WASTEWATER PLANT PERFORMANCE EVALUATION

September – October, 2010

Lower Salford Township Authority
Harleysville Sewerage Treatment Works

NPDES #PA0024422

Bureau of Water Standards & Facility Regulation
POTW Optimization Program

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

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Attachments

1 Optimization Report

In August 2010, DEP staff asked the engineer and staff of Lower Salford Township's Harleysville wastewater treatment facility to participate in a Wastewater Plant Performance Evaluation (WPPE), a new program that seeks to optimize effluent quality through process monitoring and control. The WPPE program is currently funded under an Environmental Protection Agency (EPA) grant for studying the effect of process optimization on the reduction of dangerous waterborne pathogens found at drinking water treatment facilities within a ten-mile distance downstream from municipal wastewater plant discharges. DEP staff employed continuous-recording nutrient and water chemistry probes and a portable wastewater laboratory to effect process optimization, following an initial evaluation of the candidate facilities.

On-site activities for the WPPE took place during September and October. DEP staff installed both the continuously monitoring digital probes and portable wastewater laboratory during the final week of August and began collecting data recorded at fifteen-minute intervals, downloading probe data to a notebook computer set up in the facility's process monitoring laboratory. In addition, staff conducted a variety of process monitoring tests when on-site. This data generally confirmed the data already being recorded by plant staff in their process monitoring activities, and DEP staff also obtained aqueous samples from different sampling points in the treatment process, delivering the samples to PA-DEP's Bureau of Laboratories facility in Harrisburg for supplemental routine analysis. Generally, staff attended the site two or three days per week during the WPPE. Specific sampling required under terms of the study grant was undertaken on three occasions, where 10-liter samples of final effluent, background receiving stream, and impacted surface waters downstream were analyzed using EPA Method 1623 for waterborne pathogens Cryptosporidia oocyst and Giardia lamblia cyst, two species of particularly noxious drinking water pathogens which must be removed by downstream potable water filtration facilities.

DEP staff completed on-site activities on November 3, 2010, and held an exit meeting a week later, where preliminary findings and recommendations were made to assembled staff, the township engineer, and with the consulting engineer in attendance. These findings and recommendations are summarized in this section, below.

Most daily findings and recommendations were communicated to the Chief Operator when DEP staff was on site. Staff demonstrated some alternate methods of process monitoring, such as development of Dynamic Sludge Age data and refinements to the existing Solids Retention Time (SRT) worksheets already in use at the facility.

Minor process adjustments were recommended during the evaluation; however, no major process changes would be tried by the operators until after October, when the growing season nutrient limit would not be in effect. Lists of the monitoring equipment used, a schematic, and photos of the installation are provided in attachments E and F.

A description of the WPPE Program follows as Attachment A, with a listing of program participants in Attachment B. Descriptions of the Harleysville plant, its designed operational characteristics, and a schematic of the current flow configuration is attached at C. Attachment D consists of a review of operations process monitoring and control. Tables of test results are shown in Attachment K and graphic representations following in attachments G and J.

Attachment H includes results of water pathogen tests performed as part of the WPPE, while Attachment I displays a typical example of the bench test results for on-site process monitoring done by DEP staff. Attachment K includes tables of data based on weekly sampling and testing performed at DEP's Bureau of Laboratories, and Attachment N lists the facility's current NPDES reporting limits. Finally, Attachments L and M show examples of solids control spreadsheets discussed with the operators during the WPPE. A CD-ROM disk of data tables, photographs, and reference materials employed during this evaluation is provided with the paper copies of this report.

The Department is grateful to all Lower Salford Township Authority and Harleysville operators for their participation and assistance in this plant performance evaluation and commends them on their continued efforts to apply professionalism and duty to their work on behalf of township residents and businesses.

1.1 Nutrient Impairment in Receiving Stream

The Harleysville plant discharges to an impaired reach of an unnamed tributary of Indian Creek watershed (UNT 01182). In 2008, EPA promulgated a total maximum daily load (TMDL) for this watershed, based on sediment and nutrient contamination and its adverse effect on water ecology within the 54-square mile watershed. The TMDL is fully implemented as of June 2013, at which time point-source discharges such as Harleysville will be required by federal regulators to meet more stringent criteria for nutrient reduction. At Harleysville, the nutrient-of-concern is phosphorus. The proposed TMDL for the Indian Creek watershed would result in Harleysville having an average daily maximum load of 0.69 pounds per day (ppd) of phosphorus expressed as phosphorus (P), or an average concentration of 0.0475 milligrams per liter (mg/L) of P for a discharge of 0.700 MGD.

As a practical matter, the NPDES permit for Harleysville, currently under appeal since its renewal date in 2006, would initially impose no further reductions of phosphorus than under the current permit, for at least a five-year period. The facility has a discharge limit of 0.16 mg/L phosphorus as P for a design average flow of 0.700 MGD. (Earlier permits listed this requirement as 0.5 mg/L phosphorus as orthophosphate [PO_4^{3-}], which represents biologically available phosphorus as a nutrient.) The proposed permit differs from previous permits in that it establishes a winter concentration limit of 0.32 mg/L, during the non-growing season months from November through March. Furthermore, eventual implementation of the TMDL in 2013 requires that phosphorus in the discharges be reduced until the maximum daily load, 0.69 lb., is reached, so that sometime during the latter half of a subsequent 5-year permit cycle, the effluent concentration will be lower than 0.16 / 0.32 mg/L, although such a final concentration-based limit has not been resolved. Suffice it to note that at current average daily flows of about 0.500 MGD, the concentration limit could be nearer to 0.10 mg/L P during the growing season in order to satisfy the loading limit required by the federal TMDL. In our discussions of process optimization, we use this concentration value as the voluntary optimization goal to strive for during the growing season months from April through October.

Several communities within the Indian Creek watershed are collaborating in efforts to reduce pollution to Indian Creek. Among solutions being discussed, as alternatives to lower discharge limits at point-source dischargers, are development of riparian buffers and adoption of more conservative agricultural practices aimed at reducing both nutrient and sedimentation contamination to the creek. This collaboration to reduce watershed pollution is commendable, and it represents good stewardship of environmental resources in the face of heated land development issues.

Because nutrient contamination was a focus for US-EPA in its development if TMDLs for the Indian Creek Watershed, DEP and facility staff conducted the WPPE by evaluating the Harleysville Wastewater Treatment Facility with an eye toward achieving higher quality effluent than that required under the current permit. This evaluation also examined existing configuration and practices that would reduce the prevalence of wastewater pathogens, although the method for evaluating pathogens inactivated by exposure to ultraviolet light disinfection is somewhat undefined.

Results of our evaluation are summarized below as Operational Strengths and Focus Points for Improvement.

1.2 Operational Strengths

- Operators conduct routine assessments of treatment facility on a regular basis. These assessments include process monitoring such as:
    - Measurement of dissolved oxygen concentrations at several points,
    - 30-minute sludge Settleability tests with results taken at 5-minute intervals,
    - Frequent grab testing for phosphorus residual, as a basis for adjusting the chemical feed pumps,
    - Sludge Blanket thickness in all clarifiers, which in combination with the totalizer measurements for Return Sludge and Wasted Sludge rates is used to control return rates,
    - Ammonia-nitrogen levels in mixed liquor supernatant, used to adjust Stage 2 treatment time,
    - Alkalinity, a measure of the chemical buffering capacity of the biomass and its ability to nitrify ammonia waste,
    - Digester conditions.
- The operator and lab technician at the Mainland Plant operates a certified laboratory for testing wastewater strength, gravimetric and volatile solids, and nutrient levels for compliance reporting. The laboratory is well-organized and meets or surpasses the minimum requirements for facilities of its size.
- The operator's understanding of adjustments to RAS and WAS rates is beneficial to sustaining the operation, and he should continue to refine this in order to maintain steady-state process control, and the facility has more flow totalizer locations than usually seen at operations of this size, all of them with current calibration certificates.
- Use of a digital dissolved oxygen probe (Hach LDO) in Stage 2 aeration to pace blower output maximizes the energy efficiency of that stage of the treatment process.
- Phosphorus control during the growing season has been generally favorable. The Phosphorus limit of 0.16 mg/L is presently met by addition of Ferric chloride to

precipitate iron phosphate. ($Fe_3(PO_4)_2$) The operators give ample attention to phosphorus control through frequent testing of water samples.

- Biomass is reasonably maintained in steady-state conditions despite potential for solids washout, although it tends toward old sludge age and could benefit from some recommendations made during the WPPE.
- Operators, working with the engineer, have set plans to drain and examine each process unit over the next year, in order to perform preventative maintenance and repair damage due to wear and tear. Already, they have drained one of the Stage 2 tanks (S2T4), the UV disinfection tank, where the weir and launder were replaced, and half of Stage 1 tanks, to perform maintenance.
- Waste sludge solids are gravity thickened and digested aerobically, then removed in liquid form for disposal off site.
- Clarifiers are well-maintained on frequent basis, with weirs and launders regularly scoured to remove algae and buildup.
- Maintenance records show that facility equipment maintained and operated in balance, with manual records readily available for review.
- Facility generally has maintained continual NPDES compliance, with one exception occurring during September due to excessive phosphorus loading; however, the plant quickly returned to compliance after additional monitoring was performed.
- Electronic records database is housed in the ALLMAX Operator 10 suite of programs. This package is a useful recordkeeping utility, and it can be programmed to calculate many important activated sludge treatment parameters that are useful in gauging treatment effectiveness and the relative health of the biomass.
- Automatic samplers are located at the headworks, the inflow to Stage 2 aeration, and at the final effluent freshening tank. Setting aside some minor details, the equipment is in serviceable working order and the final effluent sampler has a working calibration thermometer to assure correct holding temperatures.
- Operators are conscientious and coordinated. As a team, members work well together under most circumstances.
- Operators have all achieved certification for activated sludge facilities.

1.3 Focus Points for Improvement:

- There is an immediate need to increase food load to Second Stage: inflow BOD averages only about 15 mg/L, when solids levels are around 3,400 mg/L. VSS/TSS ratio is about 40%, suggesting a well-digested biomass with mostly inert bacteria and much inorganic material, such as Iron deposits from phosphorus treatment.
- $FeCl_3$ dosage may be too high, given the visibly high concentrations of iron in second stage, and this could cause metal toxicity that further inhibits biological growth. It may be useful to revisit bench-scale testing to arrive at an effective breakpoint dose, which would save money and labor.
- Stage 1 contact/stabilization, while it reduces inflow BOD_5 from c. 360 to c. 15 mg/L, may not be the best use of this treatment capacity, as the operators told us the blower capacity is insufficient to aerate both trains. This presents an opportunity to experiment with other configurations and with lowering solids concentration. Theoretically, the

upgraded Stage 1 blowers should be able to aerate both trains of treatment (T-7 to T-3, T-8 to T-4).

- During the WPPE, we experimented with alternate locations for the Stage 2 LDO probe that paces the Stage 2 blowers, to gauge blower performance and dissolved oxygen content in the aeration tanks. We found that relocating the probe to Tank 2 of 4 allowed for higher DO residual in all four tanks of Stage 2; however, due to low food values at this location, DO often exceeded the recommended 3.5 to 4.0 mg/L recommended maximum saturation for activated sludge biomass.
- Solids concentration reduction: Both MLSS and RAS concentrations may be considered too high for the facility, as evidenced by poor Settleability in laboratory tests, septic odors, low dissolved oxygen concentrations, inability to simultaneously operate all Stage 1 tanks. It may be useful to operate the facility with lower MLSS concentrations during the growing season months, gradually changing solids concentration while monitoring waste rates, to achieve a younger, healthier biomass more capable of efficiently treating raw wastewater.
- Biomass enhancement: Since most of Second Stage biomass appears to be inert due to age and unbalanced food/mass ratio, it remains necessary to enhance biomass through addition of "new" microorganisms on a regular schedule. Different formulations of "bugs" may be found among a number of vendors, and some vendors may customize them to the needs of your particular facility. Use of seed sludge from other activated sludge processes or digesters is not favored absent emergency situations like plant upsets or die-offs, because such biomass may be contaminated or inert or unreliable.
- Ongoing Tank Maintenance: We recommend that staff continue to drain and inspect each treatment unit, preferably on an annual schedule, to allow for repair and maintenance of equipment, removal of solids, and assurance of structural integrity. In addition, open, cracked, or abandoned electrical conduit should be closed, sealed, repaired, or replaced when found.
- Second Stage blower pacing can be improved by permanently relocating Hach dissolved oxygen probe from Tank 4 to Tank 2 or even Tank 1: High DO found in tanks 2 through 4 after temporarily moving the probe indicated that tanks 3 and 4 were probably not necessary for wastewater treatment under the present configuration.
- Cross-training of Personnel: Licensed wastewater operators should serve rotations through differing areas of operation, if they do not already do so. This is especially critical for laboratory practices: Staff should all become proficient in recognizing qualities of healthy biomass versus adverse conditions, such as endogeny, filamentous organisms, slug loads, and toxicities. Process monitoring tests should include regular microscopy, analysis of oxygen uptake and respiration rates, and sludge inventory tests necessary for calculating sludge age, cell residence time, sludge volume index, and food-to-mass ratio. These data, taken as a whole, provide a solid foundation on which to base process control decisions; however, using any one parameter by itself may not be sufficient to truly understand the condition of the system. Now that personnel have obtained licenses, they should continue to build their skill sets through continuing education and practical operations exercises outside of their particular disciplines. Cross-training assures the township that their treatment team can deploy to any one of the three facilities on short-notice.

- Automated Recordkeeping: The facility employs Operator 10, a good, serviceable software package, but its formulae should be edited so that operational values and calculations are correct (e.g.: The program's formula for First Stage MCRT values are calculated for 0.144 MG volume, not 0.07 MG presently under air.)
- During the WPPE, we modified the SRT worksheet to make it more flexible to changes in operations and to remove common Excel errors. (e.g., eliminated "div/ 0" errors by inserting if/then statements into the spreadsheet) This worksheet is reproduced in Attachment M and was emailed to the plant operator.
- Process Optimization as a Business Strategy: Optimization requires setting voluntary goals for treatment quality which are better than the minimum permit requirements. For example, although there may be no requirement to maintain low phosphorus loading to the receiving stream during the winter months, the facility may voluntarily set a limit and strive to meet it through continued dosing of ferric chloride, while carefully recording and reporting progress to the Authority and to the regulatory agencies.
  - Operators should see their job not as "running a sewage treatment plant" but "manufacturing a high quality effluent and/or biosolids" for further utilization. It's a mindset that is adopted and cultivated through ongoing self-improvement and continuing education.
- Site Security: Recently, the PA Water and Wastewater Systems Operator's Certification Act has required that all licensed water and wastewater treatment operators complete a course on facility security as part of the routine continuing-education requirement. Staff can access a web-based course "Securing Drinking Water and Wastewater Treatment Facilities" through the DEP's eLearn website at http://www.padepelearn.com. Licensed operators can log on to the site and complete this course during the current licensing cycle, if they have not already done so.
  - Although past incidence of unauthorized entry at Lower Salford's facilities is non-existent-to-remote, site security should be enhanced by locking doors to various buildings at all times, particularly after hours, and maintaining a controlled set of keys, use of remote-notification alarms, and other security devices to protect critical facility features. The perimeter fence by itself is a "good start," but the facility remains vulnerable to unauthorized entry. Consider adopting additional recommendations listed in the training course described above.

1.4 Process changes to consider:

- Plant configuration: Eliminate "contact-stabilization" and go to "extended air" or "conventional" activated sludge treatment mode, whereby return sludge and raw wastewater enter the first of three tanks under air.
- Remove "stages" by eliminating Stage 1 clarifiers and operate entire plant as single unit, extending the contact time for removal of carbonaceous and nitrogenous waste.
- Flow Equalization: Install aeration to equalization basin and incorporate the tank into the flow pattern, following screening & grit removal and in advance of secondary treatment, to attenuate variations of flow and loading. This option will be energy intensive, and malodors could become a problem during the summer months. Additionally, the tank bottom will be more difficult to clean with aeration fixtures installed.

Alternatively, excess tank capacity such as the Stage 1 clarifiers could also be re-purposed as flow equalization tanks.

- <u>Operate each Stage independently of the other</u>: This proposal is to separate Stage 2 from Stage 1, re-purpose both as conventional or extended aeration plants, (Plant A and Plant B,) splitting inflow evenly between the two or alternating inflow on different days as necessary during low-flow periods. Doing so would preserve the biomass in either plant in a ready-to-go condition.
- <u>Voluntary Nutrient Reduction Strategy</u>: Adopt "Ad-hoc Modified Lutzak-Ettiger" configuration, turning part of Stage 1 plant into denitrification tanks by returning both Stage 2 RAS and Stage 2 nitrate-rich mixed liquor to the first tanks in Stage 1 and eliminating the Stage 1 clarifiers. There is much literature available on the conversion to nutrient removal configurations, and the consulting engineer would be able to study the feasibility of this.
- <u>Reconfigure effluent discharge tank</u>: The final tank in Harleysville, where effluent is re-aerated using a mechanical mixer prior to discharge to UNT Indian Creek, may be eliminated if dissolved oxygen is high enough at effluent end of UV Disinfection Tank. It no longer serves its original purpose but consumes energy and collects algae. Alternatively, eliminate the inefficient mechanical surface aerator and replace it with sub-surface, fine-bubble diffuser system, although doing this would require additional expense and energy for an auxiliary blower.

1.5 WPPE Rating:

Background of the rating system for WPPE is described in Attachment A. As a result of our evaluation and our on-site interaction with the plant operators, we have assigned a facility rating of **Satisfactory**, because the plant routinely meets its compliance requirements, despite the challenges of discharging to an impaired watershed that has low nutrient thresholds, and because the facility's management and operators conscientiously strive to improve plant performance and effluent quality.

1.6 Re-evaluation:

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

2 Downstream Water Treatment

The Indian Creek watershed is part of the larger Skippack Creek watershed. Skippack Creek joins Perkiomen Creek approximately 3 miles upstream of Perkiomen's confluence with the Schuylkill River, approximately 1.7 miles downstream of the community of Audubon in Lower Providence Township, Montgomery County. **PAWC-Norristown Water Treatment Plant** (PAWC-Norristown) is the nearest downstream potable water filtration plant to Harleysville, approximately 10 river miles downstream on the Schuylkill River in Norristown, Montgomery County, PWSID 1460046. The Harleysville effluent does not appear to adversely affect water quality of the Schuylkill near the water intakes for this potable water plant. Our pathogen tests included two sampling events at the Schuylkill River at Hawes Avenue Bridge, upstream from the river intakes to the water plant and away from an interfering stream confluence adjacent to the water works. Both Crypto and Giardia were not significant at this location, certainly not due to the effects of Harleysville, which is upstream.

2.1 FPPE Review—

DEP conducted a Filter Plant Performance Evaluation (FPPE) at Norristown in December 2008. The water system has 93,000 consumers through over 25,000 metered service connections in the City of Norristown and parts of Montgomery County, and it withdraws up to 18 MGD from the Schuylkill River. The water works consists of four upflow flocculation/clarification clarifiers, seven dual-media filters, a 2.8 MG distribution well, and associated chemical feed and pumping systems. The system is SCADA-controlled.

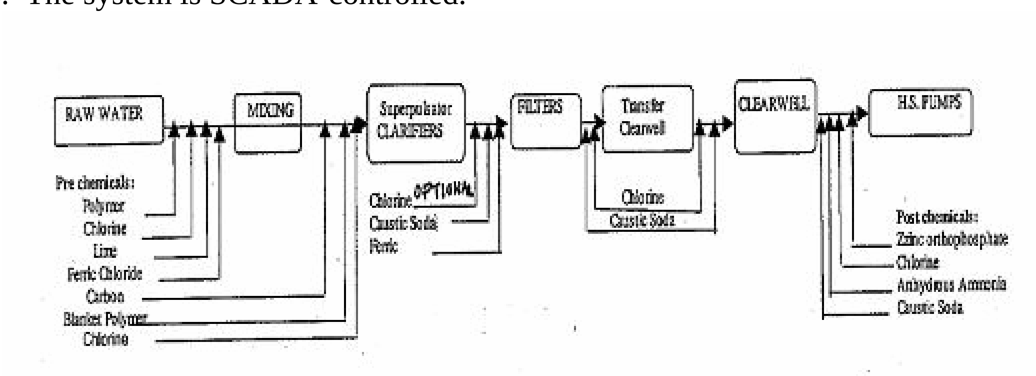

Figure 2.1: Flow Schematic for PA American Norristown Water Filtration Plant

PAWC-Norristown completed a Source Water Assessment Public Summary in December 2001. This report identified several potential significant sources of contamination, including municipal point-source (wastewater treatment) discharges having moderate to high protection priorities. Long-term protection efforts are focused on enhancing wastewater discharges and mitigating stormwater runoff within the Schuylkill River watershed, as demonstrated by the development of TMDLs for the Indian Creek watershed.

2.2 Water Chemistry—

Finished water turbidities at PAWC-Norristown typically have turbidities around 0.02 NTU, as well as rapidly recovering post-backwash turbidities, showing that the plant regularly produces low-turbidity water. Source water samples were made on two occasions at the Hawes Avenue bridge. Test results for a standard suite of analyses are shown in the table below.

Sample #	388	428				
Date	10/7/10	11/3/10				
Time	17:35	11:27				
Locus	DWS2	DWS2				
Lab#	**i2010031313**	**i2010034468**	**Average**	**Max**	**Min**	**Std.Dev.**
Field Temp	9.8	5.7	7.8	9.8	5.7	2.9
Field DO		12.37	12.37	12.37	12.37	na:
Field pH		7.35	7.35	7.35	7.35	na:
BOD5	1.00	1.60	1.30	1.60	1.00	0.42
pH	7.3	7.9	7.6	7.9	7.3	0.4
Alkalinity	63.2	90.8	77	91	63	20
TDS	220	252	236	252	220	23
TSS	12	<5	na:	na:	na:	na:
VSS	<5	10	na:	na:	na:	na:
%Volatile	na:	na:	na:	na:	na:	na:
NH3-N	0.04	0.10	0.07	0.10	0.04	0.04
NO2-N	0.01	0.03	0.02	0.03	0.01	0.01
NO3-N	2.60	2.77	2.69	2.77	2.60	0.12
TKN	<1.00	<1.00	na:	na:	na:	na:
PO4-P	0.12	0.137	0.13	0.14	0.12	0.01
Chloride	3	43.4	23.2	43.4	3.0	28.6
Bio#	**B2010011802**	**B2010012642**	**GeoMean**	**Max**	**Min**	**Std.Dev.**
Tot.Coliform	2200	51000	10,592	51,000	2,200	34,507
Fec.Coliform	240	8100	1,394	8,100	240	5,558
Me1623	**B2010052485**	**B2010052503**				
Giardia	1	0				
Crypto	2	0				

Table 2.1: Schuylkill River Source Water Sample Test Results

The nitrate content of both samples was below the drinking water MCL of 10 mg/L, although the presence of nutrients in the river suggests nutrient contamination from both point sources (such as wastewater plants) and non-point sources (such as agricultural and urban/suburban stormwater runoff.)

2.3 Pathogen Discussion—

Although two sampling events is not statistically significant, we note here on October 7, the Schuylkill River was still flowing high and turbid due to significant rainfall events within the previous week. Turbidity may have accounted for the presence of Cryptosporidium and Giardia in the sample on that date. Note, though, that Coliform bacteria was low, compared to that of the second sample, taken when the river was low and its water clear.

Below are two charts showing the relative presence of pathogens in the raw water samples, with the background samples included:

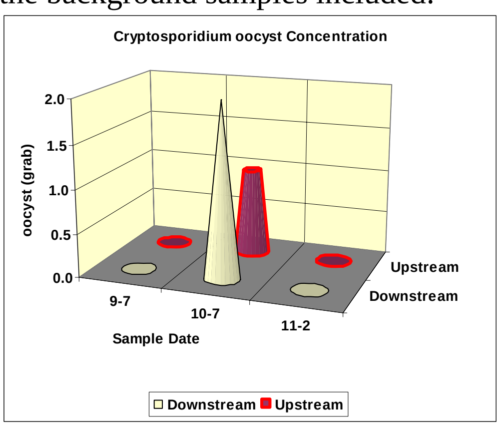

Figure 2.2: Cryptosporidium test results

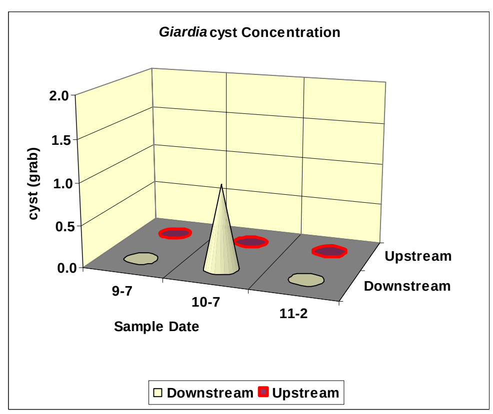

Figure 2.3: Giardia test results

We have theorized that waterborne pathogens such as these tend to shelter within masses of suspended solids. That the only sample which yielded the presence of these two pathogens was taken when the river was running high and turbid tends to support this theory.

PAWC-Norristown filtered water samples tested for waterborne pathogens show no Cryptosporidia or Giardia present; thus, the water treatment has proven effective at removing what pathogens do exist in the river.

Because the Schuylkill River source water for the Norristown Water Treatment Facility contains the effluents of many municipal treatment plants, as well as overland flow from the watershed, we cannot assert any connection between these pathogen results and the Harleysville plant ten miles upstream; however, water treatment operators should be aware that these pathogens may be present in the raw water source, that conventional sewage treatment disinfection processes do not eliminate them, and that measures must continue to be taken at the water works to destroy or remove these pathogens, because general wastewater plant optimization will not do so.

ATTACHMENTS

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G— Graphs: Daily and Monthly Monitoring Examples

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

I—Process Monitoring Tests: Example WPPE Bench Data

J— Site Sample Test Results by BOL

K—Tables of BOL Test Data

L—Example of Dynamic Sludge Age Charts

M—Example of SRT Worksheet

Attachment A—Program Description

POTW Optimization Program

Description and goals

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

The goal of this program is to encourage wastewater treatment facilities to voluntarily produce higher-quality effluent than mandated by the limits set in their NPDES permits and to optimize treatment in such a way that reduces contaminants and pathogens in surface waters that are consumed for drinking water following filtration at facilities downstream.

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

Process Optimization

- Purpose of Optimization: Set production goals as if running the process were an industry that makes a product: clean water and biomass.
- Goal-Setting: Voluntary meeting of limits that are better than the minimum required limits in the permit in order to reduce pathogen, nutrient, and emerging contaminant loadings to downstream drinking water facility intakes.
- Action Items: Break down optimization tasks into various activities or adjustments that should be done to improve routine operation.

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.

Potential Obstructions to Success

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

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

Attachment B—Harleysville WPPE Team

Lower Salford Township Authority—Harleysville Wastewater Treatment Plant

WPPE Team

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

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

Municipal Wastewater Plant Representatives

Craig Forewood, P.E., Township Engineer
Lower Salford Township Authority
P.O. Box 243
Mainland, PA 19451-0243
(215) 256-6127
craig.forewood@comcast.net

Robert Keenan, Chief Operator
Harleysville WWTP
650 Main Street
Harleysville, PA 19438
215-256-6862
bob.keenanlsta@comcast.net

Gary Clemens, Operator
Harleysville WWTP
650 Main Street
Harleysville, PA 19438
215-256-6862

Christina Nelson, Laboratory Supervisor
Lower Salford Township Authority
P.O. Box 243
Mainland, PA 19451-0243
215-256-6127
chris.m.nelson@comcast.net

George Derstine, Operator
Harleysville WWTP
650 Main Street
Harleysville, PA 19438
215-256-6862

Brian Henry
Harleysville WWTP
650 Main Street
Harleysville, PA 19438
215-256-6862

C—Plant Description and Treatment Schematic

Harleysville is currently operated as a two stage activated sludge plant: Stage 1 operates as contact/stabilization mode (0.072 MG capacity) and Stage 2 operates as extended aeration. (0.144 MG capacity). Each stage has its own closed loop between aeration and settling, and both return and waste sludge streams are independently operated for each stage. A treatment schematic follows. Below are features of the treatment system:

Configuration:

Headworks—The facility includes a raw wastewater wet well with submersible pumps, screening of trash and large solids, and grit removal. Both screening and grit removal occur in open channels.

Stage 1 Aeration—A series of six tanks in the "original" facility, divided into two trains of three tanks each, comprises Stage 1 aeration. Air is supplied by rotary lobe blowers through Sanitaire disk diffusers. The volume allocated to Stabilization is greater than that used for Contact of raw wastewater with the activated sludge. The Sanitaire system has a related cleaning system permitting introduction of anhydrous hydrochloric acid gas to clear blockages in the aeration system, although it was reported that this system has not been recently used. At present, only one train is employed, owing partly to the inability of the blowers to provide enough air at the suspended solids concentrations of the mixed liquor. MLSS concentrations for the Contact portion of the tank averaged 3,790 mg/L, and Return Sludge averaged 11,690 mg/L. Since the Stabilization portion of Stage 1 Aeration was made up entirely of Return Sludge, the RAS numbers were used in calculations for both Stabilization tanks and Return Sludge calculations.

Stage 1 Clarifiers—These clarifiers are located behind the pump house and had replaced those originally built with Stage 1 treatment plant. Operated in parallel, these clarifiers function normally, with good settling and with blanket levels routinely recorded within range of 0.5 ft. Clarifier effluent containing approximately 5% of the raw wastewater soluble carbonaceous waste, and most of the nitrogenous waste, flows to Stage 2 for further treatment, beginning with the T-22 sampling site.

Stage 2 Aeration—By design, there are two trains of two tanks each, 0.072 MG capacity subtotal, to be operated in parallel for 0.144 MG of capacity. The tanks were originally designed for contact/stabilization and employed mechanical mixers. Flows are controlled through the use of sliding gates, allowing flexibility of configuration. The tanks today employ subsurface aerators controlled by blowers separate from Stage 1 processes. All four available tanks are operated in series, with air supplied by centrifugal blowers equipped with energy efficient motors and regulated by a dissolved oxygen sensor located in the final tank of the series. Influent wastewater has low soluble BOD averaging 16.7 mg/L but is high in nutrient content. MLSS concentrations averaged 3,300 mg/L, and Return Sludge averaged 11,440 mg/L for samples taken during the WPPE.

Second Stage Clarifiers—Two clarifiers, operating in parallel, with good settling, no solids carry-over, allow for secondary settling, after which treated water flows on to disinfection process. Return activated sludge is pumped to the Stage 2 tanks, and waste sludge is sent to the aerobic digester by another set of pumps. Sampling points for return and waste sludges were at the pumps in the basement of the pump house.

Disinfection—Until recently, the disinfection process employed chlorine gas, but this was replaced during the last permit cycle by the use of ultraviolet light in a footprint half the size of the original process. There are two UV light arrays controlled on the basis of ultrasonic flow detector located in the outfall side of the disinfection tank. During WPPE, one of the electronic controller boards for a bank of UV lights had gone bad and was backordered for replacement. Replacement was still pending at end of October. During WPPE, operators replaced deteriorated aluminum weir and launders with stainless steel ones. Leaks in the old launders had caused water level in the tank fall below the top of the UV light arrays, threatening treatment efficiency.

Freshening and Discharge—Final effluent flows from disinfection to a holding tank where it is re-aerated using a mechanical mixer. An automatic composite sampler for the final effluent is located at this tank. The freshened water is discharged to the UNT 01182 of Indian Creek nearby.

Side-stream Stormwater Detention—Following the previous facility upgrade, operators began employing a side stream stormwater detention tank for detaining excessive plant inflows and slowly feeding these surges back to the plant headworks after high flow events have ceased. The tank has a 27’-0” side-wall depth. It is not aerated, as operators note that detained storm surges are bled back to the system typically on the following day after a storm.

Solids Handling—Solids wasted from Stages 1 and 2, by way of clarifier underdrains, is stored in a dual-train aerobic digester, decanted in an old primary clarifier of the original plant configuration, and pumped into tanker truck for disposal off site. Biosolids are eventually used in commercial soil amendment. During the WPPE on-site activities, there were no problems in particular with the biosolids processes, and LSTA staff cleaned the base of the digesters to remove inert solids that had accumulated over time.

Biosolids production and fate are reported monthly on a DEP Supplemental Reporting Form.

<u>Performance Track Record:</u>

Past Performance—Plant upgrades over the years have typically followed continuing exurban development in the portion of the Township drained by the Harleysville collection system. Most recently, the plant had issues with inflow and infiltration (I/I) in the collection system, requiring a facility upgrade and re-rate, addition of a sidestream storm detention tank, repair/relining of parts of the interceptor to reduce I/I, and ongoing efforts to televise and map the collection system continue to hunt and resolve I/I problems.

During the WPPE on-site activities, a +6” rain event caused flow surging at the plant headworks, filling the stormwater detention tank, pushing the facility to its limits for maximum design daily flow, and eventually overflowing from the headworks. Minor flooding about 8” deep in the maintenance rooms and garages below the lab building resolved within twelve hours or less, with no lasting damage to the facility or contents. At no time were solids washed from the two aeration stages, despite high flows, and facility staff worked diligently to minimize flood damage.

Current Performance—The facility now routinely meets its requirements for NPDES permit, although the September phosphorus limit was exceeded as a result of contamination of the biomass with high-phosphorus waste. This had been due to misunderstanding surrounding disposal of septic sludge from the bottom of an empty tank. (Orthophosphate increased following pumping of this material to head of plant; high Phosphorus resulted during following three weeks, gradually diminishing until monthly average daily concentration limit was achieved through performance of additional testing and increased use of ferric chloride chemical treatments.)

Particular attention was paid to return sludge and sludge wasting rates, as well as to phosphorus removal, during the course of on-site activities. Replacement of the disinfection tank weirs and launders and cleaning of the second stage aeration side channels took place, and routine maintenance scheduling had the plant pumps cycled on a monthly schedule. During the WPPE, township staff continued to perform I/I sequestration and repair activities, routine cleaning of clarifiers, decanting and disposal of aerobically digested sludge, and began upgrading of an air conditioning system for the lab and office. Older, cracked sampler tubing was replaced, and routine checks of the sampler refrigerator showed the unit to be working as intended.

In September, plant staff exchanged active tanks in Stage 1 aeration, because a header leak occurred in one of the evenly-numbered tanks. Flow and instrumentation were relocated to the spare train with no interruption of service.

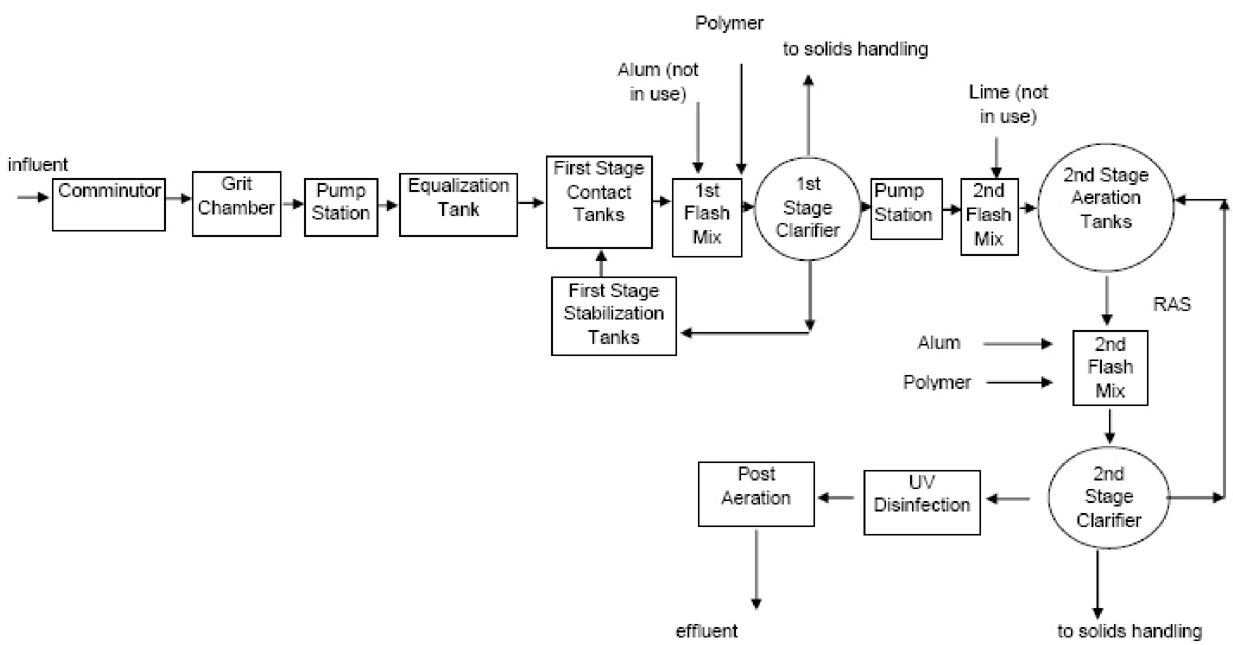


Figure C-1: Flow Schematic for Lower Salford Twp. Harleysville STP (Parsons, Feb. 2008)

D—2010 Process Monitoring and Control for Harleysville Plant

Equipment Deployment: During week of August 24, 2010, we deployed 5 electronic probes to facility to monitor activated sludge treatment process in two stages. Stage 1 had dissolved oxygen (DO), oxidation/reduction potential (ORP), and pH probes. Stage 2 had, initially, nitrate-nitrogen (NO3-N), ammonia-nitrogen (NH3-N), and ORP probes. In September, three more instruments were added to measure pH, ORP, and DO in additional process tanks.

The probes were installed and calibrated, then gave readings every fifteen minutes to a laboratory computer for the duration of the study. The purpose of these probes was to monitor biomass, never for compliance purposes. The data generated allow operators to observe trends showing improved treatment efficiency over time.

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

Lower Salford Township Authority (LSTA) operates an Accredited Laboratory (46-01655) located at its Mainland facility, to conduct regular process monitoring and compliance reporting tests for all three of its wastewater treatment facilities. As part of the evaluation, we toured the laboratory under the auspices of Christina Nelson, Lab Director, and found the written standard operating procedures, calibration records, and test records to be in compliance with state requirements. We commend Ms. Nelson on her work to keep the LSTA wastewater lab up-to-date and well-managed.

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

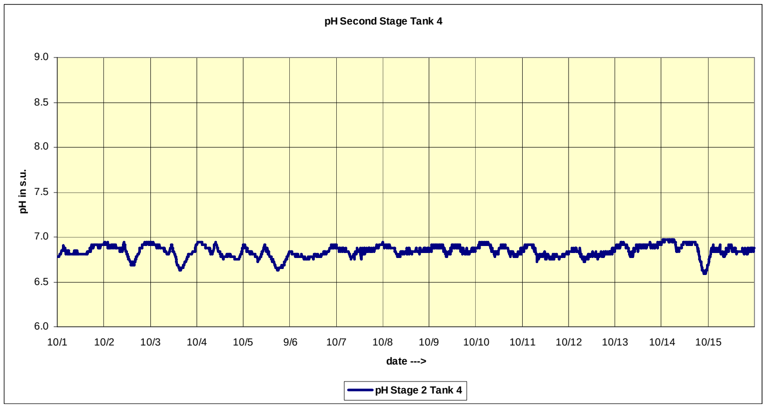
Interpretation of Data

Permit Modifications—Observations or recommendations for improving treatment may entail modifications to facility physical plant or to flow patterns. If permanent modifications are contemplated, the facility operators should obtain the proper permits or permit modifications (Part II NPDES) prior to enacting any permanent changes.

Solids Management: There are four methods available for managing solids inventory in a wastewater treatment plant; typically, Mean Cell Residence Time (MCRT) is employed, although Food to Mass Ratio (F/M) is often substituted. The Harleysville facility uses the Solids Retention Time (SRT) method, which is like MCRT but simpler to calculate, because it assumes that both influent and effluent suspended solids are significantly smaller than solids under aeration or solids wasted from the process. This works for facilities that are not experiencing solids-loss plant upsets. The SRT calculation table for Harleysville is shown in Attachment M.

While working at the facility, DEP staff suggested use of the Dynamic Sludge Age (DSA) method, which accounts for solids inventory on a continuous basis rather than a day-to-day snapshot. The more traditional Sludge Age calculation is modified to include an accounting of previous calculations for sludge age, sort of a "rolling average," so that when the plant is at steady-state conditions, the sludge age cannot change more than a day in a twenty-four hour period. During the evaluation, DEP staff created a DSA spreadsheet using data provided by the operators. An illustration of it is provided as Attachment L. The data showed that, following an eight-week period, the DSA stabilized at 38 days under steady-state conditions. Thus, if the target value of SRT is 30 days, the operators should very gradually increment waste rates on Second Stage until an equilibrium DSA of 30 days is achieved.

pH/Temperature: At the facility, we deployed one pH probe into the Second Stage aeration, at the final tank in the process. pH generally stayed within a range of 6.6 to 7.0. Records indicated that the raw wastewater pH is routinely within five tenths of a standard unit above or below the neutral condition at 7.0 s.u.

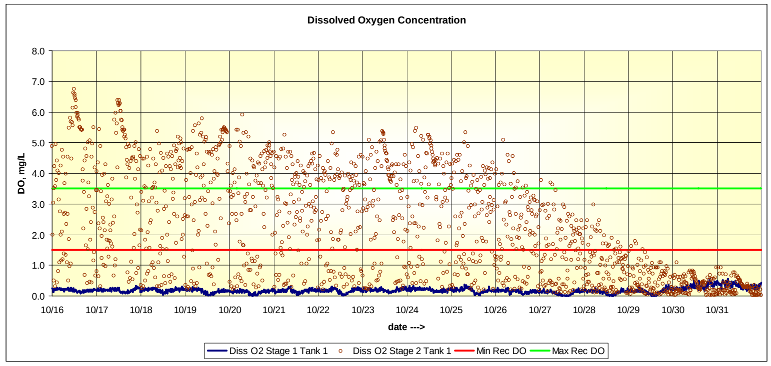


During the WPPE, operators reported that the pH of the raw wastewater may vary sometimes because of industrial or commercial users' process and cleaning schedules. The only way to determine this for certain is to employ a composite sampler at the head of the plant employing twenty-four sample bottles instead of the usual single composite carboy. Each sample should be checked for pH to determine when a slug of highly caustic or acidic raw wastewater occurs. Experience suggests that large commercial facilities usually perform cleaning and sanitation over night, when the treatment plant would not normally be occupied. Use of individual hourly sample bottles will help confirm the occasions when slug loads may have occurred.

In addition to trying this at the headworks, DEP staff suggested to the operators that they develop a program to routinely place composite samplers at locations throughout the collection system, doing so in order to characterize the waste load coming from different areas or at different pumping stations. This doesn't have to be continual, but occasional, random placement of samplers may deter unwanted slug loads from established users.

DO Findings—Employing continuously monitoring dissolved oxygen (DO) probes in Stage 1 Tank 1 (the Contact Tank of the Contact/Stabilization process in Stage 1) and in Stage 2 Tank 1 (the first of a four-tank extended aeration mode operated in series) allowed permitted characterization of DO as a function of time. The intent was to look for patterns or trends in daily, weekly, and monthly intervals. Ideally, for activated sludge aeration plants, DO concentrations are maintained between 1.5 and 3.5 mg/L for oxic treatment zones. At Harleysville, DO is usually well below 1.0 mg/L in Stage 1 stabilization tanks. This is because the biomass there had been without mechanical aeration while in the clarifiers, and it is starved for oxygen. Due to solids concentrations averaging over 10,000 mg/L, the existing aeration capacity of Stage 1 is insufficient to provide enough oxygen to freshen the return sludge. As a result, DEP staff recommended that the plant operators seek a lower concentration of biomass in Stage 1, preferably in the range of 7,000 mg/L to 9,000 mg/L as return sludge. To achieve this, sludge blankets in the Stage 1 clarifiers may have to be reduced to about half of their current average thickness.

The histogram at the right shows dissolved oxygen in the Contact tank of Stage 1 and the final tank of the series in Stage 2 for the second half of October. In this chart, Stage 1 DO is depicted as a solid line, while that of Stage 2 is depicted as a cloud of sample points. The trend for the Contact tank is that DO rarely rose above 0.3 mg/L, making it difficult for the biomass to recover from its detention in the Stage 1 clarifiers, and in terms of "stabilization," aerobic bacteria under such anoxic conditions cannot readily convert the carbon waste it adsorbs in the Contact phase into useful products for cell metabolism. Under these conditions, odors are inevitable because other types of bacteria will predominate, converting waste to organic acids, hydrogen sulfides, and ammonia.



DEP Staff moved the township's DO probe to Tank 2 to obtain higher DO throughout all four tanks. Prior to doing this, Tank 4 had moderately high DO, while Tanks 1 through 3 had fairly low DO. Moving the probe greatly elevated the DO throughout Stage 2 and allowed us to further characterize the biological processes within those tanks.

The Stage 2 DO data shows that DO was often above the preferred residual limit of 3.5 mg/L while the blower controlling DO probe was located in Tank 2. At the end of the month, when DEP staff returned this DO probe to its former location in Tank 4, the DO returned rapidly to its former condition of averaging below the preferred lower limit of 1.5 mg/L, suggesting that the DO levels in Stage 2 would not support healthy processing of carbon and nutrient wastes were the BOD loading to be higher than its current values.

DO Grab Testing—DO was measured in each tank of the process, using a hand-held LDO probe. The purpose of this was to observe conditions in each tank and also to look for "dead" spots or zones where aerators may have been plugged or obstructed. DO was generally low throughout Stage 1 to effectively determine if dead zones were present, and in Stage 2, the DO varied in response to BOD loading and to blower output in response to a dedicated DO probe located in Tank 4 of the four-tank series. DO was highest in Tank 4 which had been recently cleaned. Other tanks which were slated for cleaning may have accumulation of inert solids atop aerators, diminishing soluble oxygen transfer capacity. As a rule, the literature suggests operators should conduct cleaning and inspection of every tank at least once per year, and the township's new engineer has informed DEP staff that his goal is to achieve this within the next twelve months, and during the WPPE, plant staff vacuumed inerts from the standby channels along Second Stage aeration.

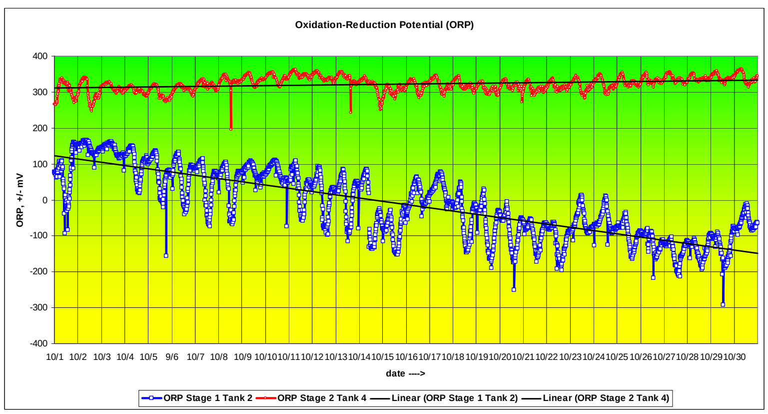
Oxidation/Reduction Potential—This measure is used in secondary wastewater treatment as a means of determining whether nitrification or denitrification are able to occur, according to a range of bioelectrical charges in the outer membranes of bacteria. The following table depicts the ranges within which the differing processes occur:

ORP (mV)	Process	Electron Acceptors	Condition
> +100	1	O2	Aerobic
≤ +100	2	NO3	Anoxic
≥ -100	2	NO3	Anoxic
< -100	3	SO4	Anaerobic

1= Nitrification
2= De-Nitrification
3= Methane Formation

Table D-1: Oxidation-Reduction Potential (ORP) Ranges for Bacterial Activity.

At the Harleysville plant, testing determined that most of the available wastewater carbon is depleted after first stage aeration; the second stage tanks remove about 10% of carbon waste and then nitrify any ammonia nitrogen. Nitrification occurs above a charge of +100 millivolts (mV). If denitrification is to take place, it must occur within an anoxic zone where mechanical mixing of a carbon source with the activated sludge occurs. Within this zone, the charge drops below +100 mV as low as -100mV, and denitrifying organisms consume carbon and scour oxygen from nitrates, replicating and producing nitrogen gas as a by-product.

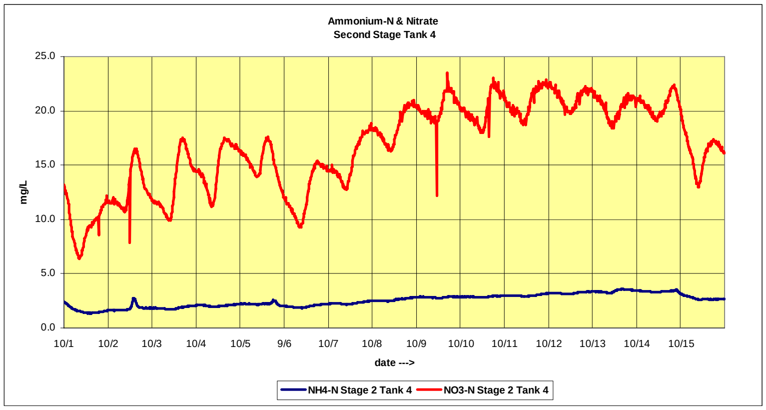


Stage 1 ORP values averaged +35mV plus or minus 89 mV and ranged from +168mV to -262mV in the example data from September and October. The chart at the right shows the ORP histogram from October, with the declining blue line showing the ORP values for Stage 1. Were there no fine-bubble aeration and these values the result of cellular activity in anoxic conditions, where subsurface mixers kept the biomass in contact with both carbon and nitrate sources, these conditions would be considered ideal for denitrification to take place; however, at best all one could expect under the current circumstances is an increase in undesirable organisms such as filamentous bacteria and fungal hyphae. Because the average nitrate present in primary clarifier effluent averaged 0.39 mg/L, while ammonia-nitrogen averaged 19.98 mg/L, it appears that no nitrification occurs in Stage 1 processes.

Second Stage values for ORP at or above +300 mV showed conditions favorable for nitrification, where ammonia-nitrogen concentration was reduced to nearly zero, but very little denitrification occurred in the presence of such high ORP. The average nitrate concentration in the final effluent was 17.9 mg/L. ORP probes are especially useful in facilities where dedicated denitrification processes are operating; however, they can also indicate whether anoxic systems are trending toward anaerobic conditions so that operators can reverse this trend before malodors and plant upsets occur.

Nitrate- and Ammonia-Nitrogen: Nutrient control is currently an ascendant issue in wastewater treatment. For many years, treatment facilities did not concern themselves with the concentration of nitrates and phosphates in effluent discharges, but with more modern treatment technologies and with public concern over nutrient pollution in receiving waters, nutrient control has become a hot topic.

As regards nitrate and ammonia-nitrogen, the Harleysville facility is capable of converting all of its incoming ammonium hydroxide to fully-oxidized nitrate before the effluent leaves the facility. Given the volume of second stage aeration and the current loading to that process, one may conclude that this is the extended aeration portion of the facility, and extended air plants are exceptionally good at converting all available ammonia to nitrate.



The chart shown here demonstrates this: Nitrates for the period shown, 10-1-10 through 10-15-10, show that nitrate concentrations vary diurnally but averages17.9 mg/L while ammonia-nitrogen levels were consistently lower. (In point of fact, the ammonia-nitrogen probe has a high error rate, and bench testing resulted in values considerably lower than those depicted here.) Diurnal trends in loading and nutrients are not unusual in facilities treating domestic sewage.

If Lower Salford ever does pursue biological nitrogen removal as a treatment strategy, the ammonium and nitrate probes demonstrated at the facility would prove useful in monitoring the environments within which denitrification takes place.

Phosphorus Control: Harleysville STP discharges to a phosphorus-impaired tributary of the Indian Creek Watershed. On-site test data for the two-month WPPE period confirm that LSTA does work diligently to meet its difficult NPDES permit limit of 0.16 mg/L Total Phosphorus. The facility employs ferric chloride as the chemical of choice in precipitating phosphorus from the system. However, because the US-EPA has determined that UNT 01182 of Indian Creek, specifically, is nutrient-impaired for phosphorus, the federally imposed TMDL that will finalize in 2013 will make efforts to control phosphorus increasingly more difficult for the authority and the plant operators.

During the WPPE, our test results for phosphorus showed an average concentration of 0.079 mg/L for effluent grab samples, and staff conducted comparison testing for TP that showed a 0.030 mg/L difference between test methods for a 20-hour composite effluent sample where the average reported TP was 0.10 mg/L using the DREL 2800 ascorbic acid orthophosphate test. With the exception of a mishap at the end of September, the facility has done a great job controlling phosphorus releases in the effluent.

It is instructive, also, that the mishap caused by the introduction of high-strength sludge waste into the treatment system required most of a month to mitigate. This will be important to remember in the future, should there be an opportunity for recurrence: Waste sludge from tanks removed from service should always be disposed of either immediately off-site or else to the plant digesters. In addition, increased testing intervals after corrective action had been taken can help to mitigate the effect of such a slug load.

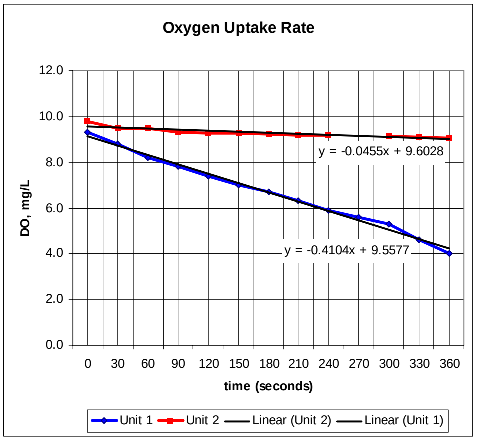
The current NPDES permit limits in force are those of a permit which lapsed a few years ago. The proposed five-year permit imposes winter limits on phosphorus concentration in the effluent, while future permits will consider further gradual reductions of the nutrient overall, in an effort to meet the TMDL of the watershed. Subsequent permits may require the operators to statutorily meet TP limits equal to our average TP finding during the WPPE sampling. The EPA could require further reductions over the years to come.

Our concern for Harleysville is that the future requirements which may be brought to bear by the federal government in order to meet the TMDLs established for the Indian Creek watershed. It is reasonable to expect that the phosphorus limit will be lower in future years, beyond the next permit cycle. For this reason, it may be useful to investigate ways to modify the existing treatment train to include Biological Phosphorus Removal (BPR) as an alternative to the addition of more treatment chemicals to the existing effluent burden. Currently, operators report that excess precipitate builds atop the diffusers in the Second Stage aeration tanks. This accumulation will hinder the soluble oxygen transfer in these tanks, making it more difficult for the biomass to naturally absorb nutrients for cellular respiration.

Sludge Settleability Tests—During the WPPE, we conducted weekly assessments of the biomass, including sludge Settleability tests. The photograph at right illustrates typical settling characteristics for Stage 1 and Stage 2 solids. As seen here, the biomass sample taken from Stage 1 Contact Tank (left) exhibits slow settling quality. This may be due to the high concentration of solids and the inability of the blowers to maximize soluble oxygen transfer in that process, although other lab tests of this biomass showed it to be relatively active. Note that the supernatant of this first stage sample is very clear, with no straggler floc or bulking. This sludge settles in the clarifier, but because the concentration is high, it takes longer to do so.

The sample on the right side of the photo is mixed liquor taken from the Stage 2 extended aeration system. Here, the solids settled rapidly, leaving much turbidity in its wake. Although the solids concentrations were similar, the sample from Stage 2 contained ferric chloride to remove phosphorus, and this may have aided in the rapid settling.

Oxygen Uptake Rate Tests—Weekly samples of the biomass were analyzed for oxygen uptake, a test that shows how well the bacteria metabolize food and which can also show evidence of



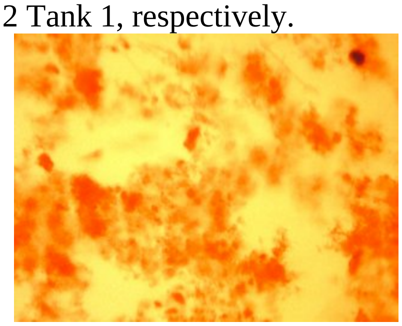
overloading, lack of oxygen, and presence of toxicity. In the example graph of OUR shown left, from October 8, the biomass sample from Stage 1 exhibits an average decline of oxygen in the sample, meaning that the bacteria are using oxygen to metabolize the available food source. Microscope examination supported this conclusion because it showed fairly active free swimming ciliates.

The sample taken from Stage 2 aeration exhibited a flatter oxygen decline, as would be expected were the food source to be somewhat diminished. (The evidence for this conclusion is supported by the low soluble BOD entering Stage 2, the relative high dissolved oxygen in the tank, and the relative lack of activity observed during microscopic exam.) Such OUR test results were typical during the 8-week on-site evaluation.

Microscopic Exam— During the WPPE, we scoped the mixed liquor on occasion and recorded photographs of typical slide images. We recommend that operators routinely perform microscopic examination of the mixed liquor to observe biomass conditions and look for the presence of indicator organisms. Presently, Harleysville samples are routinely examined by Ms. Nelson at the LSTA lab in Mainland, and any unusual findings are reported back to the Harleysville operators. With the low cost for microscopes that are capable of viewing wastewater treatment microlife, it may help the operators were they to get in the habit of regularly doing this analysis on site, as well, to enhance their routine process monitoring.

In the photomicrographs shown below are representative examples of biomass found in Stage 1 Contact Tank and Stage 2 Tank 1, respectively.


Stage 1 Contact Tank


Stage 2 Tank 1

The Stage 1 sample depicts a rotifer anchored to a clump of bacteria and stretching to reach a probably food source. Samples from the Stage 1 Contact Tank usually had indicator organisms present.

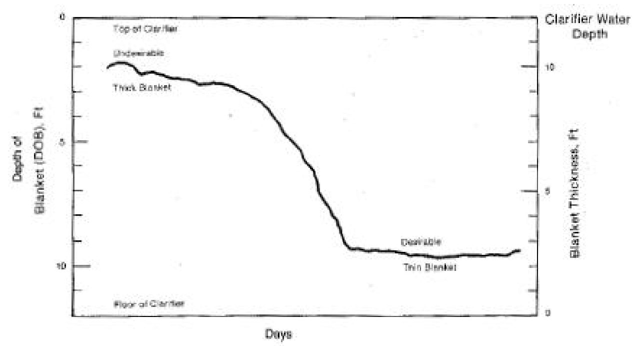
The sample from Stage 2 Tank 1, which would have the highest microbial activity of the four Stage 2 tanks, revealed a mixture of biomass bacteria and inert solids but few indicator organisms, suggesting, as did other tests, that the biomass in Stage 2 did not have as much activity as Stage 1, although the solids concentrations were similar.

Indicator organisms can be used as a determinant of relative sludge age: More free swimming ciliates usually indicate “young sludge” conditions, while the presence of mostly rotifers and nematodes indicate “old sludge.” The presence of equal numbers of free swimming ciliates and stalked ciliates usually suggests a biomass that exhibits good Settleability and peak growth conditions for treating wastewater.

The important thing to remember is that process monitoring test results must be taken in their totality and not just a single test here or there, to give the operator a good indication of the relative stability of the treatment system: for example, good Settleability and moderate OUR and

DO above 1.5 mg/L and the presence of free swimming and stalked ciliates together all indicate a healthy condition. There are many text books and resources available on the subject of process monitoring and control.

Clarifier Blanket Level & Core Sampling—Harleysville routinely collects data on the thickness of clarifier sludge blankets, but over time, the connection of the data to solids inventory has been forgotten. Graphing the sludge blankets can provide operators with information as to the health of the operation; for example, a rising sludge blanket may indicate plant upset in the near future and allow operators time to intervene. Further, the EPA suggested once that operators use sludge blanket with gravimetric or volumetric solids tests to determine sludge inventory of the clarifiers: the formulae follow:



(1) Sludge blanket (ft.) ÷ side-wall depth (ft) x Return sludge solids (mg/L = ppm) x clarifier tank capacity (MG) x 8.34 lb. = Clarifier Solids (lb.)

–or—

(2) Sludge Blanket (ft.) ÷ side-wall depth (ft) x Return sludge solids (%v/v) x clarifier tank capacity (MG) x 8.34 lb. x 0.001 = Clarifier Solids (lb.)

Employing sample numbers from plant records, the results of these calculations were 1,129 lb. and 1,377 lb., respectively, a difference of about 18%. However, the data is useful if one method is chosen and applied consistently, so operators will have another set of data by which to observe and record trends. The end result of trend analysis is to find a range within which the plant best operates and then control the operation to remain within that range.

Flow Measurement—Harleysville uses several calibrate flow meters in its operation. Daily records include both influent and effluent flows. The plant's disinfection system relies on data from the effluent flow meter for its operation. In addition, flow meters record return and waste sludge flows through two sets of meters. The facility's Chapter 94 reports include information on the calibration of these flow meters. We commend operator Bob Keenan in his diligent efforts to control plant solids through his awareness of the data provided by these in-plant flows.

Power Consumption—This evaluation did not study past or present power consumption trends. Use of the digital DO probe to pace blowers for Second Stage is a good beginning, as are efforts to employ energy efficient motors, soft-start systems, and the like. The largest cost for a treatment system is for the power required to run aeration tanks. We encourage the Authority to continue its efforts to save energy through its efforts to modernize equipment as older, less efficient motors are replaced.

US EPA offers, on their website, a simple utility program to calculate efficiency of motors used in treatment facilities, "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 regular basis according to the manufacturer's specifications. It is important that, when exercising a generator set, that both engine and generator are exercised, so that the operators can be assured that the treatment plant will continue to operate off line power.

eDMR—Facility records used in this report were obtained from data sent to DEP through the electronic DMR reporting system (eDMR) and also provided by the facility owner and operator on site. We are grateful that LSTA uses eDMR, as its use reduces the possibility for transposition errors in data entry or other optical scanning errors.

Inflow/Infiltration—Harleysville has benefited from ongoing efforts to reduce I/I in the collection system. Current Wasteload Management (Chapter 94) reports show that the efforts to mitigate and reduce I/I are an ongoing full-time activity of the Authority.

Pathogen Control—As required by our EPA grant, we studied the occurrence of waterborne pathogens, including Drinking Water Pathogens *Giardia lamblia* cyst and *Cryptosporidium* oocyst, in addition to total and fecal *Coliform* testing. There was no correlation between facility optimization and waterborne pathogen reduction, although the final series of Method 1623 tests for *Cryptosporidium* and *Giardia* showed no pathogens found in any of three samples.

Operations Regulations & Operator-in-Charge—It's important to remember that the Operator licensing regulations have been updated to better define the concept of "Operator in Charge," who is the licensed operator responsible for making process control decisions. Many of the regulations changes provide stronger protections for plant operators and facility owners by establishing systematic criteria for assuring operator and owner responsibility.

LSTA's Harleysville operators have been diligent in obtaining and maintaining professional licensure, and we commend operators who have recently passed the state licensing exams to qualify for the activated sludge process.

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

Digital, Continuously Monitoring Probes:
1 – Laptop computer with signal converter
2 – SC1000s
2 – LDO probes
1– pH probe
2 – ORP probe
1 – NH_4D probe w/Cleaning System
1 – Nitratax probes
1 – Solitax probes

Laboratory Equipment On-loan:
1 – Hach HQ40d handheld pH and LDO meter
1 – LBOD probe
1 – DR2800 spectrophotometer
1 – Wastewater Field Test Kit
1 – Raven centrifuge
1 – Raven Core Taker sampler
2 – Raven settleometers
1 – COD Heater Block
1 – Microscope with photographic/video capability

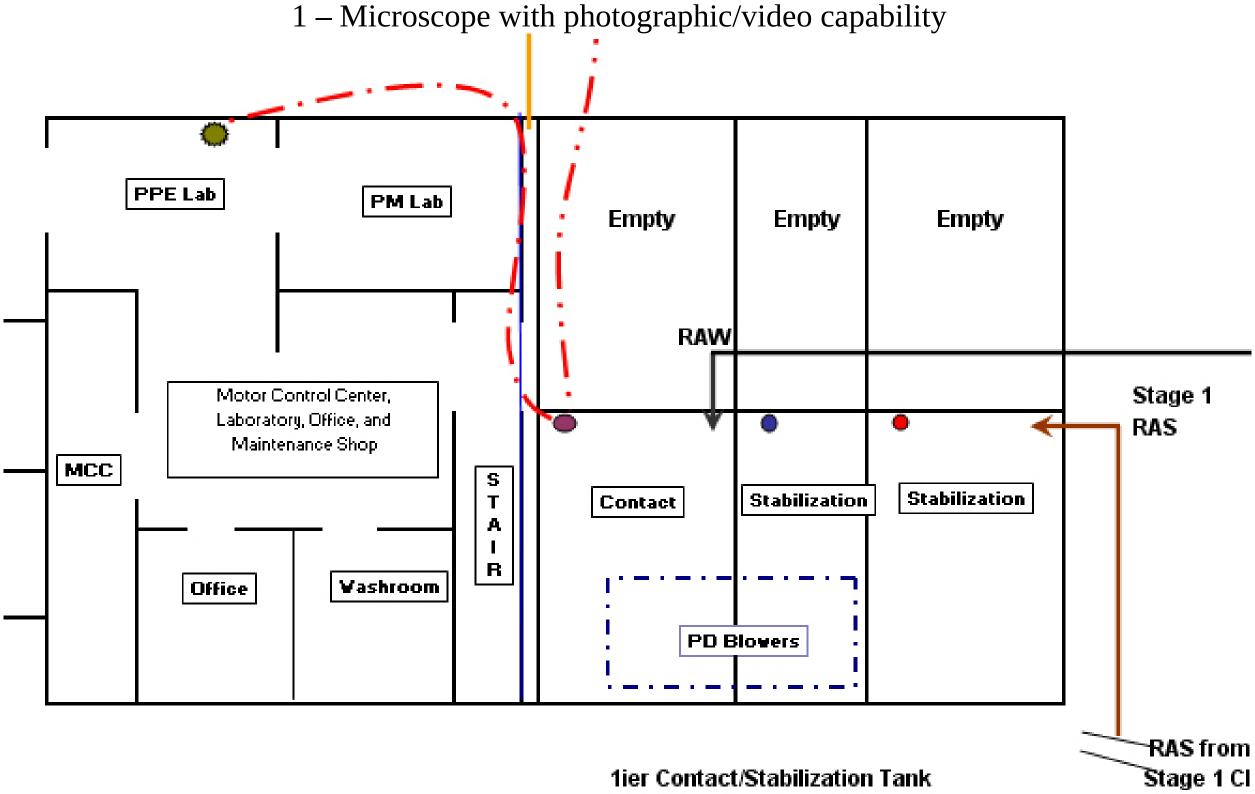


Figure E-1: Stage 1 Equipment Placement & Computer

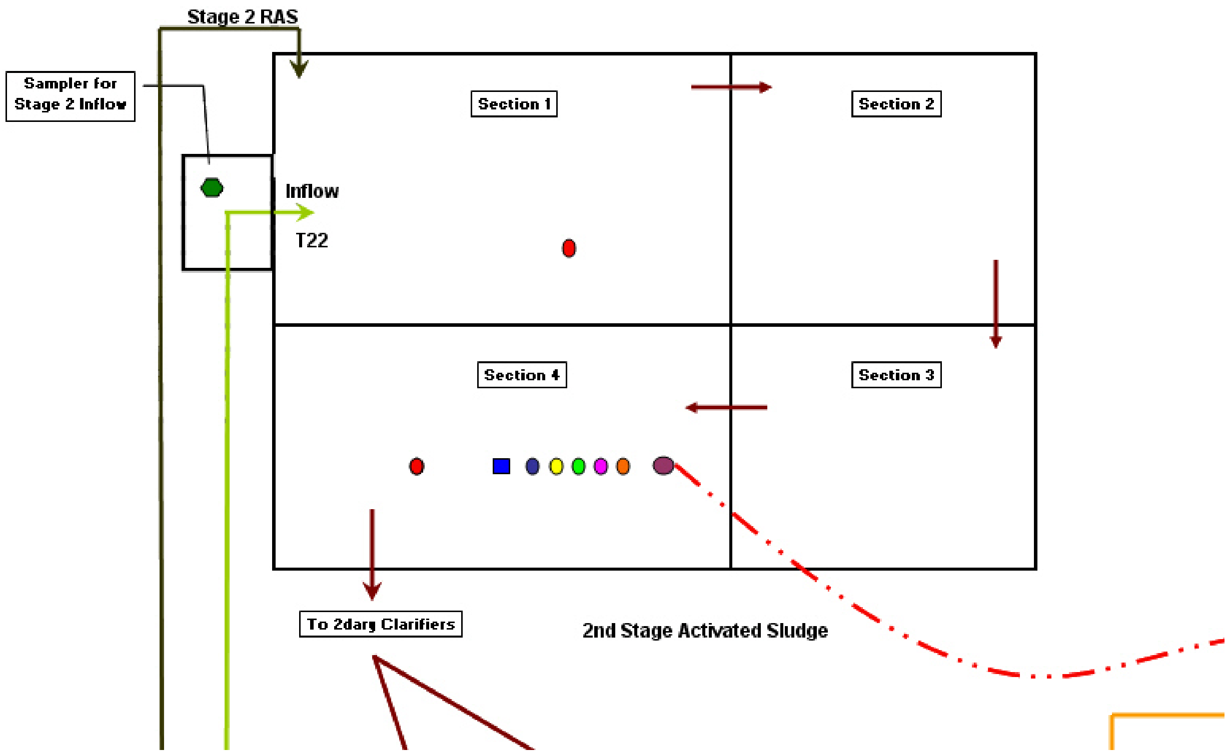


Figure E-2: Stage 2 Equipment Placement

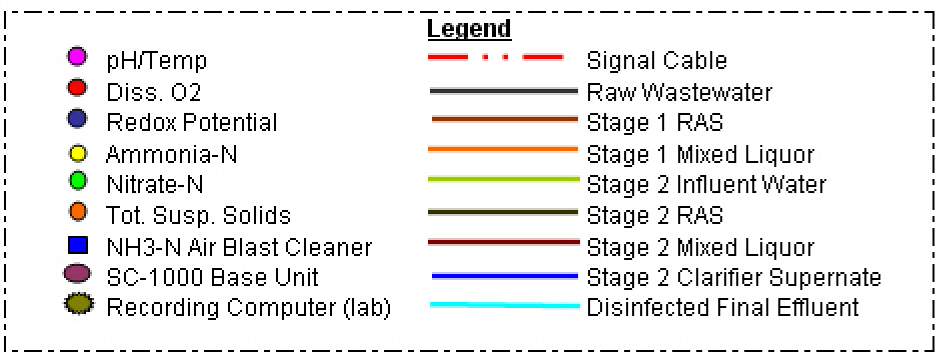


Figure E-3: Legend for Equipment Placement Diagrams

(Note: Complete diagram is available on accompanying data disk)

F—Equipment Placement Photos

Figure F.1: SC-1000 Base Unit, Stage 2 Aeration

Figure F.2: Portable Display Module attached to Base Unit

Figure F.3: Stage 2 Air Compressor for NH4Dsc Probe & clamps for probe poles

Figure F.4: Stage 2 Air Compressor in Operational Mode

Figure F.5: Stage 1 Probe and Base Unit, with Display

Figure F.6: Stage 1 Display

Figure F.7: Stage 2 Tank 1 Dissolved Oxygen Probe

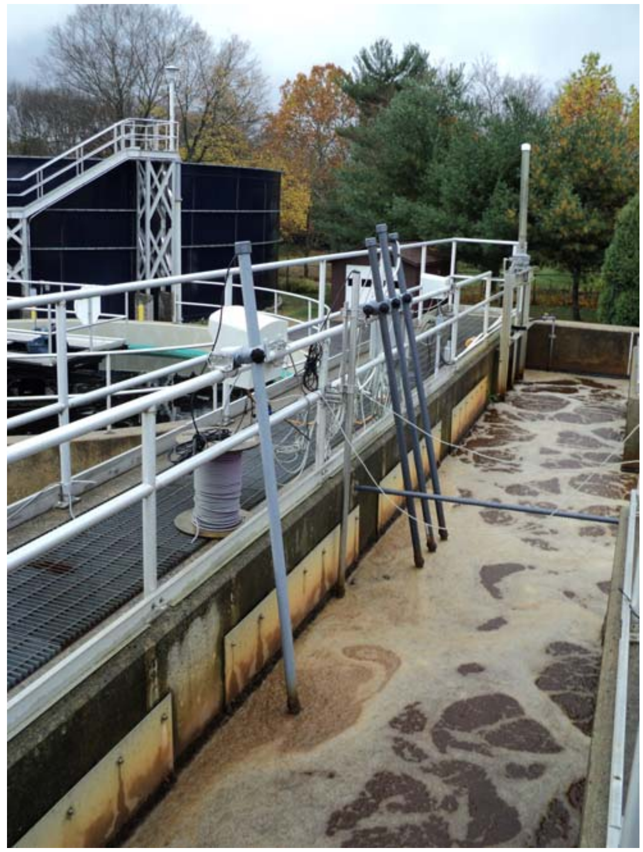


Figure F.8: Stage 2 Tank 4 Probes Network

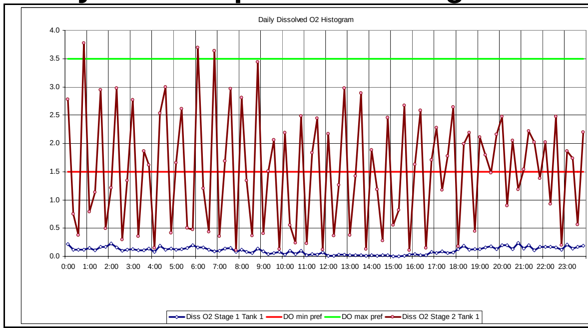
Figure F.9: Laboratory Computer linked to SC-1000 network.

Figure F.10: WPPE Process Monitoring Equipment.

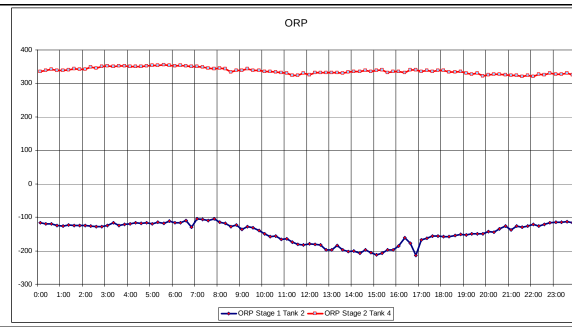
Attachment G— Continuous Digital Monitoring Charts

The following charts are examples of the data recorded from the continuous digital monitoring probes, set at 15-minute intervals. Additional data is available on the Data Disk.

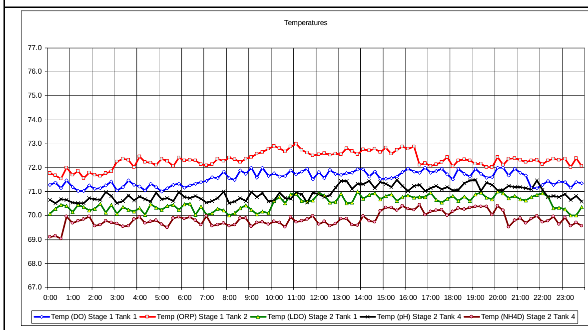
Daily Data Acquisition Histograms



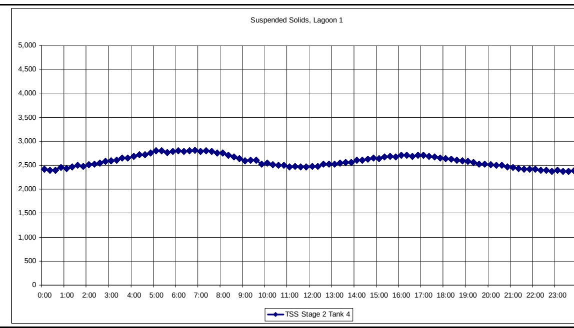
ML Dissolved Oxygen Histogram, 10/27/2010



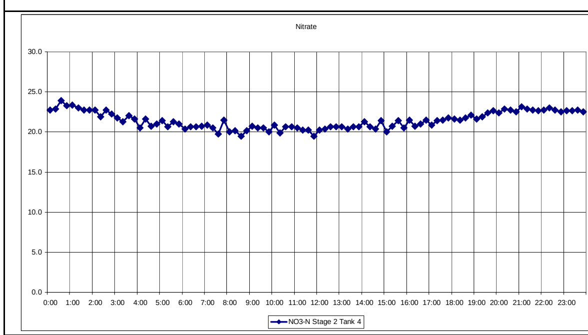
ML Oxidation/Reduction Histogram, 10/27/2010



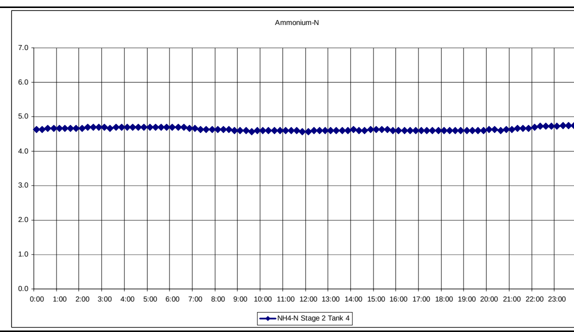
ML Temperature Histogram, 10/27/2010



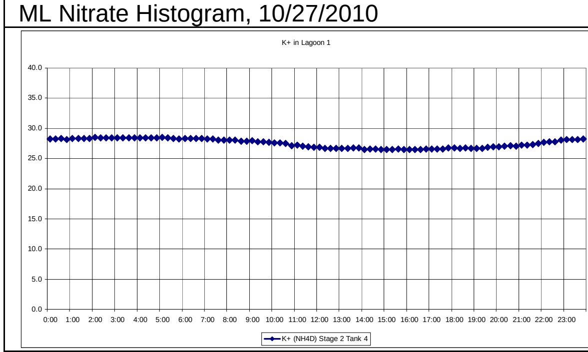
ML Suspended Solids Histogram, 10/27/2010



ML Nitrate Histogram, 10/27/2010



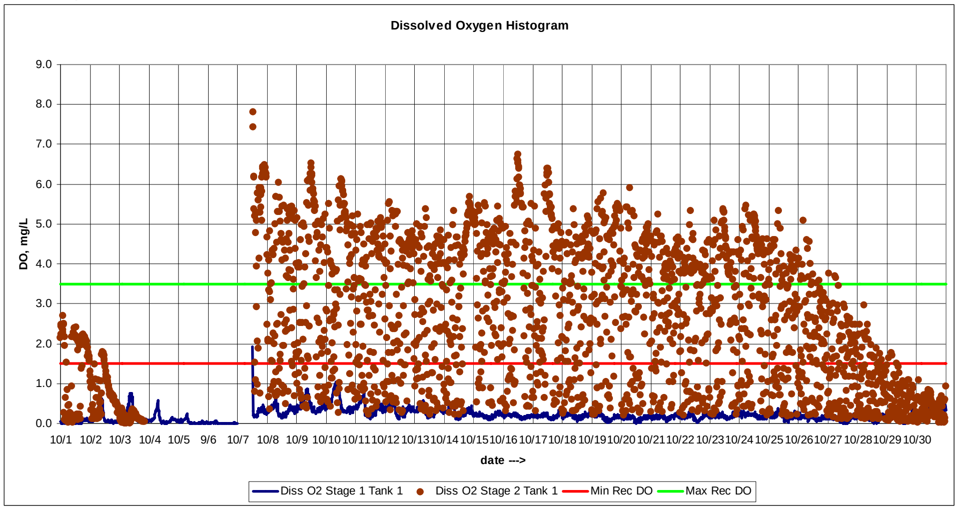
ML Ammonia Nitrogen Histogram, 10/27/2010



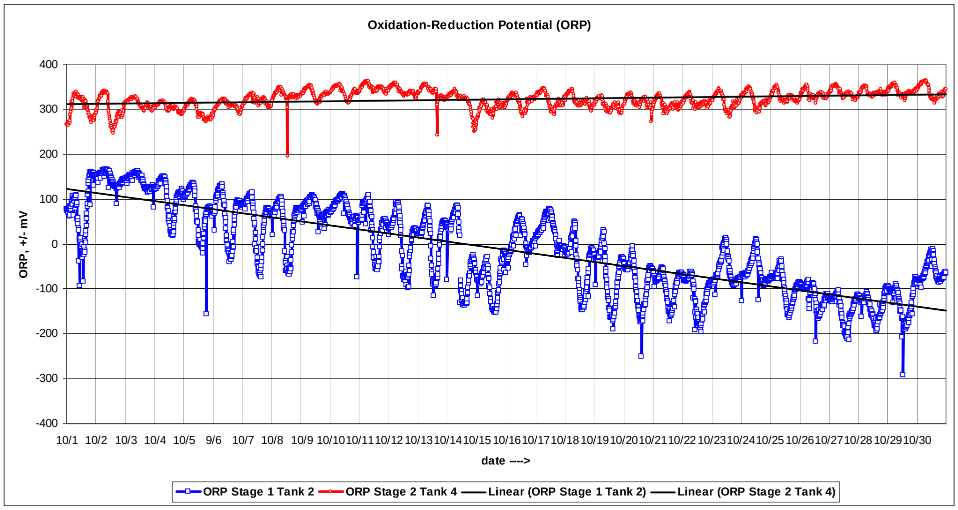
ML Potassium histogram, 10/27/2010

Note: All probes were placed in Mixed Liquor (ML) under aeration. The chief locations were Stage 1 Stabilization and Contact Tanks, and Stage 2 Tank 4, which is the final tank in the series.
Actual charts may be seen on the accompanying CD-ROM disc.

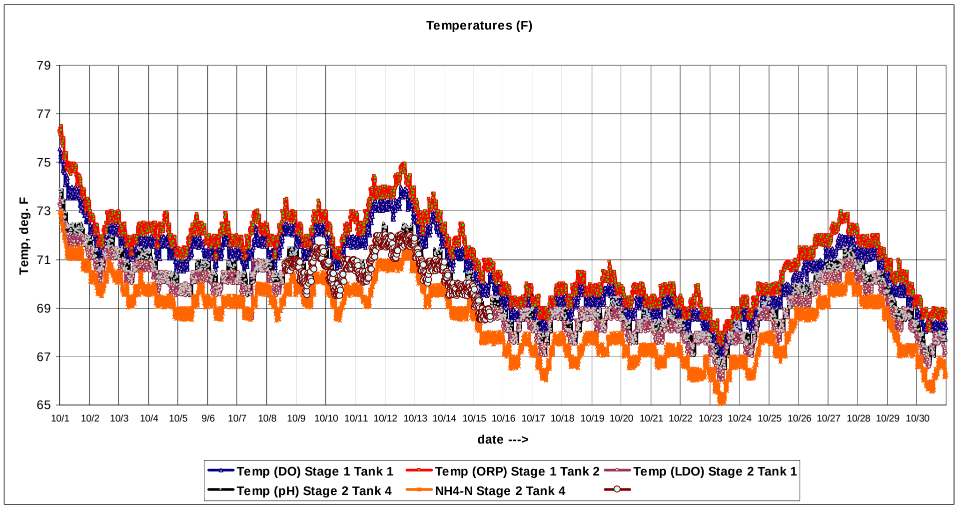
Monthly Histogram Examples:



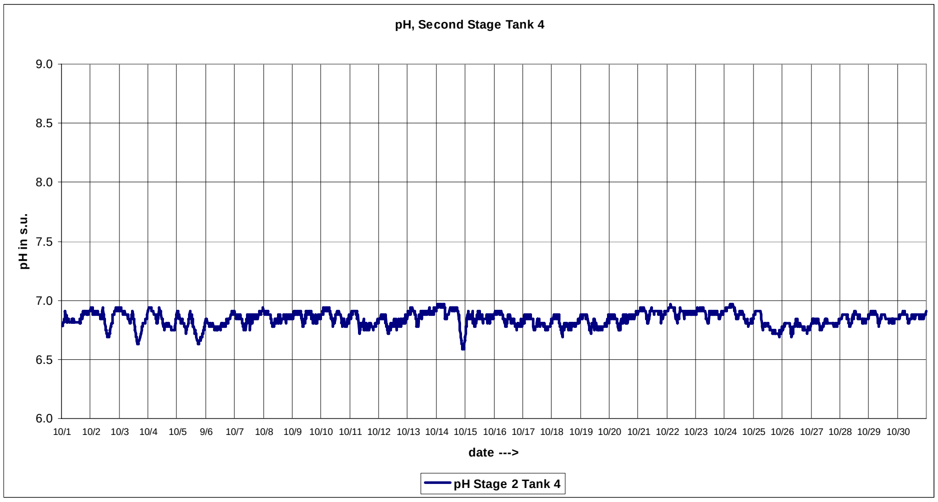
First and Second Stage Mixed Liquor Dissolved Oxygen Histogram, October 2010



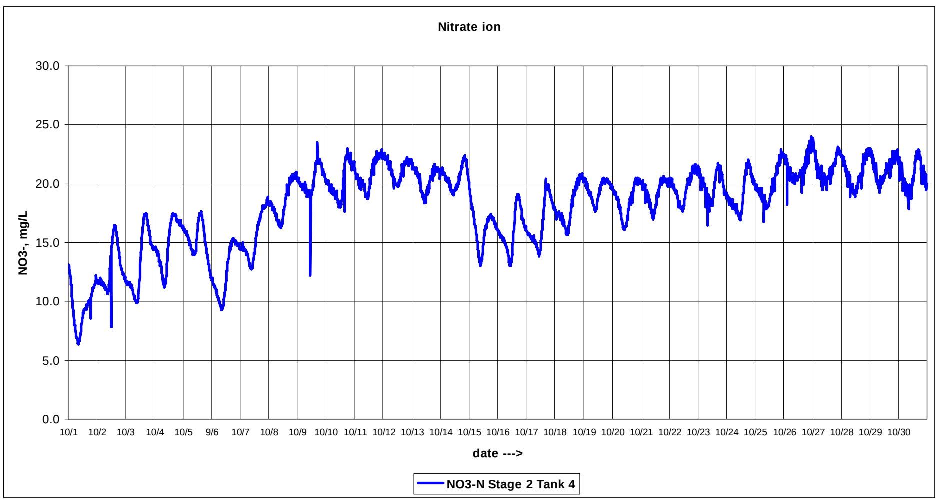
First and Second Stage Mixed Liquor Oxidation Reduction Histogram, October 2010



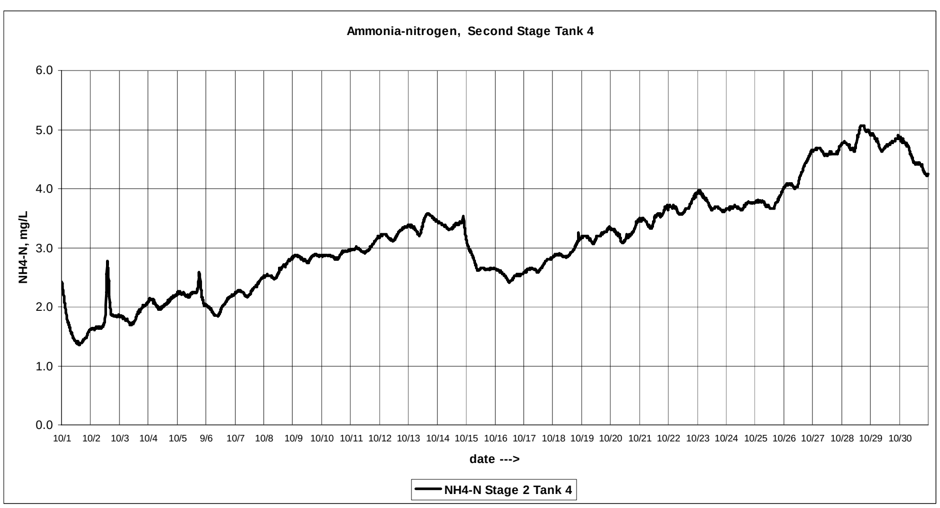
Temperature Histogram, October 2010



Second Stage Mixed Liquor pH Histogram, October 2010



Second Stage Mixed Liquor Soluble Nitrate Histogram, October 2010



Second Stage Mixed Liquor Ammonium-ion Histogram, October 2010

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

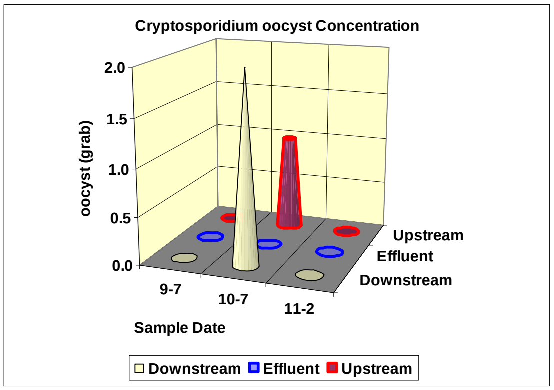
***Cryptosporidium* oocyst and *Giardia lamblia* cyst**

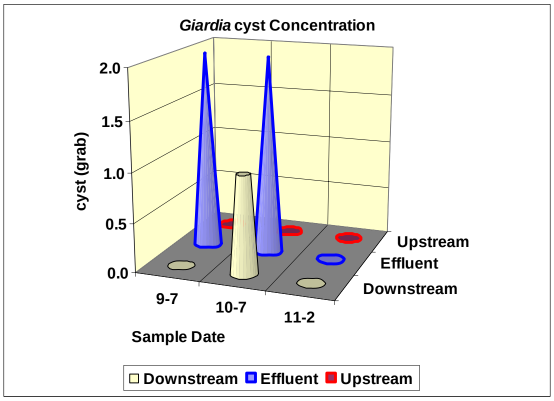
Tests for drinking water pathogen cysts, using EPA Method 1623, were performed on 3 sets of 10-liter samples taken on three separate days. Sampling points were

- Upstream/Background: Upstream of Outfall 001 for "background" purposes
- Effluent: Harleysville final effluent at facility sampling point
- Downstream/Impacted: Two sample locations were used: first, downstream of Outfall 001 at the stone bridge over UNT00183 of Indian Creek (DWS1); second, under the Hawes Avenue Bridge in Norristown, upstream of the raw water intake for the PAWC-Norristown Water Filtration Plant (DWS2).

Pathogen testing detected no *Cryptosporidium* on September 7 or November 2. Samples taken a week following heavy rains, when the background and impacted sampling points were still running swift and deep, revealed *Cryptosporidium* although the plant effluent did not.

As we have found at other treatment facilities, *Giardia* cyst was more likely to be found in treated effluent than *Cryptosporidium*; however, the test method does not confirm whether the pathogens are capable of reproducing. UV disinfection may reduce or totally inactivate these cysts without destroying their structural appearance, so they may be detected without our truly knowing if exposure to UV light had damaged or killed them.





HARLEYSVILLE	LOCATION	GIARDIA	CRYPTO	DESCRIPTION
9/7	UPS	0	0	Upstream UNT01182
9/7	EFF	2	0	Plant Effluent
9/7	DWS1	0	0	Downstream UNT01182
10/7	UPS	0	1	Upstream UNT01182
10/7	EFF	2	0	Plant Effluent
10/7	DWS2	1	2	Downstream Schuylkill River
11/2	UPS	0	0	Upstream UNT01182
11/2	EFF	0	0	Plant Effluent
11/2	DWS2	0	0	Downstream Schuylkill River

Table H-1: Method 1623 Pathogens: UPS=Background; EFF=Effluent; DWS1=Impacted UNT01182; DWS2=Impacted Schuylkill River.

In treating these pathogens, we have found that the best current methods are probably outside the budgets of wastewater treatment systems, because the best approach is to expose the pathogens to more than a single disinfection method. Combining UV radiation with ozonation, combining chlorination with filtration, even tripling the exposure methods, reduces the survival rate of these persistent cysts; however, there are no requirements for wastewater treatment systems to expend resources on multiple treatment technologies.

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

STP Process Monitoring Data for
Wednesday, October 27, 2010

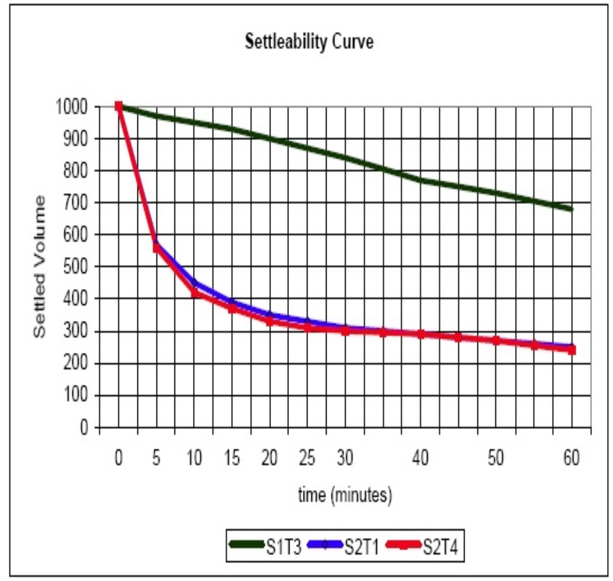
Raw WW	1:2, HR 914 mg/L COD =	572 3,385 lb/day	BOD5 Analog = 695 mg/L	= 2,572 lb/day
Flow at noon:	0.444 MGD			

Settleability:

Time	S1T3	S2T1	S2T4
0	1000	1000	1000
5	970	570	560
10	950	450	420
15	930	390	370
20	900	350	330
25	870	330	310
30	840	310	300
	805	300	295
40	770	290	290
	750	280	280
50	730	270	270
	705	260	255
60	680	250	240

OUR

	S1T3	S2T1	S2T4
time	reading	reading	reading
0	6.18	8.68	7.93
30	5.17	8.06	7.60
60	4.75	7.79	7.28
90	4.36	7.48	6.95
120	3.92	7.17	6.64
150	3.53	6.81	6.31
180	3.10	6.48	5.99
210	2.71	6.10	5.68
240	2.30	5.78	5.36
270	1.93	5.45	5.04
300	1.48	5.18	4.71
330	1.09	4.95	4.37
360	0.72	4.8	4.05
Slope	0.94	0.70	0.64
OUR	56.4	42.0	38.6
check			
Slope2	0.426	0.323	0.322
OUR	51.12	38.76	38.65



T22 COD 84.6 LR, full

Parameter	S1T3	S2T1	S2T4
SSV-30	840	310	300
MLSS	4,076	3,878	3,464
SVI	206	80	87
VSS	3,300	1,784	1,504
VSS/SS %	81%	46%	43%

Centrifuge solids by volume

S1T3	S2T1	S2T4
5.5	3.6	3.6

RAS Spins	
1R1	21
1R2	21.5
2R1	15
2R2	14
percent by volume	

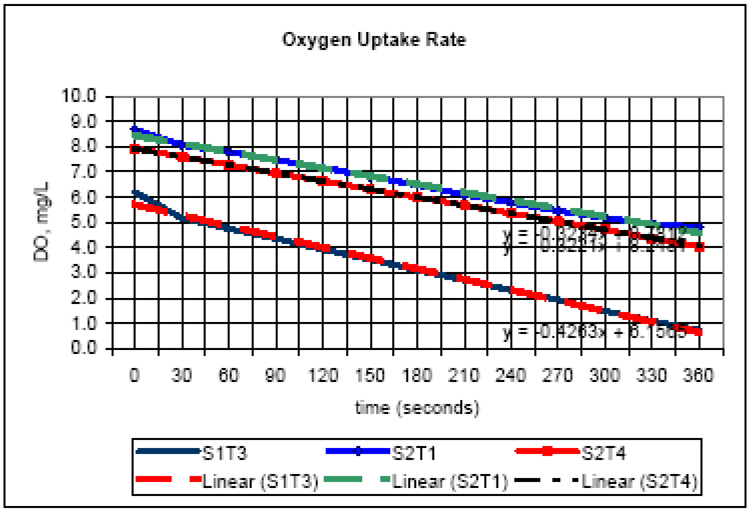
Nutrients:	PO4-P	Dilution	Tube	Under/Over	NH4-N	Dilution	Tube	Under/Over	NO3-N	Dilution	Tube	Under/Over
INF												
S1T3												
S2T1												
S2T4					0.02	no	ULR	no				
Effluent	0.090	no	LR	no	n.d.	no	ULR	no				
	0.071											
	0.084											

Notes:

Settled Sludge Concentration

time	S1T3	S2T1	S2T4
0	5.5	3.6	3.6
5	5.7	6.3	6.4
10	5.8	8.0	8.6
15	5.9	9.2	9.7
20	6.1	10.3	10.9
25	6.3	10.9	11.6
30	6.5	11.6	12.0
	6.8	12.0	12.2
40	7.1	12.4	12.4
	7.3	12.9	12.9
50	7.5	13.3	13.3
	7.8	13.9	14.2
60	8.1	14.4	15.0

Figure I-1: Example of Process Monitoring Bench Testing Results.



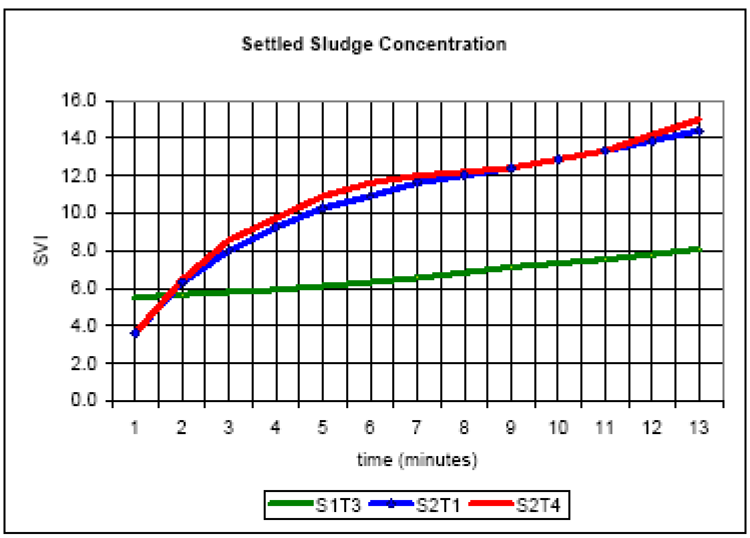


Figure I-2: Example of Process Monitoring Bench Testing, cont'd.

J—Graphs: Process Monitoring Test Results

The following pages represent 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.

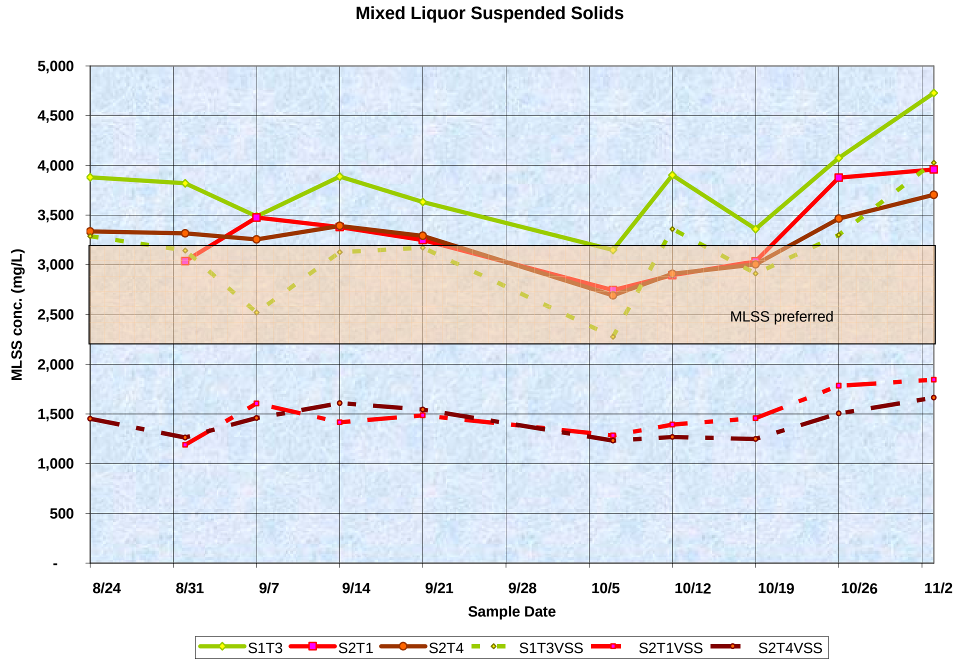


Figure J-1: Mixed Liquor Suspended Solids for BOL Samples

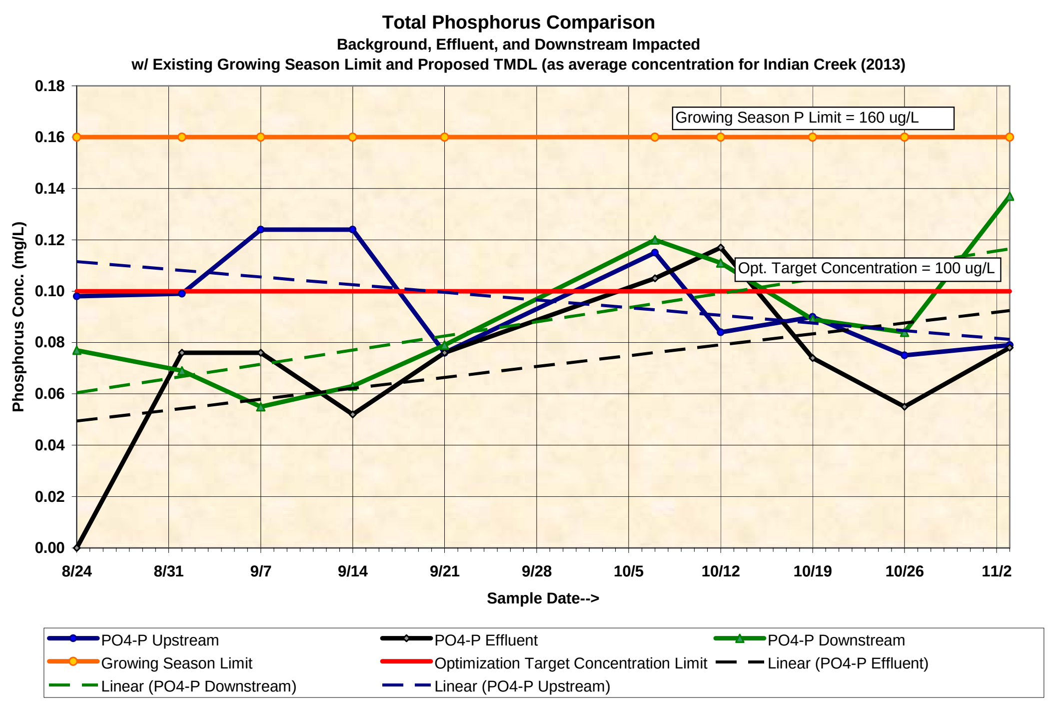


Figure J-2: Phosphorus Test Results for BOL Samples.

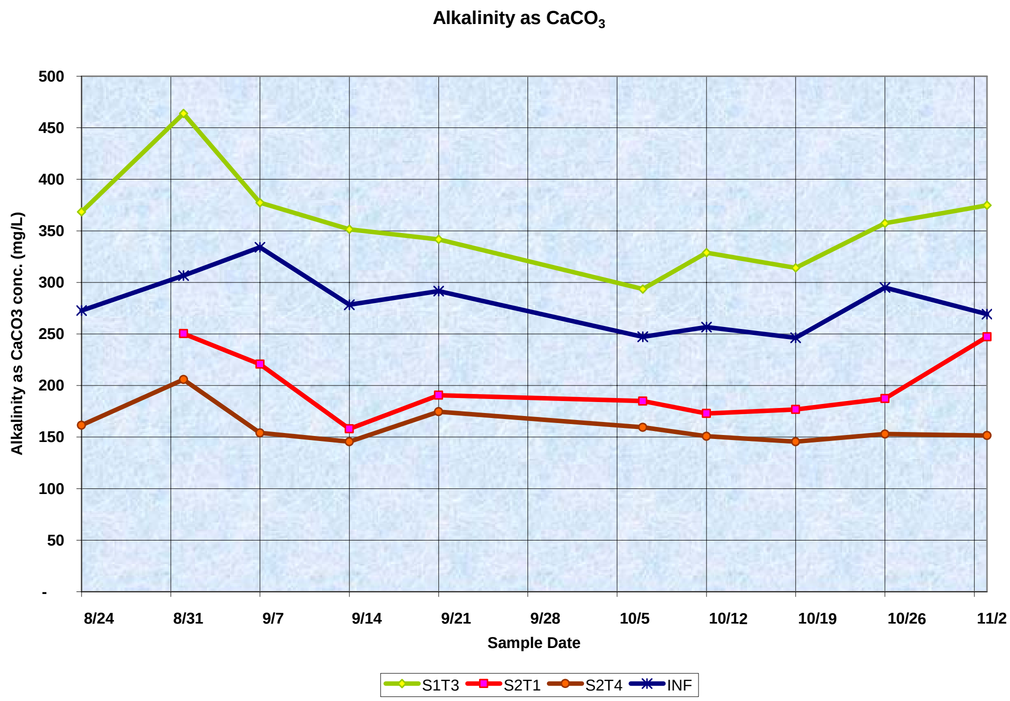


Figure J-3: Mixed Liquor & Raw WW Alkalinity in BOL Samples

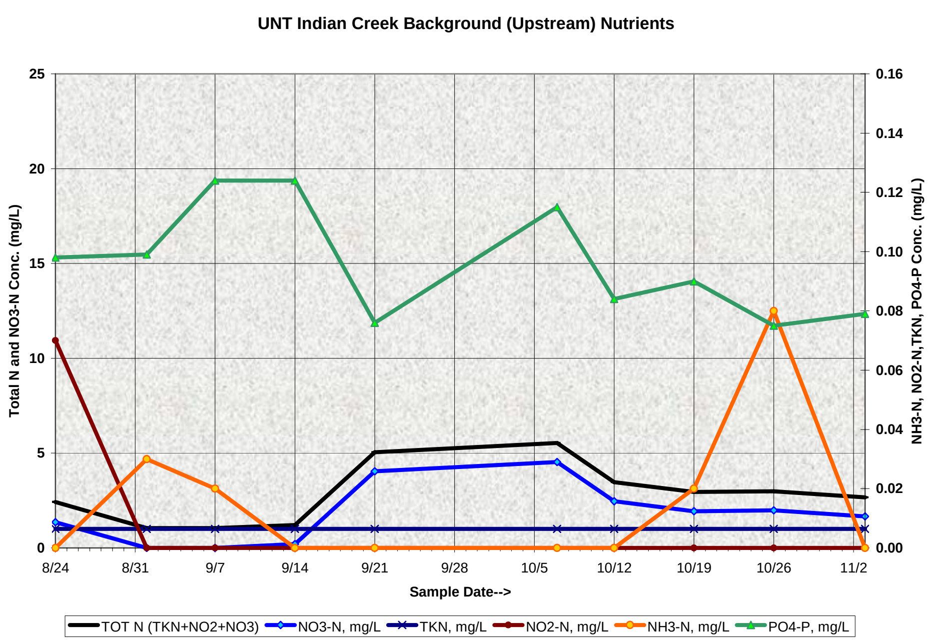


Figure J-4: Background Nutrient Concentrations found in BOL Samples

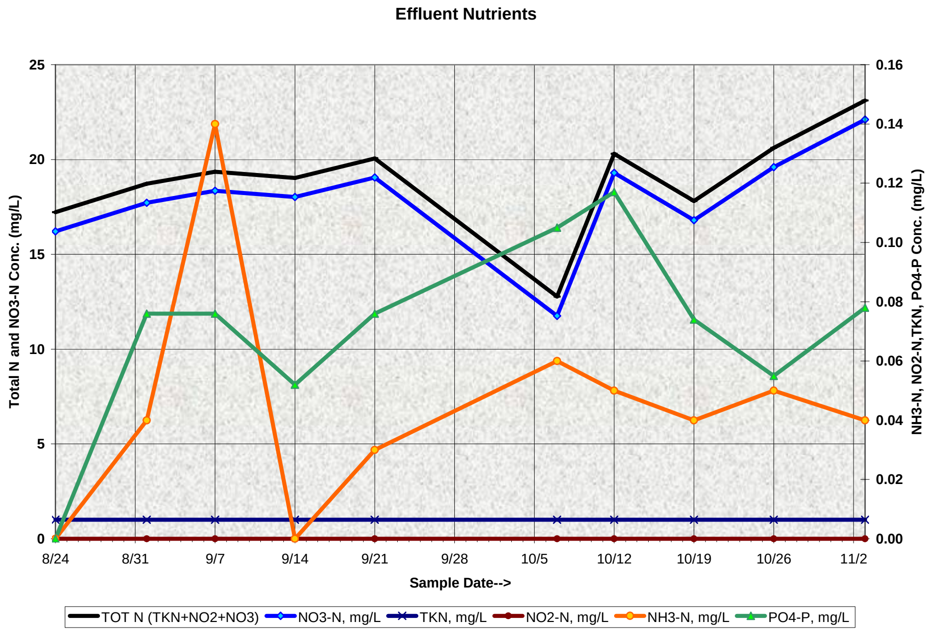


Figure J-5: Effluent Nutrient Concentrations found in BOL Samples

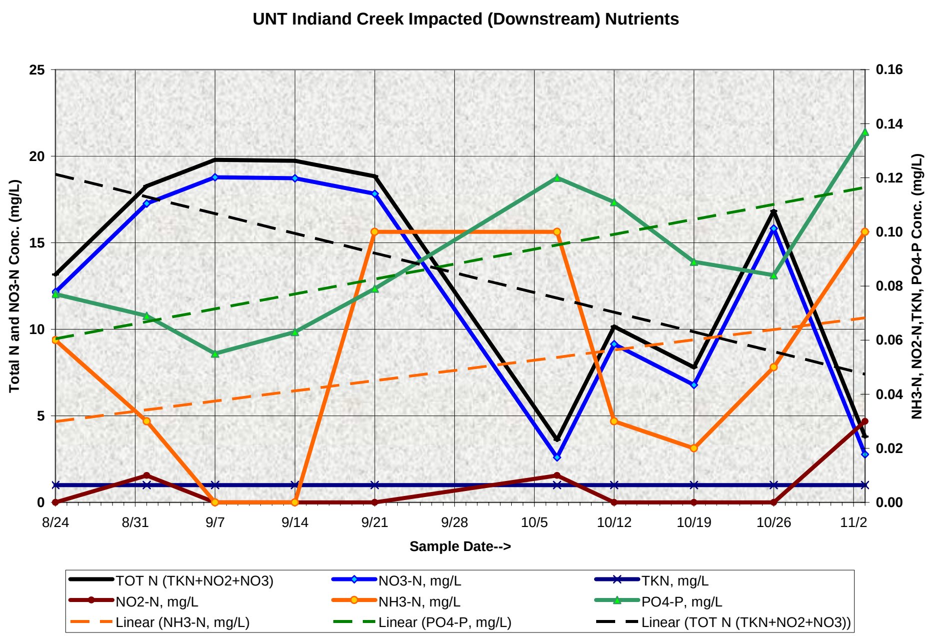


Figure J-6: Impacted Receiving Waters Nutrients found in BOL Samples

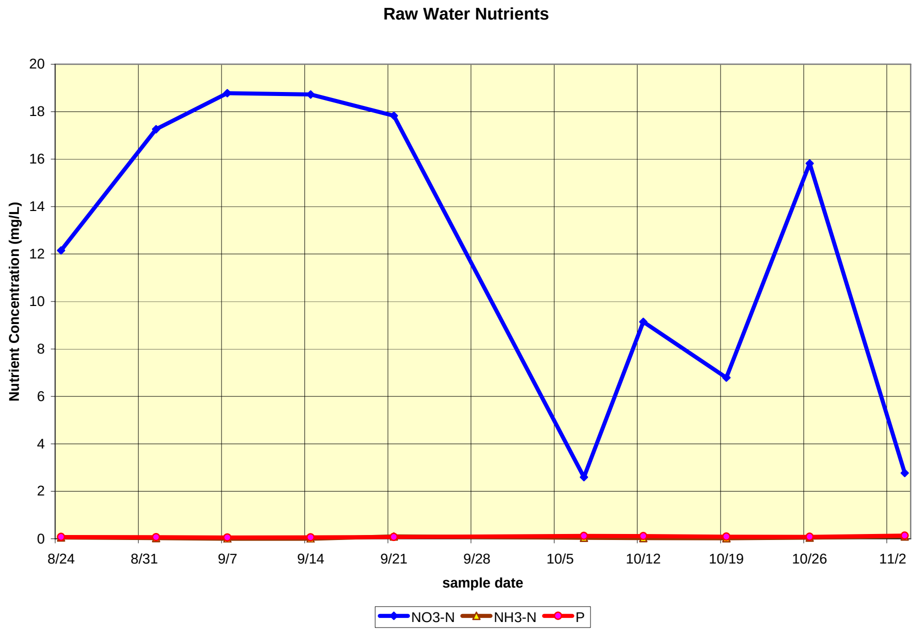


Figure J-7: Raw Water Nitrates, Ammonia-nitrogen, and Phosphorus found in BOL Samples

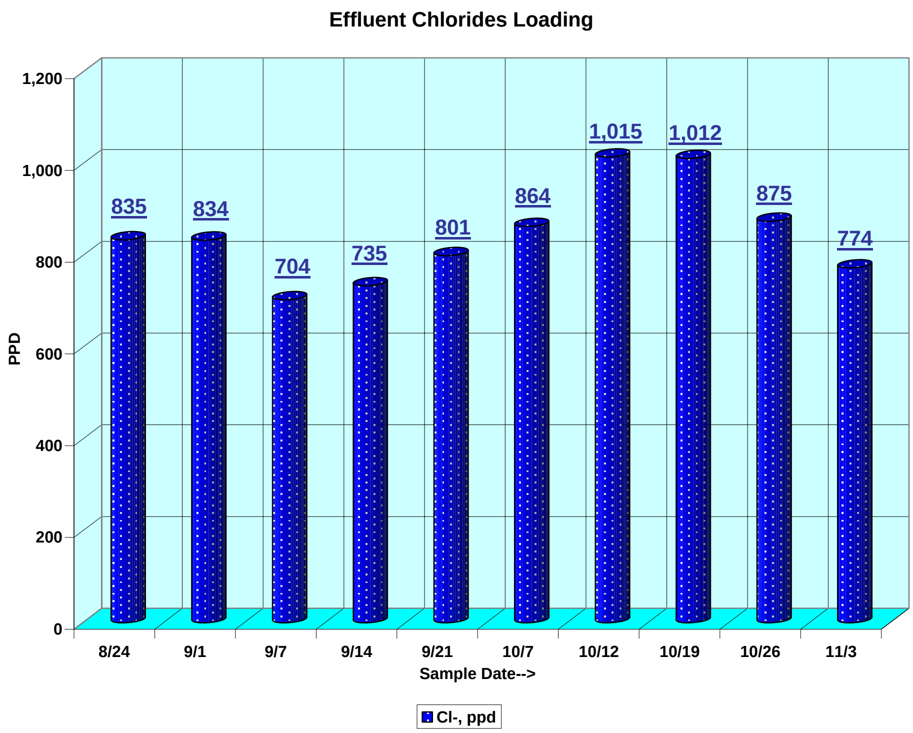


Figure J-8: Chloride Loading on Sample Days, expressed as PPD.

Attachment K—Tables of Sample Data from Bureau of Labs Testing

Lower Salford Township Authority
Harleysville Wastewater Treatment Facility
Test Results

Harleysville BOL Samples

Red entries denote results that are non-detectable using the available technology.

Completed Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530V	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
335	8/24/10	14:16	INF	I2010027046	287.00		314.7	7.4	272.8	544	204	204	100%	26.86	<0.01	<0.04	37.10	5.789	126.1
336	8/24/10	14:25	EFF	I2010027047		0.30		7.5	68.4	636	<5	<5	na:	<0.02	<0.01	16.21	<1.00	<0.01	200.2
337	8/24/10	15:18	UPS	I2010027048	0.40			7.6	107.4	336	<5	<5	na:	<0.02	0.07	1.36	<1.00	0.098	98.7
338	8/24/10	14:54	DWS	I2010027049	0.50			7.6	84.2	536	<5	<5	na:	0.06	<0.01	12.15	<1.00	0.077	167.4
339	8/24/10	18:16	S2T4	I2010027048					161.6		3336	1452	44%						
340	8/24/10	16:20	T22	I2010027051	15.80			8.0	220.2		6	10	na:	18.26	0.38	0.18	19.36	0.349	197.3
341	8/24/10	16:35	RS2	I2010027052							11628	4680	40%						
342	8/24/10	18:13	RS1	I2010027053							11268	9088	81%						
343	8/24/10	16:31	S1T3	I2010027054					368.4		3880	3288	85%						

Completed Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
344	9/1/10	13:13	INF	I2010027926	330.00		544	7.5	306.6	686	236	204	86%	31.91	<0.01	<0.04	45.53	6.911	198.9
345	9/1/10	13:10	EFF	I2010027927		0.90		7.9	93.4	738	<5	8	na:	0.04	<0.01	17.72	1.00	0.076	228.4
346	9/1/10	14:11	UPS	I2010027928	1.30			7.6	162.4	440	<5	6	na:	0.03	<0.01	<0.04	<1.00	0.099	131.4
347	9/1/10	14:20	DWS	I2010027929	1.30			8.1	95.8	724	<5	10	na:	0.03	0.01	17.26	<1.00	0.069	225.3
348	9/1/10	13:24	S2T4	I2010027930					205.8		3316	1262	38%						
349	9/1/10	13:21	T22	I2010027931	30.80			8.2	276.6		11	26	na:	23.9	0.46	0.16	24.08	0.567	375.4
350	9/1/10	13:42	RS1	I2010027932							8960	7180	80%						
351	9/1/10	13:29	RS2	I2010027933							10828	3868	36%						
352	9/1/10	13:39	S1T3	I2010027934					463.8		3820	3144	82%						
353	9/1/10	13:36	S2T1	I2010027935					250.4		3036	1188	39%						

Completed Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
354	9/7/10	12:15	INF	I2010028210	359.00		564.1	7.6	334.2	406	394	394	100%	33.59	<0.01	<0.04	51.55	8.104	162.8
355	9/7/10	11:55	EFF	I2010028211		0.50		7.7	59.6	656	<5	6	120%	0.14	<0.01	18.35	<1.00	0.076	217.6
356	9/7/10	10:35	UPS	I2010028212	0.70			8.1	173.8	434	<5	<5	na:	0.02	<0.01	<0.04	<1.00	0.124	127.7
357	9/7/10	11:00	DWS	I2010028213	0.70			7.8	60.2	676	<5	<5	na:	<0.02	<0.01	18.78	<1.00	0.055	215.8
358	9/7/10	12:22	S1T3	I2010028214					377.4		3488	2520	72%						
359	9/7/10	12:18	RS1	I2010028215							10472	8964	86%						
360	9/7/10	13:26	T22	I2010028216	24.20			8.1	213.6		9	8	89%	19.93	1.04	0.76	20.95	0.546	226.1
361	9/7/10	13:32	S2T1	I2010028217					220.8		3476	1604	46%						
362	9/7/10	13:38	S2T4	I2010028218					154		3256	1458	45%						
363	9/7/10	13:45	RS2	I2010028219							12824	5640	44%						

Completed Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
364	9/14/10	12:15	INF	I2010028860	291.00		397.9	7.5	278.4	506	246	214	87%	43.64	<0.01	<0.04	50.07	6.297	100.6
365	9/14/10	11:55	EFF	I2010028861		0.30		7.8	63	700	<5	<5	na:	<0.02	<0.01	18.02	<1.00	0.052	216
366	9/14/10	10:46	UPS	I2010028862	1.00			8	138.4	376	<5	<5	na:	<0.02	<0.01	0.2	<1.00	0.124	95.1
367	9/14/10	10:35	DWS	I2010028863	0.60			8	61	702	<5	<5	na:	<0.02	<0.01	18.72	<1.00	0.063	214.6
368	9/14/10	13:20	S1T3	I2010028864					351.6		3888	3128	80%						
369	9/14/10	13:24	RS1	I2010028865							9888	6625	67%						
370	9/14/10	13:35	T22	I2010028866	14.60		63	8.2	221.8		10	<5	50%	29.28	1.03	0.48	23.57	0.527	223.9
371	9/14/10	13:39	S2T1	I2010028867					158		3380	1416	42%						
372	9/14/10	13:42	S2T4	I2010028868					145.6		3392	1608	47%						
373	9/14/10	13:50	RS2	I2010028869							11664	4668	40%						

Lower Salford Township Authority
Harleysville Wastewater Treatment Facility
Test Results

Harleysville BOL Samples

Red entries denote results that are non-detectable using the available technology.

Completed

Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
374	9/21/10	12:15	INF	i2010029516	341.00		705.3	7.3	291.6	578	128	190	148%	45.99	<0.01	<0.04	48.18	6.898	138.7
375	9/21/10	12:19	EFF	i2010029517		0.50		7.8	69.8	730	<5	<5	na:	0.03	<0.01	19.05	<1.00	0.076	252.6
376	9/21/10	10:49	UPS	i2010029518	<0.20			7.4	97.6	1836	<5	<5	na:	<0.02	<0.01	4.04	<1.00	0.076	779.6
377	9/21/10	11:15	DWS	i2010029519	0.40			8.2	70.2	776	<5	<5	na:	0.1	<0.01	17.83	<1.00	0.079	270.6
378	9/21/10	12:25	S1T3	i2010029520					341.8		3632	3172	87%						
379	9/21/10	12:28	RS1	i2010029521							9508	8076	85%						
380	9/21/10	12:47	T22	i2010029522	53.40			7.7	223.8		42	50	na:	22.36	1.11	0.74	0.74	1.542	246.3
381	9/21/10	12:50	S2T1	i2010029523					190.6		3248	1486	46%						
382	9/21/10	12:53	S2T4	i2010029524					174.6		3292	1544	47%						
383	9/21/10	13:00	RS2	i2010029525							9360	4456	48%						
384	9/21/10	08:15	EFC	i2010029526										0.05	<0.04	20.35		0.074	

Completed

Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
385	10/7/10	12:07	INF	i2010031310	176.00		291.5	7.4	247.2	482	159	152	96%	22.59	<0.01	<0.04	33.86	4.332	132.3
386	10/7/10	12:10	EFF	i2010031311		<0.20		7.2	82.8	500	<5	<5	na:	0.06	<0.01	11.76	<1.00	0.105	159.6
387	10/7/10	11:00	UPS	i2010031312	0.50			7.4	117	320	<5	<5	na:	<0.02	<0.01	4.53	<1.00	0.115	71.7
388	10/7/10	17:35	DWS2	i2010031313	1.00			7.3	63.2	220	12	<5	na:	0.1	0.01	2.6	<1.00	0.120	3.0
389	10/7/10	13:30	S1T3	i2010031314					293.6		3,148	2,276	72%						
390	10/7/10	13:36	RS1	i2010031315							12,760	9,420	74%						
391	10/7/10	14:00	T22	i2010031316	12.10			7.8	207.2		10	<5	50%	15.27	0.48	0.48	17.86	1.261	156.4
392	10/7/10	14:10	S2T1	i2010031317					185		2,746	1,284	47%						
393	10/7/10	14:14	S2T4	i2010031318					159.6		2,692	1,232	46%						
394	10/7/10	14:28	RS2	i2010031319							11,564	5,668	49%						

Completed

Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
395	10/12/10	12:25	INF	i2010031492	346.00		359.9	7.3	256.8	634	176	162	92%	26.57	<0.01	<0.04	42.92	8.174	173.7
396	10/12/10	11:07	EFF	i2010031493		0.80		7.6	67.6	694	<5	<5	na:	0.05	<0.01	19.29	<1.00	0.117	217.8
397	10/12/10	10:07	UPS	i2010031494	<0.20			7.9	95.4	268	<5	<5	na:	<0.02	<0.01	2.46	<1.00	0.084	59.3
398	10/12/10	10:35	DWS1	i2010031495	0.40			7.9	83.2	390	<5	<5	na:	0.03	<0.01	9.14	<1.00	0.111	124
399	10/12/10	12:30	S1T3	i2010031496					328.8		3,902	3360	86%						
400	10/12/10	12:34	RS1	i2010031497							13,676	10410	76%						
401	10/12/10	12:50	T22	i2010031498	40.90		112.9	7.7	222.8		11	14	na:	19.81	0.81	0.21	23.04	2.431	268.6
402	10/12/10	12:53	S2T1	i2010031499					173.0		2,896	1,392	48%						
403	10/12/10	12:56	S2T4	i2010031500					150.8		2,910	1,268	44%						
404	10/12/10	13:05	RS2	i2010031501							11,260	5,380	48%						

Completed

Sample #	Date	Time	Locus	Lab#	BOD 00310	CBOD 00314	COD 00335	pH 00403	ALK 00410	TDS 00515	TSS 00530	VSS 00535	%Volatile	NH3-N 00610	NO2-N 00615A	NO3-N 00620A	TKN 00625A	PO4-P 00665A	Chloride 00940A
405	10/19/10	12:42	INF	i2010032286	275.00		381.8	7.5	246.4	478	196	184	94%	22.13	<0.01	<0.04	33.2	5.208	94.9
406	10/19/10	12:26	EFF	i2010032287		0.50		7.5	69.2	646	<5	<5	na:	0.04	<0.01	16.8	<1.00	0.074	208.2
407	10/19/10	11:46	UPS	i2010032288	1.40			7.8	88.8	234	<5	<5	na:	0.02	<0.01	1.94	<1.00	0.090	51.6
408	10/19/10	12:10	DWS1	i2010032289	0.90			7.8	85.2	356	<5	<5	na:	0.02	<0.01	6.79	<1.00	0.089	93.3
409	10/19/10	12:45	S1T3	i2010032290					314.2		3,360	2,912	87%						
410	10/19/10	12:48	RS1	i2010032291							12,644	11,336	90%						
411	10/19/10	14:10	T22	i2010032292	13.60		53.0	8.0	216.8		8	10	na:	0.776	0.12	0.07	20.88	0.776	191.3
412	10/19/10	14:08	S2T1	i2010032293					176.8		3034	1456	48%						
413	10/19/10	14:04	S2T4	i2010032294					145.6		3004	1248	42%						
414	10/19/10	14:20	RS2	i2010032295							11984	5328	44%						

Lower Salford Township Authority
Harleysville Wastewater Treatment Facility
Test Results

Harleysville BOL Samples

Red entries denote results that are non-detectable using the available technology.

Completed					BOD	CBOD	COD	pH	ALK	TDS	TSS	VSS		NH3-N	NO2-N	NO3-N	TKN	PO4-P	Chloride
Sample #	**Date**	**Time**	**Locus**	**Lab#**	**00310**	**00314**	**00335**	**00403**	**00410**	**00515**	**00530**	**00535**	**%Volatile**	**00610**	**00615A**	**00620A**	**00625A**	**00665A**	**00940A**
415	10/26/10	13:26	INF	i2010033402	550.00		386.3	7.4	295.0	632	214	212	99%	36.93	<0.01	<0.04	52.17	7.131	155.3
416	10/26/10	12:20	EFF	i2010033403		0.40		7.3	57.8	708	<5	<5	na:	0.05	<0.01	19.6	<1.00	0.055	221.9
417	10/26/10	10:20	UPS	i2010033404	0.50			7.8	138.6	380	<5	<5	na:	0.08	<0.01	1.98	<1.00	0.075	99.2
418	10/26/10	10:54	DWS1	i2010033405	1.10			8.0	76.0	636	<5	<5	na:	0.05	<0.01	15.82	<1.00	0.084	187.4
419	10/26/10	13:37	S1T3	i2010033406					357.4		4,076	3,300	81%						
420	10/26/10	13:31	RS1	i2010033407							14,136	10,870	77%						
421	10/26/10	13:51	T22	i2010033408	23.30		96.4	7.8	247.4		13	18	na:	25.34	0.01	<0.04	26.81	3.749	222.7
422	10/26/10	13:46	S2T1	i2010033409					187.4		3878	1784	46%						
423	10/26/10	13:48	S2T4	i2010033410					153.0		3464	1504	43%						
424	10/26/10	14:08	RS2	i2010033411							13540	5420	40%						

Completed					BOD	CBOD	COD	pH	ALK	TDS	TSS	VSS		NH3-N	NO2-N	NO3-N	TKN	PO4-P	Chloride
Sample #	**Date**	**Time**	**Locus**	**Lab#**	**00310**	**00314**	**00335**	**00403**	**00410**	**00515**	**00530**	**00535**	**%Volatile**	**00610**	**00615A**	**00620A**	**00625A**	**00665A**	**00940A**
425	11/3/10	14:33	INF	i2010034465	478.00		704.0	7.2	269.2	662	240	234	98%		<0.01	<0.04	50.83	7.743	158.5
426	11/3/10	14:18	EFF	i2010034466		0.80		7.2	64.8	712	<5	12	na:	0.04	<0.01	22.1	<1.00	0.078	231.4
427	11/3/10	13:07	UPS	i2010034467	0.90			7.7	133	380	<5	<5	na:	<0.02	<0.01	1.66	<1.00	0.079	108.8
428	11/3/10	11:27	DWS1	i2010034468	1.60			7.9	90.8	252	<5	10	na:	0.10	0.03	2.77	<1.00	0.137	43.4
429	11/3/10	14:31	S1T3	i2010034469					374.8		4,728	4,028	85%						
430	11/3/10	14:29	RS1	i2010034470							13,570	11,400	84%						
431	11/3/10	14:48	T22	i2010034471	17.50		116.0	7.8	253.8		9	24	na:	24.91	0.02	<0.04	27.51	1.478	259.9
432	11/3/10	14:53	S2T1	i2010034472					247.2		3,960	1,844	47%						
433	11/3/10	14:55	S2T4	i2010034473					151.6		3,704	1,664	45%						
434	11/3/10	14:59	RS2	i2010034474							9,696	4,568	47%						

Lower Salford Township Authority Harleysville WWTP

Loading Values of BOL Test Samples, based on reported Constituent Flows for Sampling Days:

Influent Loadings for Sample Days

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
Q, MGD	0.500	0.438	0.388	0.408	0.380	0.649	0.559	0.583	0.473	0.401	0.478	0.649	0.380	0.093
CBOD, ppd	1,197	1,205	1,162	990	1,081	953	1,613	1,337	2,170	1,599	1,331	2,170	953	371
COD, ppd	1,312	1,987	1,825	1,354	2,235	1,578	1,678	1,856	1,524	0	1,535	2,235	0	609
Alk ppd	1,138	1,120	1,081	947	924	1,338	1,197	1,198	1,164	900	1,101	1,338	900	140
TDA, ppd	2,268	2,506	1,314	1,722	1,832	2,609	2,956	2,324	2,493	2,214	2,224	2,956	1,314	481
TSS, ppd	851	862	1,275	837	406	861	821	953	844	803	851	1,275	406	209
VSS, ppd	851	745	1,275	728	602	823	755	895	836	783	829	1,275	602	176
NH3-N, ppd	112	117	109	148	146	122	124	108	146	0	113	148	0	43
NO2-N, ppd	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.05	0.04	0.03	0.04	0.05	0.03	0.01
NO3-N, ppd	0.17	0.15	0.13	0.14	0.13	0.22	0.19	0.19	0.16	0.13	0.16	0.22	0.13	0.03
TKN, ppd	155	166	167	170	153	183	200	161	206	170	173	206	153	18
PO4-P, ppd	24	25	26	21	22	23	38	25	28	26	26	38	21	5
Cl-, ppd	526	727	527	342	440	716	810	461	613	530	569	810	342	146

Items in red represent maximum possible loadings for values where testing returned a "nondetected" result.
The minimum possible loading for these red values, of course, is Zero (0) ppd.

T22 Loadings for Sample Dates, based on effluent flow and sample test data:

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
Q, MGD	0.500	0.438	0.388	0.408	0.380	0.649	0.559	0.583	0.473	0.401	0.478	0.649	0.380	0.093
CBOD, ppd	65.89	112.51	78.31	49.68	169.24	65.49	190.68	66.13	91.91	58.53	94.8	190.7	49.7	48.5
Alk ppd	918	1,010	691	755	709	1,122	1,039	1,054	976	849	912.3	1,121.5	691.2	153.7
TSS, ppd	25.0	40.2	29.1	34.0	133.1	54.1	51.3	38.9	51.3	30.1	48.7	133.1	25.0	31.3
VSS, ppd	41.7	95.0	25.9	17.0	158.5	27.1	65.3	48.6	71.0	80.3	63.0	158.5	17.0	42.1
NH3-N, ppd	76.14	87.30	64.49	99.63	70.86	82.65	92.36	3.77	99.96	83.31	76.05	100.0	3.8	27.9
NO2-N, ppd	1.58	1.68	3.37	3.50	3.52	2.60	3.78	0.58	0.04	0.07	2.072	3.8	0.0	1.5
NO3-N, ppd	0.8	0.6	2.5	1.6	2.3	2.6	1.0	0.3	0.2	0.1	1.2	2.6	0.1	1.0
TKN, ppd	80.7	88.0	67.8	80.2	2.3	96.7	107.4	0.0	105.8	92.0	72.1	107.4	0.0	39.2
PO4-P, ppd	1.46	2.07	1.77	1.79	4.89	6.83	11.33	3.77	14.79	4.94	5.364	14.8	1.5	4.5
Cl-, ppd	823	1,371	732	762	781	847	1,252	0	879	869	831.5	1,371.3	0.0	362.3

Items in red represent maximum possible loadings for values where testing returned a "nondetected" result.
The minimum possible loading for these red values, of course, is Zero (0) ppd.

Effluent Loadings for Sample Days

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
Q, MGD	0.500	0.438	0.388	0.408	0.380	0.649	0.559	0.583	0.473	0.401	0.478	0.649	0.380	0.093
CBOD, ppd	1.25	3.29	1.62	1.02	1.58	1.08	3.73	2.43	1.58	2.68				
Alk ppd	285	341	193	214	221	448	315	336	228	217	279.9	448.2	192.9	80.7
TDA, ppd	2,652	2,696	2,123	2,382	2,314	2,706	3,235	3,141	2,793	2,381	2,642.3	3,235.5	2,122.8	356.6
TSS, ppd	20.9	18.3	16.2	17.0	15.8	27.1	23.3	24.3	19.7	16.7	19.9	27.1	15.8	3.9
VSS, ppd	20.9	29.2	19.4	17.0	15.8	27.1	23.3	24.3	19.7	40.1	29.6	40.1	19.4	10.4
NH3-N, ppd	0.08	0.15	0.45	0.07	0.10	0.32	0.23	0.19	0.20	0.13	0.30	0.5	0.1	0.2
NO2-N, ppd	0.04	0.04	0.03	0.03	0.03	0.05	0.05	0.05	0.04	0.03	0.040	0.1	0.0	0.0
NO3-N, ppd	68	65	59	61	60	64	90	82	77	74	70.0	89.9	59.4	10.3
TKN, ppd	4.2	3.7	3.2	3.4	3.2	5.4	4.7	4.9	3.9	3.3	4.0	5.4	3.2	0.8
PO4-P, ppd	0.04	0.28	0.25	0.18	0.24	0.57	0.55	0.36	0.22	0.26	0.321	0.6	0.2	0.1
Cl-, ppd	835	834	704	735	801	864	1,015	1,012	875	774	845.0	1,015.4	704.1	104.1

Items in red represent maximum possible loadings for values where testing returned a "nondetected" result.
The minimum possible loading for these red values, of course, is Zero (0) ppd.

Lower Salford Township Authority Harleysville WWTP

T7 or T8 Contact Sludge Solids Under Air — **Where volume = 17,500 gallons**

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
Alk., ppd	54	68	55	51	50	43	48	46	52	55	52	68	43	6.7
TSS, lbs	566	558	509	567	530	459	569	490	595	690	553	690	459	64
VSS, lbs	480	459	368	457	463	332	490	425	482	588	454	588	332	70

Stage 1 Return Sludge Composite Sample

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
RAS SS, lbs	13,626	10,902	12,723	11,468	11,652	15,654	16,777	15,323	16,752	16,411	14,129	16,777	10,902	2,326
RAS VSS, lbs	10,990	8,736	10,891	7,684	9,898	11,557	12,770	13,738	12,881	13,787	11,293	13,787	7,684	2,075
% Volatile	81%	80%	86%	67%	85%	74%	76%	90%	77%	84%	80%	90%	67%	6.6%
Stage 1 RAS Flow	144,996	145,890	145,675	139,067	146,948	147,099	147,090	145,311	142,092	145,007	144,918	147,099	139,067	2,528
Stage 1 WAS Flow	7,104	6,993	6,094	6,596	6,129	4,467	4,551	5,047	6,135	10,782	6,390	10,782	4,467	1,805
Stage 1 WAS ppd	668	523	532	544	486	475	519	532	723	1,220	622	1220	475	224
% Solids Wasted	4.90%	4.79%	4.18%	4.74%	4.17%	3.04%	3.09%	3.47%	4.32%	7.44%	4.41%	7.44%	3.04%	1.3%

Stage 1 Activated Sludge Solids under Air, where volume = 70,000 gallons

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
TSS, lbs	5,500	4,481	5,094	4,897	4,693	6,046	6,558	6,027	6,784	6,632	5,671	6,784	4,481	853
VSS, lbs	4,459	3,603	4,293	3,357	3,999	4,457	5,048	5,388	5,241	5,579	4,542	5,579	3,357	760

S2T1 and S2T2 Activated Sludge Solids Under Air, where volume is 72,000 gallons:

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
Alk., ppd		150	133	95	114	111	104	106	113	148	119	150	95	19.8
TSS, lbs		1,823	2,087	2,030	1,950	1,649	1,739	1,822	2,329	2,378	1,979	2,378	1,649	253
VSS, lbs		713	963	850	892	771	836	874	1,071	1,107	898	1,107	713	130
% Volatile		39%	46%	42%	46%	47%	48%	48%	46%	47%	45%	48%	39%	3%

Volatile percentage should be within range of 70% to 82% for conventional activated sludge systems.

Stage 2 Return Sludge Composite Sample

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
TSS, lbs	18,819	17,639	20,911	19,209	15,076	18,583	18,041	19,171	21,628	15,607	18,468	21,628	15,076	2,047
VSS, lbs	7,574	6,301	9,197	7,687	7,177	9,108	8,620	8,523	8,658	7,353	8,020	9,197	6,301	943
% Volatile	40%	36%	44%	40%	48%	49%	48%	44%	40%	47%	44%	49%	36%	4%
Stage 2 RAS Flow	194,057	195,325	195,516	197,463	193,128	192,683	192,118	191,816	191,530	192,996	193,663	197,463	191,530	1,910
Stage 2 WAS Flow	1,707	1,186	506	945	1,010	904	920	1,073	836	804	989	1,707	506	310
Stage 2 WAS ppd	166	107	54	92	79	87	86	107	94	65	94	166	54	30
% Solids Wasted	0.88%	0.61%	0.26%	0.48%	0.52%	0.47%	0.48%	0.56%	0.44%	0.42%	0.51%	0.88%	0.26%	0.16%

Note: Volatile ratio so far in excess below the expected values for Activated Sludge indicate extremely endogenous, digested material.
Also, the presence of Iron phosphate precipitate in the sample will skew the inorganics higher.

T3 & T5 or T4 & T6 Stabilization Sludge Solids Under Air — **Where volume = 52,500 gallons**

Date-->	8/24/10	9/1/10	9/7/10	9/14/10	9/21/10	10/7/10	10/12/10	10/19/10	10/26/10	11/3/10	Average	Max	Min	StDev
TSS, lbs	4,934	3,923	4,585	4,329	4,163	5,587	5,988	5,536	6,189	5,942	5,118	6,189	3,923	834
VSS, lbs	3,979	3,144	3,925	2,901	3,536	4,125	4,558	4,963	4,759	4,991	4,088	4,991	2,901	738

Attachment L—Example Dynamic Sludge Age Worksheets

Dynamic Sludge Age (DSA) uses calculations based on “rolling averages” to establish sludge age for a process, and it does so in a way that when the process is at “steady-state” conditions, the sludge age will not change more than 1 day during a 24-hour period. This bests the traditional sludge age (TSA) calculation employed by many facilities. TSA provides a snapshot of the process at an instantaneous time, and a collection of TSA results usually does not follow a logical sequence even at steady-state conditions, because changes in sludge age can be days or weeks of time in just 24 hours. Thus, some engineers have suggested adopting the DSA as a means of establishing process control goals for a given facility.

On the following pages, we calculated loadings based on data made available by Ms. Christina Nelson, the laboratory director for the three Lower Salford Township plants. The lab performs gravimetric analysis of mixed liquor suspended solids approximately three times per week and makes this data available to the plant operators for their use in determining solids retention time (SRT), the method by which the operators have tracked process control.

Whether using SRT, TSA, DSA, or other methods such as Food-to-Mass (F/M) or Mean Cell Residence Time (MCRT), the important thing to do is establish ideal operating ranges for summer, winter, and transitional steady-state conditions based on the specific treatment plant’s historical record, and then adjust sludge wasting rates in an attempt to maintain steady-state. Each facility’s operator-in-charge should set a standard and then maintain it, remembering that sludge quality is highly dependent on the quality and quantity of the food load, oxygen and nutrient availability, and temperature.

DSA does have some disadvantages compared to instantaneous digital monitoring systems; however, when applied consistently, it will prove useful.

The table on the following page is an example of the DSA worksheet.

DYNAMIC SLUDGE AGE
Harleysville STP Stage 2 Aeration
Lower Salford Township, Montgomery County

Date	Elapsed Time Interval	Mass of Sludge in System	Mass Waste Rate	Rate of Change in Mass	Sludge Production Rate	Dynamic Sludge Age	Traditional Sludge Age
	(days)	(lbs.)	(lbs per day) **			(days)	(days)
	t	M	W	K	P	DSA	TSA
9/1/2010	------	4,011	96	--	--	30	42
9/3/2010	2	4,017	76	3	79	31	53
9/7/2010	4	3,038	107	-245	-138	40	28
9/15/2010	8	4,528	72	186	258	30	63
9/17/2010	2	4,786	96	129	225	29	50
9/20/2010	3	4,432	88	-118	-30	32	50
9/22/2010	2	4,311	53	-60	-7	34	81
9/24/2010	2	4,347	93	18	111	35	47
9/27/2010	3	4,900	94	184	278	32	52
9/29/2010	2	5,044	69	72	141	32	73
10/6/10	6	3,729	204	-219	-15	39	18
10/8/10	3	3,981	68	84	152	37	59
10/11/10	3	4,053	78	24	102	37	52
10/13/10	2	4,035	52	-9	43	38	77
10/15/10	2	4,528	72	246	318	35	63
10/18/10	3	4,347	70	-60	9	38	63
10/21/10	3	4,528	63	60	123	38	72
10/25/10	4	4,714	76	47	123	38	62
10/27/10	2	4,798	35	42	77	38	137
10/29/10	2	4,990	86	96	182	38	58
0	-40480	1	1	0	1	1	1
0	1	1	1	0	1	1	1

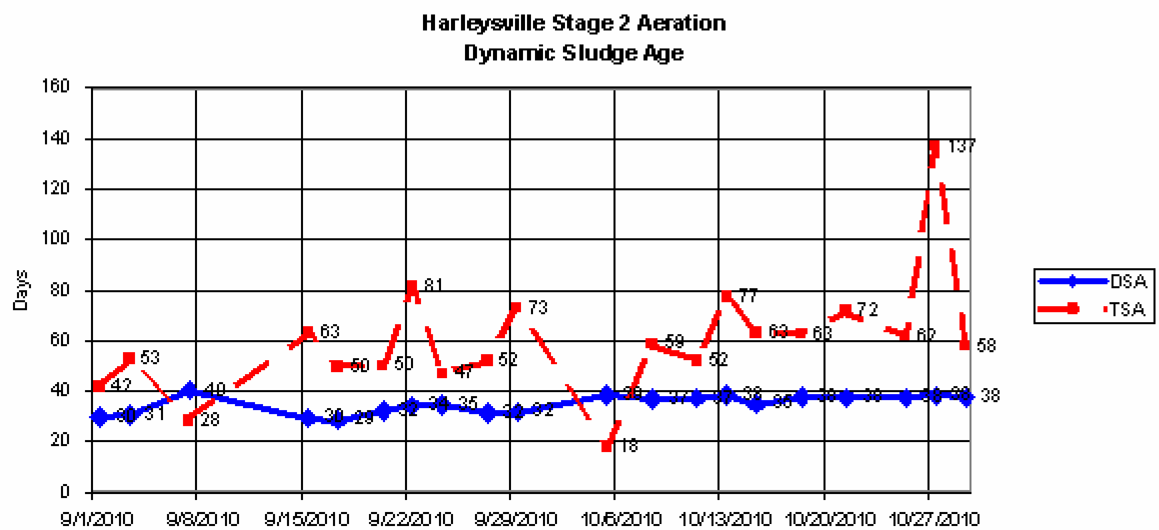


Figure L-1: Example DSA worksheet with graph comparing DSA with traditional sludge age (TSA).

Attachment M—Example Solids Retention Time Worksheets

SRT Days 1st Stage

11/30/2010

	T - 3	T - 4	T - 7	T - 8
MLSS	7,200	6,800		
RAS - SS			16,000	14,000
Waste Flow GD	1,200			
Effl. SS T-22				

SRT Days (Single)		Both trains are in use, use value on next line
SRT Days (2 tanks)	51.0	

	MLSS	SRT
Desired (Optimal)	3,200	30
GPD to Waste		
GPD to Waste (2 tanks)	35,467	3,298

1st Stage Waste

	T - 3	T - 4	T - 7	T - 8
MLVSS		3,800		
RAS VSS				9,800

Volatile Percentage: na: 56%

70% is Old Sludge; 80% is Young Sludge

SRT Days - 2nd Stage

MLSS	3,380
RAS - SS	12,840
Waste Flow GD	1,966
Effl. SS	
SRT Days	19

2nd Stage Waste

MLVSS	1,470
RAS VSS	5,010

Volatile Percentage: 43%

	MLSS	MCRT
Desired (Optimal)	3,500	20
GPD to Waste	0	1,895

Figure M-1: Example Solids Retention Time Worksheet, using if/then statements.

Here are some of the calculations used in this spreadsheet:

Cells used for Data Entry and for Calculations or Comments:

C3: date entry

B7	Enter actual T-3 MLSS in mg/L
C7	Enter actual T-4 MLSS in mg/L
D8	Enter actual T-7 RAS SS in mg/L
B8	Enter actual T-8 RAS SS in mg/L
B9	Enter actual Waste Sludge flow, in gal/day
B10	Enter actual Effluent SS in mg/L, if available
B12	Calculated SRT if only one side of First Stage in operation, with note to enter WAS flow if there is no entry in B9:: '=IF(I7=0,"",(IF(ISNUMBER(K9),"",(IF(ISNUMBER(B9),(I7*0.07*8.34)/(I8*(B9/1000000)*8.34),"Enter WAS flow")))))
C12	Instructions for reading results based on whether one or both sides of First Stage aeration are in operation: =IF(ISNUMBER(C7),IF(B7,"Both trains are in use, use value on next line","Single train in use"),"Single train in use")
B13	Calculated SRT if both sides of First Stage are in operation: =IF(ISTEXT(K7),"",((I7+J7)/2)*0.14*8.34/(I8*(B9/1000000)*8.34))
B16	Enter desired MLSS in mg/L
D16	Enter desired SRT in days
	=IF(ISTEXT(B12),"",IF(I7-B16>0,((I7-B16)*0.07*8.34/(I8*8.34))*1000000, ""))
D18	Calculated sludge wasting target in gal/day, if only one side of First Stage is being operated, based on desired SRT in days: =IF(ISTEXT(B18),"",((I7*0.07*8.34)/(I8*D16*8.34))*1000000)
B19	Calculated sludge wasting target in gal/day, if both trains of First Stage are being operated, based on desired MLSS in mg/L: =IF(ISTEXT(B13),"",IF(((I7+J7)/2)-B16>0,((((I7+J7)/2)-B16)*0.14*8.34/(K8*8.34)*1000000, ""))
D19	Calculated sludge wasting target in gal/day, if both trains of First Stage are being operated, based upon desired SRT target in days: =IF(ISTEXT(B13),"",IF(K7=FALSE,"",((((I7+J7/2)*0.14*8.34)/(K8*D16*8.34))*1000000)))
B28	Calculated volatile percentage, if data is entered for T-3 and T-7 '=IF(B25,(B25/B7),"na:")
C28	Calculated volatile percentage, if data is entered for T-4 and T-8 =IF(ISNUMBER(C7),(C25/C7),"na:")
B47	Sludge to waste in gal/day, to achieve desired MCRT =B37*0.144*8.34/(B38*(B39/1000000)*8.34)
E41	Calculated volatile percentage
B45	Enter desired MLSS in mg/L =E37/B37
D45	Enter desired SRT in days
B37	Enter actual MLSS in mg/L
E37	Enter actual MLVSS in mg/L
B38	Enter actual RAS SS in mg/L
E38	Enter actual RAS VSS in mg/L
B39	Enterr actual Waste Sludge flow, in gal/day
B47	Sludge to waste, in gal/day, based on desired MLSS and data entered for Second Stage: =IF(B37-B45>0,((B37-B45)*0.144*8.34/(B38*8.34))*1000000, 0)
D47	Sludge to waste, in gal/day, based on desired SRT and data entered for Second Stage: =((B37*0.144*8.34)/(B38*D45*8.34))*1000000

Note: Worksheet is password protected to prevent accidental changes to cell calculations, password is "excel"

Attachment N—NPDES Effluent Discharge Limits

Discharge Parameter	Effluent Limitations							Monitoring Requirei	
	MassUnits (lbs/day)[1]			Concentrations (mg/l)					
	Average Monthly	Average Weekly	Max. Daily	Inst. Min.	Average Monthly	Average Weekly	Inst. Max.[2]	Minimum Measure-ment Frequency	Required Sample Type
FLOW (MGD)	Monitor/ Report		Monitor/ Report					Continuous	Recorded
$CBOD_5$ (5-1 to 10-31)	98	148			20	30	40	1/Week	24 Hour Comp.
$CBOD_5$ (11-1 to 4-30)	123	197			25	40	50	1/Week	24 Hour Comp.
TOTAL SUSPENDED SOLIDS	148	222			30	45	60	1/Week	24 Hour Comp.
AMMONIA (as N) (5-1 to 10-31)	7.4				1.5		3.0	1/Week	24 Hour Comp.
AMMONIA (as N) (11-1 to 4-30)	14.8				3.0		6.0	1/Week	24 Hour Comp.
PHOSPHORUS (as PO_4) (4-1 to 10-31) (issuance thru plant upgrade)	2.5				0.5		1.0	1/Week	24 Hour Comp.
PHOSPHORUS (as Total P) (4-1 to 10-31) (plant upgrade thru expiration)	0.8				0.16		0.32	1/Week	24 Hour Comp.
FECAL COLIFORM					200/#100 ml			1/Week	Grab
DISSOLVED OXYGEN				Minimum of 5.0 mg/l at all times				Daily	Grab
TOTAL RESIDUAL CHLORINE (issuance thru plant upgrade)					0.01		0.03	Daily	Grab
pH (STD Units)	Within limits of 6.0 - 9.0 STD Units at all times							Daily	Grab
ALUMINUM, TOTAL					Monitor/ Report		Monitor/ Report	1/Month	24 Hour Comp.

c. The permittee shall provide for effective disinfection of this discharge to control disease-producing organisms during the swimming season (May 1 through September 30) by achieving a fecal coliform concentration not greater than 200/100 ml as a geometric average (mean), and not greater than 1,000/100 ml in more than 10 percent of the samples tested. During the period October 1 through April 30 the fecal coliform concentration shall not exceed 200/100 ml as a geometric average (mean).

d. All discharges of floating materials, oil, grease, scum and substances which produce color, tastes, odors, turbidity or settle to form deposits shall be controlled to levels which will not be inimical or harmful to the water uses to be protected or to human, animal, plant, or aquatic life (93.6)(b).

e. Except as otherwise specified in this permit, the 30-day average percent removal for carbonaceous biochemical oxygen demand and total suspended solids shall not be less than 85 percent.

f. For discharges in the Delaware River Basin only - the permittee shall provide for effective disinfection of this discharge to control disease producing organisms by continuously achieving a fecal coliform concentration of not greater than 200/100 ml as a geometric average.