Report to

Zone 7 Alameda County Flood Control and Water Conservation District

Nitrate Reduction Alternatives for the South Livermore Valley

December 2000

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December 20, 2000

Mr. Matthew Katen
Water Resources Engineering
Zone 7 Water Agency
5997 Parkside Drive
Pleasanton, CA 94588-5127

Subject: Evaluation of Nitrate Reduction Options in the South Livermore Valley

Dear Mr. Katen:

We are pleased to submit this report on methods to reduce nitrate loadings to the groundwater from existing and proposed septic tanks in the South Livermore Valley.

Two alternatives were investigated in this report:

- Advanced On-Site Treatment, in which an extra treatment step for nitrogen removal is added to the existing system of private septic tanks and leach fields.
- Centralized Wastewater Treatment Plant, in which the existing system of private septic tanks and leach fields are abandoned and a centralized package wastewater treatment plant and collection system are built to serve the non-sewered areas of the Valley.

Our evaluation indicates that, of the two alternatives, a centralized treatment plant provides higher quality effluent at a lower overall cost and also produces an effluent that can be used as a supplemental water supply for non-potable uses.

If nitrate reduction in the wastewater from the non-sewered areas of the South Livermore Valley is implemented, it is recommended that a centralized treatment plant be further investigated as the preferred alternative.

We enjoyed the opportunity of working with you on this project. Please call Marilyn Bailey at 925-299-6733 if you have any questions on this evaluation or need any further assistance on this matter.

Sincerely,

Randy Raines/MB

Randy Raines,
President and Principal-in-Charge

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SUMMARY

This report is a reconnaissance-level analysis of methods to reduce nitrate loadings to the groundwater from existing and proposed septic tanks in the South Livermore Valley. As part of their groundwater monitoring program, Zone 7 has detected a plume of high nitrate concentration exceeding the State maximum contaminant levels for drinking water. Empirical evidence indicates that the source of the nitrates is leachate from existing septic tanks and leach fields in the unsewered portions of the South Livermore Valley.

The wastewater flow from the existing homes and commercial uses in the study area is approximately 33,000 gallons per day (gpd). The South Livermore Valley Specific Plan identifies 13 potential commercial development sites within the area which would produce an additional flow of approximately 21,000 gpd.

Two alternatives were investigated:

- Advanced On-Site Treatment, in which an extra treatment step for nitrogen removal is added to the existing system of private septic tanks and leach fields.
- Centralized Wastewater Treatment Plant, in which the existing system of private septic tanks and leach fields are abandoned and a centralized package wastewater treatment plant and collection system are built to serve the non-sewered areas of the Valley.

A comparison of the advantages and disadvantages of the two alternatives follows:

	Advanced On-Site Treatment	Centralized Wastewater Treatment Plant
Advantages	Can be retrofitted into existing individual septic tanks if they are in good repair	Individual households do not have to maintain or operate process equipment
	No need for sewer construction	Effluent can be used for irrigation or other non-potable uses
	Removes approximately 70% of nitrogen.	Removes approximately 90% of nitrogen.
Disadvantages	Individual households must maintain on-site blowers and replace air filters	Requires weekly attention from certified wastewater operator
	Significant area is required for leach fields for larger commercial developments	Requires construction of a sewer system
	Effluent is discharged to leach fields and is not suitable for reuse	Requires permitting and overview from the Regional Water Quality Control Board

The comparative costs of the two alternatives are as follows:

	Estimated Costs	
Alternative	Capital	Annual O&M
On-Site, Advanced Treatment	$2,368,000	$187,000
Centralized Treatment Plant	$1,789,000	$75,000

The cost of both alternatives is high compared to typical costs for a large municipal treatment plant. This is due to the need for advanced treatment for nitrogen removal, because the small sizes do not offer any economies of scale and, for the centralized plant option, the need to construct new collection systems. However, of the two alternatives, a centralized treatment plant provides higher quality effluent at a lower overall cost and also produces an effluent that can be used as a supplemental water supply for non-potable uses.

If nitrate reduction in the wastewater from the non-sewered areas of the South Livermore Valley is implemented, it is recommended that a centralized treatment plant be further investigated as the preferred alternative.

INTRODUCTION

This report has been prepared for the Zone 7 Alameda County Flood Control and Water Conservation District (Zone 7). Zone 7 is the wholesale water supplier for the South Livermore Valley. Portions of the Valley are subject to high nitrate concentrations in the groundwater due to leachate from existing septic tank systems. This report analyses methods to reduce nitrate loading to the groundwater from existing and proposed private sewage disposal systems in the South Livermore Valley.

The portion of the Valley included in this study is adjacent to, but outside the City of Livermore urban growth boundary and is characterized by several existing vineyards and wineries, bed and breakfast inns, and homes primarily along Buena Vista Avenue. In addition to the existing uses, the South Livermore Valley Specific Plan identifies 13 potential commercial development sites within the area. Since the area is outside of the urban growth boundary it is not currently, and cannot be in the future, served by the City of Livermore municipal wastewater collection and treatment system. Instead, the Alameda County Ordinance, Chapters 15.16.120 – 15.16.250 (Alameda County Ordinance) regulates wastewater disposal requirements for residential and commercial facilities in this area. The standard method of private sewage disposal system for the area is septic tanks and leach fields.

Groundwater quality within the South Livermore Valley is monitored by Zone 7. Areas of the Valley have been designated by Zone 7 as "areas of special concern" due to high nitrate concentrations in the groundwater. As shown on Figure 1, part of the study area is underlain by a plume of high nitrate concentration that exceeds the State drinking water maximum contaminant level (MCL) of 45 mg/l as NO_3, or 10 mg/l as Nitrogen. Since the general direction of the groundwater flow is from the southeast to the

northwest, there is empirical evidence that leachate from the existing septic tank systems is the source of the high nitrates.

The Alameda County Ordinance does not provide for the use of alternative sewage disposal systems. However, alternative systems are generally allowed by the Regional Water Quality Control Board where required to provide enhanced treatment and/or to mitigate environmental impacts as long as adequate maintenance and monitoring programs are demonstrated. Any private sewage disposal system within the limits of Zone 7 may be subject to the requirements of that agency for groundwater protection. This report therefore evaluates two methods to reduce nitrate levels from wastewater in the study area:

- Upgrade of the existing and proposed septic tank systems to include nitrogen removal
- Replacement of the existing septic tank systems with a package-type local wastewater treatment plant

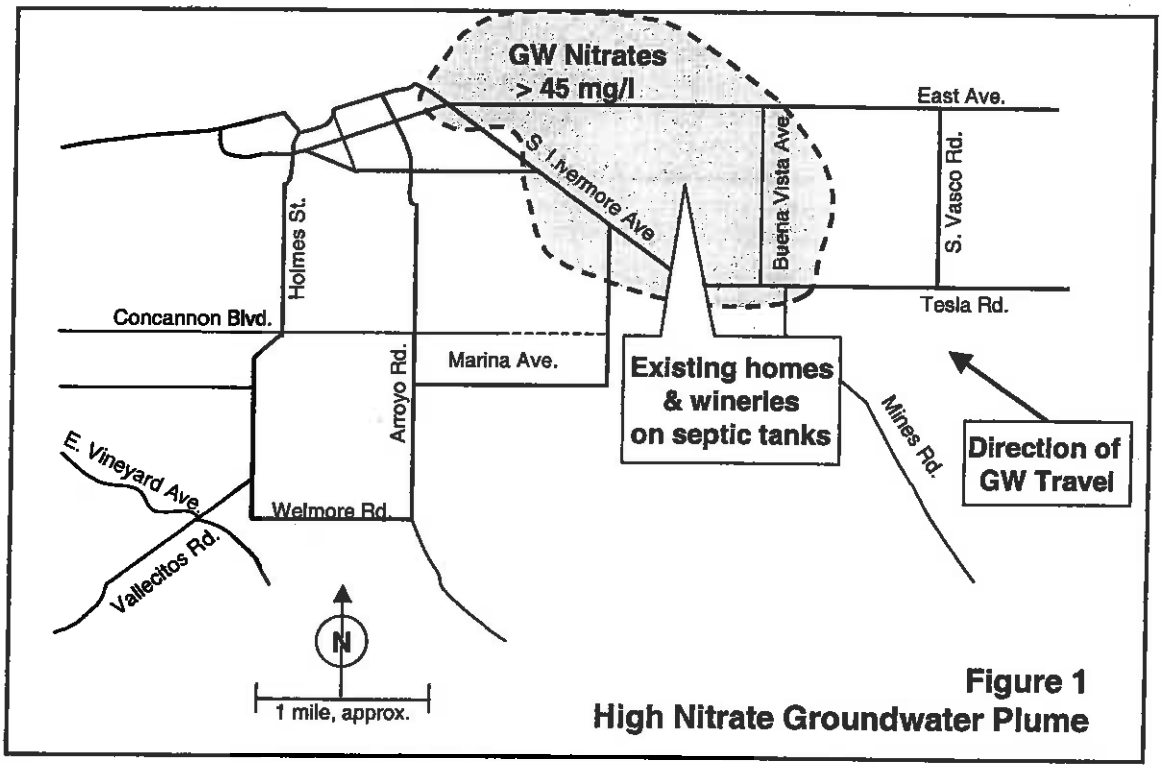


Figure 1
High Nitrate Groundwater Plume

Projected Wastewater Flows and Loadings

The existing development in the study area is located primarily in the area bound by Buena Vista Avenue, East Avenue, Tesla Road, and S. Livermore Avenue as shown on

Figure 1. The existing uses include 93 homes and three wineries, one having a restaurant.

In addition to the existing uses, the South Livermore Valley Specific Plan (Specific Plan) identifies 13 potential commercial development sites within the area. The new commercial sites are located within five subareas as shown on Figure 2. The new commercial uses that could be permitted are as follows:

- Proposed Wetton Bed and Breakfast: Includes a small restaurant and retail shop
- Subarea #3: A small winery or a bed-and-breakfast ; and,
  A tasting room or small restaurant
- Subarea #4: An olive press;
  Two small wineries; and,
  A small restaurant or a small winery
- Subarea #5: A Wine Country retail center;
  Two small wineries;
  A Wine Country inn;
  A large restaurant; and
  A bed-and-breakfast or two residential units
- Subarea #6: A medium-size winery
- Subarea #7 A medium-size winery

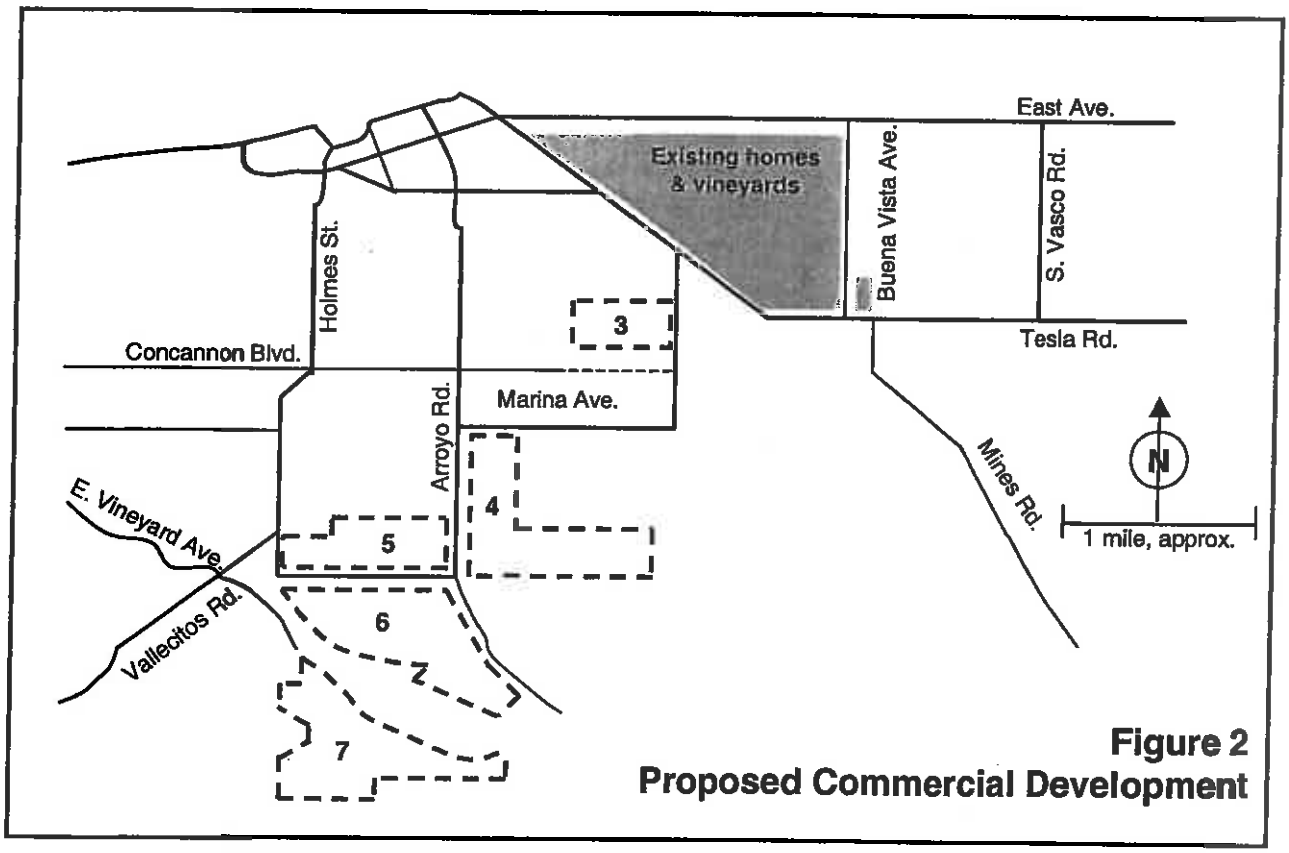


Figure 2
Proposed Commercial Development

The Alameda County Draft Ordinance estimates the quantity of sewage flow from single family residences and from various commercial establishments. These unit quantities were used in conjunction with the planned commercial development from the Specific Plan to estimate the total quantity of sewage flow generated in the study area. Note that for the Stony Ridge winery, which includes a restaurant, the estimated flow is from a report entitled "*On-site Sewage Disposal Feasibility and Design Report for Stony Ridge Winery*, February 22, 2000, Questa Engineering Corp".

Table 1 summarizes the estimated wastewater flows within the service area from both the existing services and proposed developments. As shown on Table 1, the estimated wastewater flows are as follows:

Existing services:	33,000 gpd average and 42,000 gpd peak day
New commercial developments:	21,000 gpd average and 39,000 gpd peak day
Total potential flow:	54,000 gpd average and 81,000 gpd peak day

Table 1
Estimated Wastewater Flows from Existing Sources and Planned Development

	Estimated flow, gallons per day per unit [1]									
	Single Family Residence per house	B&B per room	Restaurant per seat	Retail center per toilet room	Medium Winery [2] avg	Medium Winery [2] peak day	Small Winery [3] avg	Small Winery [3] peak day	Total Flows avg	Total Flows peak day
Wastewater Sources	320	60	30	400	1500	7600	300	1600		
Existing Flows										
Buena Vista homes	76								24,320	24,320
Testa Road homes	9								2,880	2,880
E. Livermore homes	8								2,560	2,560
Stony Ridge Winery [4]			20				1	1	965	3,300
Concannon Winery					1	1			1,500	7,600
Retzlaff Winery							1	1	300	1,600
Subtotal Existing Flows									**33,000**	**42,000**
Proposed Flows										
Wetton B&B		14	50	1					2,740	2,740
Subarea #3										
B&B		12							720	720
Small restaurant			50						1,500	1,500
Subtotal Area #3									2,220	2,220
Subarea #4										
Olive press							0.5	0.5	150	800
2 small wineries							2	2	600	3,200
Small restaurant			50						1,500	1,500
Subtotal Area #4									2,250	5,500
Subarea #5										
Retail center			30	6					3,300	3,300
2 small wineries							2	2	600	3,200
Wine Country Inn		30	50						3,300	3,300
Large Restaurant			100						3,000	3,000
B&B		10							600	600
Subtotal Area #5									10,800	13,400
Subarea #6										
Medium Size Winery					1	1			1,500	7,600
Subarea #7										
Medium Size Winery					1	1			1,500	7,600
Subtotal Proposed Flows									**21,000**	**39,000**
TOTAL Potential Flow									**54,000**	**81,000**

Notes:
(1) Estimated Quantities per Draft Alameda County Ordinance
(2) Average Day: Assumes 85,000 cases of wine at 4.8 gal per case plus 150 wine tasting visitors per day at 2.5 gallons per visitor
Peak Day: Assumes 85,000 cases of wine at 4.8 gal per case over 60 day crush plus 300 wine tasting visitors per day at 2.5 gallons per visitor
(3) Average Day: Assumes 7,500 cases of wine at 4.8 gal per case plus 75 wine tasting visitors per day at 2.5 gallons per visitor
Peak Day: Assumes 7,500 cases of wine at 4.8 gal per case over 30 day crush plus 150 wine tasting visitors per day at 2.5 gallons per visitor
(4) Estimated flows from *On-site Sewage Disposal Feasibility and Design Report for Stony Ridge Winery, February 22, 2000, Questa Engineering Corp*

In addition to wastewater quantity, the projected wastewater quality is of importance in evaluating alternatives. For this report, the following values were assumed for wastewater quality:

	Raw Wastewater Concentration, mg/l	
Constituent	Residential and B&B	Commercial
Biochemical Oxygen Demand (BOD)	250	1000
Total Suspended Solids (TSS)	250	1000
Total Nitrogen as N	50	50

TREATMENT OPTIONS

To provide better effluent water quality than that of septic tank effluent and to remove nitrogen for the protection of the groundwater, more advanced biological treatment processes must be used. Biological treatment uses microorganisms to transform solids and organic material into biological cell mass, carbon dioxide and nitrogen gas. The biological process provides an environment for microbial growth using nutrients, BOD, and TSS in the wastewater as a food source. Microorganisms are removed from the wastewater as settled sludge, and carbon dioxide and nitrogen gas are released to the atmosphere. For nitrogen removal, the biological process passes through two phases. In the aerobic phase where there is oxygen present, the organics are consumed, and ammonia is converted to nitrates. In the anoxic phase there is minimal oxygen and nitrates serve as the oxygen source thereby converting the nitrates to nitrogen gas.

This report considers two categories of treatment options for reduction of nitrogen. One category is decentralized, on-site treatment in which an additional treatment step is added to the existing individual septic tanks and leach fields. The second category is centralized treatment in which the septic tanks are abandoned and wastewater is conveyed to a package wastewater treatment plant. The following sections discuss each category of treatment option.

Advanced On-Site Treatment

The first category of treatment options is to maintain the individual private septic tank and leach field systems currently in place in the study area, but to add an additional treatment step to remove nitrogen and improve the overall water quality of the effluent. Representative of this type of advanced septic treatment is the FAST™ (fixed activated sludge treatment) system, which is a submerged filter unit installed below ground in a configuration similar to that of a standard septic tank. Wastewater enters the primary settling zone of the tank where primary solids are removed. Flow is then recirculated through the FAST™ filter at the effluent end of the tank where microorganisms attached

to the filter media provide more advanced nitrogen and organic removal. A small portion of the recirculated wastewater flow is periodically discharged to a leaching field. An enclosed, above-ground blower supplies are to the system to support bacterial growth the filter media.

As with a septic tank, solids must be periodically pumped out and trucked away for disposal. For existing households, the FAST™ system can be installed in the second compartment of an existing septic tank if the tanks is in good repair. Otherwise, it is installed in a separate septic tank downstream from the existing tank. The treatment system does not have a significant land requirement since the only above-grade equipment is the blower. However, significant land must be reserved for the leaching fields used for disposal of the effluent.

Figure 3 is a schematic of an advanced on-site treatment system using the FAST™ unit.

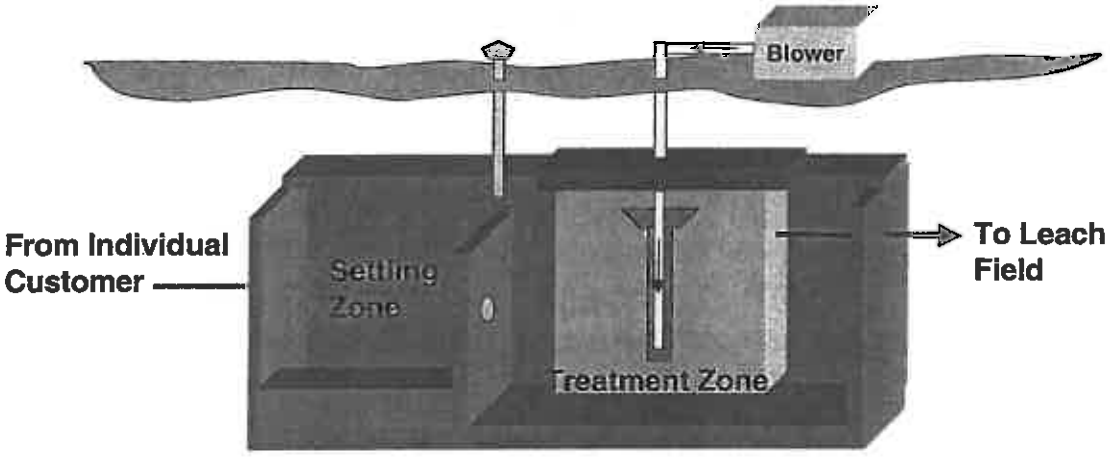


Figure 3
On-Site Treatment Schematic

The FAST™ system offers two basic units; one suitable for regular strength wastewater such as residential units, and one suitable for high-strength commercial wastewater. The manufacturers of the FAST™ process state that the FAST™ system achieves 70% denitrification. Assuming an influent total nitrogen concentration of 50 mg/l, the expected effluent total nitrogen concentration would be approximately 15 mg/l.

The advantages of on-site treatment using a FAST™ -type system include:

- Can be retrofitted into existing individual septic tanks and leach fields if they are in good repair
- Eliminates need for sewer construction
- Septage pumping requirements are similar to a standard septic system

- Provides greater level of treatment than existing septic tank effluent and removes approximately 70% of nitrogen
- Easier to permit since present system of private sewage disposal system is maintained

The disadvantages of on-site treatment include:

- Effluent quality is not as good as a package plant
- More maintenance is required by individual households to maintain on-site blowers and replace air filters
- The effluent nitrogen, while significantly lower than septic tank effluent is still higher than the State MCL for drinking water
- Significant area is required for leach fields for larger commercial developments
- Effluent is discharged to leach fields and is not suitable for reuse for irrigation or other non-potable purposes

Estimated Costs

The capital and operating costs were estimated for four sizes of wastewater sources, retrofit of single family residences, small wineries, medium wineries, and a larger system to serve the clustered development in Subarea #5. The costs are order-of-magnitude estimates based on estimates of the flows and loadings generated from the various sources, quotes from vendors, and cost curves for similar facilities.

Details of the cost estimate appear in the appendix and are summarized below in Table 2.

Table 2 Summary of Estimated Costs for Individual, Advanced On-Site Treatment

Wastewater Source	Average Flow, gpd	Capital Cost	Annual Operating Cost
Retrofit of Existing Residential Septic Tank Customers	320	$7,000 per household	$1,000 per household per year
Small Winery	965	$92,000 per winery	$5,000 per winery
Medium Winery	1,930	$140,000 per winery	$9,000 per winery
Subarea #5 development	12,000	$576,000 for entire subarea	$15,500 for entire subarea
Total for all Existing and Planned Sources	56,000	$2,368,000	$187,000

Centralized Package Wastewater Plants

The second category of treatment options is construction of a centralized small wastewater plant to serve the area. The existing individual septic tank and leach fields would be removed from service and sewers would be constructed to convey the wastewater to the centralized treatment plant.

Numerous types of package wastewater treatment plants have been developed over the years to serve small developments or non-sewered areas that are not suitable for individual septic tank systems. The package plants are characterized by having a small footprint and minimal operational requirements. Typical package plant types have included rotating biological contactors, sequencing batch reactors, standard activated sludge processes, etc. These types of package plants typically have a tank where the biological process takes place followed by a clarifier for solids/liquid separation. The treatment plants can be configured to provide nitrogen removal and, with the addition of tertiary filtration and disinfection, the effluent can be used for non-potable uses such as irrigation water.

The type of treatment plant used in this evaluation is a submerged membrane bioreactor plant represented by the ZenoGem system manufactured by Zenon. This type of treatment plant uses microfiltration membranes for solids/liquid separation. The membranes are submerged in the biological process, thus eliminating the need for separate clarifiers. The biological process operates at a higher rate than most package plant and provides nitrification/denitrification for nitrogen removal. A unique feature of the process is that the microfiltration membranes also remove bacteria and many viruses, thus eliminating the need for separate tertiary filtration. The effluent is disinfected with ultraviolet light (UV) and the resulting water meets State of California Title 22 requirements for non-potable water reuse. The process equipment is relatively compact, with a total footprint of approximately 40 ft by 40 ft.

Figure 4 is a schematic of a centralized wastewater treatment plant using the ZenoGem process.

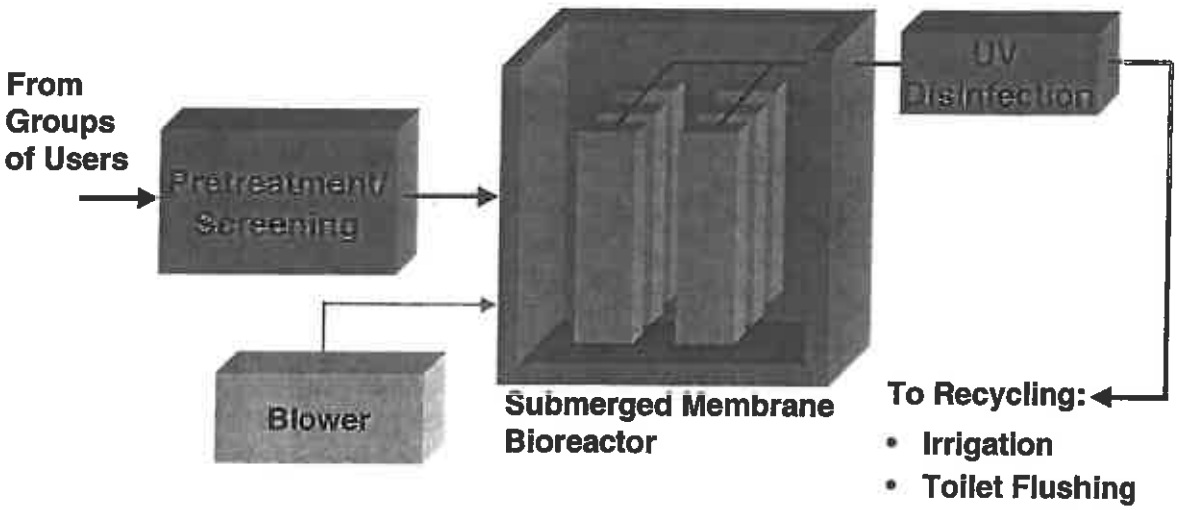


Figure 4
Centralized Treatment Plant Schematic

The expected water quality of the effluent from the ZenoGem package treatment plant is as follows:

Constituent	Expected Effluent Quality
BOD	<10 mg/l
TSS	<10 mg/l
Total Nitrogen	<8 mg/l
Total Coliforms	<2.2 MPN/100 ml

The advantages of a centralized treatment plant using a ZenoGem-type system include:

- Produces higher quality effluent than an on-site system
- Individual households do not have responsibility for operation or maintenance of the process equipment
- Effluent meets State requirements for recycled water and can be used for irrigation or other non-potable uses
- Provides high degree of nitrogen removal; effluent nitrogen meets State MCL requirements for drinking water

The disadvantages of the centralized treatment plant include:

- Construction of a sewer system is required to convey flows to the plant
- The treatment plant will need to be serviced approximately 2 hours per week by a certified wastewater operator
- Land will need to be purchased for construction of the plant
- The treatment plant will require permits from the Regional Water Quality Control Board including a National Permit Discharge Elimination System (NPDES) permit and a permit for the recycled water uses

Treatment Plant Alternatives

Two alternatives of centralized treatment were considered that trade off the price of the treatment plant versus construction of the sewer system. The first alternative is to build two separate plants to reduce the amount of sewer construction. The first plant would be located near the junction of Buena Vista Avenue and Tesla Road and would serve the existing homes and wineries and Subarea #3. A second plant would be built near the intersection of Arroyo Road and Wetmore Road and would serve the cluster of new development located in Subareas 4, 5, 6, and 7 as they are developed. The second alternative is to build a single, larger centralized plant near Buena Vista and Tesla that would initially serve the existing sources and be expanded to serve the new subareas as they are developed. These options are illustrated below in Figures 5 and 6.

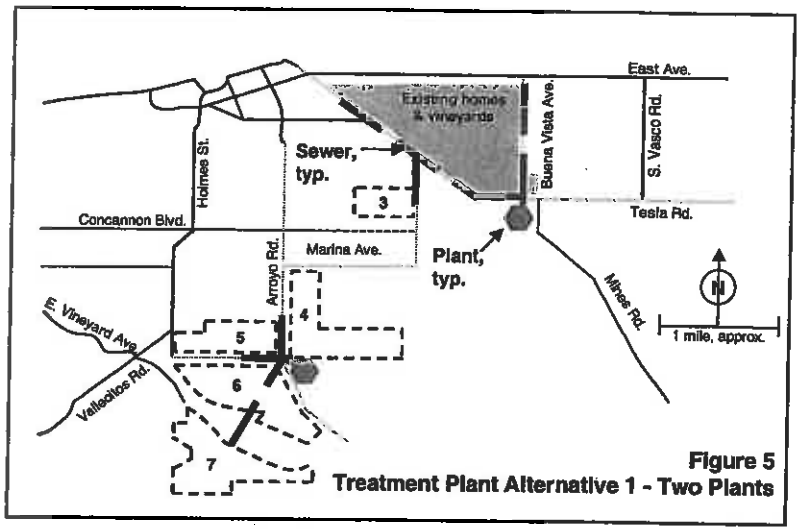


Figure 5
Treatment Plant Alternative 1 - Two Plants

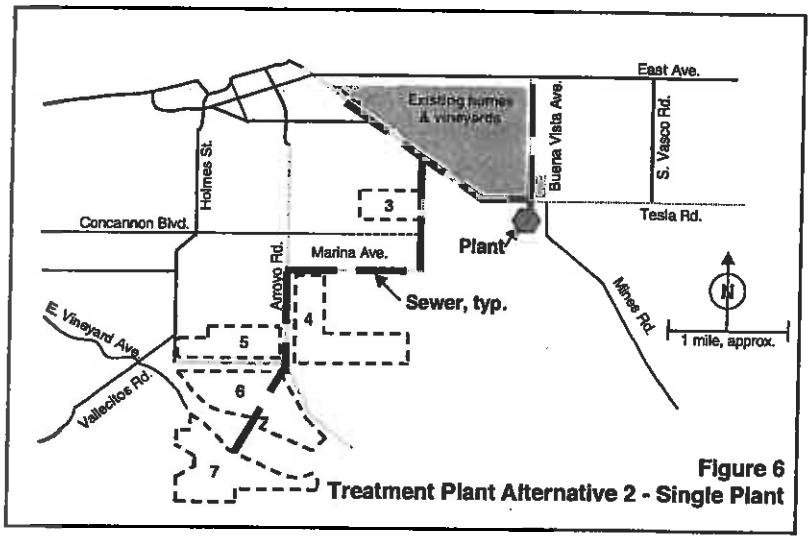


Figure 6
Treatment Plant Alternative 2 - Single Plant

Note that for either alternative, remote sites away from the sewer system would be served by installation of on-site holding tanks. The wastewater generated would need to be hauled several times per week to one of the treatment plant sites.

The water produced from the treatment plants is suitable for unrestricted non-potable reuse. For Alternative 1, the effluent from the plant serving the existing services produces approximately 40 AF/yr and can be used for irrigation of adjacent vineyards. The effluent from the plant serving the new developments can be used for irrigation and can also be recycled for toilet flushwater in the new retail center. This is a common use of the water at other ZenoGem installations across the country and can reduce the water requirements of new retail developments by up to 85%. For Alternative 2, the single larger plant would produce approximately 60 AF/yr and could be used for vineyard irrigation.

Estimated Costs

The costs for the two centralized treatment plant alternatives were estimated based on quotes from vendors and cost curves for similar facilities. The costs include the following components:

- Removal of existing septic tanks
- Construction of laterals to the collection system
- New collection system
- Package treatment plant
- Recycled water distribution system

Details of the cost estimate appear in the appendix and are summarized below in Table 3.

Table 3 Summary of Estimated Costs for Centralized Treatment Plants

		Alternative 1: 2 Plants	Alternative 2: Single Plant
Capital Cost			
	Abandon septic tanks and construct laterals	$227,000	$227,000
	Collection system	$523,000	$749,000
	Treatment Plant	$985,000	$716,000
	Recycled water distribution	$81,000	$97,000
	Total Capital Cost	**$1,816,000**	**$1,789,000**
Annual Operational Cost		$100,000	$75,000
Cost for Remote Sites			
	Capital cost of Tank installation	$8,000	per site
	Hauling cost to treatment plant	$2,000	per week per site

The estimated capital and operating costs are lower for Alternative 2 and it is used as the preferred alternative in the following comparison of alternatives.

Comparison of Alternatives

Two options were evaluated for reduction of nitrate in leachate to the groundwater in the South Livermore Valley:

- Advanced On-Site Treatment, in which an extra treatment step for nitrogen removal is added to the existing system of private septic tanks and leach fields.

- Centralized Wastewater Treatment Plant, in which the existing system of private septic tanks and leach fields are abandoned and a centralized package wastewater treatment plant and collection system are built to serve the non-sewered areas of the Valley.

Table 4 summarizes the effluent quality and costs of each option.

Table 4 Comparison of Costs and Effluent Quality

Alternative	Effluent Total Nitrogen, mg/l	Use/Disposal of Water	Estimated Costs	
			Capital	Annual O&M
On-Site, Advanced Treatment	~15	Leachfields	$2,368,000	$187,000
Centralized Treatment Plant	< 8	Non-potable water reuse	$1,789,000	$75,000

The cost of both alternatives is high compared to a large municipal treatment plant because of the following factors:

- The need for advanced treatment
- The small sizes do not offer any economies of scale
- The costs include collection system costs for the centralized treatment plant option and disposal costs for both options

Of the two alternatives, a centralized treatment plant provides higher quality effluent at a lower overall cost and also produces an effluent that can be used for supplemental water supply for non-potable uses.

If nitrate reduction in the wastewater generated in the non-sewered areas of the South Livermore Valley is needed, it is recommended that a centralized treatment plant be further investigated as the preferred alternative.

Appendix

Cost Estimates

Manufacturer's Information on Treatment Options

Estimated Capital and O&M Costs for On-Site Advanced Treatment
Using FAST-type underground system

	Quantity	Unit	Unit Price	Total Cost	Comments
A. Costs for Retrofit of Existing Septic Tank Residential Customers					
Capital Cost per household					
Septic Tank	1	EA	$3,000	$3,000	Quote from A-1 Septic Tanks
FAST System	1	EA	$3,000	$3,000	Quote from Bio-Microbics
Connections, Electrical, Misc.	1	LS	$1,000	$1,000	
Total				$7,000	
Operational Costs					
Truck Hauling (2/yr)	2	LS	$425	$850	Quote from Williams Sanitary Service
Blower Operation (1/3 hp)	2160	kw-hr	$0.10	$220	Assume 24 hr operation, 365 days/year
Total				$1,070	
B. Costs for Stony Ridge On-Site System (small winery)					
Capital Cost					
Grease Interceptor	1	EA	$8,000	$8,000	Quote from A-1 Septic Tanks
Septic Tank	1	EA	$8,000	$8,000	Quote from A-1 Septic Tanks
FAST vaults	2	EA	$8,000	$16,000	Quote from A-1 Septic Tanks
FAST 3.0 treatment system	2	EA	$13,000	$26,000	Quote from Bio-Microbics
Effluent pump station					
Vault	1	EA	$8,000	$8,000	
Duplex pump system	1	EA	$2,000	$2,000	
Leachfields					
Piping, 4" PVC	650	LF	$5	$2,990	
Drain Rock	220	CY	$58	$12,760	
Misc. piping, electrical, sitework				$8,400	
				$92,150	
Operational Costs					
Truck Hauling per year	6	EA	$425	$2,550	Quote from Williams Sanitary Service
Blower Operation (2 at 2 hp ea)	20900	kw-hr	$0.10	$2,090	Assume operational 80%
Pump Operation (2 at 1/3 hp ea)	4380	kw-hr	$0.10	$440	Assume continuous operation
				$5,080	

Estimated Capital and O&M Costs for On-Site Advanced Treatment
Using FAST-type underground system

C. Costs for Medium Winery On-site System	Quantity	Unit	Unit Price	Total Cost	Comments
Capital Cost					
Grease Interceptor	2	EA	$8,000	$16,000	
Septic Tank	2	EA	$8,000	$16,000	
FAST vaults	2	EA	$8,000	$16,000	
FAST 4.0 treatment system	2	EA	$19,000	$38,000	
Effluent pump station					
Vault	1	EA	$8,000	$8,000	
Duplex pump system	1	EA	$2,000	$2,000	
Leachfields					
Piping, 4" PVC	1300	LF	$5	$5,980	
Drain Rock	430	CY	$58	$24,940	
Misc. piping, electrical, sitework				$12,700	
				$139,620	
Operational Costs					
Truck Hauling per year	8	EA	$425	$3,400	
Blower Operation (2 at 4 hp ea)	41800	kw-hr	$0.10	$4,180	
Pump Operation (2 at 1 hp ea)	13060	kw-hr	$0.10	$1,310	
				$8,890	
D. Costs for Subarea #5 On-Site System					
Capital Cost					
Grease Interceptor	5	EA	$8,000	$40,000	Quote from A-1 Septic Tanks
Septic Tank	5	EA	$8,000	$40,000	Quote from A-1 Septic Tanks
FAST vaults	10	EA	$8,000	$80,000	Quote from A-1 Septic Tanks
FAST 7.5 treatment system	10	EA	$27,000	$270,000	Quote from Bio-Microbics
Effluent pump station					
Vault	1	EA	$8,000	$8,000	
Duplex pump system	1	EA	$8,000	$8,000	
Leachfields					
Piping, 4" PVC	3250	LF	$5	$14,950	
Drain Rock	1080	CY	$58	$62,640	
Misc. piping, electrical, sitework				$52,400	
				$575,990	

Estimated Capital and O&M Costs for On-Site Advanced Treatment Using FAST-type underground system

Operational Costs	Quantity	Unit	Unit Price	Total Cost	Comments
Truck Hauling per year	12	EA	$425	$5,100	Quote from Williams Sanitary Service
Blower Operation (2 at 7.5 hp ea)	78400	kw-hr	$0.10	$7,840	Assume operational 80%
Pump Operation (2 at 2 hp ea)	26130	kw-hr	$0.10	$2,610	Assume continuous operation
				$15,550	

Summary of Total Costs for all Existing and Planned Developments

	Estimated Total Costs	
Sources	**Capital**	**Annual Operating**
Buena Vista - 76 homes	$532,000	$81,320
Tesla Road - 9 homes	$63,000	$9,630
E. Livermore - 8 homes	$56,000	$8,560
Stony Ridge small winery	$92,150	$5,080
Concannon medium winery	$139,620	$8,890
Retzlaff small winery	$92,150	$5,080
Welton B&B equiv. 2 single family residences	$14,000	$2,140
Subtotal Existing Sources	**$989,000**	**$121,000**
Subarea #3		
B&B, equiv. 2 single family residences	$14,000	$2,140
Small restaurant, equiv. medium winery	$139,620	$8,890
Subarea #4		
Olive press, equiv 1/2 small winery	$46,075	$2,540
2 small wineries	$184,300	$10,160
Small restaurant, equiv medium winery	$139,620	$8,890
Subarea #5	$575,990	$15,550
Subarea #6 Medium Winery	$139,620	$8,890
Subarea #7 Medium Winery	$139,620	$8,890
Subtotal New Developments	**$1,379,000**	**$66,000**
Total Existing and New Sources	**$2,368,000**	**$187,000**

Estimated Capital and O&M Costs for Centralized Treatment Plant Using ZenoGem Package System

	Quantity	Unit	Unit Price	Total Cost	
A. Cost for two separate plants					
1) Package Plant Costs to Serve Existing Sources plus Subarea #3					
Capital Cost per household					
New 4" Lateral Connection to Street	200	LF	$8	$1,600	
Cleanout	1	EA	$40	$40	
Remove exst septic tank	1	LS	$800	$800	
Total per household				$2,440	
Subtotal for 93 houses				$227,000	
Collection System Costs					
Buena Vista Sewer, 10"	5280	LF	$20	$105,600	
S. Livermore/Tesla Sewer, 10"	7000	LF	$20	$140,000	
Subarea #3 sewer, 8"	3500	LF	$20	$70,000	Connect to S. Livermore sewer
Contingencies for MH, PS, misc.	10%	LS		$31,560	
Subtotal				$347,000	
Package Plant Costs					
Process Equipment	1	LS	$248,000	$248,000	Quote from Zenon
Concrete Tanks	75	CY	$500	$37,500	
Sludge Handling Equipment	1	LS	$100,000	$100,000	
Pre-engineered Building	1600	SF	$80	$128,000	
Misc. piping, electrical, sitework				$51,400	
Subtotal				$565,000	
Distribution Costs for Vineyard Irrigation					
Piping, 4" PVC	3000	LF	$20	$60,000	Assume connection to exst. vineyard irrig. systems
Pump Station	1	LS	$8,000	$8,000	
Misc. piping, electrical, sitework				$6,800	
Subtotal				$75,000	
Total Capital Costs				**$1,214,000**	
Operational Costs					
Blower and pump operation	127000	kw-hr	$0.10	$12,700	Quote from Zenon
UV disinfection	1533	kw-hr	$1.10	$1,690	Quote from Zenon
Sludge hauling and disposal	1	LS	$30,000	$30,000	
Effluent Pump Operation, 3 hP	9800	kw-hr	$0.10	$980	
Operator's Labor					
Emergency Service, 1.5 hr month	18	hours/year	$60	$1,080	Quote from Zenon
Routine Service, 1.5 hr/wk	78	hours/year	$60	$4,680	Quote from Zenon
Yearly Service, 2 days/year	16	hours/year	$60	$960	Quote from Zenon

Estimated Capital and O&M Costs for Centralized Treatment Plant Using ZenoGem Package System

	Quantity	Unit	Unit Price	Total Cost	
Parts & Repair	1	LS	$3,600	$3,600	Quote from Zenon
Membrane Replacement	1	LS	$3,500	$3,500	Quote from Zenon
Sodium Hydroxide	1	LS	$500	$500	Quote from Zenon
Total Operational Costs				**$60,000**	

2) Package Plant Costs to Serve New Development in Subareas 4-7

Collection System Costs					
10" sewer to Arroyo/Welmore	8000	LF	$20	$160,000	
Contingencies for MH, PS, misc.	10%	LS		$16,000	
Subtotal				$176,000	
Package Plant Costs					
Process Equipment	1	LS	$242,000	$242,000	Quote from Zenon
Concrete Tanks	35	CY	$500	$17,500	
Sludge Handling Equipment	1	LS	$50,000	$50,000	
Pre-engineered Building	900	SF	$80	$72,000	
Misc. piping, electrical, sitework				$38,200	
Subtotal				$420,000	
Reuse Costs					
Pump Station	1	LS	$5,000	$5,000	Assume on-site reuse
Misc. piping, electrical, sitework				$500	
Subtotal				$6,000	
Total capital costs				**$602,000**	
Operational Costs					
Blower and pump operation	63400	kw-hr	$0.10	$6,340	Quote from Zenon
UV disinfection	790	kw-hr	$1.10	$870	Quote from Zenon
Effluent Pump, 1HP	3270	kw-hr	$2.10	$6,870	
Sludge hauling and disposal	1	LS	$15,000	$15,000	
Operator's Labor					
Emergency Service, 1.5 hr month	18	hours/year	$60	$1,080	Quote from Zenon
Routine Service, 1.5 hr/wk	78	hours/year	$60	$4,680	Quote from Zenon
Yearly Service, 2 days/year	16	hours/year	$60	$960	Quote from Zenon
Parts & Repair	1	LS	$3,000	$3,000	Quote from Zenon
Membrane Replacement	1	LS	$1,315	$1,320	Quote from Zenon
Sodium Hydroxide	1	LS	$240	$240	Quote from Zenon
Total Operational Costs				**$40,000**	

Estimated Capital and O&M Costs for Centralized Treatment Plant
Using ZenoGem Package System

	Quantity	Unit	Unit Price	Total Cost	
Total Costs for Two Separate Package Plants to serve Existing plus Planned Development					
Total Capital				**$1,820,000**	
Total Annual Operational				**$100,000**	

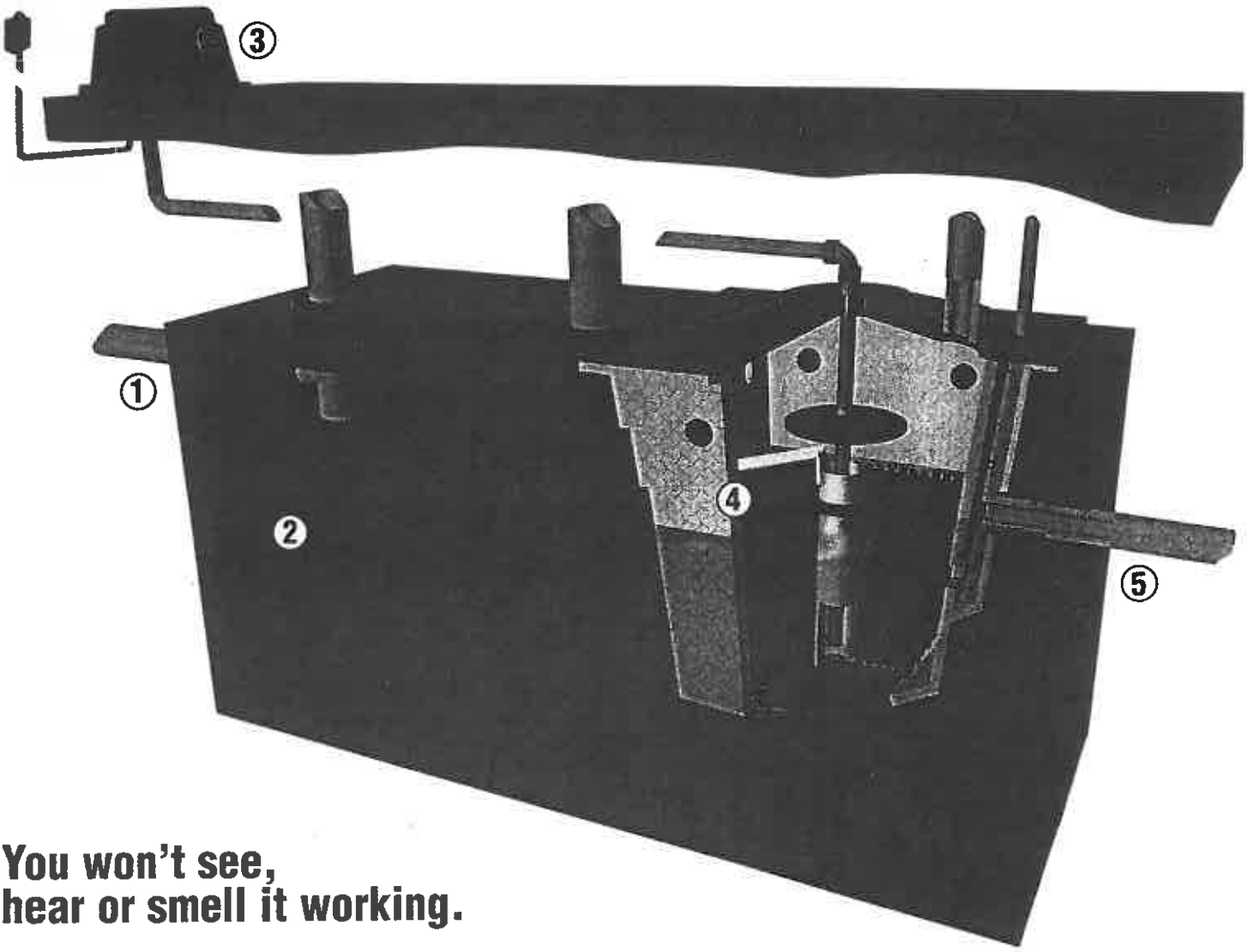
B. Cost for single, larger centralized plant to serve all flow

Capital Cost per household					
New 4" Lateral Connection to Street	200	LF	$8	$1,600	
Cleanout	1	EA	$40	$40	
Remove exst septic tank	1	LS	$800	$800	
Total per household				$2,440	
Subtotal for 93 houses				$227,000	
Collection System Costs					
Buena Vista Sewer, 10"	5280	LF	$20	$105,600	
S. Livermore/Tesla sewer, 12"	7000	LF	$25	$175,000	
Sewer for new developments, 10"	20000	LF	$20	$400,000	
Contingencies for MH, PS, misc.	10%	LS		$68,060	
Subtotal sewers				$749,000	
Package Plant Costs					
Process Equipment	1	LS	$291,000	$291,000	Quote from Zenon
Concrete Tanks	100	CY	$500	$50,000	
Sludge Handling Equipment	1	LS	$150,000	$150,000	
Pre-engineered Building	2000	SF	$80	$160,000	
Misc. piping, electrical, sitework				$65,100	
Subtotal				$716,000	
Distribution Costs for Vineyard Irrigation					
Piping, 4" PVC	4000	LF	$20	$80,000	Assume connection to exst. vineyard irrig. systems
Pump Station	1	LS	$8,000	$8,000	
Misc. piping, electrical, sitework				$8,800	
Subtotal				$97,000	
Total capital costs				**$1,790,000**	
Operational Costs					
Blower and pump operation	164000	kw-hr	$0.10	$16,400	Quote from Zenon
UV disinfection	1533	kw-hr	$1.10	$1,690	Quote from Zenon
Sludge hauling and disposal	1	LS	$40,000	$40,000	
Effluent Pump Operation, 4 hP	13100	kw-hr	$0.10	$1,310	
Operator's Labor					

Estimated Capital and O&M Costs for Centralized Treatment Plant Using ZenoGem Package System

	Quantity	Unit	Unit Price	Total Cost	
Emergency Service, 1.5 hr month	18	hours/year	$60	$1,080	Quote from Zenon
Routine Service, 1.5 hr/wk	78	hours/year	$60	$4,680	Quote from Zenon
Yearly Service, 2 days/year	16	hours/year	$60	$960	Quote from Zenon
Parts & Repair	1	LS	$4,200	$4,200	Quote from Zenon
Membrane Replacement	1	LS	$4,375	$4,380	Quote from Zenon
Sodium Hydroxide	1	LS	$500	$500	Quote from Zenon
Total Operational Costs				**$75,000**	

Introducing FAST® Wastewater Treatment Systems



You won't see, hear or smell it working.

(1) FAST wastewater treatment systems process all the wastewater from single family homes, clusters of homes, small communities or even the high strength wastes from restaurants or commercial facilities.

(2) Natural separation and settling processes occur in the first compartment of the underground tank.

(3) Remote blower (the system's only moving part) delivers large volumes of air into the heart of the system, creating vigorous water movement. FAST is oxygen-rich and self-cleaning.

(4) Proven, reliable FAST treatment module provides the perfect environment for "friendly bacteria" to grow and multiply. FAST consistently processes and removes more than 95% of common impurities. Special patented technology allows exceptional Total Nitrogen reductions (including nitrates) of more than 70%.

(5) Clear, odorless treated water is ready for standard or innovative dispersal.

The real beauty of this remarkable system is how well it works.

The science behind a FAST® wastewater treatment system is environmentally sound and simple. FAST is an acronym for Fixed Activated Sludge Treatment. Here's why this technology is so effective:

A FAST wastewater treatment system is a pre-engineered modular apparatus designed to treat wastewater from residential, commercial, high strength and small community applications.

FAST is a fixed film, aerated system utilizing a combination of attached and suspended growth, capable of nitrification/denitrification in a single tank. This innovative combination includes the stability of fixed film media and the effectiveness of proven activated sludge treatment, making FAST technologically advanced and extraordinarily reliable.

A FAST system provides an ideal home for large volumes of friendly organisms in the inner aerated media chamber to digest the wastewater and turn it into a clear, odorless, high-quality effluent. The attached growth system assures that more organisms remain inside the system instead of being flushed out, even during times of peak hydraulic flows (for example, during large social gatherings or on multiple-washload laundry days). During times of low usage, the large volumes of thriving organisms prevent a dying-off of the system, making FAST equally well suited to intermittent use applications.

Sufficient conditions are present which allows nitrification and denitrification to occur in the same tank—without any system modifications. Special patented technology allows FAST to consistently reduce nitrogen levels—including nitrates and all other nitrogen species —by over 70%.

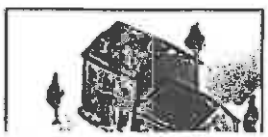
Installation of the lightweight and durable FAST system is easy. It simply mounts into a septic tank. FAST is designed to be efficient, dependable, user-friendly and very easy to install.

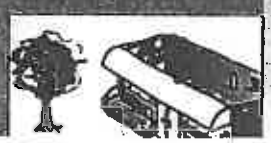
Once installed, the FAST system is virtually maintenance free. Tastefully located below ground level, the clean, odorless system blends beautifully into any landscaping design. The only moving part is the quiet aerating blower, placed above ground level in the most convenient location. FAST needs no other filters or pumps.

FAST is ideally suited for residential development, high strength waste, light commercial applications and renovation of failing systems on marginal or severely limited sites.

FAST wastewater treatment systems share many advantages:

Single Family Dwellings	Clustered Subdivisions	High Strength Commercial	Failed System Renovation
Hidden, installs underground	Makes marginal sites buildable	Robust process handles even the toughest applications	Simple, dependable retrofi
Quiet, automatic operation	Flexible development and landscape planning	Virtually maintenance free—less mess	Minimal disruption
Garbage disposal and dishwasher compatible	Saves money versus centralized system	Pretreatment or complete treatment	Low cost, long-lasting solution
Affordable options			Renovates soil and leach fields



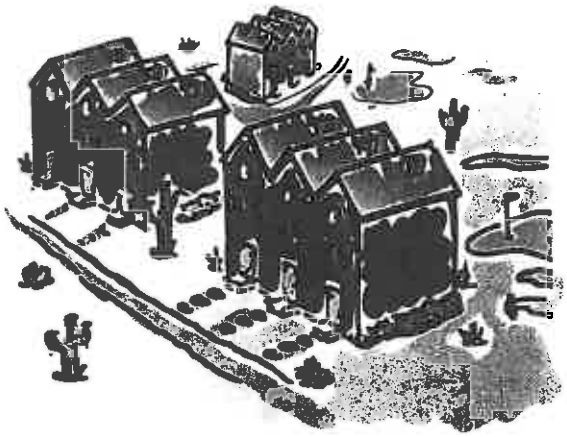



Single Family Dwellings

- Environmentally safe treatment allows full use of property by homeowners, children and pets
- Proven high performance levels could mean reductions in lot size, separation distances and other limiting factors
- Possible innovative re-use of precious water resources for irrigation
- Advanced wastewater treatment system ready for next generation requirements

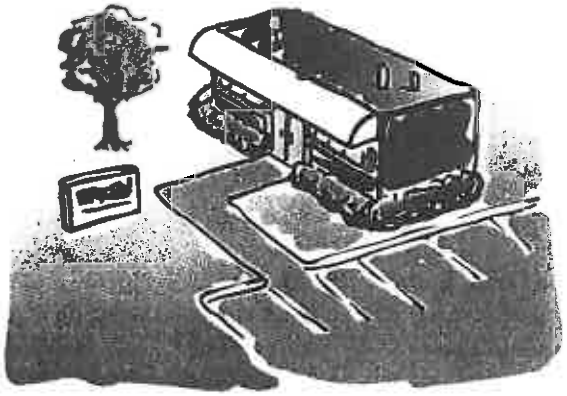
Clustered Subdivisions

- FAST may make previously unbuildable land useful and profitable
- Modular design of FAST system allows project planners maximum flexibility
- Builders and developers are able to purchase and install only when and where needed, saving large capital expenditures of a costly centralized system



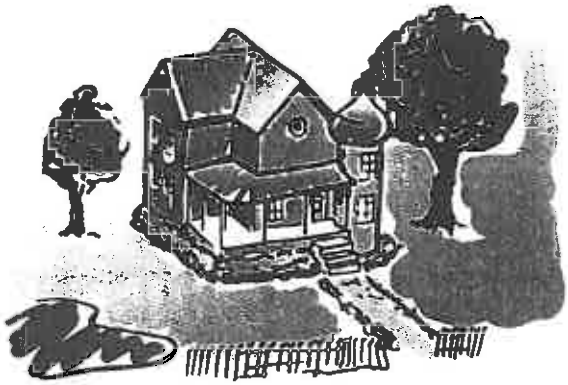
High Strength Commercial

- Restaurants and other difficult high strength waste applications are effortlessly treated with FAST's robust aerobic process
- Clubhouses, schools, trailer parks, office buildings and other commercial properties are natural fits for a FAST wastewater treatment system
- With FAST's reliable process engineering design, operation is simple and virtually maintenance free



Failed System Renovation

- Failing septic systems can easily be retrofitted and upgraded with the simple, affordable design of FAST
- Small communities now have a practical, proven alternative to cost prohibitive centralized sewer systems
- Modernizing the wastewater treatment system with FAST increases value and usefulness of the property



Proven, safe, reliable.

The advanced technology behind FAST was originally developed by Smith & Loveless, Inc., a worldwide leader in the design and manufacture of wastewater treatment equipment since 1946. FAST has been used successfully for many years in municipal, industrial, marine, commercial and residential applications. Known globally for superior engineering and manufacturing, the Smith & Loveless companies are one of the most recognized water and wastewater transfer and treatment groups in the world. This innovative group of companies is known for high standards, proven technology, engineering expertise and manufacturing quality.

Environmental Protection

FAST systems greatly reduce groundwater contamination and help protect the delicate ecosystem. Potentially harmful nitrates and all other forms of nitrogen are removed at unparalleled rates (more than 70%) through the patented FAST process. FAST is made with post-consumer recycled materials. Use of this remarkable system allows for responsible new development and the renovation of failed conventional systems.

FAST Certifications

U. S. Coast Guard
Canadian Great Lakes
UK Department of Trade
NSF Standard 40, Class I
International Maritime Organization (IMO)

Technical Specifications

Power required: Normal household current (120v, 60Hz). Other options (220v and international requirements) are available.

Materials of construction: Made with 100% corrosion resistant materials and contains post-consumer recycled materials.

Underground housing: FAST systems can be housed in concrete, fiberglass, steel or plastic tanks. Always check local regulations before installing or altering a wastewater system. Contact Bio-Microbics or a dealer near you for more information on the availability of proper tankage in your area.

Dispersal Options: Check your local regulations. The extraordinarily high treatment levels may allow reductions in drain field areas, use of treated water for irrigation or other innovative discharge methods.

Capacity: Available in several convenient, affordable sizes and configurations. Please contact Bio-Microbics or a dealer near you for more information on the FAST system that's right for your application.

Bio-Microbics, Inc.
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Shawnee, KS 66227

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Web site: www.biomicrobics.com

BIO-MICROBICS® INCORPORATED

ZENON Membrane

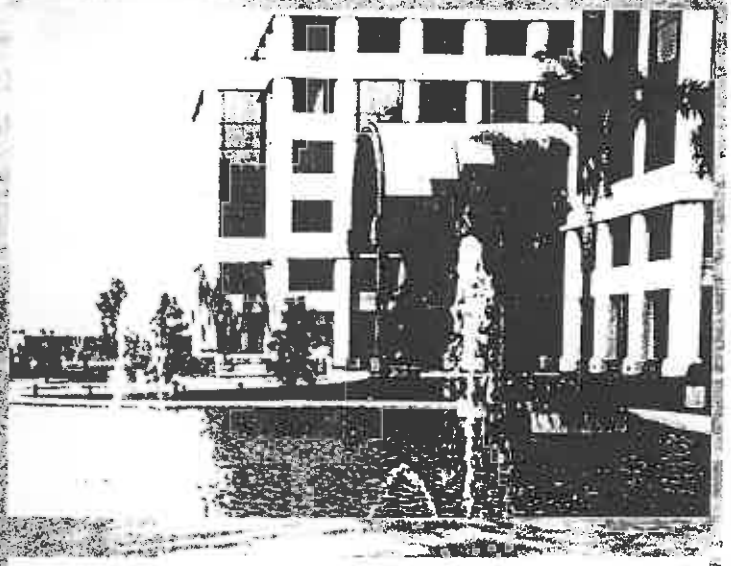
Proven Wastewater Treatment

Frequently, land development is delayed or stopped because of:

- a lack of existing sewer access
- high development charges for new sewers
- stringent effluent discharge criteria
- the extent of valuable space that is needed to house conventional wastewater treatment
- an inability to handle increases in flow within the existing treatment area foot print
- the remoteness of some locations
- the lack or cost of full-time operators

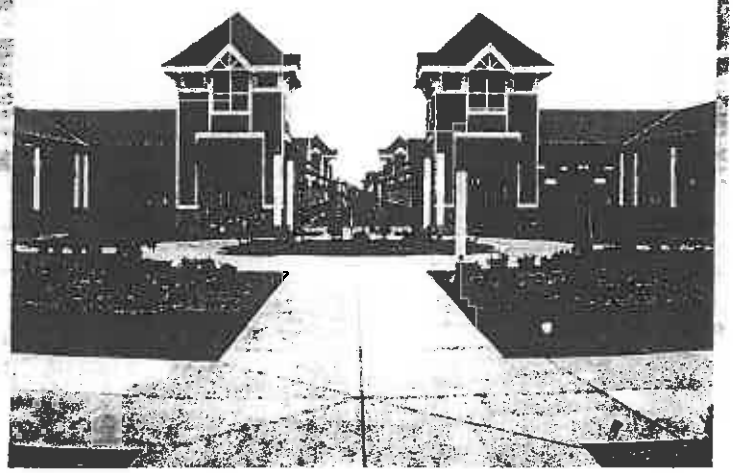
The Proven Solution:

ZENON's **ZenoGem®** and **Cycle-Let®** bioreactor systems are the effective combination of biological treatment and membrane separation technologies, and the proven solution for tough wastewater problems. Compact, odor-free, easy to install and simple to maintain, **ZenoGem®** and **Cycle-Let®** systems provide cost-effective and reliable wastewater treatment, consistently delivering an effluent quality that is acceptable for any discharge option and many reuse applications, without the need for a full-time operator.



Office park dramatically reduces water consumption and wastewater discharge

At a major office complex in California, the **Cycle-Let®** bioreactor system was a key factor in reducing the effluent discharge from the development to almost zero. Using a range of water conservation concepts, water consumption at the office park was reduced by almost 80%. Then, by reusing water from the on-site wastewater treatment in a creative, water-feature landscaping design, sewer discharges were virtually eliminated from the facility.



Shopping mall recycling system dramatically reduces area required for wastewater treatment and improves land utilization

With no sewer availability, the capacity limits of a conventional leaching field prevented the developer of a premium outlet mall in Connecticut from building the proposed 400,000 ft² facility. The conventional discharge level for a building of this size is 40,000 gpd. Using the ZENON **Cycle-Let®** bioreactor system, high-quality processed water was recycled back to the toilets and the urinals, reducing the discharge to under 6,500 gpd, for an annual saving of over 12,800,000 gallons of water, and minimizing the environmental impact of the mall.

echnology Makes Wastewat

Revolutionary Technology

Resort development expansion at a remote, environmentally-sensitive site

For the owners of a ski resort in Western Canada, the strict environmental guidelines and limited capacity at the existing treatment plant were major challenges. Future growth at the site was extremely difficult because of the need to preserve the natural pristine waters and wildlife of the surrounding area, and the problems inherent in a conventional treatment system: major land requirements and unacceptable odors. The reliable, effective and unobtrusive solution was the **ZenoGem®** bioreactor system, designed to operate with intermittent attention and capable of meeting the strictest discharge criteria. Providing trouble-free service since start-up, this easily-expandable, low-maintenance system will allow for significant resort growth in the future.

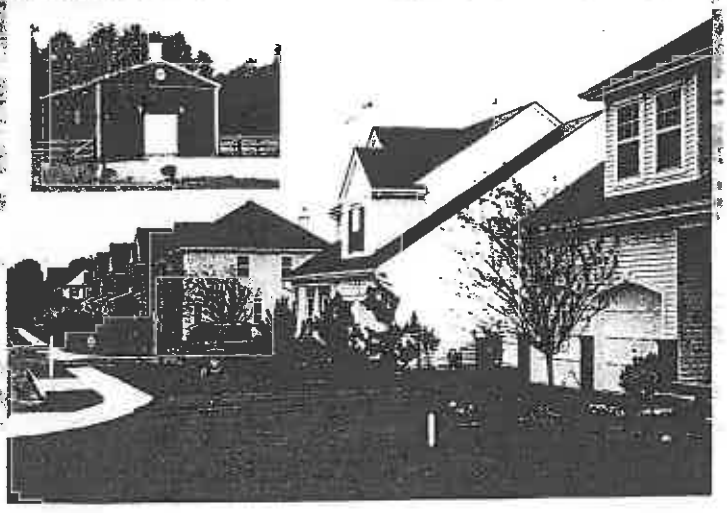
Typical Effluent Quality Guarantee

BOD_5	<3 mg/L
TSS	<3 mg/L
pH	6 to 9
Turbidity	<2 NTU
Fecal Coliform	<2.2 cfu per 100 mL
Total Nitrogen	<3 mg/L
Phosphorous	<0.1 mg/L*

* The ZenoGem® & Cycle-Let® process achieves better than tertiary treatment effluent quality in a single step and may be easily adapted to meet low phosphorus levels.

The ZeeWeed® membrane

At the heart of the **ZenoGem®** and **Cycle-Let®** bioreactor systems, the revolutionary **ZeeWeed®** membrane is the key to process efficiency and treatment effectiveness. A unique, microfiltration membrane, the **ZeeWeed®** module is immersed in the biological treatment tank, in direct contact with the mixed liquor. Under a slight vacuum, the biologically-treated wastewater is drawn to the inside of the membrane for discharge or reuse. The biodegradable contaminants, and the harmful micro-organisms, are unable to pass through the fine pores of the membrane and remain in the treatment reactor. The **ZeeWeed®** technology provides extremely high-quality effluent with low sludge volumes, and minimal operator attention.



Residential development proceeds without sewer connection

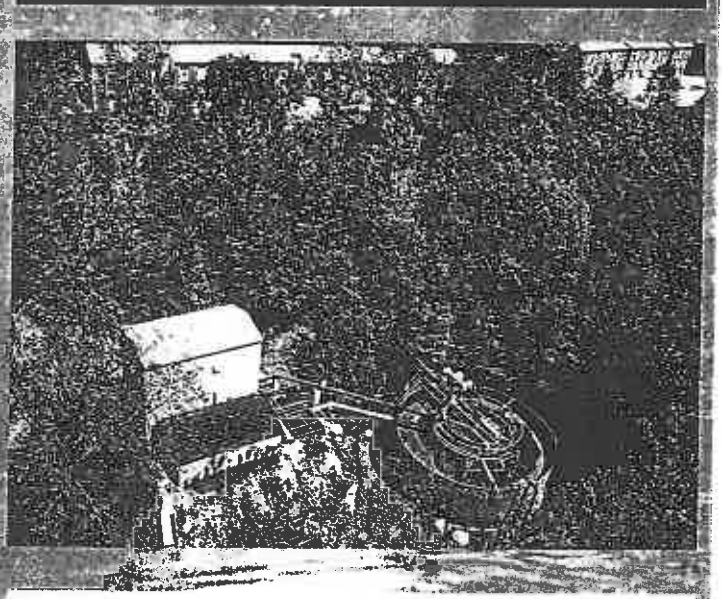
The lack of available sewers was a major obstacle for the developer of a residential subdivision in Western New Jersey. A compact, state-of-the-art **ZenoGem®** bioreactor system provided the ideal solution. Exceeding the strictest of discharge requirements and housed within a building which blended with the local architecture, the award-winning design was acknowledged for its contribution to the preservation and conservation of natural resources. These small-footprint, modular systems are allowing residential property developers to add processing capacity in line with demand, thereby reducing front-end development charges.

Treatment Simple

Economically Efficient Solution

Cycle-Let® is the solution to development in areas with water conservation requirements

Many areas lack sewers and experience severe water shortages. Across North America, ZENON's wastewater treatment and recycling systems are reducing the consumption of water and wastewater discharge in schools by up to 85%. In addition to saving thousands of gallons of water per year, the **Cycle-Let®** bioreactor system is an environmentally-friendly solution for most wastewater problems.



Apartment complex upgrades discharge quality and treatment capacity, with no interruption in service

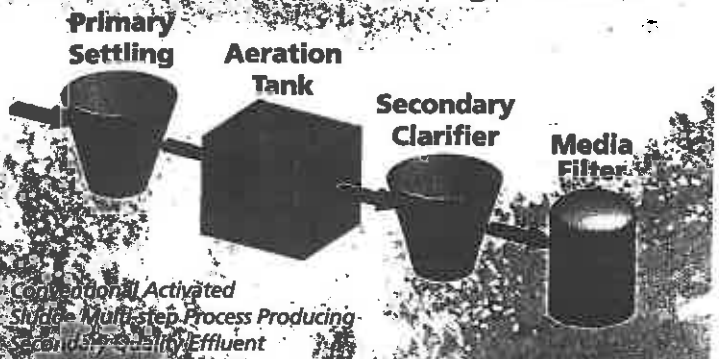
The need to meet strict, new discharge criteria and handle increased wastewater flows posed a major problem for the owners of an East Coast apartment complex. With the ZENON **ZenoGem®** bioreactor system, however, the old secondary contact stabilization plant, sized at approximately 120,000 gpd, was upgraded to an advanced 175,000 gpd plant, while exceeding the local regulations for groundwater recharge, and with no interruption of service. By staying within the footprint of the current plant and by using much of the existing equipment, the capital expenses were dramatically lower than the cost of a new facility.

ZENON technology brings shopping center into compliance with fast, seamless upgrade

Facing severe legal problems over an on-site treatment system which could no longer handle the effluent loading and satisfy the environmental regulations, the owners of an East Coast shopping center turned to ZENON for the solution. The fast and seamless change-over to the **ZenoGem®** bioreactor system, from the conventional activated sludge process, brought the facility into compliance, reliably and consistently, without stopping the commercial operation of the center.

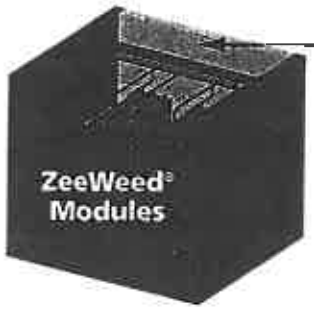
Conventional Wastewater Treatment vs ZenoGem®

Conventional Activated Sludge Process



Conventional Activated Sludge Multi-step Process Producing Secondary Quality Effluent

ZenoGem® Bioreactor System



Single-step ZenoGem® process
Producing Near-potable Quality Water from Sewage
Occupying less than 1/4 the space

The Cycle-Let® Wastewater Recycle System