Processing Septage & Biosolids with Aerobic Microorganism Technology and meeting EPA 503 Standards for Exceptional Quality Biosolids

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By: John W. Campbell

The Problem

Application of septage; municipal biosolids; fats, oils and grease (FOG); porta-jon waste, and holding tank waste to the land. Pollutants entering both ground water and surface waters. (Kendzierski 2002)

Planting the Seed

During a committee meeting of the Health Department of Northwest Michigan a device (Fife) was operational in a septic tank. A question was asked, "Why wouldn't that device work in reducing septage solids and nitrogen?" Testing began in a 1500 gallon tank. Positive results were indicated. A reduction of solids, biological oxygen demand, ammonia, and phosphorus was indicated. (Fife 2005)

Table 1
Influent – Effluent February 10, 2005

Septage	**Septage**	**Processed**
BOD 5-day EPA 405.1	2,450 mg/l	>150 mg/l
Nitrogen, Ammonia – EPA 350.1	58.3 mg/l	ND
Nitrogen, Nitrate – EPA 353.2	ND	ND
Nitrogen, Nitrite – EPA 353.2	0.113 mg/l	ND
Residue, Non-filterable(TSS)/SM2540D	7,400	860 mg/l

Construct a Facility

How to design an enclosed facility that would provide a safe environment. What is needed to provide clean effluent. How to process the material? Numerous questions to be answered. How to obtain all of the permits required from local and state agencies?

Materials and Methods

The operating system would be totally aerobic. A microbial innoculator/generator which produces a microbial aerobic process (MAP) in the facility was selected. Inorganics needed to be screened from the septage and biosolids. Microbial blend of microbes to be selected and placed in a stable environment. The facility must provide adequate oxygen and detention time for the microbes to complete their work. A waste water testing laboratory constructed to provide operating information.

Goal

Meet and exceed the requirements of the 'Order of Determination'. And ultimately recycling 100% of our influent material.

Kendzierski, Scott, June 2002. Health Department of Northwest Michigan, 2202 W. Garfield Street, Charlevoix, Michigan 49720 USA.
Fife, Jerry, November 2005.1875 Jay Road, Occidental, California 95465 USA.

Table 2
Order of Determination

List "A"	5-day biochemical oxygen demand (BOD_5)—300 mg/L Total suspended solids—350 mg/L Ammonia nitrogen—65 mg/L pH must be greater than 6.5 and less than 9.0, (per current NPDES Permit) Total phosphorus—3 pounds per day (36 mg/L at 10,000 gallons per day) Dissolved oxygen must be 4.0 mg/l or greater
List "B"	Oil and grease—100 mg/L Monitor total lead, total copper, total mercury, and total zinc

Table 3
Influent & Effluent January 2006 – July 2007

		pH	DO	Temp	BOD	TSS	P	NH3	NO2	NO3
		SU	ppm	Deg F	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
July	2007									
	Influent	7.69	1.0	81.7	3106	6932	253.0	101.0		
	Effluent	7.43	4.7	78.9	210	266	21.1	36.5		
%	Removal				93.2	96.2	91.7	63.9		
June	2007									
	Influent	7.11	0.0	73.2	3695	9657	285.2	25.6		
	Effluent	7.28	5.3	74.5	148	228	23.5	2.7		
%	Removal				96.0	97.6	91.8	89.5		
May	2007									
	Influent	6.83	0.0	69.8	3682	9478	260.0	29.0		
	Effluent	7.62	6.0	67.0	81	228	24.7	5.3		
%	Removal				97.8	97.6	90.5	81.7		
April	2007									
	Influent	7.44	1.0	67.1	3052	14063	507.00	121.0		
	Effluent	7.99	7.3	71.6	111	207	20.2	3.1		
%	Removal				96.3	98.5	96.0	97.4		
March	2007									
	Influent	7.36	1.7	64.3	4380	13521	652.0	63.0		
	Effluent	7.79	8.1	65.2	96	115	11.4	6.7		
%	Removal				97.8	99.1	98.3	89.3		
February	2007									
	Influent	7.36	2.3	67.3	3675	12475	32.0	407.0		
	Effluent	7.78	7.7	65.3	73	132	5.8	3.3		
%	Removal				98.0	98.9	81.9	99.2		
January	2007									
	Influent	7.32	1.9	67.9						
	Effluent	7.45	8.2	74.6	112	195	11.6	6.6		
	Removal				NA	NA	NA	NA		

		pH	DO	Temp	BOD	TSS	P	NH3	NO2	NO3
		SU	ppm	Deg F	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
December	2006									
	Influent	7.25	2.5	66.5	2603	13413	17.0	78.0		
	Effluent	7.77	8.1	70.1	216	296	8.4	9.1		
%	Removal				91.7	97.7	50.6	88.3		
November	2006									
	Influent	6.89	1.8	62.9	2479	7760	74.0	54.0		
	Effluent	7.26	3.6	66.0	417	789	3.7	13.0		
%	Removal				83.2	89.8	95.0	75.9		
October	2006									
	Influent	6.69	2.6	62.1	1999	4675	88.3	66.7	16.7	0
	Effluent	6.67	2.7	68.1	422	1261	25.8	19.0	5.0	19.0
%	Removal				78.9	73.0	70.8	71.5		
September	2006									
	Influent	6.15	2.4	66.7	3550	19681	218.0	59.0	75.0	42.0
	Effluent	7.23	4.1	72.3	243	526	9.7	9.6	10.2	4.5
%	Removal				93.2	97.3	95.6	83.7		
August	2006									
	Influent	6.36	2.2	74.7	1257	11845	131.0	59.0		
	Effluent	7.33	4.8	76.0	80	204	2.4	14.1	9.3	2.5
%	Removal				93.7	98.3	98.2	76.1		
July	2006									
	Influent	7.70	2.4	74.2	528	9764	328	30		
	Effluent	7.08	4.8	71.3	41	54	0	10.3	2.0	24.0
%	Removal				92.2	99.4	100.0			
June	2006									
	Influent	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Effluent	6.68	5.2	66.2	74	149	2.3	20.6	7.8	20.6
%	Removal				NA	NA	NA			
May	2006									
	Influent	5.71	2.2	68.5	507	5967	5.0	21.0	UR	116.0
	Effluent	6.13	4.6	66.2	141	1262	6.3	33.2	8.0	106.0
%	Removal				72.2	78.9	NA			
April	2006									
	Influent	7.20	5.2	63.7	875	6662	38.1	14.4	50.0	33.1
	Effluent	5.56	4.5	63.1	44	146	3.1	6.2	3.5	38.5
%	Removal				95.0	97.8	91.9			
March	2006									
	Influent	7.99	5.9	61.9	389	1662	32.0	2.6	41.0	27.0
	Effluent	8.23	4.0	62.7	51	189	3.3	2.3	20.0	11.9
%	Removal				86.9	88.6	89.7			

		pH	DO	Temp	BOD	TSS	P	NH3	NO2	NO3
		SU	ppm	Deg F	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
February	2006									
	Influent	7.45	3.0	61.9	853	1537	32.1	51	45	95
	Effluent	7.75	4.3	61.4	52	102	11.2	44	49	87
%	Removal				77.6	89.8	21.9			
January	2006									
	Influent	7.61	4.9	58.0	165	865	31.4	89	287	221
	Effluent	7.54	5.0	56.0	37	70	24.5	80	346	252
%	Removal				77.6	89.8	21.9			

Results and Discussion Phase I Reduction of Effluent Values

Numerous questions came to light during this initial research & development program. Residuals (biosolids) must be land applied. The values of BOD, TSS, Ammonia, Nitrate, Nitrite, and Phosphorus meet our discharge limits. Discussions dealing with pharmaceuticals, endocrine disruptors and hormones entering ground water and surface waters began at the research level.

Table 4

Class 'B' Biosolids reduced 89% average January 06 – July 07

	Influent	to	Effluent	
Ammonia	60 mg/l	to	10 mg/l	
Nitrite	275 mg/l	to	3 mg/l	
Nitrate	60 mg/l	to	4 mg/l	
Phosphorus	74 mg/l	to	3.7 mg/l	
BOD	9000 mg/l	to	<450	
TSS	20,000 mg/l	to	<526	
ph	6.5	to	7.25	

Three Issues Remain

Biosolids that could not be further reduced by our aerobic process and reducing cost per gallon for treatment. Could we further develop the process to meet ground water discharge limits?

Next Steps

What is required for the production of Exceptional Quality Class 'A' Biosolids? Locating a process to accomplish following the EQ designation set forth in the EPA 503 standards procedures for vector attraction reduction and pathogen reduction. (Olsen 2007)

Olsen, Roger, 2007. FKC, Co., Ltd., 2708 West 18th Street, Port Angeles, Washington 98363 USA.

Table 5
EPA 503 Exceptional Quality Standards

Pathogens
If the percent solids of the biosolids is 7% or higher, then the temperature of the biosolids shall be 50 degrees Celsius or higher; the time period shall be 20 minutes or longer; and the temperature and time period shall be determined using equation (3).
equation (3) $D = \frac{131{,}700{,}000}{10^{0.1400t}}$

Vector attraction reduction
pH of biosolids is raised to 12, remains at 12 or higher for 2 hours and then at 11.5 or higher for an additional 22 hours.

Protocols for testing pharmaceuticals, endocrine restrictors, and hormones are being finalized (Rose 2007).

We continue to see improvements in the effluent reduction of TSS, BOD, Ammonia, Nitrate; and increases dissolved oxygen.

System Conclusion 11/12/07
Big Fish significantly reduces suspended solids and nutrients of septage, municipal biosolids, porta-jon waste and holding tanks and produces a Exceptional Quality Class 'A' Biosolid.

Table 6
Exceptional Quality Class 'A' Biosolids

Organic	99.9%		99.9%
Metals	Limits mg/kg		Actual mg/kg
Arsenic	75		4.8
Cadmium	85		2.5
Copper	4300		888.
Lead	840		30.
Mercury	57		1.020
Molybdenum	75		1.34
Nickel	420		15
Selenium	100		3.9
Zinc	7500		2550.
Total Kjeldhal Nitrogen			684,000mg/kg
Nitrate			22mg/kg
Nitrite			4.2 mg/kg
Fecal coliform			<100 colonies/1mg

Rose PhD, Joan, 2007. College of Agriculture and Natural Resources, 13 Natural Resources, Michigan State University, East Lansing, Michigan 48824-1222 USA.

Table 7
Test Results July 14, 2007 – October 31, 2007

		pH	DO	Temp	BOD	TSS	P	NH3	NO2	NO3
		SU	ppm	Deg F	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
October	2007									
	Influent	7.34	3.2	75.5	3600*	11000*	330.0*	124.0*	29.4	4.6
	Effluent	7.67	5.9	76.6	89	15	2.5	43.0	26.3	7.3
%	Removal				97.5	99.9	99.2	65.3		
September	2007									
	Influent	7.42	0.9	81.1	3598	11021	332	124.0	26.0	4.0
	Effluent	7.61	4.9	81.2	150	37	2.9	38.5	42.6	9.2
%	Removal				95.8	99.7	99.1	70.0		
August	2007									
	Influent	7.71	1.0	81.7	3598	11021	332	124.0	61.0	6.0
	Effluent	7.74	4.9	81.9	108	99	4.5	51.0	50.0	4.0
%	Removal				97.0	99.1	98.6	58.9		

***NOTE – used historical BOD, TSS, P & NH3 Influent averages**

For the municipal waste water treatment plant operator the processing solves numerous plant operational issues:

- The ability to accept septage
- Receive high dissolved oxygen effluent
- Process its biosolids daily, weekly or monthly on site
- Produce a Exceptional Quality Class 'A' Biosolid for municipal and public use

Septage will provide a income source and for a commercial operation and an opportunity to serve the municipal and private septage and biosolids industry.

Ground water discharge limits are being pursued. Plant processing capacity has been increased; and processing cost per gallon decreased.

Future

To reach ground water discharge limits, set by the Michigan Department of Environmental Quality, Drinking Water Bureau, and Environmental Protection Agency, plant operation techniques and passive devices and being evaluated.

BIG FISH ENVIRONMENTAL, LLC
SEPTAGE RECEIVING AND TREATMENT FACILITY
CHARLEVOIX, MICHIGAN

OPERATING PLAN
March 1, 2006

Revised
March 7, 2007
October 1, 2007

Owner:	Big Fish Environmental, LLC 12608 Taylor Road – P.O. Box 528 Charlevoix, Michigan 49720
Operator:	Site Planning Development, Inc. 12608 Taylor Road – P.O. Box 528 Charlevoix, Michigan 49720
Facility Location:	12608 Taylor Road Charlevoix, Michigan 49720

1.0 Purpose:

Big Fish Environmental, LLC ("Big Fish") is a privately held enterprise formed for the purpose of providing treatment of household domestic septage and municipal wastewater treatment plant biosolids in an arrangement of vessels designed specifically to treat the material to a level acceptable for discharge to a municipal Wastewater Treatment Facility. This treatment facility was designed to employ the aerobic micro organism wastewater treatment technology with the express purpose of non-conventional treatment of septage and municipal biosolids.

This receiving facility, located in Charlevoix Township, Michigan, discharges its treated effluent to the Charlevoix wastewater treatment plant via existing sanitary sewers under contract with the City of Charlevoix sewer collection system.

This program was proposed in accordance with the feasibility study conducted by the Health Department of Northwest Michigan to determine potential methods for proper management and disposal of septage material. In particular, the Big Fish program follows Option 3B of the *Interim Report to the Septage Waste Disposal Committee of the Septage Feasibility Study*. Specifically, this option presents the potential for a private entity to construct a pretreatment system featuring enclosed receiving, screening, equalization, liming, mixing, EQ biosolids, and effluent discharge, below wastewater concentrations, to a wastewater treatment system.

2.0 Acceptable Material:

2.1 Material Type:

Material not listed in paragraph (a) below will require prior approval from the facility operator in order to discharge into the Big Fish receiving facility.

(a) Acceptable Materials:
   i. Domestic septage, including septic tank and holding tank material consisting solely of sanitary sewage.
   ii. Portable toilet wastes.
   iii. Wastewater treatment plant biosolids. (October 2007)

(b) Conditionally Acceptable Materials:
   i. Food establishment septage consisting of grease trap material. This material will require prior specific approval by the facility operator on a limited basis. (Offer October 2007, testing only)
   ii. Food processing facility waters or wastewaters. This material will require testing and review by the facility operator prior to acceptance. Initial testing is paid for by the discharger.
   iii. Other biologically treatable materials not listed in paragraph (a) above.

(c) Unacceptable Materials:
   i. Petroleum laden waters or wastewaters.
   ii. Waters containing chlorinated solvents.
   iii. Waters containing certain high metal concentrations such as from, but not limited to, metal plating operations.
   iv. Any material not normally treatable by biological processes or otherwise found unacceptable to the facility operator.

2.2 Conditions of Acceptance

(a) Food establishment septage may be accepted by specific approval of the facility's operator.

(b) A load manifest clearly indicating point of origin and type of material (e.g. septage or holding tank material) will accompany all delivered material. The hauler is solely responsible for materials meeting the facility operator's acceptance.

(c) Any costs incurred by the Big Fish receiving facility for clean-up, equipment damage, permit violations, discharge violations or other damages due to materials delivered to Big Fish without the facility operator's approval or for materials delivered that were not as stated on manifests will be borne upon the hauler. All haulers will be required to agree to contract terms prior to discharging to the Big Fish facility. A sample contract is included in Appendix A.

3.0 Hours of Operation:

Normal operating hours for accepting materials are 7:30 a.m. to 5:00 p.m. Monday through Friday, except holidays.

If a hauler has a need to deliver materials outside of these hours, the hauler may call (231) 547-4429 to make an appointment. Calls made to this number after normal office hours (7:30 a.m. to 5:00 p.m. Monday through Friday) will be directed to a 24 hour Emergency Service Center that will immediately notify on-call staff and a return call will be made to the hauler to make the appointment. The facility will be manned when receiving material. Contracted haulers have facility access 24 hours a day 7 days a week including holidays.

4.0 Service Area:

The Big Fish facility will service haulers on a contractual basis, not necessarily defined by a geographical area.

Commencing 1 October 2007, a geographical service area of 15 radial miles from the receiving facility is established. This area includes portions of Emmett, Charlevoix and Antrim Counties roughly bounded by the cities of Eastport, East Jordan, Boyne City, Walloon Lake, Petoskey and Harbor Springs, Michigan. North Port and Beaver Island are excluded.

After October 12, 2010, the service area shall expand to 25 radial miles based on the capacity of the facility, extending the range to the cities of Bellaire, Elmira, Alanson and Cross Village, Michigan. A map showing the service area radiuses is shown in Appendix B.

5.0 Fee Structure:

A fee charged to the hauler has been initially established at a flat rate of $0.10 per gallon received.

6.0 Facility Capacity:

6.1 Hydraulic Capacity:

The Big Fish facility is permitted by the city of Charlevoix for a hydraulic capacity of 20,000 gallons per day (gpd).

6.2 Organic Capacity:

The organic capacity of the facility is estimated at a minimum of approximately 2,000 pounds per day of 5-day biochemical oxygen demand (BOD_5). This is equivalent to approximately 12,000 mg/l BOD_5 at 20,000 gpd. This estimate is based on aerobic micro organism technology based facilities at lower hydraulic capacities. Because the application of the microbial aerobic process technology is largely undocumented at this capacity, the stated organic capacity may be revised after a period of operating the facility. Capacity of the plant has been increased with the addition of EQ Class 'A' processing of biosolids.

Organic and hydraulic capacities are influenced by the type of materials accepted and treated at the facility. For example, the facility's hydraulic capacity of materials containing high concentrations of fats, oils and grease (FOG) will be

much lower than the facility's capacity of treating materials containing high concentrations of sugars, as typically found in fruit processor waste waters.

7.0 Facility Features:

The Big Fish Septage Receiving and Treatment Facility has six primary features or facility components:

7.1 Receiving: Deliveries are received at a heated, enclosed structure with a partitioned, indoor drive-through lane for septage delivery vehicles. Haulers access the indoor receiving point by use of an access card. A hauler simply inserts the card into the card reader located on the exterior of the building, allowing entrance into the facility. Once entered, the hauler connects the delivery truck to the Septage Receiving Station via cam-lock couplings. The Receiving Station provides grinding, ¼-inch screening and dewatering of removed inorganic solids for landfill disposal. As the truck discharges, the Receiving Station automatically tallies the flow. Questions regarding the delivery process can be answered by the on-site facility operator.

Material entering the facility is continuously monitored for pH at the Receiving Station. The facility is programmed to close an electrically actuated valve if the pH of any material is outside of established limits.

The facility also automatically monitors available capacity within the receiving tank. If the receiving tank does not have sufficient space, a float switch actuates a valve, preventing further discharges to the plant until space is made available.

The receiving building uses an odor control system consisting of exhaust fans and a biofilter to scrub the exhaust air. Offensive odors are vented directly from the tank and from the building atmosphere to the biofilter. Material receiving takes place within the drive-through lane when both the entrance and exit doors are closed.

7.2 Equalization Tank: After flow measurement, and screening, material is sent directly to a partitioned 15,000-gallon equalization tank. The first section of the tank (4,000 gallons) will receive the initial flow from the delivery vehicle and provide a basin for settlement of inorganic material (grit) that has passed through the screening process. As more material is delivered to the facility, the first chamber material cascades into the second chamber.

The second chamber (11,000 gallons) provides an aerated mixing area for blending raw material as needed to balance waste strength and initial treatment inoculation. The initial bacterial inoculation occurs using a series of aerobic micro organism generating units. The blended/inoculated material in the second chamber will be pumped into the next 15,000 gallon vessel.

7.3 As septage is pumped from the 15,000 gallon vessel, lime is added to the septage obtain aa pH of 12.0, mixed in 1 (one) of 2 (two) 20,000 gallon tanks maintaining a pH of 12.0 for 2 (two) hours and continuing to mix for 22 (twenty two) hours maintaining a pH of 11.5.

7.4 Following completion of lime mixing, the material is pumped into a dewatering system.
Effluent from the dewatering system flows to a pH neutralization treatment vessel.

7.5 Solids are processed into EQ Class 'A' Biosolids.

7.6 Treatment Vessels: The treatment train of the process is conducted through one, 15,000-gallon and eleven, 2,000-gallon treatment vessels. Each vessel is equipped with aerobic micro organism technology. As flow is pumped from the equalization tank, the partially treated material cascades from one treatment vessel to the next.
Cascading through the vessels provides the appropriate contact time with the bacteria blend and air to treat the material to a level that can be sent to the municipal wastewater treatment facility for final treatment and discharge to the environment.

7.7 Post Equalization Tank: The Big Fish facility incorporates a post-equalization tank prior to discharging treated material to the municipal collection system. The post-equalization tank provides a semi-quiescent zone for settling of solids not consumed in the treatment vessels. Settled solids are pumped back to the front of the plant for further treatment. Treated effluent may also be returned to the equalization tank if additional blending material is needed.

7.8 Effluent Discharge: The facility will produce a treated effluent with waste strength characteristics equal to or less than that seen in a typical domestic household waste stream. The treated effluent is discharged to the City of Charlevoix wastewater collection system for final treatment at the Charlevoix Wastewater Treatment Facility, as per "Order of Determination".

7.9 Biosolids will be stored on site after being mixed with topsoil. The biosolids will be stored under cover and used in the landscape industry as a soil amendment.

8.0 Facility Staffing:

The Septage Receiving Facility will be staffed during normal business hours and at other times when receiving septage. An attendant will be on site during unloading operations.

The attendant will be responsible for monitoring the unloading operation and checking the delivered material for contamination that cannot be treated within the plant as currently configured.

9.0 Truck Traffic:

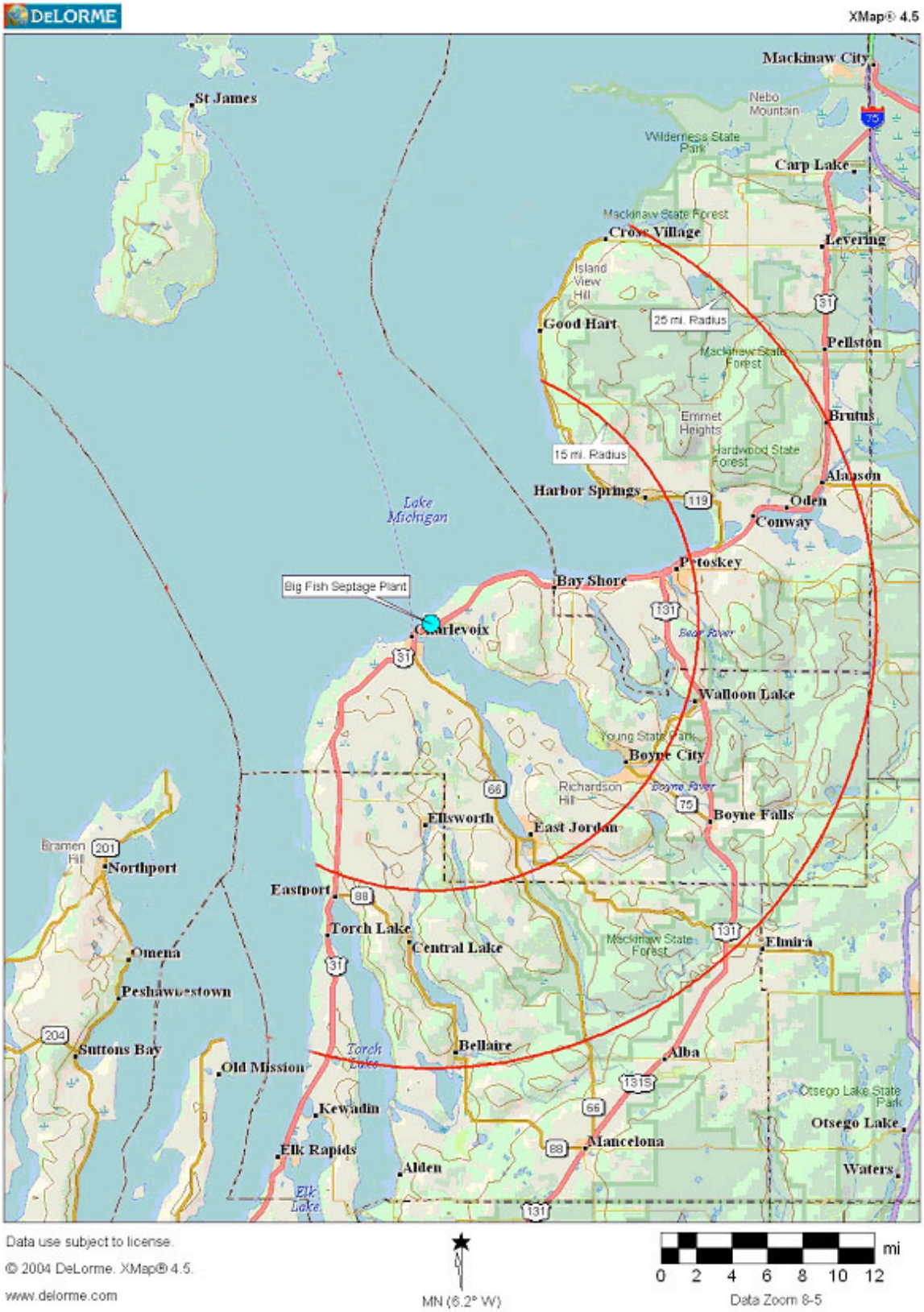
With established contractual relations with haulers the facility expects to receive up to seven to ten truck loads per weekday. The facility is located in a commercial/industrial zoned location within the Township of Charlevoix, and anticipated truck traffic is within accepted uses.

APPENDIX A

Sample Hauler Agreement

Please call for more information
1-231-547-4429

APPENDI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Nebo Mountain
Wilderness State Park
Carp Lake
Mackinaw State Forest
Cross Village
Levering
Island View Hill
25 mi. Radius
Good Hart
Pellston
Mackinaw State Forest
Emmet Heights
Brutus
15 mi. Radius
Hardwood State Forest
Alanson
Harbor Springs
119
Oden
Conway
Lake Michigan
Petoskey
Bay Shore
Big Fish Septage Plant
Charlevoix
131
Bear River
Walloon Lake
Young State Park
Boyne City
Richardson Hill
Boyne River
75
Boyne Falls
66
Ellsworth
East Jordan
Bramen Hill
201
Northport
Eastport
88
Torch Lake
Central Lake
Mackinaw State Forest
Elmira
Omena
Peshawbestown
204
Suttons Bay
Torch Lake
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