

# Unrestricted Water Reuse & Low Energy Cluster Wastewater System Producing TN < 4 mg/l – Malibu Creek Plaza, Malibu, CA

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Figure 1. Malibu Creek Plaza Location Map

## ABSTRACT

The Malibu Creek Plaza is a shopping plaza consisting of both retail and commercial businesses, located in an environmentally sensitive area adjacent to the famous Surfrider Beach in Malibu, California. Lombardo Associates, Inc. (LAI), retained to engineer a compliant wastewater management system, designed a cost-effective wastewater management system that employs a septic tank effluent pump collection system and treatment system consisting of the Nitrex™ Nitrogen Removal Technology, recirculating media pretreatment of septic tank effluent, and an ozone – UV disinfection system. The treatment system has met permit requirements and unrestricted water reuse standards and the paper will present these results.

**Keywords:** water reuse, nitrogen removal, low energy, wastewater

## INTRODUCTION

The Malibu Creek Plaza is a shopping plaza consisting of both retail and commercial businesses, with 406 restaurant seats, 3,600 square feet of office space, and 26,000 square feet of retail space. Some of the current occupants include: a multi-screen theater, three full serve restaurants, an ice cream parlor, a dry cleaner, a bank, a pet store which also grooms pets, and other

retail businesses. It is located in an environmentally sensitive area. Malibu Lagoon is approximately 200 feet south of the site. The Pacific Ocean and famous Surfrider Beach are approximately 1,400 feet south of the site.

Lombardo Associates, Inc. (LAI) was retained to review the existing system and site conditions and design a permit, as described in Table 1, compliant wastewater management system that would be protective of the nearby sensitive environmental receptors.

Table 1: Effluent Standards for Malibu Creek Plaza

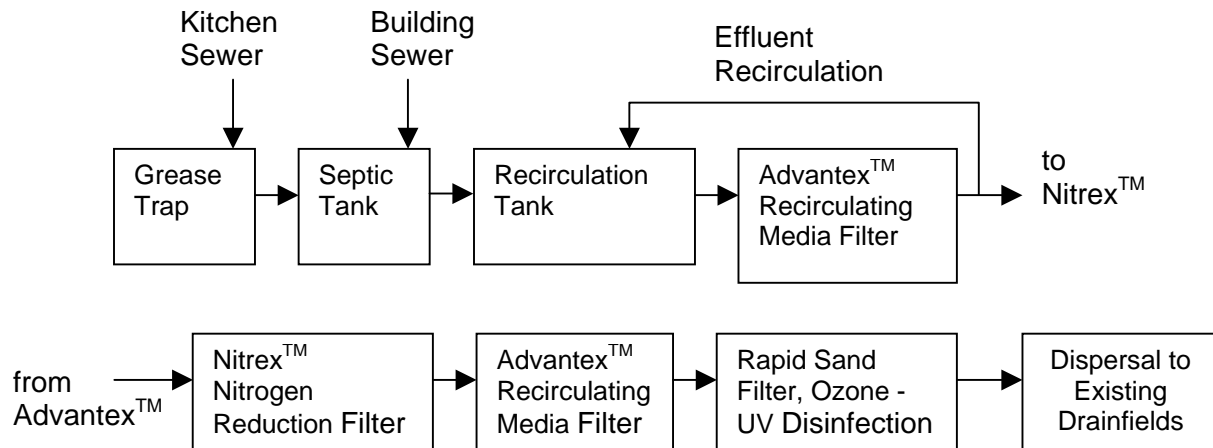
Monthly Constituent	Unit	Avg	Max
BOD <sub>5</sub>	mg/L	30	45
Suspended solids	mg/L	30	45
Turbidity	NTU	10	15
TDS	mg/L	-	2,000
Sulfate	mg/L	-	500
Oil and Grease	mg/L	-	15
Chloride	mg/L	-	500
Total Nitrogen	mg/L	-	10
Fecal Coliform <sup>(a)</sup>	MPN/100 mL	-	200
Enterococcus <sup>(b)</sup>	MPN/100 mL	24	104

(a) The limits for coliform shall apply, prior to discharge of the effluent into the leach fields

(b) The Enterococcus limit is based on geometric mean of at least 5 equally spaced samples in any 30-day period.

The Malibu Creek Plaza wastewater management system was designed to collect, treat and disperse the wastewater generated in the Plaza based on a number of factors. The factors determining the design parameters include actual measured water usage, expected flows, water quality sampling data from the existing system, regulatory requirements, and future expansion requirements. Figure 2 shows the process flow diagram for the new wastewater system at Malibu Creek Plaza.

Figure 2: Malibu Creek Plaza Process Flow Diagram



The treatment system was designed to treat existing flows and will be expanded as additional capacity is needed. The treatment system's modular design is conducive to this design approach.

The Malibu Creek Plaza wastewater system design flows are:

Base flow	12,000 gpd
Peak flow and growth allowance	4,000 gpd
	16,000 gpd

Based upon information provided, the system's operator, wastewater characteristics for Malibu Creek Plaza (*i.e.*, septic tank effluent as septic tanks are part of treatment process) are presented in Table 2. Samples were collected from 2001 through 2003. The septic tank effluent wastewater quality data was used to design the treatment system. Tank 2 serves the North portion of the Plaza (office/retail) and Tank 5 serves the South portion of the Plaza. The BOD<sub>5</sub> data for Tank 5 is substantially higher than that for Tank 2. LAI was of the opinion that Tank 2 is more representative of the wastewater quality from the retail/office units and Tank 5 is more representative of the septic tank effluent quality from restaurants. A flow weighted average of the BOD<sub>5</sub> load from each tank was used in the design of the wastewater treatment system.

Table 2: Septic Tank Effluent Wastewater Characteristics

Wastewater Characteristics	Tank 2			Tank 5		
	Mean	Min	Max	Mean	Min	Max
pH (s.u.)	7	6	8	6	6	8
TSS (mg/L)	63	9	382	220	54	1363
BOD <sub>5</sub> (mg/L)	143	22	352	453	137	2059
Oil & Grease (mg/L)	21	5	103	24	5	63
Total Nitrogen (mg/L)	31	1	54	47	2	147

Source: BioSolutions, Inc. 2001-2003

## TREATMENT SYSTEM DESIGN

### Headworks

A hydraulic residence time (HRT) factor of 3-days for the grease traps, the minimum required by the Advantex™ Biofilter treatment system manufacturer, was employed. A total volume of 22,000 gallons is provided for the grease traps.

The septic tanks were sized based on design flows with a HRT of 3-days for those serving office and retail units and 4-days for those serving restaurant units. The HRT employed is the minimum HRT required by the Advantex™ Biofilter system manufacturer for system design. A total volume of 51,000 gallons capacity was provided for septic tanks.

### Flow Equalization Tank

A 16,000 gallon equalization tank has been provided to dampen the variations in wastewater flows and strengths. The equalization tank was sized based on an analysis of daily wastewater generation. On a daily basis the treatment plant actual wastewater flow using the peak period of May to July 2004 water use data was approximately 14,000 gallons, with 16,000 gallons of equalization.

## Recirculation Tanks

A recirculation tank was used to mix the recycled effluent from the Advantex™ biofilters with the influent to the biofilters. The mixing helps promote denitrification. The recirculation tank provides 1 day HRT. A 20,000 four-compartment tank was installed. The first two compartments are for recirculation and are 12,000 and 4,000 gallons respectively. The other two compartments are 2,000 gallons each and serves as pump chambers.

## Advantex™ Biofilters

The Advantex™ biofilters were sized both on a hydraulic and mass loading rate.

The areal hydraulic application rate to the Advantex™ filters is 10 gallons per day per square foot (gpd/sf) for restaurant facilities and 25 gpd/sf for office/retail facilities as specified by the manufacturer. The flow weighted loading rate was calculated to be 1,300 gpd per AX-100 pod (i.e. 13 gpd / sf), which reflects that restaurant facilities account for the majority of the wastewater generated. Thus, for a design flow of 16,000 gpd, 12 pods were required on a hydraulic loading rate.

The Advantex™ treatment system was also sized based on a design BOD loading rate of 0.04 ppd/ft<sup>2</sup>, with the constraint of an average hydraulic loading rate less than 25 gpm/ft<sup>2</sup>. Sampling data showed that the typical BOD concentration of septic tank effluent for the restaurants and similar commercial tenants was 453 mg/L. The average BOD concentration for offices/retail tenants was 143 mg/L. A flow-weighted average resulted in an Advantex™ influent wastewater BOD concentration of 404 mg/L. Using this concentration with a design flow of 16,000 gpd, an average BOD loading rate of 54 ppd was calculated. Using the Advantex™ AX-100 units with a treatment area of 100 ft<sup>2</sup> each, a total of 14 units were needed to treat septic tank effluent from the plaza based on the mass loading. The BOD loading rate governed the final design.

Fourteen (14) Advantex™ AX-100 Biofilters were installed for BOD, TSS and NH<sub>4</sub> removal. The Advantex™ Biofilters are recirculating media filters with part of the Biofilter effluent returned to the recirculation tank. Recycling to the recirculation tank was assumed to provide approximately 50 percent denitrification.

Two of the Advantex™ AX-100 pods are used to polish the effluent from the Nitrex™ units before disinfection.

## Nitrex™ Filters

The Nitrex™ component of the wastewater system was sized based on LAI's previous experience with Nitrex™ systems and consultation with the technology patent holder. Five (5) Nitrex™ Filters (anoxic bioreactors), each in a 15,000-gallon tank, follow the Advantex™ Biofilters for nitrogen reduction. A pumping station receives the effluent from the Nitrex™ Filters. All pump stations, are watertight with alarms should excess water enter the system or pumps fail.

## Disinfection System

The proposed disinfection system is an ozone and ultra-violet (UV) light disinfection system. It was sized by the required flow rate and effluent requirements. For Malibu Plaza a system with a 12 gpm flow rate was employed. Disinfection is achieved by passing the treated wastewater from the Nitrex™ through a rapid sand filter, then through an ozone treatment unit, and finally through UV chambers before discharging to the drainfields. Redundant disinfection units were used due to the environmental sensitivity of the site.

## Drainfields

New drainfields were installed at 2.47 gpm / ft<sup>2</sup>. There are three drainfields, measuring 2,160 square feet each, for a total capacity of 16,000 gpd.

## PERFORMANCE

The system was installed and has been operational since July 2007. Table 3 shows the performance summary for the system.

## SUMMARY

Malibu Creek Plaza is located in an environmentally sensitive area. The former wastewater system was a conventional septic system, which provided little nitrogen or bacteria removal. The Plaza was the source of groundwater pollution that was adversely affecting Malibu Creek and Malibu Lagoon and issued a consent order requiring upgrade of the wastewater system at the Plaza. LAI designed a decentralized wastewater management system, which employs the Advantex™ recirculating media filter, the Nitrex™ media filter for nitrogen removal and an ozone – UV disinfection system for removal of pathogenic organisms and emerging contaminants, and achieves unrestricted water reuse standards. O&M requirements of the system are monthly visits for sampling and minor maintenance. The Treatment System is continuously monitored via an on-site PLC and telephone/internet connection.

Table 3: Malibu Creek Plaza Performance Summary

	Constituent	BOD <sub>5</sub>	Total Suspended Solids	Turbidity	Oil & Grease	TDS	Total Nitrogen	Fecal Coliform	Enterococcus	Total Coliform	Flow @ Sampling Date	Average Monthly Flow
	Units	mg/l	mg/l	NTU	mg/l	mg/l	mg/l	MPN/100 ml	MPN/100 ml	MPN/100 ml	gpd	gpd
Malibu Creek Plaza Effluent Standards	Average	30	30	10.0	-	-	-	-	24			
	Max	45	45	15.0	15	2,000	10.00	200	104			
Title 22 Unrestricted Reuse Requirements	Average			2.0						2.2		
	Max			10.0						23		
<i>Aug. 2007 Avg.</i>		71	23	25.55	<5	940	4.24				12,755	15,244
<i>Sept. 2007 Avg.</i>		<6	5	1.76	<5	590	4.75	<2	<1	<2	10,938	11,778
<i>Oct. 2007 Avg.</i>		<7	5	1.08	<5	572	3.94	<2	<1	<2	13,011	20,425
<i>Nov. 2007 Avg.</i>		<5	<5	0.85	<5	526	3.23				12,475	11,692
<i>Dec. 2007 Avg.</i>		12	9	1.80	<5	688	3.57	2	<1	8	10,834	9,519
<i>Jan. 2008 Avg.</i>		6	5	1.10	<5	604	4.73	<2	<1	50	9,982	9,725
Average from 9/1/07		<8	6	1.32	<5	596	4.04	<2	<1	<4	11,448	11,802