WASTEWATER PLANT PERFORMANCE EVALUATION

August 6 – October 4, 2009

Ephrata Borough Authority

Ephrata No. 2
Water Pollution Control Facility

NPDES #PA0087181

Bureau of Water Standards & Facility Regulation
POTW Optimization Program

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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1. Executive Summary

The Pennsylvania Department of Environmental Protection conducted a Wastewater Plant Performance Evaluation (WPPE) of the Ephrata Wastewater Treatment Plant Number 2's (Ephrata 2) treatment facility, NPDES # PA-0087181, located at 43 Springhouse Road, Ephrata Township, Lancaster County, from August through September of 2009, at the invitation of Mr. Steven Bonner, following a site visit on July 9, 2009. 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 at drinking water intakes directly downstream of the subject facility, with an overall goal of improving surface water quality.

The optimization program has four goals:

- Evaluate existing practices and promote voluntary improvements that produce better effluent quality than is required by the system's National Pollutant Discharge Elimination System (NPDES) permit;
- Employ non-capital process modifications to increase treatment efficiency and nutrient reduction;
- Reduce energy consumption; and,
- Optimize operation for reduction of wastewater pathogens.

The WPPE was performed by Robert DiGilarmo and Marc Neville of PA DEP's Operations Monitoring and Training Division, Bureau of Water Standards and Facility Regulation. 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 the number of parasitic wastewater pathogens *Cryptosporidium* oocyst and *Giardia lamblia* cyst in the finished effluent. This is of major concern because a Water Works is located 1.7 stream miles downstream on Cocalico Creek, a major county waterway that drains fifty-five square miles.

The following items summarize some of the Operational Strengths identified during the WPPE:

- Plant operations appear to be optimal with solids levels at approximately 1,800-2,200 mg/l during the late summer months, while loading typically averages 233 mg/L BOD5 or 1,780 pounds per day at roughly 1 MGD average flow;
- Dissolved Oxygen concentrations are maintained at or near maximum 3.5 mg/L in the ditches and seldom deviate higher, as recommended to avoid wasting energy. Any DO level above 3.5 to 4.0 mg/L essentially represents wasted energy, because the biological activity required to treat sewage occurs at lower DO concentrations. It is optimal to maintain DO levels at least 1.5 to 2.0 mg/L during the aeration phase to ensure that nitrification is occurring in the aeration tanks and limit excursions above 3.5 to 4.0 mg/L;
- The facility has an inherently flexible operation, readily able to switch among varying phases of operation and allowing staff to react quickly to changes in daily flow and loading.
- Staff closely monitor the waste treatment process to reduce effluent nutrients discharged to a receiving stream that is used as a public water supply within a mile downstream.
- Machinery and service areas are well-maintained and orderly.

The following items have been identified as Optimization Focus Points. Operators should review the focus points and are encouraged to incorporate them into their daily operating procedures when feasible. While some of these items will require more of the operator's time to perform the outcome is expected to be favorable by improving the plants discharge quality and thereby improving downstream water quality.

- Consider using ORP probe in addition to DO probe to evaluate nitrification/denitrification in the SCADA system that runs the Phased Isolation Ditches (PID);
- For additional fine tuning of the duration of cycles, consider adding ammonia and nitrate probes to the PID;
- Save laboratory time by adopting the EPA-approved pre-measured test kits similar to those we demonstrated for determining ammonia nitrogen on the bench;
- Experiment with ferrous chloride dosing points in the side stream flows from solids dewatering, to optimize chemical use for phosphorus reduction when biological operations seem not to be operating efficiently;
- Continue cross training personnel in operation of the biological treatment system;
- Notify downstream water works personnel to be alert for increased crypto and *Giardia* cyst concentrations when the region experiences significant rainfall following extended dry periods, for the initial flush of the collection system may result in higher cyst concentrations;
- Work with water works personnel to reduce pathogen contamination of Cocalico Creek by encouraging upstream agricultural users to build stream bank erosion controls and to keep cattle out of the creek, especially during drier periods of the year;
- Chemical treatment for phosphorus is necessary when centrate and filtrate from the solids dewatering processes are reintroduced to the wastewater treatment system. The facility is equipped with more than one chemical dosing point, but we feel that when ferrous chloride is used, it should be added closer to the generation sources than at the anoxic selector or at points further downstream. Therefore, consider introducing ferrous chloride to the centrate and filtrate in a tank or pipeline static mixer in the solids handling building rather than out in the activated sludge process.
- Consider ongoing upgrades to the SCADA system, to reap benefits of technological improvements since the initial installation;
- Use eDMR for routine discharge monitor reports;
- As long as the facility remains underutilized due to lack of continued economic development in the region, consider using excess plant capacity for hauled-in wastewater, to generate additional revenue for the Borough or the Authority, provided that a program is developed to test such wastes and assure they will not negatively impact plant performance;
- Address seasonal trends with nutrient removal by adjusting chemical treatment when biological treatment becomes less efficient during the winter;
- Establish optimization goals for the coming year(s), based on past performance data and reasonable expectations of expense and difficulty.

2. Background

The Pennsylvania Department of Environmental Protection (PADEP) has recently undertaken a project in its Bureau of Water Standards and Facility Regulation (BWSFR) to improve the quality of surface waters withdrawn by Drinking Water Filtration Plants (DWFP) through optimization of sewage treatment at Publicly Operated Treatment Works (POTW) upstream of DWFP intakes. A primary goal of this project is to reduce pathogens and nutrients in the effluent from the wastewater treatment plant. BWSFR's optimization program is called the Wastewater Plant Performance Evaluation (WPPE) and is modeled on PA DEP's successful program for drinking water filtration plants that has been operating for the past twenty plus years, the Filter Plant Performance Evaluation (FPPE) program. The WPPE program is more fully discussed in Attachment A.

Process Optimization Goals:

A principal part of the WPPE program is to encourage facility owners to voluntarily set and meet stricter standards than those imposed by the NPDES system. It is akin to a private company setting production goals for a business cycle, then working to achieve that goal. In the case of process optimization, surface water quality improves as a result of reduced loading from the permit holder, and the facility benefits through increased treatment efficiencies, finding it easier to meet more stringent regulatory requirements should they eventually be imposed by federal regulatory agencies. In this regard, the WPPE program often suggests ways to set improvement goals and establish them as part of business strategy.

For example, a facility may choose to reduce its annual total phosphorus (TP) loading by ten percent of its permitted annual total. This could be done by setting monthly concentration goals or by setting quarterly loading goals that will achieve an overall reduction by year's end. A ten percent reduction of phosphorus by concentration would mean achieving a monthly concentration average of 1.8 mg/L instead of a permit-required 2.0 mg/L; in a highly efficient facility already performing well within its permit limits, operators may choose to meet a self-imposed concentration limit that is ten percent below their annual average concentration;

--e.g.: Permit, 2.0 mg/L; Annual Average Year-1, 1.6 mg/L; optimization goal, 1.44 mg/L

In POTW Optimization, the Department does not suggest what the goals of the permittee should be; rather, the permittee sets its own goals and then strives to achieve them. Since the process is voluntary, there are no adverse consequences for failing to meet these goals, only perhaps that goals can be tailored to the realistic expectations of the permittee. A facility that had posted two or three noncompliances during the previous year may choose to set as its goal a reduction of noncompliances in the following year, through process optimization or through a specific type of process monitoring and control.

Ephrata Borough Wastewater Treatment Plant No. 2:

Ephrata Borough's Wastewater Treatment Plant No. 2 (Ephrata 2,) NPDES Permit Number PA0087181, is a Bio-Denipho mode phased isolation ditch (PID) process employing a three-stage anaerobic selector and consisting of two carousel ditches currently linked for in-series operation, followed by two secondary clarifiers and two chlorine contact tanks. The facility discharges effluent to Outfall 001A at Cocalico Creek, a warm-water fishery and potable water supply in watershed 7-J. The nearest withdrawal point for potable water use is the Ephrata

Borough Water Works, located approximately 1.7 miles downstream of the Ephrata 2 point-source discharge. Due to the proximity of the discharge and intake this wastewater plant was selected to participate in a Wastewater Plant Performance Evaluation.

The facility's headworks employ automatic fine screening and grit removal, with removed solids material going to landfill. The biosolids treatment train consists of an autothermal thermophilic aerobic digestion system (ATAD,) augmented by rotary-drum thickening and a 2-meter belt/filter press for dewatering. Biosolids thus produced are employed in agricultural recycling at permitted sites. The entire facility is monitored and controlled through use of a Supervisory Control and Data Acquisition (SCADA) system. Through its modern design and technology, the facility is able to remove organic waste (BOD), ammonia nitrogen, nitrates, and phosphorus through biological selection. An inorganic phosphorus reduction system employing ferrous chloride serves as a backup system for ensuring phosphorus removal. Storm water from the Ephrata 2 site is discharged to an on-site detention pond where it percolates back into the water table. This pond is generally dry and grassy most times of the year.

Ephrata 2 has a design flow of 2.3 MGD average daily flow and an organic design capacity of 7,300 pounds per day of BOD. Its peak daily flow is rated at 3.5 MGD, and for the past year, the average daily flow was 1.011 MGD with a range of 0.665 to 3.554 MGD. Organic loading in 2009 averaged 4,787 pounds of BOD per day with a maximum daily load of 2,671 pounds. These flows and loadings are well within the design parameters of the facility, and no overloading is projected for several years.[1]

Ephrata 2's National Pollutant Discharge Elimination System (NPDES) permit lists concentration and loading limits. Nutrient loading limits have been established for the Ephrata 2 facility because of the Chesapeake Bay Initiative that requires all point-source discharges within the bay's drainage area to manage nutrient releases. Ephrata 2 is required to discharge no more than 54,550 pounds per year of Total Nitrogen (TN) and 6,818 pounds per year of Total Phosphorus (TP) to Cocalico Creek, a tributary of the Conestoga River that is part of the larger Chesapeake Bay drainage basin via the Susquehanna River. Table 2.1, below, lists the NPDES Effluent Discharge Concentration and Chesapeake Loading Limits for Ephrata 2:

[1] Source: 2009 Waste Management Report for Wastewater Treatment Facility #2, Ephrata Borough Authority, 124 South State St., Ephrata Borough, PA 17522, January 2010.

Parameter	Average Monthly (mg/l)	Average Weekly (mg/l)	Instantaneous Maximum (mg/l)
$CBOD_5$	25	40	50
Total Suspended Solids	30	45	60
NH_3-N (5-1 to 10-31) (11-1 to 4-30)	 4.0 12	 - -	 8.0 24
Total Residual Chlorine	0.48	-	1.6
Total Phosphorus	2.0	-	4.0
Dissolved Oxygen	Minimum of 5.0 at all times		
pH	From 6.0 to 9.0 inclusive		
Fecal Coliform (5-1 to 9-30) (10-1 to 4-30)	 200/100 ml as a geometric average 2,000/100 ml as a geometric average		

Chesapeake Bay Requirements			
	Concentration (mg/L)	Mass (lbs)	
	Monthly Average	Monthly	Annual
Ammonia---N	Report	Report	Report
Kjeldahl---N	Report	Report	XXX
Nitrate-Nitrite as N	Report	Report	XXX
Total Nitrogen	Report	Report	Report
Total Phosphorus	Report	Report	Report
Net Total Nitrogen	XXX	Report	54,550*
Net Total Phosphorus	XXX	Report	6,818*

Table 2.1: NPDES Effluent Concentration & Chesapeake Loading Limits for Ephrata 2, permit no. PA 0087181.

	Mass Units (lbs. day)	
Discharge Parameter	**Monthly Average**	**Weekly Average**
Total Suspended Solids	575	863
CBOD (5/1 to 10/31)	480	737
NH3-N (5/1 to 10/31)	77	xxx
NH3-N (11/1 to 4/30)	230	xxx
Total Phosphorus	38	xxx

Table 2.2: NPDES Effluent Loading Limits for Ephrata 2, permit no. PA 0087181.

Table 2.2, above lists the NPDES effluent loading limits for the facility. As seen there, the nutrient limits change over the course of the year, because treatment efficiency is temperature-dependent, and in winter, it is difficult for many facilities to maintain the temperatures required for nitrification to take place.

The service area includes several municipalities, including Ephrata Township, where the treatment facility is located, parts of Ephrata Borough, Denver Borough, and parts of East

Cocalico Township, all in Lancaster County, and the waste stream is comprised of domestic sewage and industrial discharges. According to the 2009 Waste Management Report, there are approximately 4,688 sewer connections. Each of the contributing municipalities has adopted sewer use ordinances based on those of Ephrata Borough, including its industrial pretreatment program. A depiction of the service area is shown as a Sewer Index Map, Figure 2.2, on page 7.

On-site Process Monitoring

DEP contacted Stephen Bonner of the Ephrata Borough Authority with a request to deploy and operate the instrumentation at the Ephrata Borough Wastewater Treatment Plant Number 2 (Ephrata 2) for a period of two months in order to assess current plant operations and provide the operators with process monitoring data for use in making process modifications that improve effluent quality and downstream surface water quality at the Borough water works drinking water intake. DEP staff later met with Mr. Bonner and the Chief Operator, John Keller, and his staff, to discuss the program. DEP staff chose Ephrata 2 for this project because of the facility's superb operations record and to see if it is possible to increase the treatment efficiency of already-highly functioning plants through the use of additional instrumentation. In particular, the Bio-Denipho process, which involves six phases of alternating oxic and anoxic environments to promote nutrient reduction, can be optimized through the use of ammonium, nitrate, and oxidation/reduction potential (ORP) probes to adjust the phases and cycles of treatment in the oxidation ditches. Bio-Denipho is a modification of Bio-Denitro phased isolation ditch (PID) technology whereby accumulation of certain bacteria within an anoxic selector upstream of the oxidation ditches can be manipulated into biologically absorbing phosphorus in order to remove it from water. Several variations of PID technology exist, each an adaptation of an earlier process in order to eliminate some additional inhibiting constraint to treatment effectiveness.

DEP employed a trailer, seen in figure 2.1, rented from Hach Company, containing up to nineteen in-line probes installed within the secondary treatment processes. In addition, DEP brought instruments and test kits to the facility's laboratory for use during the evaluation and made these available for the plant operators during the WPPE. This equipment supplements the in-line continuous monitoring and provides operators with the opportunity to utilize test equipment that is essential to making process control adjustments. Ephrata 2 already hosts a Class A wastewater treatment laboratory and performs most of its process monitoring, control, and regulatory reporting analyses in-house. Some of the additional equipment that DEP provided employs newer technologies or processes that simplify routine bench testing. A list of all the equipment employed during this WPPE is included as Attachment G.

Figure 2.1: Hach Trailer with Monitoring Equipment

In conducting this WPPE, DEP made no recommendation for or endorsement of any particular brand or model of equipment or testing methodology. DEP encourages those who review this report to survey the market and contact any of several companies manufacturing or selling this technology that can be used for improving monitoring and operations, before they acquire any particular technology.

In addition, this WPPE has been provided as a *gratis* service to the client as part of a research project funded by the federal and state government. The services offered during the WPPE are part of an effort to enhance surface water quality throughout the Commonwealth and are not meant to compete with private-sector services aimed at improving a client facility's operations or upgrading its capabilities. Oftentimes, POTW Optimization requires the client facility to achieve effluent quality above and beyond NPDES permit requirements in order to obtain improved drinking water quality downstream. Clients are encouraged to contact their consulting engineers when contemplating any process changes to a facility where engineering or design services may be necessary. Furthermore, any process or procedural changes may be subject to regulatory reporting and permitting processes through PADEP or the US Environmental Protection Agency (USEPA.)

Attachment B lists the WPPE team and participating staff of Ephrata 2.

Plan for the WPPE

The basic plan for the WPPE was as follows:

1) Following consultation with the plant operators, DEP and Hach staff deployed the trailer with probes on site to the facility in early August.
2) Background samples would be collected, analyzed, and recorded over a period of two weeks to determine current operating conditions at the outset of the evaluation.
3) Using the Hach technology and supplementing it with laboratory bench tests, records from the facility, and weekly sampling and testing for water quality parameters at DEP's Bureau of Laboratories, DEP staff would determine if and where process control should focus on operational inefficiencies that could hinder optimization. The Hach probes would be set to record data at fifteen-minute intervals, 24/7.
4) Following such determination, DEP and plant staff would cooperatively adjust and monitor the wastewater treatment operation, attempting to optimize effluent quality by adjusting the length of various operational cycles of the PID and anoxic selector.
5) Sampling and testing would continue throughout the WPPE, to see if the adjustments were working.
6) A total of three sampling events for Method 1623 pathogens, *Cryptosporidium* oocyst and *Giardia lamblia* cyst, would be conducted over the course of the WPPE: background phase, optimization phase, and optimized phase.

After about six to eight weeks, on-site activities would stop and DEP staff would evaluate the wealth of data generated over the course of the evaluation.

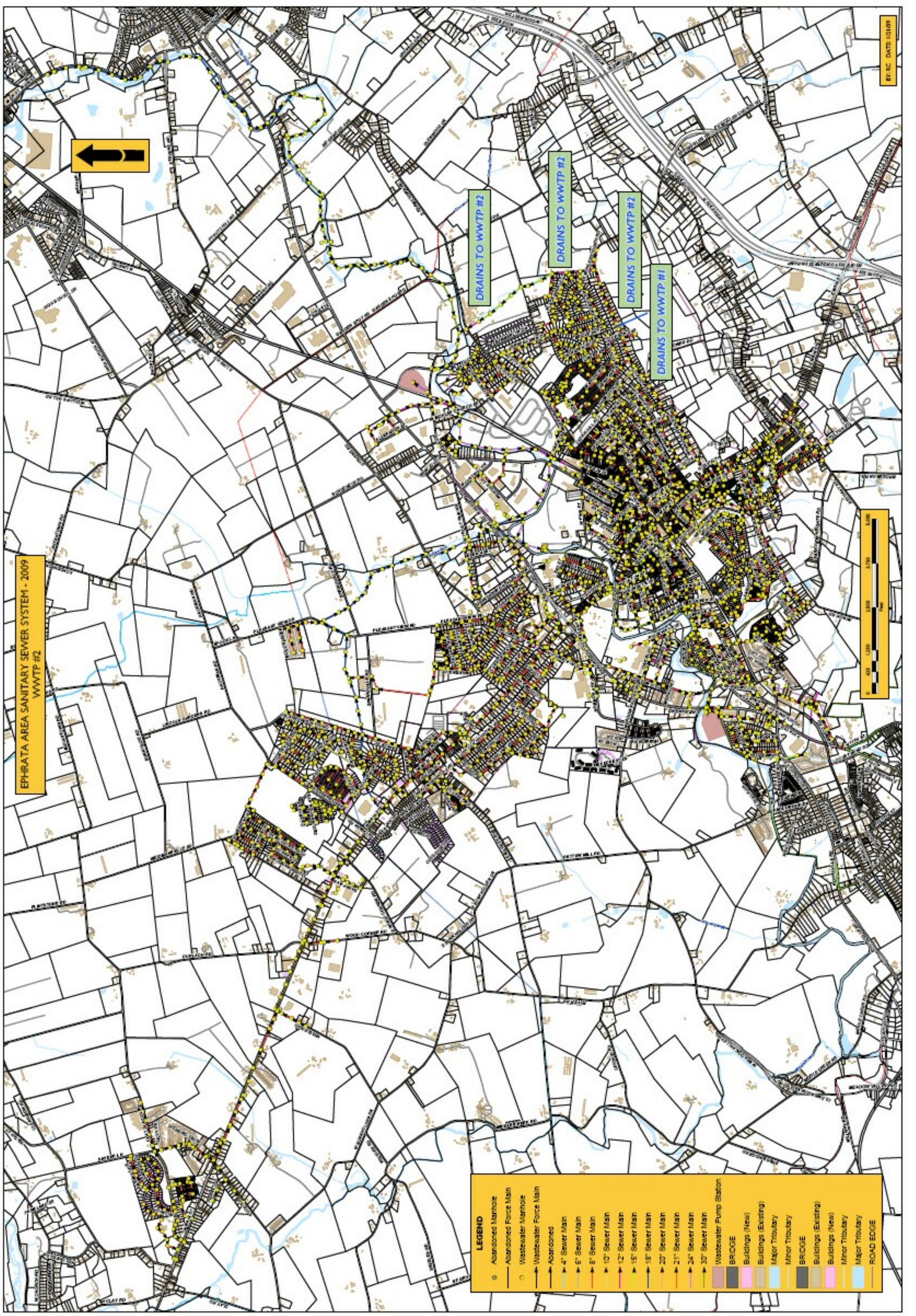


Figure 2.2: Sewer Index Map for Ephrata 2.

3. Initial Observations

Plant Description

Ephrata Borough's Wastewater Treatment Plant Number 2 is located in Ephrata Township at 43 Springhouse Road, just southeast of PA State Route 272 (North Reading Road,) near the northeastern edge of Ephrata Borough. It treats domestic sewage from its collection system servicing the boroughs of Ephrata and Denver and the townships of Ephrata and East Cocalico, located in northeastern Lancaster County. The facility was constructed in 1997.

NPDES Permit No. PA0087181 establishes the operations and monitoring requirements for treated sewage at Ephrata 2. The WWTP discharges treated effluent to Cocalico Creek, designated as a warm water fishery and domestic water source. Cocalico Creek is in the 7-J watershed, contributing to the Chesapeake Bay by way of confluence with the Conestoga River at Talmage in West Earl Township, Lancaster County. Discharge from the plant represents approximately 28% of the downstream stream flow within this creek at design flow, considering Q7-10 stream flows of 9.1 cfs (5.8 MGD) and plant flow of 2.3 MGD. Stream flow data was gathered from the DEP Water Quality protection report.

The instream waste concentration (IWC) is based on plant design flow and the Q7-10 flow of Cocalico Creek. The Q7-10 flow is the lowest average, consecutive 7-day flow that would occur with a frequency or recurrence interval of one in ten years (from SRBC website). The Q7-10 flow and IWC are used in the Department's NPDES permitting process. The IWC for Ephrata No. 2 is 28.11%, indicating that during relatively dry conditions the Ephrata No. 2 discharge flow would represent 28.1% of the stream flow. The stream flow of Cocalico Creek was not measured during the WPPE, but from permit review calculations, it was shown that the creek flow at the plant discharge is typically 5.9 MGD (9.13 cfs) during dry, summer conditions and 7.0 MGD during winter conditions. Permit conditions were based on the combined flows of both Ephrata treatment plants to the watershed, based on the past performance of Ephrata 2 as not having water quality impacts downstream. In 2009, based on the annual average daily flow of 1.011 MGD, all other factors being the same, the Ephrata 2 plant actually contributed 15% of the total creek flow downstream.

A process description and treatment schematic are depicted in Attachment D.

This site was chosen for the WPPE because of its proximity to the Ephrata Borough Water Works, PWSID 7360045, drinking water intake which is located approximately 1.7 miles directly downstream of Ephrata 2's outfall. The borough's water works serves a population of 17,937 people and employs a conventional filtration process. The water source is supplemented by groundwater wells during times of high turbidity on Cocalico Creek.

Ephrata 2's overall operating efficiency appears to be very good with no recent violations of its operating permit. Following deployment of the WPPE equipment, the instrumentation was used to collect data that supplemented existing operations by providing the operator with additional process data used when making decisions on modifying treatment plant control with the ultimate goal of improving effluent quality.

Background samples were collected on August 4, 2009, and process samples were taken every week during the WPPE and analyzed by the DEP's Bureau of Laboratories facility in Susquehanna Township, Dauphin County. A summary of the results for all sampling is listed in Attachment E.

Figure 3.1, below plots Ephrata 2's treatment plant and outfall to Cocalico Creek along with the borough water works drinking water intake.

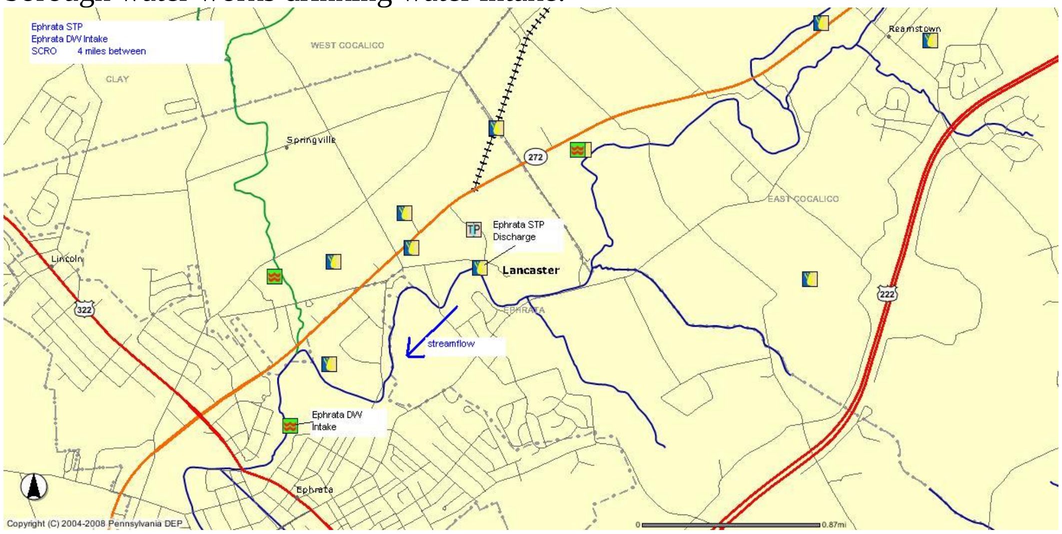


Figure 3.1: Ephrata Borough WWTP No. 2 and Ephrata Water Works raw water intake: Approximately 1.7 stream miles separate the two locations.

Past Performance

Ephrata Borough has an extensive record of operations of both of its wastewater treatment plants and of its water works. The in-house laboratory is a Class A facility, with test data generated most work days and supplemented by weekend readings. A review of plant records showed that the facility was operating most efficiently when both ditches were operated together: A gate between Ditch 1 and Ditch 2 also remained open during the course of the evaluation. Ephrata 2's operators, maintenance personnel, and laboratory staff are to be commended for the consistently high effluent quality produced from this facility and for correcting potential permit excursions quickly, avoiding any violations or detriment to downstream water quality.

During file review, we reviewed the facility's NPDES Permit, its Part II Permit, Water Quality Protection Report, monthly Discharge Monitoring Reports (DMR), Chapter 94 Report, as-built drawings, and available daily process monitoring records.

DMRs for all of 2009 were reviewed in order to develop an understanding of the facility's daily operating ranges. For 2009, the average daily flow was 1.011 MGD with a peak daily influent flow of 3.554 MGD on December 9, 2009. The minimum daily flow of 0.665 occurred during the WPPE, on September 6.

According to the 2009 Waste Management Report, the average daily influent organic loading had been 1,787 pounds of BOD5 per day, well below the design peak loading of 7,300 lb./day that would occur were the peak monthly flow of 3.5 MGD attained. The maximum daily organic load occurred on May 26, 2009, when 2,671 lb./day occurred.

These records indicate that the facility is operating well within its design parameters and does not expect to approach overload conditions for several years, even if growth and development of the service area defy the current stagnant economic outlook, where housing starts are down and commercial development appears to have halted. Because of the recent development of the service area, there are no combined sewers in the collection system. We did not investigate the possibility of wildcat connections or roof downspouts and basement sump pumps discharging into the sewer system. Ephrata Borough Authority has an aggressive program for managing the collection system and reducing inflow/infiltration (I/I) with ongoing surveys, repairs, and reinforcement, with all surveillance and repairs noted in the Authority's annual Chapter 94 report.

The Ephrata No. 2 WWTP appears to consistently produce effluent of a high quality and the results of this project along with the review of Ephrata's lab records and the DMRs for calendar year 2009 supported this conclusion, see Table 3.1 below.

Month	Q Inf MGD	WAS Q MGD	PRECIP in.	INF BOD lb/day	INF TSS lb/day	Aer SS lbs.	EFF TP lb/day	EFF NH3-N lb/day	EFF TKN lb/day	EFF NO3-NO2 N lb/day	EFF TN lb/day	EFF CBOD lb/day	EFF TSS lb/day	EFF TRC lb/day
Jan	33.560	0.525	1.70	54,702	49,034	-	567	298	725	2,743	3,468	756	945	94
Feb	24.506	0.576	0.24	47,441	43,226	-	261	132	567	1,850	2,417	529	521	75
Mar	24.949	0.684	1.15	56,322	48,718	-	270	158	714	638	1,358	483	266	51
Avr	31.188	0.664	4.35	52,881	53,817	-	370	134	414	1,706	2,120	635	3,434	67
May	36.991	0.682	4.57	53,351	64,648	-	442	137	488	1,676	2,164	785	865	116
Jun	33.823	0.644	6.00	55,344	56,093	-	354	133	413	1,819	2,231	623	726	72
Jul	26.855	0.598	2.85	55,278	49,795	-	342	59	293	1,613	1,906	576	433	79
Aug	26.218	0.540	5.03	57,086	65,072	-	299	66	269	788	1,057	545	379	83
Sep	24.048	0.540	4.06	46,135	48,035	-	283	83	189	1,685	1,874	2,701	308	83
Oct	31.597	0.558	6.37	58,588	55,105	-	321	78	362	1,965	2,327	618	419	68
Nov	25.647	0.540	1.89	47,493	37,525	-	273	58	274	1,474	1,748	468	340	60
Dec	49.171	0.558	4.80	65,901	59,626	-	535	151	495	2,213	2,708	985	780	122
Annual Surr	368.552	7.109	43.01	650,522	630,693	-	4,316	1,487	5,202	20,170	25,378	9,705	9,415	968
AverageMo	30.713	0.592	3.58	54,210	52,558	-	360	124	434	1,681	2,115	809	785	81
					12 month load		**4,316**	**lb TP**			**25,378**	**lb. TN**		
Red means calculated value					**Annual Nutrient Limi**		**6,818**	**lb TP**			**54,550**	**lb. TN**		
					Percentage of capaci		**63%**				**47%**			

Table 3.1: Ephrata No. 2 WWTP 2009 DMR data summary, month and annual sums[2]

Current Performance

Flow into the treatment facility averaged 1.011 MGD and BOD concentrations averaged __ mg/L over the course of the WPPE. This equates to an average BOD loading of 1,787 lbs/day. The flows were approximately 44% of the design flow and approximately 24% of the permitted organic loadings that the plant is designed to treat. Solids load averaged 1,732 lbs./day. According to plant records, the facility also maintained the following operational values:

Combined Ditches in Bio-Denitro Mode

Parameter	Ditches
F/M ratio	0.53
Hydraulic Retention Time	18 hours
MCRT	31 days
Sludge Volume Index	129

A more comprehensive summary follows in Attachment D, with the treatment schematic.

[2] September 2009 data includes calculated values because some data was missing from our records.

Headworks

The facility headworks, shown right and below, provide for removal of non-degradable solids through use of Rotomat fine screen and an automatic, self-cleaning grit removal flume. Solids removed at this point in treatment is consolidated and disposed of in a regulated landfill. Our study did not include an assessment of the quantity or nature of solids removed at this point; however, other studies have shown that regular removal of grease and solids at this point can lower downstream plant loadings by up to a third of the overall waste load. Improved headworks also remove non-degradable material, plastic trash, and grit that damages pumping equipment downstream and prevents accumulation of solid, inert material within those treatment processes. Prior to compacting and disposal, the solids are rinsed so that most of the water-soluble organic BOD continues to further treatment.

Figure 3.2: Headworks

DEP staff installed a total organic carbon probe (Hach UVAS) in the influent channel downstream of grit removal and connected its output to an SC-1000 data acquisition unit located near the influent end of the ditches. This point in the channel was also used for manual sampling of influent wastewater for laboratory testing.

Figure 3.3: Inflow Channel after Grit Removal

According to the facility's most recent Municipal Wasteload Management report, the facility is not running near its hydraulic and organic operating capacity, and inflow-infiltration is considered minimal. The plant operator-in-charge told us development in the service area around the site had slowed in recent years due to a general economic downturn, and development locally has tended to occur south of the Borough rather than northeast toward Reamstown and Denver. Figure 3.4 depicts the 2009 flows including monthly average and design values. A summary of daily flow measurements for April through July 2009 is listed in Attachment F.

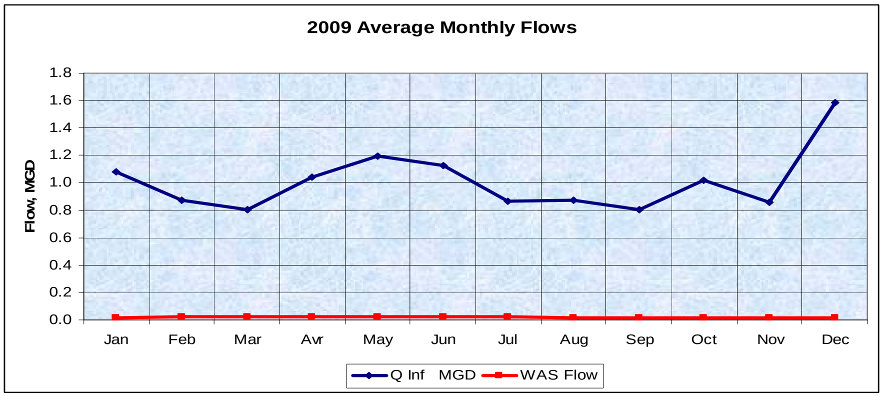


Figure 3.4: 2009 Month Average Daily Flow with Wasting Rate

Figure 3.5, below depicts the 2009 daily inflows by day, with the peak daily inflow that occurred on December 9, 2009.

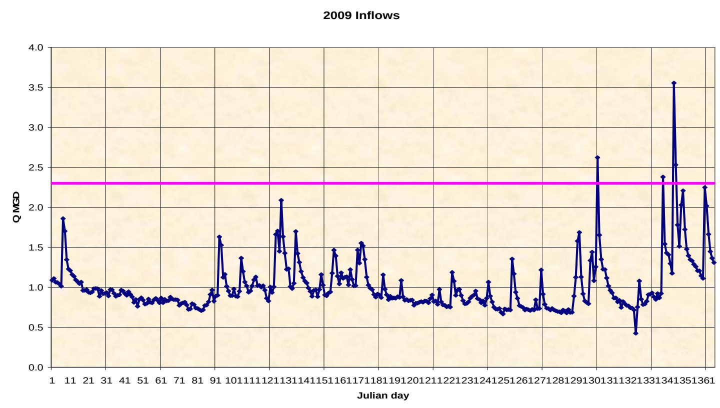


Figure 3.5: 2009 Daily Inflows, showing Peak Daily Inflow and Design Average Daily Flow (magenta line) of 2.4 MGD

Anaerobic Selector Tanks

Return activated sludge from the clarifiers is introduced to the anaerobic selector tanks, pictured below, three successive tanks in series, where the process separates activated sludge metabolism into two distinct steps: BOD uptake in the Selector and BOD oxidation in the Ditches. By passing the Return Activated Sludge (RAS) and influent through the anaerobic selector, microorganisms capable of using stored polyphosphate as an energy source are proliferated. This energy is used to transport BOD into the cells when free or combined forms of oxygen are not available for respiration. Typically, the anaerobic selector tanks are equipped with submersible mixers to maintain biosolids in suspension. RAS is discharged to the first tank of the selector, while raw influent is directed to the second stage. Centrate from the rotary drum thickeners and filtrate from the belt filter press are introduced into the third tank when sludge management processes are running. Phosphorus removal is supplemented with the use of Ferrous chloride when centrate from the sludge handling facilities is returned to the tank. From this third tank, the mixed liquor then is channeled to an inflow selector that alternates inflow to either of the two phased isolation ditches (PID.)

Figure 3.6: Anaerobic Selectors

By staggering the RAS and raw wastewater influent locations, volatile fatty acids and soluble BOD, which promote phosphorus-release, are not consumed during RAS denitrification. In the second tank, denitrified RAS mixes with the influent wastewater in the absence of oxygen, and the anaerobic environment stresses the microorganisms, which begin to break down stored polyphosphate reserves into orthophosphate. Throughout the remainder of the anaerobic selector, orthophosphate is expelled from the microorganisms releasing energy that is used to absorb BOD into their cells.

In subsequent anoxic and oxic phases in the oxidation ditches, the BOD is oxidized and the cells reproduce. In the oxic phases, these cells replenish phosphorus. This results in a net phosphorus uptake. Phosphorus removal from the wastewater is, ultimately achieved by wasting phosphorus-rich sludge from the system. As an added benefit, the anaerobic selector inhibits the growth of filamentous bacteria that cause bulking sludge.

Bio-Denitro Oxidation Ditch Secondary Treatment

The heart of the treatment technology is found in two Kruger PID having a total capacity of 2.64 MG where BOD is oxidized and where nitrification and denitrification occur during oxic and anoxic semi-batch process cycles regulated by changing the flow path through the two parallel tanks. A gate between the two ditches allows flow between the two tanks, so that one ditch receives influent while the other ditch is discharging. Submersible brush rotors operated within prescribed DO ranges maintain the oxidation phase and are operated at optimal submergence to minimize power consumption. Submerged mixers maintain flow through the ditch channels during anoxic periods. The process can have four or six cycles, depending on the mode of operation. To further refine the process, the ditches can be operated in an A/O mode during high-flow periods, where one ditch has distinct aerobic and anaerobic (oxic/anoxic) zones.

Figure 3.7: Oxidation Ditch

There are currently three strategies for operating these cycles. First, when phase lengths are of fixed duration; second, when constant set points such as dissolved oxygen level are used to switch between phases and result in variable phase length; and third, when set points become variable based on instrumentation such as nutrient probes. The process can be optimized for biological nutrient removal. Ephrata 2 uses constant set-points to control phase length.

Secondary Settling

Discharge from the ditches flows through a distribution point to two (2) seventy-five foot diameter (75'-0" d.) secondary settling tanks, or clarifiers. Here, activated sludge solids settle by gravity and are withdrawn by return sludge pumps for reintroduction to the ditches by way of the anoxic selector, or for wasting to the ATAD system. The clarifiers are baffled to prevent short-circuiting of flow through the clarifiers.

Figure 3.8: Secondary Clarifiers

Typically, the clarifiers operate with half-foot (0'-6") sludge blankets, and these levels did not vary much throughout the course of the evaluation. At the outset of the evaluation, DEP staff installed a sludge blanket sounding device (Hach Sonatax) on one of the clarifiers; however, the instrument failed early in the study and had not been repaired or replaced within sufficient time to yield any useful data. As a fallback, staff employed a Raven Core-taker to manually sample sludge blanket thickness at this and the other clarifier, although after determining that Ephrata 2 staff was already performing this measurement on a daily basis, DEP staff chose to rely on Ephrata's data.

Disinfection

Ephrata 2 employs gas chlorination for disinfection of the treated wastewater, injecting it at the head of the chlorine contact tank. The capacity exists for dechlorination; however, the injection of Sulphur dioxide was not performed during 2009. After sufficient contact time, the effluent flows over a stepped reaeration cascade prior to discharge. The outfall at Cocalico Creek is approximately 500 meters from this final process. At the tail end of the chlorine contact tanks, within an effluent channel collecting the combined discharge from both tanks, DEP staff installed sample analysis equipment for effluent ammonia-nitrogen (Hach Amtax system) and phosphate-phosphorus (Hach Phosphax system.) These test units supplied signals to an SC-1000 controller at this location for data consolidation, reporting, and downloading. Regrettably, we were unable to link the SC-1000 to the others for centralized data processing and had to download information by hand.

Figure 3.9: Disinfection Tank

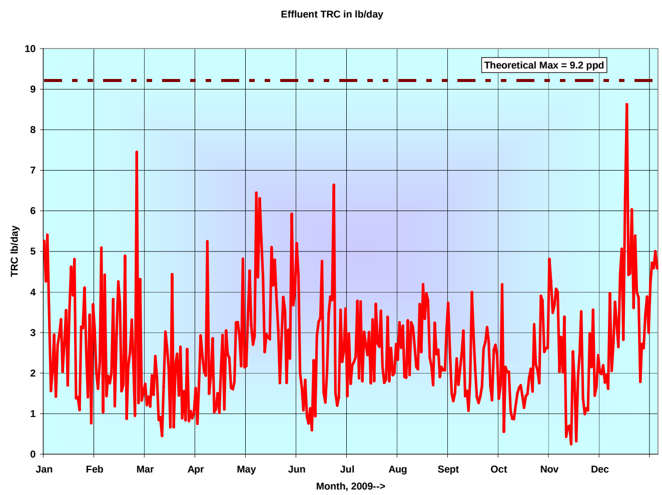


Figure 3.10: Effluent TRC in lb/day for 2009.

Figure 3.10, above shows a histogram of the effluent total residual chlorine, in ppd. Although most chlorine is consumed prior to release from the treatment plant, there is some residual which passes into the surface water receiving stream. The graph shows a theoretical daily maximum load of 9.2 ppd residual loading, based on design flow criteria, although we would encourage adopting an optimization goal somewhat lower and within reach of the historical record, for example, 4.8 ppd.

Solids Management and Inventory Control

The solids management and inventory control program is based primarily on mixed liquor suspended solids analysis, MCRT, and operator interpretation of the current operating conditions. During the on-site visits, DEP staff did not make a comprehensive review of the biosolids treatment operation at Ephrata 2, other than to discuss the impact of internal recycle flows on the operation of the treatment system and the use of ferrous chloride to assist in phosphorus removal. (The principal mission brief for the WPPE program is optimizing the biological water treatment process to remove pathogens and nutrients.)

Autothermal Thermophilic Aerobic Digestion (ATAD)

Ephrata 2 employs an ATAD as the heart of the biosolids treatment system. This high-temperature, proprietary Kruger technology produces in ten days a Class A biosolids that is free of pathogenic organisms and which meets state requirements for inert content, making the material suitable for use as agricultural fertilizer and soil amendment. The system includes three insulated steel tanks with aspirating mixers, circulating aspirators, foam cutters, and a supervisory control system that maintains temperature and tank level monitoring. All ATAD loading and material transfer occurs within a narrow, prescribed time frame, so as to prevent adverse effects to the oxidation ditches. According to the literature, the ATAD reaction time is 23 hours per day. Prior to material withdrawal from the ATAD, the biosolids achieve a temperature of 140 degrees (F) that guarantees destruction of pathogenic bacteria.

Figure 3.11: ATAD System

Dewatering and Biosolids Processing

Finished biosolids are stored in a 330,000-gallon storage tank prior to dewatering on a Kromline-Sanderson 2-meter belt filter press that increases the total solids content of digested sludge to 20%. In 2009, the facility produced 172 dry tons of Class A biosolids.

The ATAD is supplemented by use of two Hycor rotary drum thickeners to achieve a 3% total solids in its waste activated sludge prior to its introduction to the ATAD process, with the centrate being returned to the activated sludge treatment system via the third tank of the anaerobic selector.

Figure 3.12: Belt Filter Press

Biosolids cake is stored in a large open shed area where loading facilities allow for material to be cleanly removed from the site for agricultural soil amendment. In addition, the facility employs a three-bay biofilter to provide odor control at the facility. Malodorous air can be withdrawn from the headworks building, the ATAD, and the solids dewatering building, humidified with a water spray to entrain the organic chemicals causing odors, and then blown through three beds containing a mixture of wood chips and compost.

Figure 3.13: Storage Area

Equipment Installation & Calibration

On August 4, 2009, Bob DiGilarmo and Marc Neville arrived at Ephrata No. 2 to diagram the instrument layout and install the mechanical connections for the in-line probes. Representatives and technicians from Hach Company brought a leased instrumentation trailer to the facility to assist in setting the probes and connecting the communications lines between the probes and SC1000 control units.

The in-line monitoring equipment is described as having microprocessor technology built into each probe. Each probe has sufficient memory to retain several days' worth of readings. The SC1000 and SC100 base units are microprocessor-driven routing and transit computers, working in conjunction with detachable display units. The display units are used to calibrate the attached instruments, in addition to relaying information to other microprocessors. The technology allows plant operators to observe and track operational trends that can be interpreted using readily available literature, reinforcing an operator's process control decisions and showing him/her, in real time, the results of process changes that affect plant performance. The entire system is capable of being combined with a Supervisory Control and Data Acquisition (SCADA) operations and monitoring system.

Figure 3.14: Deploying Probes

The portable wastewater trailer utilized in this WPPE contained a portable notebook computer for displaying the continuous signals from the digital probes. This is an enhancement, as the SC1000 units installed on the trailer also support displays that provide graphical depiction of trends collated from the data recorded by the probes. Use of the notebook computer allowed for downloading and recording information from the probes at regular intervals. DEP staff incorporated this data into charts and graphs that were used for showing trends and predicting future behavior.

Figure 3.15: Wiring the System

This WPPE utilized a sufficient number of probes to allow for monitoring equipment to be installed in both oxidation ditches, the majority of which were placed at the discharge end of the flow channel. Additional probes were placed in the anoxic selector for dissolved oxygen (DO), pH, and Oxidation-Reduction Potential (ORP.)

The installations were:

- 3 Hach SC1000 base units: 1 at Anoxic Selectors, 1 at Disinfection Tank, and 1 mounted on the trailer;
- 4 SC100s mounted on the trailer;
- 1 Amtax and Phosphax placed in the discharge channel of chlorine contact tanks;
- DO, ORP, pH, DO, Nitrate, and Ammonia and Total Suspended Solids sensors in each of the aeration tanks;

- UVAS, an ultraviolet total organic carbon monitor, in the influent flume following screening and grit removal;
- pH in the second of three selector tanks, ahead of the Phased Isolation Ditches;
- ORP and DO initially in the Anoxic Selector, Stage 1, later moved to north end of Ditch 2

Attachment G shows a diagram of where the continuous monitoring probes were installed.

Remote Continuous Digital Monitoring

In this application remote monitoring capability by HACH WaterEye™ was established to communicate with the notebook computer attached to the SC-1000 and SC-100 units. The remote monitoring capability proved useful because it permitted team members in Ebensburg and Harrisburg to observe data through an Internet web-link. After logging into a website set up for Ephrata 2, users were able to view current measurements of all probes, download data, and view trends. The equipment was set to log measurements at 15 minute intervals. This was a "luxury" upgrade similar to the way SCADA systems may now be hosted at websites for remote access. An example of the WaterEye output is included at the end of Attachment K.

Laboratory Equipment

Ephrata's operators have a Class A laboratory for monitoring their operation. Testing and monitoring the treatment process have been diligent and shows discipline on the part of the plant operators. The laboratory routinely performs all testing for both treatment facilities owned by Ephrata Borough Authority. This testing includes nutrient concentrations, gravimetric solids determination, and effluent water quality tests required as conditions of the Permit. Additional testing is performed by external environmental laboratory for quality assurance purposes.

The laboratory operation is commendable. Many treatment plant operators had stopped performing process monitoring tests when the lab certification requirements were enacted, instead sending samples to proprietary labs for compliance purposes, and forgetting process monitoring tests in the process. Ephrata 2, on the other hand, has continued to perform tests to a high degree of precision and accuracy.

As part of the WPPE program, the continuous monitoring digital probes provide the plant operators with graphical output that allows them to see how the tested parameters fluctuate over time. However, the optimization program supplements their use by making available portable laboratory equipment at no cost to the facility, to be used for obtaining process monitoring "snapshots" of plant conditions using relatively simple test methods . This equipment was also utilized to verify the quality of data being collected with the digital probes. The process monitoring equipment may be purchased at modest cost from a variety of vendors and included:

Figure 3.16: Example Portable WW Lab

- Microscope with digital recording camera and computer interface;
- Raven Products centrifuge, settleometers, and clarifier core-taker for sampling and

testing according to sludge inventory methods developed by Al West and cited in Activated Sludge Manual of Practice No. OM-9

- Portable LDO and pH/temperature instruments;
- Portable spectrophotometer and packaged wastewater lab, for colorimetric analyses of water and wastewater;
- Chemical oxygen demand (COD) heater block and test kit
- Hach portable HQ40d microprocessor with LDO, pH, and BOD probes adapted to rough service.

The purpose of this equipment is to supplement the digital recording probes with a variety of lab tests that can be used by plant operators to track solids inventory, health, and condition of the biomass, and relative strength of incoming wastewater. A small lab set such as this can be used in lieu of digital equipment, long after the WPPE has finished.

Still, it was obvious that the operators at Ephrata 2 did not need to use this supplemental lab equipment; however, they were impressed with the newer technology offered by Hach Company and its "Test in Tube" (TNT) portable lab assays for nutrients. The TNT method employs bar-coded information that is used by the DREL 2800 Spectrophotometer to determine proper light wavelength and test results more quickly than the traditional wet-methods used in the Ephrata 2 laboratory for nutrient determination. (Please note, however, that the Department may not endorse any particular brand of equivalent laboratory tools or methods. Whatever methods and technologies used in any laboratory should be codified in Standard Operating Procedures and posted on-site in a manner already in practice at Ephrata.)

Figure 3.17: Hach TNT, Spectrophotometer, and Digestion Heater Block

The end result of process monitoring and testing is to provide an operator with data needed to develop Mean Cell Residence Time (MCRT), Food to Mass Ratio (F/M), or Sludge Age (AGE) methods of managing activated sludge treatment facilities. Ephrata 2 employs the MCRT method of tracking plant performance, based on pounds of biomass under aeration divided by the combination of pounds of biomass wasted and pounds of biomass lost as effluent solids. A typical value for this Ephrata plant is 38 days.

There were a significant number of process control tests performed during the WPPE, some representative spreadsheets of the output data are included at Attachment I.

Sampling & Tests Ordered

As DEP staff was developing test protocols for the overall project during this WPPE, sampling and testing for facility operating and effluent conditions, as well as those of the background receiving stream and at the downstream water works, varied during our attempts to refine program requirements. Typically, water and wastewater samples were tested according to standardized suites of analyses used in testing compliance samples.

Our water chemistry sample locations were:

- INF: Influent Wastewater—sampled at UVAS probe in raw wastewater flume, following grit removal, to assay what actually enters the Bio-Denipho process;
- EFF: Final Effluent—sampled at discharge cascade to assay effluent quality at or near surface water outfall
- UPS: Upstream of Outfall 001—sample background conditions of the receiving stream at least 100 meters upstream of the outfall so as to avoid influence of plant discharge;
- DWS: Downstream of Outfall 001—sampled at or near intake to Ephrata Water Works to determine the effect of plant effluent on receiving water quality and its impact on raw water for the PWS filtration system;
- D1W: Ditch 1 Mixed Liquor Suspended Solids—sample at the south end of the ditch, near where the instruments had been placed;
- D2E: Ditch 2 Mixed Liquor Suspended Solids—sample at the south end of the ditch, near where the instruments had been placed;
- RAS: Return Activated Sludge--sampled at the inflow pipe to Stage 1 of the Anoxic Selector

A typical analysis suite included tests for BOD_5, pH, TSS, VSS, NH-N, NO2-N, NO3-N, TKN, (TN by calculation,) TP, Alkalinity, and Chlorides. Also tested were Total and Fecal Coliforms. Additional testing may have been added to clarify specific issues or as part of the evaluation.

Of special interest to the project were the Method 1623 Pathogen Assays employing antibody markers, analyses performed at DEP Bureau of Laboratories. The program required three pathogen assays for the project: Initial, Intermediate, and Final conditions. DEP staff collected three 10-Liter samples of waters, as shown below:

A summary of all the Bureau of Laboratories test results is located in Attachment E with copies of the lab reports.

4. Process Monitoring

Beginning on August 8, and lasting until October 4, we obtained digital data from the in-line probes installed at Ephrata 2. Some interruptions of data collection occurred because of power interruption and due to power surges during a thunder storm. To prevent future occurrences, Hach representatives installed an uninterrupted power supply on the laptop computer and modem hardware; this seemed to prevent further instances of signal loss and data collection.

Attachments J and K include graphs of monthly and daily data, respectively, collected by the digital probes. These graphs were developed in-house using MS Excel. The data collected during this project was available remotely though Hach software, WaterEye®. The use of WaterEye permitted on-line discussions of data collection and its reliability with Hach technicians and DEP staff while both parties were off site, and it allowed us to observe and note when instrument adjustments were necessary.

Table 4.1, below, lists the test results for samples collected by Mr. Neville at Ephrata 2 and analyzed by DEP at its Bureau of Laboratories facility in Susquehanna Township, Dauphin County. Samples were collected according to standard DEP protocols; however, due to budget reasons and the fact that these were process monitoring rather than compliance samples, extraneous sampling such as collection of method blanks, trip blanks, and standards blanks were not included in the sampling plan.

Interpretation of Data

Concentrations	8/4/2009	8/11/2009	8/20/2009	8/27/2009	9/1/2009	9/9/2009	9/15/2009	9/22/2009	9/29/2009	10/6/2009	Avg.
Effluent Sample	0907 057	0907 061	0907 074	0907 083	0907 091	0907 102	0907 113	0907 128	0907 142	0907 171	
CBOD	0	0.2	0.9	0.02	2	0.6	0.6	1.1	0.6	0.3	0.6
TSS	5	5	5	5	5	5	5	5	5	5	5.0
Alkalinity	168.8	182.6	186.6	201.2	191.4	179.2	185.4	177	170.8	153.8	179.7
NO2-N	0.01	0.01	0.04	0.01	0.04	0.06	0.02	0.02	0.01	0.06	0.03
NO3-N	6.2	2.43	4.72	2.05	5.1	6.26	3.88	7.03	7.2	10.05	5.49
NH3-N	0.07	0.1		0.09	0.08	0.15	0.1	0.12	0.08	0.11	0.10
TKN	1.00	1.00	1.00	1.00	1.00	1.32	1.06	1.09	1.07	1.52	1.21
Phosphorus	0.918	0.909	0.995	1.386	2.054	1.416	1.434	1.461	1.073	0.538	1.22
TOT N(TKN+NO3+NO2)	7.21	3.44	5.76	2.06	5.1	7.64	4.96	8.14	8.28	11.63	6.42
Total Coliform								1900	200	20	706.7
Fecal Coliform							<20	<20	20		20.0
Chloride	154	143.2		150.9	139.6	304.2	139	157.5	142.7	164	166.1
pH	7.9	8	7.9	8	8.1	7.8	7.9	7.9	8.1	7.9	8.0
Crypto					7		1		0		2.7
Giardia					167		121		128		138.7

Table 4.1: BOL Test Data—Effluent Concentrations.

Concentration numbers in red indicate results that were below the detections limits for the test or the dilution series, unless otherwise noted. Of particular interest to the study were pathogen and nutrient results. Coliform testing began on a regular basis in September and continued weekly through the end of that month. As noted above, the Fecal Coliform results were undetectable or threshold limits. Waterborne pathogens *Giardia lamblia* cyst and *Cryptosporidium* oocyst were tested by EPA Method 1623, the addition of a fluorescent-tagged antibody to the pathogens and then quantifying them in a plate-count method, after which the concentration was standardized to a 10 liter aliquot. Over the course of the month, *Cryptosporidium* oocyst decreased while *Giardia* cyst held constant within one standard deviation.

A secondary interest of the study is the concentration and loading rate for nutrients in the effluent. As seen in Table 4.2, below, we quantified the effluent stream loadings for nitrogen and phosphorus, using the final effluent flows reported for the sample days. Effluent samples were collected over a period exceeding twenty (20) minutes to assure that they would not be used for compliance purposes.

Effluent Loadings	8/4/ 2009	8/11/ 2009	8/20/ 2009	8/27/ 2009	9/1/ 2009	9/9/ 2009	9/15/ 2009	9/22/ 2009	9/29/ 2009	10/6/ 2009	Avg.
Effluent Sample #	**0907 057**	**0907 061**	**0907 074**	**0907 083**	**0907 091**	**0907 102**	**0907 113**	**0907 128**	**0907 142**	**0907 171**	
CBOD	0.0	1.5	6.7	0.1	12.5	3.6	3.9	6.6	3.9	1.7	4.1
TSS	32.5	37.5	37.0	32.3	31.3	30.1	32.1	30.2	32.8	29.1	32.5
Alkalinity	1,097	1,368	1,381	1,301	1,197	1,078	1,192	1,068	1,119	896	1,170
NO2-N	0.065	0.075	0.296	0.065	0.250	0.361	0.129	0.121	0.066	0.349	0.18
NO3-N	40.3	18.2	34.9	13.3	31.9	37.7	24.9	42.4	47.2	58.5	34.93
NH3-N	0.455	0.749		0.582	0.500	0.902	0.643	0.724	0.524	0.641	0.64
TKN	6.50	7.49	7.40	6.46	6.26	7.94	6.81	6.58	7.01	8.85	7.44
Phos	5.97	6.81	7.36	8.96	12.85	8.52	9.22	8.82	7.03	3.13	7.87
TOT N(TKN+ NO3+ NO2)	46.9	25.8	42.6	13.3	31.9	46.0	31.9	49.1	54.3	67.7	40.95
Chloride	1,001	1,073		975	873	1,830	893	950	935	955	1,054

Table 4.2: BOL Test Data—Effluent Loadings, based on Reported Flows for Dates Noted.

Ammonia nitrogen in the ten weekly samples averaged 100 parts per billion (0.1 mg/L), evidence that nitrification was virtually complete. Compared to influent concentrations of NH3-N, the facility has a 99.7% removal rate for this pollutant. In addition, effluent nitrates averaged 5.49 mg/L for the sample population, well below the usual 30-to-40 mg/L seen in the average activated sludge treatment system. This indicates that not only is nitrification occurring to an optimum extent, but also is denitrification, thanks to the technology employed at Ephrata 2. Nitrate loadings for the collection averaged 35 ppd.

The total nitrogen loadings for the period August 4 through October 6, based on these samples, averaged 41 pounds per day (ppd) and would represent an annualized loading of 14,965 ppd, compared to an annual permit limit of 54,550 ppd. These quantities are lower than annual data reported by the facility's lab, (24,378 lb. TN for RY2009,) because the nitrogen loadings are much higher during the winter months and our evaluation took place during late summer.

Similarly, the total phosphorus loading for the test cycle averaged 7.87 ppd and would represent an annualized loading of 2,873 ppd, compared to the annual loading of 4,316 ppd reported in the Chapter 94 report and the an annual limit of 6,818 ppd. In either case, the facility is clearly performing well above the expectation of the existing permit, as also seen in its annual Chapter 94 reported nutrient loadings well below the required permit limit.

Interestingly, solids loading to the Cocalico was virtually nil. The numbers shown in Table 4.2 are all based on non-detect results for total suspended solids; id est, there were no solids detected in the ten weekly samples. We have theorized that the two pathogens-of-concern, *Giardia* and *Cryptosporidium*, "hide" within solids that are ashed from the facility in its effluent. It stands to reason that one would not expect to find significant amounts of these pathogens based on the results of solids testing. Yet even with the solids undetectable in the effluent, *Giardia* cyst averaged 1.39 cysts/Liter during our sampling events, indicating there may be a source within the collection system. We have yet to evaluate a facility where solids ashing is a problem, so as yet, our hypothesis regarding the link between high pathogen cysts and high solids remains to be seen or disproved.

As an aside, we note here that, with respect to effluent suspended solids, the Ephrata 2 facility maintains a very clean chlorine contact tank. The absence of settled solids there means that more hypochlorous acid is available for disinfection at lower dosage rates than in facilities whose operators pay less attention to housekeeping.

The benefit of using digital probes for continuous process monitoring is that operators can see what occurs during the time when the facility is unoccupied. Since municipal wastewater treatment plants generally do not employ equalization basins to store raw wastewater, whatever enters the collection system will flow unattenuated through the treatment processes, unless the collection system itself has an extraordinary buffering capacity. When attached to a SCADA system, the probes may be used to notify operators when some analyte value or set point is exceeded. Following are some examples of the records (histograms) developed from the data record.

DEP staff installed a UVAS probe at the headworks, 2/3 of the distance of the inflow flume following screening and grit removal. The UVAS probe can be set to analyze for total organic carbon (TOC) which is an analog of BOD. Figure 4.1, following, is an example daily record for 9/1/09: one can see that there is a diurnal change of TOC concentration in the raw wastewater during the day, and this peak/valley pattern is repeated in the graphs of successive days as seen in figure 4.2, which shows the UVAS record for August 2009. Use of the UVAS probe would also allow operators to look for loading spikes that might indicate slug loads from commercial or industrial users. If the raw wastewater is not routinely sampled with a 24-hour composite sampler, an analysis can be done to highlight the best sampling time for taking a grab sample: In figure 4.1, the average concentration was 123 mg/L, a point that occurred sometime shortly before noon. As illustrated, a grab sample taken around 9 A.M. for analysis would have been taken when concentration was near its lowest point. For facilities that are manned for only part of the day, we recommend that 24-hr. composite samplers be used for these process monitoring samples.

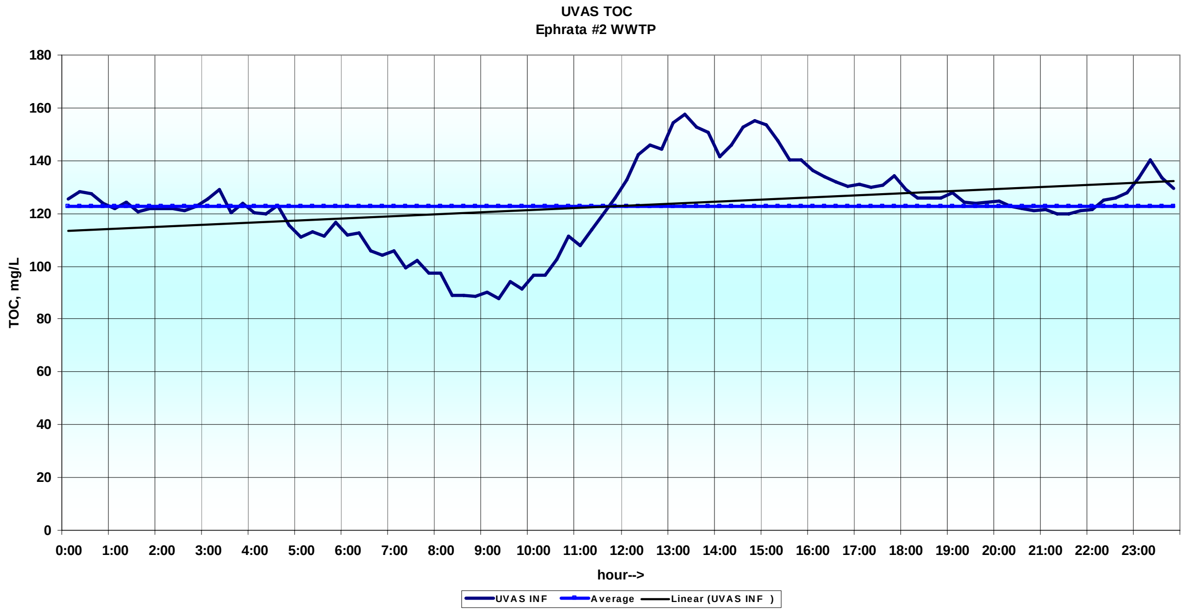


Figure 4.1: UVAS histogram for 8/7/09 shows small peak concentration over course of day, with average concentration in blue, and trend line showing optimal sampling time where trend and average cross (near noon.)

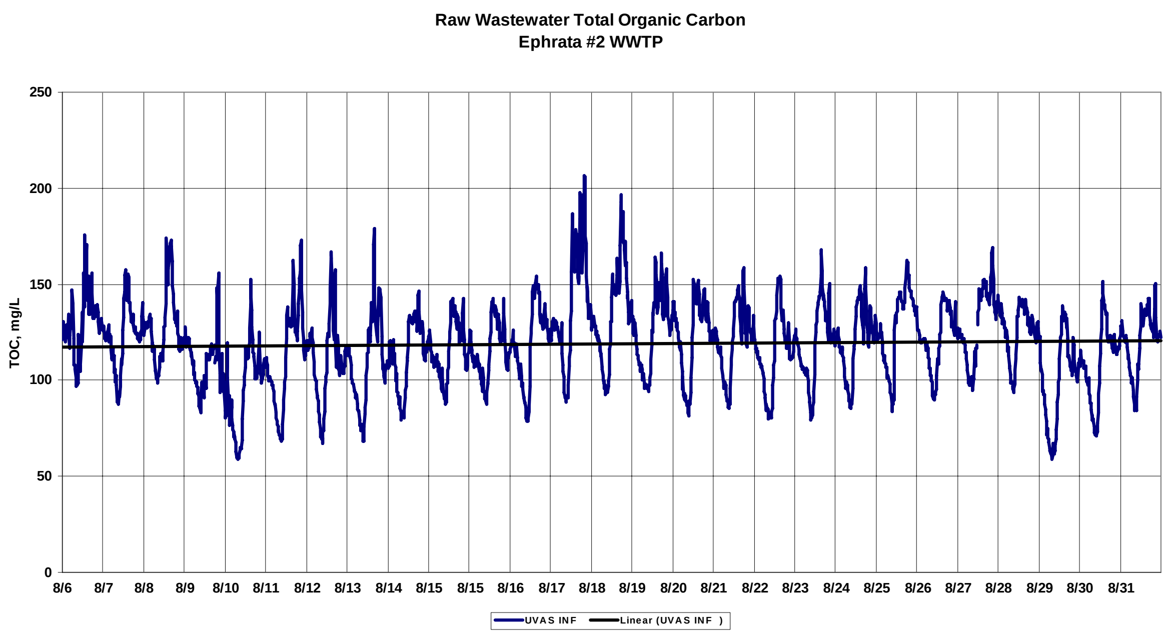


Figure 4.2: UVAS histogram for August 2009 shows diurnal peaks of TOC loading and month avg. conc. of 119 mg/L.

Figure 4.3, below, depicts the mixed liquor suspended solids levels in the aeration tanks during the month of September, adjusted to remove data points determined to be the result of fouling of the probe's working pathway. As seen here, MLSS typically ranged within 200 mg/L of the 2,000 line. Use of the Hach Solitax probe for determining total suspended solids has proven to be problematic in a sewage treatment environment, because there are many fine solids that actually hinder the probe from reliably functioning. During the WPPE, we had to filter data to remove values that were well in excess of the median—"fliers" that sometimes exceeded 20,000 mg/L! The Hach staff reported to us that theses excessive readings are caused by filaments such as human hair obstructing the light pathway of the probe, causing it to report maximum values. Using the Solitax on a regular basis in this environment would require plant operators to check and clear the lens of the instrument at least once per shift. In our opinion, the Solitax probe would probably be best suited for making determinations of TSS levels in the final effluent, where the chance for this type of contamination is greatly reduced.

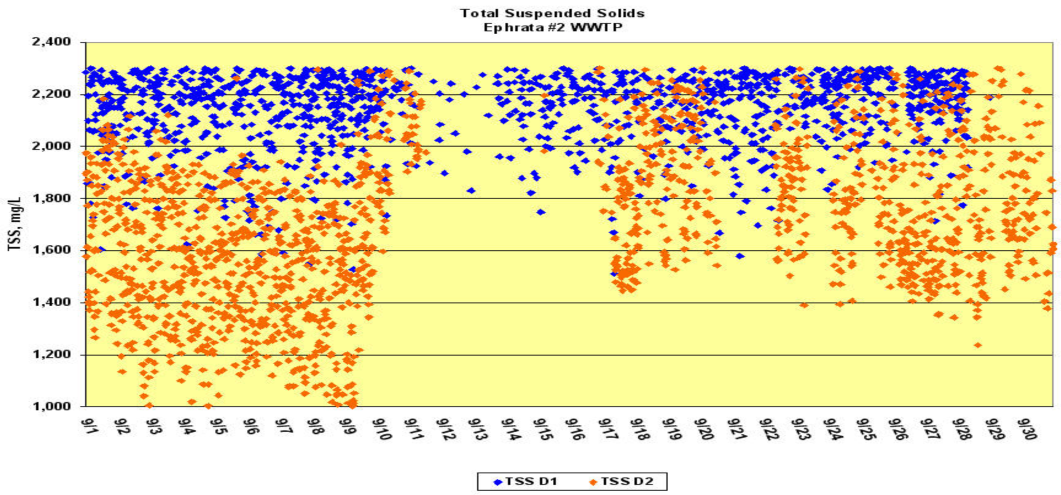


Figure 4.3: Mixed liquor suspended solids

At the Ephrata No. 2 plant, we observed that DO levels were maintained within a range adequate for aerating the activated sludge without excessively over-aerating it, which would have wasted energy and caused floc-shearing, a condition that inhibits good settling in the secondary clarifiers. As seen in the histogram below, DO in the ditches peaked between 3.5 and 4.0 mg/L, which is the recommended level for good aeration. The chart also shows that DO reached minima of 0 mg/L during prescribed anoxic periods, when the rotors were de-energized.

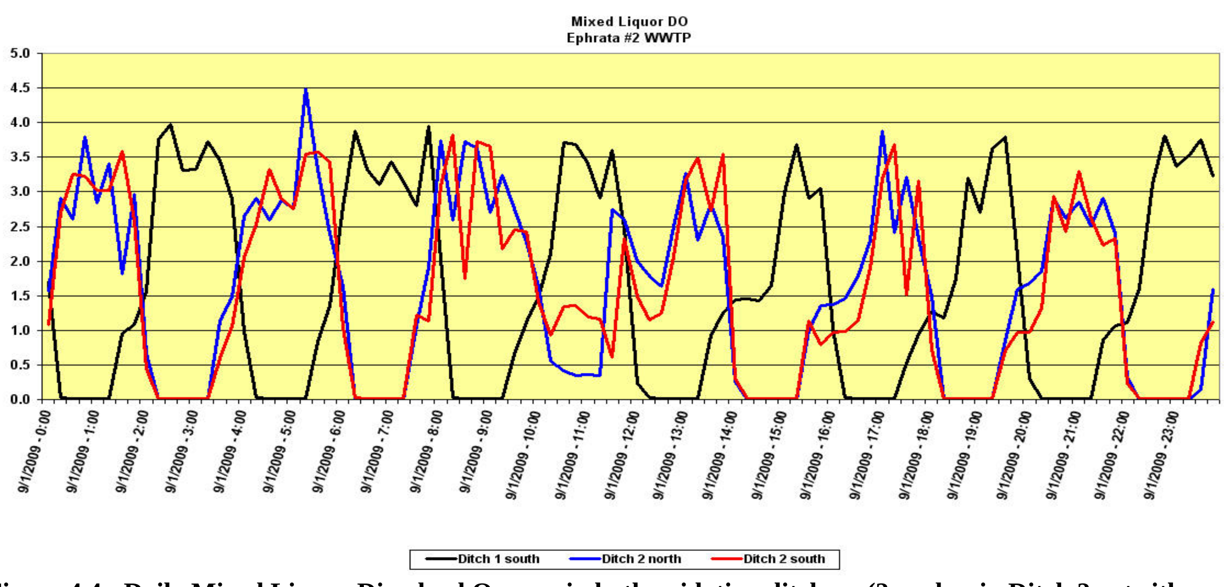


Figure 4.4: Daily Mixed Liquor Dissolved Oxygen in both oxidation ditches. (2 probes in Ditch 2, at either end) for 9/1/09.

Optimal DO range for activated sludge plants is usually between 1.5-2.0 mg/L and 3.5-4.0 mg/L. Any DO over 3.5 mg/L usually represents wasted energy, because the biomass functions adequately within this prescribed range. DO below 1.5 mg/L, when in an uncontrolled condition, usually suggests that either the BOD loading is too high for the aerator capacity or the mixed liquor solids concentration is too high to adequately aerate it. When uncontrolled low DO conditions or "dead" zones occur within aeration tanks, adverse conditions support the growth of undesirable filamentous bacteria that will inhibit clarification, and anaerobic conditions can create obnoxious and foul odors.

During prescribed anoxic periods, the Ephrata 2 oxidation ditches rely on submerged mixers to maintain flow through and mixing within each carousel. For a short time during the evaluation, one of these mixers was out of service for motor replacement; however, there was no negative effect observed in the efficiency of the process.

Figure 4.5, below, shows trend lines applied to the ammonia-nitrogen and dissolved-oxygen data that show as DO maxima steadily decreased, nitrification became inhibited, resulting in increases in the maximum concentrations of ammonia-nitrogen in the mixed liquor. The data suggest that

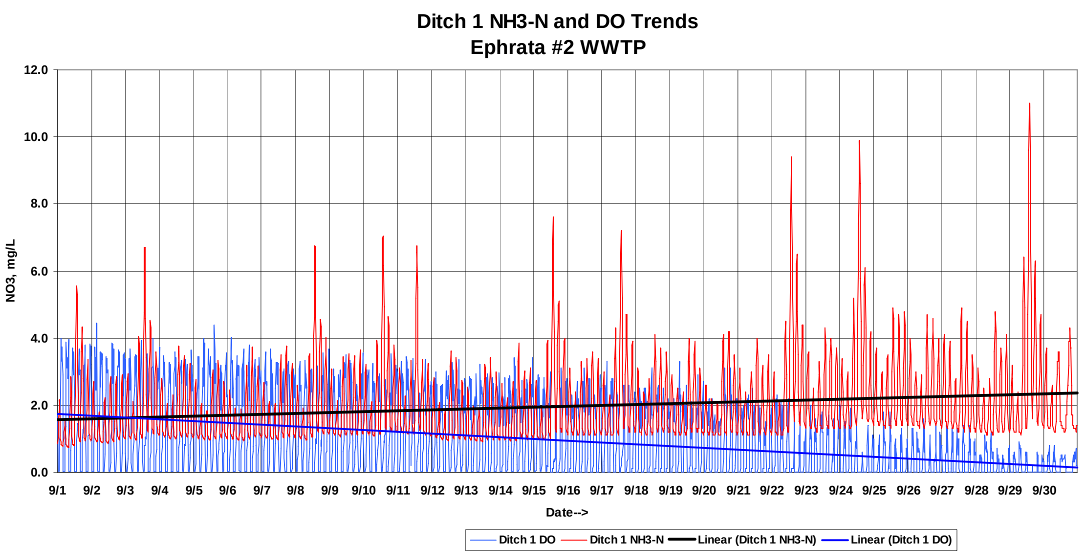


Figure 4.5: Ammonia concentration inverse of DO

use of instrumentation such as the probes lent for this evaluation could notify operators when DO adjustments should be made to the SCADA program to allow for oxygenation rate to increase when a parameter such as ammonia-nitrogen concentration begins to rise.

Figure 4.6 show that during the same period, the DO maxima decreased while ORP fluctuations trended upward. ORP, in particular, never really dipped below +100 mV during the anoxic phase. +100 mV is the upper threshold for denitrification to occur, as happens during the anoxic phase of the cycle. One might interpret this to mean that perhaps the anoxic phase should be extended to allow ORP to drop closer to zero or to less than -100 mV, so that denitrifiers could have more time to remove nitrate from the mixed liquor. This suggests that perhaps the anoxic phase of the ditch should have a longer duration than it currently has, to assure that denitrification is promoted.

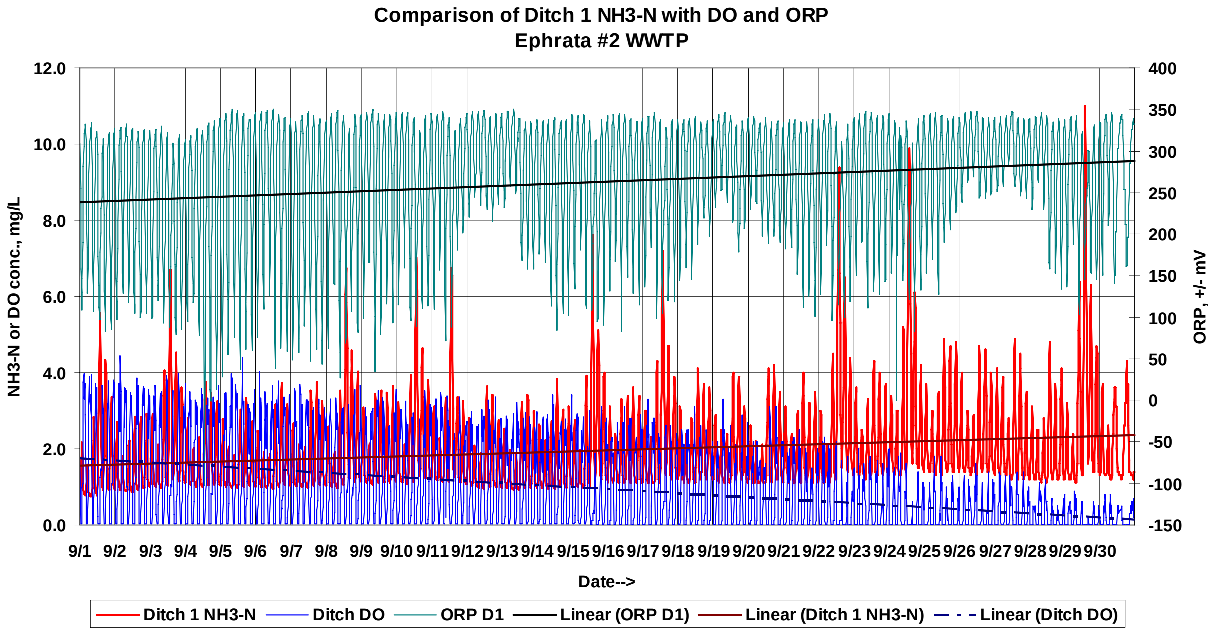


Figure 4.6: Trending of NH3-N with DO and ORP, Ditch 1

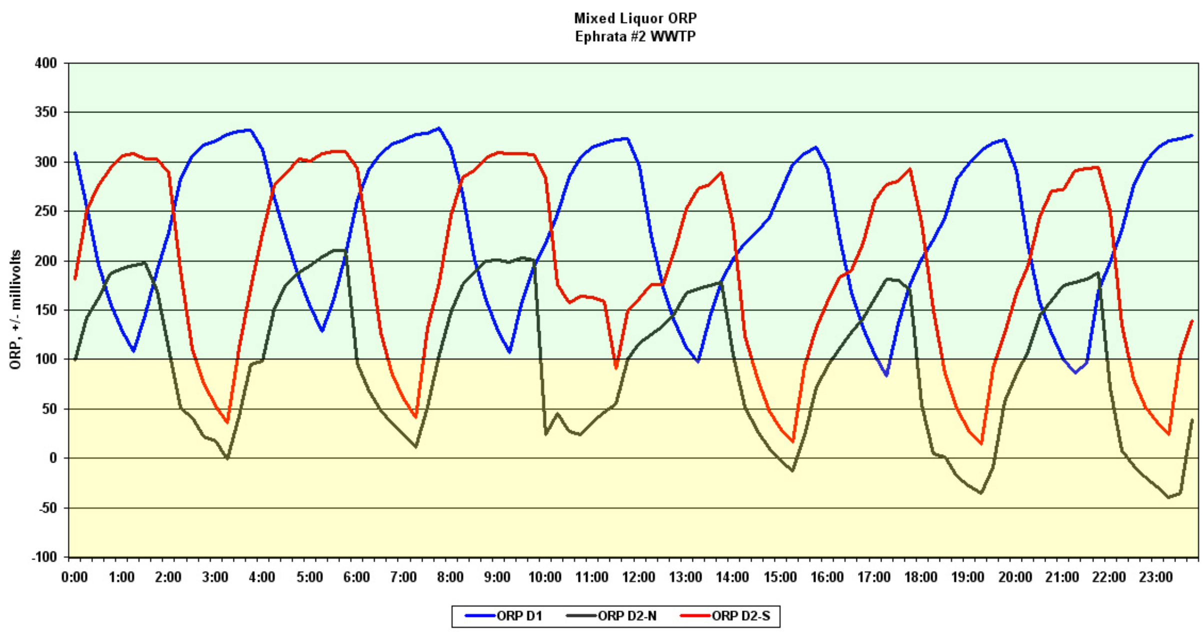


Figure 4.7: ORP Daily Histogram for 9/1/09.

Figure 4.7 shows an example histogram of the mixed liquor Oxidation/Reduction Potential as it cycles through the oxic/anoxic conditions of the treatment process over the course of a single day. The green shading shows the region where the ORP charge supports nitrification; the yellow region, where it supports anoxic conditions and denitrification. Although the system is finely tuned to promote denitrification and biological phosphorus uptake, the ORP usually remained in the oxic condition.

Figure 4.8, below, shows a typical profile for mixed liquor nitrate levels in mixed liquor over a single day, in this example 9/1/09. These data suggest that changes in wastewater strength may lead to an up-tick in concentration levels later in the day, and that denitrification is not sufficient

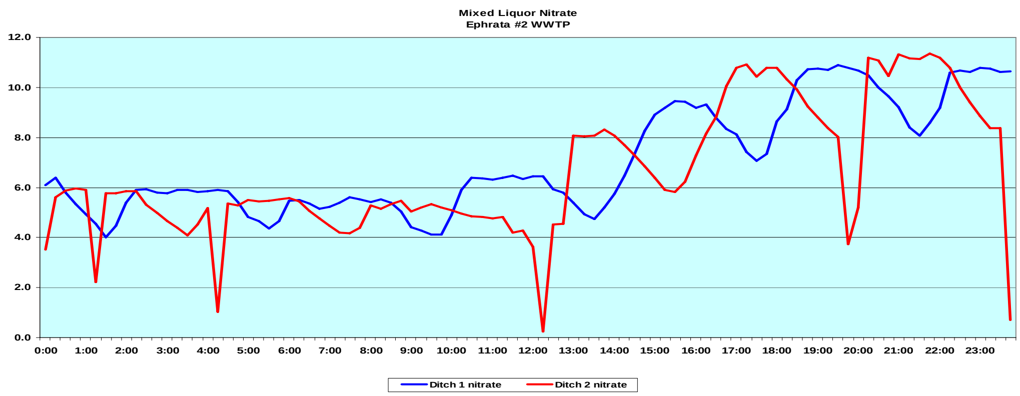


Figure 4.8: Daily Mixed Liquor Nitrate Levels in Oxidation Ditches 1 and 2 for 9/1/09

at that time to make up the difference. The ORP was lower in the north end of the ditch, where wastewater and RAS are reintroduced, than at the south end, which was closed for effluent at the time. There is a hint of a diurnal pattern in the histograms.

Effluent ammonia-nitrogen and orthophosphate-phosphorus are shown in the following figure. Over the course of this example day, the effluent ammonia remained fairly constant, although phosphorus increased slightly, an upward trend seen on days when digester contents were being processed. The equipment used for measuring these nutrients in the effluent stream were much more precise than those used in the oxidation ditches, and the values correlated well with those developed in Ephrata 2's laboratory. Use of the Phosphax probe would allow operators to predict adverse trends in phosphorus concentration, allowing them sufficient time to apply chemical treatments such as ferrous chloride.

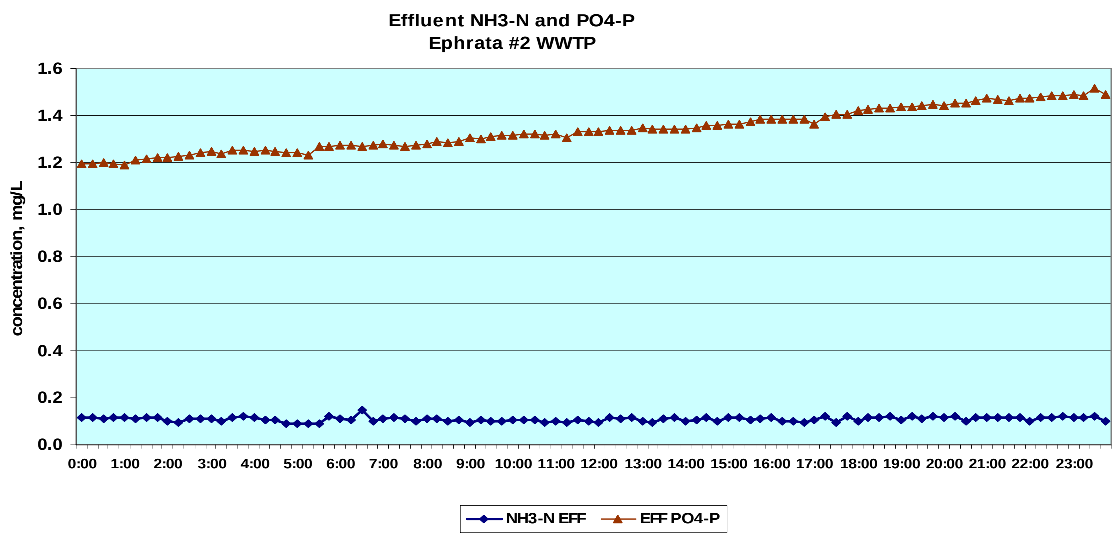


Figure 4.9: Daily NH3-N and PO4-P concentration readings for 9/14/09

Figure 4.10 shows a histogram of effluent phosphorus and ammonia-nitrogen concentrations for August 2009. Many of the phosphorus tests registered null values, where phosphorus was below the detection limit for the instruments.

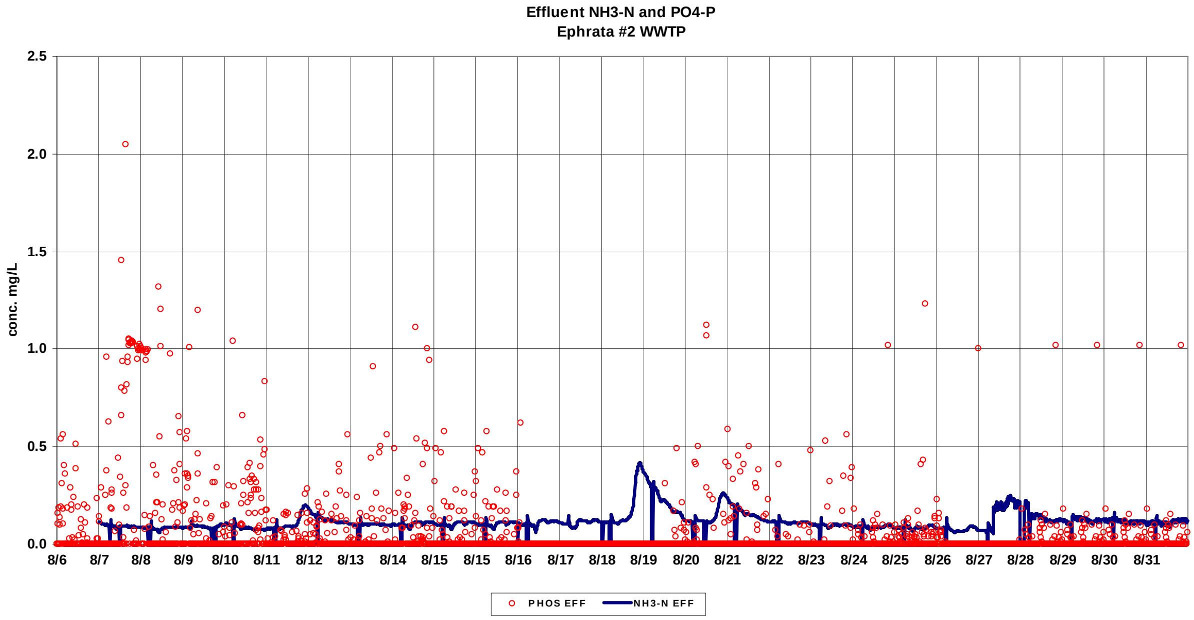


Figure 4.10: Effluent Phosphorus and Ammonia-Nitrogen Histogram, August 2009

In Figure 4.11 below, the DEP Bureau of Laboratories test results for mixed liquor suspended solids are shown. Ephrata 2's operators draw one sample from a point representative of both ditches for their daily solids testing. DEP staff drew samples from each ditch for comparisons. The ditch solids are rather much the same at any given time.

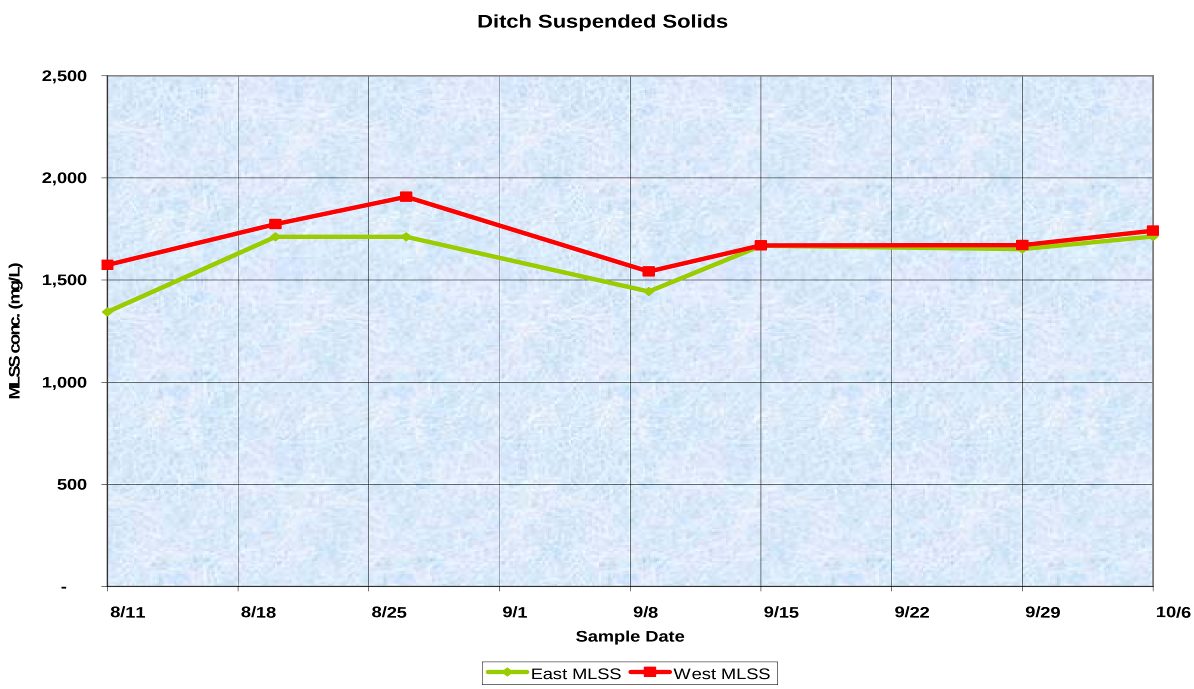


Figure 4.11: BOL Test Results for MLSS, in mg/L.

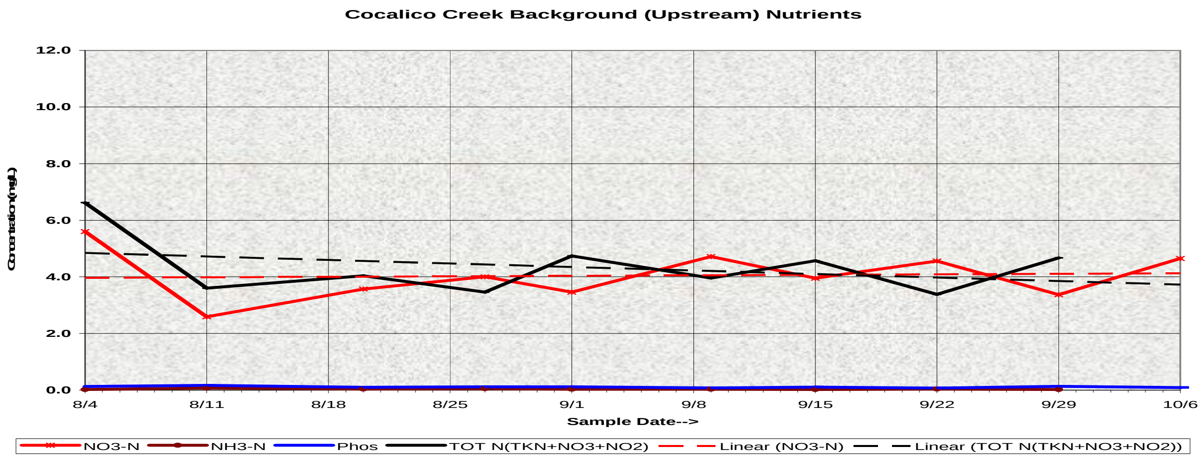


Figure 4.12: Upstream, Background Nutrient Sampling Results

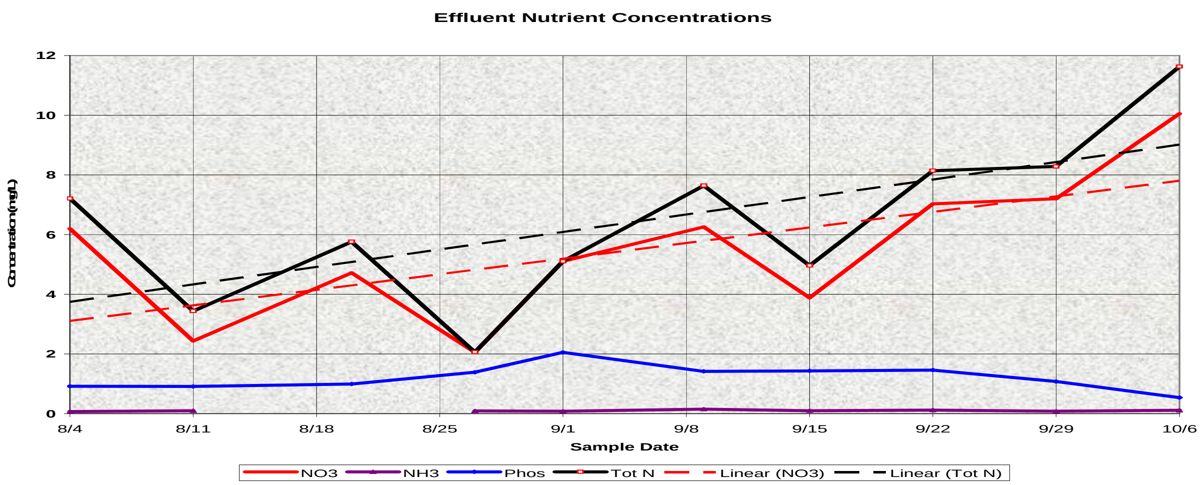


Figure 4.13: Discharge at Outfall 001 Sampling Results

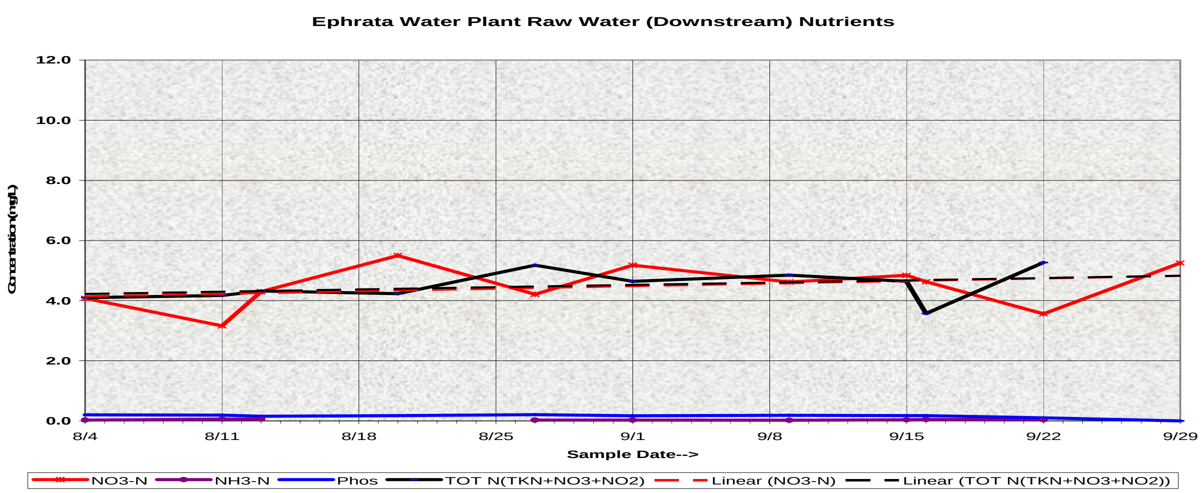


Figure 4.14: Downstream, Impacted Sampling Results

Figures 4.12 through 4.14 depict our lab results for nutrient testing for background (upstream Cocalico Creek,) effluent at Outfall 001, and impacted (downstream.). The evidence of these tests shows that the effluent introduced to the Cocalico Creek does adversely impact the water quality, albeit very slightly, according to the trend lines shown for both the background and impacted samples. Because effluent nutrients did trend upward, a minor trend upward was also observed for the impacted samples taken downstream. However, the impact appears to be very slight.

Microscopy with Digital Photography

A microscope is a beneficial addition to any wastewater laboratory, as Ephrata 2 has demonstrated with their frequent plate counts of indicator organisms. As part of the WPPE, DEP provides temporary use of a microscope so that operators become familiar with the organisms of the activated sludge process, including indicator organisms that may be used to predict the relative health of the biomass and the operating condition of the facility. When asked about the microlife, the operators showed us the operating procedure for conducting microscopy and told us that it is a regular part of the laboratory discipline.

Following are some example photographs of the Ephrata No. 2 activated sludge samples taken during September.

Figures 4.15 through 4.18, below, shows protozoa and metazoa in a mixed liquor sample of the Ditch 2. Stalked ciliates can be indicators of a good settling sludge when present with free swimming ciliates and rotifers. Several samples collected at Ephrata No. 2 contained stalked ciliates, rotifera, and some nematodes. The microscopic analysis supports other indications suggesting that the microlife is reasonably health, at the top of the bacterial growth curve, trending somewhat older but within expectations for phased oxidation ditches.

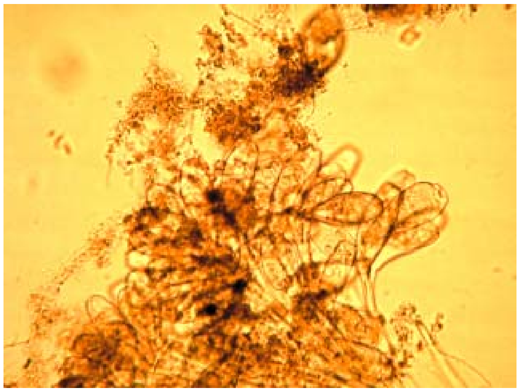


Figure 4.15: Stalked Ciliates in Ditch 1

Figure 4.16: Stentor

Figure 4.17: Vaginocola

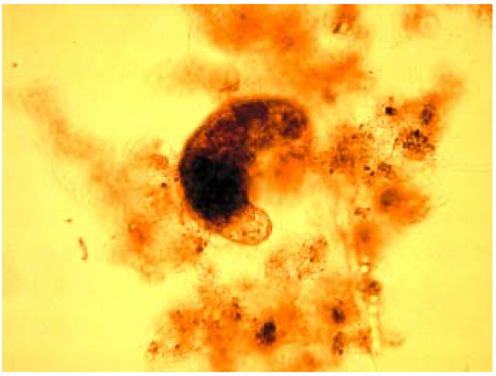


Figure 4.18: Small nematode

5. Process Control

General

The objective of Process Monitoring and Testing is to develop regular monitoring procedures for the individual treatment facility. Typically, an operator chooses to maintain a facility according to mean cell residence time (MCRT) or food-to-mass (F/M) ratio. The objective of these broad parameters is to find a level where plant performance is optimal for the current conditions (including season, amount of precipitation, loading variations, industrial or commercial contributors) and then adjust the treatment processes in order to maintain a steady-state. For example, if an operator runs a facility according to constant Food to Mass ratio of 0.35, if the plant loading (the "food" value) is either naturally constant (based on collection system) or can be sufficiently buffered (using flow equalization tanks), then their objective in maintaining constant F/M is to assure that the biomass (the "mass" value, or the amount of MLSS in the system) can be adjusted through wasting in order to keep the ratio at or near a constant 0.35.

Mean Cell Residence Time is a method by which the operator adjusts solids retention to achieve a steady sludge age. MCRT incorporates a regularly tested solids inventory with adjustments to the wasting rates and an accounting for the expected growth rate due to plant loading. The end result of such operation is an MCRT of x-number days.

Guidance manuals generally suggest that an operator choose a parameter and then operate the facility accordingly. Operators have found that doing so maintains conditions in an optimized state whereby the chance of plant upsets is mitigated or controlled.

Ephrata 2 regularly calculates MCRT for the facility and maintains operations according to the concept discussed. An example chart of MCRT for September is shown below. This practice is commendable, because it proves that the operators are paying close attention to the biological process.

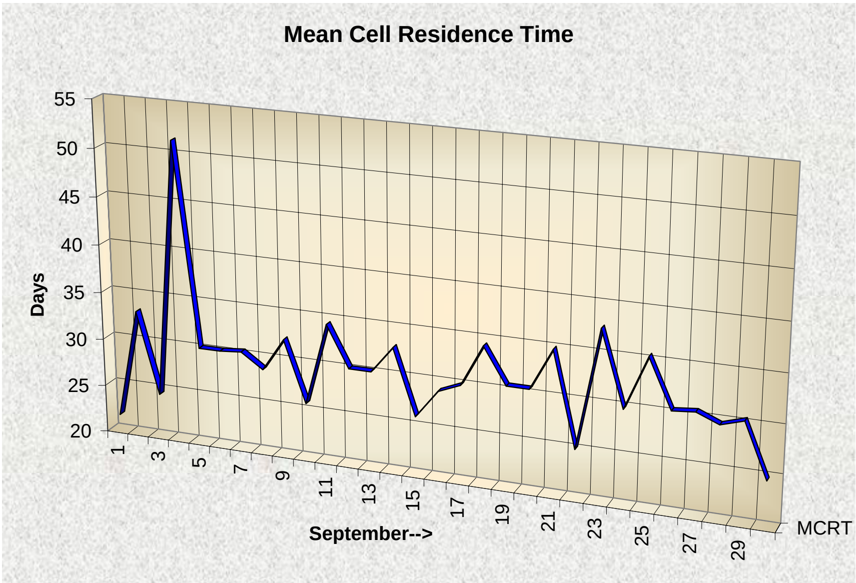


Figure 5.1: MCRT for September 2009.

Permit Modifications

Should the facility contemplate any upgrades or physical changes to the treatment processes, an amendment to the Water Management Permit will be necessary. If operators are unsure whether a permit modification is necessary then they should contact the DEP South Central Regional Office in Harrisburg prior to making any modifications.

When making temporary process changes which could impact effluent quality, whether positively or adversely, the regional office should also be notified, although permit modifications may not be necessary. For example, during the course of the WPPE, one of the submerged mixer motors failed, and the mixer had to be removed temporarily for service. In such cases, it is considerate for the operators to notify DEP of the temporary outage, even though no changes to the treatment process resulted from the event. Such notifications foster better communications between the regulated community and the state, and they actually make things easier for all when something serious actually happens.

No permit modifications are anticipated to be needed at this time, as the facility is running below its design capacity. The plant operators noted, however, that the system may be examined by their consulting engineers to determine whether or not further nutrient control methods will be required in order to meet Chesapeake loading limits when the facility approaches its design capacity.

Solids Tracking

At present, the Ephrata No. 2 facility tracks sludge solids in the oxidation ditches by performing daily gravimetric tests for mixed liquor suspended solids (MLSS) on the outflow to the clarifiers. (Both ditches are considered to be one multi-phased process.) A core-taker is used to monitor solids blanket depth in the clarifiers twice per day, in the mornings and afternoons. It is the practice of the operators to maintain a ½-foot level in the two clarifiers, making that portion of the solids inventory negligible, and the volume of the anoxic selector tanks essentially comprises the mass of solids that one would find in clarifiers at other facilities.

Ephrata employs the mean-cell residence time method for tracking solids retention, and this figure is calculated every day that solids test data is available (usually excluding weekends and holidays.) We have found that Ephrata does well in assaying and controlling their solids inventories.

We employed Hach Solitax suspended solids sensors in each oxidation ditch to track changes in the mixed liquor suspended solids. By itself, use of this instrument can provide the operator with intelligence on the volume of solids under aeration. Correctly used, a solids monitoring probe can be used predictively to warn of increases in solids levels they may lead to decreased performance and/or poor solids settling in the clarifiers. This device is calibrated by comparing to gravimetric solids test results.

However, during the course of the WPPE, we found that the Solitax probe required almost daily attention to clear hair and fibers from the sensor pathway. Without diligent ongoing preventative maintenance, the instrument will yield artificially high readings in an activated sludge environment. For this reason, we do not feel it would prove useful at Ephrata, where there is already a commendable laboratory process in place for tracking solids.

DO findings

The DO readings at this facility swing between maxima of 3.5 to 4.0 mg/L concentration and absolute minima of 0 mg/L, based on the cycling of the brush rotors and the operational phase of the Kruger process. The DO is kept within economic operating parameters by virtue of its SCADA system and ongoing monitoring by plant operators. The biomass depletes oxygen fairly quickly once the aerators cycle off.

DO Grab Testing

During the course of the study, DO grab samples were collected at various locations in the ditches for process control purposes and to validate in-line monitoring equipment. These samples were also used to perform OUR testing on both ditches to analyze biomass health and food supply. Generally, this additional testing validates the effectiveness of the aeration system in use and confirms that there currently are no evident anoxic spots or “dead zones” in the ditches during the oxic cycle. When the rotors were off, of course, the DO was low and even approached zero, depending on how long into the anoxic cycle the testing happened to occur. The online digital probes did a better job of profiling the DO levels in the ditches than our “grab” DO readings, and DO is fairly consistent throughout the ditches. Insofar as it was possible, we conducted a DO profile of one of the ditches over a period of several sampling events, and the data is shown below in Figure 5.2, parts a through d. The illustration depicts the ditch during an oxic cycle. We chose to perform the profile when the one of the rotors was operating.

After the in-line monitoring equipment has been removed the DO within the ditches can be tracked and trended using this same method of occasional DO profiling to ensure sufficient oxygen is available for nitrification to occur. In truth, though, this type of DO profiling is better suited to facilities employing bottom diffusers than rotors, because one can usually find clogged or broken diffusers using this method.

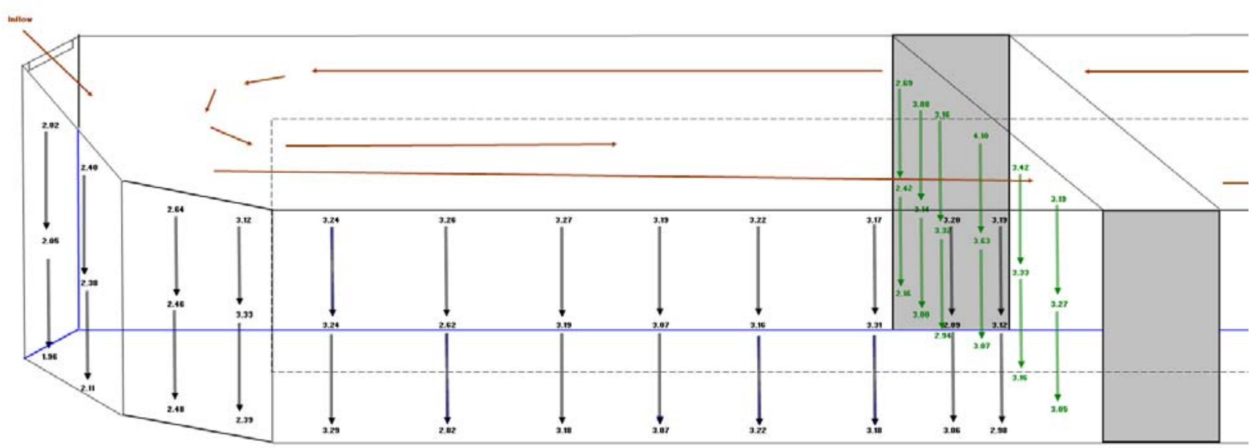


Figure 5.2.a: DO Profile of Ditch 1, August 19, 2009.

Access to the ditch for DO profiling was limited to the west side wall, the two rotor bridges, and the north and south ends of the tanks. Sampling points varied from 8 to 10 foot intervals, and readings were taken at three depths: approximately one foot below the surface, midway, and approximately one foot off the bottom. Because of the number of DO points, the tests occurred during the evaluator's free time among other activities associated with the site visit, so the sampling does not represent a single time event.

To complete the DO profile, staff employed a Hach HQ40d digital hand microprocessor and an IntelliCAL light-based dissolved oxygen (LDO) probe on a fifteen-foot cable. The instrument was calibrated to air, with the cable marked for 1'-0", 5'-6", and 11'-0" intervals. DO readings were recorded to memory on the unit.

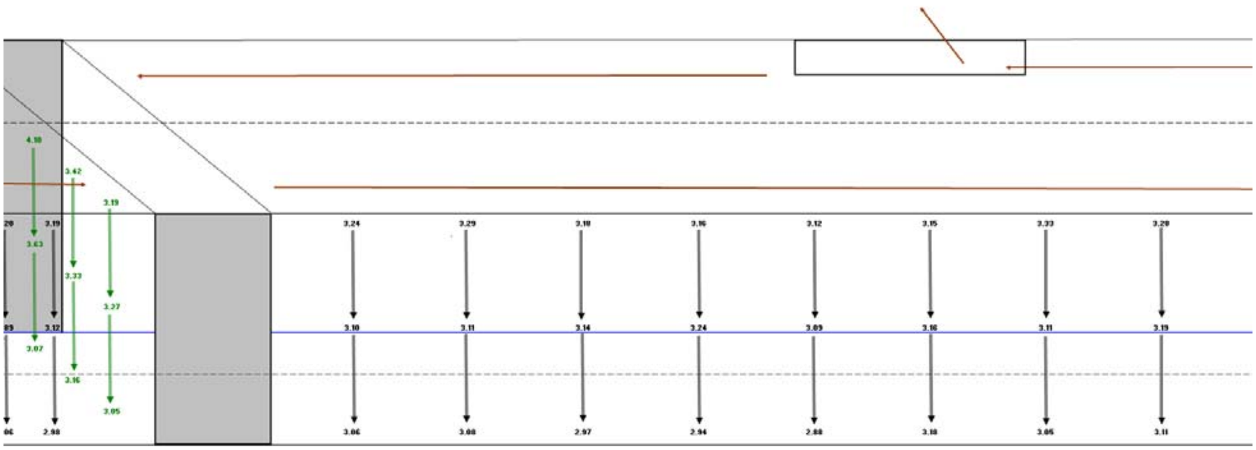


Figure 5.2.b: DO Profile of Oxidation Ditch

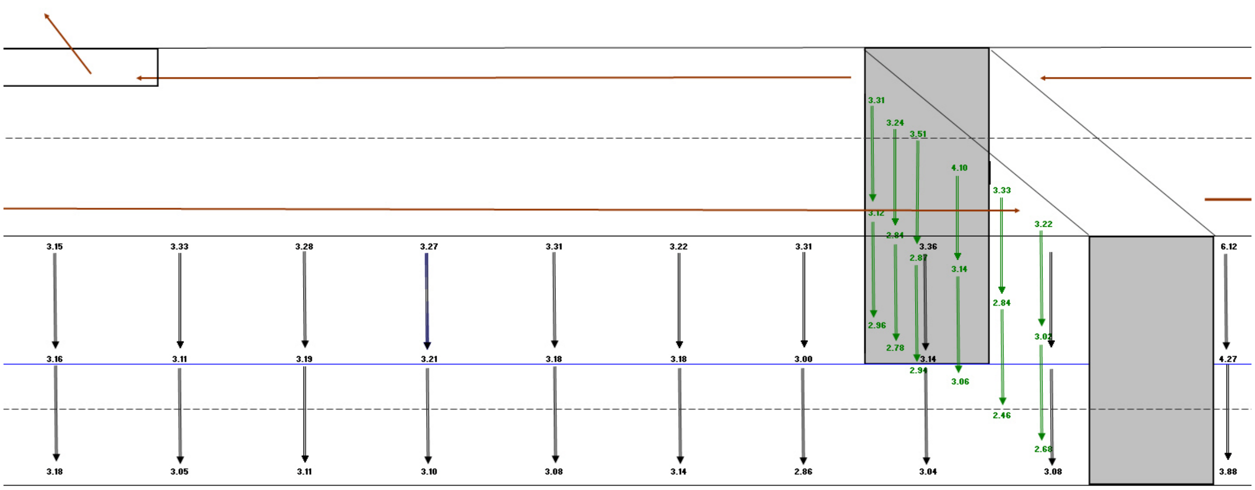


Figure 5.2.c: DO Profile of Oxidation Ditch

The HQ40d with LDO, pH, and BOD probes is part of the portable lab package on loan to the participating facility during the WPPE.

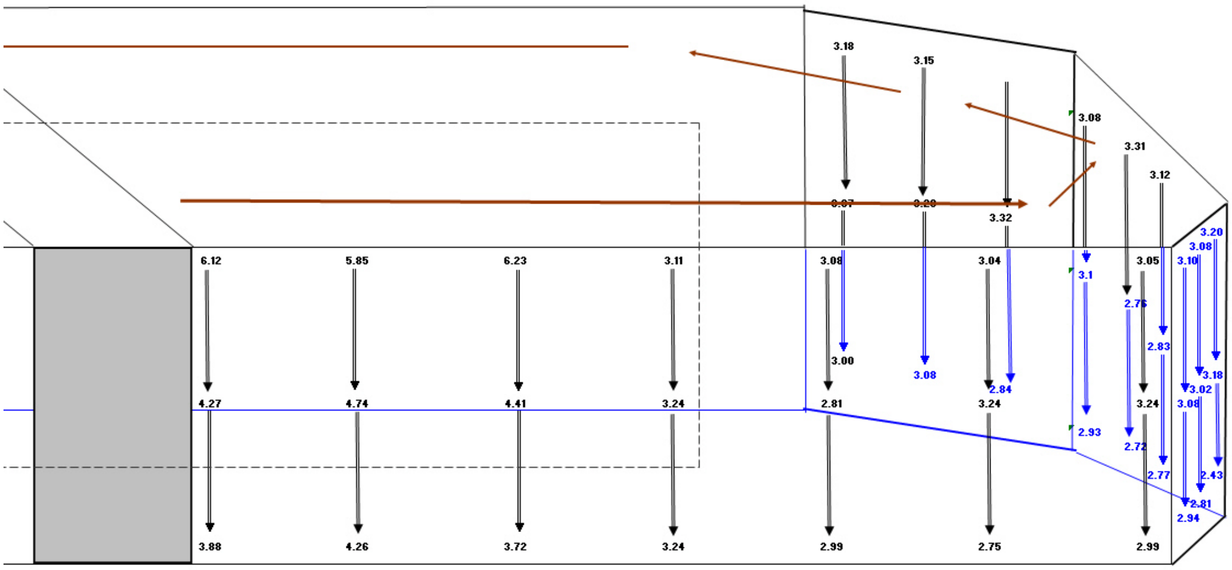


Figure 5.2.d: DO Profile of Oxidation Ditch

The complete drawing is on an Excel file on the accompanying CD disk.

ORP

ORP can be used by the operators to control periods of anoxic or oxic treatment conditions, as described earlier, for the removal of nitrates. The following table depicts ORP values at which denitrification occurs, within the range described by the yellow shading; we have recommended that denitrification occurs best when ORP is within a range of +100 mV to -100 mV. Below -100 mV, the mixed liquor becomes anaerobic, nitrates are no longer the electron sink, and sulphur becomes the electron acceptor of choice, generating that familiar hydrogen sulfide odor.

General values for ORP used to determine which biological condition exists within a particular treatment unit:

ORP (mV)	Process	Electron Acceptors	Condition
+300	1	O2	Aerobic
+200	1	O2	Aerobic
+100	1	O2	Aerobic
0	2	NO3	Anoxic
-100	2	NO3	Anoxic
-200	3	SO4	Anaerobic
-300	3	SO4	Anaerobic
-400	3	SO4	Anaerobic

Table 5.1: ORP Chart

Guide:
1= Nitrification

2= De-Nitrification

3= Methane Formation

ORP readings are typically used in conjunction with the DO readings to identify the effectiveness of a given biological treatment process and the condition of each zone. During the anoxic phase when the DO levels reached 0 mg/L, the ORP readings allowed us to determine if effective denitrification had been occurring.

Nitrate and Ammonia Nitrogen

As observed from the records and from our own data developed during the WPPE, it appears that Ephrata 2 produces on average about 47% of their annual limit for Total Nitrogen. This is because the process in place effectively denitrifies the water prior to discharge. The mixed liquor ammonia-nitrogen detected by the probes averaged 1.2 to 2.0 mg/L. The NH4Dsc probes are not meant for compliance purposes but rather operate in a range that is more useful for process monitoring. At the effluent discharge, the Amtax ammonia-nitrogen test module yielded an average NH3-N of 0.12 mg/L for September, compared with ten 24-hr. composite sample laboratory average of 0.32 mg/L. The lab reports 99% removal of ammonia-nitrogen.

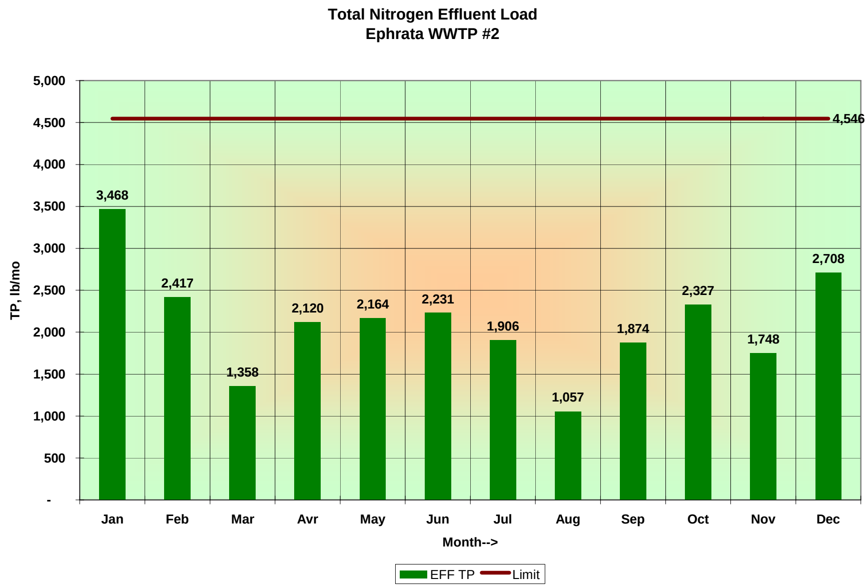


Figure 5.3: Total Nitrogen Effluent Load by Month, 2009, with regulatory limit.

Nitrate-nitrogen, as measured by the Nitratax probes in the oxidation ditches, averaged 6.3 to 8.2 mg/L for September. Mixed liquor nitrate-nitrogen is not evaluated by the laboratory, although effluent NO3-N is, and it is reported on the DMR supplement. The Nitratax probes in the oxidation ditches can be useful for monitoring and trending nitrate production and elimination, so that the phase lengths may be adjusted to maximize nitrogen removal efficiency. (See Demonstration Of Phase Length Control Of Bio-Denipho® Process Using On-Line Ammonia And Nitrate Analyzers At Three Full-Scale Wastewater Treatment Plants, by Zhao, Freed, DiMassimo, et al., of Kruger Inc., presented at the 2004 WEFTEC Conference.)

Without extensive development of the service area in the near future, Ephrata 2 should not have any problem meeting its Chesapeake Bay Compact requirements for total nitrogen.

Phosphorus Removal

The 2009 Chapter 94 report noted that the plant had released a total loading of 4,316 lbs. total Phosphorus to the watershed, some 63% of their annual limit. Laboratory test data for the evaluation period showed phosphorus removal efficiency of about 80% in tests performed twice per week. Figure 5.4 shows the Phosphorus Effluent Loading, by month, for 2009.

DEP staff employed the Hach Test-in-Tube (TNT) rapid orthophosphate test kit for conducting colorimetric analyses of process monitoring phosphorus results, and they deployed a Hach Phosphax automated test station at the final effluent discharge. For the month of September, the Phosphax instrument reported average effluent phosphorus of 1.59 mg/L, compared with the lab's value of 1.52 mg/L.

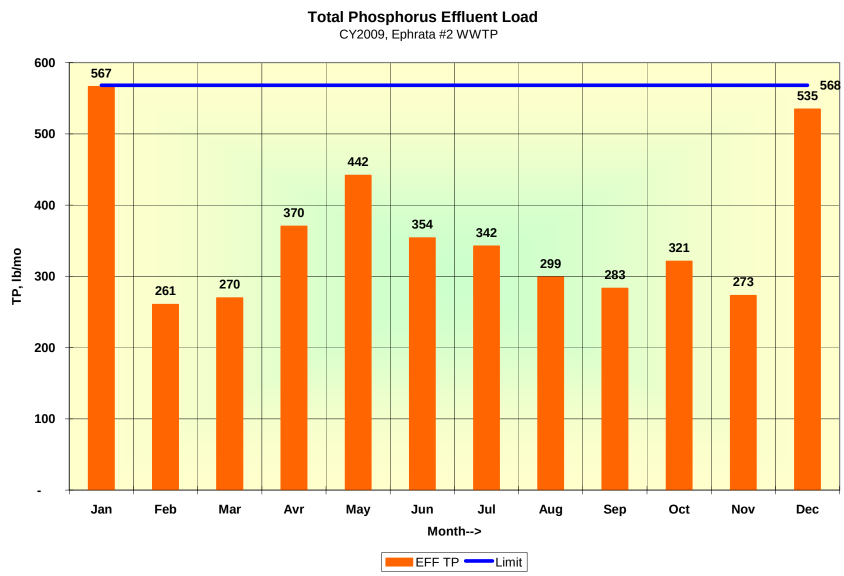


Figure 5.4: Total Phosphorus Effluent Load by Month, 2009, with regulatory limit.

Biological phosphorus uptake is one of the selling points of the Bio-Denipho process, yet even with the best available technology, it is necessary sometimes to supplement this with chemical addition, especially when the biosolids handling operation has been working for several days. Setting an optimization goal to cut phosphorus emissions by a percentage of those shown in this histogram would require additional chemical usage; however, the cost could be balanced by savings made in greater efficiencies elsewhere.

Effluent Nutrient Loading

Figure 5.5, below, depicts the annual effluent nutrient loading for Ephrata 2, based on the Wasteload Management Report for 2009.

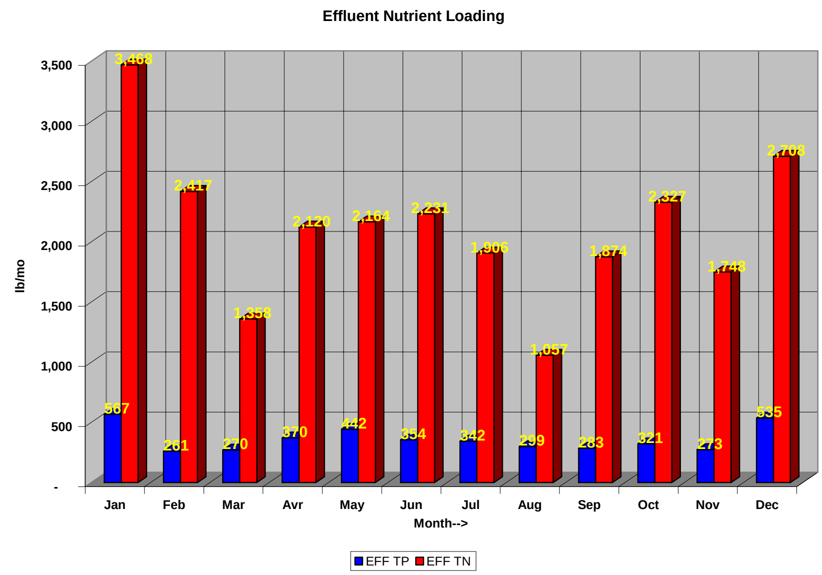


Figure 5.5: Nutrient Effluent Load by Month, 2009.

pH, Temperature

Our study showed that the plant's operating pH and temperatures were normal for the times and conditions observed. Generally, the optimum pH for nitrification is in the 7.5 to 8.5 s.u. range. In Ephrata 2 s case, pH values of 6.8 to 7.0 are typical. There is no chemical addition for pH adjustment. The alkalinity in the effluent is usually less than 100 mg/l. The nitrification process consumes approximately 7.2 lbs of alkalinity for each pound of ammonia converted to nitrate.

Regular testing of the pH of the raw wastewater can predict the quality of the wastewater entering the facility. The pH of the raw wastewater was in the 7.0 – 7.5 s.u. range during the WPPE and the effluent wastewater had a pH in the 7.7 – 8.1 s.u. The NPDES permit typically limits effluent pH to a range from 6.0 to 9.0 s.u.

Clarifier Blanket Level & Core Sampling

The clarifier blankets are measured utilizing a core-taker sampler. Clarifier sludge blanket is measured twice per day to determine at what plant conditions the best effluent is produced by the clarifiers. Operators at Ephrata 2 prefer maintaining a minimal blanket level in the clarifiers, no doubt because of the way the system employs an anoxic selector. Return solids in the selector are exposed to BOD5 from influent wastewater, allowing the denitrifiers to convert nitrate to nitrogen gas.

Flow Measurement

The Ephrata No. 2 totalizer readings were utilized for calculating loadings during the WPPE. During the evaluation period from August 6 through October 6, 2009, the average daily flow was 0.826 MGD and the maximum average daily flow was 1.35 MGD. Minimum flow was 0.665 MGD, and the standard deviation (range within 67% of all measurements fall) was 0.142 MGD. Since the WPPE occurred in late summer and early fall, precipitation was not a significant factor in plant operations while we were there.

Laboratory Tests

A significant part of the WPPE includes sampling on-site using a centrifuge, pH and DO meters, COD heater block, and a spectrophotometer. Also, the clarifier sludge blankets are monitored to define the blanket depth and clarity.

Much of this testing proved redundant at the Ephrata 2 facility, because the laboratory is already accomplishing tests that most other WPPE sites send to contract laboratories. Personnel in the lab demonstrated their alternative procedures for every type of test for which we had prepared the mobile laboratory, some of which are superior.

Nevertheless, it was found during the WPPE that the operators were employing a substantially more time-consuming test for ammonia-nitrogen (Winkler method) that was available in the Hach field kit. Operators were impressed with the preparation time and accuracy of the Hach TNT methods we demonstrated, and they were happy to learn that the method had been approved by EPA for compliance purposes, so they could adopt the method by rewriting their DEP-approved operating procedures and showing competence on the method.

To verify the accuracy of the digital probes, we provided a field spectrophotometer kit that included test materials for several water quality parameters. During the WPPE, we used this kit to determine nitrate, phosphate, COD, and ammonia nitrogen.

Attachment I contains examples of the Process Control Testing worksheets prepared during the WPPE.

The digital-reading microscope is an excellent tool for observing the biomass for indicator organisms. Doing so helps plant operators to determine the relative sludge age and health of the system. Generally, the observance of only free-swimming amoeboids and ciliates indicates a very young sludge, while observance of rotifers and nematodes indicates an old sludge. Ideally, one would observe a dominance of free and stalked ciliates, indicator organisms that show sludge with optimal settling characteristics, near the peak of their growth curve.

Ephrata already regularly assays its biomass through microscopy with plate-counting methods. There was no new ground broken here.

Power Consumption

Electrical usage is commonly the highest expense when operating a wastewater treatment facility. Ephrata 2 presently employs dissolved oxygen probes as part of its SCADA control of the treatment process. Run times on the brush rotors were originally based on oxygen depletion and appropriate anoxic periods. We had suggested to the operators that use of the Oxidation/Reduction probes (ORP) may allow them to fine-tune this process. Use of additional probes such as those for nitrate and ammonium may also help secure the optimal efficiency of the treatment process, reducing power demands. The current SCADA system, installed when the facility was commissioned in the 1990s, may be nearing the limits of its efficacy due to rapid improvements in microcomputer technology; it may be advantageous to add additional capabilities to any planned or future upgrade of the existing system.

Ephrata Borough has a practice of replacing damaged or failed motors with energy efficient motors. A very useful tool for motor replacement guide is the US-EPA's free computer program "Motor Master+ 4.0" which allows plant supervisors to assess motor efficiency and determine costs of replacements. This program is available from EPA's website, at http://www1.eere.energy.gov/industry/bestpractices/software.html

Typically, with motor rewinds, we note the following:

- Traditional fast cheap motor rewinds have an average loss of 20% efficiency each time the coil is repaired.
- Even with reliable repair shops, using OEM or OEM-equivalent materials, the efficiency loss is 1% or 2% each instance.
- We recommend that motors be replaced if:
  - Motor of any age has a rating less than 40 hp;
  - The cost of the rewind exceeds 65% of the price of a new energy efficient motor;
  - The motor was rewound before 1980.

During the WPPE, we did not evaluate the facility's emergency power generator, although we did note that the operators run the generator on a weekly basis according to the manufacturer's specifications.

Laboratory methods

Ephrata 2 has a Class A wastewater laboratory and conducts many process monitoring and control tests on a regular basis. Therefore, much of the equipment that DEP brought to the site for the operators' use was redundant. Typically, the facility conducts testing for both itself and also for the older wastewater plant located within Ephrata Borough (Ephrata 1.) Gravimetric solids are determined every standard work day, yielding the MCRT upon which wasting rates are based. Nutrient and organic loading tests are performed twice per week or more often, if necessary. Data is recorded on several laboratory worksheets and then consolidated on a computer for reports and records.

DEP staff brought on site the following wastewater lab equipment:

- Raven Products Solids Inventory Kit, including Settleometers, Centrifuge and tubes for volumetric solids analysis, and a Core-taker for the clarifiers;
- Hach Field Wastewater Test Laboratory, including a DREL 2800 automated spectrophotometer and test vials for various operations parameters;
- Microscope with digital camera, for recording conditions of the activated sludge biomass.

Use of the centrifuge, settleometers, and core-taker would allow the operators to develop a sludge inventory based on sludge units (SLU), which is a product of both solids-by-volume percent and process volume or total flow. Developing such a sludge inventory also allows the operators to determine a Sludge Age (AGE) for the process, which on a daily basis is used similar to the MCRT as an operational guideline. Volume-based methods for determining solids are quicker than gravimetric testing, requiring only fifteen minutes to spin down the sample, allowing an operator to quickly determine sludge inventory within a facility. One advantage of using sludge age instead of MCRT is that the solids inventory cannot "age" more than one "day" in a 24-hour period the way that MCRT does.

In either case, whether using AGE or MCRT, it is beneficial to plant operators to find an ideal operational set point and then adjust the process to maintain the plant at or near that set point. It is somewhat like flying by instruments instead of using visual flight rules. Intuition and experience with the appearance of the facility does help, but it only goes so far.

Ephrata 2's lab is fully capable of producing both process monitoring and compliance test results for their discharge monitoring reports. It is equipped for nutrient testing, BOD determinations, gravimetric and volumetric analyses, microscopy, and other tests beyond the scope of the WPPE program.

Since Ephrata 2 personnel are already well-aware of their facility's process and its ideal operating parameters, we did not need to conduct regular testing and relied on Ephrata's already substantial records of process monitoring information. It was clear from early on that their laboratory practices are among the best.

eDMR

With respect to reporting, DEP is encouraging NPDES holders to take advantage of its electronic reporting system, eDMR (electronic discharge monitoring reports.) This program can be accessed over the Internet and allows a facility to send its monthly reports to the regulators without employing paper forms. eDMR adds each monthly report to a database that allows for quick retrieval of the historical record for export to other programs, making work with the records easier. Another advantage of this is that the chance for reporting errors may be reduced, because numbers do not have to be repeatedly copied from one form to another. We encourage Ephrata Borough Authority, as we do all others, to use this program.

Inflow/Infiltration

As are many POTWs in the Commonwealth, the collection system is impacted by inflow and infiltration. A maximum daily flow of 3.55 MGD on December 9, 2009, indicates that I/I does exist and, while rare, could adversely affect operations. Continued maintenance on the collection system reduces these impacts. The managers of contributing collection systems feeding Ephrata 2 should maintain their aggressive policy to find and disconnect wildcat connections, storm drains and downspout connections, and root infiltration in its collection system, as indicated in the 2009 Chapter 94 report. According to the records supplementing this and the reports from previous years, Ephrata and its contributing partners are doing a commendable job maintaining their collection system.

Pathogen control

Disinfection for fecal Coliform reduction is currently performed with the addition of chlorine gas. No solids were noted in the chlorine contact tank during the WPPE, because plant operators regularly clean the tanks.

Generally, the recent trend has been to eliminate gas chlorine disinfection in favor of ultraviolet light systems. Doing so eliminates the hazards associated with using gas chlorine, and this may be advantageous, especially because the plant is in such close proximity to the borough's water works. Chlorine disinfection sometimes generates halogenated byproducts in treated wastewater, such as chloramines and organohalides, which may be deleterious to human health when consumed in drinking water.

We make no recommendation concerning changes to the current disinfection process; however, when funding and conditions exist (such as equipment replacement, plant upgrades, etc.), alternative methods for disinfection should be evaluated.

Drinking Water Pathogens

One of the driving factors for development of the WPPE program was to see if sewage treatment plants can reduce the number of drinking water pathogens that are released with the final effluent. In particular, the cysts of *Giardia lamblia* and the oocysts of *Cryptosporidium* are highly resistant to conventional disinfection processes, and for some unknown reason, these organisms are generated in high numbers from sewage treatment plants. This is of growing concern because downstream drinking water plants which use surface water sources must now meet ever-increasing restrictions on the quantity of these cysts—essentially, no cysts at all—in the finished drinking water. Recent sorting of water works into bin groups has resulted in some surface water filtration plants being required to achieve 99.99% removal of these parasites, usually at great capital expense.

Attachment F shows a table of test results for Method 1623 testing performed at Ephrata 2 and Cocalico Creek during September 2009. The charts below reproduce the data from that attachment here. In figure 5.6, the level of *Giardia lamblia* cysts found in 10L samples is shown. In this illustration, the treatment plant produced a much higher quantity of *Giardia* cyst than was present in the upstream samples, where concentration averaged 3 cysts per 10 liters. Giardia was found in lower quantities at the downstream, drinking water plant intake, where the average level was 2.7 cyst per 10 liters. The treatment plant levels of 139 cysts per 10 liters in September may represent contamination washing into the collection system through surface water run-off or it could be due to the presence of rodents within the collection system, where their contaminated feces are flushed downstream during rain events. The high number of *Giardia* does not indicate that the disease causing organism is endemic in the population of the service area; neither does the test indicate whether the organisms have been inactivated by disinfection methods.

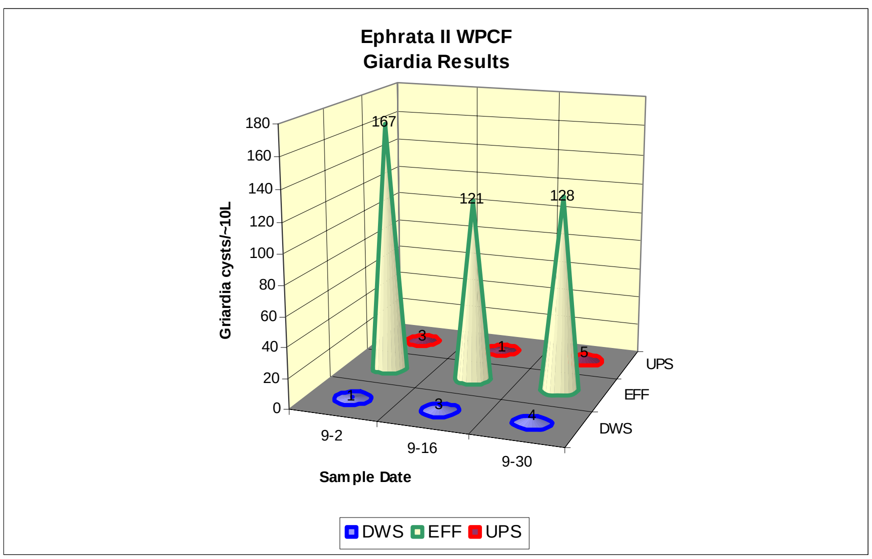


Figure 5.6: *Giardia lamblia* cysts per 10 L sample, taken over 28 days.

Downstream pathogen sampling demonstrated some reductions in *Cryptosporidium* oocysts as shown in Figure 5.7, below. *Cryptosporidium* was present in the upstream background samples but was not detected on two sampling events in the downstream samples. The oocysts dropped of significantly in the effluent samples, despite the fact that optimization efforts at the plant amounted to no more than increased vigilance in the operation. The presence of pathogens during the summer months is more a function of increased zoological and biological activities concurrent with the time of year; it may be that as September grew slightly colder during the evenings, rodent and wildlife activities in or near the collection system slowed. However, given only three sample events, no statistical conclusion may be drawn from this evidence. Our conclusion is that the data do not show any trend based on optimization; rather, the apparent reductions are more a function of outside factors, most notably agricultural sources upstream and rodent activity nearby or within the collection system.

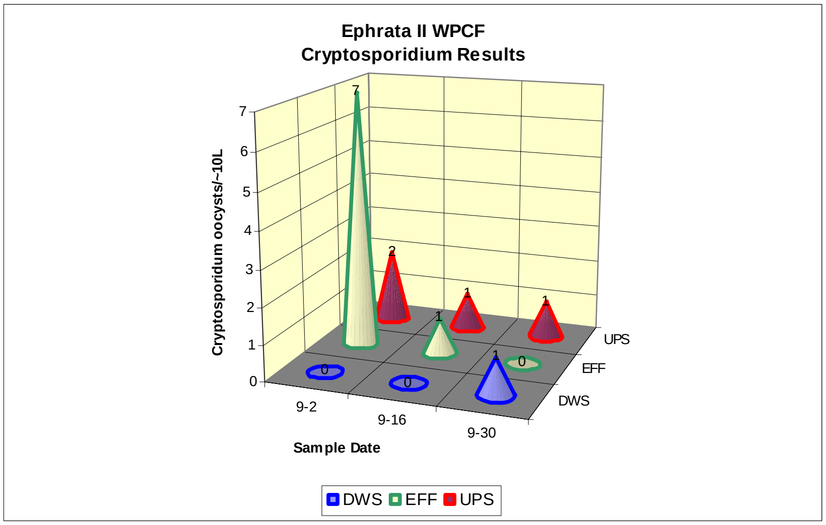


Figure 5.7: *Cryptosporidium* oocysts per 10 L sample, taken over 28 days.

We have hypothesized that pathogenic, parasitic organisms such as these tend to accumulate in suspended solids. If the treatment plant is working properly, without excessive ashing of solids in the effluent, one can infer that the incidence of pathogenic organisms will be low or null. We noted that during the evaluation, we did not observe solids carry-over into the disinfection tank or the effluent line. Reduction of *Cryptosporidium* may be due to good solids control.

Figure 5.8, below, compares *Giardia* cyst to effluent flow in an attempt to look for correlation.

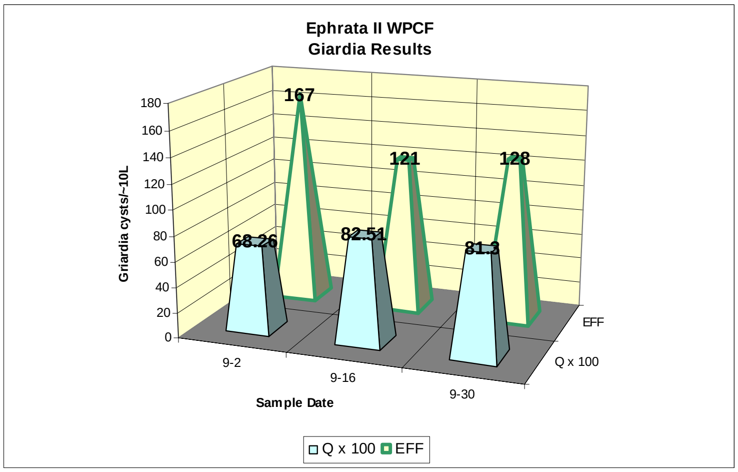


Figure 5.8: Giardia cyst levels versus Effluent Flow (MGD x 100)

There was almost an inverse relationship; however, the confidence interval was too low for us to be certain the two parameters were even related. One of the problems of the Method 1623 testing as originally envisioned is that there is insufficient quantity of samples, due to the high cost of the laboratory assay, to make a statistically significant population. We would have liked to generate a background population of at least twenty sample events, taken over the course of the year, to make a sound statistical analysis. Given the numerous factors contributing to *Giardia* cyst concentrations in the creek, we cannot say for certain why they are there and where they come from.

Thus, testing for drinking water pathogen reduction proved inconclusive during this WPPE. There had been no significant change to the way the plant was operated during the project, but the test results did show that *Giardia* and *Cryptosporidium* are endemic to sewage treatment plants, and even the most well-operated plants like Ephrata 2 do not satisfactorily kill these pathogens.

Researchers have proposed that destruction of these pathogens requires use of multiple methods of disinfection: chlorination combined with UV, UV combined with ozone, conventional disinfection combined with membrane filtration. Such a level of pathogen reduction is presently above any reasonable expectation of the costs associated with treating sewage.

DEP staff investigated the relatively high background pathogen counts. In the neighboring township along the Cocalico Creek, upstream from both Ephrata II and the Water Plant, staff observed many cattle standing in the creek. There were no riparian buffers along the creek in this agricultural zone; the fences or wire actually appeared to create a zone in the creek where the cattle could wade. The photograph shown here provides just one example of the potential sources of *Cryptosporidium* and *Giardia* entering this source water:

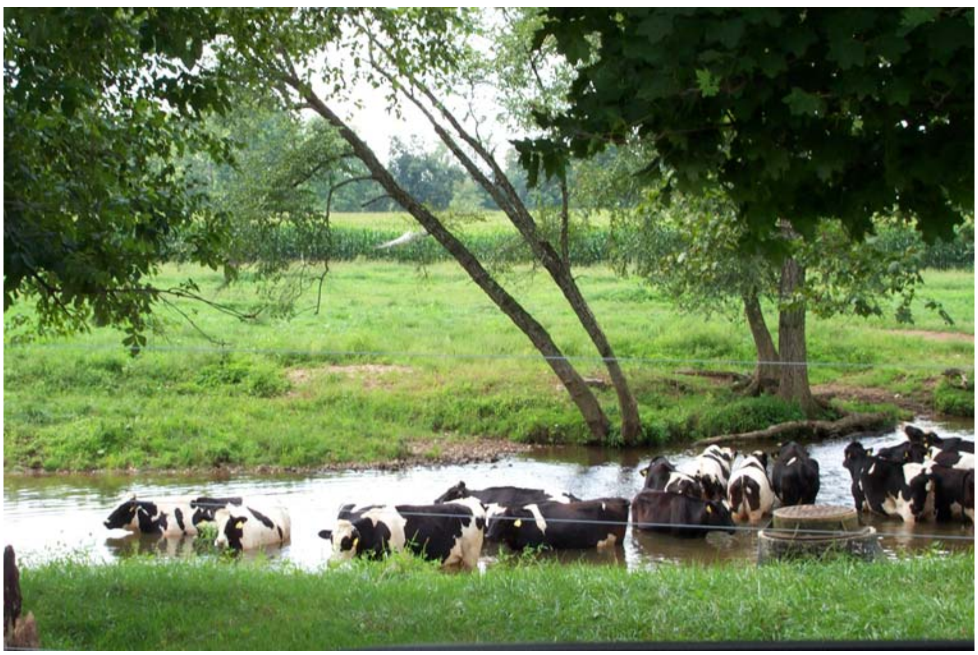


Figure 5.9: Cattle in Creek near Cocalico Creek Road at Covered Bridge

Although Ephrata II does contribute large amounts of *Giardia* to Cocalico Creek, relative to the upstream watershed, it is readily apparent that there are other significant sources present. Figure 5.9 above, shows cattle wading in the Cocalico on a late summer day. It appeared that the pasture wires actually promote use of this particular watering hole, with no consideration of the water works or other uses downstream. Because POTW Optimization is not favorable to the removal of these pathogens from the plant effluent, and because there are other sources upstream which contribute them to water works downstream, it is incumbent upon the water filtration plant staff to assure their filtration and disinfection processes continue to be top-notch.

Therefore, it is recommended that plant operators be aware of the potential for pathogen occurrences and share information with their colleagues at the water works downstream. This may be done by occasional testing; however, it is very expensive. A substitute method may be to correlate Effluent Total Suspended Solids and Fecal *Coliform* testing to *Giardia* and *Cryptosporidium* testing: Essentially, whenever plant effluent solids or fecal Coliforms are high, operators can warn the water works that there is a potential for high pathogen loads in the Cocalico, so that the water works operators may initiate higher levels of disinfection or pathogen destruction.

Conclusions

During the course of the evaluation, it became evident that pathogen reduction by virtue of minor process changes would not yield the results which we had originally proposed to the operators. Cryptosporidium and Giardia are evident in the effluent of the Ephrata facility, although effluent total suspended solids were non-detectable throughout the WPPE. We feel there is insufficient information at the present time to conclude whether or not the presence of pathogen cysts is related to the level of effluent suspended solids.

Because we could not determine ways for the facility to control these waterborne pathogens without investing significant time and money in additional treatment technologies, it is important for the operators to know that there will be times when the facility is likely to see an increase in Giardia and Cryptosporidium in the effluent. One such example is when there is a heavy rainfall following a long dry period, resulting in a flush of the collection system, usually due to inflow and infiltration. At such times, it would be helpful if the operators could notify their colleagues at the downstream water works that a high potential exists for increased pathogens. The water works could then take necessary steps, such as switching their water sources from Cocalico Creek to the municipal wells.

Further, as we had noted potential upstream sources of surface water contamination, the Borough of Ephrata should enter into discussions with adjoining townships to erect buffers between cow pastures and the waterway. This is a difficult issue that is outside the scope of this report; however, it is a reminder that the best solution to contamination of the surface water is to avoid polluting it in the first place.

It should be possible for the facility to employ inline, continuous nutrient probes such as those used for the evaluation, to make adjustments to the duration of the nitrification and denitrification phases of the Kruger cycle. We recommend that the facility work with a vendor to further investigate how continuous monitoring technology can be integrated into the existing SCADA system to supervise the length and duration of the nitrification and denitrification cycles. The most basic addition to the system would be to use Oxidation/Reduction Potential in conjunction with existing Dissolved Oxygen probes: The ORP probe could be used to assure that the denitrification phase is of sufficient duration for denitrification to fully deplete soluble nitrate.

To fine-tune the phase lengths, both the ammonia-nitrogen and the nitrate probes could be employed in addition to the use of DO and ORP probes, which would allow the operators to determine phase lengths based on the reduction of ammonia and nitrogen. Phase lengths would be directly related to the desired level of nutrient removal, reducing energy demand by shortening phase lengths to just the amount of time needed to achieve ammonia or nitrate reduction. Any or all of these probes could easily be integrated into an upgraded SCADA system.

Given that the facility has been operating below its design capacity, and because development of the surrounding community has not been as swift as anticipated, the Borough might benefit from establishing a haul-in waste program to profitably take advantage of unused capacity. Alternatively, it may be possible to use excess capacity to take some of the loading off the Borough Authority's other wastewater plant, until such time as capacity is required by the facility's service area.

Some recommendations for improvements that could further benefit the facility follow here:

- Consider using ORP probe in addition to DO probe to evaluate nitrification/denitrification in the SCADA system that runs the PID;
- For additional fine tuning of the duration of cycles, consider adding ammonia and nitrate probes to the PID;
- Save laboratory time by adopting the EPA-approved Hach TNT method for determining ammonia nitrogen on the bench;
- Experiment with ferrous chloride dosing points in the side stream flows from solids dewatering, to optimize chemical use for phosphorus reduction when biological operations seem not to be operating efficiently;
- Continue cross training personnel in operation of the biological treatment system;
- Notify downstream water works personnel to be alert for increased crypto and *Giardia* cyst concentrations when the region experiences significant rainfall following extended dry periods, for the initial flush of the collection system will result in higher cyst concentrations;
- Work with water works personnel to reduce pathogen contamination of Cocalico Creek by encouraging upstream agricultural users to build stream bank erosion controls and to keep cattle out of the creek, especially during drier periods of the year;
- Consider ongoing upgrades to the SCADA system, to reap benefits of technological improvements since the initial installation;
- Use eDMR for routine discharge monitor reports;
- As long as the facility remains underutilized due to lack of continued economic development in the region, consider using excess plant capacity for hauled-in wastewater, in accordance with carefully developed internal policy, to generate additional revenue for the Borough or the Authority.

During the WPPE, we learned that the facility is already operating in an efficient state with respect to nutrient control, although it is still possible to achieve further efficiencies. We encourage the facility operators to use this as a starting point to setting annualized optimization goals for the reduction of nutrients, for the increase of energy efficiency, and for overall fine-tuning performance factors, in order to reinforce a culture of continuous quality improvement. In all respects of general operation and maintenance, Ephrata 2 is a top-notch facility that should continue to produce quality effluent well into its future.

6. Downstream Water Treatment

The nearest downstream surface water filtration facility from the Ephrata 2 plant is the Ephrata Water Works, PWS #7360045, whose raw water intake is approximately 1.7 stream miles downstream on Cocalico Creek from Ephrata 2's outfall. The facility is supervised 24/7 over three work shifts and includes a swing shift.

Cocalico Creek originates near Stricklerstown in Millcreek Township, Lebanon County, at an elevation of 1,320 feet, and it flows south for ten miles, then southwest for another sixteen miles, to its confluence with the Conestoga River at Talmage in West Earl Township, Lancaster County, at an elevation of 278 feet. Its watershed has a total area of 140 square miles. The name Cocalico is a Lenape description for "snake dens."

Constructed in 1935, the Ephrata Borough Water Works serves the community of Ephrata Borough and surrounding townships (West Ephrata, Clay, West Earl). In addition to Cocalico Creek, there are ground water wells that supply water to the system. The Ephrata Area Joint Authority provides water to about 17,937 consumers through 7,703 metered service connections. Treatment consists of alum for coagulation, aeration, flocculation, sedimentation, dual media filtration and disinfection. Figure 6.1 shows the treatment schematic for the Ephrata Water Works. Note the availability of groundwater sources when the Cocalico is too turbid for use.

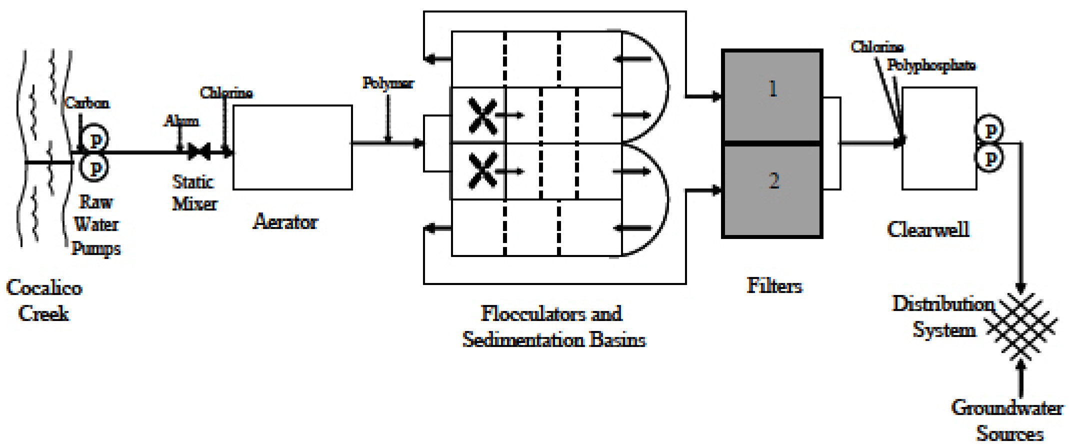


Figure 6.1: Treatment Schematic for Ephrata Water Works

During the WPPE, we sampled our downstream (impacted) water samples from the raw water tap in the laboratory at the Water Works. The sampling protocol for the WPPE required that, for every WWTP effluent water sample taken for analysis, samples of surface water source background (Cocalico Creek—Upstream) and effluent-impacted (Cocalico Creek—Downstream) would be sampled and tested for the same parameters. The only difference is in the BOD-5 test: effluent tests employed inhibition of the nitrification process while upstream and downstream samples did not. The results of all tests conducted on our behalf at the Bureau of Laboratories facility in Susquehanna Township, Dauphin County, are summarized in Attachment E. For the purposes of this section, we confine our discussion to the samples taken at the raw water tap.

Figure 6.2 shows a map of the immediate watershed surrounding the intake to the water works. The watershed is 55 square miles and is mostly agricultural (54.4%) and wooded (39.4%) according to the Source Water Assessment Program Report (June 2003) prepared by the Susquehanna River Basin Commission. With regard to the watershed generally, the area is seeing increased development mostly south of the Pennsylvania Turnpike. This development has been curtailed by recent economic downturns, most recently the one beginning in 2008 and continuing through today.

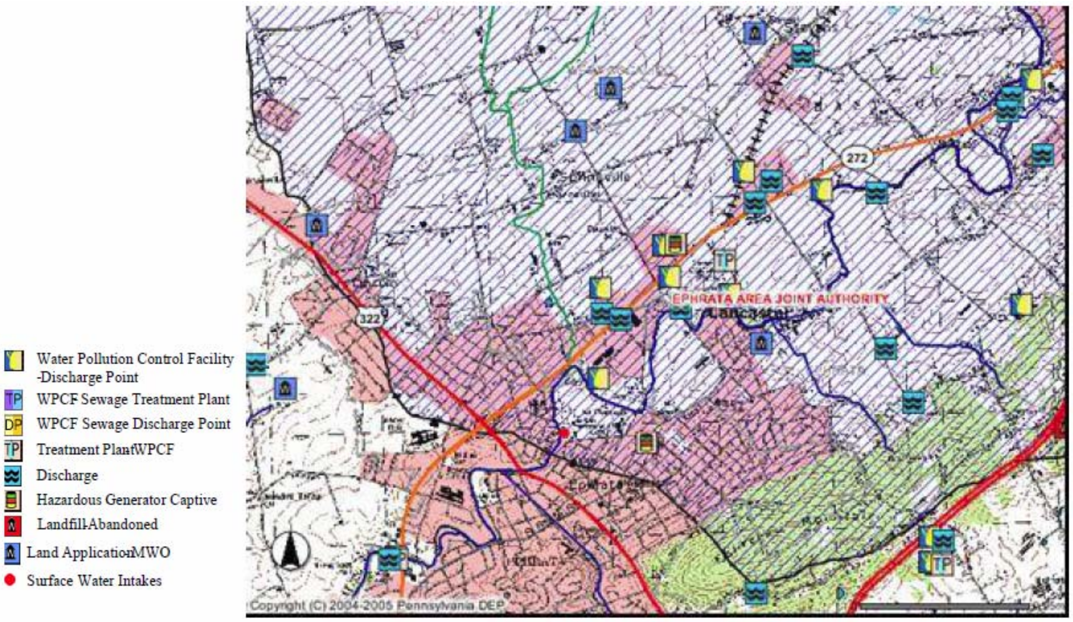


Figure 6.2: Watershed & Pollution Control Points for Ephrata Water Works

Potential pollution threats include the Pennsylvania Turnpike and other major roads and arterials, agricultural and livestock activities, sewage treatment plants, on-lot sewage systems, quarries and other activities that impact water quality characteristics. There are several direct wastewater discharges to Cocalico Creek from industrial and commercial facilities in the watershed, two hazardous waste sites, and one residual waste site. The maps below show some of the potential pollution sources and DEP regulated activities that occur in the watershed near the intake according to the Department's eMapPA program.

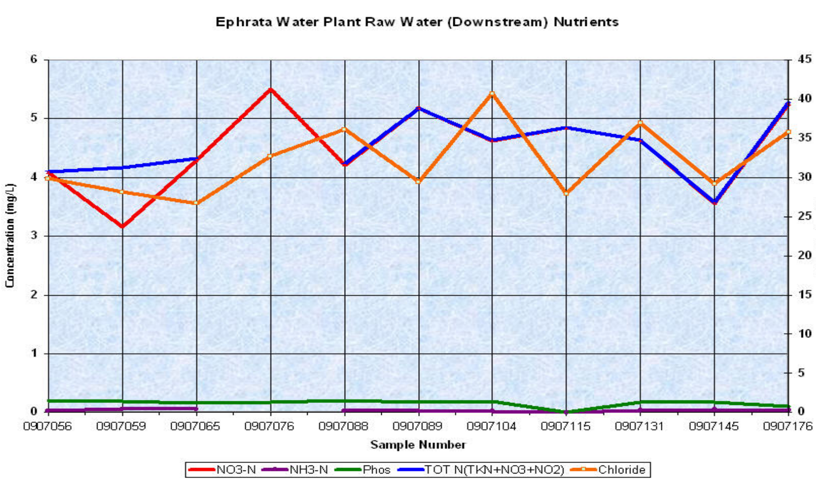


Figure 6.3: Graph of Downstream Nutrient Concentrations

Personnel at the Ephrata Water Works cooperated well with the needs of the WPPE, making their raw water tap available for sampling, answering questions, and showing us the facility process while discussing its strengths and weaknesses.

Raw Water at Ephrata Water Filtration Plant
(Downstream of Ephrata II Outfall 001)

Date	8/4	8/11	8/13	8/20	8/27	9/1	9/9	9/15	9/22	9/29	10/6	Avg.
Sample #	**056**	**059**	**065**	**076**	**088**	**089**	**104**	**115**	**131**	**145**	**176**	**mg/L**
BOD	1.1	1.2	0.7	1.3	0.6	1.2	1.1	1.1	0.6	0.9	1.1	1.0
TSS	<5	7	9	37	<5	15	<5	5	5	<5	<5	9.4
Alkalinity	115.4	107.2	122.6	147.8	138.4	147.4	138.8	133.8	129.6	116.2	129.8	129.7
NO2-N	0.02	0.01	0.02	0.03	0.02	<0.04	0.02	0.01	0.01	0.01	0.02	0.019
NO3-N	4.08	3.16	4.3	5.5	4.21	5.18	4.62	4.84	4.63	3.56	5.25	4.5
NH3-N	0.03	0.06	0.06		0.03	0.03	0.02	<0.02	0.04	0.05	0.04	0.038
TKN		<1.00	<1.00		<1.00	<1.00	<1.00		<1.00	<1.00	<1.00	<1.000
Phosphorus	0.203	0.195	0.158	0.178	0.208	0.171	0.186		0.179	0.18	0.103	0.176
TOT N (TKN+NO3+NO2)	4.10	4.17	5.32	5.53	5.23	6.22	5.64	4.85	5.64	4.57	6.27	5.2
Total Coliform									800	1600		1131
Fecal Coliform								500	280	360		369
Chloride	29.8	28.1	26.7	32.7	36.1	29.4	40.7	27.9	36.9	29.2	35.8	32.1
pH	8	8.1	8	7.7	8.1	8.1	8.2	7.8	8.1	8.2	8.2	8.0
NO3+NO2-N	4.1	3.17	4.32	5.53	4.23	5.18	4.64	4.85	4.64	3.57	5.27	4.5
Crypto						0		0		1		0.333
Giardia						1		3		4		2.7

Table 6.1 Ephrata Water Works (Downstream) sample test results, with non-detectable results shown in red

In table 6.1 above are listed the concentration values for various wastewater chemical and nutrient parameters sampled at the Water Works. As can be seen the average nitrate concentration for these grab samples was 4.5 mg/L. The MCL for nitrate in drinking water is 10 mg/L, showing that the effluent-impacted surface water is well within safety margins for that pollutant. Concurrently, the phosphorus concentration averaged 176 µg/L. BOD averaged 1.0 mg/L for the set, well below the discharge limit at Ephrata 2.

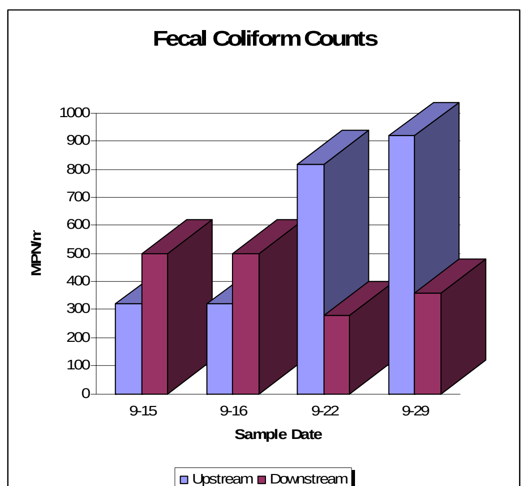


Figure 6.4: Background and Impacted Coliform results for Cocalico Creek near Ephrata 2.

The maximum nitrate concentration in the sample cohort was 5.5 mg/L on August 20, 2009, again only half the MCL concentration.

Toward the end of September, we checked the Coliform levels in the raw inflow and found low but steady concentrations of both total and fecal Coliforms. These are attributable to cattle wading into Cocalico Creek upstream of the treatment plant. Compared to the values for these parameters from upstream, background samples, this is actually an improvement: The effluent from Ephrata 2 actually diluted the background samples. Test results for background and impacted Coliform counts are depicted in Figure 6.4 on the following page.

The parasitic water-borne pathogens of concern, *Cryptosporidium* oocyst and *Giardia lamblia* cyst, were discussed in Section 5 of this report. As this relates to the downstream drinking water facility, we have found that elimination of these pathogens in wastewater plant effluent is most likely not possible without the addition of capital upgrade technologies including filtration and reverse-osmosis membranes. One disinfection method is not enough; two or more operated in series may become inordinately expensive, and then, in streams passing through rural or forested regions, altogether impractical, as non-point sources of the pathogens are likely to create more of a burden for the water plant than the upstream wastewater plant. Because of this, users of the watershed must remain in friendly communication with one another.

Staff at the water works informed us that they converse regularly with their colleagues in the wastewater plant upstream to assess the surface water quality—usually in terms of its turbidity or silting, but the conversation may also include water chemistry and effluent quality. This kind of communication allows the water operators to shut down the raw intake off the Cocalico and rely on either the stored capacity in the clear well or on the town's well water sources. For example, a wastewater operator may observe that a thunderstorm upstream in the watershed may have caused excessive runoff and increased turbidity; the water operators will then quickly shut off the raw intakes and go to alternative sources.

In like manner, the wastewater operators, knowing that I/I following an extended dry period will likely contain high concentrations of *Giardia* cyst, can warn the water operators that potential exists for an increase in those cysts in the raw intake. The water operators can then increase their treatment for these pathogens and reduce the likelihood of their passage.

Ephrata Borough encourages this kind of conversation. It is one of the advantages of having control over both processes.

As discussed in the previous section, the prevalence of cattle herds wading in the water upstream of the facility represents a significant threat to downstream users. Borough water officials should engage in discussions with township and state agriculture officials regarding methods that encourage farmers to build and maintain riparian buffers that would prevent cattle from freely wading into this surface water source. Although this is a difficult issue, fraught with political and economic traps, discussion of non-point sources that imperil water quality must be part of any water quality planning.

7. WPPE Rating

The WPPE program is a new program. As such, DEP is in the process of establishing criteria for rating each facility where a WPPE is performed, analogous to the ratings given to the drinking water systems.

Performance Rating System

WPPE staff will use the following categories to rate each plant. The ratings are based on the plant's ability and operators' skill level to maintain optimal performance over the long-term. Please note that while WPPEs may discover major treatment problems or identify and record violations of regulations, the rating system is not based on regulatory compliance.

"Commendable"
Department staff identified only minor operational, equipment, and/or performance problems that affect the facility's ability to maintain optimized performance. Plant personnel have already taken steps to improve overall water pollution control performance and maintain the long-term reliability of the facility.

"Satisfactory"
Department staff identified operational, equipment, and/or performance problems that may affect the facility's ability to maintain optimized performance. Plant personnel appear willing and capable of improving overall water pollution control performance. However, one or more of the treatment processes showed areas of weakness in operational, equipment, and/or performance that, if corrected, will improve performance and maintain the long-term reliability of the plant.

"Needs Improvement"
Department staff identified considerable operational, equipment, and/or performance problems that are affecting the facility's ability to maintain optimized performance. Limitations are apparent that hinder improvement of overall water pollution control performance. Areas of weakness affect the capability and dependability of the facility in producing a quality effluent that meets the facility's permit requirements.

Based on the observations made during this WPPE, the Ephrata Wastewater Treatment Facility No. 2 merits a "**Commendable**" rating.

ATTACHMENTS

A—Program Description
POTW Optimization Program
Description and Goals
Wastewater Plant Performance Evaluation
Potential Benefits

B—WPPE Team

C—Performance Rating System

D—Treatment Schematic

E— Laboratory Sample Results
Bureau of Laboratories Test Results (Raw Wastewater, Plant Effluent, Upstream Background, Downstream Impacted, Mixed Liquor Ditches 1 and 2, Return Sludge)

F—Pathogen Test Results (Method 1623 for *Giardia* and *Cryptosporidium*)

G—Equipment Deployed
Digital, Continuously Monitoring Probes
Laboratory Equipment On-Loan

H—Equipment Placement Photos

I—Process Monitoring Tests: Example WPPE Bench Data

J—Graphs: Monthly Monitoring Examples

K—Graphs: Daily Monitoring Examples

L—2009 Operations Parameters for Ephrata WWTP #2

M—Correspondence

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 reduce pathogen, nutrient, and emerging contaminant loadings to downstream drinking water facility intakes. The initial focus will be to work with wastewater treatment facilities within five miles upstream of these 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 new program is modeled after DEP's Filter Plant Performance Evaluations (FPPEs) conducted at Drinking Water facilities.

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, 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. We'll 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.

Attachment B— WPPE Team

Ephrata Area Joint Authority Wastewater Treatment Plant No. 2

Evaluation Information

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 717.772.4019 mneville@state.pa.us

Ephrata Borough Authority Leaders	
D. Robert Thompson, P.E. Director of Engineering and Public Works Borough of Ephrata 124 South State Street Ephrata, PA 17522 717-738-9207 bthompson@ephrataboro.org	Stephen Bonner Superintendent of Water and Wastewater Divisions Borough of Ephrata 134 South State Street Ephrata, PA 17522 717-738-9282 sbonner@ephrataboro.org
John L. Keller, Chief Operator Ephrata Wastewater Treatment Facility No. 2 43 Springhouse Road Ephrata, PA 17522 717-738-9283	Jay Snyder, Chief Chemist Ephrata Borough Wastewater Treatment Facilities 124 South State Street Ephrata, PA 17522 jsnyder@ephrataboro.org

Manufacturer Representatives / Installers	
Greg Leininger, Regional Sales Manager HACH Company 5600 Lindbergh Drive; POB 389 Loveland, CO 80539 412-788-2782 gleining@hach.com	Mark Giannascoli, Regional Sales Manager HACH Company 5600 Lindbergh Drive; POB 389 Loveland, CO 80539 800-227-4224 ext. 2134 mgiannas@hach.com
Robert J. Geary, Applications Specialist HACH Company 5600 Lindbergh Drive; POB 389 Loveland, CO 80539 315-668-2690 rgeary@hach.com	Brian Lehman, Applications Specialist Hach Company 5600 Lindbergh Drive, POB 389 Loveland, CO 80539 blehman@hach.com

Attachment C— WWTP Performance Rating System

WPPE Staff use the following categories to rate each facility, based on observations and data developed during the evaluation. The ratings are based on the facility's capabilities and the operators' skill levels to maintain optimal performance over the long term. Please note that while WPPEs may discover treatment problems or identify potential or actual violations of regulations, the rating system is not based upon regulatory compliance.

"Commendable"
Department staff have identified only minor operational, equipment, and / or performance problems that affect the plant's ability to maintain optimized performance. Plant personnel have already taken steps to improve overall facility performance, maintain high effluent quality, and consistently preserve the long-term reliability of the facility.

"Satisfactory"
Department staff have identified operational, equipment, engineering, and / or performance problems that may affect the facility's ability to maintain optimized performance. Facility personnel appear willing and capable of improving overall performance; however, one or more treatment processes showed areas of weakness in operational, equipment, and/or performance that, if corrected, will improve treatment performance and maintain the long-term reliability of the facility.

"Needs Improvement"
Department staff have identified considerable operational, equipment, and/or performance problems that are affecting the facility's ability to maintain optimized performance. Limitations are apparent that hinder improvement of overall filter plant performance. Areas of weakness affect the capability and dependability of the plant in producing a quality final effluent, increasing the potential for degradation of the receiving stream through increased nutrient and/or pathogen loading.

Attachment D—Treatment Schematic

Process Description:

Ephrata 2's treatment train is depicted in Figure D-1, following, showing Kruger's Bio-Denipho phased isolation oxidation ditch treatment process employing enhanced autothermal thermophilic aerobic digestion (ATAD) of waste solids. Plant headworks include a fine screening system and an aerated grit removal flume, as well as an in-line ultrasonic flow measuring divide. Two oxidation ditches provide for 2.64 million gallons of capacity. Secondary settling is provided in two clarifiers. Both 75'-0" diameter clarifiers operate in parallel and discharge to a dual disinfection tank, where chlorine gas is used as the disinfection agent and where sulphur dioxide may be used for dechlorination, if warranted by high chlorine residuals. Following disinfection, a stepped water cascade allows for freshening and oxygenation of the effluent prior to release from Ephrata 2's outfall into Cocalico Creek. The outfall employs a standard, shoreline point discharge and headwall.

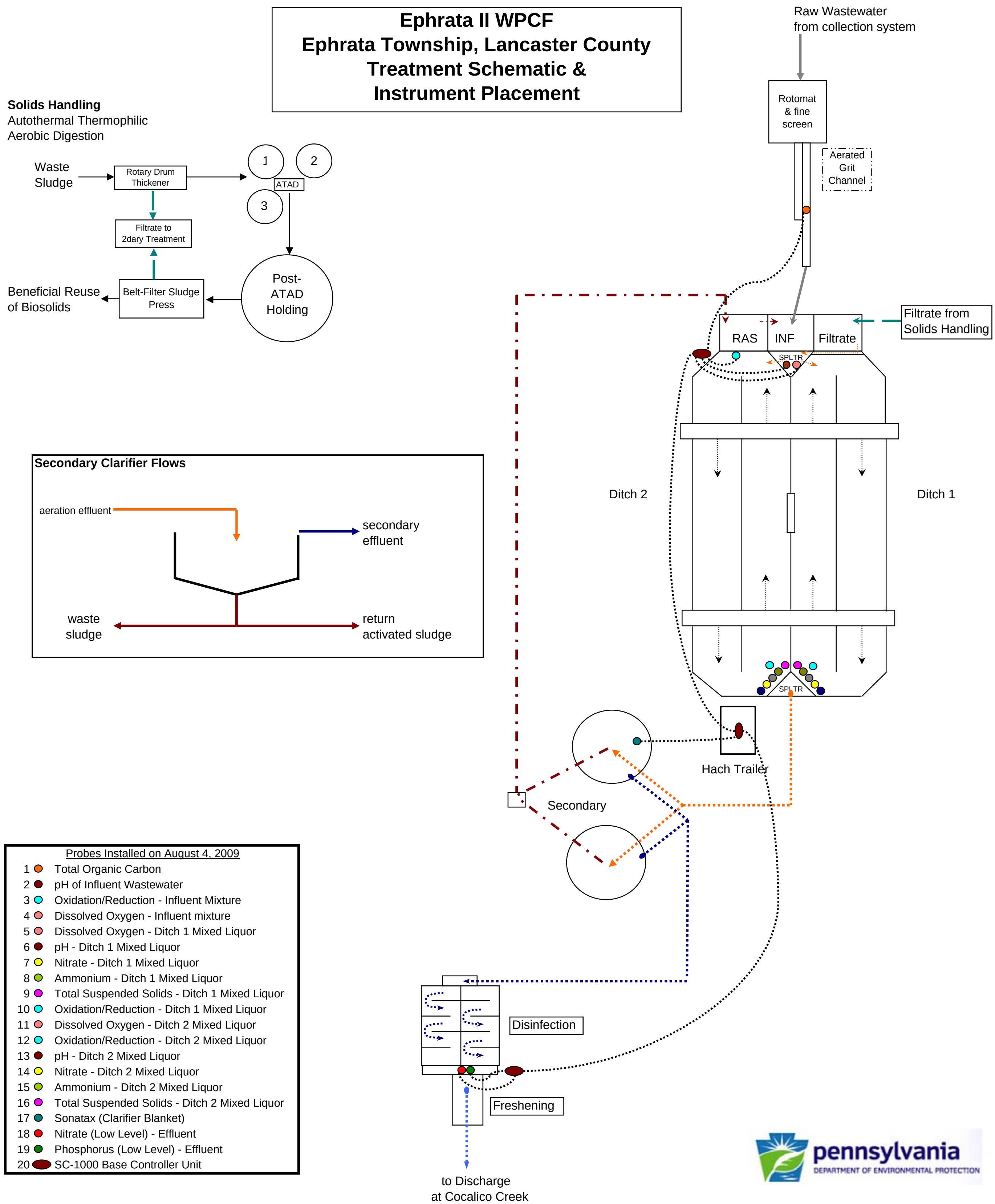
Ferrous chloride may be added for phosphorus control at the anoxic selector or into the oxidation ditches. Generally, this chemical addition occurs only while the sludge centrifuge or belt filter press operations are active. Phosphorus is usually effectively controlled through the biological release and uptake cycle during secondary treatment.

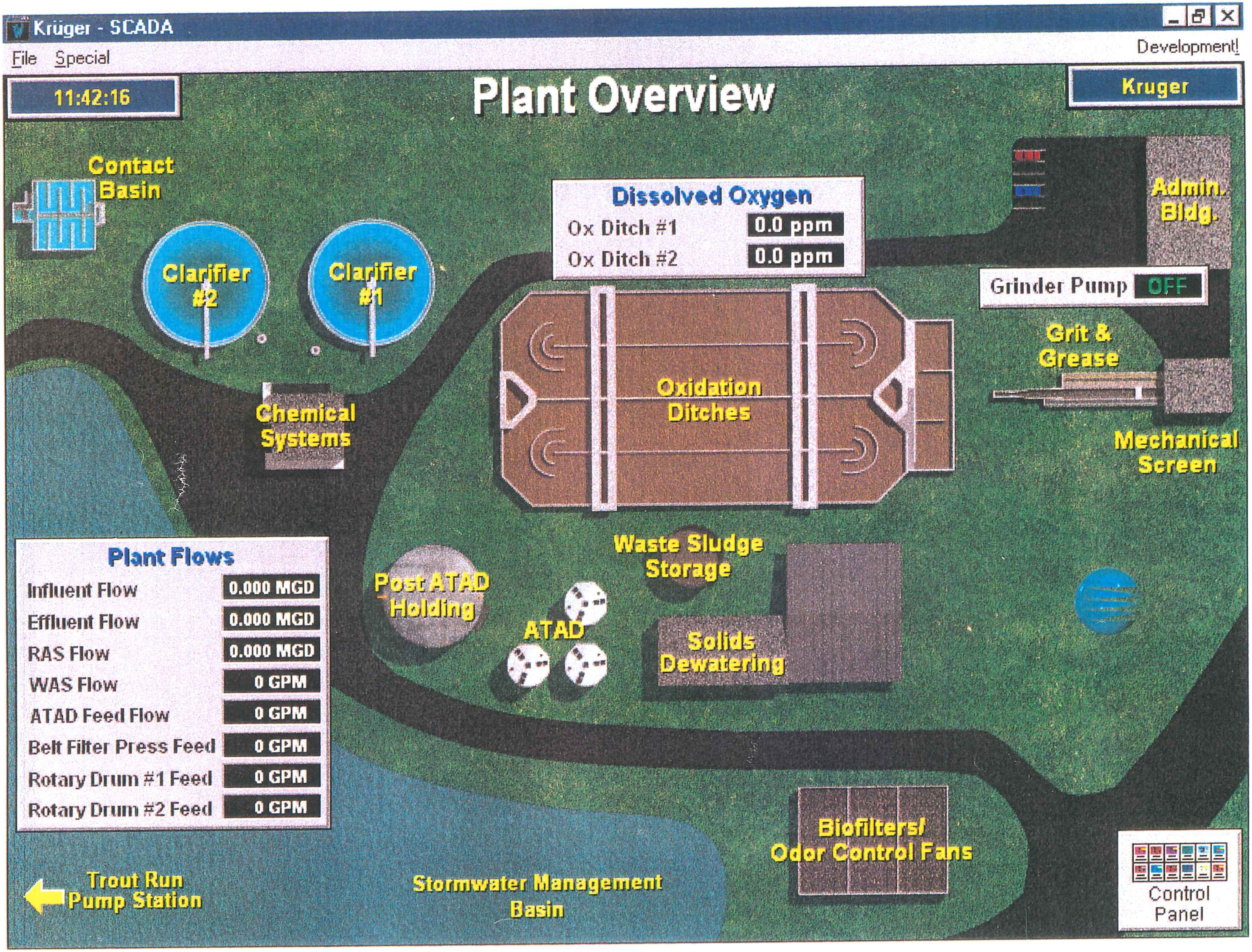
Waste sludge is transferred to the ATAD system. Sludge volume is reduced using centrifugal unit, digested by thermophilic microorganisms under elevated temperatures, and further dewatered using a 2-meter belt-filter press. Class A biosolids, having achieved thermal destruction of pathogens and reduction of volatile content, are now suitable agricultural use and stored under a covered canopy and loading area.

Odors from the biosolids management system are further treated through a self-contained filtration system which uses wood chips as a substrate for biological activity. Use of masking agents is virtually never warranted.

Figures depicting the main SCADA system screen for the Kruger process follow the schematic, reproduced from a computer screen display in the operator's office.

Attachment D--Treatment Schematic




Krüger - SCADA
File Special
Development!
11:42:16
Plant Overview
Kruger
Contact Basin
Clarifier #2
Clarifier #1
Chemical Systems
Dissolved Oxygen
Ox Ditch #1 0.0 ppm
Ox Ditch #2 0.0 ppm
Admin. Bldg.
Grinder Pump OFF
Grit & Grease
Oxidation Ditches
Mechanical Screen
Plant Flows
Influent Flow 0.000 MGD
Effluent Flow 0.000 MGD
RAS Flow 0.000 MGD
WAS Flow 0 GPM
ATAD Feed Flow 0 GPM
Belt Filter Press Feed 0 GPM
Rotary Drum #1 Feed 0 GPM
Rotary Drum #2 Feed 0 GPM
Post ATAD Holding
Waste Sludge Storage
ATAD
Solids Dewatering
Biofilters/ Odor Control Fans
Trout Run Pump Station
Stormwater Management Basin
Control Panel


Krüger - SCADA
File Special
Development!
11:57:31
Oxidation Ditch
Kruger
Mode BioDenitro
Phase Phase B
Time In Phase 0 min
To Grit & Grease Channels
Rotor A3
Rotor A2
Ditch 1
Mixer A2
Mixer A1
Rotor A1
Effluent Weirs
Influent Weirs
Mixer #1
Mixer #2
Mixer #3
Mixer B2
Mixer B1
Rotor B1
Ditch 2
Rotor B3
Rotor B2
To RAS/WAS Pump Station
To Clarifiers
Waste Sludge Tank
Dissolved Oxygen
Ditch #1 0.0 ppm
Ditch #2 0.0 ppm
Rotor Submergence
Ditch #1 0.0 inches
Ditch #2 0.0 inches
Control Panel

Attachment E— Laboratory Sampling Results

Ephrata Wastewater Treatment Plant No. 2 Laboratory Sample Results

Upstream, Downstream, Effluent, Mixed Liquor Suspended Solids

The following pages summarize laboratory reports for the samples collected by Department personnel over the project period. These samples are for informational use in identifying trends and effects of process modifications, where applicable. These samples were not collected with the intentions of being used for compliance purposes, and final effluent samples in particular were collected over twenty minutes to preclude their use for regulatory enforcement. Nevertheless, the sample results show a facility operating with high efficiency and producing an effluent whose quality excels beyond the required constraints.

	8/4/2009	8/11/2009	8/13/2009	8/20/2009	8/27/2009	9/1/2009	9/9/2009	9/15/2009	9/16/2009	9/22/2009	9/29/2009	10/6/2009
Effluent-Sample #	0907057	0907061	-	0907074	0907083	0907091	0907102	0907113	0907116	0907128	0907142	0907171
CBOD		0.20	-	0.90	<0.2	<2.0	0.60	0.60	-	1.10	0.60	0.30
TSS	<5	<5	-	<5	<5	<5	<5	<5	-	<5	<5	<5
Alkalinity	168.8	182.6	-	186.6	201.2	191.4	179.2	185.4	-	177.0	170.8	153.8
NO2-N	0.01	0.01	-	0.04	0.01	<0.04	0.06	0.02	-	0.02	0.01	0.06
NO3-N	6.20	2.43	-	4.72	2.05	5.10	6.26	3.88	-	7.03	7.20	10.05
NH3-N	0.07	0.10	-		0.09	0.08	0.15	0.10	-	0.12	0.08	0.11
TKN	<1.00	<1.00	-	<1.00	<1.00	<1.00	1.32	1.06	-	1.09	1.07	1.52
Phos	0.918	0.909	-	0.995	1.386	2.054	1.416	1.434	-	1.461	1.073	0.538
TOT N(TKN+NO3+NO2)	7.21	3.44	-	5.76	2.06	5.10	7.64	4.96	-	8.14	8.28	11.63
Total Coliform			-		-	-	-	-	-	1900	200	20
Fecal Coliform			-		-	-	-	<20	<20	<20	20	-
Chloride	154.0	143.2	-		150.9	139.6	304.2	139.0	-	157.5	142.7	164.0
pH	7.9	8.0	-	7.9	8.0	8.1	7.8	7.9	-	7.9	8.1	7.9
Crypto			-		-	7	-	1	-	-	0	-
Giardia			-		-	167	-	121	-	-	128	-
Upstream-Sample #	0907055	0907060	-	0907075	0907087	0907090	0907103	0907114	0907117	0907130	0907144	0907175
BOD	1.30	1.00	-	0.80	0.70	1.10	1.10	1.20	-	0.70	1.00	1.30
TSS	<5	9	-	<5	<5	<5	<5	<5	-	<5	<5	6
Alkalinity	134.8	93.6	-	115.8	126.8	116.4	134.4	115	-	122.2	112.4	126.8
NO2-N	0.02	0.01	-	0.02	0.02	<0.04	0.02	0.01	-	0.01	0.01	0.02
NO3-N	5.6	2.59	-	3.57	4	3.46	4.72	3.95	-	4.56	3.37	4.65
NH3-N	0.02	0.07	-		0.04	0.05	0.03	0.03	-	0.02	0.04	0.02
TKN	<1.00	<1.00	-		<1.00	<1.00	<1.00	<1.00	-	<1.00	<1.00	<1.00
Phos	0.129	0.168	-	0.098	0.114	0.117	0.077	0.106	-	0.073	0.132	0.088
TOT N(TKN+NO3+NO2)	6.62	3.6	-		4.04	3.46	4.74	3.96	-	4.57	3.38	4.67
Total Coliform			-		-	-	-	-	-	900	1200	-
Fecal Coliform			-		-	-	-	320	320	820	920	-
Chloride	21.1	18.5	-		25.3	22.6	24.7	22.4	-	24.4	21.7	25.2
pH	8.0	8.0	-	7.9	8.0	8.0	8.0	7.9	-	8.0	8.1	8.0
NO3+NO2-N			-		4.04	3.46	4.74	3.96	-	4.57	3.38	4.65
Crypto	-	-	-	-	-	2	-	1	-	-	1	-
Giardia	-	-	-	-	-	3	-	1	-	-	5	-
Downstream-Sample #	0907056	0907059	0907065	0907076	0907088	0907089	0907104	0907115	0907118	0907131	0907145	0907176
BOD	1.10	1.20	0.70	1.30	0.60	1.20	1.10	1.10	-	0.60	0.90	1.10
TSS	<5	7.00	9.00	37.00	<5	15.00	<5	5.00	-	5.00	<5	<5
Alkalinity	115.4	107.2	122.6	147.8	138.4	147.4	138.8	133.8	-	129.6	116.2	129.8
NO2-N	0.02	0.01	0.02	0.03	0.02	<0.04	0.02	0.01	-	0.01	0.01	0.02
NO3-N	4.08	3.16	4.30	5.50	4.21	5.18	4.62	4.84	-	4.63	3.56	5.25
NH3-N	0.03	0.06	0.06		0.03	0.03	0.02	<0.02	-	0.04	0.05	0.04
TKN		<1.00	<1.00		<1.00	<1.00	<1.00	-	-	<1.00	<1.00	<1.00
Phos	0.203	0.195	0.158	0.178	0.208	0.171	0.186	-	-	0.179	0.180	0.103
TOT N(TKN+NO3+NO2)	4.10	4.17	4.32		4.23	5.18	4.64	4.85	-	4.64	3.57	5.27
Total Coliform			nt		-	-	-	-	-	800	1600	-
Fecal Coliform			nt		-	-	-	500	500	280	360	-
Chloride	29.8	28.1	26.7	32.7	36.1	29.4	40.7	27.9	-	36.9	29.2	35.8
pH	8.0	8.1	8.0	7.7	8.1	8.1	8.2	7.8	-	8.1	8.2	8.2
NO3+NO2-N			4.32		4.23	5.18	4.64	4.85	-	4.64	3.57	5.27
Crypto	-	-	nt	-	-	0	-	0	-	-	1	-
Giardia	-	-	nt	-	-	1	-	3	-	-	4	-

	8/4/2009	8/11/2009	8/13/2009	8/20/2009	8/27/2009		9/9/2009	9/15/2009			9/29/2009	10/6/2009	
MLSS- East - Sample #	-	0907063	-	0907077	0907085	-	0907100	0907119	-	-	0907146	0907175	
MLSS	-	1344	-	1712	1712	-	1444	1668	-	-	1652	1714	
MLVSS	-	1014	-	1112	1160	-	976	1134	-	-	1166	1336	Avg ratio
MLSS/MLVSS ratio:	-	75.4%	-	65.0%	67.8%	-			-	-		77.9%	71.5%
Alkalinity	-	226.0	-		228.4	-	217.6	215.6	-	-	222.2	219.0	
Average probe reading	-	-	-	-	-	-	-	-	-	-	-	-	
Difference	-	-	-	-	-	-	-	-	-	-	-	-	
MLSS- West - Sample #		0907064	-	0907078	0907086		0907101	0907120	-	-	0907147	0907174	
MLSS		1574	-	1774	1908		1542	1670	-	-	1672	1742	
MLVSS		1220	-	1136	1296		1088	1156	-	-	1172	1280	Avg ratio
MLSS/MLVSS ratio:		77.5%	-	64.0%	67.9%				-	-	-	73.5%	70.7%
Alkalinity		220.0	-		249.6		226.6	240.2	-	-	211.8	194.0	
Average probe reading	-	-	-	-	-	-	-	-	-	-	-	-	
Difference	-	-	-	-	-	-	-	-	-	-	-	-	
RAS- Sample #			-				0907099	907121	-		0907148	0907177	
MLSS			-				2566	6284	-		3116	11900	
MLVSS			-				1824	4460	-		2180	7545	Avg ratio:
MLSS/MLVSS ratio:	-	-	-	-	-	-	-	-	-	-	-	63.4%	63.4%

Influent -Sample #	0907058	0907062	-	0907073	0907084	0907092	0907098	0907112	-	0907129	0907143	0907172	
BOD	307.00	266.00	-	197.00	260.00	317.00	219.00	323.00	-	245.00	279.00	416.00	
COD	250.8	287.1	-	250.7	348.0	331.7	147.2	187.7	-	170.5	280.6	387.3	Avg ratio:
BOD/COD ratio:	122%	93%	-	79%	75%	96%	149%	172%	-	144%	99%	107%	114%
TSS	236	-	-	430	260	272	240	254	-	266	284	324	
Alkalinity	323.8	308.6	-	340.0	336.0	346.8	368.0	348.0	-	399.4	373.0	311.6	
NO2-N	<.01	<.01	-	<.01	<.01	<0.04	<0.01	<0.01	-	<0.01	<.01	<.01	
NO3-N	<.04	<.04	-	<.04	<.04	<0.04	<0.04	<0.04	-	<0.04	<.04	<.04	
NH3-N	49.19	-	-	-	35.94	36.92	41.82	36.88	-	53.93	50.31	40.78	
TKN	48.0	-	-	-	52.2	48.5	50.4	49.3	-	61.8	53.6	45.5	
Phos	6.389	5.735	-	5.679	6.706	6.236	6.991	5.864	-	6.175	7.118	7.014	
TOT N	48.01	-	-	-	52.15	48.50	50.40	49.28	-	61.80	53.56	45.46	
Chloride	126.9	216.1	-	-	227.1	125.6	537.4	102.1	-	124.4	102.2	147.3	
pH	7.5	7.4	-	7.3	7.2	7.4	7.4	7.4	-	7.5	7.6	7.5	

	8/4/2009	8/11/2009	8/13/2009	8/20/2009	8/27/2009	9/1/2009	9/9/2009	9/15/2009	9/22/2009	9/22/2009	9/29/2009	10/6/2009
East MLSS Ditch			-						-		0907146	0907173
BOD			-						-		632.00	658.00
TSS			-						-		1652	1714
VSS			-						-		1166	1336
Alkalinity			-						-		222.2	219.0
NO2-N			-						-		0.24	0.38
NO3-N			-						-		4.81	4.93
NH3-N			-						-		4.36	4.68
TKN			-						-		92.85	97.19
Phos			-						-		48.270	51.390
TOT N			-						-		97.9	102.5
Chloride			-						-		143.6	166.5
pH			-						-		7.4	7.3

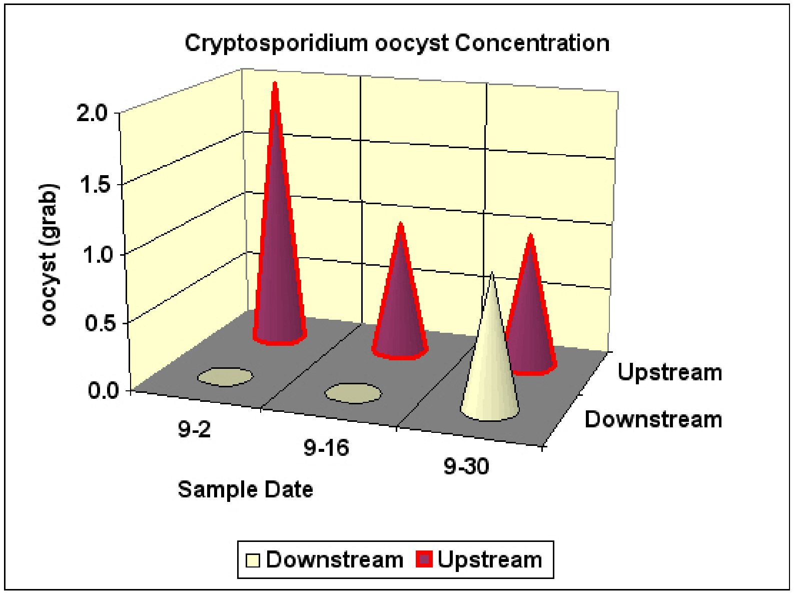
West MLSS Ditch			-						-		0907147	0907174
BOD			-						-		425.00	598.00
COD			-						-		1672	1742
TSS			-						-		1172	1280
Alkalinity			-						-		211.8	194.0
NO2-N			-						-		0.62	0.01
NO3-N			-						-		6.99	9
NH3-N			-						-		0.62	0.55
TKN			-						-		88	90.93
Phos			-						-		47.936	54.787
TOT N			-						-		95.61	99.94
Chloride			-						-		143.2	165.2
pH			-						-		7.4	7.4

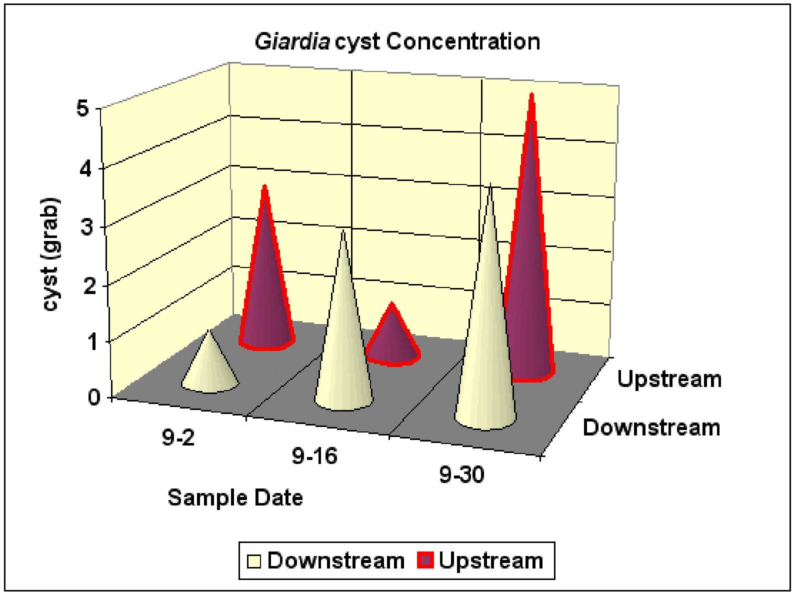
Attachment F— Pathogen Test Results (Method 1623 for *Giardia lamblia* cyst and *Cryptosporidium* oocyst)

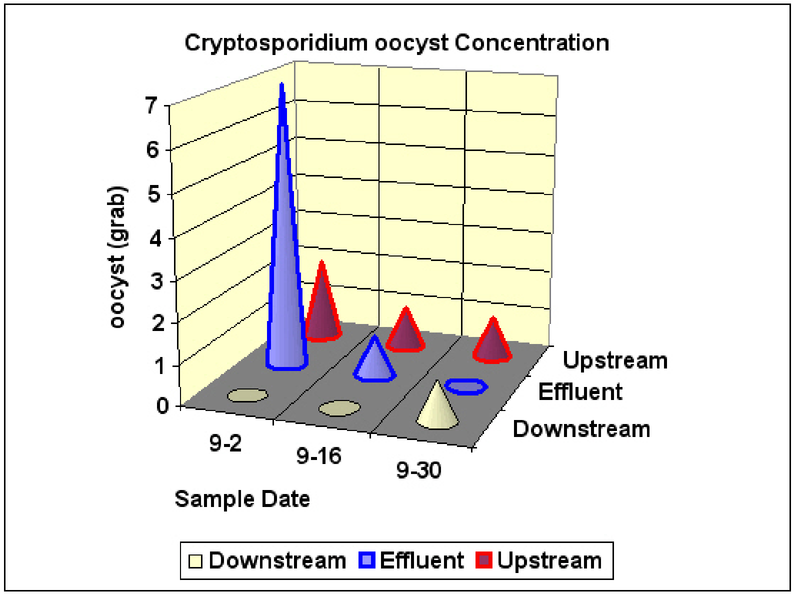
Following are DEP Bureau of Laboratory test reports showing results of pathogen testing conducted using EPA Method 1623 for *Giardia lamblia* cyst and *Cryptosporidium* oocyst, pathogens of concern at surface water filtration plants under orders to achieve more stringent controls in LT2. The Ephrata Area Joint Authority Water Works, whose intake is located just over one mile downstream on Cocalico Creek from the Ephrata 2 outfall, is a conventional sedimentation and multi-media filtration facility capable of producing 1 MGD drinking water. The recent FPPE performed at the Water Works showed that the chlorine contact time and baffling factors at the filter plant are sufficient to meet the "1-log," 90% inactivation for *Giardia* cysts.

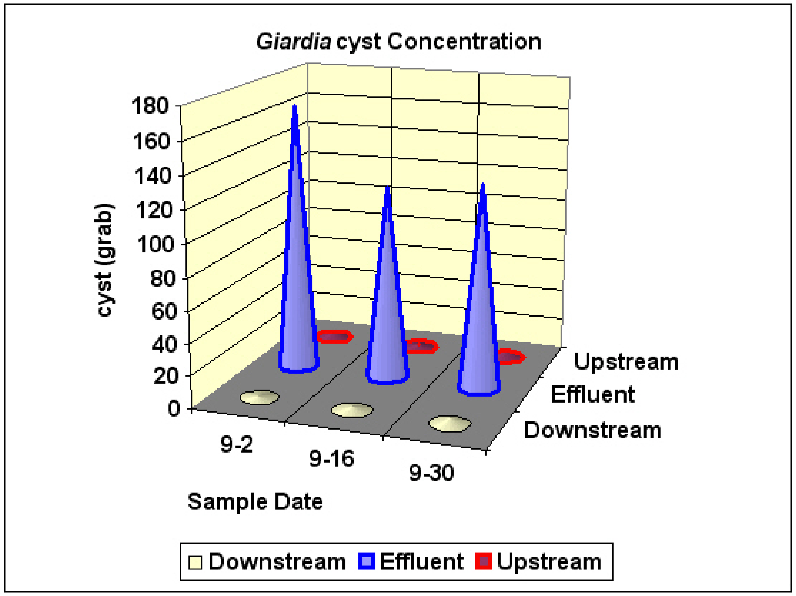
Noted in earlier FPPE reports was an item discussing the wastewater discharge being a potential infection source for the Me-1623 pathogens. These organisms, when in cyst form, are extremely resistant to disinfection processes used in wastewater treatment. As the charts on the following page show, the presence of *Giardia* cysts in concentrations of 10 to 15 cysts per liter of WWTP effluent should register concern in the Water Works operators. As comment #3 noted on page 24 of the 2007 FPPE report: "…it is critical that wastewater operators effectively communicate to filter plant operators any time there is a problematic wastewater discharge that could result in high level of waterborne pathogens."

Attachment F
Pathogen Test Results









Attachment F
Pathogen Test Results

Raw Test Results
Organisms per 10 Litre Sample

Sample Date	Effluent		Upstream		Water Works Intake	
	Giardia	Crypto	Giardia	Crypto	Giardia	Crypto
9/2/2009	167	7	3	2	1	0
9/16/2009	121	1	1	1	3	0
9/30/2009	128	0	5	1	4	1

Recorded Test Results
Organisms per Litre

Sample Date	Effluent		Upstream		Water Works Intake	
Organisms/Litre	Giardia	Crypto	Giardia	Crypto	Giardia	Crypto
9/2/2009	15.18	0.64	0.27	0.18	0.09	0.00
9/16/2009	11.00	0.09	0.09	0.09	0.27	0.00
9/30/2009	11.64	0.00	0.45	0.09	0.36	0.09

Attachment G—Equipment Deployed

Digital, Continuously Monitoring Probes:

1 – Laptop computer with 485 to 232 signal converter

3 – SC1000s
3 – LDO probes
3 – pH probe
3 – ORP probe
2 – NH_4D probe
2 – Nitratax probes
2 – Solitax probes

4- SC100s
1- Amtax
1- Phosphax
1- UVAS probe
1- Sonatax probe *

* removed from service

Laboratory Equipment On-loan:

1 – Hach HQ40d handheld pH and LDO meter
1 – LBOD probe
1 – DR2800 spectrophotometer
1 – Raven centrifuge
1 – Raven Core Taker sampler
2 – Raven settleometers
1 – COD Heater Block
1 – Microscope with photographic/video capability

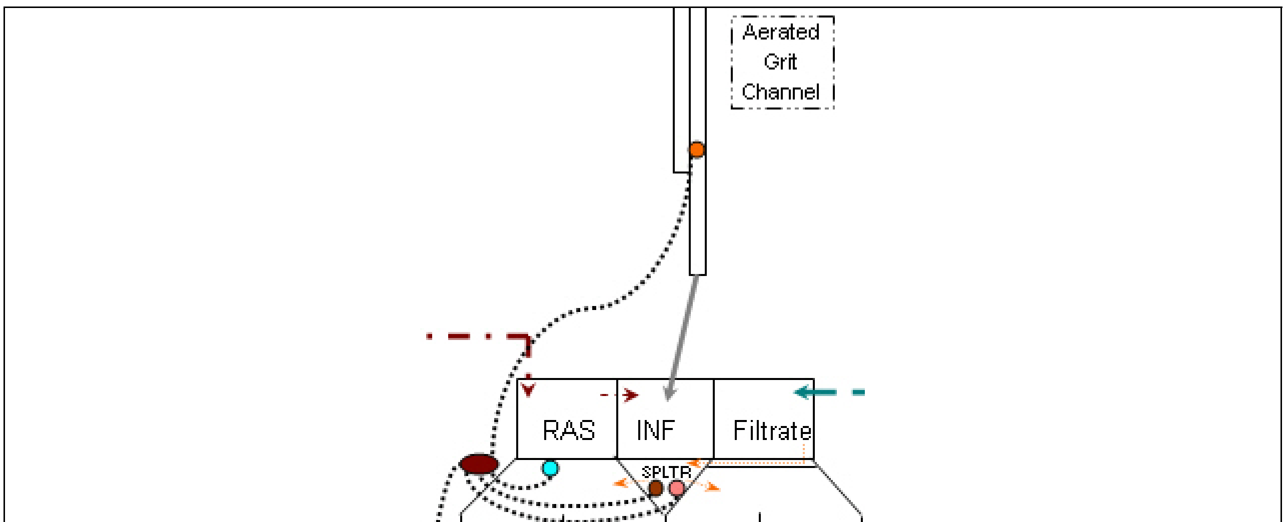


Figure G-1: Detail of online process monitoring equipment at Headworks and Anoxic Selector

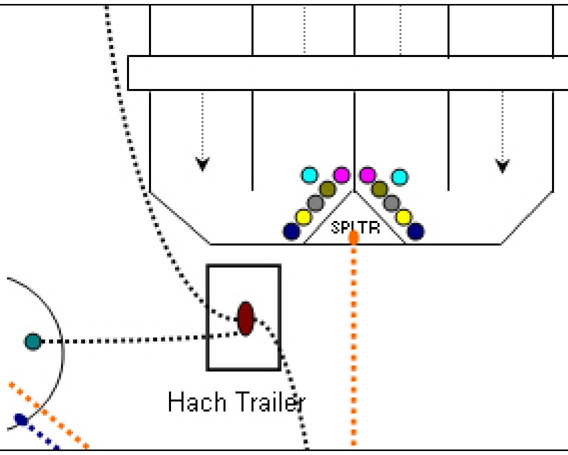


Figure G-2: Detail of online process monitoring equipment at effluent end of ditches

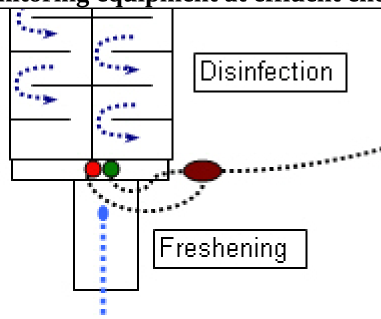


Figure G-3: Detail of online process monitoring equipment at Disinfection Tank outfall

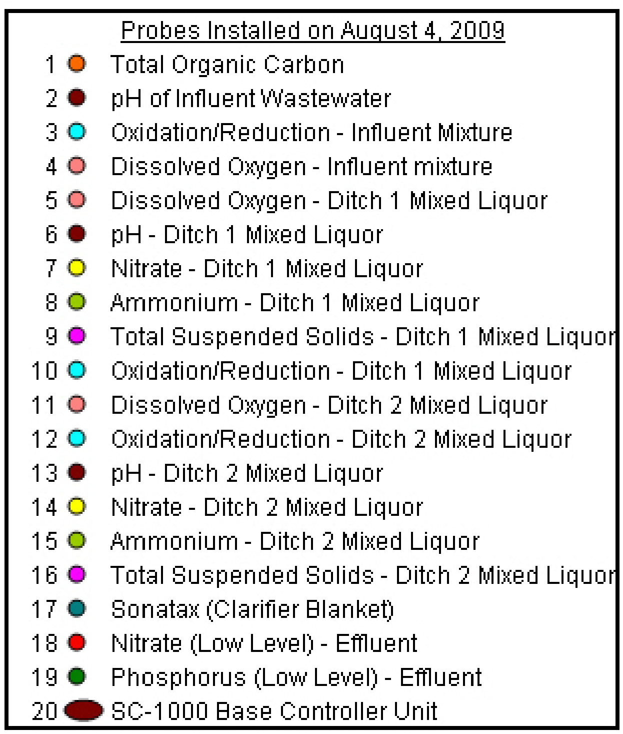


Figure G-4: Legend for Probe Placement

Attachment H—Equipment Placement Photographs

WPPE at Ephrata Wastewater Treatment Plant No. 2

Figure H-1: Nitrate, Ammonium, TSS, DO, and pH probes installed in Ditch 1

Figure H-2: Centralized Trailer for Data Collection/Probe Management

Figure H-3: Effluent monitoring equipment (Amtax NH3-N and Phosphax PO4-P)

Figure H-4: Effluent sampling units, submerged at outfall from disinfection tank.

Figure H-5: Air-sparging compressor and drive motor for Ammonium ion probe.

Figure H-6: Exposed circuitry for SC-1000 data module.

Figure H-7: Sonatax probe at clafier

Figure H-8: Submerged probes in Ditch 2

Attachment I— Process Monitoring Forms

Following are examples of the forms used by the WPPE program, as integrated into an MS Excel spreadsheet. These forms were used for DEP staff when they conducted tests to verify the instrumentation based in the Hach trailer.

Ephrata II already employs a variety of internal laboratory forms, considerably more detailed than these.

Ephrata STP #2
Bench Sheet

Date: 9/9/2009 Time: 10:00

Lab Tech: Neville

Raw Wastewater (INF)		
COD	528	mg/L
COD	3,499	lbs/day
Q	0.7947	gpd or MGD
Solids	0.02	% by vol.
Influent TSS	220	mg/L
	0.13	lbs/day

BOD	272	mg/L
	1,803	lbs/day
%BOD/COD	51.5%	

Settleometer Data

Volume= MGD x 1,000 = kgal (thousand gallons)

Loc	Ditch 2	N Clarifier	RAS	RAS+Filtrate	Ditch 1	S Clarifier	W RAS	W WAS
Spin Solids	1.24	0.40	1.40	1.10	1.28	0.40	1.40	1.40
Tank vol. (kgal)	1320	140	620	291	1320	140	620	18
SLU	1637	56	868	320	1690	56	868	25

AGE= 136 days

Loc	Ditch 2	Ditch 2	Ditch 1	Ditch 1
time	SSV	SSC	SSV	SSC
0	1000	1.24	1000	1.28
5	290	4.28	300	4.27
10	200	6.20	220	5.82
15	190	6.53	200	6.40
20	180	6.89	190	6.74
25	160	7.75	180	7.11
30	150	8.27	160	8.00
35	150	8.27	160	8.00
40	150	8.27	160	8.00
45	145	8.55	155	8.26
50	140	8.86	150	8.53
55	140	8.86	145	8.83
60	140	8.86	140	9.14

Red is an estimated calc.

SSC=[(Spin%) x 1000] ÷ SSV

WCR=TSS ÷ Spin%

	Ditch 1	Ditch 2
TSS	2,190	2,190
WCR	1,766	1,711
MLVSS	1,550	1,550
ESS	1.6	mg/L

RSF=	1240	kgal/day
WSF=	18	kgal/day

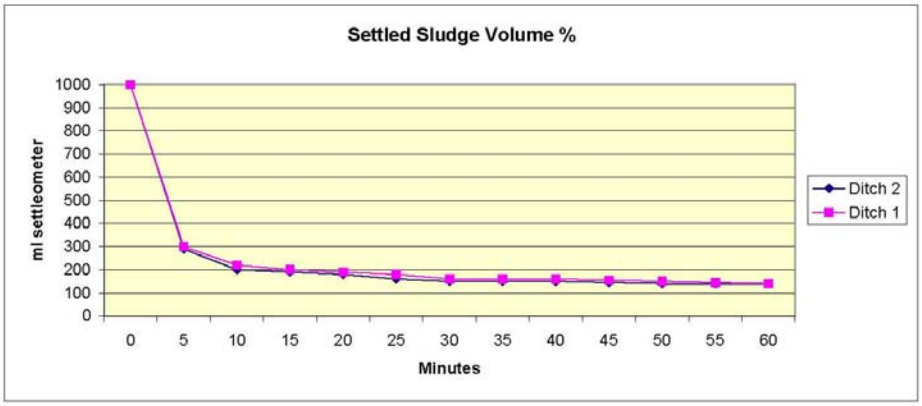
RAS & WAS flow calculations:

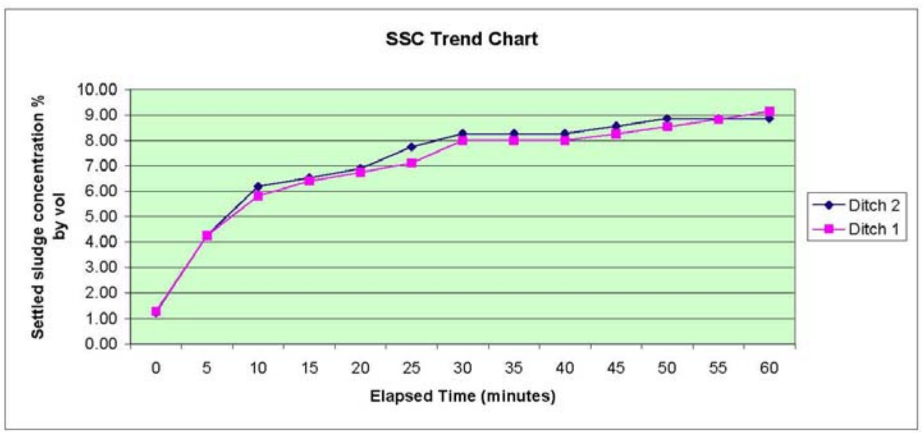
	D1 RAS	D1 WAS	D2 RAS	D2 WAS
kgal/day	272	18	272	18
SU	380	25	380	25

Notes:

Bench Tests	INF	Ditch 1	Ditch 2	N Clar	S Clar	EFF
Nitrate		3.63	8.28			
Phosphate-P	7.3					1.55
Ammonia-N	39.9	3.11	0.16			0.37
Iron						
Chloride						
Ca+ hardness						
Aluminum						
Nitrate (1:1)						
Alkalinity		210	230			
Blanket Depth				0.5	0.0	
BOD/CBOD-eff	272					2.8

Table 10: Ephrata 2 bench sheet prepared by PADEP: Q, SSV, SSC, COD, BOD eq., ions





Engineering:	one	both
Ditch vol.	1.320	2.640
Clarifier vol.	0.140	0.279
Clarifier SA	4,185	8,371
Wier length	459	917
SLR	189.9	380
Wier OFR	1,733	3,465

Figure I-2: Ephrata 2 bench sheet prepared by PADEP: pH, temperatures, DO

Ephrata STP #2
Bench Sheet

Date: 9/9/2009 Time: 10:00

Lab Tech: Neville

OUR Testing

Location: Ditch 2 E

OUR = slope x 60

slope = 0.62 / 5

OUR = 0.62 / 5 x 60

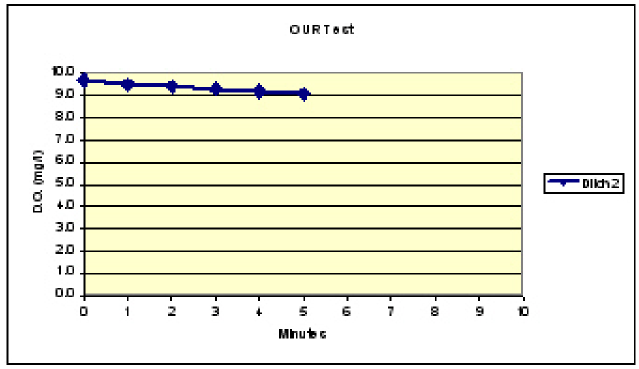
OUR = 7.4 mg O2/ L-h

RR= (1000 x OUR) ÷ VSS

= 1000 / 1550.00 x 7.44

RR = 4.80 mg O2/ g-MLVSS-h

Time	D.O.
0	9.7
1	9.5
2	9.4
3	9.3
4	9.2
5	9.1
6	
7	
8	
9	
10	



Location: Ditch 1 W

OUR = slope x 60

slope = 3.02 / 9

OUR = 3.02 / 9 x 60

OUR = 20.1 mg O2/ L-h

RR= (1000 x OUR) ÷ VSS

= 1000 / 1550.00 x 20.1

RR = 12.99 mg O2/ g-MLVSS-h

Time	D.O.
0	9.4
1	9.1
2	8.8
3	8.5
4	
5	7.8
6	7.5
7	7.1
8	
9	6.4
10	

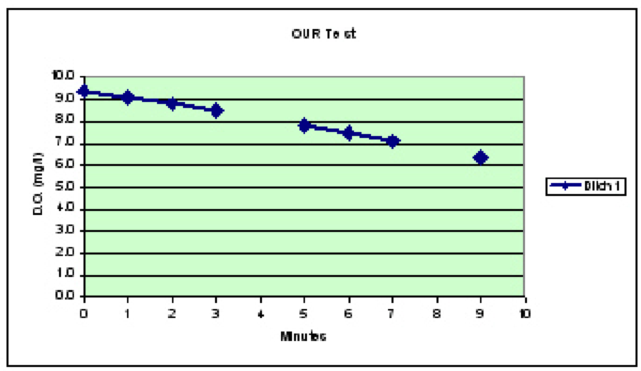


Figure I-3: Ephrata 2 Bench Sheet prepared by DEP: OUR Test Data & Charts

Ephrata STP #2 **Date:** 9/9/2009 Time: 10:00
Test Data:

Lab Tech: Neville

Loc.	pH	Temp F	DO	
INF	7.24	18.2	0.70	
Ditch 1 a	7.09	23.4	2.41	
Ditch 1 b	7.12	18.4	2.63	
Ditch 1 c	7.08	18.5	2.44	
Ditch 1 d	7.07	18.6	2.42	
Ditch 1 e	7.10	18.4	2.48	D1 Aer. Average DO
Ditch 1 f	7.09	18.4	2.37	2.5
N Clarifier				
Ditch 2 a	7.11	18.3	0.92	
Ditch 2 b	7.09	18.2	1.01	
Ditch 2 c	7.07	18.5	0.96	
Ditch 2 d	7.08	18.4	0.88	
Ditch 2 e	7.07	18.6	0.94	D2 Aer. Average DO
Ditch 2 f	7.10	18.4	0.94	1.0
S Clarifier				
Effluent	7.36	17.2	8.23	
Outfall 001	7.48	17.2	8.04	

Weather Conditions: **(check)**
x **Fair** ____ **Cloudy** ____ **Rain** ____ **in.**

Sludge Wasted: 18,002 **gallons**

____ **min.**

____ **dry**

Figure I-4: Ephrata 2 bench sheet prepared by PADEP: pH, Temperature, and Dissolved Oxygen Sheet

Attachment J—Histograms for September 2009

WPPE at Ephrata Wastewater Treatment Plant No. 2

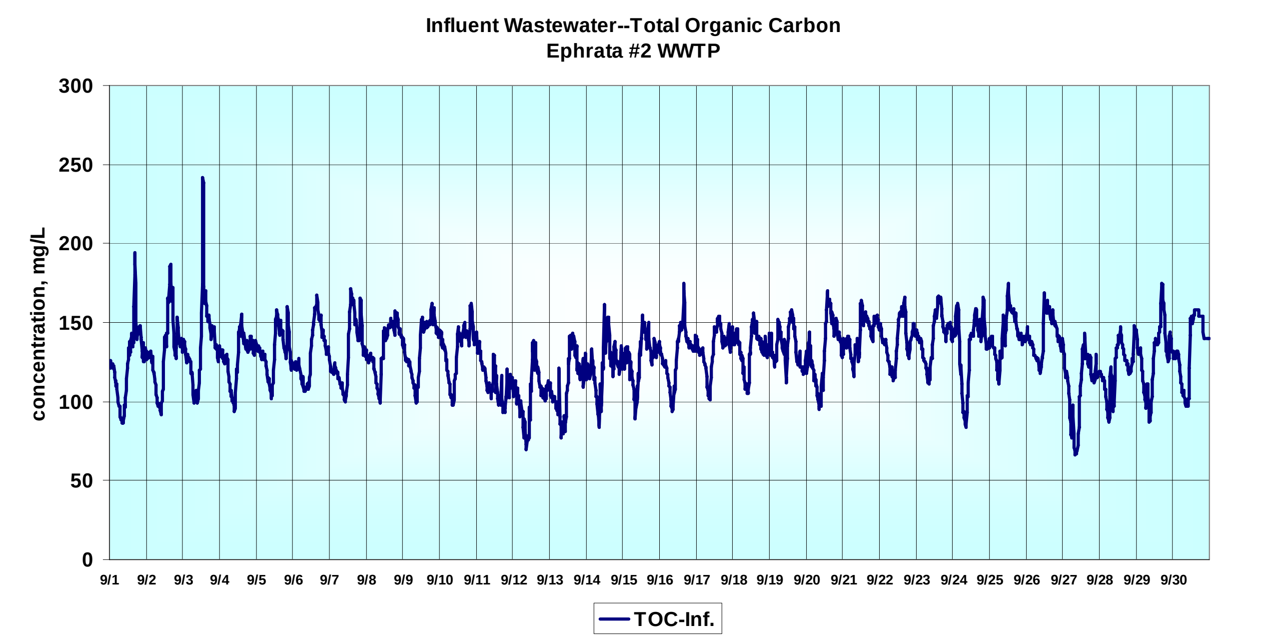


Figure 28: Raw Wastewater Total Organic Carbon (TOC,) a BOD5 Analogue

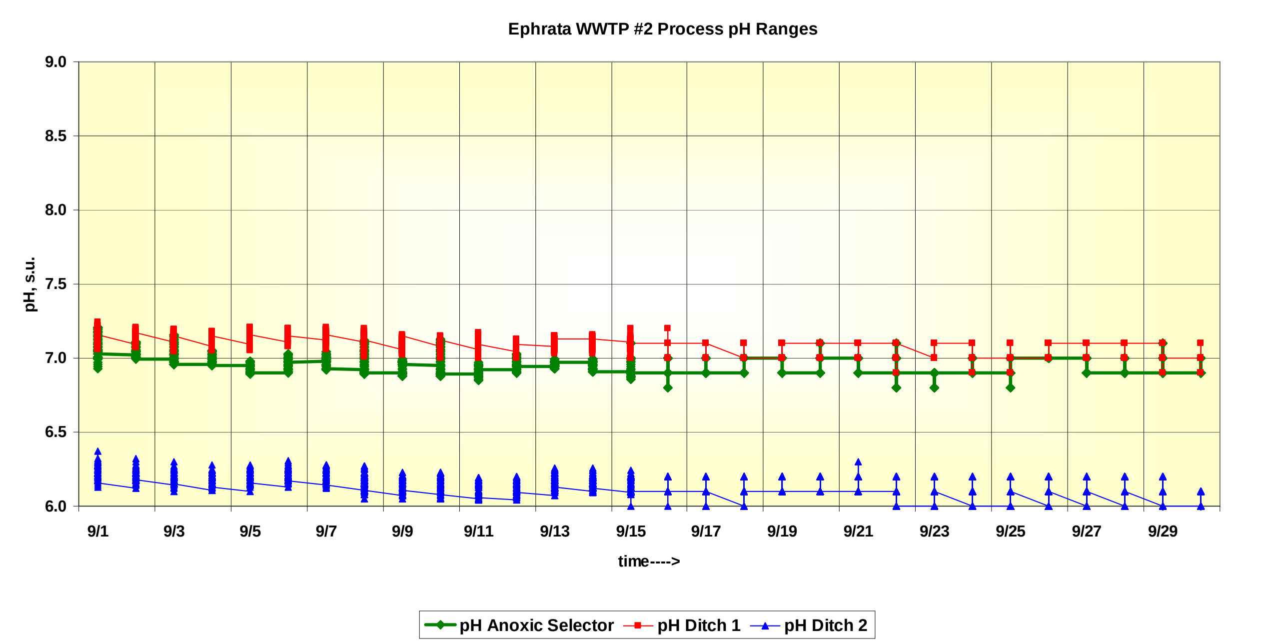


Figure 29: pH Probe Readings, Daily High/Low Ranges, at selected locations

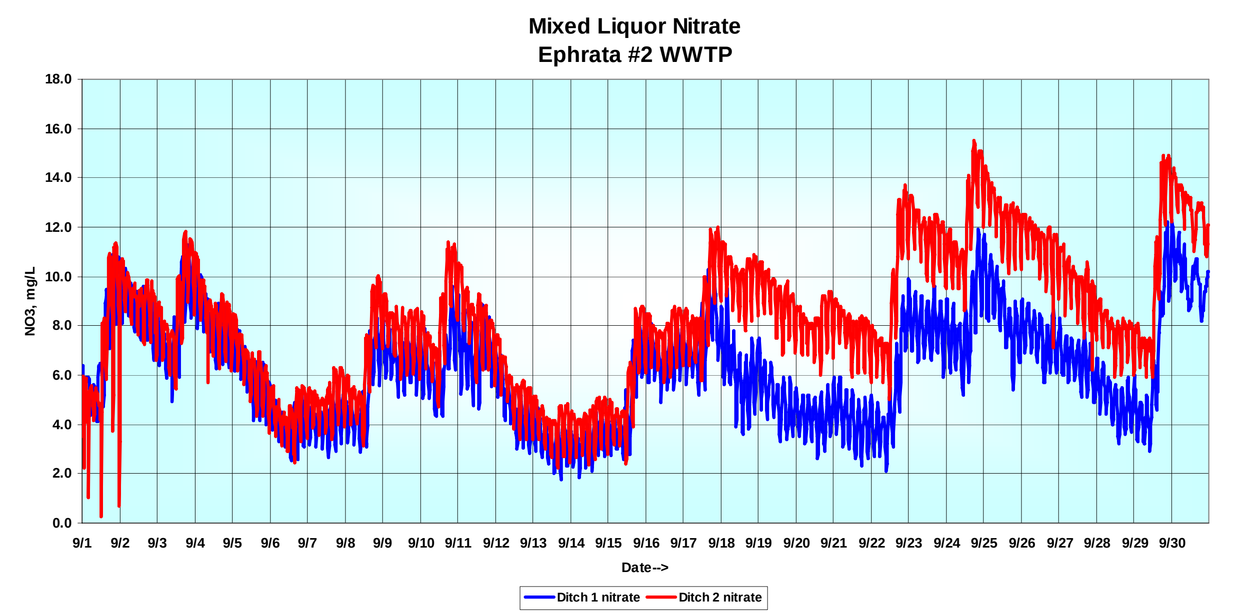


Figure 30: Mixed Liquor Nitrate Concentration in Phased Oxidation Ditches 1 and 2

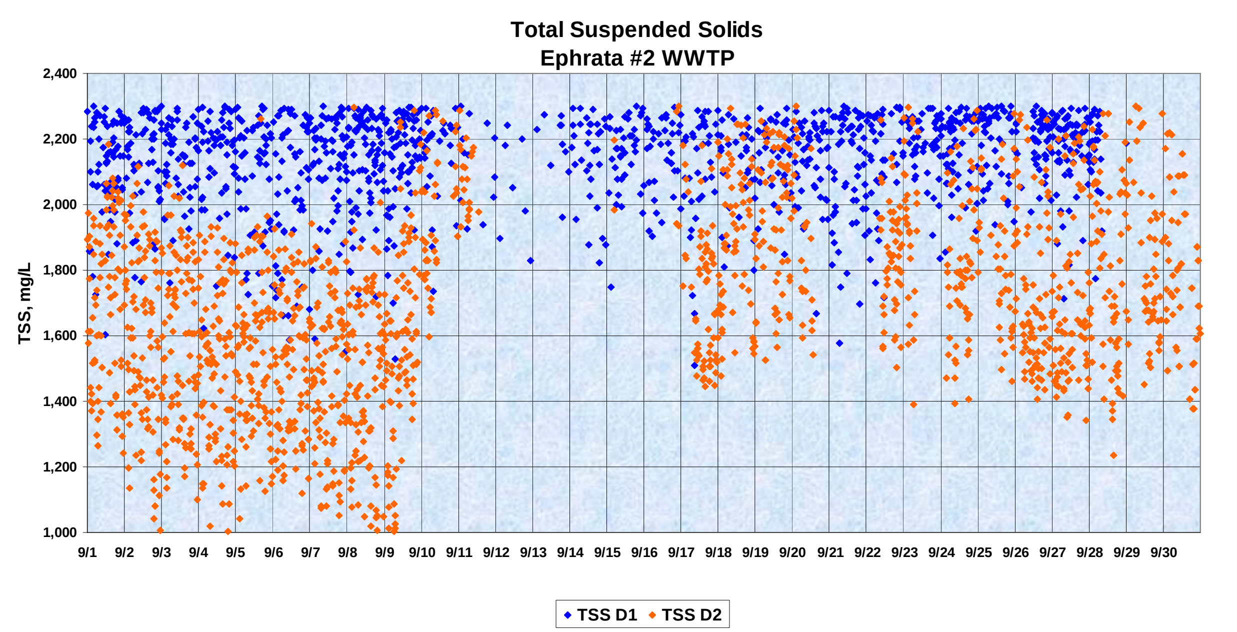


Figure 31: Total Suspended Solids in Oxidation Ditches, filtered data.

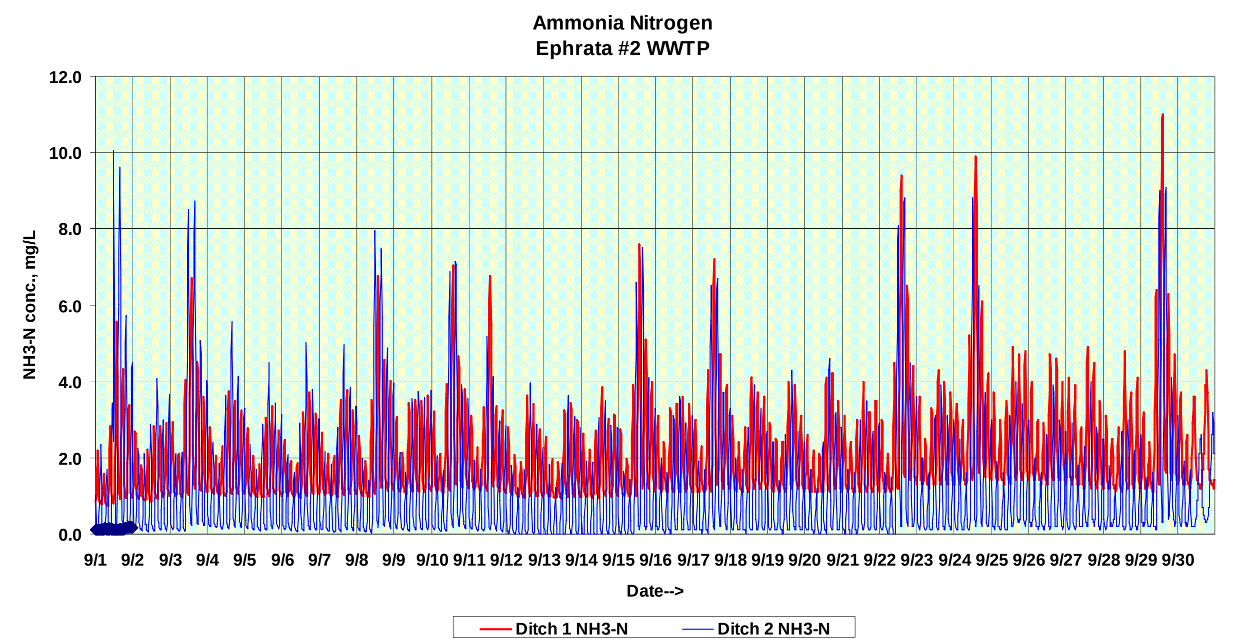


Figure 32: Ammonia-Nitrogen Concentrations in Oxidation Ditches 1 & 2, histogram for September 2009

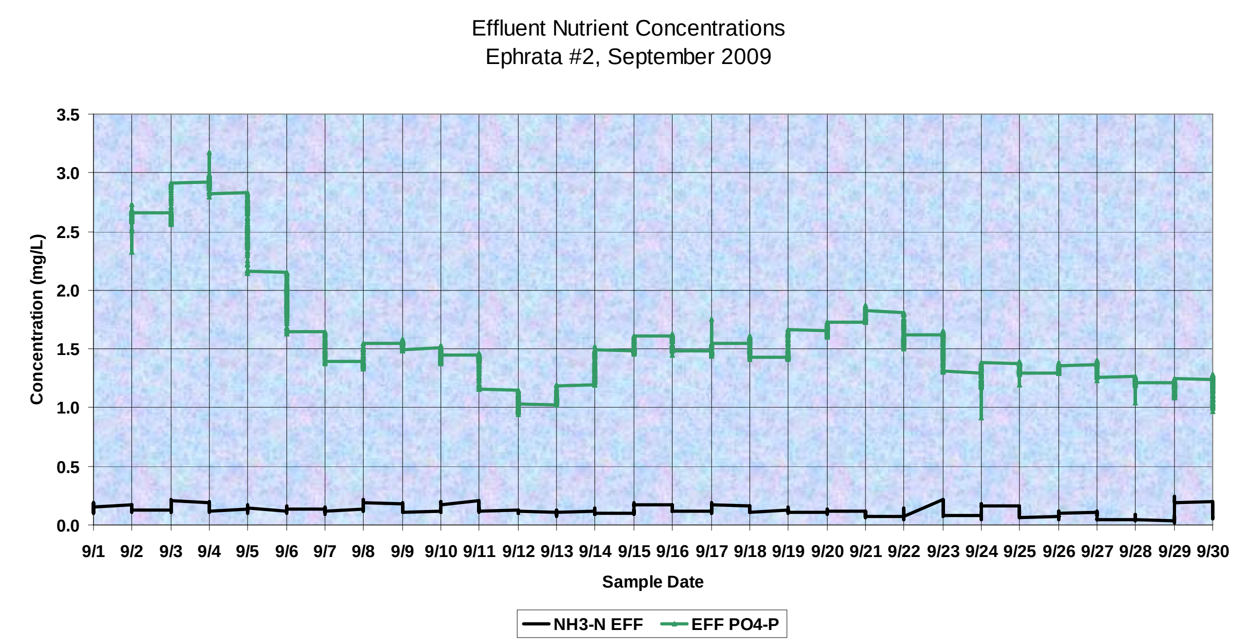


Figure 33: Effluent Nutrients, NH3-N and PO4-P, September, at Discharge Flume

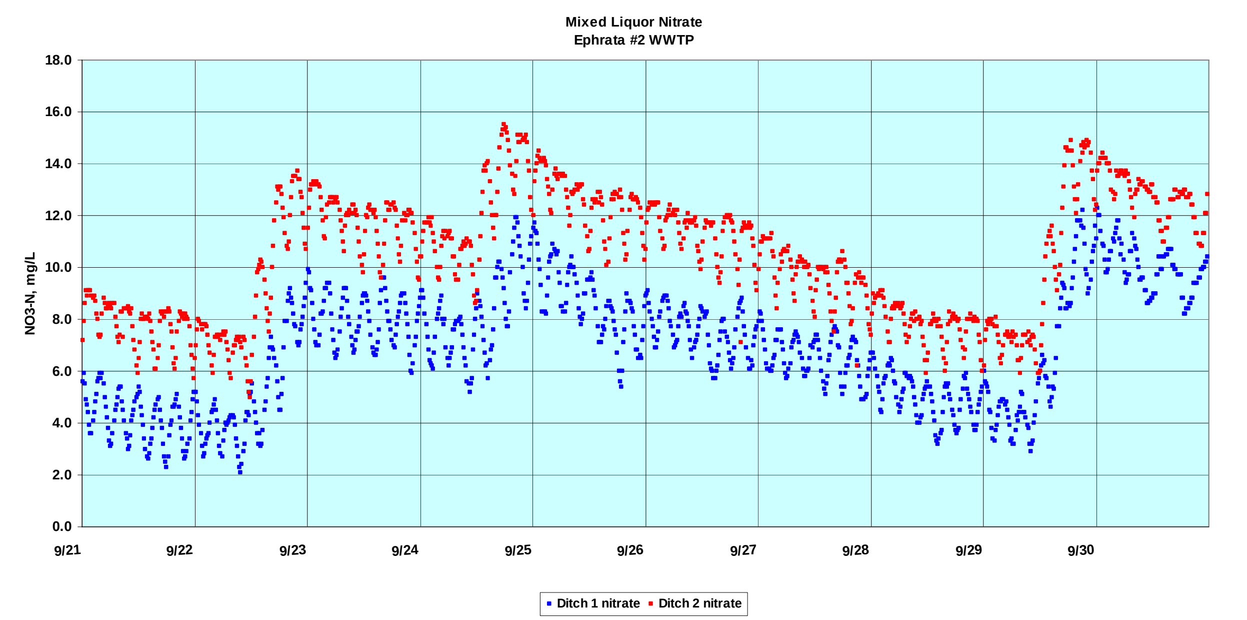


Figure 34: Mixed Liquor Nitrate-Nitrogen: Sept 21-30: note peaking…

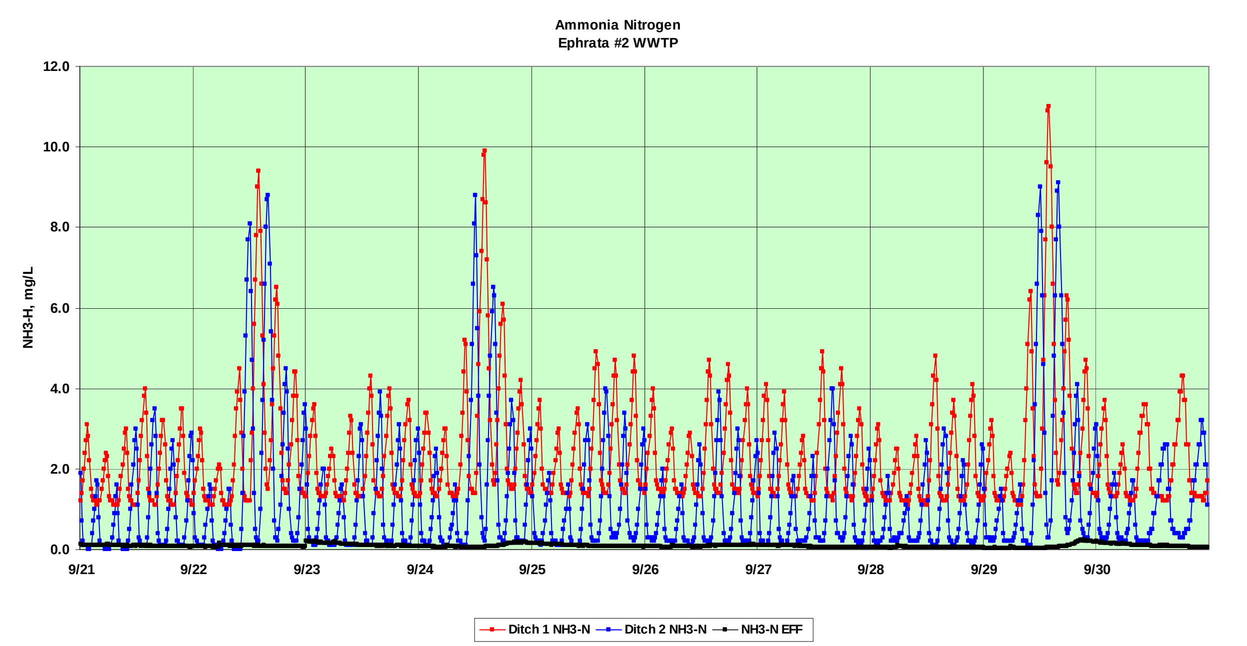


Figure 35: Ammonia-Nitrogen, same period: Note peaks and compare with Nitrate-N above

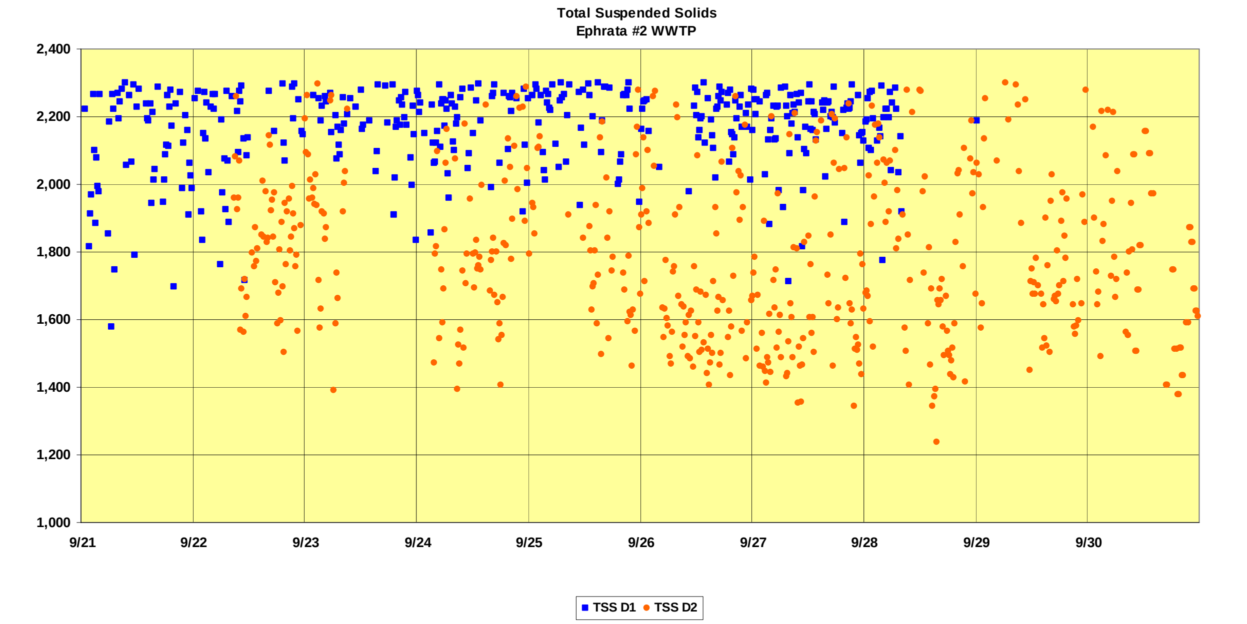


Figure 36: Mixed Liquor Suspended Solids, same period, note variability on probe readings as opposed to laboratory MLSS finding. Probes require almost daily maintenance to remove human and animal hair interferences.

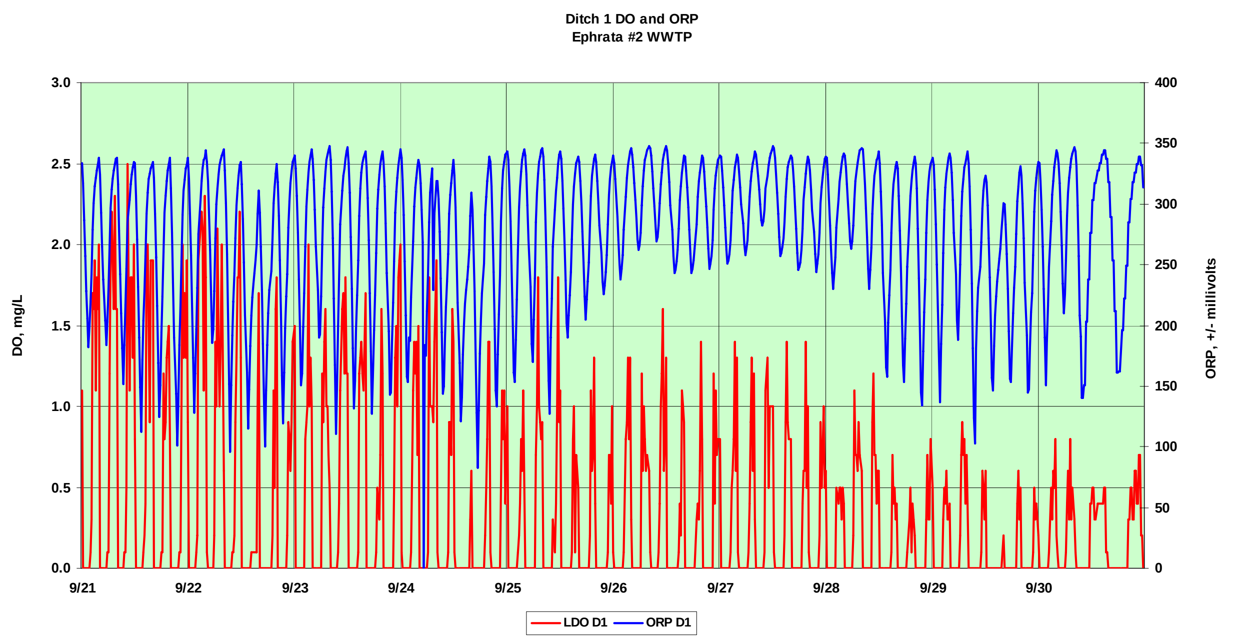


Figure 37: Comparison of D0 and ORP changes in oxidation ditch #1, Sept. 21 through Sept. 30.

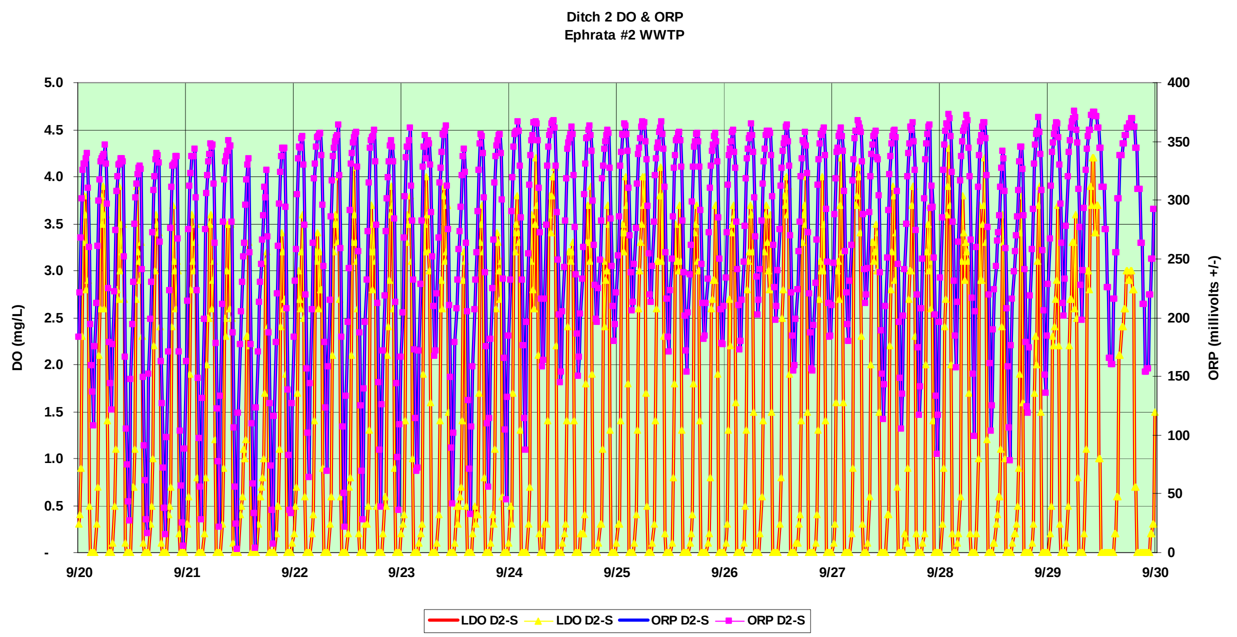


Figure 38: DO and ORP in Ditch 2, using two probes @ each end, Sept. 21 to Sept. 30.

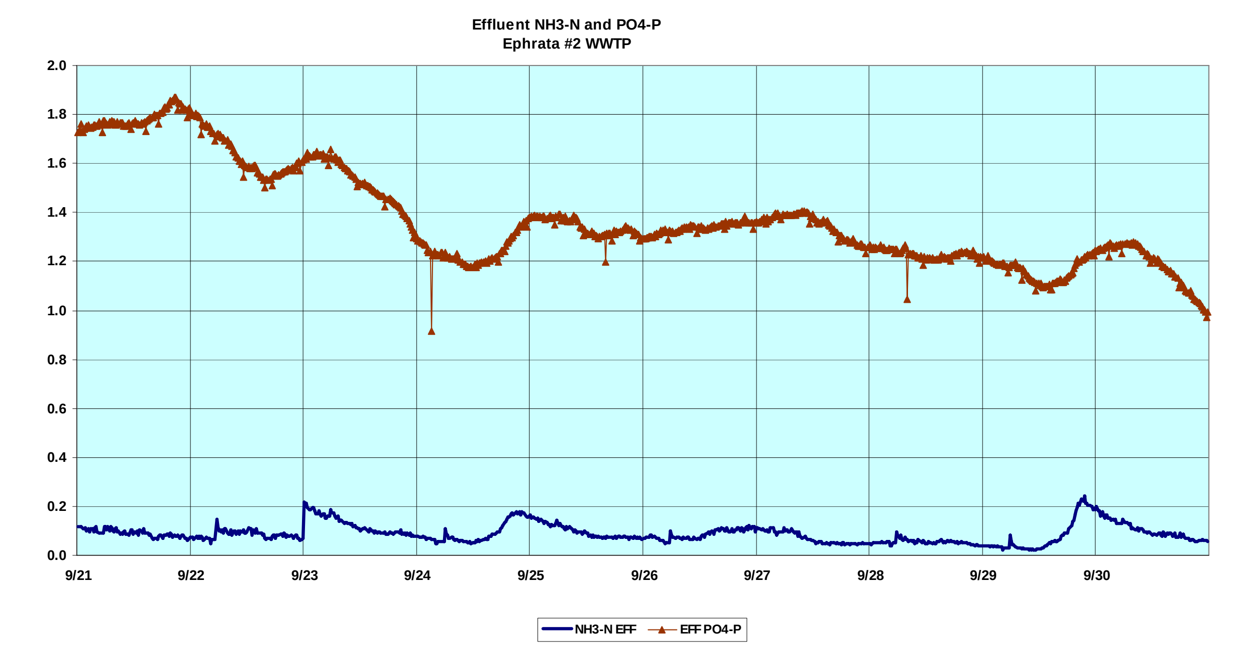


Figure 39: Effluent Nutrients NH4-N and PO4-P, Sept. 21 through Sept. 30.

Attachment K

Daily Histograms for 8/6/2009

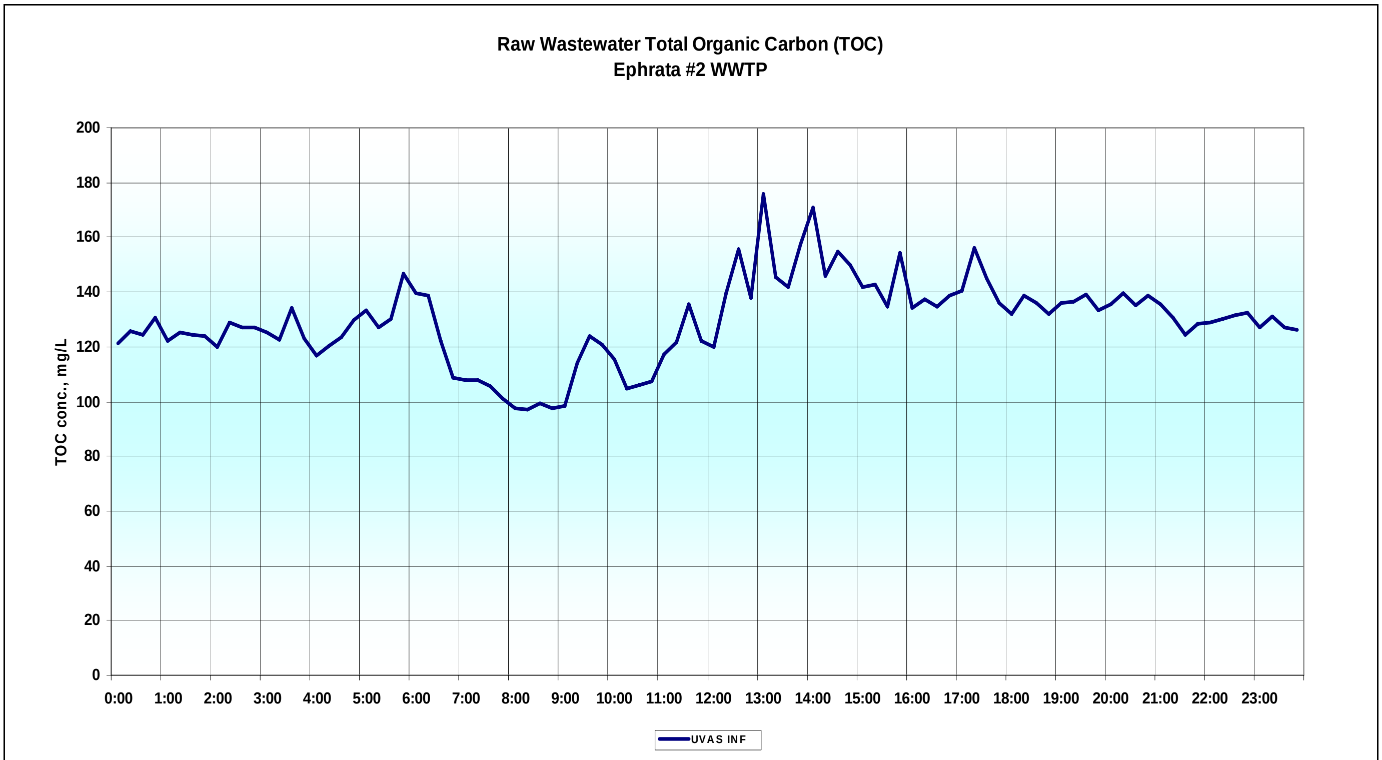


Figure D-1: Raw Wastewater Total Organic Carbon, 8/6/2009

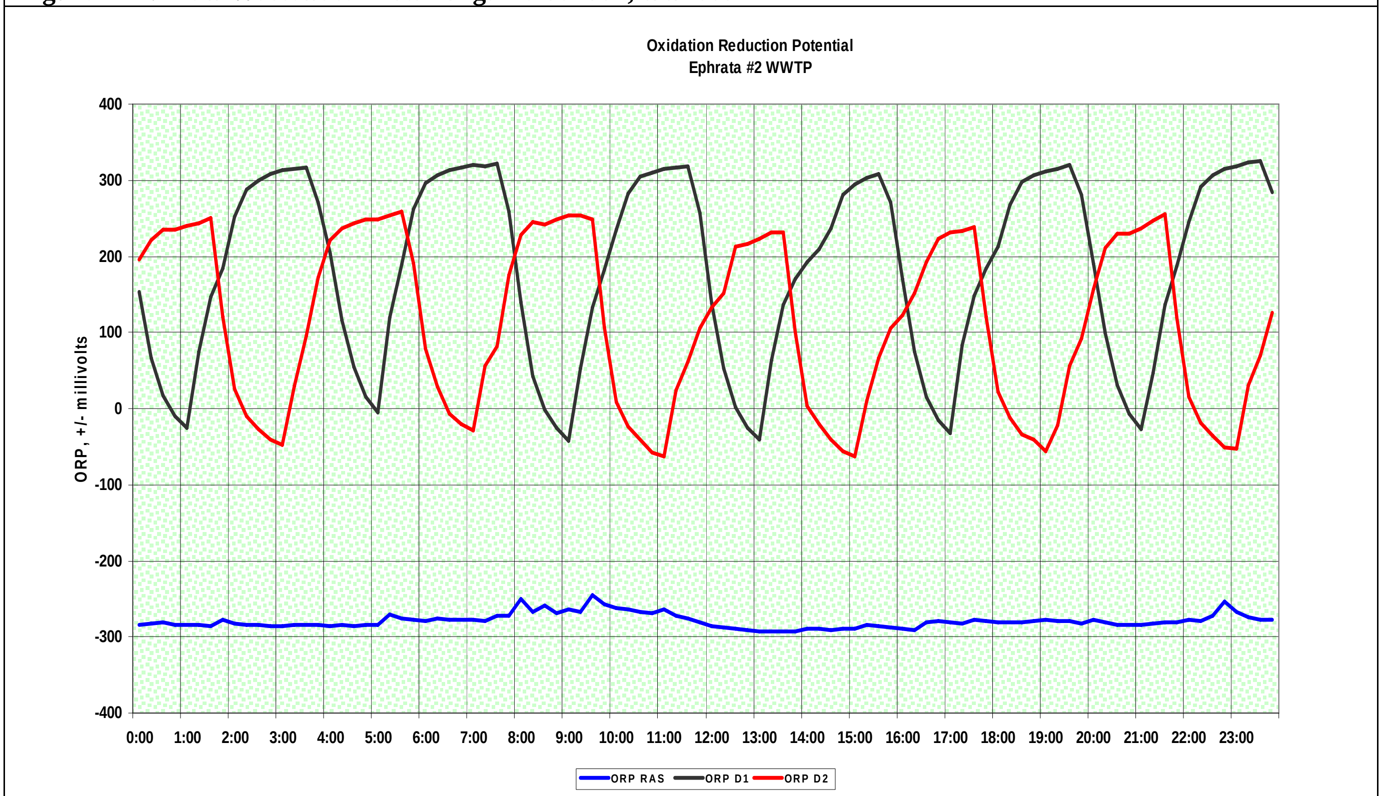


Figure D-2: Oxidation-Reduction Potential, 8/6/2009

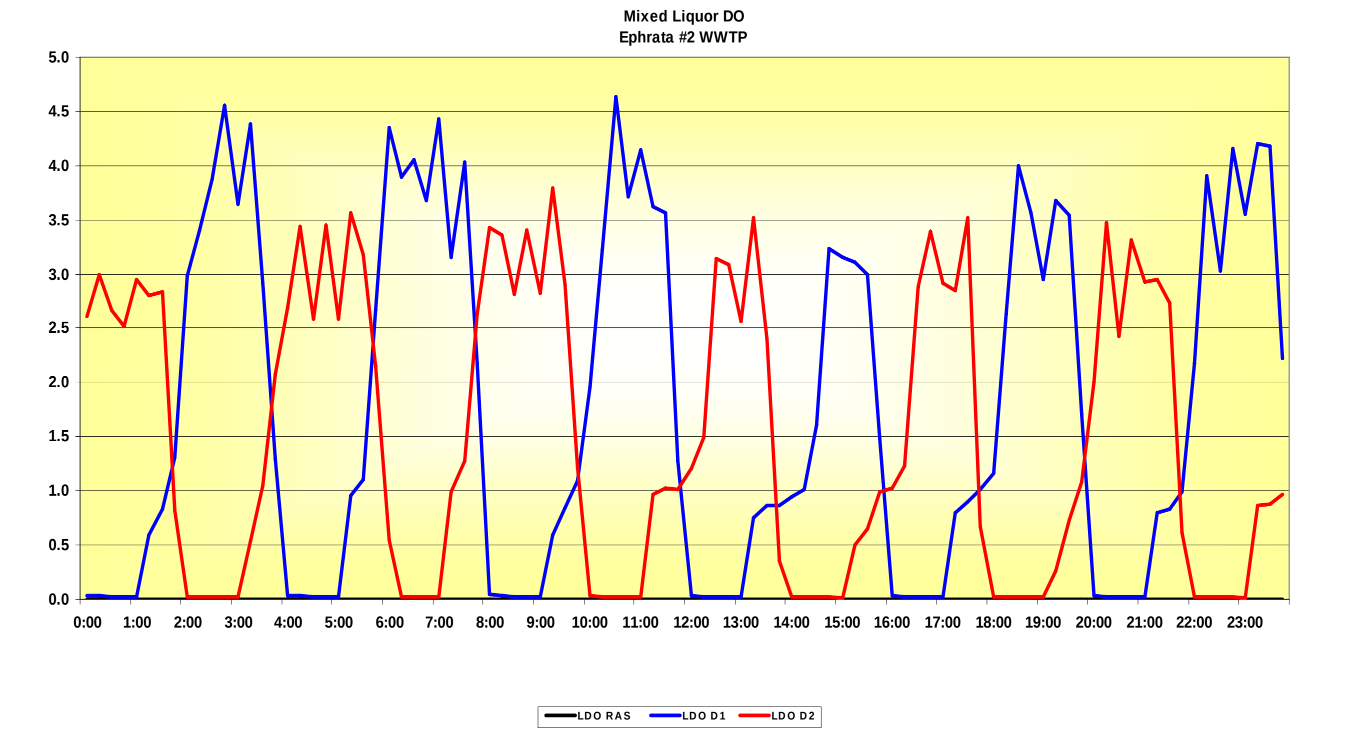


Figure D-3: Mixed Liquor Dissolved Oxygen Concentration, 8/6/2009

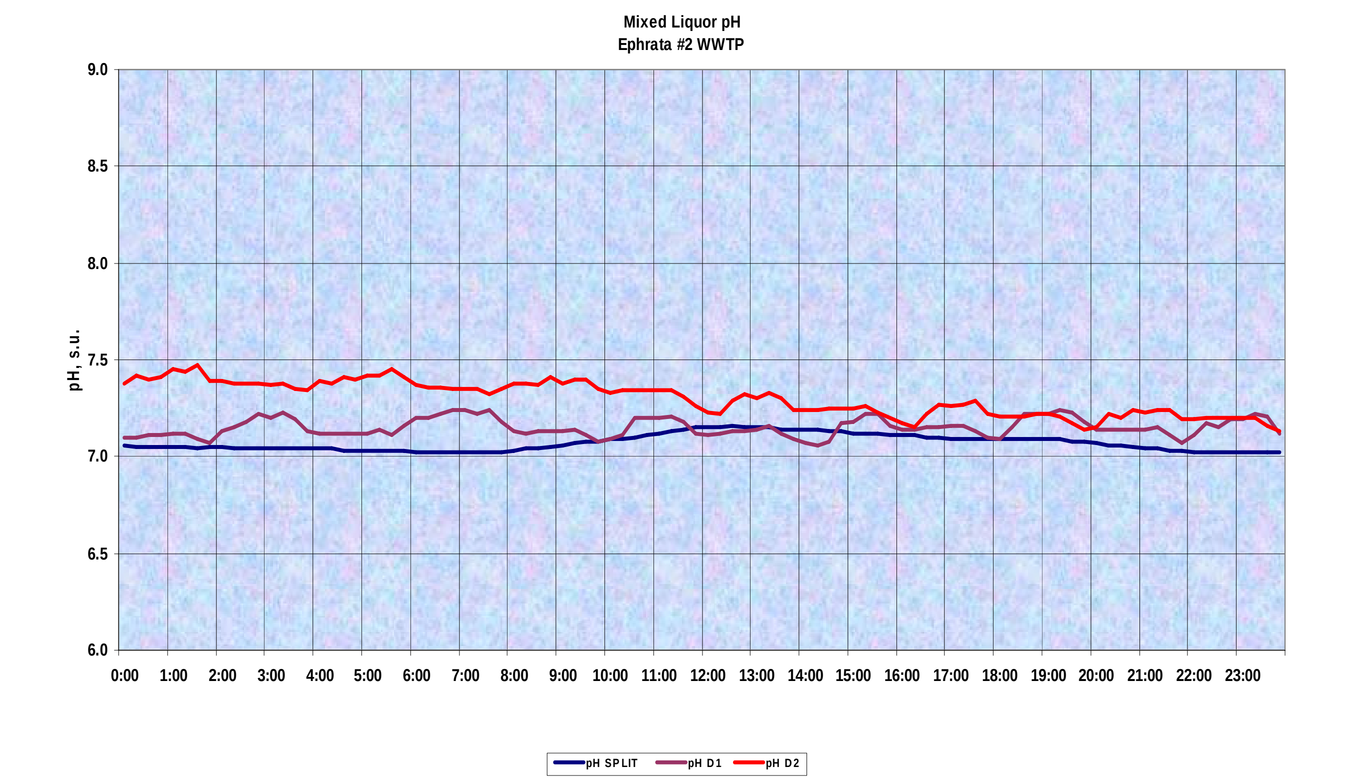


Figure D-4: Mixed Liquor pH, 8/6/2009

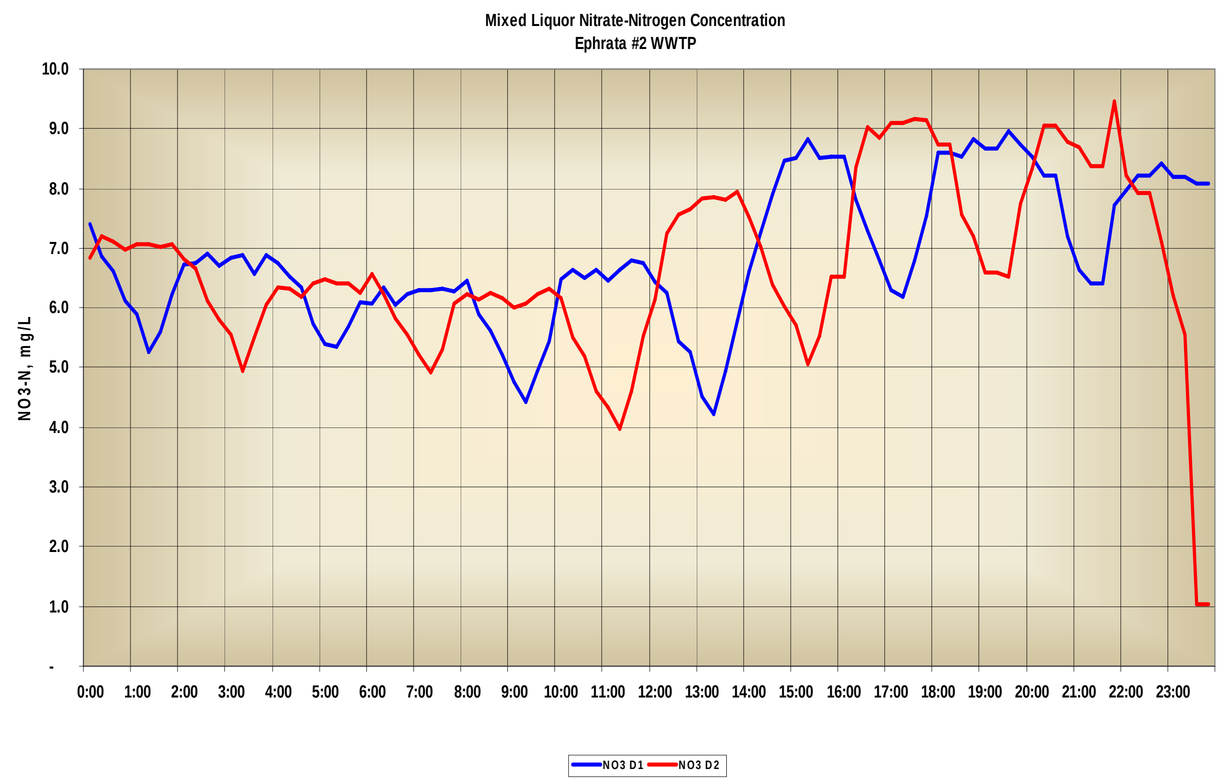


Figure D-5: Nitrate-Nitrogen Concentration, 8/6/2009

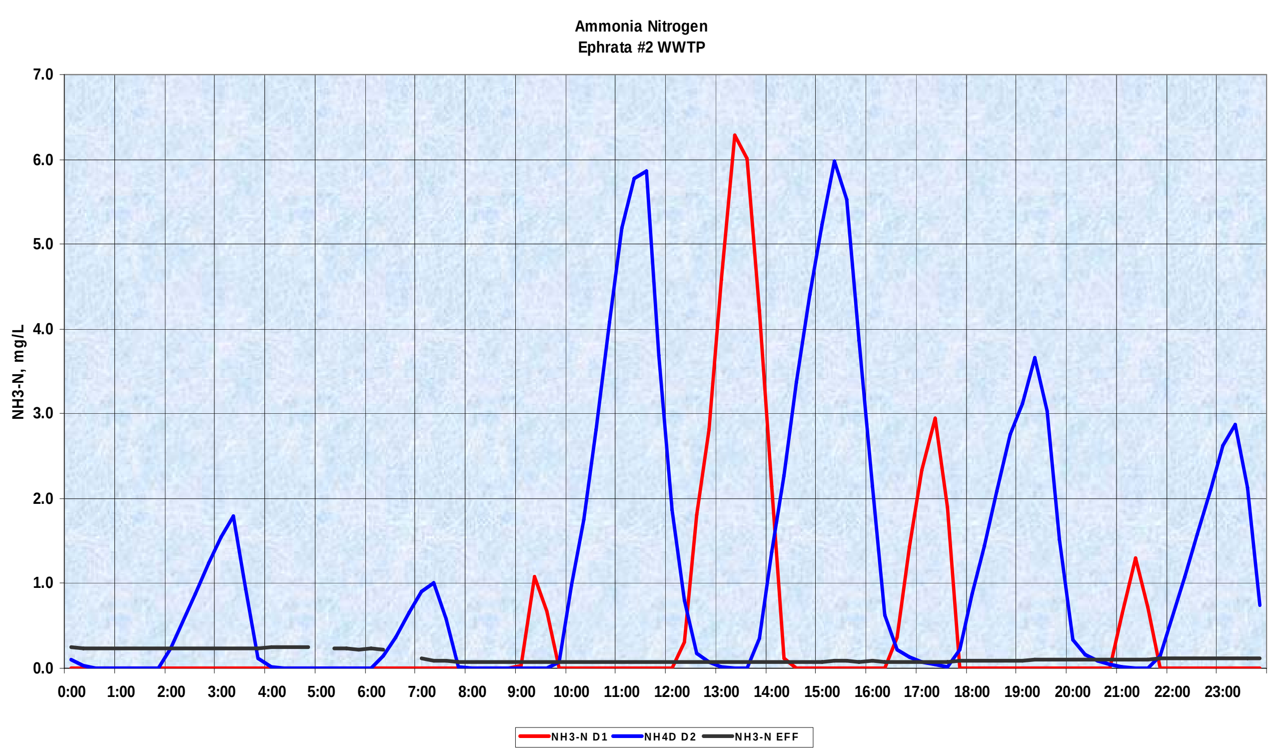


Figure D-6: Ammonia Nitrogen Concentration, 8/6/2009

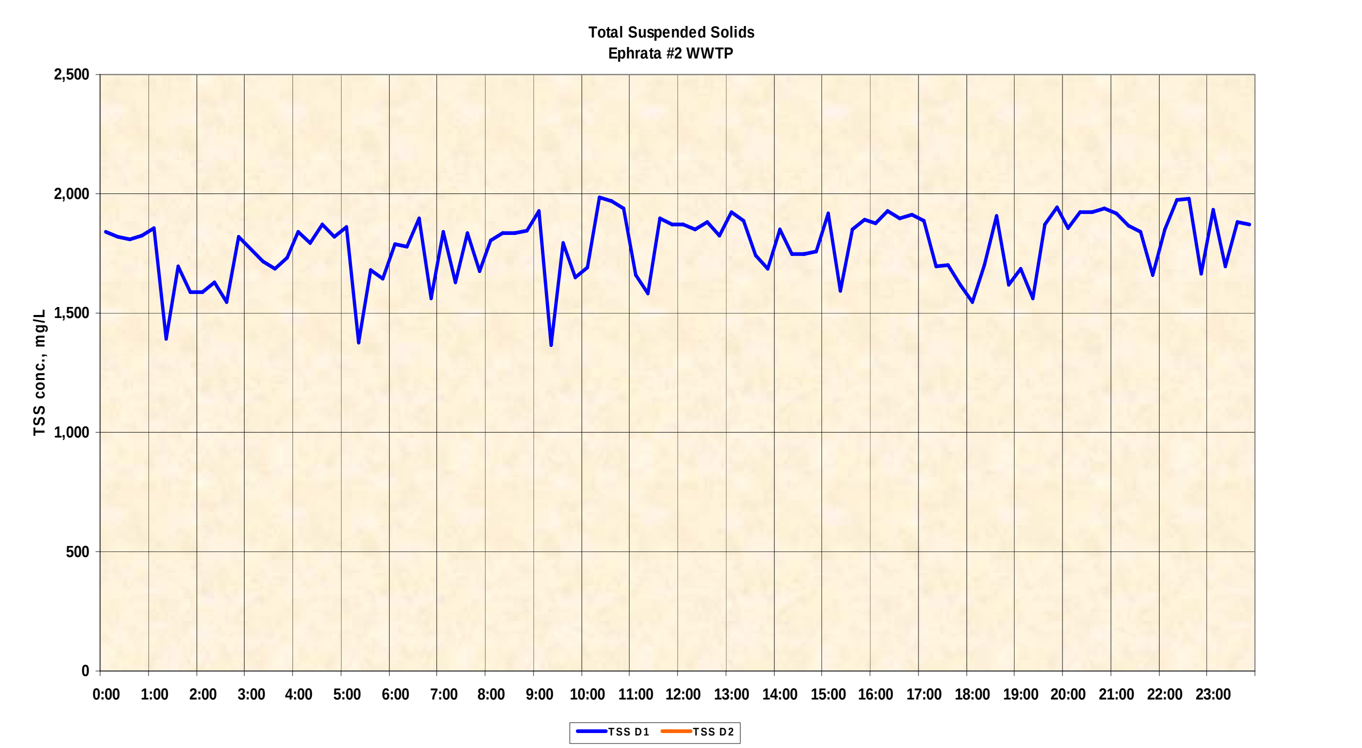


Figure D-7: Total Suspended Solids Concentration, Ditch 1, 8/6/2009

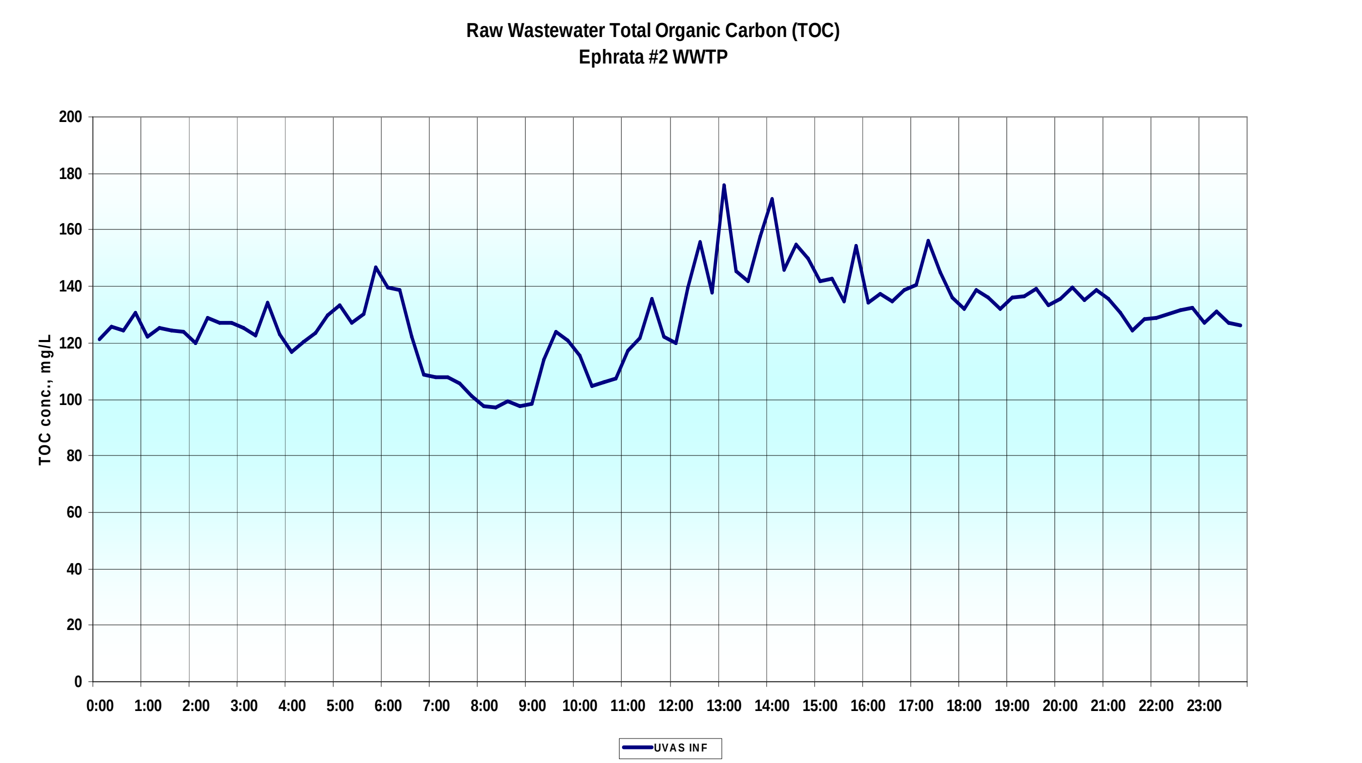


Figure D-8: Raw Wastewater Total Organic Carbon Concentration by UV, 8/6/2009

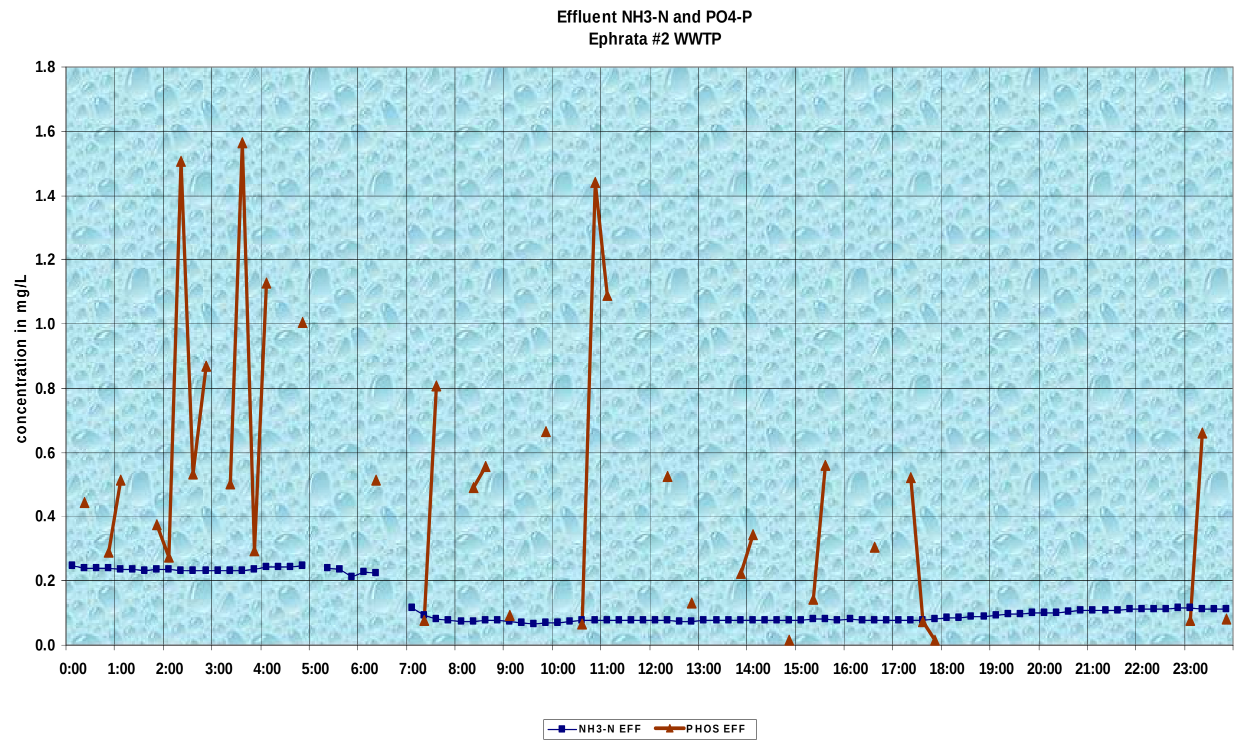


Figure D-9: Effluent Ammonia-Nitrogen and Phosphate-Phosphorus Concentrations, 8/6/2009

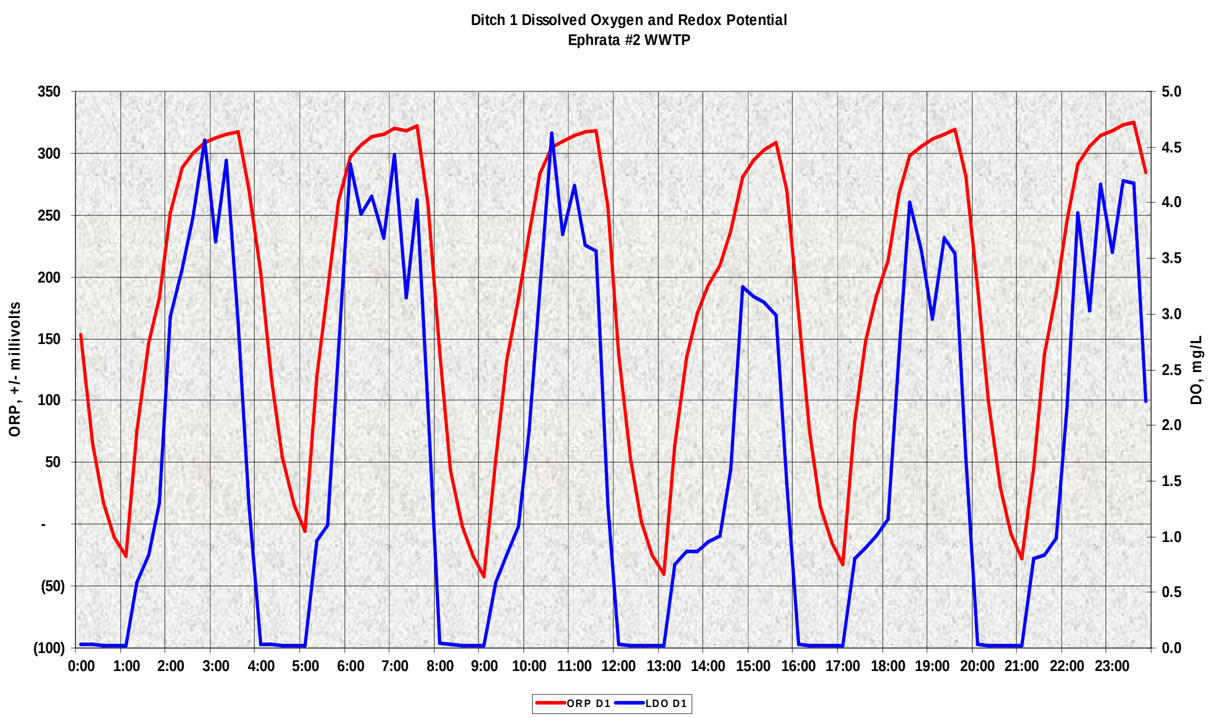


Figure D-10: Ditch 1 Dissolved Oxygen and Redox Potential, 8/6/2009

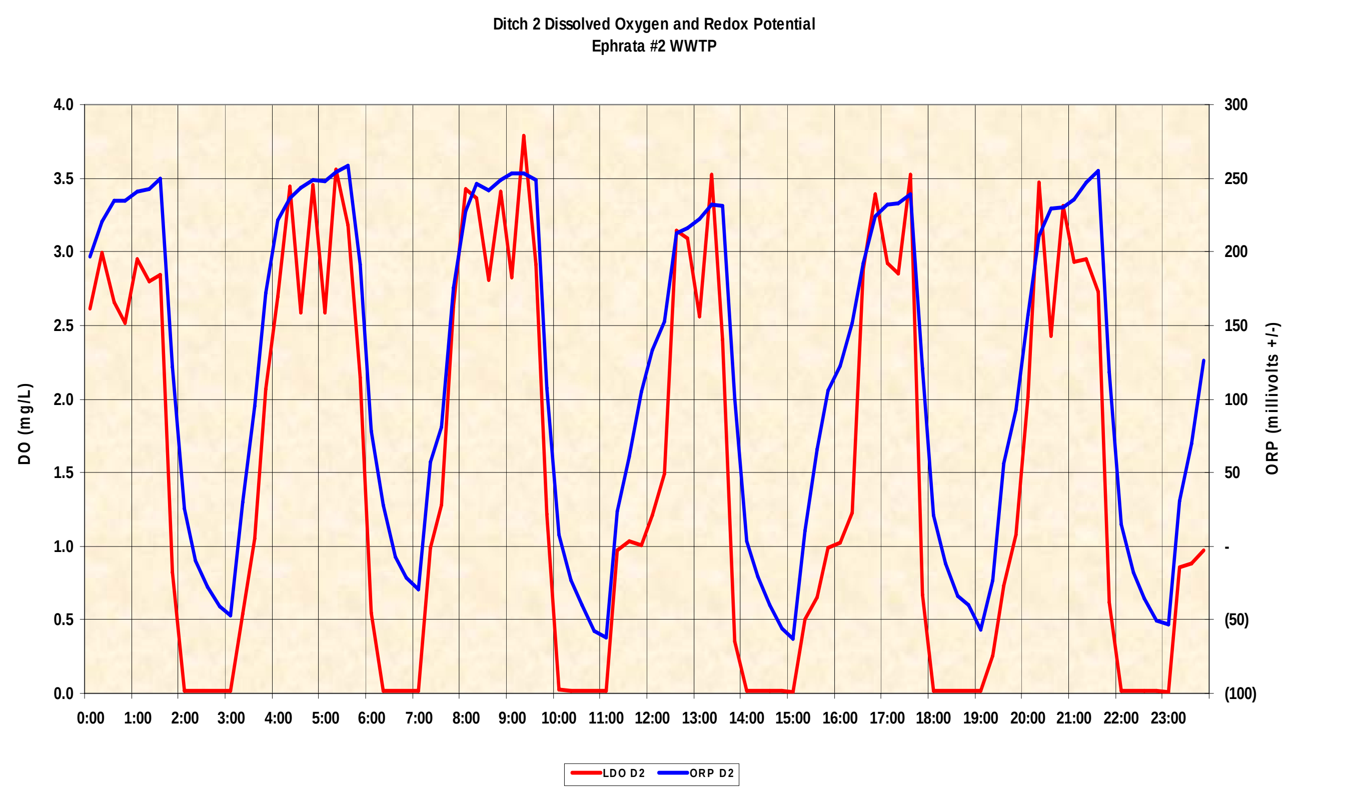


Figure D-11: Ditch 2 Dissolved Oxygen and Redox Potential, 8/6/2009

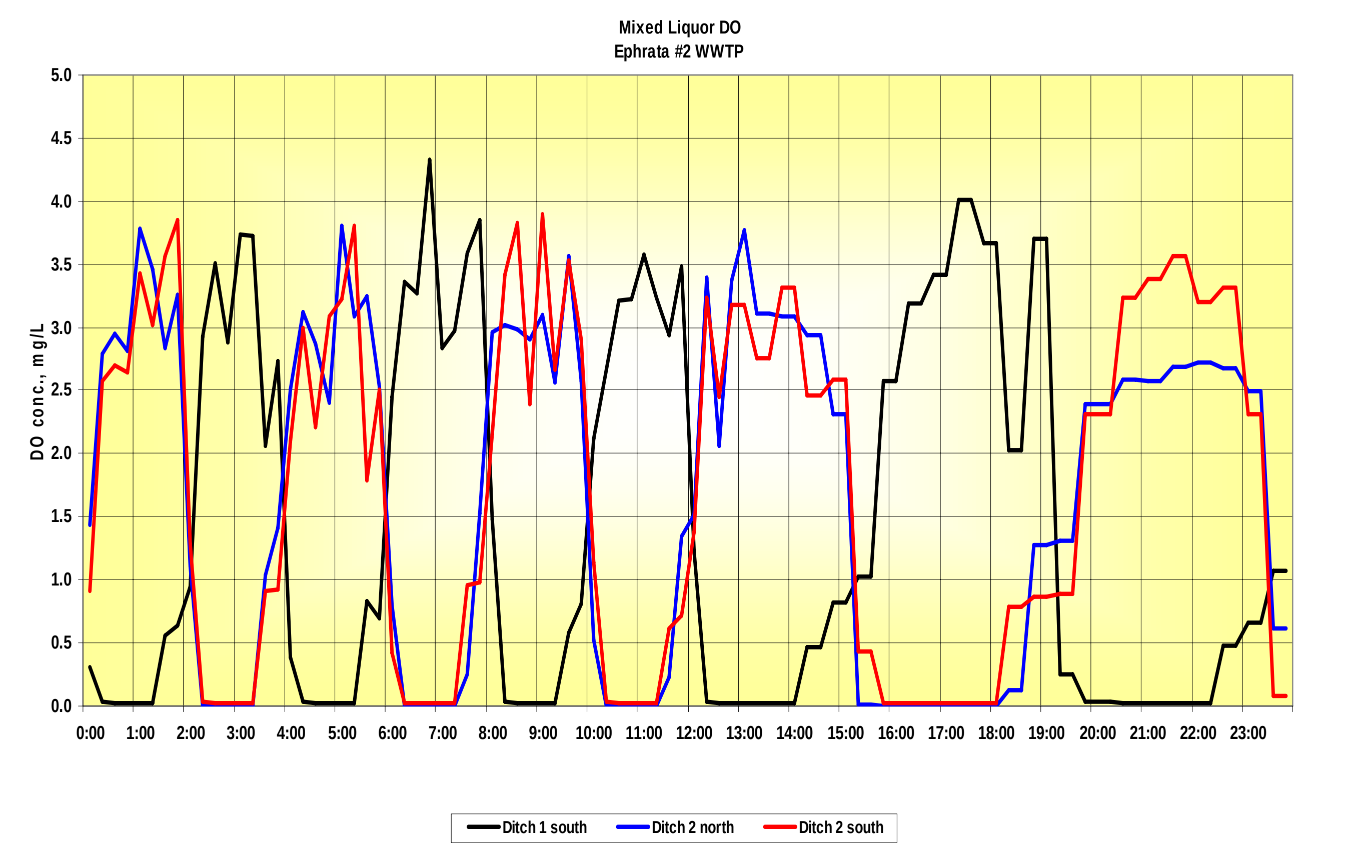


Figure D-12: Dissolved Oxygen Concentrations, 8/25/09, note Blue and Red records for Ditch 2 DO

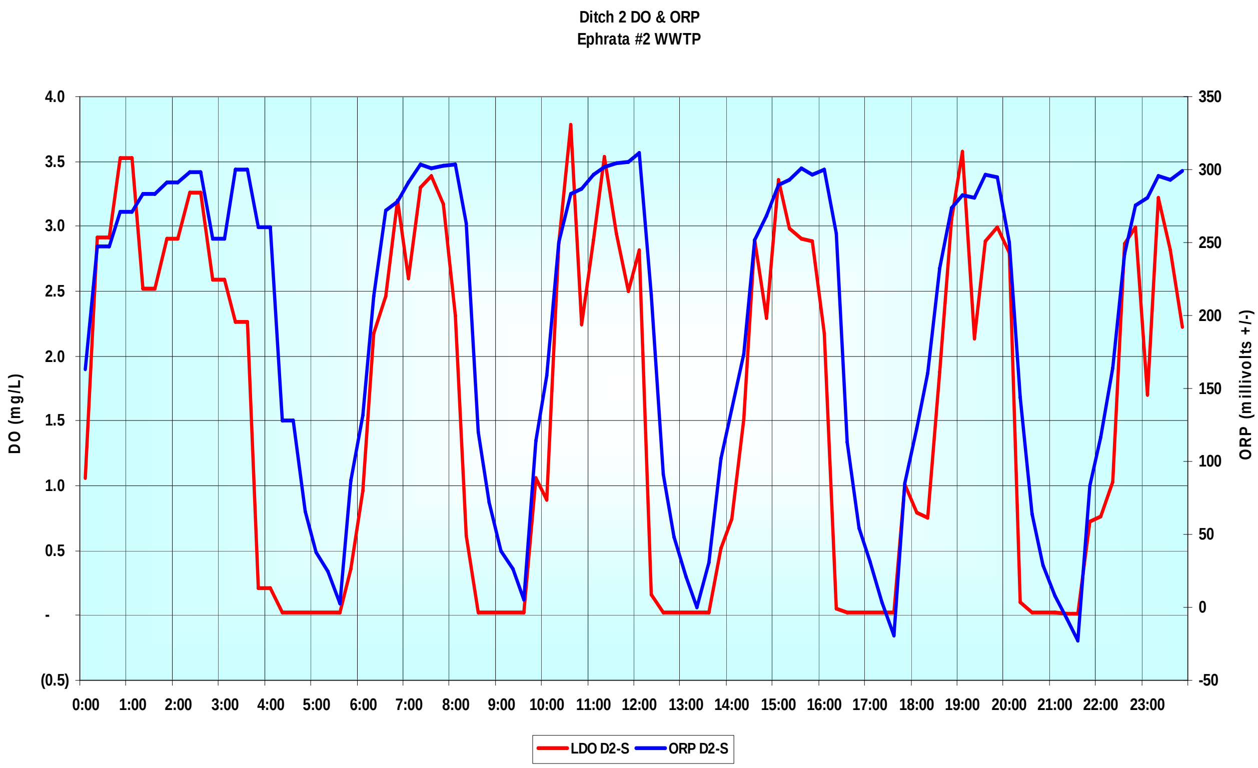
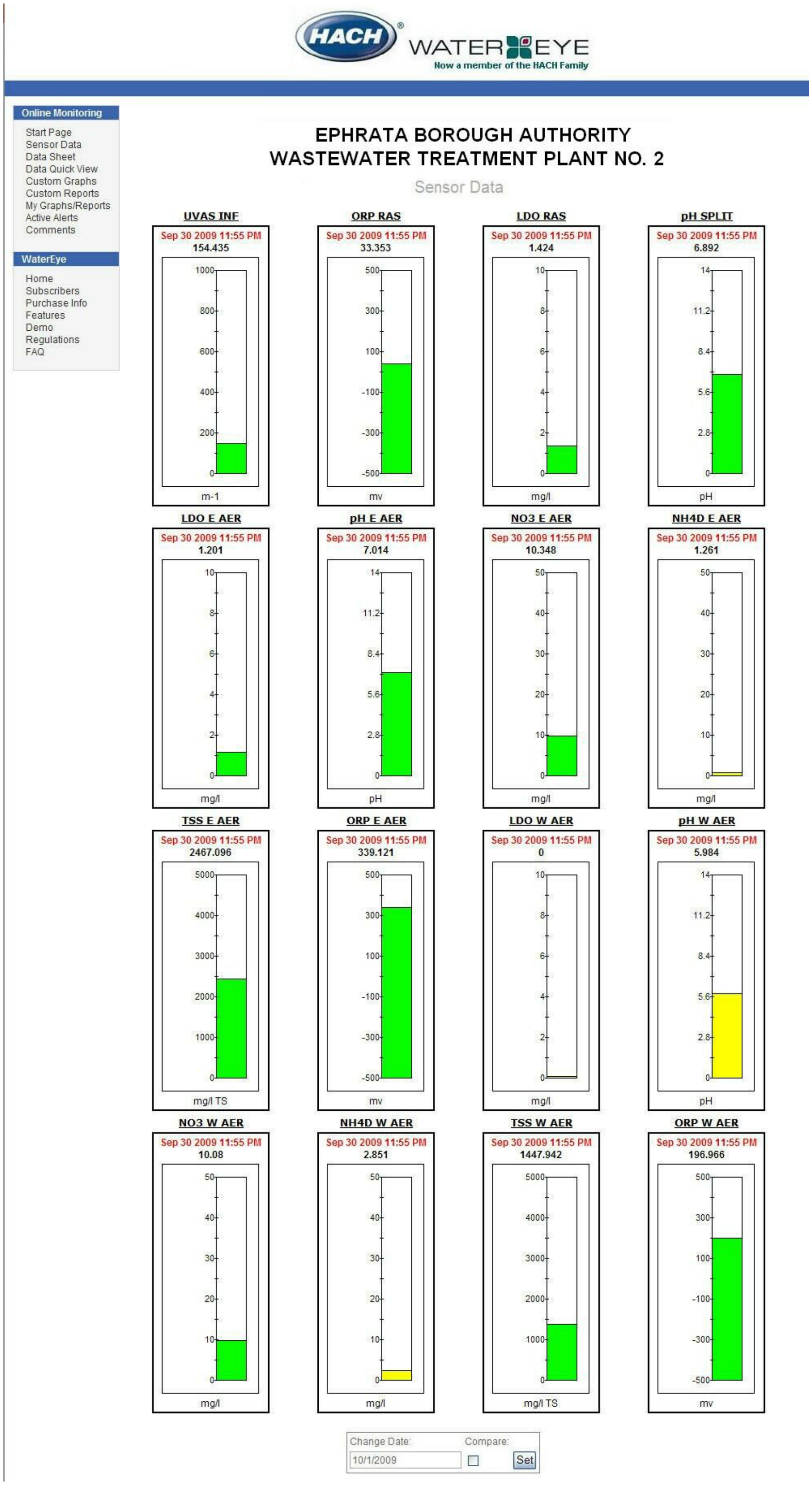


Figure D-13: DO and ORP Histogram, 8/26/09: Note how DO bottoms out at 0 while ORP continues slightly negative. If permitted, ORP could drop to -70 mV.


HACH
WATER EYE
Now a member of the HACH Family
Online Monitoring
Start Page
Sensor Data
Data Sheet
Data Quick View
Custom Graphs
Custom Reports
My Graphs/Reports
Active Alerts
Comments
WaterEye
Home
Subscribers
Purchase Info
Features
Demo
Regulations
FAQ
EPHRATA BOROUGH AUTHORITY
WASTEWATER TREATMENT PLANT NO. 2
Sensor Data
UVAS INF
Sep 30 2009 11:55 PM
154.435
m-1
ORP RAS
Sep 30 2009 11:55 PM
33.353
mv
LDO RAS
Sep 30 2009 11:55 PM
1.424
mg/l
pH SPLIT
Sep 30 2009 11:55 PM
6.892
pH
LDO E AER
Sep 30 2009 11:55 PM
1.201
mg/l
pH E AER
Sep 30 2009 11:55 PM
7.014
pH
NO3 E AER
Sep 30 2009 11:55 PM
10.348
mg/l
NH4D E AER
Sep 30 2009 11:55 PM
1.261
mg/l
TSS E AER
Sep 30 2009 11:55 PM
2467.096
mg/l TS
ORP E AER
Sep 30 2009 11:55 PM
339.121
mv
LDO W AER
Sep 30 2009 11:55 PM
0
mg/l
pH W AER
Sep 30 2009 11:55 PM
5.984
pH
NO3 W AER
Sep 30 2009 11:55 PM
10.08
mg/l
NH4D W AER
Sep 30 2009 11:55 PM
2.851
mg/l
TSS W AER
Sep 30 2009 11:55 PM
1447.942
mg/l TS
ORP W AER
Sep 30 2009 11:55 PM
196.966
mv
Change Date:
10/1/2009
Compare:
Set

Attachment L—Operations Parameters for Ephrata WWTP #2

Parameter	Value	Units
Influent Wastewater, Max. Daily Flow	3.555	MGD
Influent Wastewater, Min. Daily Flow	0.665	MGD
Influent Suspended Solids, average	224	mg/L
Influent BOD5, average	233	mg/L
Influent Ammonia Nitrogen, average	34.3	mg/L
Influent Phosphorus, average	6.11	mg/L
Influent pH	7.5	s.u.
Influent Temperature	60	deg. F
Annual Average MLSS	2,073	mg/L
Settleability @ 30 minutes	271	mg/L
Sludge volume Index	129	
Food / Mass Ration (F/M)	0.53	Ratio
Mean Cell Residence Time	31	days
Ditch #1 DO, Average	0.48	mg/L
Ditch #2 DO, Average	1.36	mg/L
RAS Total Suspended Solids, Average Daily	9,775	mg/L
RAS flow, Average Daily	0.3195	MGD
WAS flow, Average Daily	0.1955	MGD
WAS Total Suspended Solids, Average Daily	1.106	percent
WAS Volatile Suspended Solids, Average Daily	72.7	percent
Effluent Flow, Average Daily	1.004	MGD
Effluent Flow, Max Daily	3.457	MGD
Effluent Flow, Min Daily	0.617	MGD
Effluent Suspended Solids, average	2.1	mg/L
Effluent BOD5, Average Daily	2.5	mg/L
Effluent Ammonia Nitrogen, Average	0.49	mg/L
Effluent Phosphorus	1.45	mg/L
Effluent Nitrate, Average	6.7	mg/L
Effluent Nitrite, Average	0.154	mg/L
Effluent Nitrite + Nitrate, Average	6.87	mg/L
Effluent Dissolved Oxygen, Average Daily	9.2	mg/L
Effluent pH, Average Daily	7.6	s.u.
Effluent Fecal Coliform, Average Daily	9.7	per 100 ml.

Attachment M—Correspondence

Rachael Carson State Office Building
400 Market Street
Harrisburg, PA 17101
July 9, 2009

Bureau of Water Standards and Facility Regulation 717-772-4019
Operations Monitoring and Training FAX – 717-772-3249
Filter Plant Programs

Mr. D. Robert Thompson, P.E.
Director of Engineering & Public Works
Borough of Ephrata
124 South State Street
Ephrata, PA 17522

RE: Wastewater Plant Performance Evaluation
Ephrata Borough Wastewater Treatment Fac. #2
NPDES Permit No. PA0087181
Ephrata Township, Lancaster County

Dear Mr. Thompson:

As a follow-up to our site visit this morning, the Department of Environmental Protection (Department) is requesting your organization's commitment to participate in a Wastewater Plant Performance Evaluation (WPPE) at the Ephrata Borough Wastewater Treatment Facility #2, with digital monitoring equipment to be deployed at the end of July 2009 for use during August and September. This US-EPA sponsored project is expected to last up to 8 weeks. Through WPPEs, the Department seeks to assist municipal wastewater systems in optimizing their wastewater treatment plant processes as part of the Department's new Wastewater Optimization Program. The goal of this program is to improve surface water quality at drinking water filter plant intakes by reducing nutrients, pathogens, and emerging contaminants at wastewater plants upstream. While this is a new program, it is being modeled after the Department's successful Filter Plant Performance Evaluations (FPPEs) conducted at Drinking Water facilities.

Participation in this project is voluntary and there are no costs associated with the work and sampling conducted by Department staff. Operational data will be shared with the plant operators for their use in making process control modifications. Work product available to you and your staff at then end of the WPPE includes a written report summarizing the data, observations, and findings, along with comments on how similar facilities have improved performance in light of such findings. We will also make all data available to you for future use however you see fit. Please review the attached Wastewater Optimization Program Detail Sheet for more information about the program, or contact us directly.

Thank you for meeting with us and considering participation in the Department's Wastewater Optimization Program. We believe that you will find the results of this evaluation valuable for maintaining compliance with present and future wastewater regulations, optimizing your operation for the

Copy of Original Program Introduction Letter, pg. 1

Mr. D. Robert Thompson, P.E. - 2 - July 9, 2009
Borough of Ephrata

removal of disease causing organisms, and controlling operating costs through process optimization. Please call me at 717-772-4019 if you wish to discuss additional details of the WPPE and to confirm your willingness to participate in the WPPE during August and September.

Sincerely,

Marc Austin Neville
Water Program Specialist
Bureau of Water Standards and Facility Regulation

Enclosure

bcc: Stephen Bonner, Superintendent Water & Wastewater, Ephrata Borough
Randy King, SCRO, Water Management Program
Barry Sweger, SCRO, Water Management Program
Kevin Anderson, RCSOB, 11th Flr, BWSFR
Robert DiGilarmo, Cambria Mining Office
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