APPENDIX K

WASTEWATER MANAGEMENT AND FLOW ANALYSIS REPORT

Wastewater Management and Flow Analysis Report

Waterman Gardens
San Bernardino, CA

August 1, 2011

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The Housing Authority for the County of San Bernardino

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Wastewater Management and Flow Analysis Report

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1.0 Executive Summary

Water efficiency, water recycling and water reuse are powerful strategies to reduce water consumption and water, sewer and energy costs. The following data shows that despite an increase of 63% in population density, water use will actually decline from 46 million gallons to 36 million gallons per year. Not only will water consumption will be reduced, wastewater will be reduced also. Our estimates are that 21 million gallons of wastewater are discharged from the site every year. Through water efficiency and graywater irrigation of the site, a reduction of approximately 12 million gallons of wastewater can be achieved per year. The daily average sewer outflow will be approximately half of the current level. Downstream sewer flows in the City's sewer network should not be adversely affected. The maximum dispersal area of the graywater required by State code will only be approximately 6% of the site. An elimination of the community center and replacement with additional housing will not adversely affect the project.

2.0 Introduction

The following study was prepared to analyze current and proposed wastewater flows at the Waterman Gardens site. Through innovative design strategies and careful planning, the sanitary sewer flows from the site can be managed so that pipe capacity downstream of the site will not be adversely affected with the new proposed development, Even with a 63% increase in population from 844 to 1377 residents, the future wastewater discharge can be kept at or below the current estimated level of discharge from the site.

2.1 Site Investigation and Research

Site data was collected including water use records, historical site plans, and photographs. Site visits were conducted and meetings were held with relevant water and public health agencies. An array of alternative water technologies were researched including rainwater catchment, blackwater treatment, recycled water, and graywater. Soils data was available on a broad countywide scale, but no site-specific soils reports were found. In order to evaluate current soils conditions at the site, CHJ Incorporated was contracted to perform infiltration testing in May 2011 and they released their results in their report entitled "Infiltration Investigation", dated June 3, 2011.

With the goal of water conservation and reduction of wastewater, several approaches were considered including water efficiency and water reuse. Several alternative water

systems were investigated and evaluated for use onsite. An optimal strategy was selected and water flows were quantified.

2.2 Methodology

A sustainable design methodology was used for the site analysis and design strategies. The site was viewed as a holistic system and inflows and outflows and any onsite recycling were mapped. The major flows onsite include water and energy. Nature 'closes the loop' and continually cycles and recycles water and energy. By studying how water and energy are recycled in nature, design concepts developed which allowed multiple cycles and uses of resources onsite.

2.3 Assumptions

- The current population of the site is approximately 844 people living in 252 units.
- The future population is approximately 1377 people living in 411 units.
- Water fixture flow rates will conform to the "20% Reduction" standards listed in California Green Building Standards Code (CalGreen) Title 24, Part 11, Table 4.3203.2 (see table in Section 4.1 of this report).
- The graywater system will be designed in accordance with the California Plumbing Code (CPC) Chapter 16A.

2.4 Regulatory Agency Consultation

Multiple regulatory agencies were consulted to determine the applicable regulations and guidelines. This also allowed us to develop relationships with these agencies so that our designs could help them meet their goals and objectives.

The California Department of Public Health (DPH) regulates standards for potable and non-potable water. We spoke with Andres Aguirre in the San Bernardino office. He said that his only concern was that any recycled water we might generate would have to comply with Title 22 regulations. We spoke with Gary Stewart in the Santa Ana office of the Regional Water Quality Control Board (RWQCB). He said we would be required to obtain a Waste Discharge Requirement (WDR) permit if the project involved advanced wastewater (blackwater) recycling. He said that he would need to review the design to determine if a graywater system would need a permit. He said we would need to comply with Title 22, Chapter 3 of the DPH Title 22 regulations, for the treatment standard and uses of wastewater processed on the site. The California Department of Housing and Community Development (HCD) has established a new graywater code (Chapter 16A) that would apply if a graywater system is included in the project, unless local codes are more restrictive.

At the County of San Bernardino, we met with Joy Chakma from County Environmental Health- Land Use Services Department, who had no significant concerns regarding the project and referred us to the City of San Bernardino Building Department. We met with Jarrod Gibbon, National Pollution Discharge Elimination System (NPDES) stormwater engineer for the City. He is required to make sure the project is within the guidelines of the County MS4 NPDES Permit. He said we would have to prepare a Water Quality Management Plan (WQMP), which would require review and approval of our proposed Best Management Practices (BMPs). The project would need to be in compliance with the NPDES regulations. We spoke with Joseph Lease in the City Building Department, who said that there is no more restrictive local code and that no graywater systems had yet been permitted to his knowledge. We spoke with Matt Litchfield and several others from SBMWD. Matt expressed interest in developing a pilot program to install 'smart meters' to monitor various water flows on-site. We spoke with Robert Eisenbeisz, the City Engineer and Robert Sepulveda from the Department of Public Works about stormwater issues. He was concerned that bio-swales and other infiltration BMPs would prove to be less effective over time, and should have effective overflow systems.

3.0 Water and Sewer Flow Analysis

The current wastewater flow at the site was estimated by several methods. Water records were obtained from the SBWD and the data were analyzed. Research was performed to find studies citing estimations of water and wastewater use. A historical Wastewater Master Plan was reviewed and evaluated. The site infrastructure was investigated. While water use records were available, there has been no known monitoring or measurement of wastewater flow leaving the site. There is also no separate metering to determine the percentage of water that is used for landscape. Various studies and estimations were required.

3.1 Wastewater Flow Studies

In addition to the analysis performed by analyzing water records, wastewater flows were estimated by analyzing several wastewater studies. Using the weighted average of the values determined by four separate wastewater flow studies, the average gallons per person per day would be approximately 68.6 gpcd. Using this value multiplied by the current site population of 844 yields a daily discharge of 57,898 gpd on average.

Study	Number of residences	Study duration (months)	Study average (gal/pers/day)[b]	Study range (gal/pers/day)
Brown & Caldwell (1984)	210		66.2 (250.6)[b]	57.3-73.0 (216.9-276.3)[b]
Anderson & Siegrist (1989)	90	3	70.8 (268.0)	65.9 - 76.6 (249.4-289.9)
Anderson et al (1993)	25	3	50.7 (191.9)	26.1-85.2 (98.9-322.5)
Mayer et al (1999)	1188	1[c]	69.3 (262.3)	57.1-83.5 (216.1-316.1)
Weighted Average	153		68.6 (259.7)	

[a]Based on indoor water use monitoring and not wastewater flow monitoring.
[b]Liters/person/day in parentheses.
[c]Based on 2 weeks of continuous flow monitoring in each of two seasons at each home.

This table displays several wastewater flow studies that were used to estimate flow from the site

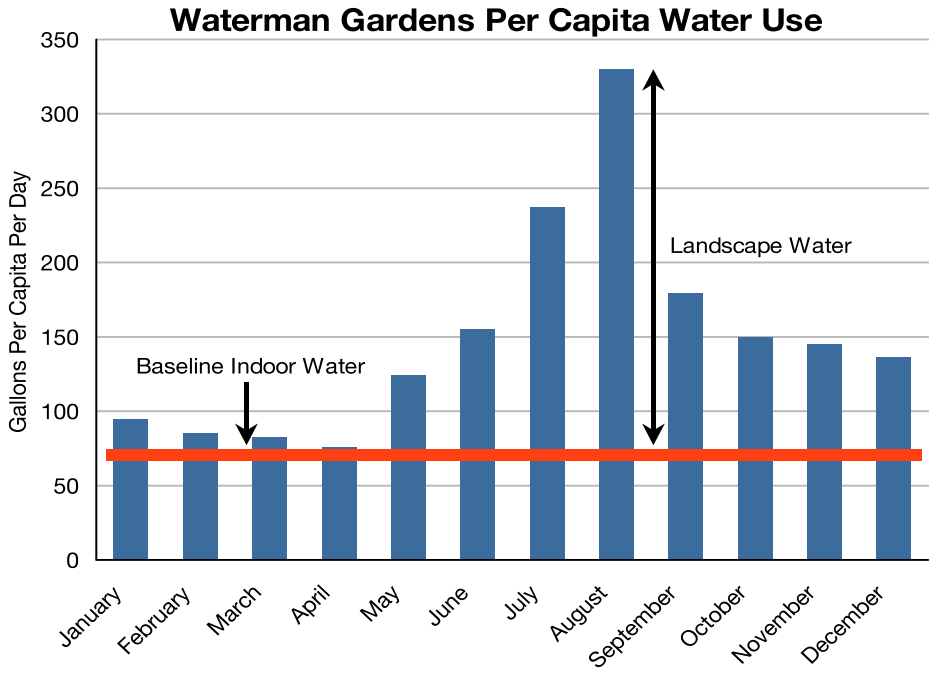
3.2 Site Data Analysis

Water use records were obtained from the SBWD through the assistance of Rishad Mitha at the Housing Authority of the County of San Bernardino (HACSB). Water use data was obtained for Asset Management Point 202, which includes 252 units at Waterman Gardens in addition to 88 other nearby units which are managed by HACSB. Several fluctuations in the data were smoothed out. Due to billing practices at the end of the fiscal year, the September water data was artificially high and the October data was artificially low. These two months were averaged, giving 55% to September and 45% to October. Due to Water records for Analysis was performed on the water data. The water data from 2008-2010 was plotted out on a monthly basis. According to available data, water use ranges from a low of 76 gallons per capita per day (gpcd) in April and a maximum of 330 gpcd in August. It was observed that April had the lowest water use number, which seemed unusual, so the four lowest water use months were averaged to get a seasonal low number of 84 gpcd.

Water use can generally be broken into two main categories, indoor and outdoor use. Average single family residential water use is roughly 50% for outdoor use. Outdoor water use in multi-family buildings is generally less because there is generally less

open space per resident. In the winter, there will still be some outdoor irrigation, so a conservative estimate would be approximately 20% for outdoor use. Applying this number to the seasonal low gives us approximately 67 gpcd for the site. Also, some indoor water use is consumptive, or does not go down the drain to the sewer system. This is very close to the study average number of 68.6 gpcd for wastewater production. Using this figure, the daily wastewater production would be approximately 56,548 gpd.

A baseline indoor water use can be estimated by inspection of the monthly water use graph.



This figure shows the monthly average water use for the Waterman Gardens Site

3.3 Wastewater Estimation by Fixture

The water flows at the site can be estimated by evaluating fixture flow rates. The California Green Building Standards Code (CalGreen) Title 24, Part 11 was consulted to evaluate fixture flow rates. Modeling was done on the current community population to determine what the flow rates would be if all the the current fixtures were in compliance with CalGreen standards. The total indoor potable water use was estimated to be

34,044 gallons per day. Since many of the fixtures at the site date back as far as the 1940s, there is probably considerably more water use. This is approximately half the amount estimated by the other methods. Modern water fixtures and aggressive conservation targets will have a large impact on water consumption. Water conservation not only saves water, but it saves on expenses for potable water, sewer charges and energy.

TABLE 4.303.2
FIXTURE FLOW RATES

FIXTURE TYPE	FLOW RATE	MAXIMUM FLOW RATE AT ≥ 20 percent REDUCTION
Showerheads	2.5 gpm @ 80 psi	2 gpm @ 80 psi
Lavatory faucets, residential	2.2 gpm @ 60 psi	1.5 gpm @ 60 psi[2]
Kitchen faucets	2.2 gpm @ 60 psi	1.8 gpm @ 60 psi
Gravity tank-type water closets	1.6 gallons/flush	1.28 gallons/flush[1]
Flushometer tank water closets	1.6 gallons/flush	1.28 gallons/flush[1]
Flushometer valve water closets	1.6 gallons/flush	1.28 gallons/flush[1]
Electromechanical hydraulic water closets	1.6 gallons/flush	1.28 gallons/flush[1]
Urinals	1.0 gallon/flush	.5 gallon/flush

1. Includes single and dual flush water closets with an effective flush of 1.28 gallons or less.
   Single flush toilets—The effective flush volume shall not exceed 1.28 gallons (4.8 liters). The effective flush volume is the average flush volume when tested in accordance with ASME A112.19.233.2.
   Dual flush toilets—The effective flush volume shall not exceed 1.28 gallons (4.8 liters). The effective flush volume is defined as the composite, average flush volume of two reduced flushes and one full flush. Flush volumes will be tested in accordance with ASME A112.19.2 and ASME A112.19.14.
2. Lavatory faucets shall not have a flow rate less than 0.8 gpm at 20 psi.

3.3 Historical Report Review and Data Analysis

Psomas Engineering prepared a Wastewater Master Plan document for the City of San Bernardino in 2002. In this report, they analyzed the wastewater system for the City of San Bernardino for current and future pipe deficiencies that might result in sewer backup and overflow. The current (2002) system was evaluated through several methods. Pipe diameters were determined and flow monitoring was conducted at five sites to measure actual flows. Flows were also measured entering the wastewater plant. The city was mapped out and land use classifications were designated for all areas of the city. Flows were also estimated based upon this flow monitoring data and also by making estimates of flows based upon building types in the network. A pipe capacity analysis was performed and graphics were produced showing areas where pipe capacity was limited and where flow might exceed the capacity of pipes to carry that flow.

In this study, the land use for the Waterman site was classified as a two family residential development with a design offsite wastewater flow of 22,800 gpd. A multi-family classification was used in some parts of the city, but this category was not

defined. As the Waterman Gardens site is multi-family residential, the design flow used should have been 76,000 gpd.

Sewer flow leaves the Waterman site from two discharge points, one on Olive street and one on Waterman Avenue. The branch from Olive Street flows southward along Waterman Avenue. The flow that enters Waterman Avenue turns at 11th Street and flows westward before it turns and flows southward.

In the Psomas study, pipes were identified as 'deficient' if the existing diameter was considered inadequate and that overflows could result in that section of pipe. No deficient pipes were identified downstream from Olive Street discharge point. The closest potential pipe deficiency on 11th Street line was located approximately 1 mile downstream.

The Psomas report goes on to estimate future flows and potential pipe capacity issues. The date for this future estimation is 2020. No capacity issues near the site were identified for the future scenario.

After reviewing the Psomas report, it appears that there are several problems with their analysis. The Waterman site was modeled as a "Two Family Residential" property, which produced an estimate of 22,800 gpd offsite wastewater flow for the site. As was shown in the previous sections, the actual flow is likely more in the range of 58,000 gallons per day. The Waterman Gardens has been a multi-family residential site since its development in 1943, and it will continue to be multi-family into the future. If Waterman Gardens had in fact been modeled as multi-family residential, the flow would have been approximately 76,000 gallons per day. While the term "multi-family" was not explicitly defined in the Psomas report, our estimate of 58,000 gallons per day is closer to the estimate for multi-family residential. The value of 22,800 gallons per day appears to be a serious underestimate of the flow from the site.

3.4 Wastewater Flow Estimation

Based upon our estimates, the current wastewater flow is estimated to be somewhere in the range of 57,000-58,000 gallons per day. In order to determine the offsite wastewater flow more accurately, flow monitoring studies could be conducted on the wastewater pipes that discharge wastewater from the site. Wastewater currently leaves the site at two sites, one on Waterman Avenue and one on Olive Street. Flow monitoring meters could be installed and data could be collected for a period of weeks to months to collect data on actual flows offsite.

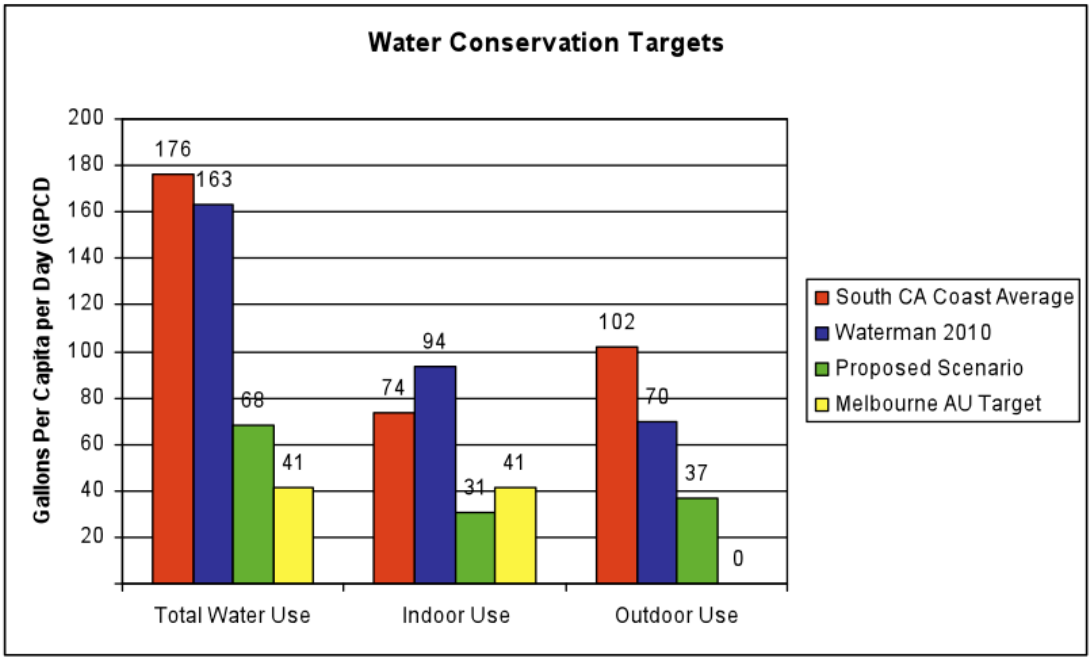
A sewer flow monitoring technician is shown here installing a flow monitor.

4.0 Wastewater Minimization Strategies

Strategies evaluated to help minimize wastewater discharge from the site include water efficiency, water conservation, and water reuse. Water efficiency is important, because less water used is less water discharged as wastewater. New innovations in water reuse allow water to be used more than once on the site, thus reducing the need for water imports.

4.1 Water Conservation Targets

Wastewater flow off the site can be greatly reduced through efficient water use. The CalGreen standards were used to select fixtures that would maximize water efficiency. Using highly efficient water fixtures greatly reduces not only potable water use and expense, but an added benefit is the reduction in sewer fees.



This graph compares Waterman current water use data and proposed versus other data and targets

Water efficiency targets were identified to show a range of possible water conservation targets. Water use at Waterman Gardens ranges from 76 gpcd in the winter to 330 gpcd in the summer, with an average of 163 gpcd on an annual basis. This is slightly better than the Southern California average of 176 gpcd. Aggressive water conservation targets are achievable. Australia has been experiencing a long period of drought and the government has set very aggressive targets for water conservation The City of Melbourne has responded to the drought and achieved significant water savings.

4.2 Water Reuse Alternative Water Solutions Research

Wastewater produced onsite can be seen as a resource rather than a waste product. Water can be treated to a California Title 22 non-potable standard and reused onsite. Use of this water has multiple benefits. Non-potable water can be used for site irrigation and for flushing toilets. This water will offset potable water purchased from the City and when this water is used for irrigation, it will result in less water being discharged to the sewer system, and will thus reduce sewer fees. Water reuse will also

result in less wastewater being discharged from the site and will help prevent sewer capacity issues downstream.

Several types of water reuse were investigated in this study. Treatment of all site wastewater including toilets (**blackwater**) was considered, but rejected due to concerns that the site residents might object to this source. **Rainwater catchment** was investigated. The advantage of rainwater is that it is free and if all of the rainfall were collected, it could meet approximately half of the site's water demand. Unfortunately, this would require several million gallons of water storage and this is uneconomical. Use of rainwater alone would also not reduce the amount of wastewater discharged from the site. Municipal recycled water is planned to be installed along Waterman Avenue at some date in the future, but no clear timetable is clear for this installation. The use of recycled water alone also would do nothing to reduce the wastewater flow from the site.

Considering all the alternative water strategy options, a graywater treatment system was selected as the optimal strategy. There would likely be less community skepticism of the water source since the source water is much cleaner than full wastewater (blackwater), and using the potable supply more than once will save water, money and avoid downstream sewer capacity issues.

5.0 Graywater Recycling and Reuse

Graywater is defined as wastewater from sinks (except kitchen sink), showers and laundry. The organic load is much lower for graywater than for blackwater (toilets and kitchen sinks), so treatment costs are less than for treatment of the entire wastewater stream. Treated graywater can be used for the same non-potable applications as treated blackwater and will yield the same type of economic benefits. Using graywater for landscape irrigation will offset the majority of landscape irrigation demand for the site.

5.1 California Graywater Regulations

The use of graywater in California is prescibed by Chapter 16A of the California Plumbing Code (CPC). The minimum area required for the dispersal of graywater onsite is prescribed by Table 16A-2. A soil evaluation and percolation tests were performed by CHJ Incorporated. They performed 10 soil borings with double ring infiltrometer percolation tests to measure the percolation rate of the soil. In their Infiltration Investigation report dated June 3, 2011, they characterized the soil as sandy silt (ML) and silty sand (SM).

These soil classifications do not directly correlate with the soil types used in Table 16A-2. Using the soil type with the slowest percolation would be the most conservative category. If this soil were classified as "clay with small amounts of sand or gravel", the most conservative category, the amount of area required for dispersal would be 120 square feet per 100 gallons of graywater. Graywater will be distributed onsite through subsurface irrigation.

Table 16A-2 Design Criteria of Six Typical Soils

Type of Soil	***Square Feet***	***Gallons***	***Square Meters***	***Liters***
	Minimum square feet of irrigation/leaching area per 100 gallons of estimated graywater discharge per day	***Maximum absorption capacity in gallons per square foot of irrigation/leaching area for a 24-hour period***	***Minimum square meters of irrigation/leaching area per liter of estimated graywater discharge per day***	***Maximum absorption capacity in liters per square meter of irrigation/leaching area for a 24-hour period***
Coarse sand or gravel	*20*	*5.0*	*0.005*	*203.7*
Fine sand	*25*	*4.0*	*0.006*	*162.9*
Sandy loam	*40*	*2.5*	*0.010*	*101.8*
Sandy clay	*60*	*1.7*	*0.015*	*69.2*
Clay with considerable sand or gravel	*90*	*1.1*	*0.022*	*44.8*
Clay with small amounts of sand or gravel	*120*	*0.8*	*0.030*	*32.6*

Table 16A-2 from the California Plumbing Code displays graywater dispersal requirements.

6.0 Water Reuse Scenarios

Two different Scenarios are being considered to manage wastewater from the Waterman site. Both scenarios collect graywater from the showers, bathroom sinks and laundry from the entire site. In both scenarios, graywater is treated with one of the above treatment systems and used for non-potable water supply on the site. In both of these scenarios, the offsite wastewater flows will be expected to average approximately 19,215 gallons per day April through September and 30,000 gallons per day from October through March.

In Scenario #1, graywater is used for full site irrigation and flushing of common toilets in the Administration Building, the Community Center Education Building, and the Community Center Recreation Building. This scenario takes advantage of some indoor use, but avoids the capital cost of plumbing separate non-potable pipes to all the units

onsite. In this scenario, the graywater system would offset 57% of the combined irrigation and common toilet demand.

In Scenario #2, graywater is used for full site irrigation and for flushing toilets in all residences and common buildings. This scenario takes more advantage of the graywater resource by using graywater indoors during the winter when the irrigation demand is low. In this scenario, the graywater system would offset 55% of the combined irrigation and site toilet demand.

In addition to not increasing peak flows, this system would reduce total annual offsite wastewater flows below what would be expected in a more conventional development. The annual wastewater discharge from the site under both scenarios would be approximately 9.0 million gallons per year. According to the Psomas estimate, approximately 8.3 million gallons of wastewater would be discharged annually. This estimate is very likely considerably less than the actual wastewater flow. The average of the two estimations in this study (academic study average and baseline from curve method) is 57,223 gallons per day. Using this number, the site would discharge approximately 21 million gallons per year. Through conservation and reuse, it is likely this site project will save approximately 12 million gallons per year in addition to increasing density and not causing flow problems downstream.

6.1 Graywater Code Compliance

In these design scenarios, there is more than adequate dispersal (irrigation) area to be in compliance with the State Graywater Code (Chapter 16A). The site has a total irrigated area of 824,000 square feet and ample area exists for dispersal of graywater.

In Scenario #1, the area required for dispersal would be a maximum of 39,334 square feet in the winter, or only 5.9% of the site landscape area. In Scenario #2, the area required for dispersal would be a maximum of 38,130 square feet in the winter, or only 4.6% of the site landscape area.

7.0 Systems Evaluated

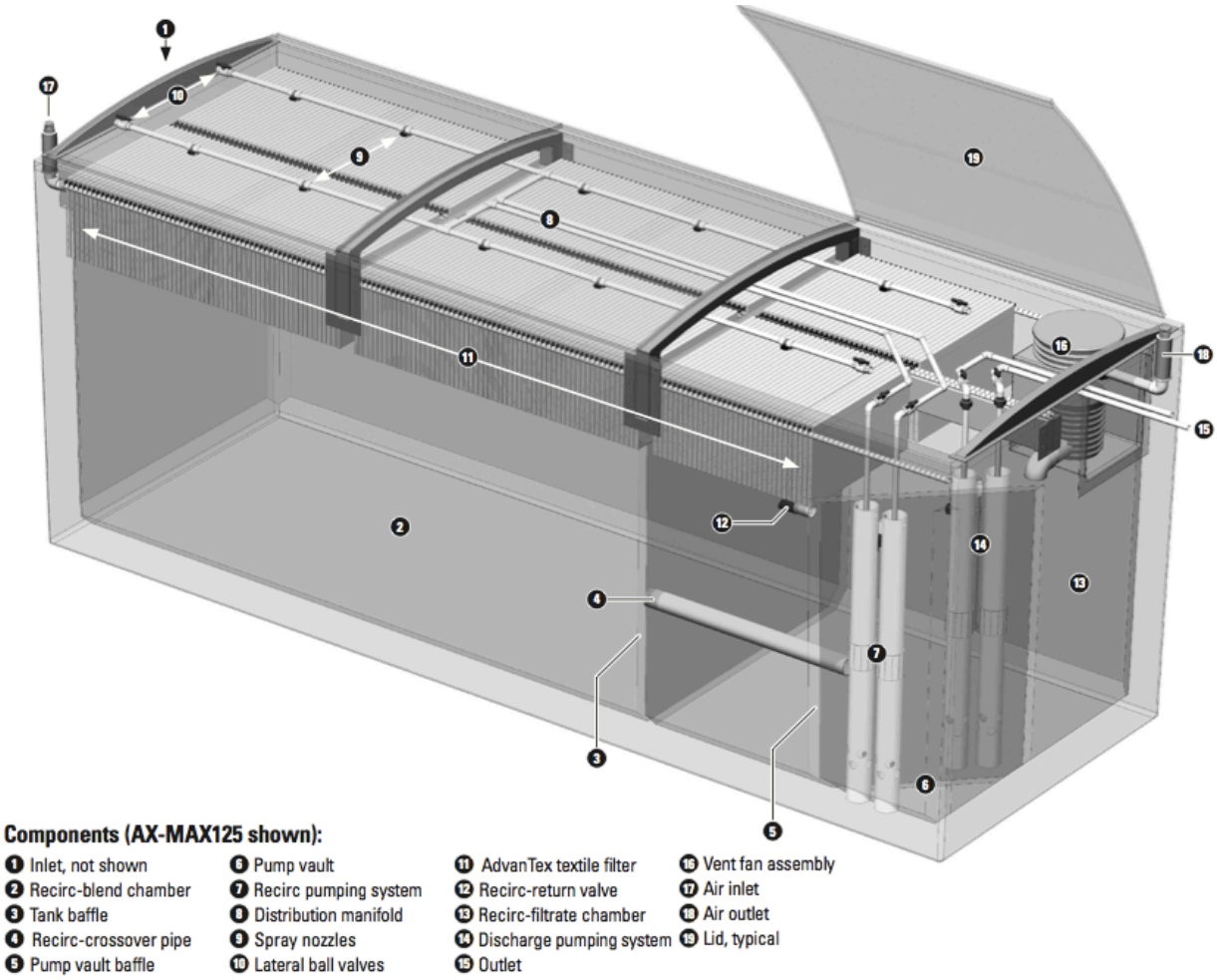
Advanced wastewater systems can fall into several categories. Wastewater can be treated by mechanical, chemical and biological processes. In general, more biological approaches require more space, but they can also be site amenities.They can provide beautiful landscape as well as an educational feature. Mechanical systems require less space, but they don't provide a site amenity.

7.1 Packed Bed Media Filter - Orenco

A packed bed media filter system was evaluated from Orenco Systems (www.orenco.com). Packed bed filters provide treatment similar to a sand filter, but they require much less space, are easier to install and maintain than sand filters. Sediments and solids settle, and microbes in the matrix consume the nutrients in the wastewater through anaerobic digestion. A technical report on the performance of packed bed filter technology can be found at: http://www.orenco.com/corporate/technical_resources/technical_pubs.cfm.

Potential system locations. It needs a rectangular excavation and can have landscaping planted around it. It will stick 1' above ground. It can be painted to match landscape.

Footprint: 735 sq.ft below ground



A cutaway drawing of an Orenco AXMAX system.

This photo shows an installation of a Orenco packed bed media filter system

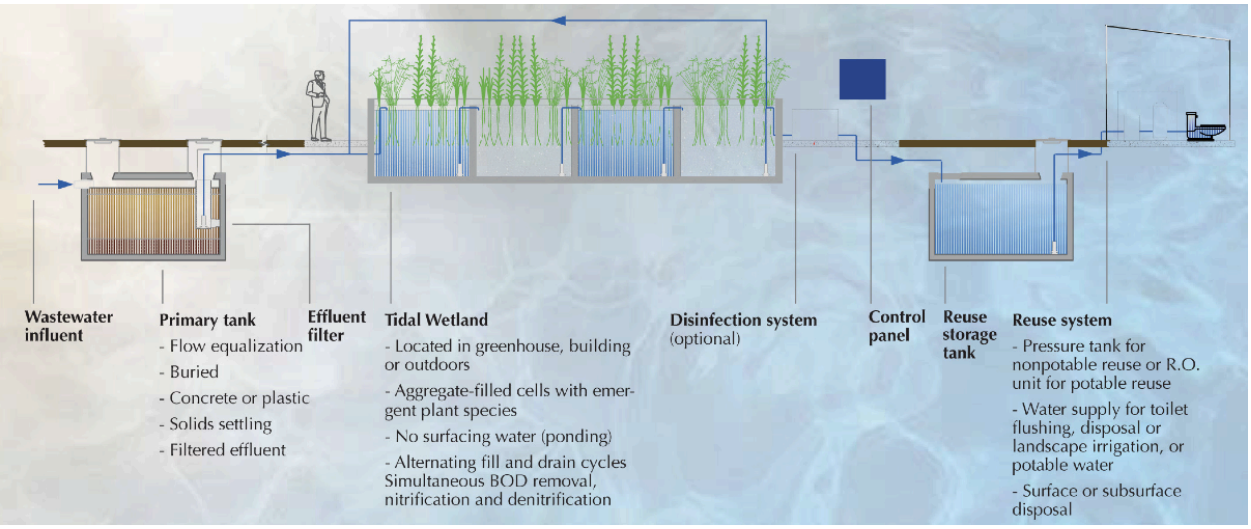
7.2 Constructed Wetland Treatment System

A Living Machine (www.livingmachines.com) treatment system was evaluated to treat graywater from the site. A Living Machine system creates a constructed wetland environment in which organic material in the wastewater is consumed aerobically by microbes in the gravel media. The advantages of this type of system is that the treatment cells can be constructed in a way that blends in with the landscape. The top of the treatment cells is planted with wetland plants that create a wetland garden type aesthetic that becomes an amenity for the site.

Potential system locations: 2 locations, Parking area island in SE corner, next to Administration Building, or the Community Center corner. It can be displayed as a landscape feature and amenity and educational feature.

Footprint: 2,300 sq.ft. aboveground

Tanks: One 10,000 gallon, One 5,000 gallon



This diagram shows the profile of a Tidal Wetland Living Machine

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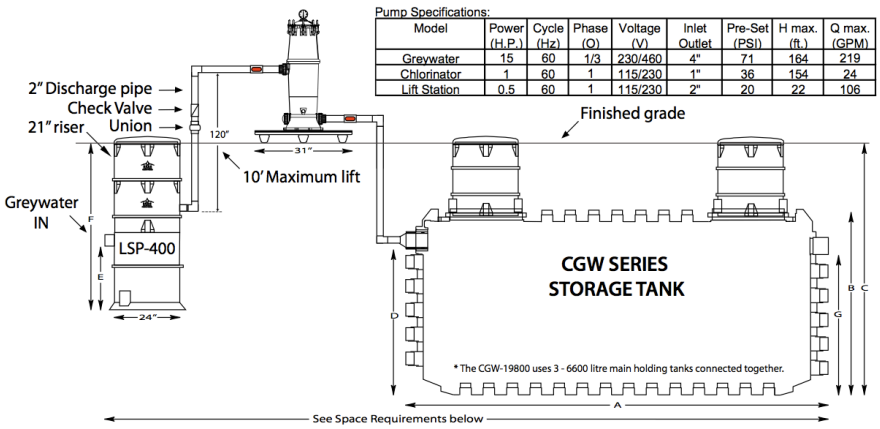
Photo of the Living Machine system at the Esalen Institute, Big Sur, CA.

7.3 Graywater Mechanical Filtration System

A graywater filtration and treatment system was evaluated from BRAC Systems (www.bracystems.com). This filtration system (CGW 19800) uses dual stage filtration and chlorination to clean the graywater to a non-potable standard.

Potential system locations: SE Corner, SW corner. It needs a rectangular excavation and can have landscaping planted around it. It will stick 1' above ground. It can be painted to match
landscape.

- Footprint: Pump Station
- 112 sq. ft. in building
Concrete Storage Tanks -
700 sq. ft. below ground
- Lift Station – 64 sq. ft.
below ground
- Total footprint above and
below ground – 876 sq. ft.



Pump Specifications:

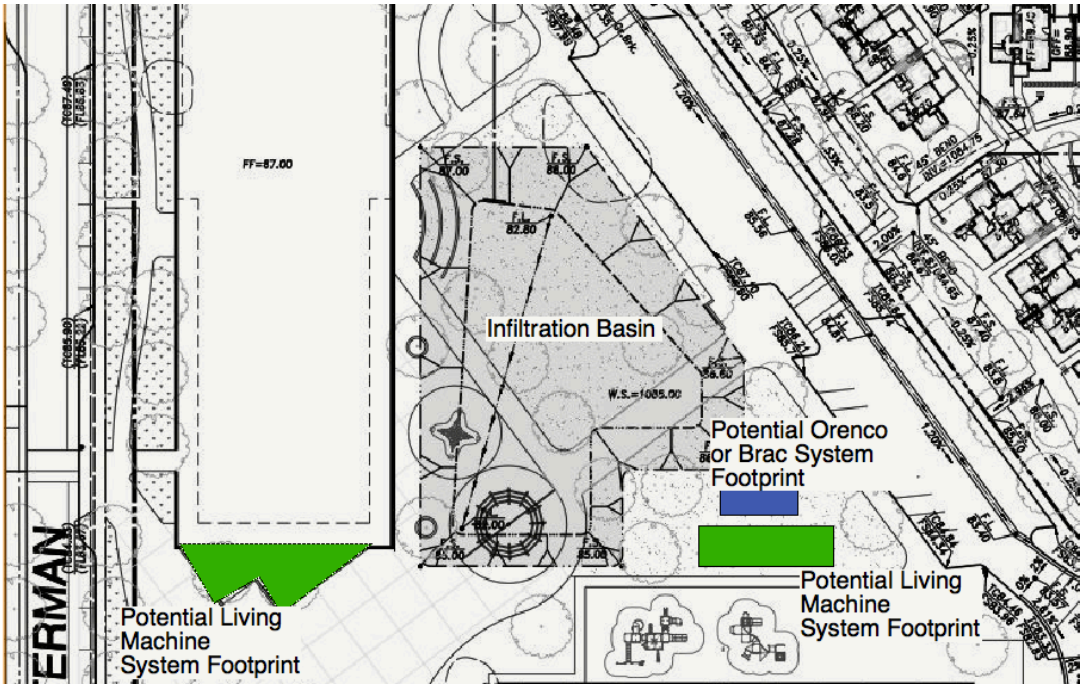
Model	Power (H.P.)	Cycle (Hz)	Phase (O)	Voltage (V)	Inlet Outlet	Pre-Set (PSI)	H max. (ft.)	Q max. (GPM)
Greywater	15	60	1/3	230/460	4"	71	164	219
Chlorinator	1	60	1	115/230	1"	36	154	24
Lift Station	0.5	60	1	115/230	2"	20	22	106

7.4 System Location Options

There are promising locations for locating treatment systems in the southeast and southwest corners of the site. Graywater can flow by gravity to the treatment facilities and then be pumped into the irrigation system or into the non-potable plumbing network to toilets throughout the site, or just in community buildings. It would be advantageous to have two locations in the lower parts of the site. The footprints of the systems are marked on the figures below. These systems are modular, so the basic footprint is scalable and divisible. If the Living Machine were selected, it would be ideal to put it in a more high visibility area, perhaps in the community corner. The other systems could be located discreetly in parking areas or in utility vaults.

Treated graywater will be distributed as irrigation throughout the site. As mentioned earlier, the maximum daily amount of graywater will need only 39,334 square feet of landscape area. This is only 5.9% of the site irrigated area. The graywater will be sufficiently dispersed so that it will not overly saturate any area of the site.

Ideal Treatment System Locations are in the SE and SW corners of the site



In the SW Corner, the Living Machine could provide an aesthetic amenity

In the SE corner, the treatment systems could be located in the parking area.

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8.0 Community Center or Additional Housing?

In the case that the community center buildings are not approved and constructed, that part of the site would be used for 89 additional housing units, for a total of 500 units. The population would increase from1377 to 1,625. This increase in population would bring the total wastewater production up to

In these design scenarios, there is more than adequate dispersal (irrigation) area to be in compliance with the State Graywater Code (Chapter 16A).

In Scenario #1, the maximum amount of water discharged in the winter would be 30,000 gallons per day in the winter and 22,587 gallons per day in the summer. This would require a minimum of 48,855 square feet of dispersal area.

In Scenario #2, the maximum amount of water discharged in the winter would be 30,000 gallons per day in the winter and 22,587 gallons per day in the summer. This would require a minimum of 35,756 square feet of dispersal area.

The total irrigated area onsite is approximately 824,000 square feet. Adequate area exists for dispersal and the maximum area either of these scenarios require is still only 5.6% of the site.

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Appendix 1: Water Calculations

Non-Residential	Offsite Resident Use	Fixture Flow Rate (GPM)	Fixture Flow Rate (GPM)	Duration (min)	Daily Uses	Total WW Produced (gal/day)	Graywater Produced (gal/day)	Black water to Sewer (gal/day)
Rec Center/Natatorium								
Showerheads	100	2.5	2.0	8	1	1,600	1,600	
Lavatory Faucets	100	2.2	1.5	0.25	1	38	38	
Flushometer Tank Toilets	100	1.6	1.28		1	128		128
Urinals	100	1	0.5		1	50		50
Filter Backwash & Splash						268	268	
Day Care Center								
Lavatory Faucets	50	2.2	1.5	0.25	4	50	50	
Flushometer Tank Toilets	50	1.6	1.28		4	171		171
Urinals	50	1	0.5		2	33		33
Kitchen Sinks								
Community Center								
Lavatory Faucets	50	2.2	1.5	0.25	1	19	19	
Flushometer Tank Toilets	50	1.6	1.28		1	64		64
Urinals	50	1	0.5		1	25		25
Admininstration Building								
Lavatory Faucets	4	2.2	1.5	0.25	4	4	4	
Flushometer Tank Toilets	4	1.6	1.28		4	14		14
Urinals	4	1	0.5		2	3		3

These are the assumptions of offsite residents that would be using community facilities

Water Calculations Continued

Residential	# of People	CalGreen Fixture Flow Rate w/ 20% reduction (GPM)	Duration (min)	Daily Uses	Gallons per day	Gallons per month	Gallons per year	Water Use GPPD
Showerheads	1377	2.0	8	1	22,032	670,599	8,047,188	16
Lavatory Faucets	1377	1.5	0.25	5	2,582	78,586	943,030	2
Kitchen Faucets	1377	1.8	4	1	9,914	301,770	3,621,235	7
Gravity Toilets	1377	1.28		5	8,813	268,240	3,218,875	6
Laundry	1377				8,179	248,960	2,987,519	6
Total Wastewater	1377				51,520	1,568,154	18,817,846	37
Maximum Graywater Potential	1377				32,793	998,145	11,977,736	24
Minimum Blackwater to Sewer	1377				18,727	570,009	6,840,110	14

These are the estimates of onsite water use by residentss

		Estimated WW Produced (gal/day)	Maximum GW Produced (gal/day)	Minimum Blackwater to Sewer (gal/day)
Total Non-Residential		2,466	1,978	487
Total Residential (1377)		51,520	32,793	18,727
Site Total		53,986	34,771	19,214
Site Per Year (gallons)		19,704,890	12,691,415	7,013,110

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List of Attachments

Orenco Packed Bed Media Filter Documents:
Orenco AX MAX spec sheet
Orenco AX MAX 42 spec sheet

Living Machine Constructed Wetland Technical Documents:
Living Machine brochure
Living Machine potential system locations

Brac Systems Mechanical Filtration Technical Documents:
Brac Brochure
Brac Fact Sheet

Orenco Packed Bed Media Filter Technical Documents

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Technical Data Sheet

AdvanTex® AX-MAX Treatment Systems

Orenco Systems® Incorporated
800-348-9843

Applications

Orenco's AdvanTex® AX-MAX is a complete, fully-plumbed, AdvanTex Wastewater Treatment Plant for residential, commercial, municipal, and mobile applications with medium-to-large-flows and permits requiring secondary treatment or better. It can be used as a stand-alone unit or in multi-unit arrays under adverse conditions in a wide range of environments.

The AX-MAX is ideal for:

- Small sites and poor soils
- Sites that require shallow bury
- Mobile and temporary installations
- Disaster response sanitation
- Remote locations
- Extreme hot or cold climates

General

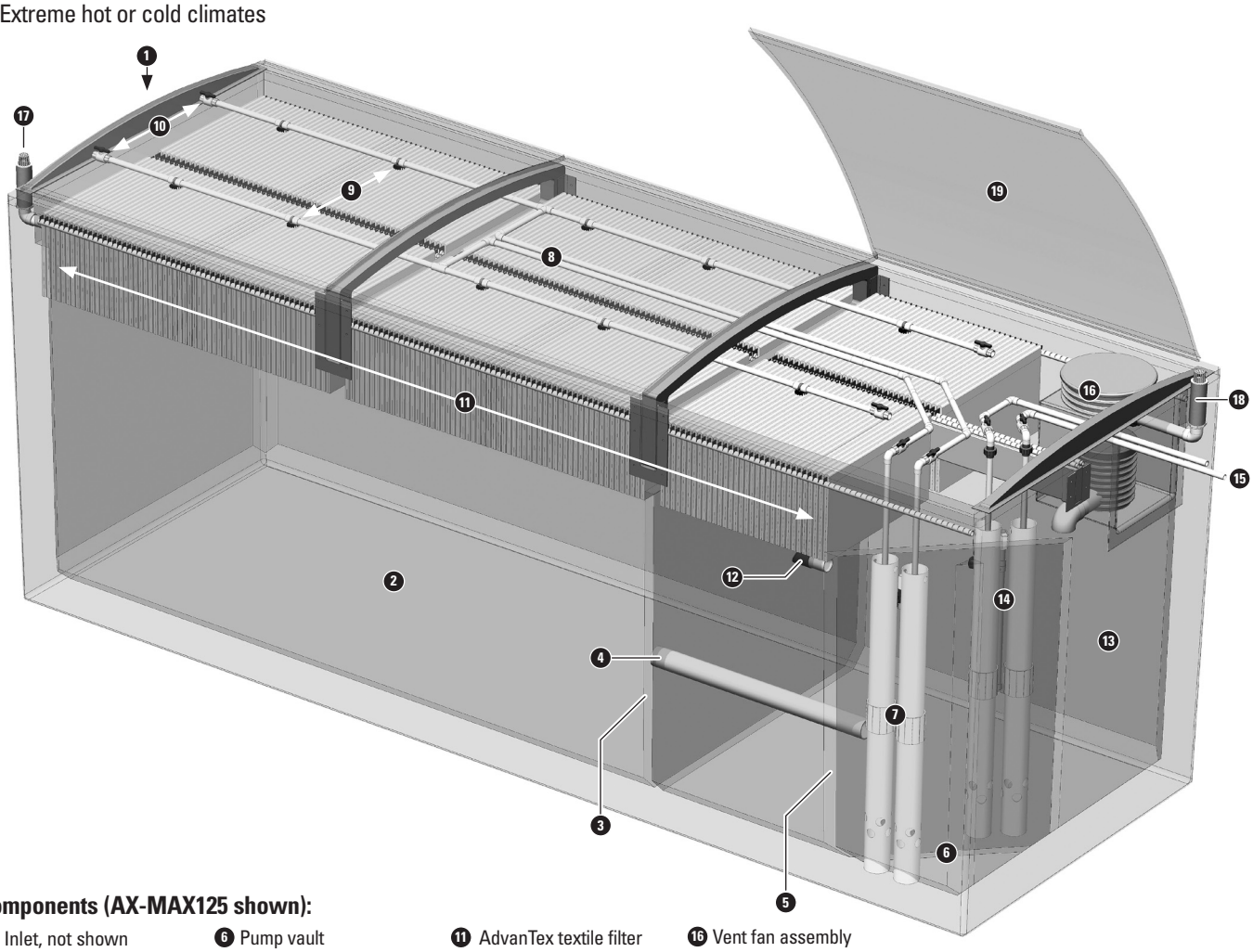
The AX-MAX is a modular system that can be preceded by primary treatment or configured to incorporate primary, secondary, and tertiary wastewater treatment before reuse or dispersal.

The heart of the AX-MAX system is the AdvanTex Recirculating Treatment Tank, a sturdy, watertight, corrosion-proof fiberglass tank that includes the same dependable, textile treatment media found in all AdvanTex products.

Standard Models

AX-MAX100-14, AX-MAX150-21, AX-MAX200-28, AXMAX-250-35, AX-MAX300 (Units without pump systems.)

AX-MAX75-14, AX-MAX125-21, AX-MAX175-28, AX-MAX225-35, AX-MAX275-42 (Units with pump systems.)



Components (AX-MAX125 shown):

1. Inlet, not shown
2. Recirc-blend chamber
3. Tank baffle
4. Recirc-crossover pipe
5. Pump vault baffle
6. Pump vault
7. Recirc pumping system
8. Distribution manifold
9. Spray nozzles
10. Lateral ball valves
11. AdvanTex textile filter
12. Recirc-return valve
13. Recirc-filtrate chamber
14. Discharge pumping system
15. Outlet
16. Vent fan assembly
17. Air inlet
18. Air outlet
19. Lid, typical

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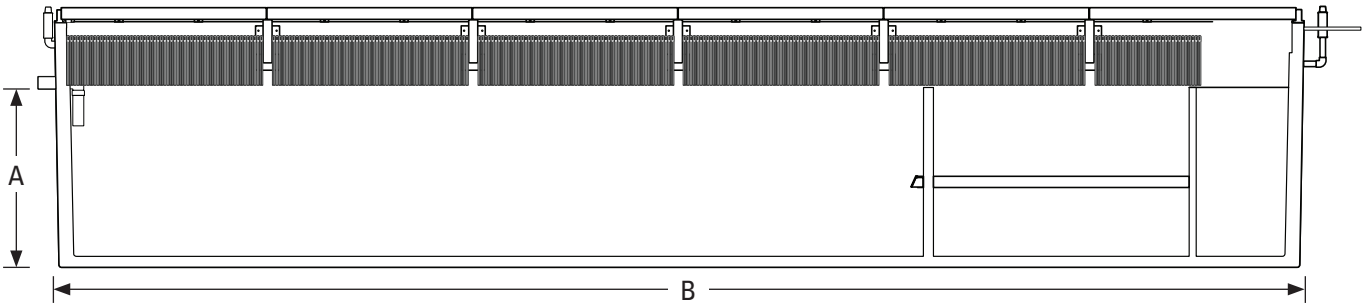
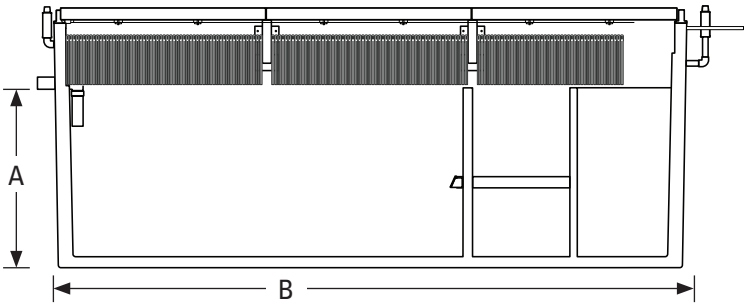
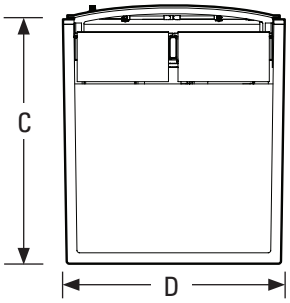
AdvanTex® AX-MAX (continued)



AdvanTex AX-MAX300-42, side view



AdvanTex AX-MAX125-21, side view



AdvanTex AX-MAX, end view (all models)

Specifications

Nominal Dimensions*

Model	**AXMAX100-14**	**AXMAX150-21**	**AXMAX200-28**	**AXMAX250-35**	**AXMAX300-42**
A , ft (m)	5.7 (1.7)	5.7 (1.7)	5.7 (1.7)	5.7 (1.7)	5.7 (1.7)
B, ft (m)	14.00 (4.2)	21.00 (6.4)	28.00 (8.5)	35.00 (10.7)	42.0 (12.8)
C, ft (m)	8.0 (2.4)	8.0 (2.4)	8.0 (2.4)	8.0 (2.4)	8.0 (2.4)
D, ft (m)	7.5 (2.3)	7.5 (2.3)	7.5 (2.3)	7.5 (2.3)	7.5 (2.3)
Footprint, ft2 (m2)	112.0 (10.4)	168.0 (15.6)	224.0 (20.8)	280.0 (26.0)	336.0 (31.2)
Model	**AXMAX75-14**	**AXMAX125-21**	**AXMAX175-28**	**AXMAX225-35**	**AXMAX275-42**
A , ft (m)	5.7 (1.7)	5.7 (1.7)	5.7 (1.7)	5.7 (1.7)	5.7 (1.7)
B, ft (m)	14.00 (4.2)	21.00 (6.4)	28.00 (8.5)	35.00 (10.7)	42.0 (12.8)
C, ft (m)	8.0 (2.4)	8.0 (2.4)	8.0 (2.4)	8.0 (2.4)	8.0 (2.4)
D, ft (m)	7.5 (2.3)	7.5 (2.3)	7.5 (2.3)	7.5 (2.3)	7.5 (2.3)
Footprint, ft2 (m2)	112.0 (10.4)	168.0 (15.6)	224.0 (20.8)	280.0 (26.0)	336.0 (31.2)

**See AdvanTex® AX-MAX Treatment System drawings for exact dimensions and specific treatment configurations.*

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Living Machine Technical Documents

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LivingMachine®

WATER FOR OUR FUTURE WORLDWIDE

Worrell Water TECHNOLOGIES

Living Machine® Systems
Treating WasteWater Nature's Way

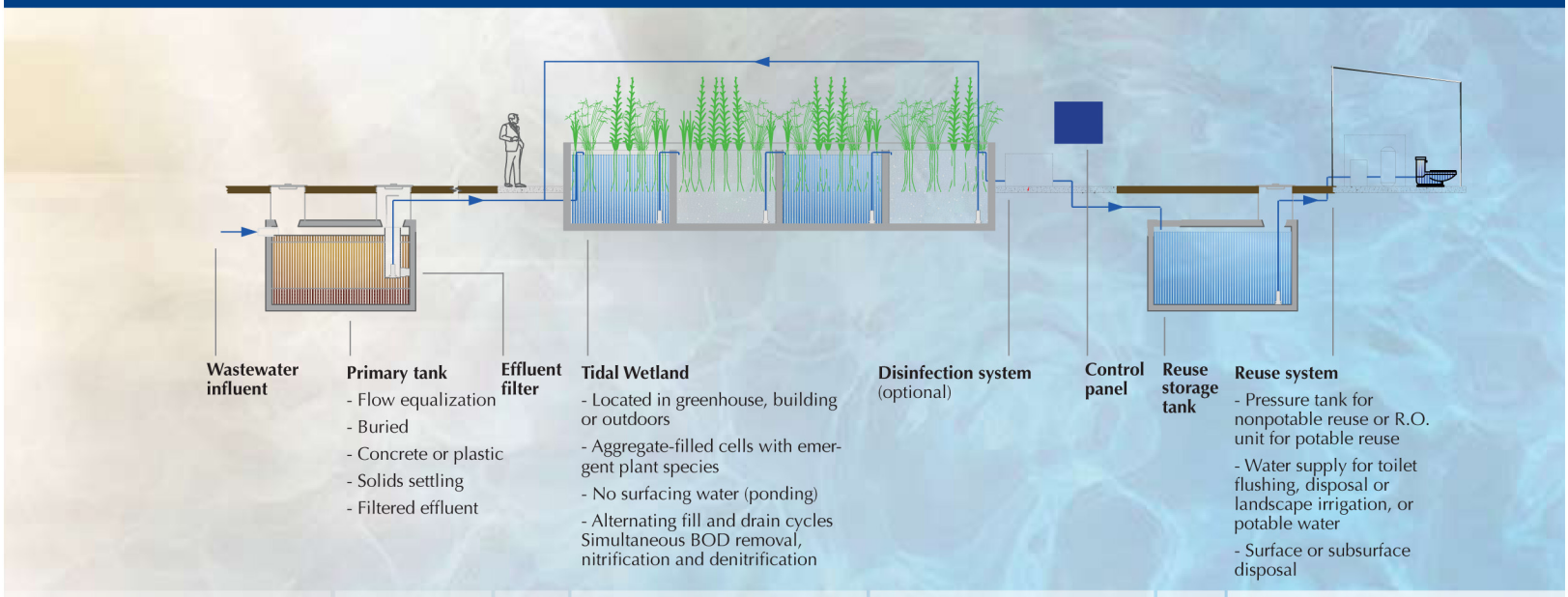
The Living Machine is an ecological wastewater treatment system that mimics processes found in wetland environments. Our patented technology enhances the natural processes with mechanical and computer systems while it minimizes energy consumption.

Living Machines provide communities, industries, academic institutions and government agencies with cost-effective,environmentally sound systems to meet their wastewater treatment needs. The systems are frequently integrated into wastewater reuse systems which minimize energy use, wastewater surcharges and operation requirements while eliminating post-primary sludge management costs. In addition, Living Machines offer communities an opportunity to enhance public awareness of sustainability through educational programs.

Living Machine Systems have successfully treated wastewater for industrial facilities, resorts, communities and institutions throughout the world. Our systems are adapted to meet the specific needs of our clients and can be scaled in size to treat a wide range of wastewater volumes.

LivingMachine®

TIDAL WETLAND LIVING MACHINE



INFLUENT | PRIMARY TREATMENT | FILTRATION | TIDAL WETLAND | DISINFECTION | REUSE STORAGE | WATER SUPPLY

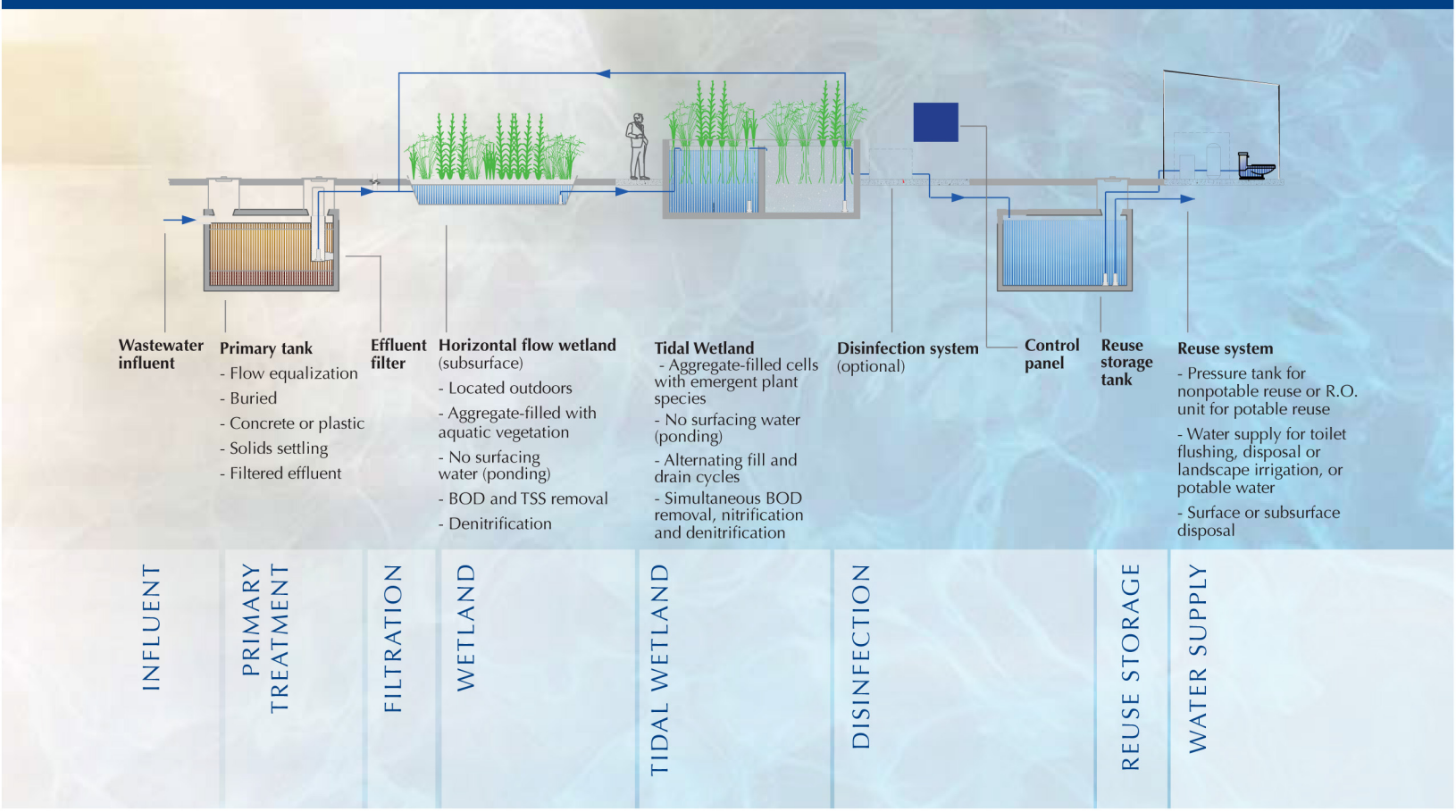
Systems Profile Comparison

	Living Machine Tidal Flow Wetland	**Living Machine Hybrid Wetland**	Horizontal Subsurface Flow Wetland	Vertical Subsurface Flow Wetland	Advanced Activated Sludge System
Footprint* (ft^2)	**150**	**550**	1,250	330	75
Energy Use**	**0.5**	**0.4**	0.1	1.0	2.0
Effluent Quality	**Tertiary + Reuse*** **	**Tertiary + Reuse*** **	Secondary	Tertiary + Reuse*** **	Tertiary
Operating Costs	**Low**	**Low**	Low	Low	High

* Sq-Ft/1000 gal/day; estimate for 30,000 gallon per day systems
** Kwh/1000 gal/day; estimate for 30,000 gallon per day systems
*** Typical non-potable reuse includes subsurface irrigation, toilet flushing, effluent discharge to rivers and lakes and/or wash water

In developing countries, more than 90% of sewage and 70% of industrial wastes are dumped untreated and pollute the usable water supply.

HYBRID WETLAND LIVING MACHINE



Worrell Water Technologies is dedicated to ensuring that individuals, communities and industries have access to safe, secure water to meet their needs. Our innovative technologies and systems are designed to maximize performance, minimize cost, conserve water and protect the environment.

Our purification technologies ensure clean drinking water, our wastewater treatment systems restore water for reuse and our custom engineering services provide innovative solutions to address your special needs.

LivingMachine®

WATER
FOR OUR
FUTURE
WORLDWIDE

Worrell Water TECHNOLOGIES

Visit our website at www.worrellwater.com.

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Brac Systems Mechanical Filtration Documents

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Rainwater Harvesting option

Rainwater harvesting is a relatively simple and effective method of retaining drained roof water for reuse. Captured rainwater can be used for many applications on a property that uses non-potable water. These applications include urinal and toilet flushing, supply for sub-surface irrigation systems, car washes, etc. By using the "free" water from the sky, your utility bills will be lowered. Another benefit of rainwater harvesting is that it helps reduce the chance of flooding in the storm sewers. By diverting the rainwater to another source, the water entering the standard drainage system is minimized and can help the sewer from becoming overwhelmed in heavy downpour situations.

BRAC SYSTEMS

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To support you locally, Brac Systems has a number of distributors, dealers and consultants

BRAC SYSTEMS

The solution for Greywater Recycling

CGW Series Commercial Product Brochure

COMMERCIAL

The CGW Series Greywater Recycling Systems have been sized to work for all applications where capturing greywater for reuse in toilet flushing or irrigation systems has been specified. Our systems are fully scalable and can operate in high demand commercial environments.

Greywater recycling offers consistent water availability to overcome drought and water restrictions. Architects can design sustainable buildings that drastically reduce water use by reusing water that would otherwise be destined for the sewer. Greywater systems are a viable means of reducing the impact on our freshwater resources and therefore have become a popular option in Green Buildings. The same reduction in outgoing sewerage can be experienced when greywater is treated and recycled rather than going to the sewer.

Intelligent Pumping System

Certified By: IAPMO R&T

BRAC Systems smart pump technology can deliver constant pressure greywater at a rate of up to 450 GPM. With multiple main holding tanks linked in parallel and buried underground, together with a common greywater screening and filtration system, the CGW Series provides a scalable system suitable for daily hydraulic loads of up to 180,000 gallons per day*.

*Maximum flow by gravity through a 4" sewer pipe based on standard engineering calculations, full-flow, 1/4 pitch, would be approximately 125 GPM.

Reduce, Reuse, Recycle
Greywater recycling in apartment blocks, townhouse complexes, commercial and industrial buildings, is now feasible by using the CGW Series BRAC Greywater Recycling Systems in the building's design. Engineers are seeking compact, all-in-one systems that allow recycling for irrigation or internal reuse in toilets and laundries.

BRAC's technology is Canadian made with International patents pending. The CGW Series uses the well-proven treatment processes of dual-stage filtration and chlorine disinfection. The filtration process captures particles larger than 100-microns while the chlorination eliminates any harmful bacteria and pathogens. The system is fully automated, and is designed to require scheduled maintenance. On-line and remote monitoring devices can be added, and these can integrate with building automation systems.

Operation
An easily understandable and detailed operation and maintenance manual is included. The maintenance personnel will receive precise instructions while the system is brought into service. If required, technical advisors can be present during installation and start-up.

Features

- All-in-one system. No extra components needed.
- In-ground main holding tanks
- In-ground primary and secondary filter housings
- Managed Chlorination System (MCS) with dedicated pump
- Variable frequency, constant pressure greywater pumping system
- Primary and secondary filter alarms
- Freshwater and greywater flow counters

Reliable and guaranteed system
Our robust, reliable and simple design makes for a smooth operation. All electrical components are guaranteed for 2 years while the main holding tank and filter housings have a 10 year warranty.

GREYWATER