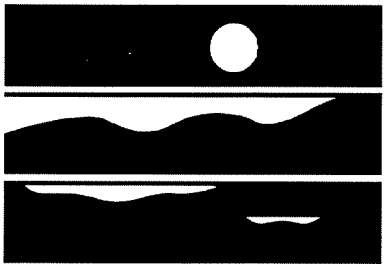

City of Ferndale
Wastewater Treatment Plant
Class II Inspection, June 16-18, 1997

June 1998

Publication No. 98-318

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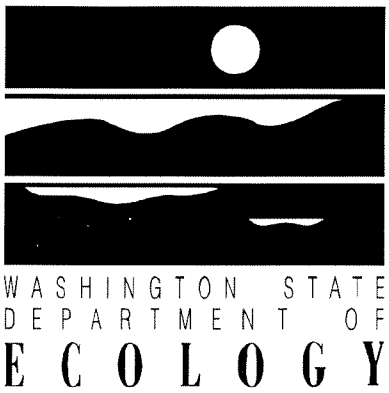

City of Ferndale
Wastewater Treatment Plant
Class II Inspection, June 16-18, 1997

by
Guy Hoyle-Dodson

Environmental Investigations and Laboratory Services Program
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June 1998

Water Body Numbers WA-03-0710, WA-07-1010

Publication No. 98-318

printed on recycled paper

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Abstract

An announced Class II Inspection was conducted June 16-18, 1997 at the City of Ferndale Wastewater Treatment Plant (Ferndale) in Whatcom County, Washington. Included was the analysis for metals of one industrial contributor to the Ferndale collection system: Recomp of Washington, Inc. Moderate reductions in BOD_5 and TSS occurred across the treatment plant. Effluent ammonia concentration was relatively high, and exceeded water quality criteria in the whole effluent. Dilution factors can be expected to reduce the impact of discharges to the receiving water. Analysis of the facility's complete mix aeration cells determined that aeration met minimum oxygenation requirements, but was inadequate for complete mixing. Aeration and detention time in the partial mix cells appear to be controlling algae growth, but may be selecting for nitrifying organisms, increasing the impact of nitrogenous BOD_5 in the effluent. Sedimentation in the partial mix cells appears to be negatively impacted by aeration, and it is recommended that aeration be reduced in the partial mix cells.

The 24-hour effluent composite BOD_5 concentration exceeded the NPDES permit weekly and monthly average limits, and a 24-hour effluent composite TSS concentration exceeded monthly average limits. Subsequent to the inspection, Ferndale's installation and operation of a fabric filter system has increased the effectiveness of BOD_5 and TSS removal. A portion of the effluent BOD_5 may be due to increased nitrogenous BOD_5. A tentative Streeter-Phelps analysis of BOD_5 in the receiving water indicated that its impact on DO would not cause a violation of water quality standards. Fecal coliform concentrations during the inspection exceeded the permit monthly and violated the NPDES weekly limits, although the inclusion of a new chlorine contact chamber has been effective in correcting this problem. Several metals exceeded the acute and chronic water quality standards in the whole effluent, although when estimated dilution factors are applied, these impacts are likely to be minimal. Several bioassays detected toxicity in the whole effluent, although these effects should also be mitigated by dilution. Recomp's effluent metal concentrations were all within state permit limits and their contribution to Ferndale effluent was less than 6% for all parameters.

Summary

Flow Measurements

Daily 24-hour effluent flow reported by Ferndale was 1.06 MGD during the period of the 24-hour composites and averaged 1.10 MGD during the inspection. Instantaneous effluent flow determined through an independent measurement by Ecology found a relative percent difference of 16% with a concurrent Ferndale instantaneous flow measurement. Daily discharge to the collection system by Recomp of Washington Inc. (Recomp) was measured by an in-line flow meter to be approximately 0.017 MGD over June 17-18.

General Chemistry Results and Treatment Plant Effectiveness

Treatment Plant Influent

Influent concentration of Total Solids was relatively strong compared to typical treatment plant influents. The five-day Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), and ammonia nitrogen concentrations were slightly less than the typical medium concentrations for untreated domestic wastewater. The total non-volatile suspended solids concentration was low compared to typical domestic wastewaters.

Aeration Cell Effluent

Reduction in total BOD_5 across the aeration cell ranged from 98% to 76%, corresponding to a range of estimated kinetic coefficients. Aeration in the cell appears to be suitable for oxygen requirements, but inadequate for mixing. For a complete mixed regime, the complete mix cell aerators provided only 62% of the minimum power requirements for mixing. The reaction rate coefficient (k) for the cells due to respiration alone ranged from approximately 0.25 d^{-1} to 0.35 d^{-1}, and was at the low end of typical values. The k_1 with substrate settling was approximately 0.8 d^{-1} which is greater than the minimum k_1 required by Ecology design standards for complete mix lagoon systems.

Partial Mix Cells

Reductions in total BOD_5 across the oxidation ponds were estimated to range from 35% to 44%. Analysis of the three-cell system indicates that the predicted effluent total BOD_5 result should be 32% less than the measured effluent BOD_5 concentration, indicating less efficient treatment than expected. Calculations of averaged typical k_1 for the three-cell system was 0.09 d^{-1}, and the averaged typical k for degradation of the soluble substrate produced negative results. This suggests that an additional source of oxygen demand may have been introduced into the system. Extensive algae blooms were not found, but it is possible that the system may be selecting for nitrifying organisms leading to increased nitrogenous BOD_5.

Total TSS concentrations across the three-cell system decreased an estimated 81%, with a final measured effluent concentration of 37 mg/L at the low end of a typical range for similar systems. Overflow rate was 14 gal/ft^2·day and the solids loading per unit area was 9.47 x 10^{-4} lb/ft^2·h, both within typical design averages. Detention time was greater than recommended minimums for settling, but also greater than typically recommended to control algae growth. It should be noted that the system design was intended to allow for extended detention time while still controlling algae growth. The sludge accumulation rate was estimated to range from between 1.88 X 10^5 lb/year to 2.84 X 10^5 lb/year, producing from 0.5 to 0.7 inches of accumulated sediment per year.

Lagoon System and Treatment Plant Effluents

The data suggest inadequate treatment of TSS and even less effective treatment for BOD_5. Ecology results showed a total BOD_5 reduction across the lagoon system of approximately 63%. BOD_5 removal across the entire treatment plant was 69% for a final effluent discharge of 60 mg/L. Subsequent to the inspection, the installation and operation of a new fabric filter system has been effective in improving treatment plant performance. Kjeldahl nitrogen, total phosphorus and ammonia all decreased slightly across the treatment plant. Chlorine residual was detected in only one sample.

At the time of the inspection the Ferndale NPDES permit did not provide acute and chronic mixing zone dilution factors. The calculated adjusted total ammonia nitrogen criteria was 91% of the allowable acute concentration, but exceeded allowable chronic concentration by a factor of 6. Tentative acute and chronic dilution factors calculated for the discharge should reduce the effluent ammonia nitrogen concentration to well below water quality criteria.

NPDES Permit Comparisons

Ecology's 24-hour composite final effluent BOD_5 result exceeded the monthly and weekly average NPDES permit limits by 100% and 33% respectively. The BOD_5 load exceeded the permit monthly average load limit but was within the weekly average limit. Percent reduction from the influent concentration was less than the required minimum monthly average. A tentative Streeter-Phelps analysis of the impact of treatment plant discharge on dissolved oxygen (DO) in the Nooksack River revealed that DO concentrations should not fall below the 8.0 mg/l water quality standard for Class A Freshwater systems.

The Ecology 24-hour composite effluent TSS concentration was within permit monthly average and weekly average limits. The effluent 24-hour composite TSS load was 42% greater than the permit monthly average load limit, but within the weekly average load limit. The percent reduction from the influent concentration was less than the minimum monthly average reduction required by the permit. Ecology data indicates that the treatment plant's design for sedimentation in the partial mix lagoon may be inadequate to meet permit limits.

During the inspection effluent fecal coliform results exceeded permit weekly and monthly average limits. One result produced a permit violation even in the case where samples from subsequent days in the week contain negligible concentrations. Ecology metal and total residual

chlorine results were all within the permit monthly and weekly averages. Ecology pH results were also within the stipulated range. The reported totalized average influent flow was below the NPDES permit maximum month average design limit. Influent BOD_5 and TSS loads were well below permit load limits.

Installation and operation of a fabric filter system for an eight-month period following the inspection has resulted in BOD_5 and TSS concentrations within permit limits. Also, the operation of a new chlorine contact chamber during that period has resulted in fecal coliform counts within permit limits.

Detected Priority Pollutant Organics and Metals

Ferndale Treatment Plant

One VOA compound, eight BNA and one pesticide were detected in either grab or composite effluent samples. Organic compound concentrations did not exceed freshwater acute and chronic water quality criteria. Four priority pollutant metals were detected in the plant composite effluent sample. Copper exceeded both the acute and chronic freshwater quality criteria in the whole effluent. Zinc and lead exceeded the chronic freshwater quality criteria. Dilutions in the receiving water should reduce these concentrations to less than criteria.

Nooksack River

Six metal compounds were detected in the upstream and downstream receiving water samples. Lead concentrations downstream of the outfall exceeded the chronic water quality criteria, as calculated for total recoverable concentrations using the conversion factors incorporated in the criterion equations. Mass balance calculations of the Ferndale effluent composite results indicate that the Ferndale plant contributed approximately 10% of the copper concentration and 7% of the lead concentration detected in the receiving water downstream of the outfall. The data suggest that Ferndale was responsible for increasing lead concentrations over criteria in the Nooksack River downstream of the outfall.

Effluent Bioassays

The *Daphnia magna* acute 48-hour survival test found 100% survival at most concentrations in the dilution series. The Lowest Observable Effect Concentration (LOEC) and the No Observable Effect Concentration (NOEC) were greater than 100%. The fathead minnow (*Pimephales promelas*) 96-hour survival test detected a small, but generally declining, survival with increasing concentration. The concentration associated with 50% mortality (LC_{50}) was greater than 100%, LOEC was less than 100%, and NOEC was 50%.

The fathead minnow (*Pimephales promelas*) chronic 7-day survival and growth test produced a survival analysis with an LC_{25} of 57% effluent concentration, LOEC of 100%, and NOEC of 50%. The growth analysis found an LOEC of 100%, NOEC less than 50%, and EC_{25} greater than 100%. Without dilution this represents a statistically significant difference in response, and a reasonable potential exists for chronic toxicity in the receiving water. If tentative dilution

factors are considered, a reasonable potential does not exists for chronic conditions in the receiving water.

Split Samples

Sample Comparisons

Relative percent differences (RPD) between all sample pairs of BOD_5 and pH were less than variation in precision cited in the EPA comparison of interlaboratory analysis of selected parameters (EPA, March 1983). The average RPD between influent TSS values was close to three times the interlaboratory variation in precision. This suggests there is a difference between Ecology and Ferndale composite sampling techniques.

Laboratory Comparisons

Ecology and Ferndale laboratory results for influent and effluent BOD_5 and TSS samples collected by Ecology were well matched. The RPD for Ecology and Ferndale effluent chlorine results was 60%. The Ecology average fecal coliform result was greater than the Ferndale average result by a factor of 23.

Industrial Discharge Results and State Permit Comparisons

Comparison of Recomp's effluent concentrations to state discharge permit limits found cadmium, lead, and zinc loads were well within state permit limits. Recomp cadmium, lead, and zinc concentrations were estimated to contribute only 6.0%, 2.5%, and 4.7% respectively to the Ferndale treatment plant final effluent loads. Recomp's contribution of lead and zinc loads in the Nooksack River were 0.12% and 0.002% respectively, assuming worst-case conditions of no removal of Recomp metals by the Ferndale treatment plant.

Recommendations

Flow Measurements

- Ferndale should independently verify the accuracy of effluent flow meters and ensure that effluent flow measurement devices are properly calibrated.

- Recomp should provide access for independent flow verification.

General Chemistry and Plant Design

- Ferndale should increase mixing power and coverage in the cells.

- Ferndale should monitor the build-up of sludge in the complete mix aeration cells.

- Ferndale should determine nitrite-nitrate nitrogen concentrations at the beginning and the end of the total BOD_5 test to estimate nitrogenous BOD_5 demand in the effluent.

- Ferndale should investigate the possibility of decreasing aeration in one or more of the partial mix cells to improve sedimentation.

- Although anticipated dilution factors should reduce the impact of discharges to the Nooksack River, Ferndale should ensure that ammonia nitrogen does not exceed water quality criteria.

NPDES Permit Comparisons

- Inclusion of a fabric filter system subsequent to the inspection has produced improved treatment effectiveness, but Ferndale should continue to ensure that monthly effluent BOD_5 and TSS concentrations and loads do not exceed permit limits and that percent reductions across the treatment plant meet permit minimums.

- Ferndale should ensure that TSS concentrations and loads do not exceed permit limits during periods of enhanced algae growth.

- Ferndale should ensure that BOD_5 samples are preserved at 4° C until analysis.

- Ecology should conduct a study of in-stream DO impacts to the Nooksack River.

- Inclusion of a new chlorine contact chamber subsequent to the inspection has improved disinfection of fecal coliform, but Ferndale should continue to ensure that these concentrations remain within permit limits.

Bioassay Results

- Although anticipated dilution factors should reduce the impact of effluent toxicity, Ferndale should characterize effluent toxicity by testing as outlined in section 050 of WAC 173-205.

Split Samples

- Ferndale should ensure that collected samples are properly processed before analysis.
- Ferndale should review laboratory procedures for chlorine and fecal coliform.

Detected Priority Pollutants

- Ecology should assess the potential for lead concentrations to exceed the water quality criteria in the Nooksack River and further evaluate Ferndale's contribution to this load.

Introduction

A Class II inspection was conducted at the City of Ferndale Municipal Wastewater Treatment Plant (WWTP) on June 16 - 17, 1997. One industrial contributor to the treatment plant was also examined. Guy Hoyle-Dodson and Steven Golding, environmental engineers for the Washington State Department of Ecology Toxics Investigations Section, conducted the investigation. Ed Abassi, Ecology Northwest Regional Office water quality engineer, provided background information and assisted during the inspection. Jerry Leuenberger, Chief Plant Operator, provided information on facility operation and assistance on site.

The facility serves the city of Ferndale (pop: 4,620) and the surrounding community. The plant design population equivalent is 5,750. The facility treats sewage from a largely residential population, with a small number of light commercial contributors. An NPDES Permit (No. WA-002245-4) was issued June 28, 1993 with an expiration date of May 31, 1998. The permit was modified July 16, 1996 to include interim limits, shellfish protection reporting, and a new design criteria. Previous to 1997 one industrial contributor, Recomp of Washington Inc. (Recomp), a waste composting and incineration facility, had been contributing metal contaminated ash and compost leachate to the treatment plant's influent. Recomp has subsequently installed a closed recovery system for this leachate, and discharges to the treatment plant are now limited to small discharges attributed to overloading of their pretreatment system. The Recomp discharge is regulated under State Waste Discharge Permit ST-7289. Leachate from three other waste disposal facilities (Cedarville County Landfill, County Construction Recyclers, and Olivine Corporation) is also discharged to the Ferndale collection system.

The Class II inspection was initiated by the Washington State Department of Ecology (Ecology) to evaluate permit compliance and provide information about facility loading and performance. Results from the principal industrial contributor will be used to evaluate the overall effectiveness of their pretreatment program. Special attention was paid to treatment effectiveness across the various components of the treatment system. The inspection also focused on flow measurements, concentrations of priority pollutant organics and metals in effluent, and receiving water characterization.

Objectives of the inspection included evaluating:

1. NPDES permit compliance by analysis of influent and effluent permit parameters to determine concentrations and loads
2. Wastewater toxicity by comparing priority pollutant organics and metals scan results to Washington State acute and chronic water quality criteria
3. Wastewater toxicity with effluent bioassays
4. WWTP performance with the goal of estimating plant efficiency and effectiveness
5. WWTP self-monitoring program through sample splits and independent laboratory analysis
6. Changes in receiving water concentrations across the outfall
7. Metals discharged to the collection system from the major industrial contributor

Setting

The Ferndale wastewater treatment facility is located in Whatcom County, Washington, southeast of the city of Ferndale on the Nooksack River (Figure 1). The WWTP treatment system consists of a main lagoon with a complete mix aeration cell and three partial mix aeration cells connected in series. Three auxiliary polishing lagoons, a chlorine contact chamber, and a single-port discharge complete the configuration in use during the inspection (Figure 2). Several new components, which had been expected to be on-line during the inspection, were not operational due to construction delays. These included a fabric continuous filter system, expanded chlorine contact chamber, and new receiving water discharge structure.

The WWTP headworks consists of a lift station and a shallow wet well. Influent from all sources in the collection system converged at the lift station. The mixed influent was pumped to the wet well for sampling and then transferred to the head of the complete mix aeration cell.

The complete mix aeration cell was aerated by ten 15-Hp surface aerators aligned in three rows longitudinal to the flow. During the inspection nine aerators were actually in operation. The following three partial mix aeration cells were arrayed in series, each with two 7.5 Hp surface aerators. The purpose of these last three cells was to provide some additional biological treatment and, due to large quiescent zones, sedimentation. The system employed a unique design intended to eliminate BOD_5 production due to algae growth. Three auxiliary lagoons, remnants of the previous treatment system, had been retained to provide polishing for the upgraded system. These consisted of a large middle lagoon connected in series to two smaller lagoons which were connected in parallel. These lagoons also served as bypass holding ponds during high flow periods. The auxiliary lagoons were generally not in use during the summer as a precaution to avoid potential algae growth in the system.

Under the final design, flow from the aeration/sedimentation lagoon system was to pass through a fabric effluent filter to remove algae-generated BOD and then be disinfected in a large dual-chamber, chlorine contact chamber. Since these were not in operation filtration did not take place, and disinfection was accomplished in a much smaller single-chamber, chlorine contact chamber situated under the treatment plant's laboratory building. Final flow was measured by an ultrasonic device at a Cippoletti weir located at the discharge from the chlorine contact chamber. Final discharge was to the Nooksack River through a side bank, single-port outfall.

One major industrial discharger contributed influent loads to the Ferndale treatment plant. Recomp of Washington, Inc. processes a variety of solid waste by composting and incineration. The facility employs extensive water recovery and pretreatment processes, but a small amount of overflow is generated and discharged to the Ferndale collection system.

Procedure

Ecology collected both grab and composite samples at the WWTP. Composite samples were collected June 17-18 from plant wastewater at three stations (Figure 2 and Appendix A):

- influent from the wet well at the collection system final lift station, approximately ¼ mile above the plant influent headworks and prior to discharge into the plant aeration lagoon
- in-plant flow exiting the final partial mix cell, just prior to the chlorine contact chamber
- disinfected effluent above the final weir, just prior to discharge to the receiving water

The influent station compositor was located at the bottom floor of the lift station structure next to the influent channel into the wet well. The partial mix cell station compositor was mounted on a pier located at the east end of the aeration lagoon with the strainer in close proximity to a submerged discharge pipe. All strainers were submerged approximately 12 inches below the surface of the flow and positioned to prevent entrainment of sediments. An additional composite sample was collected June 17-18 from the Recomp discharge to the collection system. The Recomp sample was collected from a sedimentation/holding pond just prior to discharge to the Ferndale collection system.

All composite samples were collected using Ecology ISCO composite samplers with equal volumes of the sample collected every 30 minutes over a 24-hour period. One transfer blank was collected on March 4 by running deionized (DI) water through the effluent compositor prior to sampling.

Grab samples for TSS, ammonia nitrogen, nitrate & nitrite nitrogen, total phosphorus, and volatile organics were collected at influent and effluent composite stations, both in the morning and the afternoon of June 17. Two receiving water grab samples, one above and another below the outfall, were collected on June 17 for the previously mentioned parameters. A morning and afternoon grab sample for fecal coliform was taken June 18 from the final effluent. A three-part grab composite for bioassays was collected June 17-18 from the effluent just above the final weir. Testing for chlorine residual during each bioassay grab sample revealed chlorine concentrations that were less than detect, so chlorine toxicity was not a likely source of interference in the bioassay tests.

Ferndale personnel collected composite samples from the wet well at the plant's influent headworks and from the effluent just above the final effluent weir. The Ferndale influent and effluent composite samples were taken June 17-18. The Ferndale effluent composite sample location was similar to the location of the Ecology sampler. The Ferndale influent composite sample location was separated from the Ecology sample location by approximately ¼ mile of influent pipe, but since there was no intervening treatment system the influent quality of the two samples were believed to be comparable. Ferndale also took two effluent fecal coliform grab sample at approximately the same place and time as the Ecology fecal coliform samples. Ferndale composite samples were split for analysis by both Ecology and Ferndale laboratories. Parameters analyzed, samples collected, and the sampling schedule appear in Appendix B.

Samples for Ecology analysis were put in appropriate containers and preserved. Samples were packed in ice for delivery to the Ecology Manchester Laboratory. Holding time restrictions were observed for all samples. Analytical procedures and laboratories performing the analyses are summarized in Appendix C. Sampling quality assurance included priority pollutant cleaning of sampling equipment (Appendix D).

Specific QA/QC Discussions

A transfer blank was submitted for metals analyses. Sampling quality assurance included ultra-cleaning of sampling equipment to remove trace priority pollutant contaminants. Sampling in the field followed all protocols for holding times, preservation, and chain-of-custody set forth in the Manchester Environmental Laboratory Lab Users Manual (Ecology, 1994).

Laboratory QA/QC – including holding times, Laboratory Control Sample (LCS) analysis, matrix spike and duplicate spike sample analyses, surrogate recoveries, and precision data – were within appropriate ranges, with the exceptions noted below. Initial and continuing calibration verification standards were within relevant USEPA control limits and CLP calibration requirements. Procedural blanks were predominantly free from contamination. For bioassays the conduct of testing, responses to positive and negative controls, and water quality data were all appropriate. Qualifiers are included in the data table where appropriate. The following are specific concerns:

General Chemistry

All samples for TKN, total phosphorus, and nitrate/nitrite have been qualified as estimates ("J" qualifier) due to lack of refrigeration for approximately 12 hours during storage. The refrigerator storage unit use for these samples at the lab failed and it was necessary to move these samples to another refrigerator. Relative Percent Difference (RPD) was outside the acceptance window of +\- 20% for total phosphorus, likely due to this failure in temperature control.
One fecal coliform sample and its duplicate were qualified as estimates ("J" qualifier), due to excessive fecal colony count on the plate. Two or more of these colonies could land in the same place during filtration, and the true values may be greater than or equal to the reported results.

Volatile and Semivolatile Organics

Low levels of certain target volatile and semi-volatile compounds were detected in laboratory blanks. The EPA "five times rule" was applied to all target compounds that were found in the blank. If the concentrations of the compounds in the samples were greater than or equal to five times the concentration of the compounds in the associated method blank, they are considered native to the sample. One volatile organic compound's matrix spike recovery was not recovered in one spike, and the result for this analyte has been rejected ("REJ" qualifier) as unusable in the sample.

Metals

Spike recoveries for silver in several samples by GFAA are qualified with "UJ" as undetected at the estimated detection level due to the observed low spike recoveries. There was insufficient volume to perform duplicate matrix spikes on the effluent composite sample, so another sample was used for duplicate spikes for mercury. A single spike was analyzed for mercury on this effluent composite sample. Two low-level zinc analysis by ICP-MS for the receiving water samples detected contamination in procedural blanks, and these results were qualified with the "J" qualifier to indicate that they were estimates.

Results and Discussion

Flow Measurements

Ferndale determines plant effluent flows for NPDES permit reporting purposes by totalizer flow measurements at the effluent weir. Daily 24-hour (08:00-08:00) totalized effluent flows reported by Ferndale were 1.13 MGD for June 16-17 and 1.06 MGD for June 17-18, with an average daily flow over the two-day period of 1.10 MGD. On June 16 Ecology determined, by independent measurement, an instantaneous effluent flow of 1.19 MGD. Concurrently, the Ferndale instrument reported a flow of 1.39 MGD. Relative percent difference between the two instantaneous flow measurements was 16%. Ferndale should ensure that present and future effluent flow measurement devices are properly calibrated.

The effluent discharge to the Ferndale collection system from Recomp was measured by in-line flow meter to be 0.017 MGD for the approximate 24-hour period (14:00-14:00) on June 17-18. Independent verification of Recomp's flow measurement device was not possible due to the inaccessibility of the flow. Recomp should provide access for independent flow verification.

General Chemistry Results and Treatment Plant Effectiveness

Treatment Plant Influent

Ecology general chemistry results are presented in Table 1. The influent concentration of total solids (TS - 1240 mg/L) was relatively strong compared to typical untreated domestic wastewater (Metcalf & Eddy, 1991). Five-day biochemical oxygen demand (BOD_5 - 195 mg/L), total suspended solids (TSS - 193 mg/L), and ammonia nitrogen (NH_3-N - 17 mg/L) were all slightly less than the typical medium concentration for untreated domestic wastewater. The low total non-volatile suspended solids concentration (TNVSS - 25 mg/L) likely represents the absence of inorganic constituents typically found in domestic wastewaters.

Complete Mix Aeration Cell

Aeration in the cells appears to be suitable for oxygenation requirements, but inadequate for complete mixing. A calculated estimate of the aerator power needed to achieve the required oxygen saturation across the complete mix cell ranged from 7.4 to 22 horsepower dependent on the range of kinetic coefficients used in the calculation (Metcalf & Eddy, 1992). The horsepower for typical treatment plant kinetic coefficients was 16 Hp. These are well within the available horsepower observed being used during the inspection. This power calculation relies on a complete mix cell effluent dissolved BOD_5 value calculated from a derivation of the Monod equation concerned with soluble substrate kinetics. Calculation of theoretical soluble BOD_5 concentration expected in the aeration cell effluent ranged from approximately 2.0 to 19 mg/L, with a value of 6.4 mg/L for typical kinetic coefficients.

Reductions in total BOD_5 across the aeration cells ranged from 98% to 76%, with 83% being the expected typical value. The reaction rate coefficient (k) for the entire cell due to respiration alone (no settling included), as calculated using total BOD_5 values and the 1st order kinetic equation, ranged from approximately 0.25 d^{-1} to 0.35 d^{-1} (to the base e at 20° C), with a typical value of 0.32 d^{-1}. These values are at the low end of the range of typical k_1 values for similar systems (range: 0.25 d^{-1} to 1.0 d^{-1} to the base e at 20° C - Metcalf & Eddy, 1992). The k_1 for the complete mix aeration cells, with substrate settling determined from the final effluent total BOD_5 (73 mg/L) out of the partial mix cells (assuming no additional biological degradation across the partial mix cells), was approximately 0.8 d^{-1} (base e at 20° C). The value is greater than the minimum k_1 of 0.6 d^{-1} (base e and at 20° C) as stipulated for complete mix aerated lagoon systems with settling to ensure full treatment of domestic sewage (Labib, 1996). The data indicate that biological activity in the cell was sufficient to aerobically treat the Ferndale influent BOD_5 load.

During the inspection quiescent zones were observed in the complete mix cells and it appeared likely that the cells were inadequately mixed. To conform to draft Ecology design criteria for maintaining suspended solids in aerated lagoons, power requirements greater than 50 Hp/Mgal are needed (Labib, 1996). At the low end power requirements were calculated to be 242 Hp for the 4.84 Mgal complete mix cell. Since the power required for oxygen saturation across the cell was no greater than 22 horsepower, this indicates that horsepower required for mixing would govern the design. Total horsepower of the ten 15 Hp aerators was 150 Hp in the complete-mix aeration cell, providing only 62% of the 242 HP required for complete mix. This suggests that the cell was not adequately mixed. This conclusion is supported by Dissolved Oxygen (DO) samples taken from quiescent zones in the complete mix cell. Measured DO concentrations never exceeded 7.0 mg/L, although analysis of aerator O_2 exchange rate and O_2 consumption suggests that the uniform DO concentration for the entire cell should have remained at a calculated saturation concentration of 10.2 mg/L. The anticipated accumulation of sludge within the complete mix cells may have a long-term detrimental effect on treatment as volumes decrease and flow is impeded. Ferndale should increase mixing power and coverage in the cells. Ferndale should monitor the build-up of sludge in the complete mix aeration cells.

Partial Mix Cells

Reductions in total BOD_5 across the partial mix cells was estimated to range from 35% to 44%, and the low calculated k_1 for the cells indicates that this reduction was due principally to settling. An analysis was performed using the 1st order removal rate equation for aerated aerobic-anaerobic ponds (Metcalf & Eddy, 1992), assuming a range of dispersion coefficients (0.1- 4) and a reaction rate k_1 of 0.18 d^{-1} (recommended minimum k_1 to the base e adjusted to 18° C - Labib, 1996). Measurements of effluent total BOD_5 result (73 mg/L) indicates that the three-cell system was approximately 9% less efficient than the predicted typical (i.e., dispersion and kinetic coefficients were typical) treatment system which is calculated to produce an effluent BOD_5 concentration of 50 mg/L. The predicted effluent BOD_5 concentration was 32% less that the measured value. Calculations using the measured effluent BOD_5 concentrations (total & soluble) determined that the averaged typical k_1 (with settling) for the three-cell system was 0.09 d^{-1} (base e at 18° C) and the averaged typical k for degradation of the soluble substrate produced negative results. This suggests that an additional source of oxygen demand may have been

introduced into the system. Two possible sources of additional BOD_5 are algae growth and the availability of nitrogenous BOD.

Assuming predominantly soluble substrate degradation, total TSS concentrations across the three-cell, partial-mix system were calculated to decrease an estimated 81% with a final measured effluent concentration of 37 mg/L. This percent reduction is within the low end of a typical range for these systems (WEF, 1992 and Metcalf & Eddy, 1992). The overflow rate was 14 gal/ft^2·day and the solids loading per unit area was 9.47×10^{-4} lb/ft^2·h, both within than typical design averages. Assuming a typical range for the volatile solids anaerobic reaction rate coefficient (k_d) of 0.52 y^{-1} to 0.92 y^{-1}, the sludge accumulation rate can be expected to range between 1.88×10^5 lb/year to 2.84×10^5 lb/year. Assuming a sediment specific gravity of about 1.01, the maximum uniform accumulation rate for the three-cell system ranges from 0.5 to 0.7 inches per year. Detention time in the partial mix cells (5.86 days) was greater than the recommended minimum for settling after typical aerated lagoon treatment systems (12 hr), but also greater than the two-day maximum that is typically recommended to control algae growth (Rich, 1993).

In technical support documents associated with the plant's engineering design report, it is suggested that the multicellular design and the increased turbidity due to partial aeration would act to inhibit algae growth over extended retention periods beyond two days (Rich, 1993). Although some algae growth in the partial mix cell was evident, the overall decrease in TSS across the system supports the report's premise. Comparison of total and soluble BOD_5 data indicates that the introduction of total BOD across the partial mix system is mainly due to an increase in the availability of nitrogenous BOD. The relative low soluble BOD_5 concentration leaving the system suggests that nitrifying organisms responsible for the increase in nitrogenous oxygen demand in the total BOD_5 test were filtered out prior to the soluble BOD_5 test, thus eliminating the potential for such demand. The 0.45 micron pore size used in filtering for the soluble test would have been sufficient to remove most nitrifying bacteria (Brock, 1979).
It is possible that the extended retention time and superfluous aeration were creating conditions within the system that selected for nitrifying organisms. Elevated ammonia nitrogen concentrations and nitrifying organisms could produce increased oxygen demand in both the BOD_5 test and the receiving water. Analysis of treatment plant effluent with the inhibited BOD_5 test may provide only partial utility, since inhibitors may also inhibit degradation of the carbonaceous BOD portion (Labib, 1998). It is recommended that nitrite&nitrate nitrogen concentrations be determined at the beginning and the end of the total BOD_5 test to estimate nitrogenous BOD_5 demand in the effluent.

Lagoon System and Treatment Plant Effluents

Reductions across the lagoon system as well as the entire treatment plant were calculated and the results presented in Table 2. Analysis of Ferndale samples displayed slightly greater reductions for BOD and slightly smaller reductions for TSS across the entire treatment system. The data suggest inadequate treatment for TSS and even less effective treatment for BOD_5. The BOD_5 treatment effectiveness may be heavily impacted by nitrogenous BOD_5. Overall nitrification was small.

TSS concentrations decreased 81% across the lagoon system and 83% across the entire treatment system. The performance of solids settling across the partial mix lagoon indicates that the treatment plant design for sedimentation in the partial mix lagoon may be inadequate to meet permit limits. Aeration in the partial mix cells can be expected to increase mixing which impedes settling. Subsequent to the inspection, Ferndale followed Ecology recommendations to limit aeration to the partial-mix cells by shutting off aerators in the third cell (Abbasi, 1998). Chlorine residual concentration was 2.0 mg/L in one effluent sample and below detection in another. Total phosphorus decreased 33%.

At the time of the inspection the Ferndale NPDES permit did not provide acute and chronic mixing zone dilution factors. The calculated adjusted total ammonia nitrogen criteria based upon the receiving water pH, salinity, and temperature observed during the June 17, 1997 Class II inspection were 17.2 mg/L and 2.2 mg/L for the acute and chronic criteria respectively. The inspection effluent ammonia nitrogen concentration (15.7 mg/L) evaluated without a dilution factor was 91% of the allowable acute concentration, but exceeded allowable chronic concentration by a factor of 6. A tentative dilution model analysis using 3PLUMES, the June 17, 1997 discharge rate, the diffuser configuration in use at the time of the inspection (i.e., single 15-inch diameter port), and a 7Q10 receiving water flow of 700 cfs predicts acute and chronic dilution factors of approximately 58 and 269 respectively. Dilutions in the Nooksack River at the current outfall should reduce the effluent ammonia nitrogen concentration well below water quality criteria. Subsequent to the inspection Ferndale has established dilution factors for the treatment plant's new outfall and these should provide significant dilution of the effluent (Abbasi, 1998).

NPDES Permit Comparisons

Table 3 compares inspection results to NPDES permit limits. The inspection's 24-hour composite final effluent BOD_5 result (60 mg/L) exceeded the monthly and weekly average NPDES permit limits by 100% and 33% respectively. The effluent 24-hour composite BOD_5 load (530 lb/day) exceeded the permit monthly average load limit but was within the weekly average limit. Percent reduction from the influent concentration (69%) was less than the 85% required by permit. Ferndale 24-hour effluent total BOD_5 results (57 mg/L) exceeded weekly and monthly permit limits. The Ferndale effluent sample displayed high sample holding temperature (10.7° C). BOD_5 samples should also be preserved at 4° C before analysis.

As noted before, it is possible that a large portion of effluent total BOD_5 concentration was represented by nitrogenous BOD_5. A tentative Streeter-Phelps analysis of the impact of treatment plant discharge on dissolve oxygen (DO) in the Nooksack River revealed that DO concentrations would not fall below the 8.0 mg/l water quality standard for Class A freshwater systems. This analysis suggests that a water quality based permit limit for BOD_5 would not be required. It should also be noted that a technology based limit for nitrogenous BOD_5 is not currently required by the state. It is recommended that Ecology conduct a more rigorous study of in-stream impacts of nitrogenous BOD_5 loads to the Nooksack River.

The Ecology 24-hour composite effluent TSS concentration (32 mg/L) was within NPDES permit monthly average and weekly average limits. The effluent 24-hour composite TSS load (283 lb/day) was 42% greater than permit monthly average load limit, but within the weekly

average load limit. The percent reduction from the influent concentration (83%) was less than the minimum monthly average reduction (85%) required by the permit.

During the inspection effluent fecal coliform results exceeded permit weekly and monthly average limits, with the morning and afternoon sample results exceeding weekly permit limits by factors of 4 and 15 respectively. The latter result produced a permit violation even if samples from subsequent days in the week contained negligible concentrations. The Ecology metal and total residual chlorine results were all within the permit monthly and weekly averages. The Ecology pH results were also within the stipulated range. The reported totalized average influent flow of 1.06 MGD was below the NPDES permit maximum month average design limit of 1.4 MGD. Influent BOD_5 and TSS loads were well below permit overloading limits.

It should be noted that operation of a new fabric filter system for an eight-month period following the inspection has resulted in BOD_5 and TSS concentrations within permit limits and improved treatment efficiency (Abbasi, 1998). Also, the operation of a new chlorine contact chamber during that period has resulted in fecal coliform counts within permit limits.

Detected Priority Pollutant Organics and Metals

Table 4 summarizes concentrations of organic parameters detected with priority pollutant scans and detected priority pollutant metals. Appendix E contains results of all targeted organic compounds and metals results. Tentatively identified compounds are presented in appendix F. A glossary is included in appendix G.

Ferndale Treatment Plant

One VOA compound (chloroform) was detected in the two effluent grab samples, and eight BNA compounds were detected in the treatment plant 24-hour composite effluent sample. VOA or BNA concentrations did not exceed freshwater acute and chronic water quality criteria. One pesticide, Gamma-BHC (Lindane), was detected in the effluent composite sample, but the concentration was within water quality criteria. Four priority pollutant metals were detected in the plant composite effluent sample. Copper (19 µg/L) exceeded both the acute and chronic freshwater quality criteria in the whole effluent. Two lead (9.6 µg/L) and zinc (43 µg/L) exceeded the chronic freshwater quality criteria. Dilution in the receiving water should reduce these concentrations to less than criteria.

Nooksack River

Six metal compounds were detected in the upstream and downstream receiving water samples. Receiving water grab sample results downstream of the treatment plant discharge found that lead (0.8 µg/L) exceeded the chronic water quality criteria, as calculated for total recoverable concentrations using the conversion factors incorporated in the criterion equations. Mass balance calculations of the Ferndale effluent composite results indicate that Ferndale contributed approximately 10% of the copper concentration and 7% of the lead concentration to the Nooksack River. Upstream lead concentrations exceeded chronic water quality criteria, while upstream copper concentrations were within chronic criteria. Barring any extraneous sources of

lead, the data suggest that Ferndale was likely the source of the increase of lead concentrations in the Nooksack River. It is recommended that Ecology assess the potential for lead and copper concentrations exceeding the water quality criteria during critical conditions in the Nooksack River, and further evaluate Ferndale's contribution to this load.

Effluent Bioassays

Ecology bioassay results detected a slight acute effluent toxicity, but appreciable chronic effluent toxicity (Table 5). The *Daphnia magna* acute 48-hour survival test found 100% survival at all concentrations in the dilution series, except at 6.25% effluent which produced a 5% mortality. Statistical analysis determined that the Lowest Observable Effect Concentration (LOEC) and the No Observable Effect Concentration (NOEC) were both greater than 100%. The fathead minnow (*Pimephales promelas*) 96-hour survival test detected a small but generally declining survival with increasing concentration (28% of fathead minnows died after 96 hours in 100% effluent). The analysis produced a percent mortality at 50% concentration (LC_{50}) greater than 100%, LOEC less than 100%, and NOEC of 50%.

The fathead minnow (*Pimephales promelas*) chronic 7-day survival and growth test found a significant decline in survival and growth with increasing concentration (45% of fathead minnows died after seven days in 100% effluent). The survival analysis produced an LOEC equal to 100%, NOEC of 50%, and percent mortality at 25% concentration (LC_{25}) of 57. The growth analysis produced an LOEC less than 100%, NOEC less than 50%, and a LC_{25} greater than 100%. Since a dilution factor in the undiluted effluent is not offered by the current permit, a reasonable potential exists for chronic conditions in the receiving water. If tentative dilution factors are considered, the NOEC does not represent a statistically significant difference in response at a concentration lower than the acute critical effluent concentration (an acute dilution factor of 58 produces a maximum critical concentration at 0.01% of the whole effluent), and a reasonable potential does not exists for chronic conditions in the receiving water.

In the whole effluent the cause of toxicity might be ammonia, copper, or zinc concentrations, since all were found to exceed chronic water quality criteria. The facility should investigate the cause of effluent toxicity and initiate treatment methods to decrease the discharge of these contaminants to the receiving water.

Split Samples

Sample Comparisons

With the exception of the influent TSS results, Ecology analysis of the Ecology and Ferndale composite samples collected June 17-18 generally compared well (Table 6). Relative percent differences (RPD) between all sample pairs of BOD_5 and pH were less than variation in precision cited in the EPA comparison of interlaboratory analysis of selected parameters (EPA, March 1983). The average RPD between influent TSS values was close to three times the interlaboratory variation in precision. This suggests there is a difference between Ecology and Ferndale composite sampling techniques with a predominate effect on TSS. This may be due to

inadequate mixing when dividing the sample for analysis. Ferndale should ensure that collected samples are properly processed before analysis.

Laboratory Comparisons

Ecology and Ferndale laboratory results for influent and effluent samples collected by Ecology were well matched, with average RPDs of 2.5% and 4.5% for TSS samples and average RPDs of 0.7% and 9.0% for BOD_5 samples. This would suggest that the Ferndale laboratory performance for these parameters was adequate. Ecology and Ferndale effluent chlorine and fecal coliform results were divergent. It should be noted that Ecology and Ferndale chlorine measurements were made on different days. The average RPD for chlorine between Ecology and Ferndale was 60%.. The Ecology average fecal coliform result was greater than the Ferndale average result by a factor of 23. The large difference in fecal coliform results is likely due to laboratory procedural error. The Ferndale laboratory should review laboratory procedures for these two parameters.

Industrial Discharge Results and State Permit Comparisons

Table 7 compares inspection results to Recomp's state discharge permit limits. Cadmium, lead, and zinc were detected in the Recomp effluent discharge to the Ferndale collection system, but all concentrations and loads were well within state permit limits. Recomp cadmium, lead, and zinc concentrations were estimated to contribute only 6.0%, 2.5%, and 4.7% respectively to the Ferndale treatment plant final effluent loads. Recomp's contribution of lead and zinc loads in the Nooksack River were 0.12% and 0.002% respectively, assuming worst-case conditions of no removal of Recomp metals by the Ferndale WWTP.

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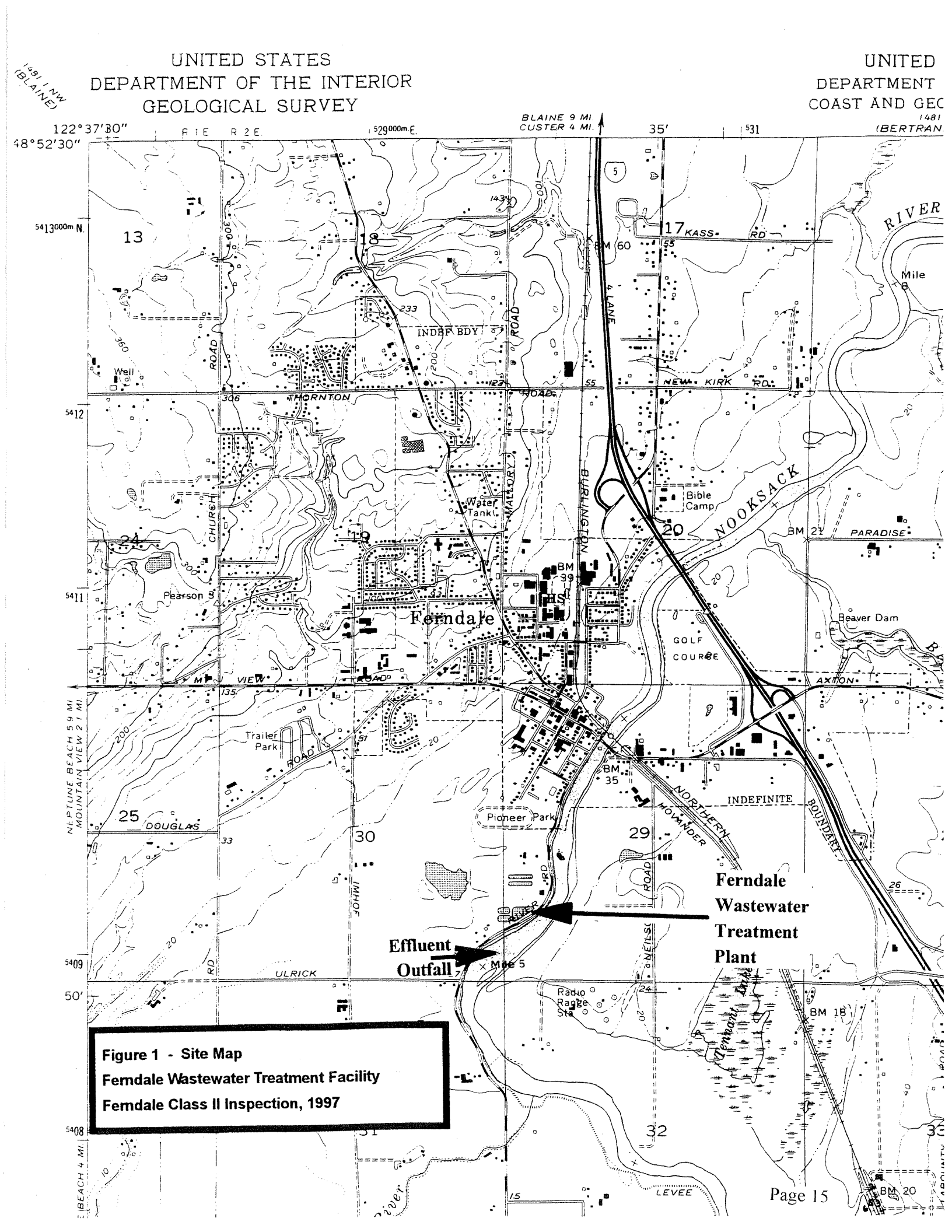

Figure 1 - Site Map
Ferndale Wastewater Treatment Facility
Ferndale Class II Inspection, 1997

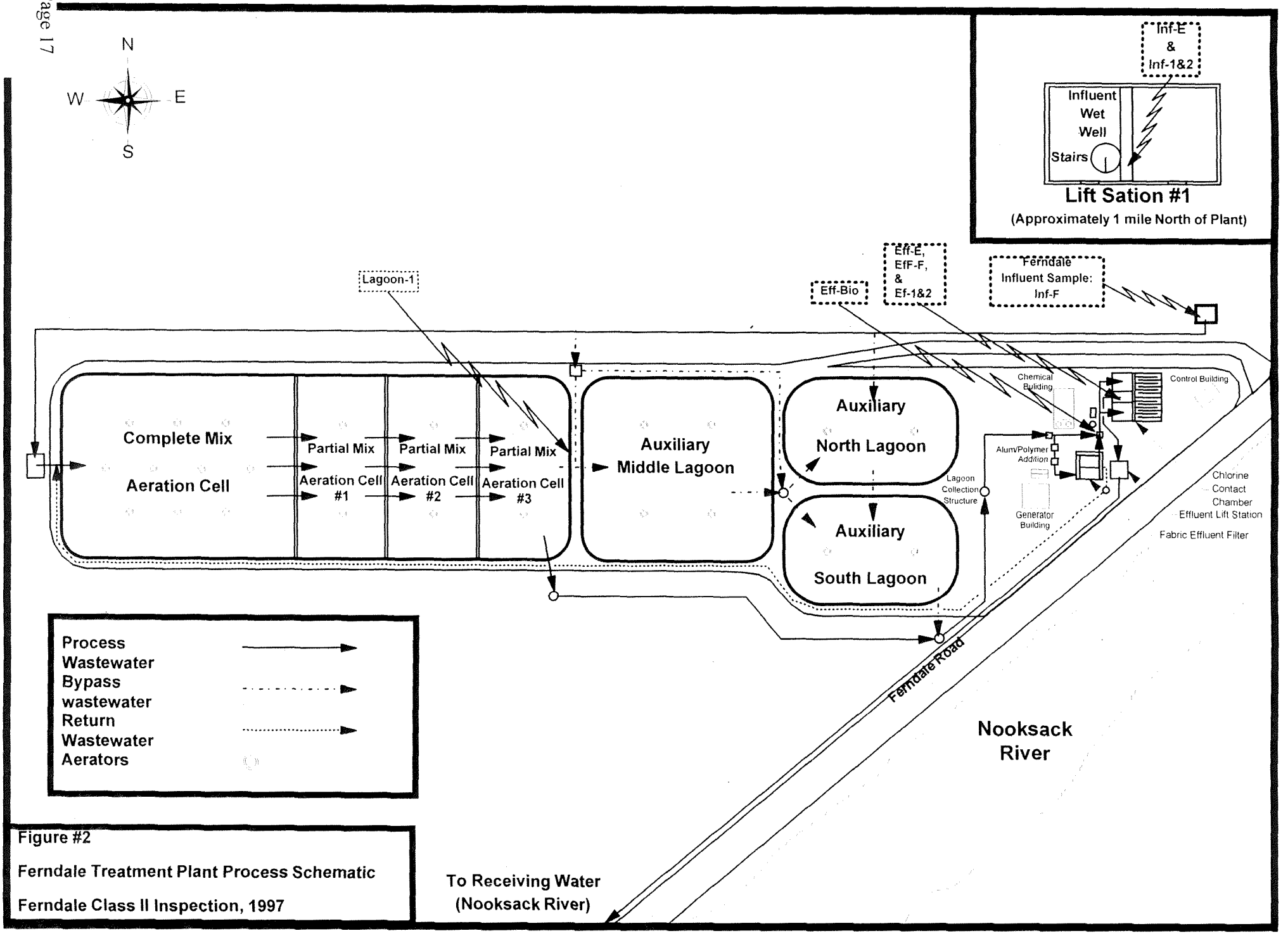

Figure #2

Ferndale Treatment Plant Process Schematic

Ferndale Class II Inspection, 1997

Table 1 - General Chemistry Results - Ferndale Class II Inspection, June 1997

Parameter	Location:	Inf-1	Inf-2	Inf-E	Inf-F	Lagoon-1	Eff-1	Eff-2
	Type:	grab	grab	comp	comp	comp	grab	grab
	Date:	06/17	06/17	06/17-18	06/17-18	06/17-18	06/17	06/17
	Time:	1100	1640	0800-0800	0800-0800	0800-0800	0940	1520
	Lab Log #:	258230	258231	258232	258233	258234	258237	258238
GENERAL CHEMISTRY								
Conductivity (umhos/cm)		701	499	1850	2570	1290	1230	1240
Alkalinity (mg/L CaCO3)				183	188	187		
Hardness (mg/L CaCO3)				94.2	93.2	104		
SOLIDS								
TS (mg/L)				1240	1530	716		
TNVS (mg/L)				880	1270	576		
TSS (mg/L)		157	85	193	128	37	23	25
TNVSS (mg/L)				25	18	9		
OXYGEN DEMAND PARAMETERS								
BOD5 (mg/L)				195	221	73		
BOD5 (Soluable - mg/L)				84	78	9		
NUTRIENTS								
Total Kjeldahl Nitrogen (TKN - mg/L)				27.1 J		22.5 J		
NH3-N (mg/L)		18.1 J	11 J	17 J	17.3 J	17.2 J	17.1 J	16.6 J
NO2+NO3-N (mg/L)		0.216 J	0.203 J	0.15 J	0.01 UJ	1.98 J	1.17 J	1.8 J
Total-P (mg/L)		4.73 J	3.32 J	4.05 J	3.92 J	3.53 J	3.02 J	3.25 J
MISCELLANEOUS								
F-Coliform MF (#/100mL)								
FIELD MEASUREMENTS								
Temperature (°C)		18.1	17.9				18.4	19.0
Temp-cool (°C)$^{+}$				4.7	8.1	3.9		
pH		7.71	7.31	7.48	7.20	7.9	7.52	7.67
Conductivity (umhos/cm)		677	493	1986	2730	1395	1294	1304
Chlorine (mg/L)							< 0.1	0.2
Dissolved Oxygen (mg/L)								

E	Ecology sample	Inf	Influent sample
F	Ferndale sample	Eff	Effluent sample
grab	Grab sample	Lagoon	Aeration lagoon effluent sample
comp	Composite sample	J	The analyte was positively identified. The associated numerical result is an estimate.
$^{+}$	Refrigerated sample	UJ	The analyte was not detected at or above the reported estimated result.

Table 1 - General Chemistry Results - Ferndale Class II Inspection, June 1997

Parameter	Location:	Eff-E	Eff-F	Eff-3	Eff-4	Eff-Bio	Recwater-U	Recwater-D
	Type:	comp	comp	grab	grab	grab-comp	grab	grab
	Date:	06/17-18	06/17-18	6/18	06/18	06/17-18	06/17	06/17
	Time:	0800-0800	0800-0800	0830	1300	1735,0830,&1250	1258	1317
	Lab Log #:	258239	258240	258241	258242	258243	258244	258246
GENERAL CHEMISTRY								
Conductivity (umhos/cm)		1240	1230	1240	1270	1250	65.3	65.5
Alkalinity (mg/L CaCO3)		176	176					
Hardness (mg/L CaCO3)		103	103				34.5	33.1
SOLIDS								
TS (mg/L)		718	694					
TNVS (mg/L)		518	584					
TSS (mg/L)		32	33	28	27	29	84	86
TNVSS (mg/L)		6	8					
OXYGEN DEMAND PARAMETERS								
BOD5 (mg/L)		60	57					
BOD5 (Soluable - mg/L)		16	12					
NUTRIENTS								
Total Kjeldahl Nitrogen (TKN - mg/L)		19.8 J						
NH3-N (mg/L)		15.7 J	15.5 J				0.01 UJ	0.01 UJ
NO2+NO3-N (mg/L)		2.52 J	2.6 J					
Total-P (mg/L)		2.7 J	2.4 J					
MISCELLANEOUS								
F-Coliform MF (#/100mL)				1400	5900 J			
FIELD MEASUREMENTS								
Temperature				16.6	17.9	17.6 ++	10.7	10.7
Temp-cool (°C)-+		4.4	10.1					
pH		7.68	7.59	7.62	7.62	7.68 ++	7.22	7.23
Conductivity		1340	1320	1310	1338	1319 ++	58	59
Chlorine						< 0.1 ++		
Dissolved Oxygen (mg/L)							11.6	11.3

E	Ecology sample	Eff	Effluent sample
F	Ferndale sample	Eff-Bio	Effluent bioassay sample
grab	Grab sample	Recwater-U	Upstream from outfall receiving water sample
comp	Composite sample	Recwater-D	Downstream from outfall receiving water sample
++	Average of grab-composite samples	J	The analyte was positively identified. The associated numerical result is an estimate.
-+	Refrigerated sample	UJ	The analyte was not detected at or above the reported estimated result.

Table 2 - General Chemistry Percent Reduction Results - Ferndale Class II Inspection, June 1997

Parameter	Location:	Inf-E	Lagoon-1	Ecology Percent Load Reduction Across Aeration Lagoon	Eff-E	Ecology Percent Load Reduction Across Treatment Plant
	Type:	comp	comp		comp	
	Date:	43268	06/17-18		06/17-18	
	Time:	0800-0800	0800-0800		0800-0800	
	Lab Log #:	258232	258234		258239	
GENERAL CHEMISTRY						
Conductivity (umhos/cm)		1850	1290	30%	1240	33%
Alkalinity (mg/L CaCO3)		183	187	-2%	176	4%
Hardness (mg/L CaCO3)		94.2	104	-10%	103	-9%
SOLIDS						
TS (mg/L)		1240	716	42%	718	42%
TNVS (mg/L)		880	576	35%	518	41%
TSS (mg/L)		193	37	81%	32	83%
TNVSS (mg/L)		25	9	64%	6	76%
OXYGEN DEMAND PARAMETERS						
BOD5 (mg/L)		195	73	63%	60	69%
BOD5 (Soluable - mg/L)		84	9	89%	16	81%
NUTRIENTS						
Total Kjeldahl Nitrogen (TKN - mg/L)		27.1 J	22.5 J	17%	19.8 J	27%
NH3-N (mg/L)		17 J	17.2 J	-1%	15.7 J	8%
NO2+NO3-N (mg/L)		0.15 J	1.98 J	-172% ♠	2.52 J	-178% ♠
Total-P (mg/L)		4.05 J	3.53 J	13%	2.7 J	33%
FIELD MEASUREMENTS						
pH		7.48	7.9	90% #♠	7.68	45% #♠
Conductivity (umhos/cm)		1986	1395	30%	1340	33%

E	Ecology sample	#	Based on the percent change in hydrogen ion concentration
F	Ferndale sample	J	The analyte was positively identified. The associated numerical result is an estimate.
comp	Composite sample	♠	Relative percent difference in loads

Table 2 - General Chemistry Percent Reduction Results - Ferndale Class II Inspection, June 1997

Parameter	Location:	Inf-F	Eff-F	Ferndale Percent Load Reduction Across Treatment Plant	Recwater-U	Recwater-D	Ecology Relative Percent Change In Receiving Water Concentrations
	Type:	comp	comp		grab	grab	
	Date:	06/17-18	06/17-18		06/17	06/17	
	Time:	0800-0800	0800-0800		1258	1317	
	Lab Log #:	258233	258240		258244	258246	
GENERAL CHEMISTRY							
Conductivity (umhos/cm)		2570	1230	52%	65.3	65.5	0.31%
Alkalinity (mg/L CaCO3)		188	176	6%			
Hardness (mg/L CaCO3)		93.2	103	-11%	34.5	33.1	-4%
SOLIDS							
TS (mg/L)		1530	694	55%			
TNVS (mg/L)		1270	584	54%			
TSS (mg/L)		128	33	74%	84	86	2%
TNVSS (mg/L)		18	8	56%			
OXYGEN DEMAND PARAMETERS							
BOD5 (mg/L)		221	57	74%			
BOD5 (Soluable - mg/L)		78	12	85%			
NUTRIENTS							
Total Kjeldahl Nitrogen (TKN - mg/L)							
NH3-N (mg/L)		17.3 J	15.5 J	10%	0.01 UJ	0.01 UJ	0%
NO2+NO3-N (mg/L)		0.01 UJ	2.6 J	≥ -198% ♠			
Total-P (mg/L)		3.92 J	2.4 J	39%			
FIELD MEASUREMENTS							
pH		7.20	7.59	59% #♠	7.22	7.23	-2%
Conductivity (umhos/cm)		2730	1320	52%	58	59	2%

E	Ecology sample	#	Based on the percent change in hydrogen ion concentration
F	Ferndale sample	J	The analyte was positively identified. The associated numerical result is an estimate.
comp	Composite sample	♠	Relative percent difference in loads

Table 3 - NPDES Comparison Results - Ferndale Class II Inspection - June, 1997.

PARAMETERS	NPDES PERMIT INTERIM EFFLUENT LIMITS		INSPECTION RESULTS							
			Ecology Composites		Ferndale Composites		Ecology Grabs			
			Location:	Inf-E	Eff-E	Inf-F	Eff-F	Eff-1	Eff-2	Eff-3	Eff-4
			Type:	comp	comp	comp	comp	grab	grab	grab	grab
	Monthly Average	Weekly Average	Date:	06/17-18	06/17-18	06/17-18	06/17-18	06/17	06/17	6/18	06/18
			Time:	0800-0800	0800-0800	0800-0800	0800-0800	0940	1520	0830	1300
			Lab Log #:	258232	258239	258233	258240	258237	258238	258241	258242
Effluent Biochemical Oxygen Demand (BOD_5)											
Concentration: (mg/L)	**30**	**45**			**60**		**57**				
Load: (lbs/day)	**430**	**646**			**530** *		**504** *				
Minimum Percent Reduction	**85%** Monthly averages shall not exceed 30 mg/L or 15% of influent monthly average				**0.69**		**74%**				
Effluent Total Suspended Solids (TSS)											
Concentration (mg/L)	**75**	**110**			**32**		**33**	**23**	**25**	**28**	**27**
Load: (lbs/day)	**200**	**300**			**283** *		**292** *				
Minimum Percent Reduction	**85%** Monthly averages shall not exceed 30 mg/L or 15% of influent monthly average				**0.83**		**74%**				
Effluent Fecal Coliform											
Concentration (#/100 mL)	**200**	**400**								**1,400**	**5,900 J**
Total Residual Chlorine (TRC)											
Concentration (mg/L)	**0.5**	**1**						**0.1 #**	**0.2**		
Load: (lbs/day)	**7.2**							**0.9**	**1.8**		
Copper											
Concentration (µg/L)	**26.56**	**30.09**			**19**						
Load: (lbs/day)	**0.38**				**0.17**						
Cadmium											
Concentration (µg/L)	**3.18**	**10.47**			**0.50**						
Load: (lbs/day)	**0.045**				**0.004**						
Lead											
Concentration (µg/L)	**43.08**	**53.14**			**10**						
Load: (lbs/day)	**0.62**				**0.09**						
Zinc											
Concentration (µg/L)	**94.44**	**163.4**			**43**						
Load: (lbs/day)	**1.35**				**0.38**						
Effluent pH											
(S.U.)	**6.0 < pH < 9.0**							**7.52**	**7.67**	**7.62**	**7.62**
Influent Flow Overloading Limits	**Maximum Month Average Flow**										
(MGD)	**1.4**			**1.060**							
Influent BOD_5 Overloading Limits											
(mg/L)				**195**		**221**					
(lbs/day)	**2,335**			**1,724** *		**1,954** *					
Influent TSS Overloading Limits											
(mg/L)				**193**		**128**					
(lbs/day)	**2,335**			**1,706** *		**1,132** *					

E	Ecology sample	Ef-3	AM effluent fecal coliform sample
F	Ferndale sample	Ef-4	PM effluent fecal coliform sample
Inf	Influent sample	*	Load calculated from daily effluent flow of 1.060 MGD recorded 06/17-18/97.
Ef	Efluent sample	#	The result is less than or equal to the reported value.
comp	Composite sample	J	The analyte was positively identified. The associated numerical result is an estimate.
grab	Grab sample.		

Table 4 - Detected VOA, BNA, Pesticide/PCB and Metals Scan Results - Ferndale Class II Inspection - June, 1997.

Parameter	Location:	Eff-1	Eff-2	Water Quality Criteria	
	Type:	grab	grab		
	Date:	06/17	06/17	Freshwater Acute	Freshwater Chronic
	Time:	0940	1520		
	Lab Log #:	258237	258238		
VOA Compounds		µg/L	µg/L	µg/L	µg/L
Chloroform		0.56 J	0.43 J	28900 *	1240 *

Parameter	Location:	Eff-E	Water Quality Criteria	
	Type:	comp		
	Date:	06/17-18	Freshwater Acute	Freshwater Chronic
	Time:	0800-0800		
	Lab Log #:	258239		
BNA Compounds		µg/L	µg/L	µg/L
Benzoic Acid		1.6 J		
Phenanthrene		0.012 J		
Pentachlorophenol		0.34 J	20 **	13 **
Bis(2-Ethylhexyl) Phthalat		2	940 *(i)	3 *(i)
2,4-Dichlorophenol		0.095 J	2020 *	365 *
Fluoranthene		0.021 J	3980 *	
3B-Coprostanol		3.6		
Caffeine		0.12 J		

E	Ecology sample	J	The analyte was positively identified. The associated numerical result is an estimate.
Eff	Effluent sample	*	Insufficient data to develop criteria. Value presented is the LOEL - Lowest Observed Effect Level.
grab	Grab sample	**	pH dependent criteria (7.8 pH used).
comp	Composite sample	i	Total Phthalate Esters

Table 4 - Detected VOA, BNA, Pesticide/PCB and Metals Scan Results - Ferndale Class II Inspection - June, 1997.

Parameter	Location:	Eff-E	Water Quality Criteria	
	Type:	comp		
	Date:	06/17-18	Freshwater Acute	Freshwater Chronic
	Time:	0800-0800		
	Lab Log #:	258239		
Pesticide/PCB Compounds		µg/L	µg/L	µg/L
Gamma-BHC (Lindane)		0.035	2	0.08

Parameter	Location:	Eff-E	Water Quality Criteria		Recwater-U	Recwater-D	Relative %	Transblk	ReComp-E
	Type:	comp			grab	grab	Increase	grab	comp
	Date:	06/17-18	Freshwater Acute	Freshwater Chronic	06/17	06/17	In Metal	06/16	06/17-18
	Time:	0800-0800			1258	1317	Concentrations	1635	1420-1345
	Lab Log #:	258239			258244	258246	Across Outfall	258245	258247
Metals		µg/L	µg/L	µg/L	µg/L	µg/L		µg/L	µg/L
Hardness =	33.1								
Arsenic			360	190	0.67	0.81	12%		
Cadmium		0.45	1.12 +	0.471 +					1.7
Chromium					2	3	25%		30
Hexavalent			15.0	10.0					
Trivalent			222 +	72.0 +					
Copper		19	6.00 +	4.41 +	3.64 #	4.26 #	10%	1.5	40.3
Lead		9.6	19.0 +	0.741 +	0.69 #	0.76 #	7%		29.3
Mercury			2.1	0.012					0.15
Nickel			555 +	61.7 +	7.91 #	8.73 #	6%		
Zinc		43	44.8 +	41.0 +	6.26 J#	12.03 J#	38%		127

E	Ecology sample	Recwater-D	Downstream receiving water sample
Eff	Effluent sample	ReComp-E	ReComp, Inc. collection system discharge sample
grab	Grab sample	J	The analyte was positively identified. The associated numerical result is an estimate.
comp	Composite sample	*	Insufficient data to develop criteria. Value presented is the LOEL - Lowest Observed Effect Level.
Transblk	Transfer blank	+	Hardness dependent criteria (33.1 mg/L used).
Recwater-	Upstream receiving water sample	#	For criteria comparison values coverted from total recoverable to dissolved using dissolved to total recoverable ratio.

Table 5 - Effluent Bioassay Results - Ferndale Class II Inspection - June, 1997

NOTE: Three-part composite sample taken from chlorine contact chamber effluent (Eff-Bio: Lab Log #258243)

Daphnia magna - 48-hour survival test

(Daphnia magna)

Sample	Number Tested *		Percent Survival
Control	20		100
6.25 % Effluent	20		95
12.5 % Effluent	20		100
25 % Effluent	20		100
50 % Effluent	20		100
100 % Effluent	20		100

Survival
LC50 Could not be calculated LOEC > 100 % effluent NOEC > 100 % effluent

* 4 replicates of 5 organisms

Fathead Minnow - 96-hour survival test**

(Pimpephales promelas)

Sample	Number Tested *		Percent Survival
Control	40		100.0%
6.25 % Effluent	40		100.0%
12.5 % Effluent	40		95.0%
25 % Effluent	40		100.0%
50 % Effluent	40		87.5%
100 % Effluent	40		72.5%

Survival
LC_{50} > 100 % effluent LOEC < 100 % effluent NOEC = 50 % effluent

* 4 replicates of 10 organisms

** Derived from dual endpoint in the fathead minnow chronic 7-day survival & growth test

Fathead Minnow - 7 day survival and growth test

(Pimephales promelas)

Sample	Number Tested *		Percent Survival	Mean Dry Weight per Fish (mg)
Control	40		92.5%	0.390
6.25 % Effluent	40		100.0%	0.387
12.5 % Effluent	40		80.0%	0.374
25 % Effluent	40		95.0%	0.370
50 % Effluent	40		75.0%	0.326
100 % Effluent	40		55.0%	0.311

Survival	Growth
LOEC = 100 % effluent NOEC = 50 % effluent IC_{25} = 57.03	LOEC < 100 % effluent NOEC < 50 % effluent IC_{25} > 100

* four replicates of 10 organisms

NOEC	No observable effects concentration
LOEC	Lowest observable effects concentration
LC_{50}	Lethal concentration for 50% of the organisms
IC_P	Inhibition Concentration 25/50% - the dilution concentration at which the exposed population showed a 25/50% growth inhibition

Table 6 - Split Sample Result Comparison - Ferndale Class II, June 1997

	Location:	Inf-E	Inf-F	Eff-1	Eff-2	Eff-3	Eff-4	Eff-F-1*	Eff-F-2*	Eff-E	Eff-F
	Type:	comp	comp	grab	grab	grab	grab	grab	grab	comp	comp
	Date:	06/17-18	06/17-18	06/17	06/17	6/18	06/18	06/18	06/18	06/17-18	06/17-18
	Time:	0800-0800	0800-0800	0940	1520	0830	1300	0850	1320	0800-0800	0800-0800
	Lab Log #:	258232	258233	258237	258238	258241	258242			258239	258240
General Chemistry											
Parameter	**Laboratory**										
TSS	Ecology	193	128	23	25	28	27			32	33
(mg/L)	Ferndale	181	148							33	35
BOD5	Ecology	195	221							60	57
(mg/L)	Ferndale	224	189							65	63
Temperature	Ecology			18.4	19.0	16.6	17.9				
(°C)	Ferndale										
pH	Ecology			7.5	7.7	7.6	7.7				
	Ferndale							7.3	7.3		
Chlorine	Ecology			<0.1	0.2						
(mg/L)	Ferndale							0.27	0.29		
Fecal coliform	Ecology					1,400	5,900 J				
(#/100ml)	Ferndale							139	176		

E	Ecology sample	*	Ferndale grab sample
F	Ferndale sample	Ef	Effluent sample
grab	grab sample	Inf	Influent sample
comp	Composite sample	Eff-3 & Eff-4	Ecology fecal coliform samples

Table 7 - RECOMP of Washington State Permit Metals Comparisons - Ferndale Class II - June, 1997

Parameter	State Waste Discharge Permit Limits			Inspection Results	
	Final* Montly Average	Interim** Daily Maximum	Location:	ReComp-E	
			Type:	comp	
			Date:	06/17-18	
			Time:	1420-1345	
			Lab Log #:	258247	
Cadmium					
Conc (Total - mg/L)		**0.33**			
Conc (Total Recoverable - mg/L)				**0.0017**	
Load (Total - lbs/day)	**0.011**				
Load (Total Recoverable - lbs/day)				**0.0002**	
Lead					
Conc (Total - mg/L)		**1.7**			
Conc (Total Recoverable - mg/L)				**0.029**	
Load (Total - lbs/day)	**0.072**				
Load (Total Recoverable - lbs/day)				**0.004**	
Zinc					
Conc (Total - mg/L)		**3.4**			
Conc (Total Recoverable - mg/L)				**0.127**	
Load (Total - lbs/day)	**0.685**				
Load (Total Recoverable - lbs/day)				**0.019**	

* Final concentration limit to be initiated by Dec 31, 1996.

** Interim load limit to remain in effect until an evaluation of the Ferndale effluent mxing zone (Nov. 1997)

Appendices

Appendix A - Sampling Stations Descriptions - Ferndale Class II Inspection - June, 1997

Inf-E-#	Ecology grab samples of Ferndale influent wastewater collected from a channel at the Ferndale collection system's final lift station, approximately 1/8 mile northeast of the treatment plant. Collected 06/17/97 in both A.M. and P.M.
Inf-E	Ecology 24-hour composite sample of Ferndale influent wastewater collected from the channel at the Ferndale collection system's final lift station, approximately 1/8 mile northeast of the treatment plant. Collected 06/17-18/97.
Ef-E-#	Ecology grab samples of Ferndale effluent wastewater collected above the final weir at the end of the chlorine contact chamber, just prior to final discharge. Collected 06/17/97 in both A.M. and P.M.
Ef-E	Ecology 24-hour composite sample of Ferndale effluent wastewater collected above the final weir at the end of the chlorine contact chamber, just prior to final discharge. Collected 06/17-18/97.
Ef-F	Ferndale 24-hour composite samples of Ferndale effluent wastewater collected below the final weir at the end of the chlorine contact chamber, just prior to final discharge. Collected 06/4-5/96.
Lagoon-1	Ecology 24-hour composite sample of Ferndale inplant wastewater at the discharge from the aeration lagoon. Collected 06/17-18/97.
Eff-#	Ecology fecal coliform grab samples of Ferndale effluent wastewater above the final weir at the end of the chlorine contact chamber, just prior to final discharge. Collected 06/18/97 in both A.M. and P.M.
Ef-Bio	Mixed three-part Ecology bioassay grab-composite sample of Ferndale effluent collected above the final weir at the end of the chlorine contact chamber, just prior to final discharge. One part collected on 06/17/97 and two parts on 06/18/97.
Transblk	Ecology grab sample of effluent compositor distilled rinse. - Collected 06/16/97.
Recwater-U	Ecology grab sample of Ferndale receiving water (Nooksack River) by boat 50 feet below Ferndale water intake at Lat:48° 50.294 N; Long:122° 35.498 W. Collected 06/17/97
Recwater-D	Ecology grab sample of Ferndale receiving water (Nooksack River) by boat 500 feet below outfall riprap at Lat:48° 50.320 N; Long:122° 35.500 W. Collected 06/17/97

Appendix B - Class II Inspection Schedule - City of Ferndale - June, 1997

Parameter	Quanity	Location:	Inf-1	Inf-2	Inf-E	Inf-F	Lagoon-1	Eff-1	Eff-2
		Type:	grab	grab	comp	comp	comp	grab	grab
		Date:	06/17	06/17	06/17-18	06/17-18	06/17-18	06/17	06/17
		Time:	1100	1640	0800-0800	0800-0800	0800-0800	0940	1520
		Lab Log #:	258230	258231	258232	258233	258234	258237	258238
GENERAL CHEMISTRY									
Conductivity	12		E	E	E	E	E	E	E
Alkalinity	5				E	E	E		
Hardness	5				E	E	E		
SOLIDS									
TS	5				E	E	E		
TNVS	5				E	E	E		
TSS	12		E	E	EF	EF	E	E	E
TNVSS	5				E	E	E		
OXYGEN DEMAND PARAME									
BOD5	5				EF	EF	E		
BOD5 (Soluble)	5				E	E	E		
NUTRIENTS									
Total Kjeldahl Nitrogen (TKN)	3				E		E		
NH3-N	9		E	E	E	E	E	E	E
NO2+NO3-N	7		E	E	E	E	E	E	E
Total-P	7		E	E	E	E	E	E	E
MISCELLANEOUS									
F-Coliform MF	2								
ORGANICS									
VOC (water)	0							E	E
BNAs (water)	2								
Pest/PCB (water) - Chlorinated	2								
METALS									
PP Metals (water)	4								
PP Metals (water - spike, dupe)	1								
BIOASSAYS									
Daphnia magna (acute)	1								
Fathead Minnow (acute)	1								
Fathead Minnow (chronic)	1								
FIELD MEASUREMENTS									
Temperature	12		E	E	E	E	E	E	E
pH	12		EF	EF	E	E	E	EF	Ef
Conductivity	12		E	E	E	E	E	E	E
Chlorine	3		E	E				EF	EF
Dissolved Oxygen	4		E	E				E	E
	142		10	10	16	15	16	12	12

E	Ecology sample	Fabric filter influent
F	Ferndale sample	Backwash return from fabric filter
Inf	Influent sample	Grab sample
Lagoon-1	West lagoon system efflu	Composite sample

Appendix B - Class II Inspection Schedule - City of Ferndale - June, 1997.

Parameter	Location:	Eff-E	Eff-F	Eff-3	Eff-4	Eff-Bio	Recwater-U	Recwater-D	Transblk
	Type:	comp	comp	grab	grab	grab-comp	grab	grab	grab
	Date:	06/17-18	06/17-18	6/18	06/18	06/17-18	06/17	06/17	06/16
	Time:	0800-0800	0800-0800	0830	1300	1735,0830,&1	1258	1317	1635
	Lab Log #:	258239	258240	258241	258242	258243	258244	258246	258245
GENERAL CHEMISTRY									
Conductivity		E	E	E	E	E	E	E	
Alkalinity		E	E						
Hardness		E	E						
SOLIDS									
TS		E	E						
TNVS		E	E						
TSS		EF	EF	E	E	E	E	E	
TNVSS		E	E						
OXYGEN DEMAND PARAMETERS									
BOD5		EF	EF						
BOD5 (Soluble)		E	E						
NUTRIENTS									
Total Kjeldahl Nitrogen (TKN)		E							
NH3-N		E	E				E	E	
NO2+NO3-N		E	E						
Total-P		E	E						
MISCELLANEOUS									
F-Coliform MF				EF	EF				
ORGANICS									
VOC (water)									
BNAs (water)		E							
Pest/PCB (water) - Chlorinated		E							
METALS									
PP Metals (water)		EF					E	E	E
PP Metals (water - spike, dupe)		2E							
BIOASSAYS									
Daphnia magna (acute)						E			
Fathead Minnow (acute)						E			
Fathead Minnow (chronic)						E			
FIELD MEASUREMENTS									
Temperature		E	E	E	E	E	E	E	
pH		E	E	E	E	E	E	E	
Conductivity		E	E	E	E	E	E	E	
Chlorine						E			
Dissolved Oxygen							E	E	
		20	17	6	6	9	8	8	1

E	Ecology sample	Recwater	Receiving water sample from above the outfall
F	Ferndale sample sample	Trnblk	Transfer balnk
Eff	Effluent sample	grab	Grab sample
Eff-Bio	Effluent bioassy sample	comp	Composite sample

Appendix C - Analytic Methods - Ferndale Class II - June, 1997

Parameter	Manchester Lab Methods	APHA Methods	Lab Used
GENERAL CHEMISTRY			
Conductivity	EPA, Revised 1983: 120.1	APHA, 1989: 2510A.	Manchester Environmental Lab
Alkalinity	EPA, Revised 1983: 310.1	APHA, 1989: 2320B.	Manchester Environmental Lab
Hardness	EPA, Revised 1983: 130.2	APHA, 1989: 2340C.	Manchester Environmental Lab
SOLIDS			
TS	EPA, Revised 1983: 160.3	APHA, 1989: 2540B.	Manchester Environmental Lab
TNVS	EPA, Revised 1983: 160.3	APHA, 1989: 2540E.	Manchester Environmental Lab
TSS	EPA, Revised 1983: 160.2	APHA, 1989: 2540D.	Manchester Environmental Lab
TNVSS	EPA, Revised 1983: 160.2	APHA, 1989: 2540D&E.	Manchester Environmental Lab
OXYGEN DEMAND PARAMETERS			
BOD5 (Total)	EPA, Revised 1983: 405.1	APHA, 1989: 5210B.	Manchester Environmental Lab
BOD5 (Soluble)	EPA, Revised 1983: 405.1		Manchester Environmental Lab
NUTRIENTS			
Total Kjeldahl Nitrogen (TKN)			
NH3-N	EPA, Revised 1983: 350.1	APHA, 1989: 4500-NH3D.	Manchester Environmental Lab
NO2+NO3-N	EPA, Revised 1983: 353.2	APHA, 1989: 4500-NO3F.	Manchester Environmental Lab
Total-P	EPA, Revised 1983: 365.3	APHA, 1989: 4500-PF.	Manchester Environmental Lab
MISCELLANEOUS			
F-Coliform MF	APHA, 1992: 9222D.	APHA, 1992: 9222D.	Manchester Environmental Lab
ORGANICS			
VOC (water)	EPA, 1986: 8260	APHA, 1989: 6210D.	Manchester Environmental Lab
BNAs (water)	EPA, 1986: 8270	APHA, 1989: 6410B.	Manchester Environmental Lab
Pest/PCB (water) - Chlorinated	EPA, 1986: 8080	APHA, 1989: 6630C.	Manchester Environmental Lab
METALS			
PP Metals (water)	EPA, Revised 1983: 200-299	APHA, 1989: 3000-3500*.	Manchester Environmental Lab
PP Metals (soil)			
BIOASSAYS			
Daphnia magna (acute)	EPA 1985	APHA, 1989: 8711B&C.	Coffey Laboratories, Inc.
Fathead Minnow (acute)	EPA 1993: 1000.0	APHA, 1989: 8910B&C	Coffey Laboratories, Inc.
Fathead Minnow (chronic)	EPA 1989: 1000.0	APHA, 1995: 8910B&C	Coffey Laboratories, Inc.

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EPA, 1985. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms. EPA/600/4-85/013.

EPA, 1989. Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving waters to Freshwater Organisms.

EPA, 1993 Methods for Measuring Acute Toxicity of Effluent and Receiving Waters to

Appendix D - Quality Assurance/Quality Control - Ferndale Class II Inspection - June, 1997

Priority Pollutant Cleaning Procedures for Wastewater Collection Equipment.

1. Wash with laboratory detergent
2. Rinse several times with tap water
3. Rinse with 10% HNO_3 solution
4. Rinse three (3) times with distilled/deionized water
5. Rinse with high purity acetone
6. Rinse with high purity Hexane
7. Rinse with high purity acetone
8. Allow to dry and seal with aluminum foil

Appendix E - Priority Pollutant Organics and Metals Results - Ferndale Class II, June 1997

Parameter	Location:	Eff-1		Eff-2	
	Type:	grab		grab	
	Date:	06/17		06/17	
	Time:	0940		1520	
	Lab Log #:	258237		258238	
VOA Compounds					
Chloromethane		1	U	1	U
Dichlorodifluoromethane			REJ		REJ
Bromomethane		1	U	1	U
Vinyl Chloride		1	U	1	U
Chloroethane		1	U	1	U
Trichlorofluoromethane		1	U	1	U
Methylene Chloride		2	U	2	U
Acetone		5	U	5	U
Carbon Disulfide		2	U	2	U
1,1-Dichloroethene		1	U	1	U
1,1-Dichloroethane		1	U	1	U
trans-1,2-Dichloroethene		1	U	1	U
cis-1,2-Dichloroethene		1	U	1	U
2,2-Dichloropropane		1	U	1	U
Bromochloromethane		1	U	1	U
Chloroform		0.56	J	0.43	J
1,2-Dichloroethane		1	U	1	U
2-Butanone		2	U	2	U
1,1,1-Trichloroethane		1	U	1	U
Carbon Tetrachloride		1	U	1	U
1,1-Dichloropropene		1	U	1	U
Bromodichloromethane		1	U	1	U
1,2-Dichloropropane		1	U	1	U
Dibromomethane		1	U	1	U
trans-1,3-Dichloropropene		0.94	U	0.94	U
Trichloroethene		1	U	1	U
Dibromochloromethane		1	U	1	U
1,2-Dibromoethane (EDB)		1	U	1	U
1,1,2-Trichloroethane		1	U	1	U
1,3-Dichloropropane		1	U	1	U
Benzene		1	U	1	U
cis-1,3-Dichloropropene		1	U	1	U
Bromoform		1	U	1	U
2-Hexanone		2	U	2	U
4-Methyl-2-Pentanone		2	U	2	U
Tetrachloroethene		1	U	1	U
1,1,2,2-Tetrachloroethane		1	U	1	U
1,1,1,2-Tetrachloroethane		1	U	1	U
Toluene		1	U	1	U
Chlorobenzene		1	U	1	U

E	Ecology sample	J	The analyte was positively identified. The associated numerical result is an estimate.
Eff	Effluent sample	REJ	The datum is unsuitable for all purposes.
grab	Grab sample	U	The analyte was not detected at or above the reported result.

Appendix E - Priority Pollutant Organics and Metals Results - Ferndale Class II, June 1997

Parameter	Location:	Eff-1	Eff-2	Eff-E
	Type:	grab	grab	comp
	Date:	06/17	06/17	06/17-18
	Time:	0940	1520	0800-0800
	Lab Log #:	258237	258238	258239
VOA Compounds				
Ethylbenzene		1 U	1 U	
Styrene		1 U	1 U	
Bromobenzene		1 U	1 U	
1,2,3-Trichloropropane		1 U	1 U	
2-Chlorotoluene		1 U	1 U	
4-Chlorotoluene		1 U	1 U	
1,2,4-Trimethylbenzene		1 U	1 U	
tert-Butylbenzene		1 U	1 U	
1,3,5-Trimethylbenzene		1 U	1 U	
sec-Butylbenzene		1 U	1 U	
p-Isopropyltoluene		1 U	1 U	
1,2-Dibromo-3-Chloropropane		10 U	10 U	
1,2,3-Trichlorobenzene		10 U	10 U	
Isopropylbenzene (Cumene)		1 U	1 U	
1,4-Dichlorobenzene		1 U	1 U	0.28 U
1,2-Dichlorobenzene		1 U	1 U	0.28 U
1,2,4-Trichlorobenzene		5 U	5 U	0.14 U
Naphthalene		10 U	10 U	0.14 U
Hexachlorobutadiene		1 U	1 U	0.14 U
o-Xylene		1 U	1 U	
1,3-Dichlorobenzene		1 U	1 U	0.28 U
m & p-Xylene		2 U	2 U	
1,1-Dichloropropanone		1 U	1 U	
1-Chlorobutane		1 U	1 U	
2-Methyoxy-2-Methylpropane		1 U	1 U	
Acrylonitrile		5 U	5 U	
Allyl Chloride		1 U	1 U	
Chloroacetonitrile		2 U	2 U	
Ethyl Ether		1 U	1 U	
Ethylmethacrylate		1 U	1 U	
Hexachloroethane		1 U	1 U	0.28 U
Methyl acrylate		1 U	1 U	
Methyl Methacrylate		1 U	1 U	
n-Butylbenzene		1 U	1 U	
n-Propylbenzene		1 U	1 U	
Pentachloroethane		1 U	1 U	
2-Nitropropane		1 U	1 U	
Tetrahydrofuran		2 U	2 U	
Trans-1,4-Dichloro-2-butene		1 U	1 U	

E	Ecology sample	U	The analyte was not detected at or above the reported result.
Eff	Effluent sample		
grab	Grab sample		
comp	Composite sample		

Appendix E - Priority Pollutant Organics and Metals Results - Ferndale Class II, June 1997

Parameter	Location:	Eff-1	Eff-2	Eff-E
	Type:	grab	grab	comp
	Date:	06/17	06/17	06/17-18
	Time:	0940	1520	0800-0800
	Lab Log #:	258237	258238	258239
BNA Compounds				
Benzo(a)Pyrene				0.14 U
2,4-Dinitrophenol				1 U
Dibenzo(a,h)Anthracene				0.14 U
Benzo(a)Anthracene				0.14 U
4-Chloro-3-Methylphenol				0.14 U
Aniline				0.28 U
Benzoic Acid				2 J
Hexachloroethane		1 U	1 U	0.28 U
Hexachlorocyclopentadiene				0.71 U
Isophorone				0.14 U
Acenaphthene				0.14 U
Diethylphthalate				0.14 U
Di-N-Butylphthalate				0.14 U
Phenanthrene				0.012 J
Butylbenzylphthalate				0.14 U
N-Nitrosodiphenylamine				0.14 U
Fluorene				0.14 U
Carbazole				0.14 U
Hexachlorobutadiene		1 U	1 U	0.14 U
Pentachlorophenol				0.34 J
2,4,6-Trichlorophenol				0.28 U
2-Nitroaniline				0.71 U
2-Nitrophenol				0.28 U
Naphthalene		10 U	10 U	0.14 U
2-Methylnaphthalene				0.14 U
2-Chloronaphthalene				0.14 U
3,3'-Dichlorobenzidine				3 U
Benzidine				0.28 UJ
2-Methylphenol				0.14 U
1,2-Dichlorobenzene		1 U	1 U	0.28 U
2,4,5-Trichlorophenol				0.28 U
Nitrobenzene				0.14 U
3-Nitroaniline				0.28 U
4-Nitroaniline				0.71 U
4-Nitrophenol				0.71 U
Benzyl Alcohol				2 U
4-Bromophenyl-Phenylether				0.14 U
2,4-Dimethylphenol				0.14 U
4-Methylphenol				0.14 U
1,4-Dichlorobenzene		1 U	1 U	0.28 U

E	Ecology sample	J	The analyte was positively identified. The associated numerical result is an estimate.
Eff	Effluent sample	U	The analyte was not detected at or above the reported result.
grab	Grab sample		
comp	Composite sample		

Appendix E - Priority Pollutant Organics and Metals Results - Ferndale Class II, June 1997

Parameter	Location:	Eff-1	Eff-2	Eff-E
	Type:	grab	grab	comp
	Date:	06/17	06/17	06/17-18
	Time:	0940	1520	0800-0800
	Lab Log #:	258237	258238	258239
BNA Compounds				
4-Chloroaniline				0.14 U
Phenol				0.14 U
Pyridine				0.28 U
Bis(2-Chloroethyl)Ether				0.28 U
Bis(2-Chloroethoxy)Methane				0.14 U
Bis(2-Ethylhexyl) Phthalate				2
Di-n-Octyl Phthalate				1 U
Hexachlorobenzene				0.14 U
Anthracene				0.14 U
1,2,4-Trichlorobenzene		5 U	5 U	0.14 U
2,4-Dichlorophenol				0.095 J
2,4-Dinitrotoluene				0.71 U
1,2-Diphenylhydrazine				0.14 U
Pyrene				0.14 U
Dimethylphthalate				0.14 U
Dibenzofuran				0.14 U
Benzo(ghi)perylene				0.14 U
Indeno(1,2,3-cd)Pyrene				0.28 U
Benzo(b)Fluoranthene				0.14 U
Fluoranthene				0.021 J
Benzo(k)Fluoranthene				0.14 U
Acenaphthylene				0.14 U
Chrysene				0.14 U
4,6-Dinitro-2-Methylphenol				1 U
1,3-Dichlorobenzene		1 U	1 U	0.28 U
2,6-Dinitrotoluene				0.71 U
N-Nitroso-di-n-Propylamine				0.14 U
4-Chlorophenyl-Phenylether				0.14 U
1-Methylnaphthalene				0.14 U
2-Chlorophenol				0.14 U
Retene				0.14 U
3B-Coprostanol				4
Caffeine				0.12 J
1,2-Diphenylhydrazine				0.14 U
N-Nitrosodimethylamine				0.28 U

E	Ecology sample	J	The analyte was positively identified. The associated numerical result is an estimate.
Eff	Effluent sample	U	The analyte was not detected at or above the reported result.
grab	Grab sample		
comp	Composite sample		

Appendix E - Priority Pollutant Organics and Metals Results - Ferndale Class II, June 1997

Parameter	Location:	Eff-E
	Type:	comp
	Date:	06/17-18
	Time:	0800-0800
	Lab Log #:	258239
Pesticide/PCB Compounds		
alpha-BHC		0.0071 U
beta-BHC		0.0071 U
delta-BHC		0.0071 U
gamma-BHC (Lindane)		0.035
Aldrin		0.0071 U
Heptachlor		0.0071 U
Heptachlor Epoxide		0.0071 U
Endosulfan I		0.0071 U
Dieldrin		0.0071 U
4,4'-DDE		0.0071 U
Endrin		0.0071 U
Endosulfan II		0.0071 U
4,4'-DDD		0.0071 U
Endosulfan Sulfate		0.0071 U
4,4'-DDT		0.0071 U
Methoxychlor		0.0071 U
Endrin Ketone		0.0071 U
Toxaphene		0.036 U
PCB - 1016		0.036 U
PCB - 1221		0.036 U
PCB - 1232		0.036 U
PCB - 1242		0.036 U
PCB - 1248		0.036 U
PCB - 1254		0.036 U
PCB - 1260		0.036 U
Endrin Aldehyde		0.0071 U
Chlordane (Tech)		0.036 U

E	Ecology sample	U	The analyte was not detected at or above the reported result.
Eff	Effluent sample		
grab	Grab sample		
comp	Composite sample		

Appendix E - Priority Pollutant Organics and Metals Results - Ferndale Class II, June 1997

Parameter	Location:	Eff-E	Recwater-U	Recwater-D	Transblk	ReComp-E
	Type:	comp	grab	grab	grab	comp
	Date:	06/17-18	06/17	06/17	06/16	06/17-18
	Time:	0800-0800	1258	1317	1635	1420-1345
	Lab Log #:	258239	258244	258246	258245	258247
Metals						
Antimony		30 U	0.1 U	0.1 U	30 U	30 U
Arsenic		30 U	0.67	0.81	30 U	30 U
Beryllium		1 U	0.1 U	0.1 U	1 U	1 U
Cadmium		0.5	0.1 U	0.1 U	0.1 U	2
Chromium		5 U	2	3	5 U	30
Copper		19	4	4	2	40
Lead		10	0.72	0.8	1 U	29
Mercury		0.1 U	0.002 U	0.002 U	0.1 U	0.2
Nickel		10 U	8	9	10 U	10 U
Selenium		2 U	0.4 U	0.4 U	2 U	2 U
Silver		0.5 UJ	0.1 U	0.1 U	0.5 UJ	0.5 UJ
Thallium		1 U	0.1 U	0.1 U	1 U	1 U
Zinc		43	6 J	12 J	4 U	127

E	Ecology sample	J	The analyte was positively identified. The associated numerical result is an estimate.
Eff	Effluent sample	U	The analyte was not detected at or above the reported result.
grab	Grab sample	UJ	The analyte was not detected at or above the reported estimated result.
comp	Composite sample		
Transblk	Transfer blank		
Recwater-U	Upstream receiving water sample		
Recwater-D	Downstream receiving water sample		
ReComp-E	ReComp, Inc. collection system discharge sample		

Appendix F - Tentatively Identified Compounds - Ferndale Class II

Location:	**Eff-1**
Type:	grab
Date:	06/17
Time:	0940
Lab Log #:	258237

	Parameter	result	qualifier	units
1	2-Butene	0.17	NJ	ug/L
2	1,4-Hexadiene	0.16	NJ	ug/L
3	Propanal, 2-Methyl-	0.15	NJ	ug/L

Location:	**Eff-E**
Type:	comp
Date:	06/17-18
Time:	0800-0800
Lab Log #:	258239

	Parameter	result	qualifier	units
1	Unknown 01	1.4	NJ	ug/L
2	Unknown 02	1.8	NJ	ug/L
3	Unknown 03	2	NJ	ug/L
4	Unknown 04	1.8	NJ	ug/L
5	Unknown 05	1.3	NJ	ug/L
6	Unknown 06	2.5	NJ	ug/L
7	Unknown 07	1.1	NJ	ug/L
8	Unknown 08	1.3	NJ	ug/L
9	Unknown 09	7.1	NJ	ug/L
10	Unknown 10	1.2	NJ	ug/L
11	Unknown 11	1.4	NJ	ug/L
12	Unknown 12	1.3	NJ	ug/L
13	Phenol, Nonyl-	1.8	NJ	ug/L
14	Arachidic Acid, Ethyl Ester	0.95	NJ	ug/L
15	Decanoic Acid, Tetra-	3.5	NJ	ug/L
16	Octadecanoic Acid	15	NJ	ug/L
17	Cholesterol	6.7	NJ	ug/L
18	Cholestanol (Van)	1.7	NJ	ug/L
19	Gamma-Sitosterol	4.8	NJ	ug/L

NJ There is evidence that the analyte is present. The associated numerical result is an estimate.

Appendix G - GLOSSARY - Ferndale Class II Inspection, 1997

BOD_5	Five Day Biological Oxygen Demand
$CBOD_5$	Carbonaceous Five Day Biochemical Oxygen Demand
$CaCO_3$	Calcium Carbonate
CLP	Contract Laboratory Program
CVAA	Cold Vapor Atomic Absorption
D.O.	Dissolved Oxygen
EPA	Environmental Protection Agency
k	Maximum rate of substrate utilization or soluble reaction rate coefficient
k_1	1st order reaction rate coefficient (derived for Total BOD_5 with settling)
Ks	Half-Velocity constant
kg	kilogram (1×10^3 grams)
L	Liter (1×10^3 milliliters)
lbs/day	Pounds per Day
LOD	Limit of Detection
m^3	Cubic meter (1×10^3 liters)
MF	Membrane Filter
mg	milligram (1×10^{-3} grams)
MGD	Million Gallons per Day
mL	Milliliter (1×10^{-3} liters)
MPN	Most Probable Number
$NBOD_5$	Nitrogenous Five-day Biochemical Oxygen Demand
NH_3	Ammonia
NPDES	National Pollutant Discharge Elimination System
PCB	Polychlorinated Biphenyls
pH	Log_{10} of Negative Hydrogen Ion Concentration
PO_4	Phosphate
PP	Priority Pollutant
ppm	Parts per million (1×10^{-6} kg/L, 1 mg/L, or 1 mg/kg)
ppt	Parts per thousand (1×10^{-3} kg/L, 1 g/L, or 1 g/kg)
QA/QC	Quality Assurance/Quality Control
RPD	Relative Percent Difference
TIC	Total Inorganic Carbon or Tentatively Identified Compound
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TNVS	Total Non-Volatile Solids
TNVSS	Total Non-Volatile Suspended Solids
TOC	Total Organic Carbon
TP	Total Phosphorous
TS	Total Solids
TSS	Total Suspended Solids

TVS	Total Volatile Solids
ug	Microgram (1 X 10^{-6} grams)
ug/L	Micrograms per Liter
VOA	Volatile Organic Analysis
VSS	Volatile Suspended Solids
WWTP	Wastewater Treatment Plant
X	Volatile Suspended Solids