. Higgins, Inc.

Project Title: *Project Manager*

Experience: *Higgins - 4 yrs.* *Others - 26 yrs.*

Education:
U.S. Navy

Professional Registration:
Certified Underground Utility & Excavation Contractor

Applicable Work Experience:

Messer has 30 years of experience installing sewer, water and storm drainage piping and associated work. He also holds a Florida State Certified Underground Utility and Excavation License.

- **City of Key West Pump Station A Rehabilitation and Force Main**, Key West, Florida
- **Sanitary Sewer Rehabilitation for Service District F & G**, Key West, Florida
- **Sanitary Sewer Rehabilitation, Service District C**, Key West, Florida
- **Flagler Interceptor, Phase II Sanitary Sewer Rehabilitation**, Key West, Florida
- **Sewer & Water System Improvements--Hilton Haven Sewer & Water Main Extensions Pump Station S**, Key West, Florida

THE HASKELL COMPANY
AMERICA'S DESIGN-BUILD LEADER®

Facsimile Letter

Date/Time: October 14, 2003

To: Robert Sheets & Charles Sweats at: Government Service Group

Fax No.: 850/224-7206 & 407/629-6963 Total No. Of Pages: 5 (including this cover sheet)

Message:

Per your request, attached please find resumes from the USBF and SBR technical representatives.

USBF – Terry M. Zaudtke of CPH Engineers
SBR – Glen R. Callthrop of Fluidyne Corporation

In addition, John Verscharen of TSC-Jacobs (Fluidyne Representative) provided the following over the phone:

Education
BS in Civil Engineering from University of South Florida – 1985
MS in Civil Engineering from University of South Florida – 1988

Employment
Post Buckley – Project Engineer – 2 Years
CH2Mhill – Project Manager – 2 Years
TSC-Jacobs – President – 14 Years

Professional Engineering Registration in 1988

Cc:
Issue File 01-004

From:

Peter M. Kinsley

Division Leader - Water

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HASKELL BUILDING ◆ JACKSONVILLE, FLORIDA 32231-4100 ◆ 904/791-4500 FAX 904/791-4699

Terry M. Zaudtke, P.E., DEE

Academic Credentials

M.S. Civil Engineering
University of Minnesota, 1979
B S. Civil Engineering
University of Minnesota, 1976

Licenses

[illegible] Minnesota, Georgia, South Carolina,
Alabama, Colorado

Principal Areas of Expertise

Quality Assurance and Quality Control
Water Supply, Pumping and Treatment
Water Distribution
Wastewater Collection, Transmission and Treatment
Reclaimed Water Treatment and Distribution
Collection System Rehab
Municipal Engineering

Professional Activities

American Academy of Environmental Engineers – Diplomat Environmental Engineer
Listed in Who's Who in Environmental Engineering)
American Society of Civil Engineers, Past Officer
Construction Specification Institute
American Concrete Institute
Concrete Reinforcing Institute
Chi Epsilon
Quill and Scroll, an honorary Journalism Society
VITA – Volunteers in Technical Assistance
Water Environment Federation
ACI – Certified Structural Masonry Inspector

Mr. Zaudtke serves the firm of CPH Engineers, Inc. as Chief Operating Officer and Project Manager/Engineer for both public and private civil projects in his areas of expertise of Environmental and Civil Engineering. These projects include work in land development, municipal engineering, water and sewer facilities, drainage, waste treatment and water supply. Mr. Zaudtke served as the Project Manager and Engineer for the City of Casselberry, U.S. Navy, City of Orlando, City of Winter [illegible] Utilities, Inc.

Mr. Zaudtke has over 20 years of consulting engineering experience, with technical duties ranging from feasibility studies through construction engineering activities. He has directly worked on all aspects of civil engineering projects, including studies, designs, permitting, inspections, financing and construction administration. The range of projects includes wastewater treatment, water treatment, water supply, water distribution, wastewater collection, sewer system rehabilitation, reclaimed water, storm drainage and other municipal engineering activities.

Recent major projects include the Guam Sewer project (ten miles of sewer reconstruction) and reclaimed systems for the cities of Winter Springs and Casselberry and a new sewer system in an existing neighborhood for the City of Orlando.

The Guam Sewer Project was performed for the US Naval Station under a design/build contract and included design, wetlands permitting and EC&I work throughout the project. In addition, Mr. Zaudtke has designed five treatment facilities for the U.S. Navy for industrial and domestic wastewater treatment.

For over 20 years, Mr. Zaudtke has been working with public and private utilities on wastewater and reclaimed water systems. This involves taking existing treatment facilities and upgrading them to public access criteria and design of new systems. The biological processes are improved and tertiary treatment is added to enhance the operation and reliability of the facility.

Prior to joining CPH, Mr. Zaudtke worked as the Research Engineer for the City of Duluth on a Direct Filtration water treatment plant for the removal of asbestos-like fibers. He was also the Staff Engineer for a 43 MGD advanced wastewater treatment facility for the Western Lake Superior Sanitary District. At both facilities, Mr. Zaudtke was responsible for improving operations.

Professional Résumé of Glen R. Calltharp

• PERSONAL DATA

Name: Glen Richard Calltharp

Address: 2202 Gold Oak Lane
Sarasota, FL 34232

• EDUCATION

University of Kansas - Lawrence, Kansas - Graduated 1968

• PROFESSIONAL EXPERIENCE

11/89 - Present Process Technologies, Inc. - Sarasota, FL - Marketing and process consultant serving the industrial, and municipal wastewater market. Owner and President

Company offers marketing assistance, including software design and implementation to industrial clients.

8/97 – Present Fluidyne Corporation – Cedar Falls, Iowa - Process and Marketing Consultant.

1/96 - 4/97 Aqua-Aerobic Systems, Inc. - Rockford, IL - Product Development Consultant, Jet Aeration. Developed jet aeration product line. Responsible for design, testing, and application software for new product line.

11/94 - 3/95 Framco Environmental Technologies - Sarasota, FL - Vice President, Operations. Responsible for day-to-day operation of the company, including engineering, production, personnel, product development, and municipal marketing.

3/93 - 3/95 Framco Environmental Technologies - Sarasota, FL - Marketing and process consultant. Retained to develop design standards, design software, specifications, and develop marketing plan for Framco to enter the sequencing batch reactor market.

6/81 - 11/89 Jet Tech, Incorporated - Industrial Airport, KS - Manufacturer of jet aerators, jet mixers, and Sequencing Batch Reactor process equipment and controls; serving the municipal and industrial wastewater treatment market. Co-founder and President.

Founded and managed company. Responsible for all aspects of operation; developed equipment design, control strategy, sales literature, specifications, and design and marketing software. Company grew to a $9.5 million per year operation with thirty employees, and representatives in twenty-two market areas. Jet Tech is a leading supplier of jet aeration systems, and Sequencing Batch Reactor equipment and controls.

6/80 - 4/81 Pentech Division Houdaille Industries - Cedar Falls, IA - National Sales Manager, responsible for all sales of company's products. Sales increased from $3.5 million to $5.5 million in less than one calendar year. Division was sold in April of 1981.

10/78 - 6/80 Pentech Division Houdaille Industries - Cedar Falls, IA - Manufacturer of jet aerators and mixers for the municipal and industrial wastewater treatment market - Regional Sales Manager

Responsible for all sales of company's products in the Midwest region which included, roughly, all area between the Mississippi River and the Rocky Mountains. Region accounted for 65% of company's total sales.

10/77 - 10/78 Wallace & Tiernan Division - Minneapolis, MN - Regional Sales Manager

Responsible for all sales of company's products in four states in the Upper Midwest. Sales office led nation in performance against quota.

6/73 - 10/77 Wallace & Tiernan Division - Shawnee Mission, KS - Manufacturer of chemical feed and control equipment for the industrial process, and municipal water and wastewater markets - Regional Indirect Sales Manager

Responsible for sales through representatives, and distributors in eight Midwestern states. Region led nation in performance against quota from 1975 through 1977.

12/69 to 5/73 Fitzwater & Associates - Kansas City, MO - Manufacturer's Representative serving the industrial process, and municipal and industrial water and wastewater markets - Sales Associate

Responsible for sales of seventeen principle's products in Kansas and Western Missouri. Products included pumps, control and relief valves, mixers and agitators, aerators, process heating and control equipment, filtration equipment, and demineralization and ion exchange equipment.

8/68 - 10/69 Black & Veatch Consulting Engineers - Kansas City, MO - Civil / Sanitary Group - Staff Engineer

Worked on design of gravity sewers, lift stations, and treatment plants. Worked in field performing flow studies, and projections.

• **PATENTS**

U.S. Patent 4,645,592*	SBR Reactor Piping and Flow Control System
U.S. Patent 4,648,967*	SBR Decanting Apparatus
U.S. Patent 4,711,716*	SBR Decanting Apparatus
U.S. Patent 4,724,073*	SBR Reactor Piping and Flow Control System
U.S. Patent 4,775,467*	SBR Reactor Piping and Flow Control System
U.S. Patent 5,021,161*	"Batch Proportional Treatment and Operating Strategy" for Sequencing Batch Reactor Process.

* Patents assigned to Jet Tech, Inc.

Charles L. Sweat
Director of Operations
Biography

Charles L. Sweat, Vice President of Government Services Group and Director of Operations for the Florida Governmental Utility Authority (FGUA), has nearly 40 years of professional water/wastewater experience, ranging from operations and customer service to upper level administration. Prior to joining Government Services Group, he served for more than five years as the President of Southern States Utilities which, at that time, was Florida's largest private water/wastewater utility.

Mr. Sweat is a licensed water and wastewater plant operator whose vast process knowledge includes lime softening, reverse osmosis, contact stabilization, extended aeration, trickling filters and sequencing batch reactor (SBR). He has extensive experience with low-pressure sewer systems. During his operational tenure, he has been responsible for the planning, design and construction of over a dozen major facility expansions. It has been estimated that over the tenure of his career, Mr. Sweat has personally supervised the installation of more than 6,000 miles of pipe to serve Florida customers. Mr. Sweat was also an early pioneer and staunch advocate of the use and benefits of reclaimed water, and his involvement can be traced back to some of the first systems to employ such methods.

Mr. Sweat is a native Florida High School graduate, and attended Seminole Community College and Rollins College in Winter Park, Florida.

Mr. Sweat is certified in Risk Assessment Methodologies for Water Utilities (RAM-W) and was named Project Manager for the EPA mandated Vulnerability Assessments for the ten FGUA water treatment facilities. Also to his credit is the development of numerous Disaster Recovery and Emergency Response Plans, for water and wastewater systems throughout Florida.

Mr. Sweat served as chairman for the Region 11 Operator's Association in 1980, Chairman of the AWWA Small Meters Committee in 1992 and President of the Florida Water Works Association in 2000. He is currently a

Director on the Executive Committee for the Sun Trust Bank, a position he has held for more than 11 years.

R. Jeff Weiler, PE — President

Mr. Weiler is a Professional Engineer registered in the State of Florida. He is the President of The Weiler Engineering Corporation specializing in residential, commercial and municipal engineering projects throughout Southwest Florida and has more than eleven years experience working in the Florida Keys.

Mr. Weiler graduated from Colorado State University in 1987 with a Bachelor of Science (BS) Degree in Civil Engineering and a minor in mathematics and is a registered Professional Engineer.

Mr. Weiler has over twenty (20) years of experience in various types of engineering, construction and surveying projects and offers specialized knowledge and proven ability in:

- Design, permitting and construction management and administration for Water Distribution and Sewage Treatment, Collection and Transmission systems.
- Design, permitting and construction administration for numerous stormwater management facilities throughout southwest Florida and the Florida Keys.
- Road, Highway and Drainage Design for municipal and private projects.
- Value Engineering and Cost estimating for private and public works projects.
- Site and Project Planning, Design, and Permitting of a variety of projects ranging from residential and mixed use subdivisions to large shopping and office centers.
- Design and permitting of individual on-site wastewater treatment units including conventional and aerobic systems.
- Structural design and permitting of residential and commercial structures to assure compliance with Standard and South Florida building codes.
- Surveying, Platting and Mapping for subdivisions, highway and engineering projects.
- Boat Ramp Design and Permitting.
- Dredge and Fill Design and Permitting.
- Design of marine facilities including docks, ramps, shelters and accessory structures.

Mr. Weiler has a long and strong track record of understanding the client's needs and managing personnel to attain project goals.

Notable projects Mr. Weiler has served as Principal or Engineer in Charge and has been responsible for include:

- Key West Resort Utilities – General Consultant
- Monroe County Wastewater Project
- Monroe County Detention Facility
- Villages at Hawk's Cay
- Indies Island Utilities
- Boy Scouts of America / SEABASE
- Mangrove Marina

Ed Castle, PE **Project Manager**

Mr. Castle has over (17) seventeen years experience in administration, supervision and laboratory services relating to water pollution control in Florida and has worked with WEC since 1998. He is licensed as a Florida Class A Wastewater Treatment Plant Operator with a Bachelor of Science Degree in Chemical Engineering from the University of Kentucky with emphasis on water pollution control and is a Register Professional Engineer in the State of Florida.

Mr. Castle is experienced in staff supervision, budget management and capital improvement projects.

Mr. Castle has specialized knowledge and proven ability in areas such as:

• Construction management and administration of multiple wastewater treatment plant operations.

• Administration and technical support of wastewater treatment plants, sanitary sewer collection systems and storm sewer systems.

• Operation and maintenance of privately and publicly owned wastewater treatment plants and individual home aerobic treatment units.

• Wastewater residuals management.

• Operation of sludge and sewage transfer stations.

• Wastewater and stormwater utility elevations and underground utility construction inspects.

• Facilities ranging from individual home units to 127 MGD.

• Sampling and analysis of water, wastewater, groundwater and surface water samples.

In addition, Mr. Castle has experience and a strong working relationship with regulatory agencies, local governmental agencies and environmental groups in the Florida Keys. Has worked closely with the Department of Environmental Protection, the US EPA, NOAA, Monroe County, the City of Key West, the US Navy and the Department of Health regarding wastewater and environmental issues.

Notable projects Mr. Castle has been involved in include:

- Key West Resort Utility
- Monroe County Wastewater Project
- Key Colony Beach
- City of Key West Wastewater Treatment Plant
- Duck Key Wastewater Treatment Plant
- City of Hollywood Wastewater Treatment Plant
- Jupiter Wastewater Treatment Plant
- Martin County Wastewater Treatment Facilities
- Stewart County Wastewater Treatment Plant
- 250 Package Plants throughout the Florida Keys

PETER M. KINSLEY
DIVISION LEADER – WATER
CIVIL GROUP

CREDENTIALS	Kinsley's experience includes lead management and direction of major projects in excess of $80 million, with an extensive knowledge of civil, structural, architectural, MEP systems and instrumentation. During his professional career, he has managed an array of projects, including water treatment, educational and telecommunication facilities.
RESPONSIBILITIES	As leader of the Water/Wastewater Division, Kinsley is responsible for developing design-build project opportunities and markets as well as the strategic planning and financial performance of the division. He establishes relationships with engineering firms and specialty subcontractors for the pursuit and delivery of water and wastewater projects. He provides oversight for all phases of project delivery including client relations, estimating, procurement, scheduling, contract administration, staffing, project controls and construction coordination. Kinsley has full authority to commit company resources as required for the successful delivery of every project.
RELEVANT PROJECT EXAMPLES	**Key Largo Wastewater Management System**, Key Largo Wastewater Treatment District, Key Largo, Florida, $7.9 Million **Hollywood WTF**, Hollywood Florida, $5.34 Million **Glades Road Water Treatment Plant**, Boca Raton, Florida, $7.96 Million **Jupiter Island Reverse Osmosis Water Treatment Plant**, Hobe Sound, Florida, $4.67 Million **JEA Plant Consolidation Highlands Water Treatment Plant Improvements**, Jacksonville, Florida $7.74 Million **JEA Cecil Commerce Center Water Treatment Plant**, Jacksonville, Florida, $10.9 Million **Allentown Business School**, Allentown, PA – $12 Million – 12 Months – Design/Build Delivery **Sprint PCS Call Center**, Orlando, FL – $8.5 Million – 13 weeks – Design/Assist Delivery **Town Creek Water Treatment Plant**, Macon, GA – $80 Million – 36 Months – Traditional Delivery **Reservoir Intake Pump Station**, Macon, GA – $4 Million – 12 months – Traditional Delivery
EDUCATION	Master of Science in Civil Engineering Virginia Polytechnic University, 1995 Bachelor of Science in Civil Engineering Vanderbilt University, 1992
REGISTRATIONS / LICENSES/TRAINING	OSHA 30-Hour Training Course in Construction Safety & Health Competent Person Training in Scaffolding and Excavation
PROFESSIONAL AFFILIATIONS	Design Build Institute of America
YEARS OF EXPERIENCE	10

Regional Process Engineer

John R. Bratby, Ph.D., P.E., DEE

Experience Summary

Dr. John Bratby has 30 years of experience in the areas of design, research and teaching. He has worked as chief process design engineer; carried out on-site research; and presented training courses for numerous treatment plants. He has functioned as senior process design engineer for numerous wastewater treatment plants, and water reclamation facilities.

Randolph Park WRF, Pima County, Tucson, Arizona
Senior Process Design Engineer. Process design of the 3.5 mgd Randolph Park WWTP, Pima County, Tucson, AZ. The plant comprises a 3.5 mgd membrane bioreactor plant. Separate process designs were carried out for two potential membrane equipment suppliers (Zenon and Kubota).

Water Resource Center, Las Vegas Valley Water District (LVVWD), Las Vegas, Nevada
Senior Process Engineer. Process design and preparation of conceptual Basis of Design for the water reclamation plant (10 mgd). Processes include preliminary treatment, equalization, activated sludge with nitrification-denitrification, secondary sedimentation, filtration, UV disinfection and odor control.

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Senior Process Design Engineer. Extensive sampling and simulation modeling of the 8 mgd biological phosphorus removal plant. The plant currently operates under the patented OWASA process. Conducted evaluation of the impacts of removing the trickling filters from the process train.

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M.S., Environmental Engineering, University of Cape Town, 1973
B.S., Civil Engineering, Loughborough University, England, 1970

Registration
Professional Engineer, 33607, Colorado, 1999
Professional Engineer, Sanitary, 28020, Arizona, 1992
Professional Engineer 13136, New Mexico, 1996
Professional Engineer 40067, Minnesota, 2000
Professional Engineer PE 900098, District of Columbia, 2000
Diplomat, American Academy of Environmental Engineers, 92-20052, 1993

Training/Certification
Arizona Department of Environmental Quality, Certified Operator, Water Treatment Plant, Wastewater Treatment Plant, Grade 4 (both); Operator ID 05940

Experience
30 years

Joined Firm
1997

Relevant Expertise
Nitrification-Denitrification
Biological Phosphorus Removal
Effluent Polishing
Process Simulation Modeling
Aeration
Sludge Thickening
Sludge Handling
Membrane Technology
Filtration
Coagulation and Flocculation
Water Sludge processing
Disinfection

Employee Information:
Stuart Oppenheim, P.E.
Vice President
Brown and Caldwell

Project Title: *Design Project Manager*

Experience: *BC - 17 yrs.* *Others - 11 yrs.*

Education:
M.C.E., Sanitary Engineering, 1975
B.S., Civil Engineering, 1974

Professional Registration:
Professional Engineer, FL(in process), IL, WA, TX

Applicable Work Experience:
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- **El Paso Water Utilities, Eastside Water Reclamation Plant Predesign, El Paso, Texas**
  Project Manager. Developed predesign study for a new 1.0 mgd water reclamation plant. Evaluated secondary processes, including SBR and IMB. Project included evaluation of each plant process, together with screens and disinfection. Evaluated deep well injection for the plant's effluent.

- **Waste Water Treatment Plant, Fabens, Texas**
  Technical Reviewer. Replaced an existing .375 mgd plant with a new 1.2 mgd facility plant which will use Sequox nitrification / denitrification process. Also, includes new screens, UV disinfection, sludge treatment and dewatering.

- **North District Plant, Miami-Dade Peak Flow Management Project, Miami, Florida**
  Project Manager. Assembly of existing capacity, management, operation and maintenance (CMOM) programs into a summary document that meets the requirements contained in the U.S. Environmental Protection Agency's proposed National Pollutant Discharge Elimination System Regulation 40 CFR 122.42.e Municipal Sanitary Sewer Systems - Capacity, Management, Operation and Maintenance Programs.

- **Carkeek Transfer/CSO Facility Plan and Design, Municipality of Metropolitan Seattle, Washington**
  Lead Project Engineer. Responsible for planning the Storm Weather Treatment Plant and Transfer System. An 8.4 mgd two-stage high head pumping station with a discharge pressure of 280 feet located within a City of Seattle park. Odor control, noise abatement, aesthetics and public involvement were integral parts of the design. The project also included the modification of an existing primary treatment plant to operate as an intermittently operated storm weather plant.

- **El Paso Water Utilities, Bustamante Wastewater Treatment Plant Expansion, El Paso, Texas**
  Project Manager. Multi-phased enlargement of El Paso's largest wastewater treatment plant. The first two phases are under construction, and include a new 88 mgd headworks (influent lift station, mechanical screening and grit removal system modifications). The second contract consists of a new 2 million gallon anaerobic digester and control building.

- **Renton Regional Water Reclamation Plant, Municipality of Metropolitan Seattle, Seattle, Washington**
  Enlargement III, Liquid Stream Contract Manager. Led the design of this $56 million expansion from 72 mgd to 108 mgd. This 50 percent expansion was accomplished by adding only 25 percent more tankage. The project included headworks expansion, new aeration basins, sedimentation and major odor control facilities.

Employee Information:

Joseph Paterniti, P.E., DEE

Practice Leader
Brown and Caldwell

Project Title: *Collection System Design Lead & Effluent Disposal Design Lead*

Experience: *BC - 3 yrs.* *Others - 20 yrs.*

Education:
B.S., Civil Engineering, 1984

Professional Registration:
Professional Engineer, FL

Applicable Work Experience:

Paterniti has over 23 years of water and wastewater municipal consulting experience and has been highly effective in providing numerous clients with cost-saving solutions for environmental problems and issues. His experience includes coordinating large-team efforts to successfully complete designs and obtain local and state permits to mitigate adverse environmental impacts. He has provided construction, administration and management for numerous facility expansions and improvement projects for Florida utilities and public works departments.

- **Surface Water Treatment Plant, Hillsborough County, Florida**
  Project Engineer. Provided peer review of the Tampa Bay Water, 66 mgd surface water treatment plant. The review included an evaluation of the engineering plans and report to confirm that the public health, safety and welfare was protected and sound engineering practices were being utilized. Results of the review were presented to the Hillsborough County Commission.

- **Wastewater Treatment Plant, Effluent Reuse System, Lehigh Utilities, Florida**
  Project Manager. Selected most cost-effective reuse main route. Designed, permitted and implemented 3.5 miles of 20-inch diameter reuse effluent transmission main. The selected route included 4 aerial canal crossings and a jack and bore county roadway crossing. Designed, permitted and implemented the 100 Hp variable speed irrigation pumping facility to apply reuse effluent to the 90-acre public golf course. This design included modifications to the existing golf course irrigation system.

- **Contract Administration and Construction Management**
  Project Manager. Construction management services included: reviewing contractor submittals, conducting pre-construction and progress meetings, and coordinated resident engineer activities to ensure quality control and conformance to contract specifications. Provided construction, administration and management for the following utility and public work expansions and improvements.

- City of Miramar, Water Treatment Plant Phase I Expansion and Access Road
- North Key Largo, Utilities Odor Control System
- City of Sunrise, Water and Forcemain Projects
- City of Sarasota, Water Treatment Plant Improvements
- City of Sarasota, Raw Water Wells
- City of Sarasota, Elevate Storage Tank
- Lehigh Utilities, Wastewater Reuse and Golf Course Irrigation Modifications
- Lehigh Utilities, Wastewater Treatment Plant Expansion
- Plantation Utilities, Reverse Osmosis Treatment Plant Expansion
- Plantation Utilities, Reverse Osmosis Water Supply Wells and Transmission Main
- Charlotte County, Water Mains and Deep Injection Well
- City of Punta Gorda, Water Treatment Plant and Finish Water Storage Tank

Employee Information:
Charles Hortenstine, P.E.
Senior Project Manager
Brown and Caldwell

Project Title: *Treatment Plant Design Lead*

Experience: *BC - 2 yrs. Others - 16 yrs.*

Education:
B.S., Chemical Engineering, 1984

Professional Registration:
Professional Engineer, FL

Applicable Work Experience:
Hortenstine has over 18 years of experience in the field of environmental engineering. He has been involved with many important wastewater treatment projects in the State of Florida. His project experience includes wastewater plant design, permitting, and construction; and, treatment process testing, evaluation and modifications.

- **2.25 MGD Wastewater Treatment Plant**, City of Edgewater, Florida
  Project Manager. The project included the design, permitting, bidding and construction of a 2.25 MGD advanced wastewater treatment plant.

- **Phase I Expansion of the Iron Bridge Water Pollution Control Facility**, City of Orlando, Florida
  Project Engineer. The project consisted of developing plans and specifications for a portion of the Phase I expansion of the Iron Bridge Water Pollution Control Facility including flow diversion, pretreatment, and odor control for the initial 12 MGD expansion. For the second 12 MGD expansion, Mr. Hortenstine prepared plans and specifications for the pretreatment system for this facility.

- **Pembroke Pines East Wastewater Treatment Plant**, The Haskell Company, Pembroke Pines, Florida
  Project Manager. The City of Pembroke Pines has contracted with a design build firm, The Haskell Company, to provide engineering contracting services for several City projects. Brown and Caldwell has been retained to provide the design and permitting of the 12 mgd wastewater treatment plant and disposal facilities.

- **City of Orlando Water Conserv II Master Pump Station and Flow Equalization**, City of Orlando, Florida
  Project Manager. Mr. Hortenstine is currently serving as project manager on the Master Pump Station and Flow Equalization Project for the Orlando Conserv II Water Reclamation Facility. Mr. Hortenstine is responsible for developing the conceptual process modifications and control scenarios for this project. The project will consist of a pump station capable of pumping in excess of 60 MGD, one 3.5 MG flow equalization basin, a flow equalization pumping station and all associated yard piping, electrical and instrumentation modifications.

- **3.0 MGD Expansion of Existing 4.5 MGD WWTP**, City of New Port Richey, Florida
  Project Manager. The project consisted of the design, permitting, bidding and construction management of a pretreatment system, odor control system, RAS system, filtration system expansion, chlorine contact/dechlorination system, non-potable water pumping system and post-aeration system which utilized both mechanical aeration and a liquid oxygen feed system.

- **1.0 MGD Expansion of the Existing Wastewater Treatment Facility**, City of Wildwood, Florida
  Project Manager. The expansion included the conversion of the existing activated sludge system to Phased Isolation Ditch technology. The project also included a new pretreatment system, an additional clarifier, a new chlorine feed system, an aerobic sludge digester, a sludge dewatering system and an administration/maintenance building.

Employee Information:
Walter Messer
Vice President
Florida Senior Project Manager
Douglas N. Higgins, Inc.

Project Title: *Project Manager*

Experience: *Higgins - 4 yrs. Others - 26 yrs.*

Education:
U.S. Navy

Professional Registration:
Certified Underground Utility & Excavation Contractor

Applicable Work Experience:

Messer has 30 years of experience installing sewer, water and storm drainage piping and associated work. He also holds a Florida State Certified Underground Utility and Excavation License.

- **City of Key West Pump Station A Rehabilitation and Force Main**, Key West, Florida
- **Sanitary Sewer Rehabilitation for Service District F & G**, Key West, Florida
- **Sanitary Sewer Rehabilitation, Service District C**, Key West, Florida
- **Flagler Interceptor, Phase II Sanitary Sewer Rehabilitation**, Key West, Florida
- **Sewer & Water System Improvements–Hilton Haven Sewer & Water Main Extensions Pump Station S**, Key West, Florida

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Facsimile Letter

Date/Time: October 14, 2003

To: Robert Sheets & Charles Sweats at: Government Service Group

Fax No.: 850/224-7206 & 407/629-6963 Total No. Of Pages: 5 (Including this cover sheet)

Message:

Per your request, attached please find resumes from the USBF and SBR technical representatives.

USBF – Terry M. Zaudtke of CPH Engineers
SBR – Glen R. Callthorp of Fluidyne Corporation

In addition, John Verscharen of TSC-Jacobs (Fluidyne Representative) provided the following over the phone:

Education
BS in Civil Engineering from University of South Florida – 1985
MS in Civil Engineering from University of South Florida – 1988

Employment
Post Buckley – Project Engineer – 2 Years
CH2Mhill – Project Manager – 2 Years
TSC-Jacobs – President – 14 Years

Professional Engineering Registration in 1988

Cc:
Issue File 01-004

From:

Peter M. Kinsley

Division Leader - Water

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Terry M. Zaudtke, P.E., DEE

Academic Credentials

M.S. Civil Engineering
University of Minnesota, 1979
B S. Civil Engineering
University of Minnesota, 1976

Licenses

[illegible] Minnesota, Georgia, South Carolina,
Alabama, Colorado

Principal Areas of Expertise

Quality Assurance and Quality Control
Water Supply, Pumping and Treatment
Water Distribution
Wastewater Collection, Transmission and Treatment
Reclaimed Water Treatment and Distribution
Collection System Rehab
Municipal Engineering

Professional Activities

American Academy of Environmental Engineers – Diplomat Environmental Engineer
Listed in Who's Who in Environmental Engineering)
American Society of Civil Engineers, Past Officer
Construction Specification Institute
American Concrete Institute
Concrete Reinforcing Institute
Chi Epsilon
Quill and Scroll, an honorary Journalism Society
VITA – Volunteers in Technical Assistance
Water Environment Federation
ACI – Certified Structural Masonry Inspector

Mr. Zaudtke serves the firm of CPH Engineers, Inc. as Chief Operating Officer and Project Manager/Engineer for both public and private civil projects in his areas of expertise of Environmental and Civil Engineering. These projects include work in land development, municipal engineering, water and sewer facilities, drainage, waste treatment and water supply. Mr. Zaudtke served as the Project Manager and Engineer for the City of Casselberry, U.S. Navy, City of Orlando, City of Winter [illegible] Utilities, Inc.

Mr. Zaudtke has over 20 years of consulting engineering experience, with technical duties ranging from feasibility studies through construction engineering activities. He has directly worked on all aspects of civil engineering projects, including studies, designs, permitting, inspections, financing and construction administration. The range of projects includes wastewater treatment, water treatment, water supply, water distribution, wastewater collection, sewer system rehabilitation, reclaimed water, storm drainage and other municipal engineering activities.

Recent major projects include the Guam Sewer project (ten miles of sewer reconstruction) and reclaimed systems for the cities of Winter Springs and Casselberry and a new sewer system in an existing neighborhood for the City of Orlando.

The Guam Sewer Project was performed for the US Naval Station under a design/build contract and included design, wetlands permitting and EC&I work throughout the project. In addition, Mr. Zaudtke has designed five treatment facilities for the U.S Navy for industrial and domestic wastewater treatment.

For over 20 years, Mr. Zaudtke has been working with public and private utilities on wastewater and reclaimed water systems. This involves taking existing treatment facilities and upgrading them to public access criteria and design of new systems The biological processes are improved and tertiary treatment is added to enhance the operation and reliability of the facility.

Prior to joining CPH, Mr. Zaudtke worked as the Research Engineer for the City of Duluth on a Direct Filtration water treatment plant for the removal of asbestos-like fibers. He was also the Staff Engineer for a 43 MGD advanced wastewater treatment facility for the Western Lake Superior Sanitary District. At both facilities, Mr. Zaudtke was responsible for improving operations.

Professional Résumé of Glen R. Calltharp

• PERSONAL DATA

Name: Glen Richard Calltharp

Address: 2202 Gold Oak Lane
Sarasota, FL 34232

• EDUCATION

University of Kansas - Lawrence, Kansas - Graduated 1968

• PROFESSIONAL EXPERIENCE

11/89 - Present Process Technologies, Inc. - Sarasota, FL - Marketing and process consultant serving the industrial, and municipal wastewater market. Owner and President

Company offers marketing assistance, including software design and implementation to industrial clients.

8/97 – Present Fluidyne Corporation – Cedar Falls, Iowa - Process and Marketing Consultant.

1/96 - 4/97 Aqua-Aerobic Systems, Inc. - Rockford, IL - Product Development Consultant, Jet Aeration. Developed jet aeration product line. Responsible for design, testing, and application software for new product line.

11/94 - 3/95 Framco Environmental Technologies - Sarasota, FL - Vice President, Operations. Responsible for day-to-day operation of the company, including engineering, production, personnel, product development, and municipal marketing.

3/93 - 3/95 Framco Environmental Technologies - Sarasota, FL - Marketing and process consultant. Retained to develop design standards, design software, specifications, and develop marketing plan for Framco to enter the sequencing batch reactor market.

6/81 - 11/89 Jet Tech, Incorporated - Industrial Airport, KS - Manufacturer of jet aerators, jet mixers, and Sequencing Batch Reactor process equipment and controls; serving the municipal and industrial wastewater treatment market. Co-founder and President.

Founded and managed company. Responsible for all aspects of operation; developed equipment design, control strategy, sales literature, specifications, and design and marketing software. Company grew to a $9.5 million per year operation with thirty employees, and representatives in twenty-two market areas. Jet Tech is a leading supplier of jet aeration systems, and Sequencing Batch Reactor equipment and controls.

6/80 - 4/81 Pentech Division Houdaille Industries - Cedar Falls, IA - National Sales Manager, responsible for all sales of company's products. Sales increased from $3.5 million to $5.5 million in less than one calendar year. Division was sold in April of 1981

10/78 - 6/80 Pentech Division Houdaille Industries - Cedar Falls, IA - Manufacturer of jet aerators and mixers for the municipal and industrial wastewater treatment market - Regional Sales Manager

Responsible for all sales of company's products in the Midwest region which included, roughly, all area between the Mississippi River and the Rocky Mountains. Region accounted for 65% of company's total sales.

10/77 - 10/78 Wallace & Tiernan Division - Minneapolis, MN - Regional Sales Manager

Responsible for all sales of company's products in four states in the Upper Midwest. Sales office led nation in performance against quota.

6/73 - 10/77 Wallace & Tiernan Division - Shawnee Mission, KS - Manufacturer of chemical feed and control equipment for the industrial process, and municipal water and wastewater markets - Regional Indirect Sales Manager

Responsible for sales through representatives, and distributors in eight Midwestern states. Region led nation in performance against quota from 1975 through 1977.

12/69 to 5/73 Fitzwater & Associates - Kansas City, MO - Manufacturer's Representative serving the industrial process, and municipal and industrial water and wastewater markets - Sales Associate

Responsible for sales of seventeen principle's products in Kansas and Western Missouri. Products included pumps, control and relief valves, mixers and agitators, aerators, process heating and control equipment, filtration equipment, and demineralization and ion exchange equipment.

8/68 - 10/69 **Black & Veatch Consulting Engineers - Kansas City, MO - Civil / Sanitary Group - Staff Engineer**

Worked on design of gravity sewers, lift stations, and treatment plants. Worked in field performing flow studies, and projections.

• PATENTS

U.S. Patent 4,645,592*	SBR Reactor Piping and Flow Control System
U.S. Patent 4,648,967*	SBR Decanting Apparatus
U.S. Patent 4,711,716*	SBR Decanting Apparatus
U.S. Patent 4,724,073*	SBR Reactor Piping and Flow Control System
U.S. Patent 4,775,467*	SBR Reactor Piping and Flow Control System
U.S. Patent 5,021,161*	"Batch Proportional Treatment and Operating Strategy" for Sequencing Batch Reactor Process.

* Patents assigned to Jet Tech, Inc.

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Port Charlotte, FL 33954

FAX COVER SHEET

DATE: 10/17/03 TIME: 11:15

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FAX: 305-853-7311

FROM: Sheri PHONE: (941) 764-6447

FAX: (941) 764-8915

RE: Email

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October 15, 2003

Charles Sweat
Government Services Group
614 N. Wymore Road
Winter Park, Florida 32789

RE: Response to email from Nos Espat

Charles:

Andy Tobin forwarded the email of October 14, 2003 from Nos Espat regarding performance of wastewater treatment plants to WEC. I would like to respond to the email on general terms and to address a few specific points.

I am in full agreement with Nos on a number of his points regarding the operation of wastewater treatment plants. The treatment plant operators need to monitor crucial elements of the process, including dissolved oxygen concentrations and return activated sludge flow rates. There are a number of other important process control parameters to monitor and adjust to keep treatment plants operating efficiently as well. I am also in full agreement that severely underloaded plants (low influent BOD strength and low flows) will not operate well. Neither will severely overloaded plants. And finally, I agree that any system may experience occasional excursions.

I would like to address a few of the examples of performance that Nos brought up.

- Although a few daily excursions have occurred, the Key West WWTP is meeting the annual average requirement of < 3.0 mg/l total nitrogen.
- The Key Colony Beach plant was designed to be able to meet AWT standards but is not required to do so at this time. The City made the decision not to operate in nutrient removal mode at this time. The cost of chemical addition for removal of phosphorous would be the same cost per pound of ortho-P removed as for any other treatment plant.
- Although the influent BOD concentration at the Island Tiki is about 3 times the design, the average daily flow is one-sixth the design flow. This means that the BOD loading to the plant is actually 50% of design loading. Most plants can operate well in this range.
- The low flows and loadings at the Islander would make operation difficult. The success seen at this facility under these adverse conditions is commendable. It is apparent that both the plant operators and the supplier of the USBF have worked together to meet the BAT standards.

- The influent at Ziggie's is again about 3 times the design BOD, and the average daily flow is one-sixth the permitted flow. The BOD loading is again about 50% of design loading.

The capital costs and O&M costs of the different systems were also addressed. Since the ISAM SBR units cost about $100,000 less each than the USBF units, and both systems require digesters and filters, it appears that the ISAM systems are more cost effective in terms of capital expenditure.

Electrical costs can be determined by examining the horsepower and estimated run times of the equipment. Per Brown & Caldwell's calculations, the ISAM will require less electricity due to intermittent operation of the jet aeration pumps. Since the USBF blowers are designed to run 24 hours per day, blowing excess air off to the atmosphere, it makes sense that more electricity should be used.

Sludge disposal is a major component of O&M costs. Sludge is produced as soluble BOD is converted into cellular tissue. The Purestream/Ecofluid Systems, Inc. paper titled Advanced Biological Wastewater Treatment Technology discusses the sludge production of the USBF on page 6. It states that the system has a "sludge yield of 0.6 lbs TSS/lb BOD removal". It also indicates that precipitation of phosphorous would result in additional sludge production, stating "the total increase in sludge production would be about 7%" due to precipitation of phosphorous. These estimates of sludge production are within the normal range from the literature. Similar sludge production can be expected for the ISAM system.

Some of the sludge produced is broken down through endogenous decay. The reduction in sludge quantity due to this decay is related to the operating SRT of the system. The higher the SRT, the more decay occurs. Since the USBF system operates at a higher SRT than the SBR system, the USBF should experience a greater reduction in sludge volume than the SBR. An aerobic sludge digester is designed, in part, to maximize the sludge reduction that occurs due to endogenous respiration. The result is maximum volatile solids reduction and minimum sludge volume to be hauled. The wastewater treatment plant plans for the Key Largo Trailer Village project include an aerobic digester for both the USBF and the SBR. Therefore, both systems will experience the benefits of volatile solids reduction in the digested sludge. The volume of digested sludge to be hauled will be nearly identical for both the USBF and the SBR if the digester is properly designed and operated.

In summary, I am in substantial agreement with much of what Nos had to say. The USBF plants perform well and except under extreme conditions appear to have no trouble meeting BAT standards. I would also like to point out that Nos has continued to provide support to the plants that are experiencing difficulties due to low loadings even though the influent characteristic do not meet the requirements of the warranty. He would be well within his rights to declare the warranty void and discontinue support. However, based on the analyses of energy costs and digested sludge disposal volumes discussed above, I am of the opinion that the O&M costs of the USBF system will not be substantially lower than the O&M costs of the ISAM system for the Key Largo Trailer Village WWTP.

Please feel free to contact me by phone or email if you have any questions regarding my comments.

Sincerely,

Ed Castle, PE
Project Manager