WASTEWATER PLANT PERFORMANCE EVALUATION

December 29, 2010 – February 18, 2011

Shenango Township Municipal Authority STP

Water Pollution Control Facility

NPDES #PA0103471

Bureau of Water Standards & Facility Regulation
POTW Optimization Program

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

1. Optimization Report

The Pennsylvania Department of Environmental Protection (DEP) conducted a Wastewater Plant Performance Evaluation (WPPE) of the Shenango Township Municipal Authority's (STMA) wastewater treatment plant (WWTP) from December 2010 through February 2011. A WPPE is an evaluation of existing operations and practices followed by small-scale operational changes meant to optimize effluent quality. The purpose for optimizing effluent quality is to reduce pathogens and nutrients at drinking water intakes directly downstream of the subject facility, with an overall goal of improving surface water quality.

An overall rating is assigned based on a review of the plants past performance, current operating conditions.

The WPPE was performed by staff of DEP's Operations Monitoring and Training Division, Bureau of Water Standards and Facility Regulation (BWSFR). The WPPE program is conducted under terms of a federal grant administered by the United States Environmental Protection Agency (USEPA). The primary objective of the site study is to determine if wastewater treatment plant optimization through process control is sufficient to reduce nitrates and phosphorus along with the number of parasitic wastewater pathogens such as *Cryptosporidium* oocyst and *Giardia lamblia* cyst in the finished effluent. This is of concern because a water works is located 15 miles downstream on the Shenango River in New Castle.

There is a large amount of additional analytical information included on the CD-ROM accompanying this report that has not been included in this written report.

1.1 Operational Strengths

The following items are Operational Strengths that were identified during the WPPE. These include strengths of both the operators and the facility itself.

- The facility employs two part time operators and one full time maintenance person all of whom show excellent dedication to plant operations and optimization as part of daily activities and as part of this WPPE.
- All testing is performed in-house which allows the operators to have the fastest turnaround time possible with lab results allowing for timely adjustment of plant processes as necessary.
- The operators are proactive and have attempted several different treatment methodologies to maximize the performance of the plant.
- The Authority is currently examining proposed upgrades to the treatment plant headworks.
- The operators have made many physical and process changes within the past 12 months that have been working at the facility which has reduced the frequency of effluent violations.
- Waste solids systems have been adjusted to operate properly; waste solids are thickened in aerobic digesters and processed through a Belt Thickener before being hauled off site in cake form.
- Final effluent sample collection is by composite sampler after all treatment

- Both part time operators are certified wastewater operators and the full time maintenance person is actively seeking certification

1.2. Focus Points for Improvement

The following items have been identified as focus points to assist in optimization efforts, and they are ranked "High," "Medium," and "Low" in terms of their importance to optimized functioning of the treatment facility. Focus points include both operational tactics and physical plant issues that can or do impact optimization efforts. These items generally demand more of the operator's attention and therefore require more of the operator's time to perform. The benefits are expected to be favorable by improving the plants discharge quality and thereby improving downstream water quality. The priority levels are defined as follows:

High- Major impact on plant performance on a repetitive basis and/or has been associated with a regulatory violation

Medium- Minimal impact on plant performance on a repetitive basis

Low- Minimal impact on plant performance on a rare basis or has the potential to impact plant performance

High:

- The current wastewater footprint includes two Oxidation Ditches and integral Boat Clarifiers for treatment. The existing clarifiers have many adjustable features including: influent flow gates, internal flow gates, scum trough weirs, 2 sets of vanes at the head end of the clarifiers, and level controls. Adjusting lagoon height necessitates adjusting, at minimum, the scum trough weirs. Since there are many of these weirs for each clarifier, the most effective treatment will be accomplished once a lagoon height is selected and the clarifiers are adjusted to that height.
- The Oxidation Ditch requires higher Mixed Liquor Suspended Solids (MLSS) levels to reduce the pollutant loadings while the boat clarifier must operate at lower solids levels to prevent clogging of return sludge ports and short circuiting, these conflicts appear to hamper treatment.
- Operators spend a lot of time cleaning the solids materials from the ports on the bottom of the clarifiers; this is a daily necessity. The operators have many other daily tasks where time could be much better spent once an effective fix has been chosen.
- To maintain operational efficiency of the boat clarifiers, it appears that the best method is maintaining low MLSS levels to prevent clogging of the clarifiers; however, doing so will result in poorer-quality effluent having a higher organic loading combined with minimal nitrification occurring in the ditches during treatment. There are many adjustments possible on the clarifiers; all combinations of adjustments to mixed liquor levels and the clarifiers could not be accomplished during this project. Further work is needed to obtain good steady-state waste treatment conditions and the fine-tuning these combination adjustments require.
- Dissolved Oxygen (DO) concentration in the Oxidation Ditches is too high. Target levels in general and per the system's Operations & Maintenance (O&M) Manual both suggest target DO ranges of 2.0 to 2.5 mg/L. DO levels during the WPPE averaged 9.2 mg/L in

January and 7.8 mg/L in February. Excessive DO not only represents wasted power consumption (electrical costs,) but over-aeration could be damaging the floc particles and contribute to poor settling in the clarifiers. Additionally, excessive foaming could result from this over-aeration, especially during seasonal changes as temperatures increase if mixed liquor solids remain low. This foaming occurs because organic waste is only partially broken down under these adverse conditions, and many organic wastes will foam under excessive aeration.

- Target Food to Mass ratio (F/M) per the O&M is 0.10. During much of the project the F/M for the west basin was much higher than this, likely meaning that there was more organic waste in the mixed liquor than the existing concentration of bacteria could completely treat. (An alternative to reducing the organic loading to the ditches would be increasing the volume of solids in the aeration basins to reduce the F/M to the desired target value.) See Attachment J. But, again, this can have its drawbacks when considering clarifier loadings.
- The target Sludge Volume Index (SVI) is 100; lowering F/M usually decreases the SVI as well. SVI during the project were over 100 with peaks in the 160's.

Medium:

- The headworks at the plant include a Comminutor with reserve Bar Screen. This system allows a significant amount of inorganic debris to make its way into the Oxidation Ditch and Boat Clarifiers. This excess debris appears to contribute to clogging in the Boat Clarifiers and increases maintenance issues throughout the plant.
- The current headworks layout does not provide for adequate composite influent sampling. It is important for operators to regularly test the raw wastewater for organic concentration so they can determine its treatment requirements and adjust operational conditions accordingly. The only way to collect raw influent samples is from within the lift station at an influent pipe approximately 20 feet below grade. Sending a man down into the lift station would be a potentially dangerous permit-required confined space entry, requiring implementation of strict safety procedures similar to OSHA 1910.146; so, "easier" sampling must be performed with a bucket on a rope at multiple intervals throughout the sampling period, a cumbersome, time-wasting task. Future plant upgrades should include installation of a raw influent composite sampling point that facilitates the collection of these samples.

Low:

- Solids management within the oxidation ditches is one of the most important aspects of treatment at this facility. STMA should acquire a centrifuge for solids testing by volumetric percentage to assist the operators in managing solids levels. We have reviewed procedures with operators that assist them in conducting proper solids inventory, tests which require this relatively inexpensive laboratory equipment.
- Current influent data collection could stand improvement: influent composite samples should be raw wastewater samples collected from the lift station prior to mixing with internal recycle flows that usually dilute but always interfere with the influent data as it is currently developed. In order to do this, the operators will have to employ the "bucket and rope" grab-sampling technique demonstrated during the WPPE; a more pro-active solution in the near-term is installation of an automatic composite sampler as discussed above.

- Microscopic evaluation of the mixed liquor identified the need for more beneficial micro-organisms, such as stalked and free swimming ciliates, rotifers, and flagellates. It may be necessary to enhance the biomass through addition of "new" microorganisms on a regular schedule. Different formulations of "bugs" may be found among a number of vendors, and some vendors may customize them to the needs of your particular facility. Use of seed sludge from other activated sludge processes or digesters is not favored absent emergency situations like plant upsets or toxicity die-offs, because such biomass may be contaminated, inert, or unreliable. Also, it creates additional solids loading on the clarifiers.

1.3 Process changes to consider

Process changes to consider are informal recommendations made as a result of the on-site evaluation, but they are voluntary considerations for the Authority and are not official recommendations or mandates by the Department of Environmental Protection. In some cases, it may be necessary to refer these matters to the Authority's consulting engineer for evaluation, and any changes made to flow patterns or treatment methodology must be approved by DEP as a Water Management Permit Amendment. The Authority is free to consider or reject these recommendations in the normal business of operating the facility. Nevertheless, we have prioritized these recommendations in order from most immediate consideration to longer-term consideration, based in part upon what will most quickly benefit plant operation and then upon what is most quickly feasible from a funding standpoint:

1. **Further study of MLSS/clarifier settings**: There are numerous combinations of mixed liquor suspended levels and clarifier settings that are possible at this facility. While the operators were very proactive with their attempts to optimize the treatment process, not all combinations were evaluated. The operators should continue their work making adjustments to the treatment process while maintaining detailed records of dates, times, adjustments made, and results of each adjustment.

2. **Replacing rotor relays**: The relays that operate the rotors providing DO to the ditch are antiquated and do not allow the operators much variation in aeration schemes. The current configuration allows one rotor to be on while the other is off and the time sequencing is also very minimal. Modern rotor relays are programmable logic controller (PLC)-driven and can be programmed through use of a microcomputer to provide a wider array of aeration schemes, including operating the ditches in a manner which promotes biological nutrient reduction (BNR.) If the relays were to be replaced, the operators would have much greater control over the treatment process in the ditches.

3. **Addition of continuous MLSS monitoring**: Since Shenango's treatment process is very dependent on MLSS levels in the ditches, much more so than at conventional activated sludge plants, STMA should consider adding in-line continuous monitoring probes to monitor solids levels. This would allow the operators to closely monitor conditions within the plant and better estimate when solids removal is necessary or when solids must be increased.

4. **Replacement of secondary clarifiers**: The boat clarifiers currently in use at the plant appear to be the limiting factor preventing optimum treatment. In order to effectively

remove BOD and Ammonia there must be enough solids present with necessary biomass that can reduce the contaminants. When the mixed liquor is at sufficient levels to reduce the contaminants, the clarifiers tend to clog and create a whole new problem with the treatment process. If the clarifiers were replaced with conventional round clarifiers, the oxidation ditch could be used to nitrify, and possibly denitrify, the wastewater in separate units allowing the operators more independent control. This would most likely increase treatment plant capacity since the full volume of the oxidation ditches could be used for treatment. Because of funding considerations, this recommendation has been given the lowest priority setting; however, its importance should not be quickly dismissed. Eventually, the requirement for more treatment capacity within the oxidation ditches will warrant building separate clarifiers.

5. **Headworks upgrade**: The current headworks do not remove any inert material from the process. Currently, it is ground up in the comminutor and processed through the treatment plant to be disposed of with the biosolids. During the WPPE, within three days time, the in-line probes in the ditches accumulated enough debris to encapsulate the probes leading to false readings. This mostly affected the ORP and MLSS probes at the outside corners of the ditches and was rectified with regular cleaning during weekly visits and with assistance from the Shenango plant representatives. These inert solids do more than interfere with instruments, though. This material can clog pump intakes, jam impellers, interferes with the boat clarifiers, and increases the requirement for draining and maintaining the oxidation ditches. The current thinking in wastewater treatment is to remove these inert solids at the head of the plant rather than to grind them and allow them to cause further trouble downstream in the process. STMA is aware of this and currently is investigating the installation of new headworks facilities.

1.4 WPPE Rating

The background of the rating system for WPPE is described in Attachment A. As a result of our evaluation and on-site interaction with the plant operators, the Department has assigned a facility rating of **Needs Improvement**, because the plant routinely faces challenges with its wastewater treatment based on limitations that appear to be directly related to the boat clarifiers and the need to meticulously manage mixed liquor solids levels within the oxidation ditches to maintain effluent quality. The limiting factors at this facility appear to be the clarifier operation and the lack of solids removal at the headworks, in that order.

It must be noted that, both during and after the WPPE, the Shenango operators and maintenance personnel acted in a very proactive, professional manner in attempting various treatment methodologies to maximize treatment efficiency. They appear to be doing the best they can do under the circumstances, working with the existing equipment and treatment technology. They should continue their attempts to optimize the treatment process as described elsewhere in this report.

1.5 Re-evaluation

Presently, there are no plans to re-evaluate the facility for the WPPE Program, although re-evaluations may become part of the program if it matures. However, the Department would like to revisit the facility within three-year's time to see if changes were made as a result of this evaluation, if optimization strategy had been adopted, and if the facility status has changed.

2. Downstream Water Treatment

2.1 FPPE Review

DEP last conducted a Filter Plant Performance Evaluation at the PA American Water Company's New Castle Water Treatment Plant in June 2007. The facility provides water to 40,585 consumers through 16,975 metered service connections utilizing water from the Shenango River, approximately 15 miles downstream from the Shenango wastewater plant discharge. For water treatment, the New Castle plant utilizes a baffled rapid mix tank, three flocculation basins containing eight flocculators arranged in four parallel lines consisting of two flocculators each, two sedimentation basins in a series, four parallel mixed media filters, and chemical feed and pumping as necessary for water treatment.

The sole raw water source for PA American Water Company's New Castle Water Treatment Plant is an intake along the Shenango River, within Neshannock Township, Lawrence County, Pennsylvania. The Shenango River watershed above the intake is approximately 793 square miles and encompasses six counties within two states. A total of 48 municipalities in Crawford, Mercer and Lawrence Counties are contained within the watershed (see Figure 2.) The primary land use within the watershed is agriculture, with the remainder being mostly forested. A small portion of the watershed is urbanized. Potential pollution threats to the water source include roads, railroads, agricultural run-off, storm water run-off, sewage treatment plants, on-lot sewage systems, industrial discharges, and other activities that impact water quality characteristics, including boating and water recreation.

Within five miles upstream of the New Castle intake, there are five sewage treatment plants and six sewage outfalls. Four of the treatment plants are owned and operated by mobile home parks and the fifth one is privately owned. Likewise, five of the discharge points are owned and operated by mobile home parks. One is privately owned, and one is controlled by Wilmington Township Sewer Authority. The nearest treatment plant and discharge point within the watershed is approximately 1.75 miles away.

Outside of the watershed, there are two treatment plants and four sewage outfalls within three miles of the plant intake. Both treatment plants are privately owned, but all four discharge points are owned and operated by the New Castle Wastewater Treatment Plant.

2.2 Water Chemistry

As part of the WPPE, DEP staff obtained both background (upstream) samples and impacted (downstream) samples of the receiving waters affected by the treatment plant discharge. The downstream samples were collected from the PA American raw water tap at the downstream water treatment plant. A total of six sampling events for water chemistry and three concurrent sampling events for water pathogens were taken. All samples were analyzed at DEP's Bureau of Laboratories facility in Harrisburg.

The nitrate concentration of all samples was well below the drinking water MCL of 10 mg/L. As seen in the table of downstream samples, the presence of nutrients in the surface water suggests an impact from both point source (such as wastewater plants) and non-point sources (such as agriculture and urban/suburban storm water runoff.)

Raw Water at PA American-New Castle Water Filtration Plant (Downstream of Shenango Twp WWTP Outfall 001)							
Sample Date	1/13/11	1/20/11	1/26/11	2/3/11	2/10/11	2/17/11	
Downstream-Sample #	0331005	0331011	0331017	0331024	0331030	0331036	Average
BOD	2.4	0.9	1.1	2.1	1.6	2.4	1.8
TSS	7	7	***5***	7	10	7	7.2
Alkalinity	56.6	67.2	69.6	71.2	75.2	64.6	67.4
NO2-N	0.03	0.33	0.04	0.03	0.02	0.02	0.1
NO3-N	1.28	1.85	1.1	1.34	1.26	1.24	1.3
NH3-N	0.12	0.25	0.18	0.26	0.17	0.13	0.2
TKN	***1***	***1***	***1***	***1***	***1***	***1***	1.0
Phos	0.09	0.086	0.079	0.121	0.084	0.083	0.1
TOT N(TKN+NO3+NO2)	2.31	3.18	2.14	2.37	2.28	2.26	2.4
Fecal Coliform	20		880	80	20	360	272.0
Chloride	36.9	70.4	40.2	191.1	72.6	71.7	80.5
pH	7.6	7.7	7.6	7.8	7.8	7.8	7.7
Crypto	0		0			0	0.0
Giardia	5		3			1	3.0
Specific Conductivity	296	421	334	854	475	441	470.2
Sulfate	23.41	25.81	26.1	33.37	30.58	28.1	27.9
TDS	198	282	216	486	266	194	273.7

Values in bold italic font indicate test results reported as below the detections limits for the test

Table 2.1: Shenango River source water sampling results

2.3 Pathogen Discussion

There were 3 pathogen samplings from the Shenango River upstream of the STMA wastewater plant discharge, and Shenango River downstream at the PA American Drinking Water plant at New Castle, PA.

Below are charts showing the relative presence of pathogens in the raw water samples:

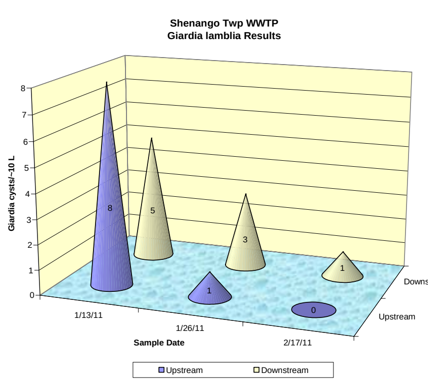


Figure 2.2: *Giardia lamblia* test results

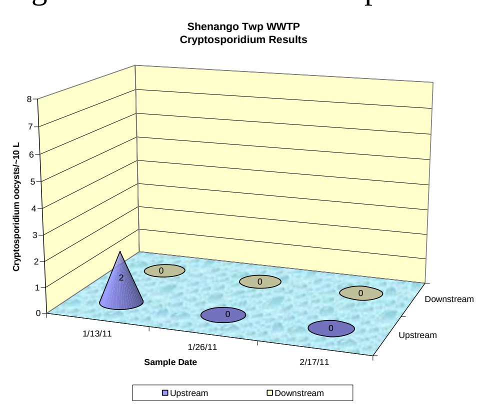


Figure 2.3: *Cryptosporidium* test results

Event	**Date**		
	1/13/2011	1/26/2011	2/17/2011
Rainfall during previous 24 hours	.25 - .50 inches	0 inches	0 inches
Stream flow	757 cfs	426 cfs	768 cfs

Table 2.2: Shenango River source water sampling results

Current theories are that these waterborne pathogens tend to bind with the suspended solids within the waste treatment process. Of the three sampling events, the sampling occurring on January 26th was during a rain event of approximately .25 - .5 inches of rain. The other two samplings occurred with no rainfall but the last event was during heavy snow melt and elevated river flows. It appears that the rainfall event had more of an impact on the *Cryptosporidium* and *Giardia* results than the elevated river level due to snow melt. While the snow melt causes higher river flows due to the added water, the snow layer itself may provide a buffer preventing surface contaminants from entering the waterways. During a rain event, surface contaminants are directly washed into the surface waterways which may directly contribute to elevated levels of *Giardia* and *Cryptosporidium*. The only sampling event that detected *Cryptosporidium* oocysts was during a measurable rainfall event.

All of the STMA wastewater plant effluent samples contained *Giardia lamblia* cysts and while the upstream and downstream samples did contain the same cysts they were in much fewer quantities.

Disclaimers:
The mention of a particular brand of equipment is in no way an endorsement for any specific company. The Department urges the permittee to research available products and select those which are the most applicable for its situation.

The goal of the Department's Wastewater Optimization Program is to improve water quality at drinking water intakes by optimizing upstream wastewater plant effluent quality. This often times involves permittees achieving effluent quality above and beyond any permit requirements.

Attachment A— Program Description

POTW Optimization Program

Description and goals

As part of an EPA-sponsored grant, the DEP has created a Wastewater Optimization Program to enhance surface water quality by improving sewage treatment plant performance beyond that expected by existing limits of the plants' National Pollutant Discharge Elimination System (NPDES) Permits.

The goal of this program is to encourage wastewater treatment facilities to voluntarily produce higher-quality effluent than mandated by the limits set in their NPDES permits and to optimize treatment in such a way that reduces contaminants and pathogens in surface waters that are consumed for drinking water following filtration at facilities downstream. This program is modeled after DEP's Filter Plant Performance Evaluations (FPPEs) conducted at Drinking Water facilities.

The initial focus will be to work with wastewater treatment facilities within ten miles upstream of these drinking water filter plant intakes. DEP will conduct Wastewater Plant Performance Evaluations (WPPEs) to assist municipal wastewater systems in optimizing their wastewater treatment plant processes as part of the Wastewater Optimization Program. Each evaluation is expected to last up to 2 months.

This program is not part of the Field Operations, Monitoring and Compliance Section. Sample collection methods utilized during this evaluation generally do not conform with 40 CFR Part 136, therefore the data collected will not be used, and in some cases is not permitted to be used for determining compliance with a facility's effluent limits established in its NPDES permit.

Wastewater plant performance evaluation

- Department staff will consult with the plant operators to explain the program, the goals, the equipment used, and the expectations for participation.
- Upon arrival at the wastewater plant, Department staff will set up equipment, including meters capable of continuous, in-line monitoring for pH, Oxidation-Reduction Potential, Ammonia, Nitrates, Dissolved Oxygen, Suspended Solids, and other parameters.
- The Department will utilize the equipment to gather data on system performance, show the operator how to gather similar data, and explain the value of gathering the data. The Department will also explain how operators could choose to modify their treatment processes based on interpretation of the data collected.
- Although the Department may show operators how to achieve effective process control by using these process monitoring tools, the operators will continue to make all process control decisions, in conformance to their licensing requirements, and retain responsibility for those changes.
- The Department will also lend the facility additional laboratory equipment which will remain on site during the WPPE to assist in data collection and interpretation.
- During this time, the operator may need to spend more time performing routine testing at the treatment plant than was done previously. This will allow correlations to be made between process modifications and the process response.

- One major goal of the program is to provide the operator with the process monitoring knowledge and experience necessary to gather useful data and utilize it to make beneficial changes in the treatment process and the receiving stream long after the Department and its equipment have been removed.
- There is no charge for the Department's review of the treatment process, setup of all equipment, the process control monitoring that will take place, lending meters to the plant during the WPPE, data collection and explanation of potential effects that process modifications can have on the treatment process.
- The municipality will be responsible for providing laboratory bench space and 120 VAC power for the instrumentation. Any costs associated with process modifications (such as equipment upgrades, chemical purchases, etc.) that the municipality deems appropriate and beneficial as a result of the WPPE remain the responsibility of the municipality. The municipality reserves the right to cease participation in the WPPE at any time.
- Following the equipment set-up, the Department will observe the facilities and review operational practices, treatment processes, chemical treatment, operational data currently collected, and overall system performance.
- During the evaluation, the Department will review monitoring records, laboratory sheets, operations log sheets, and any drawings and specifications for the treatment facility. Also of interest is data currently collected and how it is utilized for daily process modifications. This information is usually available from existing reports.

Program evaluation team will consist of 1 to 2 people: Wastewater Optimization Program Specialists, PA licensed as a wastewater plant operators with operations and compliance assistance experience.

Potential Benefits

- Use of online process control monitoring equipment during the WPPE, use of hand held meters and portable lab equipment during the WPPE, and furthering the operators' knowledge of process control strategies and monitoring techniques,
- Producing a cleaner effluent discharge which minimizes impacts to the environment and downstream water users, and possible identification of process modifications that could result in real cost savings.
- Where the optimization goals may be more stringent than current requirements of your NPDES permit, they are completely voluntary. The WPPE objective is to optimize wastewater treatment plant performance in order to enhance surface water quality, minimizing the effects of pathogen and nutrient loading to downstream drinking water plant intakes.
- Furthermore, pursuit of a good rating in the WPPE program may place the wastewater system in a better position to meet more stringent regulatory requirements in the future, should they occur. For example, regulatory changes over the last ten years have reduced the final effluent Total Chlorine Residual limits requiring dechlorination or optimization of treatment processes to reduce the levels of chlorine added to the process for disinfection. Facilities who have voluntarily maintained lower residuals than listed in their permit have found it easier to comply with the updated regulations.

Potential Obstructions to Success

Many factors may present obstructions to a successful plant optimization. Some of these are listed below:

- Inadequate use or interpretation of regular process monitoring test results
- Inadequate funding of facility operating expenses, including staff training, chemical and energy usage, equipment maintenance
- Miscommunication as to program goals and methodologies
- Obsolete, inadequate, or out-dated treatment equipment and methods

Attachment B— WPPE Team

Shenango Township Municipal Authority-Wastewater Treatment Plant

WPPE Team

Robert DiGilarmo, Water Program Specialist
DEP – Ebensburg Office
286 Industrial Park Rd
Ebensubrg, PA 15931
814-472-1819
rdigilarmo@state.pa.us

Marc Neville, Water Program Specialist
DEP- RCSOB
400 Market St
Harrisburg, PA 17105-8467
717-772-4019
mneville@state.pa.us

Municipal wastewater plant representatives

Rich Deluca, Operator
Shenango Township Municipal Authority
P.O. Box 266
West Middlesex, PA 16159-0266

Bobby Gentile, Operator
Shenango Township Municipal Authority
P.O. Box 266
West Middlesex, PA 16159-0266

Mark Budanka, Laborer
Shenango Township Municipal Authority
P.O. Box 266
West Middlesex, PA 16159-0266

Attachment C— Plant Description and Treatment Schematic

Shenango is currently operated in an extended aeration treatment process utilizing oxidation ditches followed by clarification in boat clarifiers. The boat clarifiers are physically located in the oxidation ditches. A treatment schematic follows and features of the treatment system are identified below:

Headworks—The headworks include a raw wastewater wet well with submersible pumps and comminutor with backup manual bar screen. The comminutor does not remove debris but grinds it into smaller pieces and sends it through the treatment process possibly contributing to the settling/clogging issues in the boat clarifiers.

Aeration—There are two oxidation ditches, each with a capacity of 0.225 MG. Each unit has one rotor that provides air and mixing. The DO levels in these units were between 7.0 and 9.0 mg/L over the entire project. Traditional aeration calls for DO levels between 1.5 and 3.5 mg/L; the plant operations manual calls for DO levels between 2.0-2.5 mg/L. At present, there are two part time contract operators and a full time laborer who is actively involved and interested in becoming certified also.

Clarifiers—There are two intra-channel boat clarifiers located within the oxidation ditches. They do consume some of the physical capacity of the oxidation ditches since their volume reduces the capacity of the ditches to treat wastewater. Throughout the project the clarifiers were the limiting factor in the treatment process. There is a significant amount of time invested in keeping the ports clean on the clarifier bottoms. Each clarifier has 96 ports in its bottom which return sludge to the mixed liquor. The low solids levels required to keep the ports from clogging tend to hamper the efficiency of the treatment process; at least that was the case over the time of this project. The operators utilized several different methods to clean the clarifier including: power jetting, manual plunging, manual jetting, and draining and cleaning the entire clarifier and associated ditch.

Disinfection—The disinfection process is achieved utilizing chlorine gas in 100 lb cylinders. The chlorine contact tanks are drained and cleaned every two weeks, this procedure could probably be extended and not based on time but solids accumulation in the tanks themselves. The use of a “sludge judge” and establishment of action levels could trigger tank cleaning. The tanks drain back to the headworks and flow with influent through the plant. The low mixed liquor solids levels in the oxidation ditches appear to be hampered even more with the routine addition of the chlorinated water. These conclusions are based upon microscopic evaluation of the mixed liquor on several occasions that identified minimal biological activity, also supported by sampling results.

Discharge—Final effluent flows from disinfection through a Parshall flume to its discharge location at Outfall 001 on the Shenango River. It should be noted that the permitted discharge in the NPDES permit is an UNT to Shenango River but the headwall structure is built along the bank of the Shenango River proper.

Solids Handling—Solids are wasted from the intra-channel clarifiers to a sludge pit and pumped to one of two aerobic digesters. The digesters each have a capacity of 0.045 MG. Generally, the waste sludge is pumped to the eastern digester, thickened, transferred to the western digester and from there is pumped through the belt filter press. The final solids are conveyed to a dumpster and eventually hauled off site for landfill disposal. A mass balance calculation of solids at the plant indicated lower than expected solids removal based on a raw influent loading strength of 439 lbs/day (2010 average value). Solids removal during the months of March, and October through November would put the facility above the 85% range which is within the +/- 15% range expected from such a calculation. Attachment L outlines the calculation.

Performance Track Record: Past Performance—Prior to January 2010, the plant experienced several effluent violations, experienced several types of operational challenges, and had reported elevated influent flow readings that led to exceedances of permitted hydraulic loadings.

Current Performance—The facility regularly meets its effluent limitations established in its NPDES permit; the effluent limits are detailed in Attachment N. Throughout the project the operators worked at maintaining mixed liquor solids sufficient enough to achieve reduction of BOD but not nitrification. Ammonia levels were not reduced through the plant. Generally, oxidation ditch treatment is more than sufficient to achieve BOD reduction, nitrification, and depending on other parameters, denitrification is potentially possible. The bulk of this project was spent identifying sufficient mixed liquor levels sufficient to maximize treatment for permitted parameters. Figures G.1 and G.2 show DO, Ammonia, and MLSS levels; note the increase in MLSS utilized more DO, and reduced Ammonia levels in the wastewater. Conversely, fewer MLSS increased Ammonia levels in the wastewater.

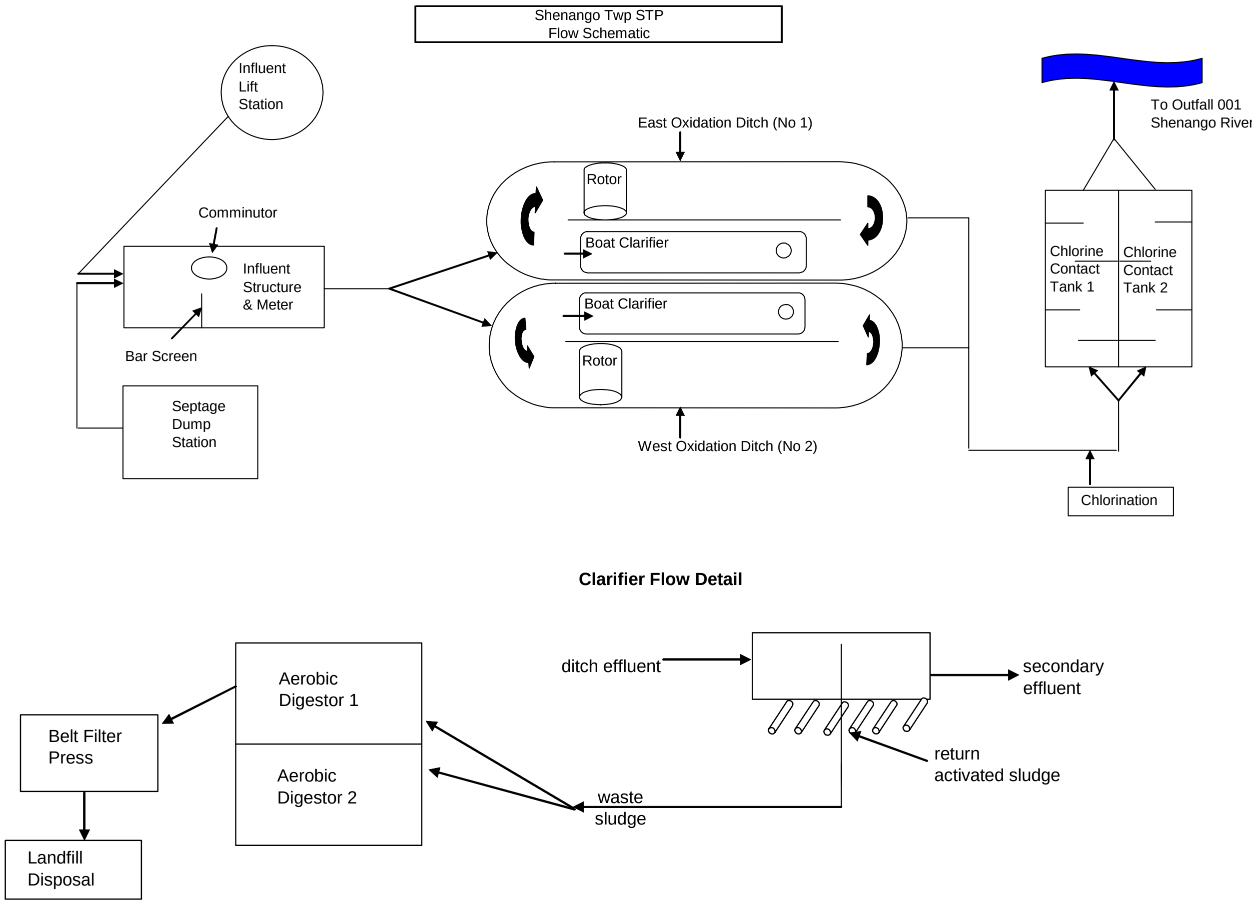


Figure C.1 Shenango wastewater treatment plant process flow schematic

Attachment D— 2011 Process Monitoring and Control

Equipment Deployment—During week of December 20, 2010, the Department deployed 8 in-line process monitoring probes to monitor the activated sludge treatment process. These included dissolved oxygen (DO), oxidation/reduction potential (ORP), pH probe, nitrate-nitrogen (NO3-N), ammonia-nitrogen (NH3-N), and mixed liquor suspended solids. Initially, the probes were installed the west oxidation ditch but were moved half way through the project to the east ditch.

The probes were installed and calibrated, then gave readings every fifteen minutes to a laboratory computer for the duration of the study. The purpose of these probes was to monitor the conditions and efficiency of the treatment process. The data generated allow operators to observe trends and the impacts of various process modifications throughout the treatment process over the course of the project. At times during the project the accumulation of solids on the north ORP probe and mixed liquor solids probe caused erroneous readings.

Laboratory Equipment—DEP staff deployed a portable wastewater lab for process monitoring, including: Centrifuge Solids inventory by Volume Percent, Settleometry for Sludge Volume Index (SVI) development, Microscopy with Digital Photography, and a Spectrophotometer for interpreting wet-chemistry tests for nutrients.

Sampling and Off-site Analyses—Weekly samples of the raw wastewater, final effluent, upstream (background) and downstream (impacted) waters were taken for analysis at our off-site laboratory, to characterize the plant operating conditions by assaying several wastewater treatment parameters. In addition, sampling and testing was performed on Mixed Liquor Suspended Solids. A table of test results for these samples follows in Attachment K.

Interpretation of Data—

Permit Modifications— Any modifications to the permitted treatment process may require an amendment to the Water Management Permit. If you are unsure whether a permit modification is necessary, please contact the DEP regional office that supports your wastewater facility prior to making any modifications.

Solids Management

The solids management and inventory control program is based primarily on ½ hour settleability tests performed on mixed liquor samples. Additionally, gravimetric tests should be performed at least once per week to correlate the settleability and centrifuge tests to actual suspended solids analysis. With these three pieces of information the operator can quickly identify the loadings on the treatment units allowing them to waste solids at the most opportune times.

The current practices include wasting solids based on settleability test results. Settleability testing alone does not give an accurate picture of the mass of solids present under aeration. While it can be effective, it best represents conditions present in the clarifier.

MLSS vs. Centrifuge Solids comparison charts were prepared for the operators use should they acquire a centrifuge, which is encouraged. Operators can use the attached charts to estimate

MLSS levels after performing a % solids test which should give a good indication of solids levels and help with deciding when to waste solids. These charts would need to be updated regularly to ensure changes in plant conditions are considered, especially seasonal considerations.

Tables D.1 and D.2, below, depict the mixed liquor suspended solids in relation to the respective centrifuge solids reading. By plotting the data and inserting a best fit line, one can use a centrifuge solids reading to effectively estimate the MLSS reading. Figures J.5 and J.6 graphically depict the MLSS / % solids relationship. To utilize the chart, find the % solids result along the x axis and draw a line vertically to the black line to find the approximate MLSS result.

While these MLSS results fluctuated over the project, more data points would increase the reliability of the predicted values. Using the chart below, the average of the centrifuge multiplier values for the east oxidation ditch is 939. Therefore, when performing MLSS centrifuge tests, multiplying the resultant % solids value by 939 will give a good approximation of the actual MLSS value for that sample. The data for the west oxidation ditch is more suspect and must certainly be validated with more data collection. Both charts should be updated with more data points and will vary seasonally. In addition, the values will not be representative if treatment should be impacted.

	2/3/11	2/10/11	1/26/11	1/20/11	2/17/11	1/13/11	1/5/11	
MLSS- E - Sample #	0331026	0331032	0331018	0331012	0331038	0331007	0331001	
MLSS-BOL	426	710	356	734	954	1448	1346	
Centrifuge	0.3	0.8	0.85	0.9	1	1.3	1.4	Avg.
MLSS/Cent solids ratio	99.93%	99.89%	99.76%	99.88%	99.90%	99.91%	99.90%	99.880%
Centrifuge # multiplier	1420	888	419	816	954	1114	961	939

Table D.1: MLSS vs. Centrifuge solids, East Oxidation Ditch

	1/13/11	1/5/11	1/20/11	1/26/11	2/10/11	2/17/11	
MLSS- W - Sample #	0331006	0331999	0331013	0331019	0331031	0331037	
MLSS-BOL	222	340	782	892	458	512	
Centrifuge	0.1	0.2	0.2	0.4	0.4	0.4	Avg.
MLSS/Cent solids ratio	99.95%	100%	99.97%	99.96%	99.91%	99.92%	99.943%
Centrifuge # multiplier	2220	1700	3910	2230	1145	1280	2081

Table D.2: MLSS vs. Centrifuge solids, West Oxidation Ditch

The ½ hour settleability test results were generally on the very low side near 100ml or less per 1000 ml. Supernatant in the samples was cloudy with pin floc present. The photographs below, taken on February 11, 2011, are representative of the mixed liquor during most sample events occurring during this project.

Figure D.1: ½ Hour settleability test results on February 11, 2011

Attachment J, figures J.7 and J.8 identify results of additional process control testing collected over the course of the WPPE.

SOUR/OUR testing—The procedure will tell you how fast the biomass or bugs are metabolizing the available materials in the wastewater. Oxygen uptake rate (OUR) and Specific oxygen uptake rate (SOUR or Respiration Rate) tests are a way to quickly monitor the toxicity or food value of sewage and wastewater to the living and breathing biomass within a wastewater treatment plant. These tests can show the rate at which oxygen is used by the bugs in the activated sludge system. They can indicate if the bugs are consuming the BOD at a normal rate; assuming several tests are done over time to establish a baseline for a particular facility. In general, plants with high MLSS levels will use more oxygen than those with lower MLSS levels. While the OUR test looks at oxygen consumption based on MLSS levels, the SOUR test looks at oxygen consumption based upon the living biomass and its ability to metabolize the wastewater. OUR testing measures milligrams of oxygen used by a liter of mixed liquor per hour and SOUR testing measures milligrams of oxygen used per hour by a gram of mixed liquor volatile suspended solids.

A SOUR less than 12 mgO2/hr/gm MLVSS can be indicative of endogenous respiration and can be accompanied by pin floc. A SOUR in the 12-20 range is usually indicative of a healthier biomass and improved settling. The SOUR rates at the facility changed dramatically over the course of the project, attributed to fluctuations in MLSS levels.

Food to Mass Ratio—The target F/M ratio for this facility is 0.1 according to the operations manual provided by the manufacturer. All samples collected from the west oxidation ditch were much higher than the recommended levels. Two samples from the east ditch were higher than recommended. Once a consistent influent loading is established then a target mixed liquor solids level can be calculated to maintain a consistent F/M ratio. Using 2010 DMR data for influent loadings of 439 lbs/day and a target F/M of 0.1, the desired mixed liquor volatile solids level would be 2347 mg/L in each oxidation ditch. This raw data included some elevated influent loadings numbers. According to influent loading data for June through December, the resulting desired mixed liquor volatile solids level would be 1481 mg/L. The influent loading data is most important is determining the necessary level of solids under aeration and confirms the need to have representative influent sampling data. Generally, MLVSS levels are 70% of MLSS levels;

at this facility the average MLVSS level was 80-86% of the MLSS level. If conducting only MLSS testing the target MLSS values would have to be adjusted based on the percent difference between the two parameters.

Microscopic Exam— During the WPPE, microscopic evaluation of the mixed liquor identified minimal biological lift in the form of protozoa. The operators should routinely perform microscopic examination of the mixed liquor to observe biomass conditions and look for the presence of indicator organisms. A microscope is present on site and with some practice the operators will be able to make a fast observation of the current mixed liquor quality.

Indicator organisms can be used to determine relative sludge age: More free swimming ciliates usually indicates a “young sludge”, while the presence of mostly rotifers and nematodes indicate “old sludge.” The presence of equal numbers of free swimming ciliates and stalked ciliates usually suggests a biomass that exhibits good Settleability and peak growth conditions for treating wastewater. As seen in the photographs below the east basin had a diverse population of biological life while the west basin was mostly void of biological activity.

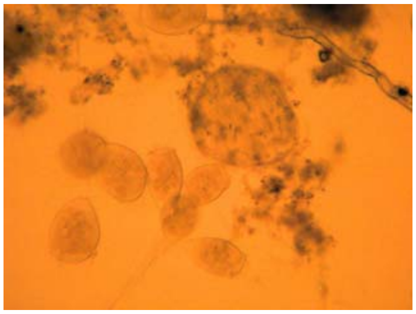


Figure D.2: Microscopic evaluation of east oxidation ditch

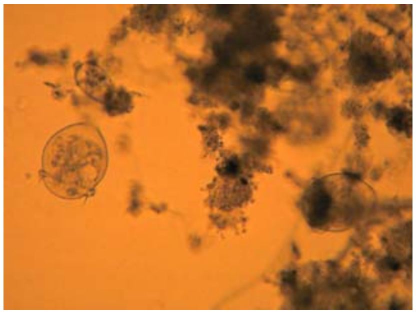


Figure D.3: Microscopic evaluation of east oxidation ditch

Hydraulic Retention Time—The HRT was generally in the 1.5 to 2.0 day range except when higher flows were present due to rainfall.

pH/Temperature—The average pH value of the project was 7.5 S.U., well within the desired range for nitrification to occur.

DO Findings—DO is usually well over 7.0 mg/L in the oxidation ditches. This is likely due to the low volume of mixed liquor solids and constant speed of the rotors. This could be corrected by increasing mixed liquor suspended solids and the modification of the relays controlling the rotor operation.

DO Grab Testing—DO was measured in each tank of the process, using a hand-held LDO probe. The purpose of this was to confirm readings measured by the in-line process monitoring probes.

Flow Measurement—Shenango utilizes influent and effluent flow monitoring in its operation. Due to internal recycle flows; effluent metering is used for reporting on Discharge Monitoring Reports as it is more representative of actual flows. Previously, influent flows were used and suggested that the flow to the plant was at or over hydraulic design. Those flows would have contained belt press filtrate, skimming water from the chlorine contact tanks, flow from cleaning out the contact tanks, and flows from draining of the oxidation ditches. At this facility, effluent metering is much more representative of actual flows than influent metering after the comminutor that includes internal recycle flows.

Method of Sludge Inventory Control—Weekly observations included Solids by volume, 30-minute Settleability, Sludge Volume Index,

eDMR—The facility records used in this report were obtained from data sent to DEP through the electronic DMR reporting system (eDMR) and records review at the DEP regional office and from on-site plant records. When submitting documents for eDMR reporting, all supporting documents required by the NPDES permit should be submitted along with the DMR form itself. These include supplemental forms, bio-solids forms, and other forms as required by the Department.

Pathogen Control—The Department studied the occurrence of waterborne pathogens, including Drinking Water Pathogens *Giardia lamblia* cyst and *Cryptosporidium* oocyst, in addition to fecal Coliform testing. While there was no definitive statistical correlation between facility optimization and waterborne pathogen reduction, the *Giardia* cyst values generally trend higher with increases in effluent suspended solids. There were no *Cryptosporidium* oocysts identified in any of the wastewater effluent sampling events.

Raw Influent Data—Current customer base includes: 11 businesses, 578 EDU's in Shenango Twp, and 772 EDU's in West Middlesex Borough. Just considering the EDU's: there are a total of 1350 EDU's. At 2.5 persons/EDU, this equates to 3375 persons connected to the collection system. Assuming 0.18 lbs BOD/day/person, the influent raw wastewater strength should be approximately 607 lbs/day. Current raw influent BOD loadings are much less this value; this is further reason supporting collecting raw influent composite samples from the raw influent entering the lift station before mixing with recycle flows.

Oxidation Reduction Potential—Also referred to as ORP, measures the ability of the wastewater to oxidize waste material. The following chart identifies select ranges of measurement.

ORP (mV)	Process	Electron Acceptors	Condition
> +100	1	O_2	Aerobic
≤ +100	2	NO_3	Anoxic
≥ -100	2	NO_3	Anoxic
< -100	3	SO_4	Anaerobic

1= Nitrification

2= De-Nitrification

3= Methane Formation

Table D.3: Oxidation Reduction Potential (ORP) ranges for bacterial activity

While the DO levels at Shenango were consistently above 7.5 mg/L to upwards of 10.0 mg/L, the ORP levels downstream of the rotors averaged about 200mV. While these levels are generally sufficient for nitrification to occur, the necessary biomass must be present to breakdown the contaminants in the wastewater. Data collected from previous projects imply that ORP levels should have been higher than 200 mV given the high DO levels; the suspected cause of the variation between expected values is due to the low solids levels in the oxidation ditches.

Attachment E— Equipment Deployed

Digital, Continuously Monitoring Probes

Laboratory Equipment On-Loan

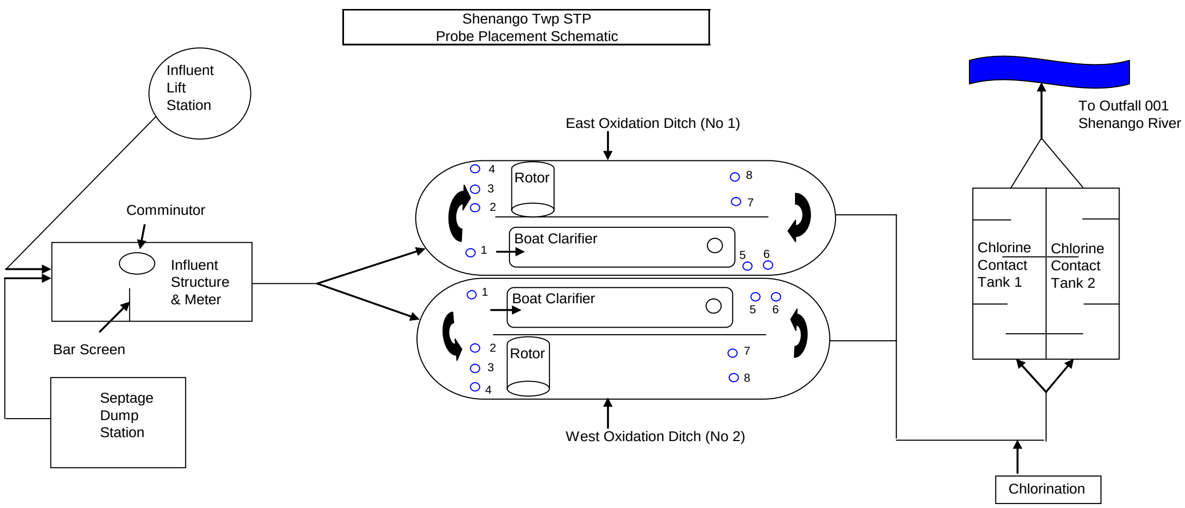
Digital, Continuously Monitoring Probes:

1 – Laptop computer with signal converter, 2 – SC1000s, 2 – LDO probes, 1– pH probe,

2 – ORP probes, 1 – NH_4D probe w/Cleaning System, 1 – Nitratax probes, 1 – Solitax probe

Laboratory Equipment On-loan:

1 – Hach HQ40d handheld pH and LDO meter 1 – LBOD probe 1 – DR2800 spectrophotometer 1 – Wastewater Field Test Kit 1 – Raven centrifuge 1 – Raven Core Taker sampler 2 – Raven settleometers 1 – COD Heater Block



Probe	
1	Ammonium
2	DO
3	Nitrate
4	ORP

Probe	
5	pH
6	MLSS
7	DO
8	ORP

Figure E.1 Locations of on-line process monitoring equipment

From the start of the project through January 26, 2011, the probes were mounted in the west oxidation ditch. On January 27, 2011 the probes were moved to the east ditch to facilitate cleaning of the west ditch; probes were maintained in the east ditch through the end of the project.

Attachment F—Equipment Placement Photos

Figure F.1: MLSS and pH probes, East Oxidation Ditch

Figure F.2: DO, ORP, and Nitrate probe placement

Figure F.3: Ammonium and Air Compressor, East Ditch

Figure F.4: SC1000 display of process monitoring data

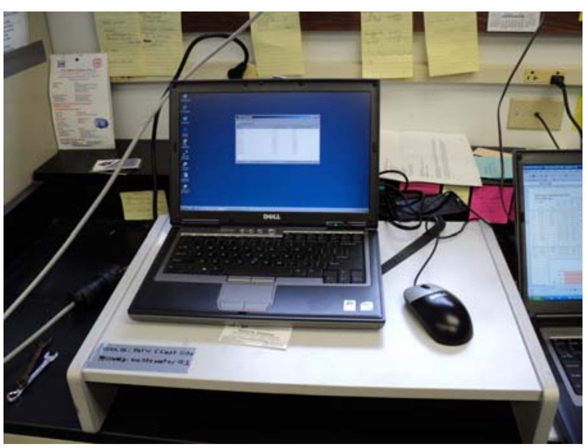


Figure F.5: Laboratory computer linked to SC1000 network

Figure F.6 WPPE process monitoring equipment

-

Figure F.7: Effluent flow meter and discharge flume

Figure F.8: Discharge end of boat clarifier

Figure F.9: Bottom of boat clarifier after draining; note return sludge ports

Attachment G— Continuous Digital Monitoring Charts

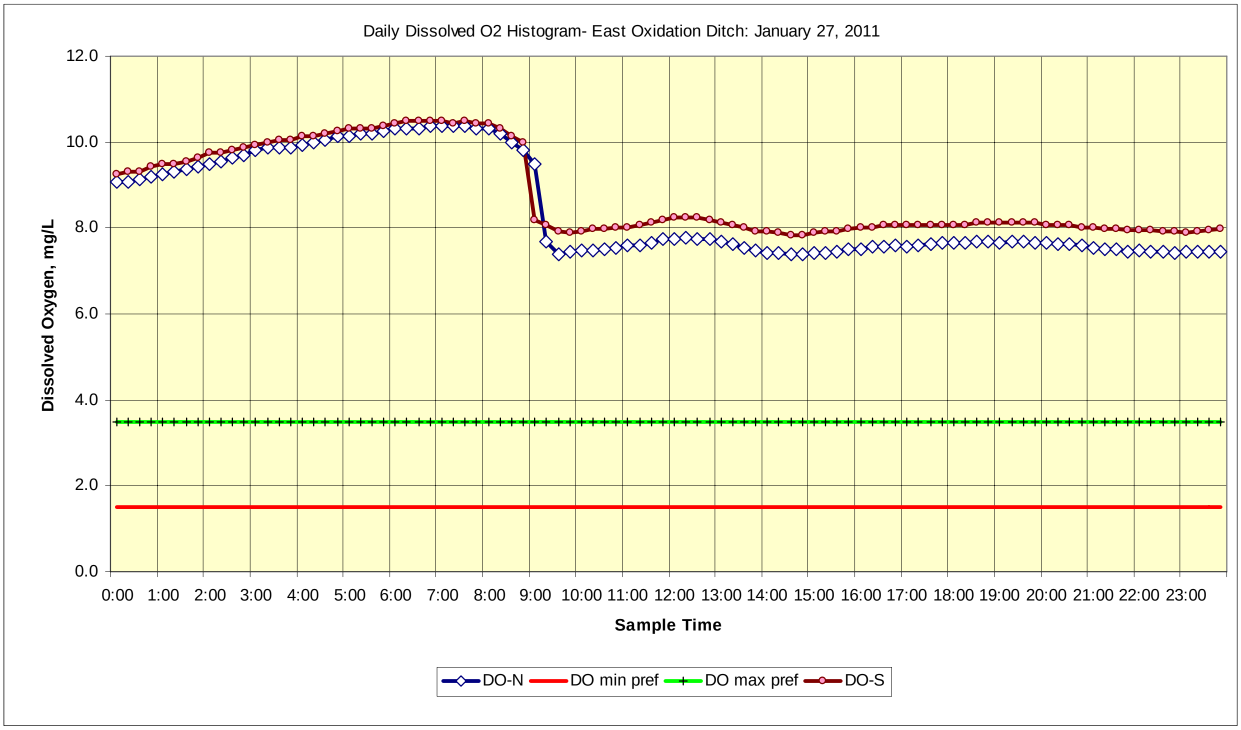


Figure G.1: Sample Dissolved Oxygen monitoring data, 24 hour period

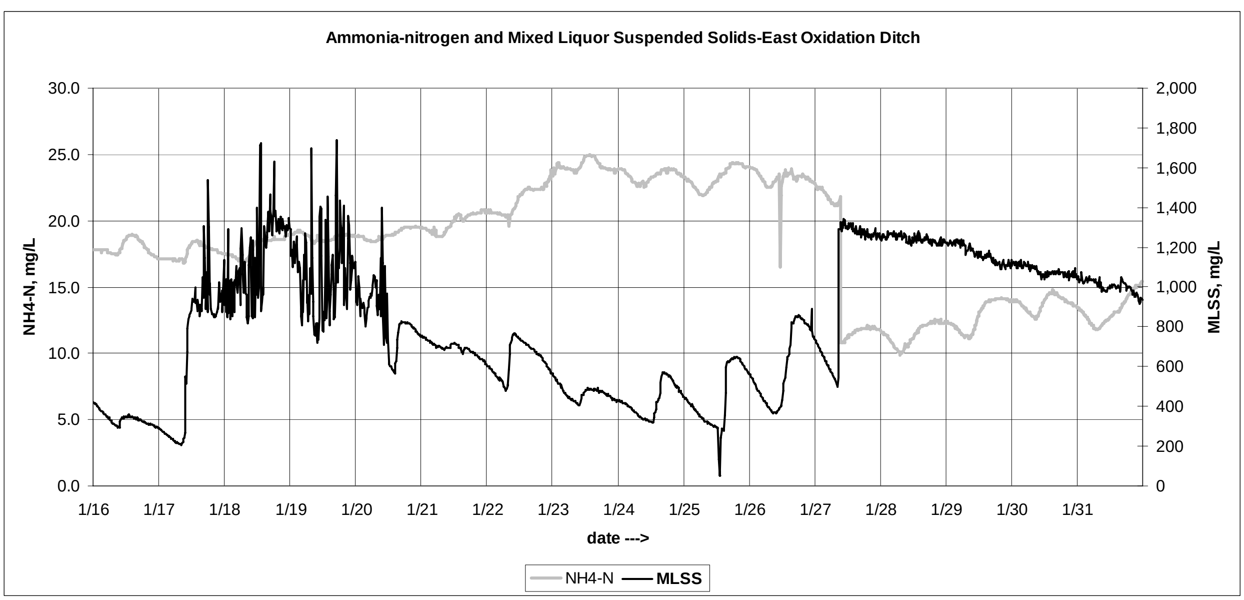


Figure G.2: Sample Ammonia, MLSS monitoring data, January 16 through January 31

Attachment H—Pathogen Test Results

(Method 1623 for ***Giardia lamblia*** cyst and ***Cryptosporidium*** oocyst)

Tests for drinking water pathogen cysts, using EPA Method 1623, were performed on 3 sets of 10-liter samples taken on three separate days. Sampling points were:

- Upstream/Background: Upstream of Outfall 001 for "background" purposes
- Effluent: Shenango final effluent at facility sampling point
- Downstream/Impacted: At the raw water tap for the PAWC-New Castle Water Filtration Plant.

Pathogen testing detected no *Cryptosporidium* oocysts during all sampling events except the January 13 upstream sampling which identified 2 colonies.

As the Department has found at other treatment facilities, *Giardia* cysts were more likely to be found in treated effluent than *Cryptosporidium*; however, the testing does not confirm whether the pathogens are capable of reproducing.

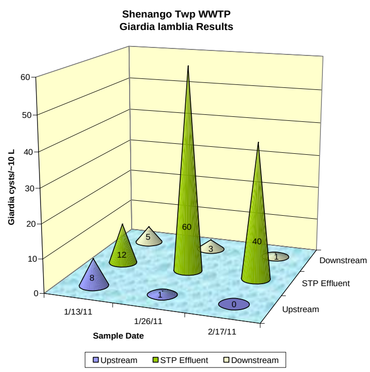


Figure H.1: *Giardia lamblia* cyst test results

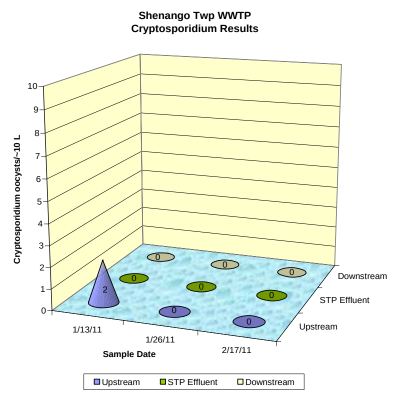


Figure H.2: *Cryptosporidium* oocysts test results

SAMPLE DATE	LOCATION	*GIARDIA*	CRYPTO
1/13	UPS	8	2
1/13	EFF	12	0
1/13	DWS	5	0
1/26	UPS	1	0
1/26	EFF	60	0
1/26	DWS	3	0
2/17	UPS	0	0
2/17	EFF	40	0
2/17	DWS	1	0

Table H.1: Summation of *Giardia*/*Cryptosporidium* Test Results

Attachment I—Process Monitoring Tests: Example WPPE Daily/Weekly Bench Data

Shenango Twp STP
Bench Sheet

Date: 2/11/2011 **Time:**

Lab Tech: DiGilarmo

Raw Wastewater (INF)		
COD		**mg/L**
Flow	0.206	**MGD**
Influent TSS	75.00	**mg/L**
Influent BOD	132.00	**mg/L**
West Flow	0.10	MGD
East Flow	0.10	MGD

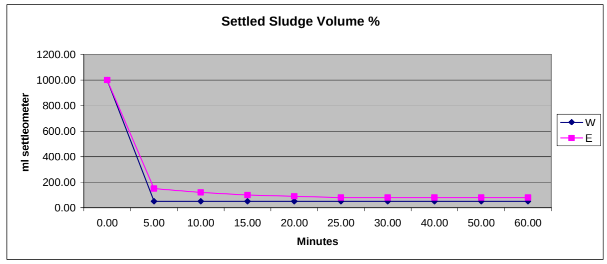
Loc	**W-Aer**	**W clar**			**E-Aer**	**E clar**		
Spin Solids	0.40				0.80			
Tank vol. (MGD)	0.225	0.016			0.225	0.016		

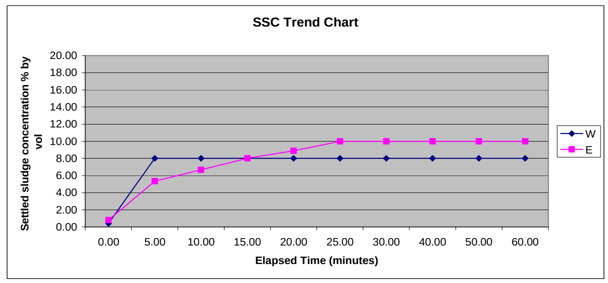
Location	**W-Aer**	**W-Aer**	**E-Aer**	**E-Aer**
Time	**SSV**	**SSC**	**SSV**	**SSC**
0.00	**1000.00**	0.40	**1000.00**	0.80
5.00	50.00	8.00	150.00	5.33
10.00	50.00	8.00	120.00	6.67
15.00	50.00	8.00	100.00	8.00
20.00	50.00	8.00	90.00	8.89
25.00	50.00	8.00	80.00	10.00
30.00	50.00	8.00	80.00	10.00
40.00	50.00	8.00	80.00	10.00
50.00	50.00	8.00	80.00	10.00
60.00	50.00	8.00	80.00	10.00

SSC=[(Spin%) x 1000] ÷ SSV

WCR=TSS ÷ Spin%

	W- Aer	**E-Aer**
TSS	458.00	710.00
WCR	1145.00	887.50
MLVSS	440.00	514.00
RAS solids		





	W-Aer		**E-Aer**	
SVI	109.17		112.68	
Sludge Age	13.34	days	20.68	days
HRT	52.43	hours	52.43	hours
F/M Ratio	0.14		0.12	

	W-Clar	**E-Clar**	
Surface overflow rate	114	114	gpd/sf
Loading rate			lbs/day/sf
HRT	3.82	3.82	hours

Notes:

Bench Tests	**INF**	**W- Aer**	**W-Aer**	**E-Aer**	**E-Aer**	**Effl**	**SC1000**	
Nitrate			0.96		1.38		0.00	
Phosphate-P								
Ammonia-N			0.139		7.520		19.100	
COD								
pH								
DO								
TRC								
Alkalinity								
Blanket Depth								
Temp°C			7.50		7.50			
TSS							1472.00	

clarifier surface area (each)= 900.00 sq ft
aeration (each ditch)= 0.2250 milion gallons
clarifier (each)= 0.0164 milion gallons
digester (each)= 0.0450 milion gallons

Figure I.1: Bench test results, operational test parameters

Shenango Twp STP
Bench Sheet

Date: 2/11/2011 **Time:**

Lab Tech: DiGilarmo

OUR Testing

Location: E- Aer

OUR = slope x 60

slope = 0.86 / 10

OUR = 0.86 / 10 x 60

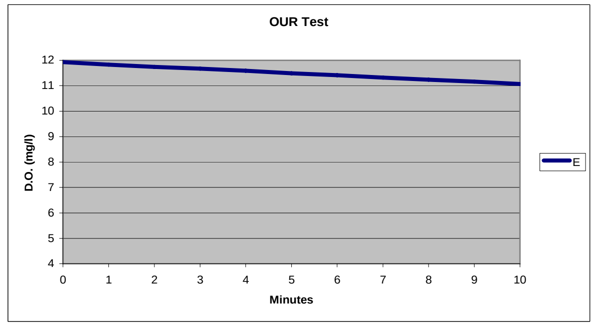
OUR = 5.16 mg O2/L-h

RR= (1000 x OUR) ÷ VSS

= 1000 / 514.00 x 5.16

RR = 10.04 mg O2/g-MLVSS-h

Time	D.O.
0	11.93
1	11.83
2	11.74
3	11.67
4	11.59
5	11.49
6	11.41
7	11.32
8	11.24
9	11.16
10	11.07



Location: W- Aer

OUR = slope x 60

slope = 0.51 / 10

OUR = 0.51 / 10 x 60

OUR = 3.06 mg O2/L-h

RR= (1000 x OUR) ÷ VSS

= 1000 / 440.00 x 3.06

RR = 6.95 mg O2/g-MLVSS-h

Time	D.O.
0	11.43
1	11.38
2	11.34
3	11.29
4	11.24
5	11.18
6	11.13
7	11.07
8	11.02
9	10.97
10	10.92

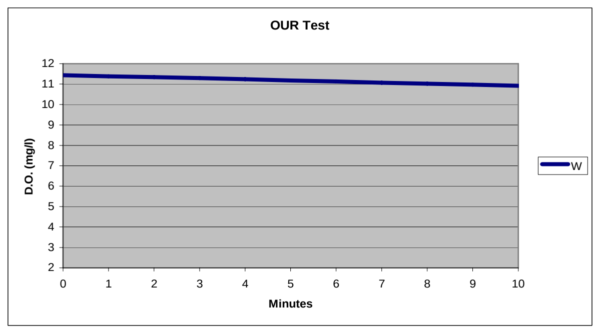


Figure I.2: **Bench test results, OUR / SOUR testing results**

Attachment J—Graphs: Process Monitoring Test Results

Shenango Township Municipal Authority STP

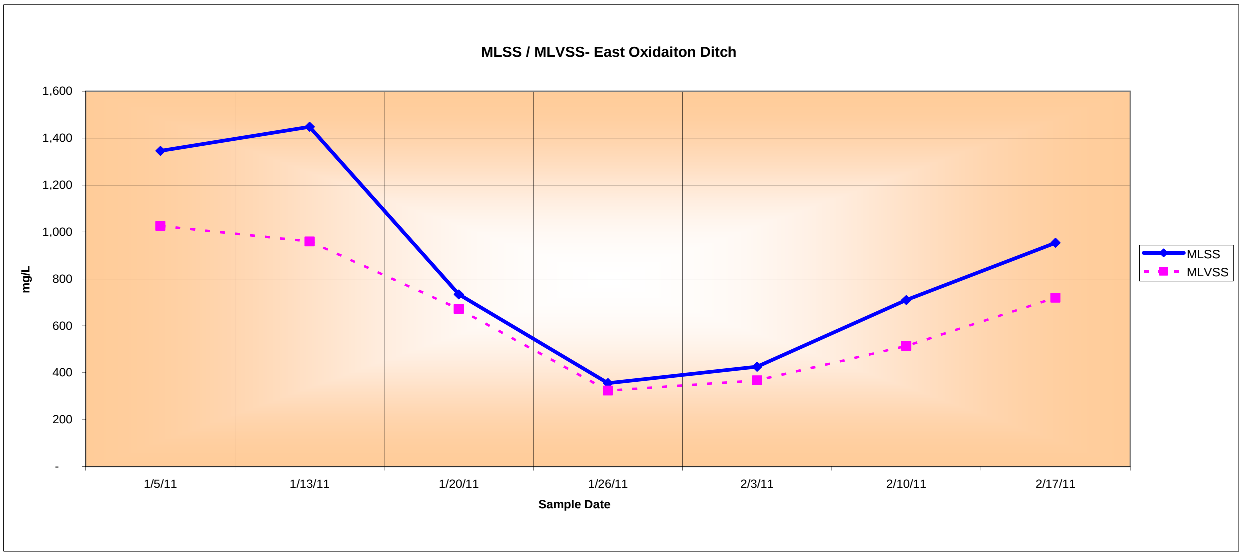


Figure J.1: East Oxidation ditch, MLSS and MLVSS

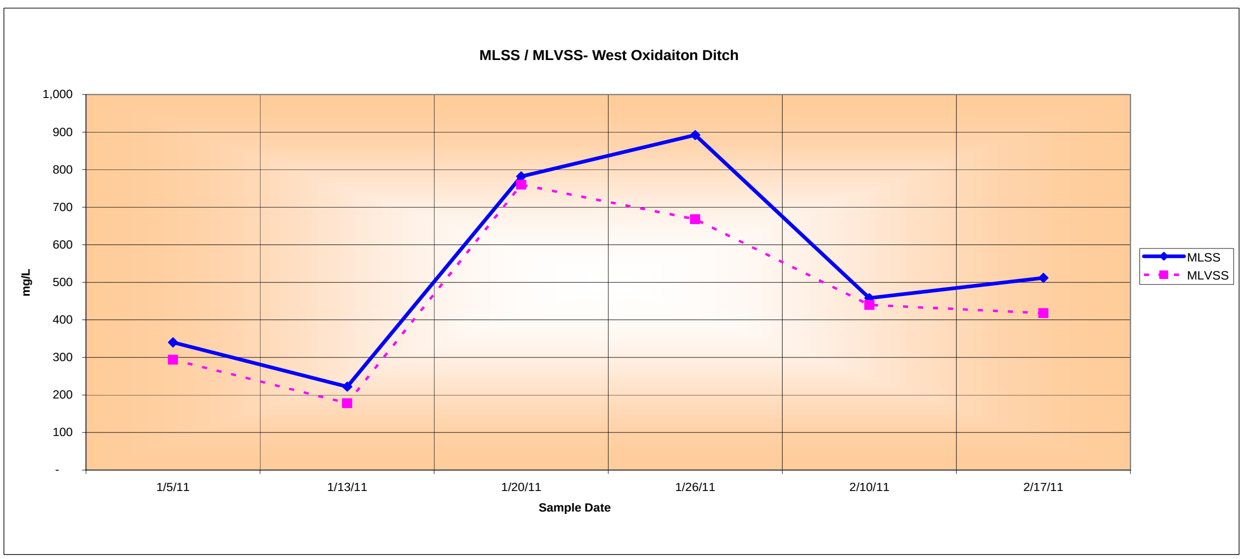


Figure J.2: West Oxidation ditch, MLSS and MLVSS

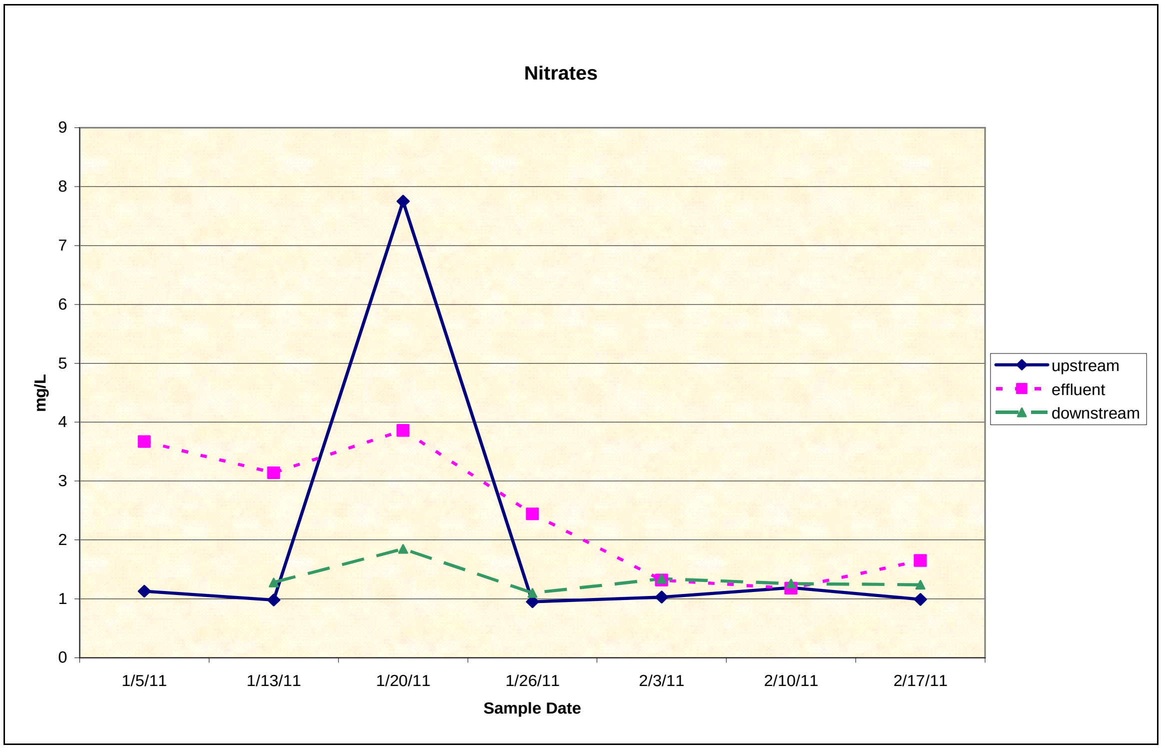


Figure J.3: Nitrate levels from DEP, BOL testing: upstream, effluent, and downstream samples

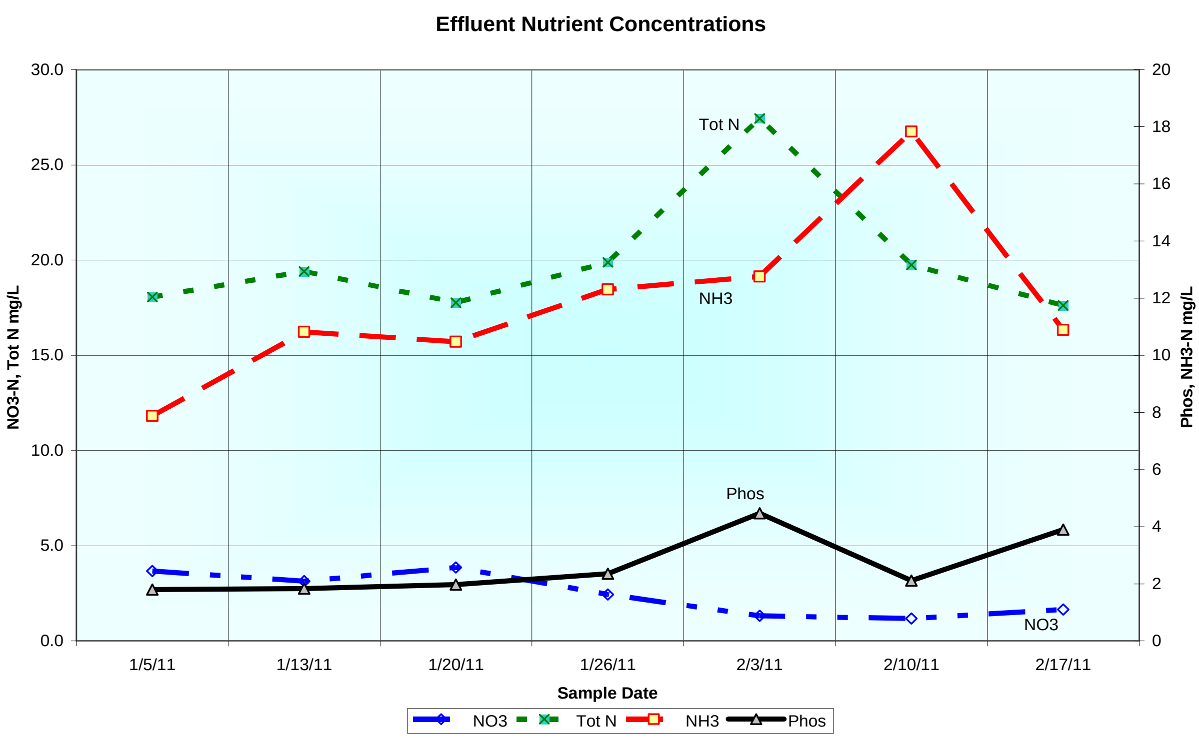


Figure J.4: Shenango effluent nutrient levels from DEP, BOL testing

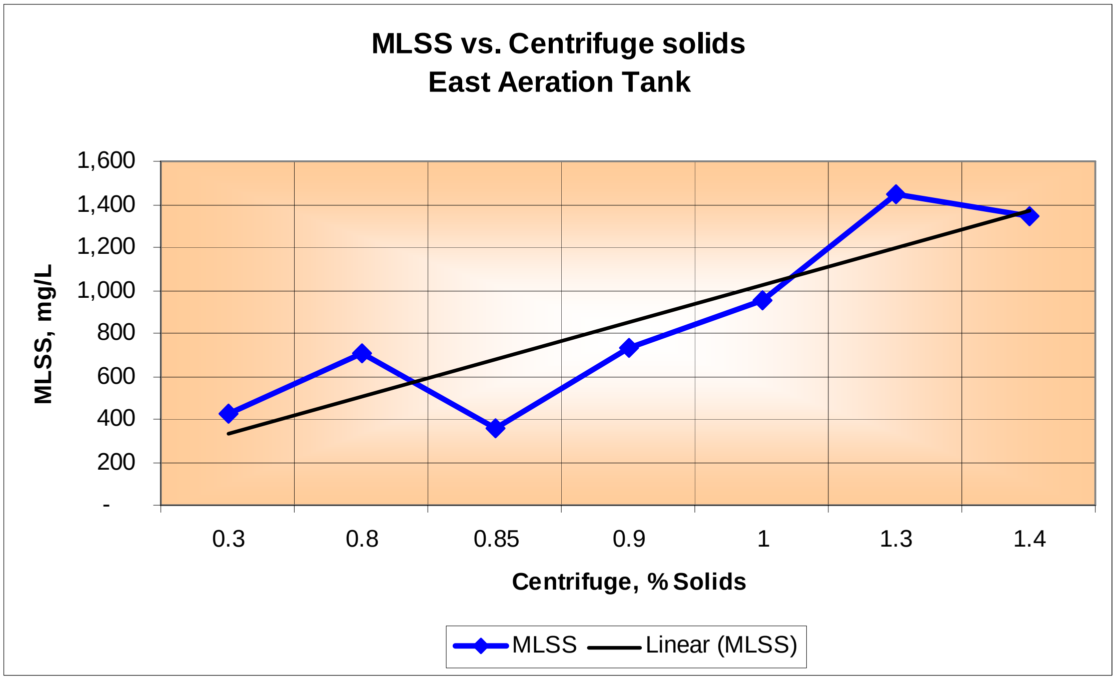


Figure J.5: MLSS vs. Centrifuge Solids process control chart, East Oxidation ditch

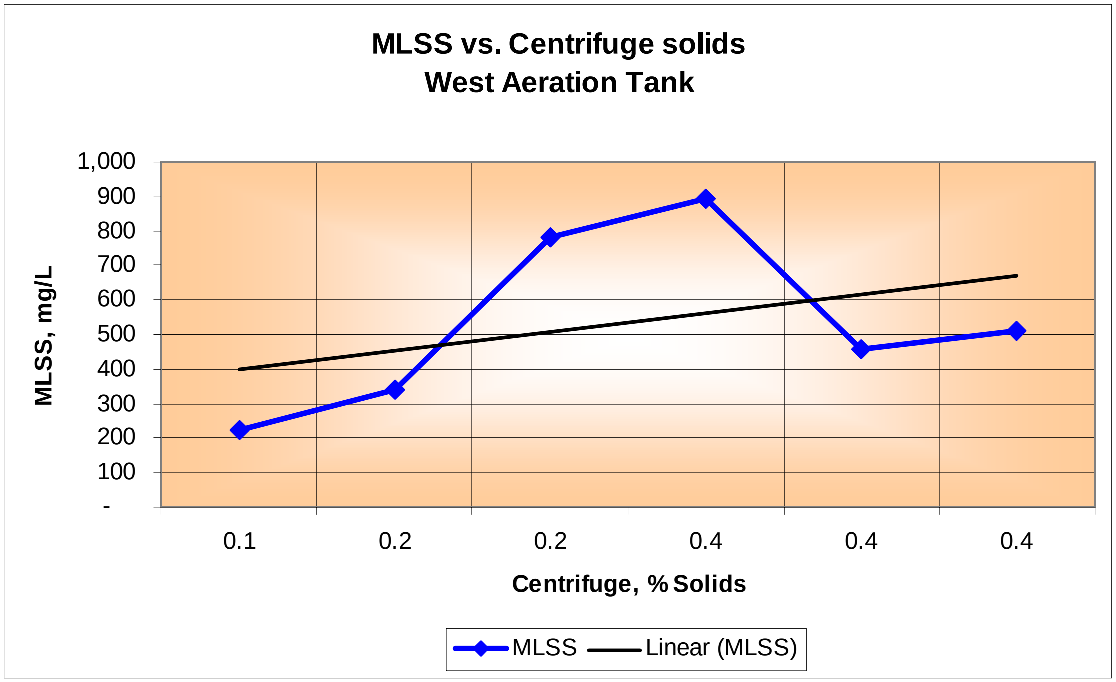


Figure J.6: MLSS vs. Centrifuge Solids process control chart, West Oxidation ditch

East Basin

Date	Flow	1/2 hr	MLSS	MLVSS	SVI	Sluge Age (days)	F/M	Cent	OUR	RR	Inf BOD	HRT (days)
1/4	0.163	160	1346	1026	119	26.17	0.06	1.4	7.56	7.37	78.8	1.38
1/5	0.13	180	1346	1026	134	32.29	0.05	1.4	8.76	8.54	78.8	1.7
1/13	0.11	170	1448	960	117	34.22	0.12	1.3	7.26	7.56	231	2.01
1/20	0.12	120	734	672	163	5.47	0.15	0.9	7.5	11.16	195	1.88
1/27	0.212	110	892	668	123	18	0.09	0.85			125	2.12
2/3	0.489	50	426	368	117	6.13	0.21	0.3	5.16	14.02	70.6	0.92
2/11	0.206	80	710	514	113	20.68	0.12	0.8	5.16	10.04	132	2.18
2/17	0.31	100	954	720	105	27.15	0.07	1	9.54	13.25	74	1.45

Figure J.7: East Basin process monitoring data

West Basin

Date	Flow	1/2 hr	MLSS	MLVSS	SVI	Sluge Age (days)	F/M	Cent	OUR	RR	Inf BOD	HRT (days)
1/4	0.16	50	340	294	147	6.6	0.19	0.3	3.36	11.43	78.8	1.38
1/5	0.13	40	340	294	118	8.16	0.16	0.2	3.42	11.63	78.8	1.7
1/13	0.11	30	222	178	135	5.25	0.65	0.1	2.94	16.52	231	2.01
1/20	0.12	40	782	760	51	5.83	0.14	0.2	3.42	4.5	195	1.88
1/27	0.212	60	356	324	168	7.2	0.18	0.43			125	2.12
2/11	0.206	50	458	440	109	13.34	0.14	0.4	3.06	6.95	132	2.18
2/17	0.31	50	512	418	98	14.57	0.12	0.4	5.46	13.06	74	1.45

Figure J.8: West Basin process monitoring data

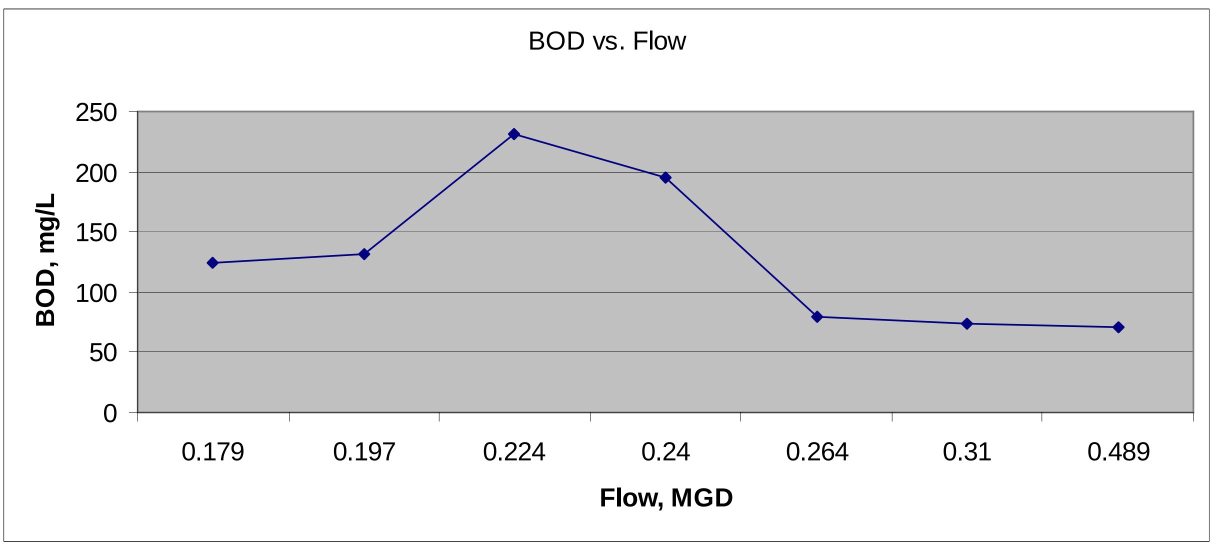


Figure J.9: BOD_5 vs. Flow during the WPPE project

Attachment K—Tables of Data from Bureau of Labs Testing

The following tables summarize all sample data collected during the WPPE.

Lab Resutls-Shenango Twp WWTP

	1/5/11	1/13/11	1/20/11	1/26/11	2/3/11	2/10/11	2/17/11	Avg.
Effluent-Sample #	0331996	0331003	0331009	0331015	0331022	0331028	0331034	
CBOD	26	11.7	12.4	22.9	148	28.3	33.9	40.5
TSS	73	26	22	35	228	54	56	70.6
Alkalinity	134	133.8	133.4	139.4	158.2	164.6	152	145.1
NO2-N	0.87	2.2	**0.01**	2.08	0.5	0.36	0.42	0.9
NO3-N	3.67	3.14	3.86	2.44	1.32	1.18	1.65	2.5
NH3-N	7.88	10.82	10.47	12.31	12.76	17.83	10.89	11.9
TKN	13.52	14.07	13.89	15.36	25.62	18.21	15.55	16.6
Phos	1.797	1.836	1.975	2.353	4.467	2.114	3.897	2.6
TOT N(TKN+NO3+NO2)	18.06	19.41	17.76	19.88	27.44	19.75	17.62	20.0
Fecal Coliform	1100	**20**		240	130000	**20**	8700	23346.7
Chloride	148.2	151.4	174.2	146.3	182.4	161.1		160.6
pH	7.7	7.7	7.6	7.6	7.5	7.8	7.7	7.7
Crypto		0		0			0	0.0
Giardia		12		60			40	37.3
STP Flow, MGD	0.264	0.224	0.24		0.489		0.31	0.3
TDS	504	486	534	506	534	542	510	516.6
Specific Conductivity	887	892	947	932	1026	1025	1035	963.4
Sulfate	53.6	50.5	53.71	53.66	50.02	54.34	51.7	52.5
STP Flow x 100	26.4	22.4	24	0	48.9	0	31	

Effluent crypto and giardia results may be compromised due to excessive sediment in sample

Upstream-Sample #	0331997	0331004	0331010	0331016	0331023	0331029	0331035	Avg.
BOD	2.4	2.3	1.4	2.4	1.8	2.3	8.1	3.0
TSS	16	21	7	13	7	12	37	16.1
Alkalinity	51.8	54.6	62.4	66.4	67.4	71.8	58.2	61.8
NO2-N	0.01	0.02	**0.01**	0.07	0.02	0.02	0.02	0.0
NO3-N	1.13	0.98	7.75	0.95	1.03	1.19	0.99	2.0
NH3-N	0.1	0.13	0.18	0.2	0.19	0.16	0.16	0.2
TKN	**1**	**1**	**1**	**1**	**1**	**1**	**1**	1.0
Phos	0.057	0.086	0.116	0.11	0.075	0.059	0.088	0.1
TOT N(TKN+NO3+NO2)	2.14	2	8.76	2.02	2.05	2.21	2.01	3.0
Fecal Coliform	200	90		60	20	**20**	220	101.7
Chloride	24.9	31.1	54.7	36.5	110.9	54.5		52.1
pH	7.5	7.6	7.7	7.7	7.7	7.7	7.7	7.7
Crypto		2		0			0	0.7
Giardia		8		1			0	3.0
Specific Conductivity	244	264	355	322	569	418	370	363.1
Sulfate	18.2	20.94	22.77	23.89	28.46	27.02	22.6	23.4
TDS	174	180	250	192	298	232	184	215.7

Downstream-Sample #	0331949	0331005	0331011	0331017	0331024	0331030	0331036	Avg.
BOD		2.4	0.9	1.1	2.1	1.6	2.4	1.8
TSS		7	7	**5**	7	10	7	7.2
Alkalinity		56.6	67.2	69.6	71.2	75.2	64.6	67.4
NO2-N		0.03	0.33	0.04	0.03	0.02	0.02	0.1
NO3-N		1.28	1.85	1.1	1.34	1.26	1.24	1.3
NH3-N		0.12	0.25	0.18	0.26	0.17	0.13	0.2
TKN		**1**	**1**	**1**	**1**	**1**	**1**	1.0
Phos		0.09	0.086	0.079	0.121	0.084	0.083	0.1
TOT N(TKN+NO3+NO2)		2.31	3.18	2.14	2.37	2.28	2.26	2.4
Fecal Coliform		20		880	80	20	360	272.0
Chloride		36.9	70.4	40.2	191.1	72.6		82.2
pH		7.6	7.7	7.6	7.8	7.8	7.8	7.7
Crypto		0		0			0	0.0
Giardia		5		3			1	3.0
Specific Conductivity		296	421	334	854	475	441	470.2
Sulfate		23.41	25.81	26.1	33.37	30.58	28.1	27.9
TDS		198	282	216	486	266	194	273.7

Bold values are "Less than", meaning belowing detection limit or method limit

Figure K.1: DEP, BOL testing results for effluent, upstream, and downstream sampling locations

Lab Resutls-Shenango Twp WWTP

	1/5/11	1/13/11	1/20/11	1/26/11	1/26/11	2/3/11	2/10/11	2/17/11	
MLSS- West - Sample #	0331999	0331006	0331013	0331019			0331031	0331037	Avg.
MLSS	340	222	782	892			458	512	534
MLVSS	294	178	760	668			440	418	460
MLSS/MLVSS ratio:	86.5%	80.2%	97.2%	74.9%			96.1%	81.6%	86.1%
Alkalinity	168.2	163.8	147.6	131.2			177	171.8	160
NH3-N								11.6	11.6
TKN								42.89	42.9
Phos								8.506	8.5
MLSS- East - Sample #	0331001	0331007	0331012	0331018		0331026	0331032	0331038	Avg.
MLSS	1346	1448	734	356		426	710	954	853
MLVSS	1026	960	672	324		368	514	720	655
MLSS/MLVSS ratio:	76.2%	66.3%	91.6%	91.0%		86.4%	72.4%	75.5%	79.9%
Alkalinity	156.2	130.2	171.4	176.6		156.2	180	178.4	164
NH3-N						11.5		10.49	11.0
TKN								73.15	73.2
Phos								14.311	14.3

				1/26/2011 Raw Infl lift station	1/26/2011 Raw Infl after comminutor				
Influent -Sample #	0331995	0331001	0331008	0331014	0331020	0331021	0331027	0331033	Avg.
BOD	78.8	231	195	125	102	70.6	132	74	126
COD	63.6	64.9	251.6	175.9	185.4	162.6	262.4	67.8	154
BOD/COD ratio:	81%	28%	129%	141%	182%	230%	199%	92%	1
TSS	71	85	166	105	93	64	75	51	89
Alkalinity	159	139.2	159	142.6	142.4	132.4	134.6	121.2	141
NO2-N	0.13	0.09	***0.01***	0.06	0.5	0.1	0.08	0.09	0
NO3-N	1.43	0.75	0.42	0.73	1.74	1.16	0.75	1.33	1
NH3-N	8.4	9.78	11.42	9.49	10.1	7.18	7.54	10.19	9
TKN	19.95	23.46	28.69	21.54	20.68	14.61	16.44	14.86	20
Phos	2.129	2.923	7.24	2.585	2.908	1.497	2.328	1.607	3
TOT N	21.51	24.3	29.12	22.33	22.92	15.87	17.27	16.28	21
Chloride	121.3	84.9	140.4	98	112.2	246.1	99.6	149.8	132
pH	7.7	7.7	7.5	7.7	7.7	7.6	7.6	7.6	8
STP Flow, MGD	0.264	0.224	0.24	0.179	0.179	0.489	0.197	0.31	0

Bold/Italics values are "Less than", meaning belowing detection limit or method limit

Figure K.2: DEP, BOL testing results for influent, East ditch, and West ditch locations

Attachment L—Biosolids production worksheet

Shenango Township Municipal Authority STP

Date: **2010 DMRs**

Plant Name: **Shenango Twp STP**

Design Flow: **0.509**

Design Loading: **775**

Avg Daily Flow

Months	Actual Sludge Disposed
Jan	0.225
Feb	3.84
Mar	0
Apr	4.23
May	3.93
Jun	2.198
Jul	1.72
Aug	2
Sep	2.41
Oct	0
Nov	0
Dec	0
0	20.553
x	2000lbs/ ton
	41,106.00
	actual lbs removed

BOD mass removed by STP

influent pounds BOD/day		439	lbs/day	*from plant data*
effluent pounds BOD/day	–	16.4	lbs/day	*from DMRs*
BOD mass removed by STP	=	422.6	lbs/day	

pre-digestion sludge mass produced by STP

BOD mass removed by STP		422.6	lbs/day
sludge production factor *	x	0.65	
pre-digested sludge mass	=	274.69	lbs/day

** sludge production factors*

- extended aeration = .65
- oxidation ditches = .65
- conventional activated sludge = .85
- contact stabilization = 1.0

post-digestion sludge mass produced by STP **

***calculate only if plant has a digestor*

pre-digestion sludge mass		274.69	lbs/day
% of pre-digestion solids remaining	x	0.65	
post-digested sludge mass	=	178.5485	lbs/day

solids reduction in digestors

- 0 days (no digestor)= 1
- 10 days = .9
- 15 days = .8 **default value**
- 20 days = .7
- \>30 days = .65

estimated amount of sludge to be removed

sludge mass (pre or post)		178.5485	lbs/day
days per year	x	365	days/yr
estimated sludge mass for disposal	=	65,170.20	lbs/yr

percentage of sludge mass for disposal

actual		41,106.00	lbs
estimated	/	65,170.20	lbs
		0.63074839	
	x	100	%
		63.07484	%

Sludge Removal Percentage

Figure L.1 Shenango Township Municipal Authority Sludge Volume Calculation

Attachment M—NPDES Effluent Discharge Limits

Shenango Township Municipal Authority STP

Discharge Parameter	Effluent Limitations				
	Mass Units (lbs/day)		Concentrations (mg/L)		
	Monthly Average	Weekly Average	Average Monthly	Average Weekly	Instantaneous Maximum
$CBOD_5$	106	168.8	25	40	50
Total Suspended Solids	127.4	191	30	45	60
Total Residual Chlorine			.5		1.6
pH	From 6.0 to 9.0 inclusive				
Fecal Coliform					
5/1 - 9/30	200/100 ml as a geometric average, not greater than 1,000/100 ml in more than 10% of the samples tested				
10/1 - 4/30	2000/100 ml as a geometric average				

Table M.1. Shenango Township Municipal Authority NPDES effluent limitations