

**THE ENVIRONMENTAL TECHNOLOGY VERIFICATION  
PROGRAM**



**U.S. Environmental  
Protection Agency**



**NSF International**

**ETV Joint Verification Statement**

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|-------------------------|--|------------------------------|
| <b>TECHNOLOGY TYPE:</b> | <b>WASTEWATER TREATMENT – CHEMICAL ADDITION,<br/>FILTRATION AND BIOLOGICAL TREATMENT</b> |                              |
| <b>APPLICATION:</b>     | <b>TREATMENT OF SEPTAGE AND HIGH STRENGTH WASTEWATER</b>                                 |                              |
| <b>TECHNOLOGY NAME:</b> | <b>BIG FISH ENVIRONMENTAL SEPTAGE AND HIGH STRENGTH<br/>WASTEWATER PROCESSING SYSTEM</b> |                              |
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The U.S. Environmental Protection Agency (EPA) created the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer-reviewed data on technology performance to those involved in the design, distribution, permitting, purchase, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations; stakeholder groups consisting of buyers, vendor organizations, and permittees; and the full participation of individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and verifiable quality are generated, and that the results are defensible.

NSF International (NSF) operates the ETV Program's Water Quality Protection Center (WQPC) under a cooperative agreement with EPA. The WQPC evaluated the performance of the Big Fish Environmental Septage and High Strength Wastewater Processing System (System) over a period of more than a year. The Big Fish System consists of lime treatment followed by solids separation in a heated screw press, with filtrate subsequently processed in an aerobic biological treatment system. Effluent from the System is discharged to a municipal wastewater treatment plant. Biosolids are also produced which may be used as fertilizer or soil amendment. This verification statement provides a summary of the test results for the Big Fish System.

## TECHNOLOGY DESCRIPTION

The following technology description is provided by the vendor and does not represent verified information.

The Big Fish System (System) combines solids treatment with aerobic wastewater treatment, processing high strength wastes to produce Exceptional Quality (EQ) Class A Biosolids (refer to Federal Rule for Class A Biosolids (40 CFR Part 503)<sup>(1)</sup> and the EPA document – *A Plain English Guide to the EPA Part 503 Biosolids Rule*<sup>(1)</sup>) and treated filtrate meeting pretreatment standards for discharge to most secondary wastewater treatment plants (typically 250-300 mg/L BOD<sub>5</sub>; 300-350 mg/L TSS; 50-70 mg/L NH<sub>3</sub>; and locally determined restrictions for total phosphorus). The system uses a combination of elevated pH for vector (rodents, insects, birds, etc.) control and elevated temperature (time-temperature combination) for pathogen control to meet the Federal Rule for Class A Biosolids. There is no actual testing for vector control addressed in the Rule, only the specified treatment. The first requirement is to treat the waste material with lime to raise the pH to a minimum of 12 for 2 hours, and then maintain a minimum pH of 11.5 after 24 hours without further lime addition. Treatment for pathogen control requires heating the biosolids to a temperature of 72°C for a period of at least 20 minutes. The term EQ Biosolids is identified in the Federal Rule to characterize Class A Biosolids that also meet low-pollutant metals concentrations (see Table 3). If the Class A Biosolids treatment requirements are met and the metal pollutant levels are not exceeded, they are considered EQ Class A Biosolids and can generally be applied as freely as any other fertilizer or soil amendment to any type of land.

Truck-delivered wastes pass through an in-line JWC Muffin Monster 0.25 in. screen to remove any large inorganic particles or debris. A flow meter records the waste volume and an in-line pH meter monitors the waste to confirm the pH is between 4.0 and 9.0. The screened waste passes through a de-grit chamber, into an 11,000-gallon aerated receiving/equalization tank, which is directly connected to a second aerated 15,000-gallon equalization tank.

When 15,000 to 20,000 gallons of waste are accumulated, the waste is pumped to one of the two 20,000-gallon lime treatment tanks. Lime is added to the waste mixture during the transfer to achieve pH 12 for a minimum of 2 hours; the mixture is then held at minimum pH of 11.5 for at least 22 hours. After lime treatment is complete, the wastewater and solids are pumped from the lime treatment tank to a flocculation tank, where polymer is added, and then to a rotary screen thickener prior to entering the screw press. Filtrate extracted by the thickener is discharged to a blending tank for pH adjustment to approximately pH 7.5 – 8.0. The thickened sludge is processed in a heated screw press that raises the solids temperature to a minimum of 72° C for at least 20 minutes which increases the solids content to 40-50%. The combination of the lime treatment and the elevated temperature in the screw press conforms to the treatment requirements established in 40 CFR Part 503 for producing Class A Biosolids. Solids are collected in a hopper and the transferred to an outside covered storage area, while the screw press filtrate is discharged to the blending tank for pH adjustment and subsequent biological treatment.

The aerobic treatment system consists of a series of aerated tanks, followed by a 2,000-gallon quiescent settling tank, a 2,000-gallon re-aeration tank, and two 2,000-gallon discharge tanks. The combined volume of the aerobic treatment tanks is 27,000 gallons. The suspended growth aerated tanks have one or more White Knight™ microbial generators suspended in the tanks to provide a source of supplemental microorganisms to the naturally occurring microorganisms. A hatchery at the facility is also maintained as an additional source of microorganisms if needed. The large capacity of the aeration tanks is designed to provide time for biological treatment to reduce the very high organic loadings that normally remain in septage type wastes after solids removal. Liquid discharged to the aerated tanks from the screw press and thickener causes water to flow through the system tanks. A float switch in the discharge tank triggers an effluent discharge by pump from the treatment system to the City of Charlevoix, MI municipal sewer system. Solids that accumulate in the settling tank are periodically pumped to the receiving tank for processing through the treatment system. All treatment processes, including truck unloading, occur inside a building equipped with a biofilter to reduce odors.

## VERIFICATION TESTING DESCRIPTION

### *Test Site*

The verification test was performed at the Big Fish facility in Charlevoix, Michigan, a full-scale System operating under a permit issued by the Michigan Department of Natural Resources and Environment (MDNRE), and in accordance with the requirements of the City of Charlevoix. Scherger Associates was the lead for the Testing

Organization (TO) for this verification and provided technical oversight during the test. The facility has been in operation for over three years, with effluent discharge to the City of Charlevoix municipal WWTP. The System receives septage waste from several septic tank cleanout companies, secondary sludge from the City of Charlevoix WWTP, commercial grease interceptor waste containing fats, oils and grease (FOG) from local businesses, portable toilet waste and fruit processing waste.

### ***Methods and Procedures***

Testing was completed in accordance with the approved test plan<sup>(2)</sup> for the System. The verification test was conducted from September 2008 through October 2009 and included thirteen sampling and analysis events over the 14-month test. Monthly sampling events included a 5-day period with two batches of waste being processed, except in March 2009 when only one batch was processed and April 2009 when there was no sampling. Sampling locations included the untreated waste material and the treated effluent. Untreated waste samples were grab samples from the aerated equalization tank. Effluent samples were both composite and grab samples collected during discharge periods. Grab samples were collected each sample day for pH, FOG, temperature, and dissolved oxygen. The composite discharge samples and untreated waste grab samples were collected each sampling day and analyzed for total suspended solids (TSS), five-day biochemical oxygen demand (BOD<sub>5</sub>), chemical oxygen demand (COD), and alkalinity. Weekly composite samples were made of the untreated waste grab samples and the composite discharge samples. This was done by combining aliquots of several individual daily samples to form batch composite samples, which were analyzed for total Kjeldahl nitrogen (TKN), ammonia, nitrite plus nitrate, and total phosphorus (TP). Samples of the biosolids material were collected twice during the verification test and analyzed for percent solids and regulated (40 CFR Part 503) metals (As, Ba, Cd, Cr, Hg, Pb, Ni, Zn). The pH of the lime treated waste material was measured and recorded in the System operating record; the temperature of the biosolids in the screw press was recorded continuously.

The approved test plan included monitoring system performance during startup. From January 2 to January 4, 2009, Big Fish personnel emptied and cleaned the System tanks and restarted the System. The tanks were filled with processed wastewater from the screw process and microorganisms were seeded to the aerated tanks by adding 1,500 gallons of material from the hatchery tank. The White Knight™ microbial generators were hung in place in accordance with standard operating practice. The normal January 2009 verification sampling was performed three weeks after startup and showed the System was producing an effluent comparable to the four months (September 2008 through December 2008) prior to the cleaning and startup demonstration.

All analyses were completed in accordance with USEPA approved methods or *Standard Methods for the Examination of Water and Wastewater*, 20<sup>th</sup> Edition. An established quality assurance/quality control (QA/QC) program was used to monitor sampling and laboratory procedures. Details on all analytical methods and QA/QC procedures are provided in the full verification report.

## **PERFORMANCE VERIFICATION**

### ***Verification Test Results and Discussion***

There were three sampling events during the verification testing that are not included in the data summaries presented in Tables 1 and 2, but are discussed in detail in the Verification Report. In March 2009, the reported effluent BOD<sub>5</sub> data was not consistent with the other reported data for the sampling event (particularly the effluent COD) so none of the day's data were included in the averages for the verification. The other two events occurred in May 2009 when the System received highly concentrated wastes, believed to be fruit waste, increasing the influent holding tank BOD<sub>5</sub> and COD concentrations to 21,000 mg/L and 31,000 mg/L, respectively (the BOD<sub>5</sub> being seven (7) times the mean influent concentrations over the course of the verification). The effluent BOD<sub>5</sub> and COD concentrations increased in the two treated batches following receipt of the waste to a BOD<sub>5</sub> of 5,500 mg/L and 5,700 mg/L, and a COD of 11,000 mg/L and 8,600 mg/L, respectively. The data for these two sampling events were determined to have resulted from System upset (defined in the *Protocol for the Verification of Wastewater Treatment Technologies*, April 2001<sup>(3)</sup>), so the data were not included in the averages for the verification testing indicated in Table 1.

Following the upset, the System was operated in normal aeration recycle mode, without additional waste loading or effluent discharge. After 10 days operation in this mode, a batch of wastes from the holding tank was processed.

The effluent BOD<sub>5</sub> (810 mg/L – facility-generated data) indicated the System was recovering, but not yet back to typical discharge concentrations. The System continued to operate with the aeration tanks in normal recycling mode for another ten days, when another batch of waste material was processed and the effluent BOD<sub>5</sub> concentration was found to be 110 mg/L. A subsequent batch of waste was processed and it was confirmed that the system had returned to normal operating conditions (effluent BOD<sub>5</sub> of 96 mg/L). The ETV verification testing for June was performed the week of June 22 and the data showed the System had recovered.

Table 1 presents the results for BOD<sub>5</sub>, COD and TSS. The influent concentrations are typical of a septage/high strength wastewater mixture. The treated effluent had a mean reduction of 97.7% (median 97.3%) for BOD<sub>5</sub>. The mean and median COD removal was 98.4% and the mean and median TSS removal was 99.6%. The mean influent FOG concentration was 370 mg /L (median 140 mg/L). The effluent mean FOG concentrations was 5.1 mg/L (median 3.0 mg/L), resulting in a mean removal of 98.6% (median 97.5%). Fourteen of the 22 effluent samples showed an FOG concentration of <3 mg/L.

Table 2 presents the results for TKN, NH<sub>3</sub>-N, NO<sub>2</sub>+NO<sub>3</sub>, and TP. Total nitrogen (TN) was determined by adding the concentrations of the TKN (organic plus ammonia nitrogen), and NO<sub>2</sub> plus NO<sub>3</sub> in the effluent. The overall system removal efficiency for TN was 80% (mean and median). Mean TP removal was 95.3% (median 97.3%).

**Table 1. BOD<sub>5</sub>, COD and TSS Data Summary**

|           | BOD <sub>5</sub> (mg/L) |          | COD (mg/L) |          | TSS (mg/L) |          |
|-----------|-------------------------|----------|------------|----------|------------|----------|
|           | Influent                | Effluent | Influent   | Effluent | Influent   | Effluent |
| Mean      | 3,300                   | 75       | 17,500     | 270      | 13,700     | 55       |
| Maximum   | 15,000                  | 190      | 31,000     | 400      | 28,000     | 170      |
| Minimum   | 27                      | 7        | 3,700      | 25       | 3,700      | 10       |
| Std. Dev. | 2,900                   | 44       | 8,000      | 96       | 6,500      | 42       |

Note: Data in Table 1 are based on 22 samples of influent and 22 samples of effluent and do not include the results for the upset period that occurred in May 2009. During the upset, BOD<sub>5</sub> removal was reduced to 43 – 74% and COD to 57 – 64%; TSS removal remained at 90 – 99% during the upset.

**Table 2. Nitrogen and Phosphorus Data Summary**<sup>1,2</sup>

|           | TKN (mg/L) |          | Ammonia (mg/L) |          | Nitrite/Nitrate (mg/L) |          |
|-----------|------------|----------|----------------|----------|------------------------|----------|
|           | Influent   | Effluent | Influent       | Effluent | Influent               | Effluent |
| Mean      | 440        | 83       | 93             | 60       | 3.2                    | 3.8      |
| Maximum   | 550        | 170      | 160            | 120      | 15                     | 13       |
| Minimum   | 170        | 42       | 8              | 14       | <0.05                  | <0.05    |
| Std. Dev. | 100        | 35       | 48             | 30       | 5.3                    | 3.7      |

|           | Total Nitrogen (mg/L) |          | Total Phosphorus (mg/L) |          |
|-----------|-----------------------|----------|-------------------------|----------|
|           | Influent              | Effluent | Influent                | Effluent |
| Mean      | 440                   | 85       | 128                     | 3.3      |
| Maximum   | 550                   | 170      | 280                     | 7.1      |
| Minimum   | 170                   | 49       | 2.6                     | <0.05    |
| Std. Dev. | 100                   | 34       | 90                      | 1.8      |

<sup>1</sup> Data in Table 2 are based on 12 samples of influent and 12 samples of effluent and do not include the results for the upset period that occurred in May 2009.

<sup>2</sup> Nitrogen data reported in mg/L as N; phosphorus data reported as mg/L as P.

The nitrogen data indicate that a large percentage of the total nitrogen was organic nitrogen. A comparison of the mean influent TKN (440 mg/L) with the mean influent ammonia concentration (93 mg/L) shows that organic nitrogen represented approximately 79% of the nitrogen in the wastes received at the facility (nitrite-nitrate was low at 3.2 mg/L). Based on review of the ammonia and nitrite-nitrate data, it appears that the biosolids produced by the

screw press contained a large amount of the organic nitrogen removed by the System. If appreciable organic nitrogen reduction were occurring in the biological system aeration tanks, the ammonia and/or nitrite-nitrate concentrations in the effluent would increase significantly (which they did not). The reduction in ammonia could be attributed to association with the biosolids or possibly volatilization from aeration in the System.

The pH ranged from 12.1 to 12.9 during the initial 2-hour period after lime addition to the treatment tanks and after 24 hours the pH ranged from 11.6 to 12.8. The programmable logic controller records show that the proper screw press rate (38% motor speed) was maintained at all times ensuring the minimum contact time in the screw press at elevated temperature was achieved. The screw-press temperature ranged from 90°C to 100° C, well above the minimum requirement of 72°C for a 20 minute contact time. Samples of the biosolids were collected and analyzed for regulated metals as part of this verification. These data are shown in Table 3. Based on the data collected during the verification test, all batches of biosolids produced met the requirements to be classified as EQ Class A Biosolids.

**Table 3. Biosolids Metals Concentration**

| Analyte      | Units | 3/13/2009 | 6/18/2009 | Pollutant Concentration Limits for EQ Class A Biosolids |
|--------------|-------|-----------|-----------|---|
| Arsenic      | mg/kg | 3.5       | 4.4       | 41  |
| Cadmium      | mg/kg | 2.4       | 2.2       | 39  |
| Chromium     | mg/kg | 18        | 19        | 1,200   |
| Copper       | mg/kg | 430       | 260       | No standard   |
| Lead         | mg/kg | 21        | 23        | 300   |
| Mercury      | mg/kg | 0.33      | 0.22      | 17  |
| Nickel       | mg/kg | 12        | 12        | 420   |
| Selenium     | mg/kg | 5.9       | 2.6       | 36  |
| Zinc         | mg/kg | 1,300     | 990       | 7,500   |
| Total Solids | %     | 50        | 60        | NA  |

**Operation and Maintenance Results**

Lime, used to raise the pH to meet the requirements for vector reduction in the biosolids and to aid in the dewatering processes, can also enhance phosphorus removal. The mean quantity of lime used was 11 lbs of lime per 1000 treated gallons. Polymer was added to the lime treated waste material as it was pumped from the holding tank to the thickener. A cationic polymer, Aquaben HF 748E, was used from September 2008 through July 2009 at mean addition rate of 0.63 gallons of concentrated polymer (as purchased) per 1000 treated gallons. A different cationic polymer, ERC Associates ERC840HX was used from August through October 2009 at a mean addition rate of 1.15 gallons of concentrated polymer (as purchased) per 1000 treated gallons. The concentrated polymer is diluted in the injection system used to feed the polymer. Muriatic acid was used to neutralize the filtrate extracted in the rotary screen thickener, which is discharged to a blending tank ahead of the aerobic processing tanks. The acid was fed from the containers received from the supplier without intermediate dilution. The mean muriatic acid use was 0.55 gallons per 1000 treated gallons.

The electric power and natural gas use during the verification test was monitored using the facility electric and gas meters. These meters measured total use for the facility. Electrical use averaged 671 kWh per day based on 5-day operating periods treating two batches per week. Steam for heating the biosolids in the screw press was generated on-site with a gas fired boiler. Natural gas use averaged 25 cubic feet per day based on the 5-day operating periods treating two batches per week during the verification test.

There were no major mechanical component failures or major downtime periods during the verification test. Operation and maintenance of the System was observed by the testing organization representatives who were on-site for several days each month to collect samples and review operating records. These observations provided

information on System operability, complexity, and degree of maintenance required. The Big Fish System was found to be easily operated, requiring only routine maintenance, and was reliable during the verification period.

**Quality Assurance/Quality Control**

Prior to the start of the verification test, NSF completed a QA/QC audit of the RTI Laboratories (RTI). These audits included: (a) a technical systems audit to assure the testing was in compliance with the test plan, (b) a performance evaluation audit to assure that the measurement systems employed at the test site and by RTI were adequate to produce reliable data, and (c) a data quality audit of at least 10 % of the test data to assure that the reported data represented the data generated during the testing. During testing, NSF conducted a QA/QC audit of the Big Fish Environmental test site. EPA QA personnel also conducted a quality systems audit of NSF’s QA Management Program.

*Original signed by*  
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**Supporting Documents**

Referenced Documents: 40 CFR Part 503, Standards for the Use or Disposal of Sewage Sludge, Subchapter O, [http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr503\\_main\\_02.tpl](http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title40/40cfr503_main_02.tpl)

- 1) *A Plain English Guide to the EPA Part 503 Biosolids Rule*, <http://www.epa.gov/OW-OWM.html/mtb/biosolids/503pe/index.htm>
- 2) *Test Plan for Big Fish Environmental, LLC Big Fish Environmental Septage Processing System*, dated July 2008; [http://www.epa.gov/etv/pubs/04\\_vp\\_wastewater.pdf](http://www.epa.gov/etv/pubs/04_vp_wastewater.pdf)
- 3) *The Protocol for Verification of Wastewater Treatment Technologies*, dated April 2001 (see below for availability).

EPA’s Office of Wastewater Management has published a number of documents relevant to this verification, including:

*Handbook for Management of Onsite and Clustered Decentralized Wastewater Treatment Systems*, <http://www.epa.gov/owm/onsite>  
*Onsite Wastewater Treatment Systems Manual*, <http://www.epa.gov/owm/mtb/decent/toolbox.htm>

Source of Verification Information:

Copies of, *Test Plan for Big Fish Environmental, LLC Big Fish Environmental Septage Processing System*, dated July 2008, the Verification Statement, and the Verification Report are available from: ETV Water Quality Protection Center Manager (order hard copy), NSF International, P.O. Box 130140, Ann Arbor, Michigan 48113-0140 (<http://www.nsf.org/etv> (electronic copy); or <http://www.epa.gov/etv> (electronic copy)). Appendices are not included in the Verification Report, but are available from NSF upon request.