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DEPARTMENT OF
ECOLOGY

Texaco USA (Anacortes)
Class II Inspection

March 1995

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Class II Inspection

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by
Guy Hoyle-Dodson and
Paul Stasch

Environmental Investigations and Laboratory Services Program
Olympia, Washington 98504-7710

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Abstract

A Class II Inspection was conducted May 9-10, 1994 at the Texaco USA Petroleum Refinery (Texaco) in Anacortes, Washington. The inspection investigated the Texaco process wastewater and stormwater treatment system. The inspection identified deficiencies in several areas of plant operation and maintenance.

General chemistry results suggest that the systems **trickling filter and aeroaccelator activated sludge units were not operating efficiently, but this was offset by the performance of the aerated lagoon. Total ammonia nitrogen concentrations in the whole effluent exceeded chronic marine water quality criteria based on critical conditions of the receiving water. Refinery effluent concentrations were all within NPDES permit limits.** Effluent organic and **metal concentrations were generally within state and EPA water quality criteria with the exception of zinc, copper, mercury, and cadmium.**

Ecology laboratory split sample analyses found some differences between Texaco and Ecology effluent samples. **Bioassays found toxicity for four out of five sensitive species. Sediments analyses found that most organic and metal concentrations did not exceed the marine sediment quality standards, with the exception of Bis(2-ethylhexyl)Phthalate. Bioassays revealed no significant toxicity in the sediment.**

Summary

Flow Measurement

Evaluation of the Texaco flow measurement device was not done during the inspection. Average flow recorded by the Texaco meter for the two days of the inspection was approximately 3.6 MGD. Average reported stormwater flow for the period was 1.4 MGD.

Process Wastewater Treatment System Operation

Several areas of the process wastewater treatment system appeared to be experiencing some operational and maintenance difficulties. The aeroaccelator activated sludge (AAS) units did not appear to be operating efficiently and may be undersized for the flow. Stormwater flume oil skimming appeared ineffective and oil was entering the final stabilization pond. The presence of a black residue on the banks of the final stabilization pond indicates either an accumulation of biosolids or problems with the separation of oil from the wastewater. The chlorine injection system, although ultimately effective, was inherently inefficient, and required relatively large quantities of chlorine to disinfect a relatively small volume of sanitary sewage mixed with a much larger volume of process water. The walls of the dissolved air floatation (DAF) units had cracks that were leaking an oily residue.

General Chemistry

Solids and oxygen demand parameter concentrations in the API effluent were comparable to concentrations in API effluents at typical refineries. Ammonia nitrogen is conceivably being air stripped in the DAF units. **Removal efficiencies of several general chemistry parameters across the trickling filter and the south AAS unit were less than what would be typically expected for either of these units,** which suggests that these components were not operating effectively. **Removal efficiencies across the aerated lagoon were better than what would typically be expected,** and indicates that a large part of the system's treatment was being performed by the lagoon. The addition of stormwater loading to the final stabilization pond appeared to have little impact on the final effluent concentrations of most parameters. A possible exception could be the ammonia nitrogen load which experienced an increase across the treatment plant. **Total ammonia nitrogen also exceeded chronic marine water quality criteria for critical conditions of the receiving water. Although the extent of dilution by the receiving water was not determined, ammonia concentrations may be of concern.**

NPDES Permit Comparisons

Refinery total effluent discharge concentrations were within NPDES permit monthly averages and daily maximum loading limits.

Detected Organics and Priority Pollutants

Volatile organic and BNA compounds were found in concentrations that did not exceed EPA water quality criteria for receiving waters. **Most metals concentrations in the whole effluent did not exceed EPA or state water quality criteria with the exception of zinc, copper, mercury, and cadmium. Zinc exceeded the state acute criteria by at least a factor of six.** Dilution with the receiving water will need evaluation to determine whether the discharge can ultimately meet the zinc criteria.

Split Samples

Analysis of effluent splits between Ecology and Texaco found the Texaco laboratory analysis to be comparable to the Ecology lab analysis. Ecology analysis of Ecology and Texaco composite samples found differences between the two samples for several parameters, suggesting dissimilarity in sampling protocols. Bioassays results from the two labs also differed substantially, suggesting serious differences between labs in laboratory bioassay protocols.

Bioassays

One bioassay found little toxicity, while four bioassays found moderate to high toxicity. Rainbow trout (*Oncorhynous mykiss*) 96-hour survival test displayed 93% survival at 100% effluent concentration. Fathead minnow 96-hour survival test found 5% survival at 100% effluent concentration. *Daphnia pulex* experienced acute toxicity (NOEC: < 6.25% effluent and LOEC = 6.25% effluent) with 8% survival at 100% effluent concentration. Two marine organism bioassays displayed acute toxicity, with echinoderm (*Strongylocentrotus purpuratus*) encountering significant sperm cell toxicity at 35% effluent concentration, and the pacific oyster exhibiting normal embryo survival toxicity at 4.38% effluent concentration. Possible sources of toxicity include metals, TSS, and ammonia.

Sediments

Sediment at both the outfall and background location consisted predominately of sand. TOC in the outfall sample was low compared to typical marine sediments. Several organics were detected in appreciable concentrations at the outfall, but only

Bis(2-ethylhexyl)Phthalate (2840 mg/Kg-dry wt.) exceeded the marine sediment quality standards chemical criteria. Amphipod/Rhepoxynius (*Rhepoxynius abronius*) 10-day emergence and survival bioassay detected no significant toxicity in the sediment.

Recommendations

Operation and Maintenance

- Correction of problems with overloading AAS units, oil skimming in the stormwater pond, oil separation processes, and excessive chlorination should improve treatment system performance.
- Texaco should inspect and seal DAF unit walls to prevent leakage of oil residue to the ground.
- The installation of a stormwater flowmeter would more accurately determine the stormwater's contribution to effluent concentrations.

Process Wastewater Treatment System

- The impact of effluent ammonia nitrogen concentrations on the receiving water should be evaluated.
- Sources of metal contamination in the process wastewater should be identified and corrective action taken to reduce these concentrations in the effluent.
- Review of composite sampling protocols and bioassay testing protocols is advised.
- The source of bioassay toxicity should be identified and efforts made to reduce the concentration of this toxic component in the effluent. The inclusion in the permit of bioassay test species other than salmonid should be considered.

Sediments

- The source of Bis(2-ethylhexyl)Phthalate in the sediment should be identified and corrective action taken.

Introduction

A Class II Inspection was conducted at the Texaco USA Anacortes petroleum refinery on May 9-10, 1994. Paul Stasch, environmental investigator, and Guy Hoyle-Dodson, environmental engineer for the Washington State Department of Ecology (Ecology) Toxics Investigations Section, conducted the inspection. Kim Anderson, permit coordinator for Ecology's Industrial Section, provided background information. Vern Stevens, Texaco plant environmental engineer, represented Texaco. Brian Rhodes, Texaco environmental engineer, assisted on-site.

Wastewater generated at the Texaco facility is primarily process water, with smaller amounts of stormwater, ballast water, and sanitary wastewater. The treated wastewater is discharged into Fidalgo Bay. The plant discharge is regulated under NPDES permit No. WA 000294-1 issued March 1, 1990. The permit's expiration date is September 1, 1994.

The Department of Ecology initiated the inspection to assess permit compliance and to aid in Ecology's ongoing compliance strategy. The inspection was unannounced to aid compliance evaluation. Specific objectives of the inspection included:

1. Evaluate NPDES permit compliance
2. Assess wastewater toxicity with comparisons of priority pollutant scans to EPA and Washington State water quality criteria
3. Assess wastewater toxicity with effluent bioassays
4. Characterize sediment toxicity with comparisons of priority pollutant scans to Ecology marine sediment criteria
5. Characterize sediment toxicity with effluent bioassays
6. Evaluate treatment plant performance with special emphasis on solids loading
7. Assess permittee's self monitoring by conducting split samples
8. Evaluate stormwater discharge

Setting

Refinery Wastewater Generation

The Texaco refinery is located in Skagit County, near Anacortes. It is situated at March Point, which extends northwest into Fidalgo Bay and northeast into Padilla Bay. (*Figure 1*). The facility refines from 125,000 to 144,000 barrels of crude oil per day, producing gasoline, diesel fuel, and other petroleum products. Refinery processes include crude distillation and desaltation, catalytic cracking, butane deasphalting, delayed coking, hydrotreating, catalytic reforming, and sulfuric acid alkylation. Effluent limitations are based on guidelines published August 12, 1985 under 40 CFR Part 419 by the Environmental Protection Agency (EPA).

The refinery generates wastewater from four sources: process water, sanitary sewage wastewater, ship ballast wastewater, and stormwater runoff. A small amount of treated process wastewater and stormwater discharge are also accepted from the nearby General Chemical Corporation. These discharges are subject to the conditions of General Chemicals's State Waste Discharge Permit, No. 7309, issued July 12, 1990. Texaco process wastewater sources includes sour water (washing, mixing and stripper water), boiler condensate, desalter water, softener regeneration, cooling tower blowdown (precipitation of heavy metals), and lab wastewater. Typical pollutants for various refinery wastestreams have been identified by the Environmental Protection Agency (EPA, 1978). Sour wastewaters typically contain oil, phenols, sulfides, ammonia, and cyanide. Desalter water contains ammonia, phenols, sulfides, and suspended solids. Hydrotreating wastewater also contains ammonia, sulfides, and phenols. Alkylation produces spent caustic and also contains dissolved and suspended solids. Organic constituents produce high BOD and COD concentrations in the refinery wastewater. Salts, particularly the chlorides, are the major source of high dissolved solids. Most metal wastewater contaminates likely originate as natural constituents of crude oil and are concentrated in the wastewater during the refining process. It was reported by the permit manager that chromium has been used as a biocide in the cooling towers, although during the inspection this application was not noted.

Sanitary sewage and other wastewater is generated by facility employees. Stormwater flows are the result of precipitation runoff from streets, parking lots, rooftops, and work yards and is accumulated by the stormwater collection system. A separate stormwater system collects wastewater that originates from containment areas around storage tanks and process units, and this flow is not mixed with the main stormwater collection system. Ballast wastewater is pumped from the tankers that serve the facility.

Refinery Wastewater Treatment System

The refinery's wastewater treatment system consists of three main sections: a stormwater runoff system, a surge/bypass system, and a process water treatment system. (*Figure 2*). Stormwater collected from containment areas surrounding tanks and process units is mixed with process wastewater prior to the API separators. Sanitary sewage and ballast flows are also mixed with process water at this point. Sanitary sewage flow is continuous, while ballast wastewater addition is intermittent. Untreated stormwater from the main stormwater collection system is retained in the stormwater flume, then mixed with treated process water effluent in the final stabilization pond. The facility does have the capacity to divert main stormwater flow through the treatment system, but during the inspection this was not observed. Surges are directed to oily water surge tanks or to containment basins. Surges can then be diverted to the process water trickling filter, stormwater flume, or a skim line. The final discharge is largely treated process water with small amounts of treated sanitary sewage, and intermittent additions of treated ballast wastewater and primarily treated stormwater. Total discharge ranges from three to eight MGD.

The process water treatment system (PWTS) consists of API separator, rapid mixer with polymer injection, dissolved air flotation devices, equalization tank, trickling filter, aeroaccelator activated sludge units, aerated primary lagoons, final stabilization pond, and chlorine injector. Flows are recorded by final pond effluent totalizer, in the discharge pipe.

Screened oily water influent enters the API separator, where oil forms a layer on top of the water phase and is then skimmed. Wastewater from the API separator flows through a rapid mixer, and injected with a polymer that complexes with the oil residue. The oil-polymer floc is aggregated in a flocculation tank, then separated from the wastewater in two dissolve air flotation (DAF) units operated in parallel. Wastewater flows through an equalization tank into a trickling filter.

Trickling filter effluent receives additional biological treatment in a pair of aeroaccelator activated sludge (AAS) units operated in parallel. The AAS units also act as secondary clarifiers with sludge returned to the trickling filter. Effluent from the AAS units flows to aerated lagoons, where further biological treatment and sedimentation occur. Sludge from the lagoons is periodically dredged and land farmed on site. Treated process wastewater is pumped to the final stabilization pond and mixed with stormwater runoff. Effluent from the final pond is injected with chlorine and pumped through a 5,000 ft, 20 inch diameter pipe. Pipe travel time is estimated at over 20 minutes and is believed to act as a contact chamber. Final effluent is discharged into Fidalgo Bay, approximately 5,000 ft from the shore to the north/northwest.

Procedures

Ecology set up compositors and collected composite samples from Texaco's process wastewater treatment system at three locations: the equalization tank effluent pipe into the trickling filter (TIF-IN), the south AAS unit effluent overflow (AIROUT), and the final stabilization pond effluent discharge just before the outfall line (TEXEFF). An additional composite sample was taken from the main stormwater collection system's stormwater flume effluent (STORM-IN), prior to the final stabilization pond (Figure 2 & Appendix A). AAS unit effluent and trickling filter samples were collected using Ecology ISCO composite samplers with equal volumes of the sample collected every 30 minutes over a 24-hour period. Equal volumes of the final stabilization pond sample were collected every 30 minutes over an eight-hour period.

Pairs of grab samples were collected at the same locations as the composite samples. The first of the grab pairs were collected in the evening of May 9 and the second grabs the next morning. A single grab sample was taken from a stormwater flow on the east side of the refinery. Two sediment samples were collected, one on April 18 at the outfall and an ambient sample taken April 6 approximately one mile east southeast of the outfall. The background location was selected to maximize similarity to outfall ambient conditions, but to minimize contamination from outfall deposition. Sediment samples were collected from a boat using a power winch and a van Veen dredge.

Texaco personnel collected one composite sample using their own compositor from the final stabilization pond effluent. Texaco's effluent sample location was approximately the same as Ecology's effluent sample location, although the Texaco sampling period was slightly longer. Ecology's and Texaco's composite samples were each split between Ecology and Texaco for analysis by each respective laboratory. One Ecology effluent grab sample was also split with Texaco for analysis of oil & grease. Parameters analyzed, samples collected, and schedules appear in Appendix B.

Samples designated for Ecology analysis were delivered to personnel from the Ecology's Manchester Laboratory. Chain-of-custody procedures were observed throughout the inspection. Analytical procedures and laboratories performing the analyses are summarized in Appendix C.

Quality Assurance / Quality Control

Sampling quality assurance included ultra cleaning (priority pollutant cleaning) of sampling equipment to remove trace priority pollutant contaminates (*Appendix D*). Sampling in the field followed all protocols for holding times, preservation, and chain-of-custody set forth in the Manchester Lab Laboratory Users Manual (Ecology, 1991).

Laboratory QA/QC including applicable holding times, procedural blanks, spike and duplicate spike sample analyses, surrogate recoveries, and check standards were, with several exceptions, within acceptable limits. 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. Specific QA/QC concerns are included in Appendix D.

Results and Discussion

Process and Sanitary Wastewater Treatment System

Flow Measurement

Independent verification of wastewater flow measurement was not performed during the inspection. An orifice plate with a pressure transducer measures differential pressure in the effluent line, from which totalized flow is calculated and recorded on an analog chart. The average effluent flow for the two days of the inspection was 3.618 MGD. Stormwater flow for the same period was reported as 1.418 MGD. To estimate stormwater flow Texaco subtracts daily total effluent flow results from a previously determined average dry weather effluent flow. This estimated stormwater flow can be independent from both actual stormwater flow to the final detention pond and measured precipitation. It should be noted that during and five days previous to the inspection the National Weather Service reported no precipitation for the region (National Weather Service, 1994). To more accurately determine the actual daily stormwater contributions, it is recommended that Texaco install a flow metering device at the stormwater flume effluent.

General Chemistry

Ecology analysis results are shown in Table 1. Although an equalization tank and dissolved air flotation units lie between the API separator outfall and the trickling filter influent sample location, comparison of trickling filter influent to typical API separator effluent characteristics is useful. The Texaco API separator appears to be functioning with normal efficiency. BOD_5, TSS, and COD trickling filter influent concentrations were all close to the mean for characteristic concentrations found in the API separator effluents typical of Washington refineries (*EPA, 1978*).

Trickling filter influent ammonia nitrogen concentration was less than 10% of such a typical mean concentration. Although pH (9.2) is not optimal for air stripping (Metcalf & Eddy), ammonia may be being volatilized in the DAF units. At a pH of 9.2 and a temperature of 30°C the amount of ammonia in the free volatile form approaches 75% (WPCF, 1977). In conjunction with the addition of air and the increased agitation of the wastewater, the DAF units produce conditions that could remove appreciable amounts of ammonia.

Ecology BOD_5, COD, and TOC concentrations were reduced across the trickling filter and south AAS unit by 49%, 48%, and 54% respectively (*Table 2*). BOD_5 reduction is an estimate based on the laboratory low detection limit for the AAS effluent result, but this reduction would be expected to be commensurate with COD and TOC reductions. TSS and ammonia removal efficiencies were less than 25%. BOD_5, COD, TSS, and ammonia removal efficiencies were generally low compared with performance of similar treatment systems found in typical Washington State oil refineries *(EPA, 1978*). This would indicate that the trickling filter and the south AAS unit were not functioning effectively during the inspection. Reduction in pH was substantial. Although the north AAS unit effluent was not sampled, it would be expected that its performance efficiency would be comparable to the south unit.

In contrast, the estimated removal efficiencies for BOD_5, COD, and TSS across the aerated lagoons were relatively high (Table 2). These results indicate that the majority of TSS removal and a good portion of biological treatment occurred across the aerated lagoons. BOD_5 and TSS removal was equal to or better than the performance of typical refinery aerated lagoon treatment processes (*EPA, 1978*). Lagoon effluent concentrations were also generally lower than the concentrations that would be expected in effluents from typical refinery aerated lagoon treatment processes (*EPA, 1978*).

An exception to the general high level of treatment in the lagoon was ammonia nitrogen removal efficiency. Ammonia appeared to increase by 62% across the lagoon. It is possible that this apparent increased load could be a function of overestimating stormwater flows, but additional loading of ammonia by the stormwater cannot be discounted. Conceivable ammonia could be formed from nitrogen ions provided by constituents in the process water, but the magnitude of total nitrogen concentration in the process water is unknown. The concentration of ammonia in the stormwater is also unknown, and testing of the stormwater would be needed to resolve the question of ammonia contamination.

Reductions in concentrations across the entire wastewater treatment system with stormwater loading was 79% for TSS, 87% for BOD_5, 66% for COD, and 54% for TOC (Table 2). Percent of effluent load for each of these parameters attributed to process wastewater alone was 95%, 97%, 98%, and 94% respectively, indicating little contribution from the stormwater for these constituents.

Total ammonia concentration in the final effluent (9.51 mg/L) exceeded a State chronic marine water quality criteria of 2.2 mg/L (Ecology, 1994). This criteria is based upon May 3, 1994 ambient results from an Ecology sampling station located in Fidalgo Bay just east of the outfall, which reported temperatures exceeding 10° C, pH exceeding 8.00, and salinity approaching 30 g/Kg (Eisner, 1995). Ambient results for other months at the same station produce criteria approaching 1.6 mg/L. Although the three-year excursion characteristics of the receiving water at the outfall have not been determined and dilution would undoubtedly play a role in mitigating effluent toxicity, ammonia toxicity may be of concern. The question of ammonia concentration's impact on the receiving water should be resolved. In particular, effluent toxicity in relation to dilutions during tidal cycles should be investigated.

Plant Operation and Maintenance

Several operational deficiencies were observed. Some components of the treatment system appeared to lack proper maintenance. Operational difficulties include:

1. The relatively low reduction in organics across the Aeroaccelator Activated Sludge (AAS) unit suggests that it was overloaded. Wastewater flow in the clarifier portion of both units appeared turbulent and a large amount of suspended solid material escaped through the perimeter weir. As a result further treatment of AAS effluent has been required by the addition of aeration to what had formally been retention ponds. Also, an uneven distribution of flow across the two AAS units was noted.

2. An oil sheen was present on the surface of the stormwater flume. Skimming of the oil appeared ineffective and some oil was observed flowing into the final stabilization pond.

3. The presence of a black residue on the banks of the final stabilization pond indicate either a buildup of biosolids or problems with oil separation and removal by the system.

4. The addition of sanitary sewage to the process water treatment system requires the chlorination of a large volume of effluent. Separate treatment and chlorination of sanitary sewage wastewater would decrease the amount of

chlorine needed, reducing the potential for creating chlorinated organic compounds.

Maintenance difficulties include:

- During the inspection a small amount of seepage was observed through cracks in the concrete walls of the API separator and the DAF units. Some of this residue appeared to be leaking to the ground. Subsequent communication with the permit manager disclosed that the interior of the API separator had been recently sealed by Texaco (Anderson, 1994)

Correcting the items noted above should improve plant performance and may improve effluent quality. Sealing cracks in the walls of DAF units would preclude potential contamination of the ground due to leaking oily residue.

NPDES Permit Comparisons

Ecology effluent loading results for BOD_5 (241 lbs/day), COD (2139 lbs/day), ammonia nitrogen (287 lbs/day), and TSS (211 lbs/day) were well within both the permit monthly average and daily maximum loading limits (*Table 3*). Ecology results for permit parameters -- oil and grease, phenolic compounds, total and hexavalent chromium, pH, fecal coliform, and salmonid bioassay -- were also within permit limits. These limitations are stipulated in the permit as based upon a plant production of three consecutive months at 116,600 bbls per day or higher, and does not include ballast and stormwater allocations.

Detected Organics and Priority Pollutants

Table 4 summarizes concentrations of organics detected with priority pollutant scans, and also summarizes priority pollutant metals. Appendix E contains results of all targeted organic compounds and metals results. Tentatively identified compounds are presented in appendix F.

VOAs, BNAs, and metals were detected in the Texaco effluent (*Table 4*). One VOA and three BNAs were detected in the plant effluent. None exceeded water quality criteria for receiving waters. Eight metals were detected in the effluent. The Ecology analysis effluent zinc result (546 µg/L) exceeded the EPA and State acute water quality criteria by more than a factor of six and the chronic criteria by a factor of seven (Ecology, 1992; EPA, 1986). The Texaco analysis effluent zinc result (15 µg/L) was far lower, introducing some ambiguity to the findings. The copper effluent concentration (5.8 µg/L) exceeded the acute marine water quality criteria. Concentrations of mercury (0.14 µg/L) and cadmium (22.7 µg/L) exceeded the chronic marine water quality criteria. A partial contributor to effluent copper concentrations appeared to be the stormwater flow, which exhibited a concentration of 8.5 µg/L. Zinc, copper, and mercury concentrations were also higher than water quality criteria in the east side stormwater flow, although this flow is not a direct discharge to Fidalgo Bay and the comparison is only advisory. The effluent selenium concentration (42.8 µg/L), although not exceeding water quality criteria, was also relatively high. The selenium concentration exceeded the concentration at which the EPA recommends that the status of fish communities in salt water should be monitored (Ecology, 1992).

The effluent metals concentrations, particularly for zinc, may be highly toxic to marine organisms. Mitigation of toxicity by receiving water dilution may occur; but the excessive effluent concentrations are still of concern, particularly in the light of bioassay results. It is recommended that metal sources in the process water be identified and efforts made to reduce their concentration in the effluent.

Bioassays

Effluent bioassays detected toxicity in two out of three acute tests (Table 5). Rainbow trout (*Oncorhynchus mykiss*) 96-hour survival test exhibit only 7% mortality at both 65% and 100% effluent concentration. The fathead minnow 96-hour survival test produced significant mortality (55% survival at 100% effluent), with an NOEC, LOEC, and LC50 of 25%, 50%, and 58% effluent concentration respectively. *Daphnia pulex* 48-hour survival test demonstrated a more severe toxicity (8% survival at 100% effluent), with an NOEC less than 6.25% effluent concentration and an LOEC equal to 6.25% effluent concentration. The LC50 for *Daphnia pulex* was greater than 100% effluent concentration.

Additional acute toxicity was evidenced by the two marine organism bioassays. The echinoderm (*Strongylocentrotus purpuratus*) sperm cell toxicity (normal fertilizations) test determined an NOEC, LOEC, and EC50 of 17.5%, 35%, and 51% effluent concentration respectively. The pacific oyster embryo 48-hour survival (normal embryo survival) test produced an NOEC less than 4.38% effluent concentration and an LOEC and EC50 equal to 4.38% and 27% effluent concentration respectively.

Although rainbow trout was the only bioassay species identified in the permit, bioassay results for other species indicate serious effluent toxicity. To be fully protective of the receiving water, the inclusion in the permit of tests for other bioassay species should be considered. Based upon effluent data, metal concentrations may be the source of the bioassay toxicity. Zinc and copper exceeded the acute criteria. Cadmium and mercury concentrations exceeded the chronic criteria, and may contribute an additive effect to acute toxicity. The selenium concentration may also contribute an additive effect. Finally, the ammonia concentration may, under certain receiving water conditions, also promote bioassay toxicity. Due to observed toxic effects at low concentrations, it cannot be assumed that dilution by the receiving water will have an adequate mitigating effect. Dilution zone studies may clarify this issue. Regardless, the source of bioassay toxicity in the wastestream and necessary corrective action to reduce the concentrations of these toxics should be investigated.

Split Samples

A Wilcoxon nonparametric signed ranks test was performed on Ecology lab results for Texaco and Ecology effluent samples (Table 6). The test found significant difference between the two sample sets at a critical level of 0.05, but relative percent differences between the paired data were generally less than the variation in interlaboratory precision estimated for those laboratory procedures (Ecology, 1991 - B). Notable exceptions were zinc and cadmium results, which were well outside the range for precision variation. The discrepancy could reflect some form of contamination, but it may also result from problems with Texaco's sampling procedure. It is suggested that Texaco review sampling procedures, especially concerning zinc and cadmium concentrations. A Wilcoxon test of Ecology lab results versus Texaco lab results found no significant difference between labs. These analyses are interpreted as indicating that Texaco's and Ecology's laboratories are generally comparable, and that composite sampling techniques may differ for some parameters.

Texaco bioassay results also differed substantially from Ecology results. This could be interpreted as differences in the bioassay protocols used at the two labs. Review of Texaco bioassay protocols is strongly encouraged.

Sediments

General Chemistry

Sediment samples were collected at the effluent outfall and at a background location east of the shipping pier. Grain size analysis found the sediment at the outfall to consist predominately of sand (Table 1). The background sample contained slightly finer material. Percent solids at the outfall was 72.4% with percent volatiles 2% of the total. TOC comprised somewhat less than 1% of the total dry weight. This is less than what might be expected for typical marine sediments (Norton, 1994), but not extreme considering the sediment's sandy composition.

Detected Organics and Priority Pollutants

Eight organic compounds were detected in the effluent outfall sediment sample (Table 7). The concentrations of all but one were well within the State marine sediment quality standards chemical criteria (Ecology, 1991). Bis(2-ethylhexyl)phthalate concentration (2840 mg/Kg-dry wt., normalized to fractional percent TOC: 996 mg/Kg TOC-dry wt.) exceeded the chemical criteria by more than a factor of twenty. Bis(2-ethylhexyl)phthalate is a prevalent environmental contaminate, used as a plasticizer in a variety of plastic products (EPA, 1981) and is employed extensively as a lubricant in vacuum pumps (Verschueren, 1983). Its ubiquity also raises the possibility of laboratory contamination, although comparison to laboratory blanks indicate that contamination in such a high concentration is unlikely. Despite its pervasiveness, the high concentration and close proximity to the effluent outfall suggests that the Texaco facility could be the source. It is recommended that this source be identified and, if determined to have originated from the Texaco facility, steps taken to eliminate the discharge.

Bioassays

Bioassays with the Amphipod/Rhepoxynius (Rhepoxynius abronius) 10-day emergence and survival test produced a 90% and 93% average percent survival in the effluent outfall sediment and the background sediment respectively (Table 8). Average percent survival was within the marine sediment quality minimum biological effects criteria (WAC-173-204-320) and the marine sediment cleanup screening levels and minimum cleanup biological criteria (WAC-173-204-520).

References

Anderson, 1994. Communication with Kim Anderson, Industrial Section Permit Manager, Washington State Department of Ecology, 1994.

APHA, AWWA, WPCF. 1989. Standard Methods for the Examination of Water and Wastewater, 17th edition. American Public Health Association. Washington DC.

Ecology, 1991. Sediment Management Standards. Washington State Department of Ecology, 1991. Chapter 173-204 WAC.

Ecology, 1991 - B. Guidelines and Specifications for Preparing Quality Assurance Project Plans. Washington State Department of Ecology, Environmental Investigations and Laboratory Services Program (E.I.L.S.) Quality Assurance Section. May, 1991.

Ecology, 1994. Manchester Environmental Laboratory Users Manual, Third Revision. Washington State Department of Ecology, 1994.

Ecology, 1992. Water Quality Standards for Surface Waters of the State of Washington, Chapter 173-201A WAC. Washington State Administrative Code, 1992. WAC, 173-201A, 1992.

Eisner, 1995. Communication with Lisa Eisner, Environmental Specialist, Ambient Monitoring Section, E.I.L.S., Washington State Department of Ecology, 1994.

EPA, 1978. Washington State Refineries: Petroleum, Petroleum Derivatives, and Wastewater Effluent Characteristics. EPA-600/7-78-040, March, 1978.

EPA, 1981. Production History of Di-(2-ethylhexyl)phthalate as a Plasticizer and Material Balance for Its Non-plasticizer Uses. Draft Report Submitted to the U.S. Environmental Protection Agency by: Versar Inc., Contract No. 68-01-6271. May, 1981.

EPA, 1984. Ambient Water Quality Criteria for Cyanide. EPA 440/5-84-028.

EPA. 1986. Quality Criteria for Water. EPA 440/5-86-001.

EPA. 1989. Short-term Methods for Estimating the Chronic Toxicity of Effluent and Receiving Waters to Freshwater Organisms, 2nd edition, U.S. Environmental Protection Agency, Cincinnati, OH. EPA/600/4-89/001.

EPA. 1991. Methods for Measuring the Acute Toxicity of Effluent and Receiving waters to Freshwater and Marine Organisms. Weber, C.I. (ed.), U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio, 4th Edition, EPA/600/4-90/027.

Metcalf and Eddy. 1991. Wastewater Engineering Treatment Disposal Reuse, Third Edition. McGraw-Hill. New York.

National Weather Service, 1994. Communication with staff from the National Weather Service Region Headquarters in Seattle reporting unpublished rainfall data for Berlington, Sedro Woolley, and Olga, Washington. Oct. and Dec., 1994.

Norton, 1994. Communication with Dale Norton, Sediment Contamination Specialist, Toxics Investigation, E.I.L.S., Washington State Department of Ecology, 1994.

Verschueren, 1983. Verschueren, Carl. Handbook of Environmental Data on Organic Chemicals, 2nd Edition. Van Nostrand Reinhold Company, New York, 1983.

WAC, 173-220, 1992. National Pollutant Discharge Elimination System Permit Program Chapter 173-220 WAC. Washington State Administrative Code, 1992.

WPCF, 1977. Wastewater Treatment Plant Design, WPCF Manual of Practice No. 36, Second Edition. Water Pollution Control Federation, Washington D.C., 1977.

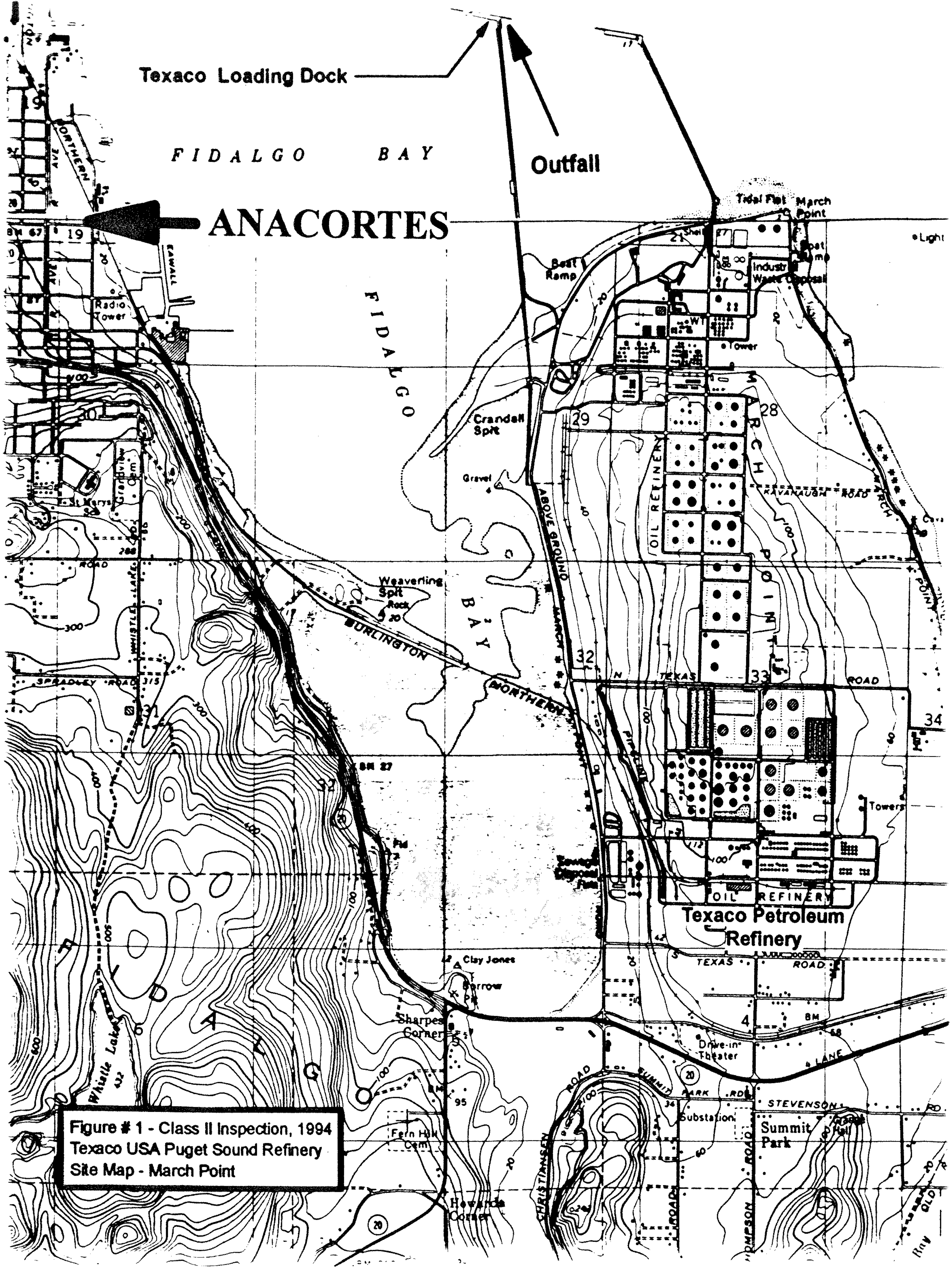

Figure # 1 - Class II Inspection, 1994
Texaco USA Puget Sound Refinery
Site Map - March Point

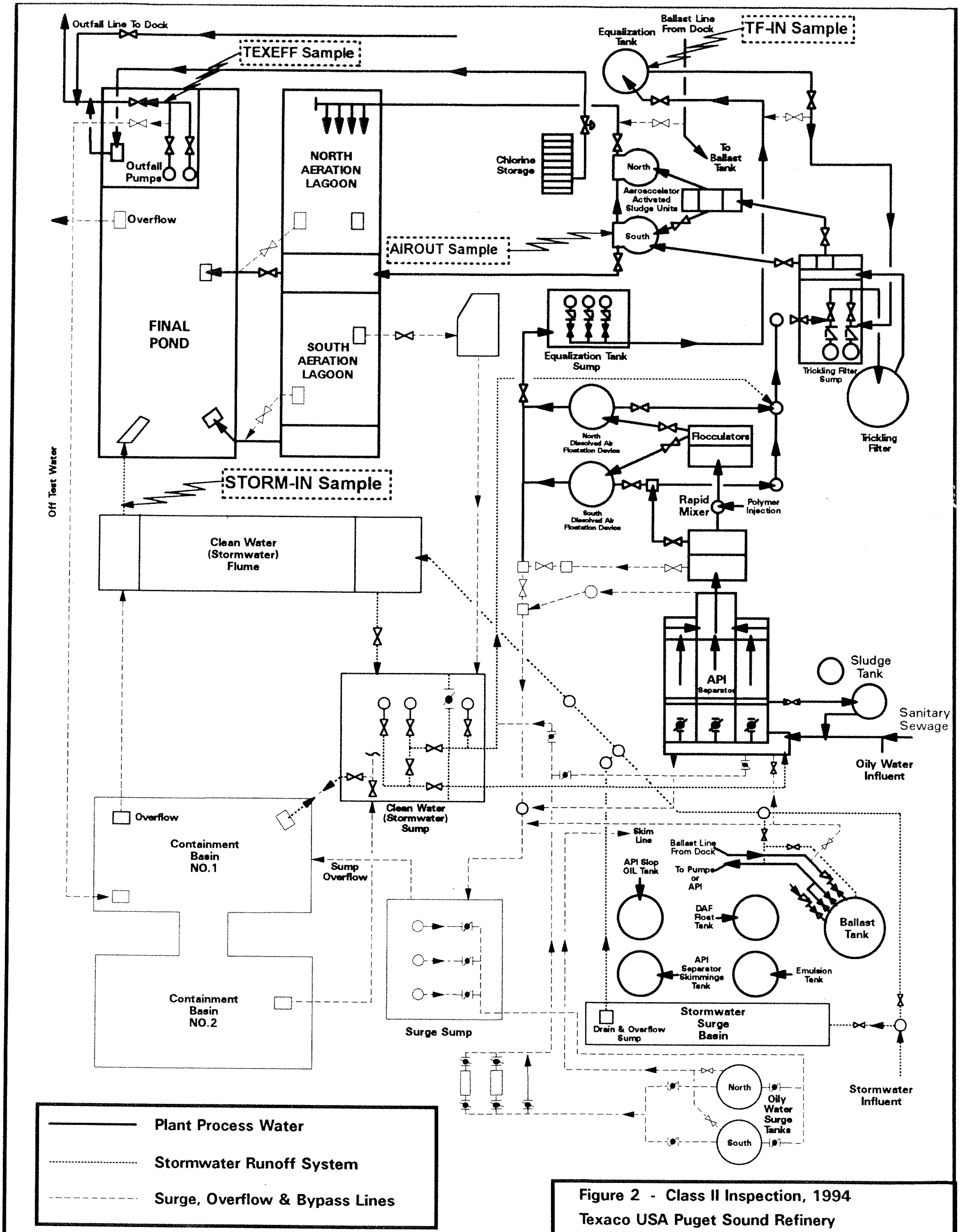

Figure 2 - Class II Inspection, 1994
Texaco USA Puget Sound Refinery
Industrial Wastewater Treatment System

Table 1 - Ecology General Chemistry Results - Texaco Oil Refinery, May 1994.

Parameter	Location:	TF-IN-1	TF-IN-2	TF-IN	AIR-OUT1	AIR-OUT2	AIR-OUT	STORM-IN-1	STORM-IN-2	STORM-IN
	Type:	grab	grab	E-com	grab	grab	E-comp	grab	grab	E-comp
	Date:	05/09	05/10	05/10	05/09	05/10	05/10	05/09	05/10	05/10
	Time:	2005	0938	@1	2015	1050	@2	2025	1115	@3
	Lab Log #:	198501	198502	198500	198511	198512	198510	198521	198522	198520
General Chemistry										
Conductivity (umhos/cm)				1540			1510			1230
Alkalinity (mg/L CaCO3)				124			112			
Hardness (mg/L CaCO3)										
Grain Size (Fractional %)										
Gravel	(>4750-850 microns)									
Sand	(850-106 microns)									
Fine Sand	(106-31.2 microns)									
Silt	(31.2-3.9 microns)									
Clay	(3.9-<0.9 microns)									
Other	(Balance)									
Solids										
TS (mg/L)				1070			967			753
TNVS (mg/L)				853			862			656
TSS (mg/L)		62	52	52	40	50	40	5	2	4
TNVSS (mg/L)				9			2			2
% Solids										
% Volatile Solids										
Oxygen Demand Parameters										
BOD5 (mg/L)				98			50 U			4 U
COD (mg/L)				339			175			9.3
TOC (water mg/L)				55			25.1	5.1	6.1	5.1
TOC (soil/sed mg/Kg-dry wt.)										
Nutrients										
NH3-N (mg/L)		11.1	13	11.6	9.39	10.8	9.68			
NO2+NO3-N (mg/L)		0.017	0.016	0.027	0.012	0.024	0.02			
Total-P (mg/L)		0.725	0.59	0.478	0.384	0.422	0.475			
Miscellaneous										
Oil and Grease (mg/L)								1 UJ	1 UJ	
F-Coliform MF (#/100mL)										
Cyanide total (ug/L)										
Cyanide (wk & dis ug/L)										
Phenol (mg/L)										0.04 UJ
Field Observations										
Temperature (C)		31.6	31.8		29.9	29.1		20.3	19.8	
Temp-cooled (C)*+				5.5			6.2			5.2
pH		8.9	9.0	9.2	7.3	7.5	7.5	9.5	9.8	9.8
Conductivity (umhos/cm)		1426	1360	1632	1790	1527	1590	1222	1130	1297

TF-IN	Ecology Trickling Filter influent sample.
AIR-OUT	Ecology Aeroaccelator Activated Sludge Unit effluent sample.
STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond
grab	Ecology grab sample
E-comp	Ecology composite sample
*+	Refrigerated sample

@1	Composite sample period: 0900 - 5/9 to 0900 - 5/10
@2	Composite sample period: 0940 - 5/9 to 0940 - 5/10
@3	Composite sample period: 1005 - 5/9 to 1005 - 5/10
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.

Table 1 - Ecology General Chemistry Results - Texaco Oil Refinery, May 1994.

Parameter	Location:	S-1	TEXEFF1	TEXEFF2	TEXEFF	EFFLUENT	TEXOUT1	SEDBACK
	Type:	grab	grab	grab	E-comp	T-comp	grab	grab
	Date:	05/09	05/09	05/10	05/10	05/10	04/18	04/06
	Time:	1900	1920	0920	@4	@5	1100	1400
	Lab Log #:	198550	198531	198532	198530	198540	168233	148230
GENERAL CHEMISTRY								
Conductivity (umhos/cm)		630			1360	1350		
Alkalinity (mg/L CaCO3)					107	107		
Hardness (mg/L CaCO3)						71.6		
Grain Size (Fractional %)								
Gravel	(>4750-850 microns)						3	0
Sand	(850-106 microns)						83	42
Fine Sand	(106-31.2 microns)						6	31
Silt	(31.2-3.9 microns)						4	15
Clay	(3.9-<0.9 microns)						3	10
Other	(Balance)						1	2
SOLIDS								
TS (mg/L)		431			800	788		
TNVS (mg/L)		287			734	724		
TSS (mg/L)		6	8	8	7	5		
TNVSS (mg/L)		3				1 U		
% Solids							72.4	58.6
% Volatile Solids							2	3.4
OXYGEN DEMAND PARAMETERS								
BOD5 (mg/L)		8			8	7		
COD (mg/L)		42			70.9	63.9		
TOC (water mg/L)		16.3	16.2	16.8	16.4	16.3		
TOC (soil/sed mg/Kg-dry wt.)							2850	8100
NUTRIENTS								
NH3-N (mg/L)			9.21	10.1	9.51	9.64		
NO2+NO3-N (mg/L)					0.049			
Total-P (mg/L)					0.626			
MISCELLANEOUS								
Oil and Grease (mg/L)			5 J	5 J				
F-Coliform MF (#/100mL)			3 U	3 U				
Cyanide total (ug/L)					0.032 J	0.043 J		
Cyanide (wk & dis ug/L)					0.004 UJ	0.027 J		
Phenol (mg/L)		0.04 UJ			0.04 J	0.04 UJ		
FIELD OBSERVATIONS								
Temperature (C)		10.8	24.5	22.7				
Temp-cooled (C)*+					5.9	11.8		
pH		7.5	7.4	7.5	7.8	8.1		
Conductivity (umhos/cm)		644	1429	1406	1426	1399		

S-1	Ecology Stormwater sample from east side of refinery	TEXOUT1	Ecology sediment sample taken at outfall.
TEX-EFF	Ecology effluent sample from final pond.	SEDBACK	Ecology background sediment sample taken east of shipping pier.
EFFLUENT	Texaco effluent sample from final pond	@4	Ecology Composite sample period: 1910 - 5/9 to 0400 - 5/10
grab	Ecology grab sample	@5	Texaco Composite sample period slightly exceeded Ecology sample period.
E-comp	Ecology composite sample	J	The analyte was positively identified. The associated numerical result is an estimate.
T-comp	Texaco composite sample		
*+	Refrigerated sample	UJ	The analyte was not detected at or above the reported estimated result.

Table 2 - General Chemistry Results Percent Removal - Texaco Oil Refinery, May 1994.

Parameter Location:	TF-IN	AIR-OUT	Percent Removal Across Trickling Filter And South Aereoaccelator	STORM-IN	TEXEFF	Percent Removal Across Aerated Lagoons from South Aereoaccelator○	Ecology Percent Removal Across Plant	Ecology Percent of Final Load Attributed To Process Wastewater*	EFFLUENT	Texaco Percent Removal Across Plant	Texaco Percent of Final Load Attributed To Process Wastewater*
Type:	E-comp	E-comp		E-comp	E-comp				T-comp		
Date:	05/10	05/10		05/10	05/10				05/10		
Time:	@1	@2		@3	@4				@4		
Lab Log #:	198500	198510		198520	198530				198540		
General Chemistry											
Conductivity (umhos/cm)	1540	1510	2%	1230	1360	3%	4%	66%	1350	5%	66%
Alkalinity (mg/L CaCO3)	124	112	10%		107				107		
Solids											
TS (mg/L)	1070	967	10%	753	800	9%	15%	69%	788	17%	69%
TNVS (mg/L)	853	862	-1%	656	734	6%	5%	67%	724	7%	67%
TSS (mg/L)	52	40	23%	4	7	73%	79%	95%	5	85%	97%
Oxygen Demand Parameters											
BOD5 (mg/L)	98	50 U	49% #	4 U	8	75% #	87% #	97%	7	89% #	98%
COD (mg/L)	339	175	48%	9.3	70.9	36%	66%	98%	63.9	70%	98%
TOC (water mg/L)	55	25.1	54%	5.1	16.4	5% **	54%	94%	16.3	54%	94%
Nutrients											
NH3-N (mg/L)	11.6	9.68	17%		9.51	-62% ###	-35% ###	100%	9.64	-35%	100%
NO2+NO3-N (mg/L)	0.027	0.02	26% **		0.049						
Total-P (mg/L)	0.478	0.475	1% **		0.626						
Field Measurements											
pH	9.19	7.45	19% ##	9.76	7.83	16% ##	18% ##		8.05	16% ##	
Conductivity (umhos/cm)	1632	1590	3%	1297	1426	3%	5%	66%	1399	7%	67%

TF-IN	Ecology Trickling Filter influent sample.
AIR-OUT	Ecology Aeroaccelator Activated Sludge Unit effluent sample.
STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond
E-comp	Ecology composite sample
T-comp	Texaco composite sample
*	Assumes steady-state flow and uniform removal through the final retention ponds.
**	Difference in results is less than the variation in the precision of the laboratory procedure
#	Based upon the low detect concentration .
##	This is percent change in pH, a logrithmic representation of active ion concentration. Assuming no buffering capacity, a linear decrease in the number of moles hydroxide ions/day approaches 5400% across the trickling filter and AAS units, 3300% across the aerated lagoons, and 4600% across the plant.
###	Assumes zero concentration in the stormwater.
@1	Composite sample period: 0900 - 5/9 to 0900 - 5/10
@2	Composite sample period: 0940 - 5/9 to 0940 - 5/10
@3	Composite sample period: 1005 - 5/9 to 1005 - 5/10
@4	Composite sample period: 1910 - 5/9 to 0400 - 5/10
U	The analyte was not detected at or above the reported result.
¤	Assumes that north aereoaccelator produces approximately the same effluent quality as the south aereoaccelator.
Ecology	Ecology sample
Texaco	Texaco sample

Table 3 - NPDES Limits Inspection Results - Texaco, 1994

Parameter	NPDES Permit Effluent Limits*			Inspection Results				
				Ecology Composite	Texaco Composite	Ecology Grab		
			Location:	TEXEFF	EFFLUENT	TEXEFF-1	TEXEFF-2	TEXEFFB
			Type:	E-comp	T-comp	grab	grab	grab-comp
	Monthly Average	Daily Maximum	Date:	05/10	05/10	05/09	05/10	05/10
			Time:	@4	@5	1920	0920	@6
			Lab Log #:	198530	198540	198531	198532	198530B
Effluent BOD5								
Concentration (mg/L)				8	7			
Loading(lbs/day)	710	1290		241	211			
Chemical Oxygen Demand								
Concentration (mg/L)				70.9	63.9			
Loading(lbs/day)	4940	9540		2,139	1,928			
Effluent TSS								
Concentration (mg/L)				7	5			
Loading(lbs/day)	570	900		211	151			
Oil & Grease								
Concentration (mg/L)						5 J	5 J	
Loading(lbs/day)	210	380				151	151	
Phenolic Compounds								
Concentration (mg/L)				0.04	0.04			
Loading(lbs/day)	4.6	9.6		1.2	1.2			
Ammonia Nitrogen								
Concentration (mg/L)				9.51	9.64	9.21	10.10	
Loading(lbs/day)	480	1040		287	291	278	305	
Total Chromium								
Concentration (mg/L)				5 U	5 U			
Loading(lbs/day)	8.9	19.5		0.15	0.15			
Hexavalent Chromium								
Concentration (mg/L)				3.1 P	2.1 P			
Loading(lbs/day)	0.7	1.5		0.09	0.06			
Effluent pH								
(S.U.)	6.0 < pH < 9.0			7.83	8.05	7.44	7.52	
Effluent Fecal coliform								
(#/100 mL)	200	400				3 U	3 U	
Salmonid Acute Bioassay								
(%) Survival	80% Survival at 65% Concentration							93

TEXEFF	Ecology effluent sample from final pond.
EFFLUENT	Texaco effluent sample from final pond
grab	Ecology grab sample
T-comp	Texaco composite sample
E-comp	Ecology composite sample
grab-comp	Grap composite sample
TEX-EFFB	Effluent bioassay grab-composite
B	Lab Log # same as TEXEFF

*	Based upon three preceding consecutive months of production exceeding 116,000 bbls/day and the absence of rainfall during the inspection period.
J	The analyte was positively identified. The associated numerical is an estimate.
P	The analyte was detected above the instrument detection limit, but below the established minimum quantitation limit.
U	The analyte was not detected at or above the reported result.
@4	Ecology composite sample period: 1910 - 5/9 to 0400 - 5/10
@5	Texaco composite sample period is slightly greater than Ecology sample period.
@6	Grab composite 1st half taken during composite period and 2nd half taken after composite period.

Table 4 - Detected VOA, BNA, and Metals Scan Results - Texaco, 1994.

Location:		STORM-IN-	STORM-IN-2	TEXEF	TEXEFF2	EPA Water Quality Criteria Summary	
Type:		grab	grab	grab	grab	Acute Marine	Chronic Marine
Date:		05/09	05/10	05/09	05/10		
Time:		2025	1115	1920	0920		
Lab Log#:		198521	198522	198531	198532		
VOA Compound	(Group)	μg/L	μg/L	μg/L	μg/L	(μg/L)	(μg/L)
Chloroform	a	0.87 J	0.7 J	0.24 J	0.23 J	12000 *(a)	6400 *(a)
Benzene		1.6	1.3			5100 *	700 *
Toluene		1.9	0.7 J			6300 *	5000 *
Ethylbenzene		0.33 J				430 *	
m p-XYLENE		1.2 J	0.51 J				
o-XYLENE		0.77 J	0.32 J				
Total Xylenes			0.84 J				
1,3,5-Trimethylbenzene		0.18 J					
1,2,4-Trimethylbenzene			0.2 J				

Location:		STORM-IN	S-1	TEXEFF	EFFLUENT	EPA Water Quality Criteria Summary		TEXOUT1	SEDBACK
Type:		E-comp	grab	E-comp	T-comp	Acute Marine	Chronic Marine	grab	grab
Date:		05/10	05/09	05/10	05/10			04/18	04/06
Time:		@3	1900	@4	@5			1100	1400
Lab Log#:		98520	198550	198530	198540			168233	148230
BNA Compounds	(Group)	µg/L	µg/L	µg/L	µg/L	(µg/L)	(µg/L)	µg/Kg	µg/Kg
1,3-Dichlorobenzene	h					1970 *(h)		5.8 J	
1,4-Dichlorobenzene	h					1970 *(h)		5.0 J	
1,2-Dichlorobenzene	h					1970 *(h)		5.1 J	
2-Methylphenol		0.08 J							
Isophorone		0.2		0.46		12900 *			
2,4-Dimethylphenol		0.13 J							
Naphthalene	n					2350 *			20.8 J
2-Methylnaphthalene									15.9 J
2,4,5-Trichlorophenol			2.6						
Acenaphthylene	n					300 *(n)			16.0 J
Dibenzofuran									7.8 J
Phenanthrene	n					300 *(n)		27.4 J	100 J
Anthracene	n					300 *(n)		7.7 J	24.3 J
Fluoranthene	n					40 *	16 *	23.3 J	111 J
Pyrene	n		0.05 J	0.33	0.29	300 *(n)		30.3 J	100 J
Retene									26.3 J
Butylbenzyl Phthalate	i	0.83 J				2.944 *(i)	3.4 *(i)		
Chrysene	n	0.17 U	0.13 U	0.23	0.34	300 *(n)		12.9 J	52.1 J
Bis(2-Ethylhexyl)Phthalate	i					2.944 *(i)	3.4 *(i)	2840	
Benzo(a)Pyrene	n					300 *(n)		19.0 J	
Indeno(1,2,3-cd)Pyrene	n					300 *(n)			22.5 J
Benzo(g,h,i)Perylene	n					300 *(n)		28.7 J	

STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond	E-comp	Ecology composite sample		
TEX-EFF	Ecology effluent sample from final pond.	T-comp	Texaco composite sample		
S-1	Ecology Stormwater sample from east side of refinery	J	The analyte was positively identified. The associated numerical result is an estimate.		
EFFLUENT	Texaco effluent sample from final pond	U	The analyte was not detected at or above the reported result.		
TEXOUT1	Ecology sediment sample taken at outfall.	UJ	The analyte was not detected at or above the reported estimated result.		
SEDBACK	Ecology background sediment sample taken east of shipping pier.	a	Total Halomethanes		
@3	Composite sample period: 1005 - 5/9 to 1005 - 5/10	h	Total Dichlorobenzenes	*	Insufficient data to develop criteria. Value presented is the LOEL - Lowest Observed Effect Level.
@4	Ecology composite sample period: 1910 - 5/9 to 0400 - 5/10	i	Total Phthalate Esters		
@5	Texaco composite sample period slightly greater than Ecology sample period.	n	Total Polynuclear Aromatic Hydrocarbons	grab	Ecology grab sample

Table 4 - Detected VOA, BNA, and Metals Scan Results - Texaco, 1994.

Location:	STORM-IN	S-1	TEXEFF	EFFLUENT	EPA & State Water Quality Criteria Summary	
Type:	E-comp	grab	E-comp	T-comp	Acute	Chronic
Date:	05/10	05/09	05/10	05/10	Marine	Marine
Time:	@3	1900	@4	@5		
Lab Log#:	198520	198550	198530	198540		
Metals (Total Recoverable)	µg/L	µg/L	µg/L	µg/L	(µg/L)	(µg/L)
Arsenic		1.5 P	2.0 P	2.0 P	69 c	36 d,cc
Cadmium		2.22	22.7 P		37.2 c	8 d
Chromium (Hexavalent)			3.1 P	2.1 P	1100 c,l	50 d
Copper	8.5 P	14 P	5.8 P	5.3 P	2.5 c	
Lead		5.3 P	1.6 P	1.2 P	151.1 c	5.8 d
Mercury		0.13 P	0.14 P	0.14 P	2.1 c	0.025 d
Selenium			42.8 J	33.1 J	300 c	71 d,x
Zinc	15 P	111	546	14 P	84.6 c	76.6 d

STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond
TEX-EFF	Ecology effluent sample from final pond.
S-1	Ecology Stormwater sample from east side of refinery
EFFLUENT	Texaco effluent sample from final pond
TEXOUT1	Ecology sediment sample taken at outfall.
SEDBACK	Ecology background sediment sample taken east of shipping pier.
@3	Ecology composite sample period: 1005 - 5/9 to 1005 - 5/10
@4	Ecology composite sample period: 1910 - 5/9 to 0400 - 5/10
@5	Texaco composite sample period slightly exceeded Ecology's sample period.
d	A 4-day average conc. not to be exceeded once every three years on average.
l	Salinity dependent effects. At low salinity the 1-hour average may not be sufficiently protective.

E-comp	Ecology composite sample
T-comp	Texaco composite sample
grab	Ecology grab sample
J	The analyte was positively identified. The associated numerical result is an estimate.
P	The analyte was detected above the instrumentation limit, but below the established minimum quantitation limit.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.
c	The 1-hour average concentration not to be exceeded more than once every three years on the average.
cc	Nonlethal effects to diatoms have been noted, and wherever practical ambient concentrations should not exceed a chronic marine concentrations of 21 µg/L.
x	The status of the fish community should be monitored whenever the concentration of selenium exceeds 5 µg/L in salt water.
☐	Exceeds criteria

Table 5 - Effluent Bioassay Results - Texaco, 1994.

NOTE: all tests were run on the effluent (TEXEFFB sample) - lab log # 198530B

Daphnia pulex - 48 hour survival test

(Daphnia pulex)

Sample	Number Tested	Percent Survival
Control	20	100
6.25 % Eff	20	75
12.5 % Eff	20	85
25 % Eff	20	85
50 % Eff	20	65
100 % Effluent	20	55

(Survival)

LC50 > 100% effluent

LOEC = 6.25 % effluent

NOEC < 6.25% effluent

Four replicates of five organisms

Fathead Minnow - 96-hour Survival Test

(Pimephales promelas)

Sample	Number Tested	Percent Survival
Control	40	100%
6.25 % Effluent	40	85%
12.5 % Effluent	40	93%
25 % Effluent	40	93%
50 % Effluent	40	68%
100 % Effluent	40	8%

(Survival)

LC50 = 58% effluent

LOEC = 50 % effluent

NOEC = 25% effluent

Four replicates of ten organisms

Rainbow Trout - 96-hour Screening-level Survival Test

(Oncorhynchus mykiss)

Sample	Number Tested	Percent Survival
Control	30	97
65% Effluent	30	93
100% Effluent	30	93

NOEC - no observable effects concentration
LOEC - lowest observable effects concentration
LC50 - lethal concentration for 50% of the organisms
EC50 - effect concentration for 50% of the organisms

TEX-EFFB	Effluent bioassay grab-composite
B	Lab Log # same as TEXEFF

Table 5 (cont.) - Effluent Bioassay Results - Texaco, 1994.

NOTE: all tests were run on the effluent (TEXEFF sample) - lab log # 198530

Echinoderm Sperm Cell Toxicity Test

(Strongylocentrotus purpuratus)

Sample	Number of Normal Fertilizations	Number of Abnormal Fertilizations	Mean % Unfertilized
Control (Brine Solution)	375	25	6
Natural Seawater Control	363	37	9
04.38 % Effluent	363	37	9
8.25 % Effluent	358	42	11
17.5 % Effluent	358	42	11
35 % Effluent	310	90	23
70 % Effluent	68	332	83

(Fertilization)
EC50 = 51 % effluent
LOEC = 35 % effluent
NOEC = 17.5 % effluent

4 replicates of 100 eggs

Pacific Oyster Embryo 48-hour Survival Test

(Crassostrea gigas)

Sample	Total Number of Embroys	Total Survival	Normal Embroys	Abnormal Embroys	Mean % Survival	Mean % Abnormal
Control (Brine Solution)	828	807	768	43	97.5	5.3
Natural Seawater Control	843	624	576	49	74	2.3
04.38 % Effluent	846	643	584	59	76	4.1
8.25 % Effluent	845	625	573	52	74	2.8
17.5 % Effluent	837	720	632	88	86	6.7
35 % Effluent	838	620	10	610	74	93.0
70 % Effluent	843	632	10	632	75	93.1

(Normal Survival)
EC50 = 27 % effluent
LOEC = 4.38 % effluent
NOEC < 4.38 % effluent

4 replicates of 150-300 embroys

NOEC - no observable effects concentration
LOEC - lowest observable effects concentration
LC50 - lethal concentration for 50% of the organisms
EC50 - effect concentration for 50% of the organisms

Table 6 - Split Sample Result Comparison - Texaco,1994

Parameter	Location:	TEXEFF	EFFLUENT	TEXEFF1	TEXEFF2
	Type:	E-comp	T-comp	grab	grab
	Date:	05/10	05/10	05/09	05/10
	Time:	@4	@5	1920	0920
	Lab Log #:	198530	198540	198531	198532
General Chemistry					
	Laboratory				
Effluent BOD5	Ecology	8	7		
(mg/L)	Texaco	14			
Effluent TSS	Ecology	7	5		
(mg/L)	Texaco	9			
Chemical Oxygen Deman	Ecology	70.9	63.9		
(mg/L)	Texaco	38	38		
TOC		16.4	16.3		
(mg/L)		14.0	14.0		
Oil & Grease	Ecology			5 J	5 J
(mg/L)	Texaco			2.8	
Phenolic Compounds	Ecology	0.04 J	0.04 UJ		
(mg/L)	Texaco	0.005 U			
Ammonia Nitrogen	Ecology	9.51	9.64		
(mg/L)	Texaco				
Total Chromium	Ecology	0.005 U	0.005 U		
(mg/L)	Texaco	ND	ND		
Hexavalent Chromium	Ecology	0.003 P	0.0021 P		
(mg/L)	Texaco	0.03			
Effluent Fecal coliform	Ecology	3 U	3 U		
(#/100ml)	Texaco				
pH	Ecology	7.83	8.05		
	Texaco	7.6			
Metals					
Antimony (µg/L)	Ecology	30 U	30 U		
	Texaco	ND	ND		
Arsenic (µg/L)	Ecology	2.0 P	2.0 P		
	Texaco	4.0	5.0		
Beryllium (µg/L)	Ecology	1 U	1 U		
	Texaco	ND	ND		
Cadmium (µg/L)	Ecology	22.7	0.1 U		
	Texaco	13	ND		
Copper (µg/L)	Ecology	5.8 P	5.3 P		
	Texaco	ND	9		
Lead (µg/L)	Ecology	1.6 P	1.2 P		
	Texaco	ND	ND		
Mercury (µg/L)	Ecology	0.14 P	0.14 P		
	Texaco	10	20		
Nickel (µg/L)	Ecology	10 U	10 U		
	Texaco	4	3		
Selenium (µg/L)	Ecology	42.8 J	33.1 J		
	Texaco	48	40		
Silver (µg/L)	Ecology	0.50 UJ	0.05 UJ		
	Texaco	ND	ND		
Thallium (µg/L)	Ecology	2.5 UJ	2.5 UJ		
	Texaco	1	ND		
Zinc (µg/L)	Ecology	546	14 P		
	Texaco	480	ND		

E	Ecology sample	J	The analyte was positively identified. The associated numerical result is an estimate.
T	Texaco sample	P	The analyte was detected above the instrumentation limit, but below the established minimum quantitation limit.
grab	grab sample		
Comp	Composite sample	U	The analyte was not detected at or above the reported result.
EFFLUENT	Texaco effluent sample from final pond	UJ	The analyte was not detected at or above the reported estimated result.
TEX-EFF	Ecology effluent sample from final pond.	@4	Ecology composite sample period: 1910 - 5/9 to 0400 - 5/10
		@5	Texaco composite sample period slightly greater than Ecology sample period.

Table 6 (cont.) - Split Sample Result Comparison - Texaco,1994

NOTE: all Ecology and Texaco tests were run on the effluent (TEXEFFB sample) - lab log # 198530B

BIOASSAY DATA

Daphnia pulex - 48 hour survival test

(Daphnia pulex)

	Ecology Results	Texaco Results
Sample	Percent Survival	Percent Survival
Control	100	
6.25 % Effluent	75	100
12.5 % Effluent	85	100
25 % Effluent	85	100
50 % Effluent	65	100
100 % Effluent	55	100

Rainbow Trout - 96-hour Screening-level Survival Test

(Oncorhynchus mykiss)

	Ecology Results	Texaco Results
Sample	Percent Survival	Percent Survival
Control	97	
65% Effluent	93	100
100% Effluent	93	65

Fathead Minnow - 96-hour Survival Test

(Pimephales promelas)

	Ecology Results	Texaco Results
Sample	Percent Survival	Percent Survival
Control	100%	
100 % Effluent	8%	40%

Table 7 - Comparison of Detected Sediment Organics to Marine Sediment Quality Standards - Texaco, 1994

Location:	TEXOUT1	SEDBACK	Marine Sediment Quality Standards Chemical Criteria
Type:	grab	grab	
Date:	04/18	04/06	
Time:	1100	1400	
Lab Log#:	168233	148230	
Organic Compounds	mg/Kg TOC -dry wt.*	mg/Kg TOC -dry wt.*	mg/Kg TOC -dry wt.*
1,2-Dichlorobenzene	1.8		2.3
1,4-Dichlorobenzene	1.8		3.1
Dibenzofuran		0.96	15
Fluoranthene	8.2	13.70	160
Pyrene	10.6	12.35	1000
Chrysene	4.5	6.43	110
Bis(2-Ethylhexyl)Phthalate	$\boxed{996}$		47
Benzo(a)Pyrene	6.7		99
Indeno(1,2,3-c,d)Pyrene		2.78	34
Benzo(g,h,i)Perylene	10.1		31

*	Normalized to fractional percent TOC
TEXOUT1	Ecology sediment sample taken at outfall.
SEDBACK	Ecology background sediment sample taken east of shipping pier.
grab	Ecology grab sample
☐	Exceeds sediment quality standard

Table 8 - Sediment Bioassay Results - Texaco, 1994.

Amphipod/Rhepoxynius - 10 day Emergence and Survival Test
(Rhepoxynius abronius)

Parameter	Control	Location	TEXOUT1	SEDBACK	
		Type:	grab	grab	
		Date:	04/18	04/06	
		Time:	1100	1400	
		Lab Log #:	168233	148230	
Average Percent Survival*	94-97%		90%	93%	
Exceeded Marine Sediment Quality Minimum Biological Effects Criteria (WAC-173-204-320)			No	No	
Exceeds Marine Sediment Cleanup Screening Levels and Minimum Cleanup Biological Criteria (WAC-173-204-520)			No	No	

*	5 replicates of 10 organisms
TEXOUT1	Ecology sediment sample taken at outfall .
SEDBACK	Ecology sediment sample sample taken east of shipping pier.
grab	Grab sample

Appendices

Appendix A - Sampling Stations Descriptions - Texaco, 1994

TF-IN-#	Grab sample of wastewater collected from the flow out of the equalization tank upstream of the trickling filter - collected in both A.M. and P.M..
TF-IN	Ecology 24-hour composite sample of wastewater collected from the flow out of the equalization tank upstream of the trickling filter.
AIR-OUT-#	Grab sample of wastewater collected below the weir from the south Aeroaccelator Activated Sludge unit overflow - collected in both A.M. and P.M.
AIR-OUT	Ecology 24-hour composite sample of wastewater collected above the weir at the south Aeroaccelator Activated Sludge unit.
STORM-IN-#	Grab sample of stormwater collected from the effluent at the Clean Water (Stormwater) Flume before it flows into the Final Pond - collected in both A.M. and P.M.
STORM-IN	Ecology 24-hour composite sample of stormwater collected from the effluent at the Clean Water (Stormwater) Flume before it flows into the Final Pond.
S-1	Grab sample of stormwater collected from a channel on the east side of the refinery before flow is discharged to the ground.
TEXEFF-#	Grab sample of disinfected effluent collected from the overflow at the Final pond - collected in both A.M. and P.M.
TEXEFF	Ecology 8-hour composite sample of disinfected effluent collected from overflow at the Final Pond.
TEXEFFB	Ecology bioassay composite grab sample of disinfected effluent collected from overflow at the Final Pond.
EFFLUENT	Texaco 24-hour composite sample of disinfected effluent collected from the overflow at the Final Pond
TEXOUT1	Sediment sample collected at the loading dock outfall location (Lat: 48° 30′ 40″ N; Lang: 122° 34′ 35″ W)
SEDBACK	Background sediment sample collected northeast of the loading dock. (Lat: 48°- 30′- 40″ N; Long: 122°- 33′- 20″ W)

Appendix B - Texaco Oil Refinery Sampling Schedule, May 1994.

Parameter Location:	TF-IN-1	TF-IN-2	TF-IN	AIR-OUT1	AIR-OUT2	AIR-OUT	STORM-IN-1	STORM-IN-2	STORM-IN
Type:	grab	grab	E-comp	grab	grab	E-comp	grab	grab	E-comp
Date:	05/09	05/10	05/10	05/09	05/10	05/10	05/09	05/10	05/10
Time:	2005	0938	@1	2015	1050	@2	2025	1115	@3
Lab Log #:	198501	198502	198500	198511	198512	198510	198521	198522	198520
GENERAL CHEMISTRY									
Conductivity			E			E			E
Alkalinity			E			E			
Hardness									
Grain Size									
SOLIDS									
Solids 4			E			E			E
TSS	E	E		E	E		E	E	
% Solids									
% Volatile Solids									
OXYGEN DEMAND PARAMETERS									
BOD5			E			E			E
COD			E			E			E
TOC (water)			E			E	E	E	E
TOC (soil/sed)									
NUTRIENTS									
NH3-N	E	E	E	E	E	E			
NO2+NO3-N	E	E	E	E	E	E			
Total-P	E	E	E	E	E	E			
MISCELLANEOUS									
Oil and Grease (water)							E	E	
F-Coliform MF									
Cyanide (total)									
Cyanide (wk & dis)									
ORGANICS									
VOC (water)							E	E	
VOC (soil/sed)									
BNAs (water)									E
BNAs (soil/sed)									
Phenolics Total(water)									E
METALS									
PP Metals (water)									E
Total chromium									E
Hexavalent chromium									E
BIOASSAYS									
Salmonid (acute 100%)									
Bivalve Larvae (chronic)									
Daphnia pulex (acute)									
Fathead Minnow (chronic)									
Echinoderm sperm cell									
Rhepoxinius (solid acute)									
FIELD OBSERVATIONS									
Temperature	E	E		E	E		E	E	
Temp-cooled* +			E			E			E
pH	E	E	E	E	E	E	E	E	E
Conductivity	E	E	E	E	E	E	E	E	E

TF-IN	Ecology Trickling Filter influent sample.	@1	Composite sample period: 0900 - 5/9 to 0900 - 5/10
AIR-OUT	Ecology Aeroaccelator Activated Sludge Unit effluent sample.	@2	Composite sample period: 0940 - 5/9 to 0940 - 5/10
STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond	@3	Composite sample period: 1005 - 5/9 to 1005 - 5/10
grab	Ecology grab sample	E	Ecology laboratory analysis.
E-comp	Ecology composite sample	T	Texaco laboratory analysis.
* +	Refrigerated sample		
* +	Refrigerated sample		

Appendix B - Texaco Oil Refinery Sampling Schedule, May 1994.

Parameters	Location2:	S-1	TEXEFF1	TEXEFF2	TEXEFF	TEXEFFB	EFFLUENT	TEXOUT1	SEDBACK
	Type:	grab	grab	grab	E-comp	grab-comp	T-comp	grab	grab
	Date:	05/09	05/09	05/10	05/10	05/9-10	05/10	04/18	04/06
	Time:	1900	1920	0920	@4	1900&0920	@5	1100	1400
	Lab Log #:	198550	198531	198532	198530	198530B	198540	168233	148230
GENERAL CHEMISTRY									
Conductivity (umhos/cm)		E			ET		E		
Alkalinity (mg/L CaCO3)					ET		E		
Hardness (mg/L CaCO3)					ET		E		
Grain Size (% phi size)								E	E
SOLIDS									
Solids 4		E			E		ET		
TSS (mg/L)			E	E	T				
% Solids								E	E
% Volatile Solids								E	E
OXYGEN DEMAND PARAMETERS									
BOD5 (mg/L)		E			ET		E		
COD (mg/L)		E			ET		ET		
TOC (water mg/L)		E	E	E	ET		ET		
TOC (soil/sed)								E	E
NUTRIENTS									
NH3-N (mg/L)			E	E	ET		E		
NO2+NO3-N (mg/L)					E				
Total-P (mg/L)					E				
MISCELLANEOUS									
Oil and Grease (mg/L)			E	E					
F-Coliform MF (#/100mL)			E	E					
Cyanide total (ug/L)					ET		ET		
Cyanide (wk & dis ug/L)					E		E		
ORGANICS									
VOC (water-ug/L)			E	E					
VOC (soil-ug/kg)								E	E
BNAs (water-ug/L)		E			ET		ET		
BNAs (soil-ug/kg)								E	E
Phenolics Total(water-mg/L)		E			ET		E		
METALS									
PP Metals		E			ET		ET		
Total chromium (ug/L)		E			ET		ET		
Chrome 6 (ug/L)		E			ET		ET		
BIOASSAYS									
Salmonid (acute 100%)						E			
Bivalve Larvae (acute)						E			
Daphnia sp. (chronic)						E			
Fathead Minnow (chronic)						E			
Echinoderm sperm cell						E			
Rhepoxinius (solid acute)								E	E
FIELD OBSERVATIONS									
Temperature (C)		E	E	E					
Temp-cooled (C)* +					E		E		
pH		E	E	E	ET		E		
Conductivity (umhos/cm)		E	E	E	E		E		

S-1	Ecology Stormwater sample from east side of refinery
TEX-EFF	Ecology effluent sample from final pond.
EFFLUENT	Texaco effluent sample from final pond
grab	Ecology grab sample
E-comp	Ecology composite sample
T-comp	Texaco composite sample
* +	Refrigerated sample
TEXOUT1	Ecology sediment sample taken at outfall.
SEDBACK	Ecology background sediment sample taken east of shipping pier.
@4	Composite sample period: 1910 - 5/9 to 0400 - 5/10
@5	Texaco composite sample period slightly exceeded Ecology's sample period.
E	Ecology laboratory analysis.
T	Texaco laboratory analysis.

Appendix C - Laboratory Methods - Texaco Class II, 1994

PARAMETER	MANCHESTER METHODS	LAB USED
GENERAL CHEMISTRY		
Conductivity (umhos/cm)	EPA, Revised 1983: 120.1	Ecology
Alkalinity (mg/L CaCO3)	EPA, Revised 1983: 310.1	Ecology
Hardness (mg/L CaCO3)	EPA, Revised 1983: 130.2	Ecology
Grain Size (% phi size)	Tetra Tech, 1986:TC-3991-04	Soil Technology, Inc.
SOLIDS		
Solids 4	EPA, Revised 1983: 160.2&3	Ecology
TSS (mg/L)	EPA, Revised 1983: 160.2	Ecology
% Solids	APHA-AWWA-WPCF 1989: 2540G.	Ecology
% Volatile Solids	EPA, Revised 1983: 160.4	Ecology
OXYGEN DEMAND PARAMETERS		
BOD5 (mg/L)	EPA, Revised 1983: 405.1	Ecology
COD (mg/L)	EPA, Revised 1983: 410.1	Analytical Resources Incorportated
TOC (water mg/L)	EPA, Revised 1983: 415.1	Ecology
TOC (soil/sed)	EPA, Revised 1983: 415.1	Sound Analytical Services, Inc.
NUTRIENTS		
NH3-N (mg/L)	EPA, Revised 1983: 350.1	Ecology
NO2+NO3-N (mg/L)	EPA, Revised 1983: 353.2	Ecology
Total-P (mg/L)	EPA, Revised 1983: 365.3	Ecology
MISCELLANEOUS		
Oil and Grease (mg/L)	EPA, Revised 1983: 413.1	Ecology
F-Coliform MF (#/100mL)	APHA-AWWA-WPCF 1989: 9222D.	Ecology
Cyanide total (ug/L)	EPA, Revised 1983: 335.2	Analytical Resources Incorportated
Cyanide (wk & dis ug/L)	APHA-AWWA-WPCF 1989: 4500-CNI.	Analytical Resources Incorportated
ORGANICS		
VOC (water-ug/L)	EPA, 1986: 8260	Ecology
VOC (soil-ug/kg)	EPA, 1986: 8240	Ecology
BNAs (water-ug/L)	EPA, 1986: 8270	Ecology
BNAs (soil-ug/kg)	EPA, 1986: 8270	Ecology
Phenolics Total(water-mg/L)	EPA, Revised 1983: 420.2	Analytical Resources Incorportated
METALS		
PP Metals	EPA, Revised 1983: 200-299	Ecology
Total chromium (ug/L)	EPA, Revised 1983: 218.3	Ecology
Chrome 6 (ug/L)	EPA, Revised 1983: 218.5	Ecology
BIOASSAYS		
Salmonid (acute 100%)	Ecology, 1981.	Parametrix, Inc.
Bivalve Larvae (acute)	ASTM, 1989:E724	Parametrix, Inc.
Daphnia pulex (chronic)	EPA, 1993	Parametrix, Inc.
Fathead Minnow (chronic)	EPA 1989:1000	Parametrix, Inc.
Echinoderm sperm cell	Dinnel, 1987	Parametrix, Inc.
Rhepoxinius (solid acute)	ASTM, 1990: E1367	Parametrix, Inc.

APHA-AWWA-WPCF, 1989.	**Standard Methods for the Exanination of Water and Wastewater, 17th Edition.**
ASTM, 1989: E724.	Standard Guide for Conducting Static Acute Toxicity Tests Starting with Embryos of Four Species Species of Saltwater Bivalve Molluses. In: Annual Book of ASTM Standards, Water and Environmental Technology. American Society for Testing and Materials, Philadelphia. Pa. SW846
ASTM, 1990: E1367.	Guide for Conducting Sediment Toxicity Tests of Estuarine and Marine Invertebrates. In: Annual Book of ASTM Standards, Water and Environmental Technology. American Society of Testing and Materials, Philadelphia, Pa.
Dinnel,1987.	Improved Methodology for a Sea Urchin Sperm Cell Bioassay for Marine Waters. Dinnel, P.A., et.al, 1987. Arch. Environ. Contam. Toxicol., 16, 23-32.
Ecology, 1981.	Static Acute Fish Toxicity Test, WDOE 80-12, revised July 1981.
EPA, Revised 1983.	Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 (Rev. March, 1983).
EPA, 1986.	Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846, 3rd. ed.,November, 1986.
EPA, 1989.	Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving waters to Freshwater Organisms.
EPA, 1993.	Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms. EPA/600/4-90/027F
Tetra Tech, 1986.	Recommended Protocols for Measuring Selected Environmental Variables in Puget Sound, Prepared for Puget Sound Estuary Program.

Appendix D - Priority Pollutant Cleaning Procedures and QA/QC Concerns - Texaco USA (Anacotes), 1994.

PRIORITY POLLUTANT SAMPLING EQUIPMENT CLEANING PROCEDURES

1. Wash with laboratory detergent
2. Rinse several times with tap water
3. Rinse with 10% HNO3 solution
4. Rinse three (3) times with distilled/deionized water
5. Rinse with high purity methylene chloride
6. Rinse with high purity acetone
7. Allow to dry and seal with aluminum foil

SPECIFIC LABORATORY QA/QC CONCERNS

1. Low levels of the volatile compounds acetone and methylene chloride were detected in laboratory blanks for both water and sediment matrices. Several volatile and semivolatile compound were detected in sediment laboratory blanks. The EPA 5 times rule was applied, where compounds are considered real and not the result of contamination if the levels in the sample were greater than or equal to five times the amount of compounds in the associated method blank.

2. Matrix spike recoveries and Relative Percent Differences (RPD) were not acceptable for a number of compounds found in both water and sediment matrices. The "J" qualifier was added to the results for those compounds in the sample.

3. Phenol distillation check standard, which typically exhibits low recoveries, was outside the QC limits. Positive Phenol results have been qualified with the "J" and non-detect Phenol results have been qualified with the "UJ" to indicate a possible low bias.

4. The samples analyzed for Phenols and CN were received unpreserved. Phenols were already qualified due to low recoveries. All positive CN results have been qualified with a "J" and all CN non-detects with a "UJ"

5. Spike recoveries for thallium were outside the CLP acceptance limits. Silver was not spiked (lab error) and no spike or spike duplicate data are available. Silver results were qualified with a "J", denoting estimates. Thallium was qualified with a "J", denoting estimated values due to poor precision.

Appendix E - VOA, BNA, and Metals Scan Results - Texaco, 1994.

Location:	STORM-IN-1	STORM-IN-2	TEXEFF1	TEXEFF2	TEXOUT1	SEDBACK
Type:	grab	grab	grab	grab	grab	grab
Date:	05/09	05/10	05/09	05/10	04/18	04/06
Time:	2025	1115	1920	0920	1100	1400
Lab Log#:	198521	198522	198531	198532	168233	148230
VOA Compounds	µg/L	µg/L	µg/L	µg/L	µg/Kg-dry wt.	µg/Kg-dry wt.
Dichlorodifluoromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
Chloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
Vinyl Chloride	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
Bromomethane	2.0 U	2.0 U	2.0 U	2.0 U	1.3 U	1.5 UJ
Chloroethane	2.0 U	2.0 U	2.0 U	2.0 U	1.3 U	1.5 UJ
Trichlorofluoromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
1,1-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Acetone	2.5 UJ	3.2 UJ	6.6 UJ	4.2 UJ	1.4 UJ	12.8 UJ
Carbon Disulfide	1.0 U	1.0 U	0.9 J	0.69 J	1.2 UJ	1.6 UJ
Methylene Chloride	1.0 UJ	1.0 UJ	1.8 UJ	1.0 UJ	1.4 UJ	1.5 UJ
trans-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,1-Dichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
2,2-Dichloropropane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
cis-1,2-Dichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
2-Butanone (MEK)	1.0 UJ	1.0 U	1.0 UJ	1.0 UJ	1.3 UJ	6.0 UJ
Bromochloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Chloroform	0.87 J	0.7 J	0.24 J	0.23 J	1.3 UJ	1.5 UJ
1,1,1-Trichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,1-Dichloropropene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Carbon Tetrachloride	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Benzene	1.6	1.3	1.0 UJ	1.0 UJ	1.3 UJ	1.5 UJ
1,2-Dichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Trichloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,2-Dichloropropane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Dibromomethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Bromodichloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
cis-1,3-Dichloropropene	0.53 U	0.53 U	0.53 U	0.53 U	0.69 U	0.82 UJ
4-Methyl-2-Pentanone (MIBK)	1.0 U	1.0 U	1.0 U	1.0 U	2.6 U	3.1 UJ
Toluene	1.9	0.7 J	1.0 UJ	1.0 U	1.3 U	1.5 UJ
trans-1,3-Dichloropropene	0.47 U	0.47 U	0.47 U	0.47 U	0.61 UJ	0.73 UJ
1,1,2-Trichloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
Tetrachloroethene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,3-Dichloropropane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
2-Hexanone	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	3.1 UJ
Dibromochloromethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
1,2-Dibromoethane (EDB)	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Chlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
1,1,1,2-Tetrachloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Ethylbenzene	0.33 J	1.0 UJ	1.0 U	1.0 UJ	1.3 UJ	1.5 UJ
m p-XYLENE	1.2 J	0.51 J	2.0 U	2.0 U	1.3 UJ	1.5 UJ
o-XYLENE	0.77 J	0.32 J	1.0 U	1.0 U	1.3 UJ	1.5 UJ
Total Xylenes	2.0 U	0.84 J	3.0 U	3.0 U	2.6 UJ	3.0 UJ
Ethenylbenzene (Styrene)	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ

STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond	grab	Ecology grab sample
TEX-EFF	Ecology effluent sample from final pond.	J	The analyte was positively identified. The associated numerical result is an estimate.
TEXOUT1	Ecology sediment sample taken at outfall.	U	The analyte was not detected at or above the reported result.
SEDBACK	Ecology background sediment sample taken east of shipping pier.	UJ	The analyte was not detected at or above the reported estimated result.

Appendix E (cont'd) - VOA, BNA, and Metal Scan Results - Texaco, 1994.

Location:	STORM-IN-1	STORM-IN-2	TEXEFF1	TEXEFF2	TEXOUT1	SEDBACK
Type:	grab	grab	grab	grab	grab	grab
Date:	05/09	05/10	05/09	05/10	04/18	04/06
Time:	2025	1115	1920	0920	1100	1400
Lab Log#:	198521	198522	198531	198532	168233	148230
VOA Compounds	μg/L	μg/L	μg/L	μg/L	μg/Kg-dry wt.	μg/Kg-dry wt.
Bromoform	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
Isopropylbenzene	0.077 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,1,2,2-Tetrachloroethane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Bromobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,2,3-Trichloropropane	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Propylbenzene	1.0 U	1.0 U	1.0 UJ	1.0 U	1.3 U	1.5 UJ
2-Chlorotoluene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,3,5-Trimethylbenzene	0.18 J	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
4-Chlorotoluene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
tert-Butylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,2,4-Trimethylbenzene	1.0 U	0.2 J	1.0 U	1.0 U	1.3 UJ	1.5 UJ
sec-Butylbenzene	1.0 U	1.0 U	1.0 UJ	1.0 U	1.3 U	1.5 UJ
1,3-Dichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
p-Isopropyltoluene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,4-Dichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
1,2-Dichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
Butylbenzene	1.0 U	1.0 U	1.0 U	1.0 U	1.3 UJ	1.5 UJ
1,2-Dibromo-3-Chloropropane (DBCP)	1.0 U	1.0 U	1.0 U	1.0 U	1.3 U	1.5 UJ
1,2,4-Trichlorobenzene	1.0 U	1.0 U	1.0 U	1.0 U	2.6 UJ	3.1 UJ
Hexachlorobutadiene	1.0 U	1.0 U	1.0 U	1.0 U	2.6 UJ	3.1 UJ
Naphthalene	1.3 UJ	1.0 UJ	1.0 UJ	1.1 UJ	2.6 UJ	7.7 UJ
1,2,3-Trichlorobenzene	1.0 UJ	1.0 U	1.0 UJ	1.0 UJ	6.5 UJ	7.7 UJ

Location:	STORM-IN	S-1	TEXEFF	EFFLUENT	TEXOUT1	SEDBACK
Type:	E-comp	grab	E-comp	T-comp	grab	grab
Date:	05/10	05/09	05/10	05/10	04/18	04/06
Time:	@3	1900	@4	@5	1100	1400
Lab Log#:	198520	198550	198530	198540	168233	148230
BNA Compounds	μg/L	μg/L	μg/L	μg/L	μg/Kg-dry wt.	μg/Kg-dry wt.
Dimethylnitrosamine	0.17 U	0.13 U	0.29 U	0.28 U	126 UJ	174 U
Pyridine	0.17 U	0.13 U	0.29 U	0.28 U	126 UJ	174 U
Aniline	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Phenol	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Bis(2-Chloroethyl)Ether	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
o-Chlorophenol	0.17 U	0.13 U	0.29 U	0.28 U	62.8 UJ	174 U
1,3-Dichlorobenzene	0.17 U	0.13 U	0.29 U	0.28 U	5.8 J	174 UJ
1,4-Dichlorobenzene	0.17 U	0.13 U	0.29 U	0.28 U	5.0 J	174 U
1,2-Dichlorobenzene	0.17 U	0.13 U	0.29 U	0.28 U	5.1 J	174 U
Benzyl Alcohol	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 UJ
2-Methylphenol	0.076 J	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Bis(2-Chloroisopropyl)Ether	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U

STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond	grab	Ecology grab sample	@3	Composite sample period: 1005 - 5/9 to 1005 - 5/10
TEX-EFF	Ecology effluent sample from final pond.	E-comp	Ecology composite sample	@4	Composite sample period: 1910 - 5/9 to 0400 - 5/10
S-1	Ecology Stormwater sample from east side of refinery	T-comp	Texaco composite sample		
EFFLUENT	Texaco effluent sample from final pond	J	The analyte was positively identified. The associated numerical result is an estimate.		
TEXOUT1	Ecology sediment sample taken at outfall.	U	The analyte was not detected at or above the reported result.		
SEDBACK	Ecology background sediment sample taken east of shipping pier.	UJ	The analyte was not detected at or above the reported estimated result.		
		@5	Texaco composite sample period slightly exceeded Ecology's sample period.		

Appendix E (cont'd) - VOA, BNA, and Metal Scan Results - Texaco, 1994.

Location:	STORM-IN	S-1	TEXEFF	EFFLUENT	TEXOUT1	SEDBACK
Type:	E-comp	grab	E-comp	T-comp	grab	grab
Date:	05/10	05/09	05/10	05/10	04/18	04/06
Time:	@3	1900	@4	@5	1100	1400
Lab Log#:	198520	198550	198530	198540	168233	148230
BNA Compounds	μg/L	μg/L	μg/L	μg/L	μg/Kg-dry wt.	μg/Kg-dry wt.
N-Nitroso-di-n-Propylamine	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
4-Methylphenol	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Hexachloroethane	0.17 UJ	0.13 U	0.29 U	0.28 U	62.8 UJ	174 U
Nitrobenzene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Isophorone	0.2	0.13 U	0.46	0.28 U	62.8 U	174 U
2-Nitrophenol	0.33 U	0.26 U	0.58 U	0.57 U	62.8 U	348 U
2,4-Dimethylphenol	0.13 J	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Bis(2-Chloroethoxy)Methane	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Benzoic Acid	6.7 UJ	5.3 UJ	11.6 UJ	11.3 UJ	48.0 UJ	6960 UJ
2,4-Dichlorophenol	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
1,2,4-Trichlorobenzene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 UJ	174 U
Naphthalene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	20.8 J
4-Chloroaniline	0.17 U	0.13 U	0.29 U	0.28 U	62.8 UJ	174 UJ
Hexachlorobutadiene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
4-Chloro-3-Methylphenol	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
2-Methylnaphthalene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	15.9 J
Hexachlorocyclopentadiene	3.3 UJ	2.6 U	5.8 U	5.7 UJ	REJ	3480 UJ
2,4,6-Trichlorophenol	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
2,4,5-Trichlorophenol	0.17 U	2.6	0.29 U	0.28 U	62.8 U	174 U
2-Chloronaphthalene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
2-Nitroaniline	0.33 U	0.26 U	0.58 U	0.57 U	62.8 U	348 U
Dimethyl Phthalate	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
2,6-Dinitrotoluene	0.17 UJ	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Acenaphthylene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	16.0 J
3-Nitroaniline	0.33 U	0.26 U	0.58 U	0.57 U	126 U	348 UJ
Acenaphthene	0.17 U	0.13 U	0.29 U	0.28 U	68.2 UJ	174 U
2,4-Dinitrophenol	6.7 UJ	5.3 UJ	11.6 UJ	11.3 UJ	314 UJ	6960 UJ
4-Nitrophenol	3.3 U	2.6 U	5.8 U	5.7 U	62.8 U	3480 U
Dibenzofuran	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	7.8 J
2,4-Dinitrotoluene	0.33 U	0.26 U	0.58 U	0.57 U	62.8 U	384 U
Diethyl Phthalate	0.2 UJ	0.26 UJ	0.29 U	0.28 U	62.8 U	174 U
Fluorene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
4-Chlorophenyl Phenylether	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
4-Nitroaniline	0.83 U	0.66 U	1.4 U	1.4 U	126 U	870 UJ
4,6-Dinitro-2-Methylphenol	3.3 UJ	2.6 UJ	5.8 UJ	5.7 UJ	314 UJ	3480 UJ
N-Nitrosodiphenylamine	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
1,2-Diphenylhydrazine	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
4-Bromophenyl Phenylether	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Hexachlorobenzene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Pentachlorophenol	1.7 U	0.13 U	2.9 U	2.8 U	126 U	1740 UJ
Phenanthrene	0.17 U	0.13 U	0.29 U	0.28 U	27.4 J	100 J

STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond
TEX-EFF	Ecology effluent sample from final pond.
S-1	Ecology Stormwater sample from east side of refinery
EFFLUENT	Texaco effluent sample from final pond
TEXOUT1	Ecology sediment sample taken at outfall.
SEDBACK	Ecology background sediment sample taken east of shipping pier.

grab	Ecology grab sample
E-comp	Ecology composite sample
T-comp	Texaco composite sample
J	The analyte was positively identified. The associated numerical result is an estimate.
U	The analyte was not detected at or above the reported result.
UJ	The analyte was not detected at or above the reported estimated result.
@5	Texaco composite sample period slightly exceeded Ecology's sample period.

@3	Composite sample period: 1005 - 5/9 to 1005 - 5/10
@4	Composite sample period: 1910 - 5/9 to 0400 - 5/10

Appendix E (cont'd) - VOA, BNA, and Metal Scan Results - Texaco, 1994.

Location:	STORM-IN	S-1	TEXEFF	EFFLUENT	TEXOUT1	SEDBACK
Type:	E-comp	grab	E-comp	T-comp	grab	grab
Date:	05/10	05/09	05/10	05/10	04/18	04/06
Time:	@3	1900	@4	@5	1100	1400
Lab Log#:	198520	198550	198530	198540	168233	148230
BNA Compounds	µg/L	µg/L	µg/L	µg/L	µg/Kg-dry wt.	µg/Kg-dry wt.
Anthracene	0.17 U	0.13 U	0.29 U	0.28 U	7.7 J	24.3 J
Carbazole	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Di-n-Butyl Phthalate	0.17 UJ	0.35 UJ	0.29 U	0.28 U	62.8 UJ	174 U
Fluoranthene	0.17 U	0.13 U	0.29 U	0.28 U	23.3 J	111 J
Benzidine	1.7 UJ	1.3 UJ	2.9 UJ	2.8 U	126 U	1740 U
Pyrene	0.17 U	0.049 J	0.33	0.29	30.3 J	100 J
Retene	0.17 U	0.13 U	0.29 U	0.28 U		26.3 J
Butylbenzyl Phthalate	0.83 J	0.66 U	1.4 U	1.4 U	62.8 U	870 U
Benzo(a)Anthracene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
3,3'-Dichlorobenzidine	0.33 U	0.26 U	0.58 U	0.57 U	126 U	348 U
Chrysene	0.17 U	0.13 U	0.23	0.34	12.9 J	52.1 J
Bis(2-Ethylhexyl)Phthalate	0.17 UJ	0.2 UJ	0.29 UJ	0.28 UJ	2840	174 UJ
Di-n-Octyl Phthalate	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Benzo(b)Fluoranthene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Benzo(k)Fluoranthene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Benzo(a)Pyrene	0.17 U	0.13 U	0.29 U	0.28 U	19.0 J	174 U
Indeno(1,2,3-cd)Pyrene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	22.5 J
Dibenzo(a,h)Anthracene	0.17 U	0.13 U	0.29 U	0.28 U	62.8 U	174 U
Benzo(g,h,i)Perylene	0.17 U	0.13 U	0.29 U	0.28 U	28.7 J	80.6 UJ

Location:	STORM-IN	S-1	TEXEFF	EFFLUENT
Type:	E-comp	grab	E-comp	T-comp
Date:	05/10	05/09	05/10	05/10
Time:	@3	1900	@4	@5
Lab Log#:	198520	198550	198530	198540
Metals	µg/L	µg/L	µg/L	µg/L
Antimony	30 U	30 U	30 U	30 U
Arsenic	1.5 U	1.5 P	2.0 P	2.0 P
Beryllium	1 U	1 U	1 U	1 U
Cadmium	0.01 U	2.22	22.7	0.1 U
Chromium (Total)	5 U	5 U	5 U	5 U
Chromium (Hexavalent)	2 U	2 U	3.1 P	2.1 P
Copper	8.5 P	14 P	5.8 P	5.3 P
Lead	1.0 U	5.3 P	1.6 P	1.2 P
Mercury	0.1 U	0.13 P	0.14 P	0.14 P
Nickel	10 U	10 U	10 U	10 U
Selenium	2.0 UJ	2.0 UJ	42.8 J	33.1 J
Silver	0.50 UJ	0.50 UJ	0.50 UJ	0.50 UJ
Thallium	2.5 UJ	2.5 UJ	2.5 UJ	2.5 UJ
Zinc	15 P	111	546	14 P

STORM-IN	Ecology Cleanwater (stormwater) Flume effluent sample into Final Pond	@3	Composite sample period: 1005 - 5/9 to 1005 - 5/10	grab	Ecology grab sample
TEX-EFF	Ecology effluent sample from final pond.	@4	Composite sample period: 1910 - 5/9 to 0400 - 5/10		
S-1	Ecology Stormwater sample from east side of refinery	@5	Texaco composite sample period slightly exceeded Ecology's sample period.		
EFFLUENT	Texaco effluent sample from final pond	J	The analyte was positively identified. The associated numerical result is an estimate.		
TEXOUT1	Ecology sediment sample taken at outfall.	P	The analyte was detected above the instrumentation limit, but below the established minimum quantitation limit.		
SEDBACK	Ecology background sediment sample taken east of shipping pier.				
E-comp	Ecology composite sample	U	The analyte was not detected at or above the reported result.		
T-comp	Texaco composite sample	UJ	The analyte was not detected at or above the reported estimated result.		

Appendix F - Tentatively Identified Compounds - Texaco (Anacortes), 1994

Sample Location:	STORM-IN-1
Type:	grab
Date:	05/09
Time:	2025
Sample ID:	198521

Volatile Organics:

Compound Name	Estimated Concentration (μg/L)	Qualifier
1. Methylcyclohexane	2.8	NJ
2. 1-Ethyl-3-Methylbenzene	4.5	NJ
3. Methyl(1-methylethyl)Benzene	3.2	NJ

Sample Location:	TEXEFF-1
Type:	grab
Date:	05/09
Time:	1920
Sample ID:	198531

Volatile Organics:

Compound Name	Estimated Concentration (μg/L)	Qualifier
1. 2-methoxy-2-methylpropane	2.2	NJ

Sample Location:	TEXEFF2
Type:	grab
Date:	05/09
Time:	0929
Sample ID:	198532

Volatile Organics:

Compound Name	Estimated Concentration (μg/L)	Qualifier
1. 2,3-dimethyl-2-Butanol	2.1	NJ

Sample Location:	TEXOUT1
Type:	grab
Date:	04/18
Time:	1100
Sample ID:	168233

Volatile Organics:

Compound Name	Estimated Concentration (μg/Kg)	Qualifier
1. Methane, Thiobis	1.6	NJ

Appendix F (cont.) - Tentatively Identified Compounds - Texaco (Anacortes), 1994

Sample Location:	STORM-IN
Type:	E-comp
Date:	05/10
Time:	@3
Sample ID:	198520

Bases/Neutrals/Acids:

Compound Name	Estimated Concentration (μg/L)	Qualifier
1. 7-Oxabiocyclo[4.1.0]Heptane	0.99	NJ
2. 2-Cyclohexen-1-Ol	0.51	NJ
3. 2-(2-Butoxyethoxy)Ethanol	4.0	NJ
4. Unknown Hydrocarbon 1	0.38	J
5. 2-(2-Butoxyethoxy)Ethanol	9.2	NJ
6. Unknown Hydrocarbon 2	0.68	J
7. Unknown Hydrocarbon 3	0.53	J
8. Unknown Hydrocarbon 4	0.60	J
9. 1H-Indol-5-)Ol	3.8	NJ
10. Unknown Hydrocarbon 5	0.82	J
11. Unknown Hydrocarbon 6	0.72	J
12. Unknown Hydrocarbon 7	1.0	J
13. Unknown Hydrocarbon 8	1.4	J
14. 4-Methyl-Dibenzofurane	0.26	NJ
15. Unknown Hydrocarbon 9	0.37	J
16. Unknown Hydrocarbon 10	0.97	J
17. Unknown Hydrocarbon 11	0.86	J
18. Hexanedioic Acid, Bis(2-Ethy+	3.0	NJ
19. Unknown Hydrocarbon 12	0.43	J
20. Unknown Hydrocarbon 12	0.44	J

NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.
J	The analyte was positively identified. The associated numerical result is an estimate.

Appendix F (cont.) - Tentatively Identified Compounds - Texaco (Anacortes), 1994

Sample Location:	TEXEFF
Type:	E-comp
Date:	05/10
Time:	@4
Sample ID:	198530

Bases/Neutrals/Acids:

Compound Name	Estimated Concentration (μg/L)	Qualifier
1. Unknown Compound 1	21.7	J
2. Unknown Compound 2	13.9	J
3. Unknown Compound 3	3.6	J
4. Unknown Compound 4	7.9	J
5. 1-Ethyl-2-Methyl Aziridine	3.8	NJ
6. Unknown Compound 5	3.1	J
7. Unknown Compound 6	2.7	J
8. Aziridine, 2-(1,1-dimethyle+	2.5	NJ
9. 2,6-Piperazinedione, monoox+	8.2	NJ
10. Unknown Compound 7	5.8	J
11. 1-Piperidineethanamine	5.1	NJ
12. Unknown Compound 8	2.2	J
13. Unknown Compound 9	3.1	J
14. Unknown Compound 10	10.1	J
15. Unknown Compound 11	3.1	J
16. Unknown Compound 12	2.6	J
17. Benzene, (methylsulfinyl)+	11.8	NJ
18. 2-(2-Butoxyethoxy)-Ethanol	14.8	NJ
19. Unknown Compound 13	6.2	J
20. Pyrrolidine, 1-(1-pentenyl)+	8.1	NJ

NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.
J	The analyte was positively identified. The associated numerical result is an estimate.

Appendix F (cont.) - Tentatively Identified Compounds - Texaco (Anacortes), 1994

Sample Location:	EFFLUENT
Type:	E-comp
Date:	05/10
Time:	@5
Sample ID:	198540

Bases/Neutrals/Acids:

Compound Name	Estimated Concentration (μg/L)	Qualifier
1. 2-Butanol, 2,3-dimethyl+	4.1	NJ
2. Benzenemethanamine, N,N-dim+	2.2	NJ
3. Unknown Compound 1	20.4	J
4. Unknown Compound 2	4.5	J
5. Unknown Compound 3	8.2	J
7. Piperidine, 1-ethyl-2methyl	4.6	NJ
8. Unknown Compound 4	5.2	J
9. Aziridine, 1-ethyl-2-methyl+	4.6	NJ
9. Unknown Compound 5	3.6	J
10. Unknown Compound 6	5.1	J
11. Unknown Compound 7	4.0	J
12 Aziridine, 2-(1,1-dimethyle+	3.6	NJ
13. 2,6-piperazinedione, monoox	9.5	NJ
14. Unknown Compound 8	2.2	J
15. 1-Piperidineethanamine	4.5	NJ
16. Unknown Compound 9	2.1	J
17. Unknown Compound 10	4.0	J
18. Benzene, 1-methoxy-3-(methy+	3.0	NJ
19. Unknown Compound 11	2.8	J
20. Unknown Compound 12	2.1	J
21. Benzene, (methylsulfinyl)+	5.7	NJ
22. Unknown Compound 13	5.1	J
23. Cyclohexane,1,1'-(1-methyl+	6.8	NJ
24. Pyrrolidine, 1-(1-pentenyl+	7.2	NJ
25. 1H-Indol-5-ol	20.7	NJ

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

J The analyte was positively identified. The associated numerical result is an estimate.

Sample Location: S-1
Type: grab
Date: 05/09
Time: 1900
Sample ID: 198550

Bases/Neutrals/Acids:

Compound Name	Estimated Concentration (μg/L)	Qualifier
1. 4-Hydroxy-4-Methylpendtan-2-o	37.5	NJ
2. 7-Oxabicyclo [4.1.0]Heptane	0.64	NJ
3. 2-Cyclohexen-1-ol	0.53	NJ
4. 2-methyl-2, 4-Pentanediol+	45.7	NJ
5. 3,4-Dichlorophenyl Isocyanat+	0.86	NJ
6. Tetradecanoic Acid	0.44	NJ
7. 1H-Indole-3-Carboxaldehyde	1.1	NJ
8. Unknown Compound 1	0.59	NJ
9. Unknown Compound 2	0.49	NJ
10. 9-Hexadecenoic Acid	3.2	NJ
11. Hexadecanoic Acid	2.8	NJ
12. Bromacil	2.6	NJ
13. Unknown Compound 3	1.6	J
14. Unknown Compound 4	5.6	J
15. Unknown Compound 5	0.85	J
16. Unknown Compound 6	8.6	J
17. Cholestrol	1.5	NJ
18. Ergosta-7, 22-dien-3-ol, (3.+	1.3	NJ
19. Stigasterol	1.3	NJ

NJ There is evidence that the analyte is present. The associated numerical result is an estimate.
J The analyte was positively identified. The associated numerical result is an estimate.

Appendix F (cont.) - Tentatively Identified Compounds - Texaco (Anacortes), 1994

Sample Location:	TEXOUT1
Type:	grab
Date:	04/18
Time:	11:00
Sample ID:	168233

Bases/Neutrals/Acids:

Compound Name	Estimated Concentration (μg/Kg)	Qualifier
1. Toluene	58.3	NJ
2. 2-Pentene, 2,4-dimethyl+	789	NJ
3. Unknown Compound 1	751	J
4. Unknown Compound 2	45.4	J
5. 2-Cyclohexen-1-one, 3,5-Dime+	50.1	NJ
6. Unknown Compound 3	49.3	J
7. Unknown Compound 4	66.8	J
8. Unknown Compound 5	36.3	J
9. Unknown Compound 6	98.1	J
10. Unknown Compound 7	136	J
11. Unknown Compound 8	79.5	J
12. Unknown Compound 9	44.2	J
13. Unknown Compound 10	43.2	J
14. Unknown Compound 11	64.1	J

NJ There is evidence that the analyte is present. The associated numerical result is an estimate.
J The analyte was positively identified. The associated numerical result is an estimate.

Appendix F (cont.) - Tentatively Identified Compounds - Texaco (Anacortes), 1994

Sample Location:	SEDBACK
Type:	grab
Date:	04/o6
Time:	14:00
Sample ID:	148230

Bases/Neutrals/Acids:

Compound Name	Estimated Concentration (μg/Kg)	Qualifier
1. IntStd: o,p'-DDE	480	NJ
2. Hexadecanoic Acid	1910	NJ
3. Olic Acid	687	NJ
4. Tetradecanoic Acid	404	NJ
5. 9-Hexadecenoic Acid	2510	NJ
6. Unknown Hydrocarbon 1	336	J
7. Unknown Hydrocarbon 2	442	J
8. Unknown Hydrocarbon 3	449	J
9. Unknown Compound 1	6580	J
10. Unknown Compound 2	2610	J
11. Unknown Compound 3	5380	J
12. Unknown Compound 4	591	J
13. Unknown Compound 5	560	J
14. Unknown Compound 6	509	J
15. Unknown Compound 7	728	J
16. Unknown Compound 8	369	J
17. Unknown Compound 9	1650	J
18. Unknown Compound 10	1720	J

NJ	There is evidence that the analyte is present. The associated numerical result is an estimate.
J	The analyte was positively identified. The associated numerical result is an estimate.

Appendix G - GLOSSARY

AAS	Aeroaccelator Activated Sludge
BNA	Base-neutral acids, semivolatiles
BOD	Biological Oxygen Demand
CLP	Contract Laboratory Program
COD	Chemical Oxygen Demand
CVAA	Cold Vapor Atomic Absorption
DAF	Dissolved Air Floatation
EPA	Environmental Protection Agency
kg	kilogram (1 X 10^3 grams)
L	Liter (1 X 10^3 milliliters)
LC50	Concentration which is lethal to 50% of the test organisms
LOD	Limit of Detection
LOEC	Lowest Observable Effect Concentration
m^3	Cubic meter (1 X 10^3 liters)
MF	Membrane Filter
mg	milligram (1 X 10^{-3} grams)
mL	Milliliter (1 X 10^{-3} liters)
NH_3	Ammonia
MPN	Most Probable Number
NOEC	No Observable Effect Concentration
NPDES	National Pollution Discharge Elimination System
PCB	Polychlorinated Biphenyl
pH	Hydrogen Ion Concentration
PP	Priority Pollutant
ppm	Parts per million (1 X 10^{-6} ug/L or ug/kg)
ppt	Parts per thousand (1 X 10^{-3} ug/L or ug/kg)
PWTS	Process Water Treatment System
QA/QC	Quality Assurance/Quality Control
TIC	Total Inorganic Carbon or for GCMS Tentatively Identified Compound
TNVS	Total Non-Volatile Solids
TNVSS	Total Non-Volatile Suspended Solids
TOC	Total Organic Carbon
TP	Total Phosphorous
TPH	Total Petroleum Hydrocarbons
TS	Total Solids
TSS	Total Suspended Solids
TVS	Total Volatile Solids
ug	Microgram (1 X 10^{-6} grams)
ug/m^3	Microgram per cubic meter
VOA	Volatile Organic Analysis
VOC	Volatile Organic Carbon

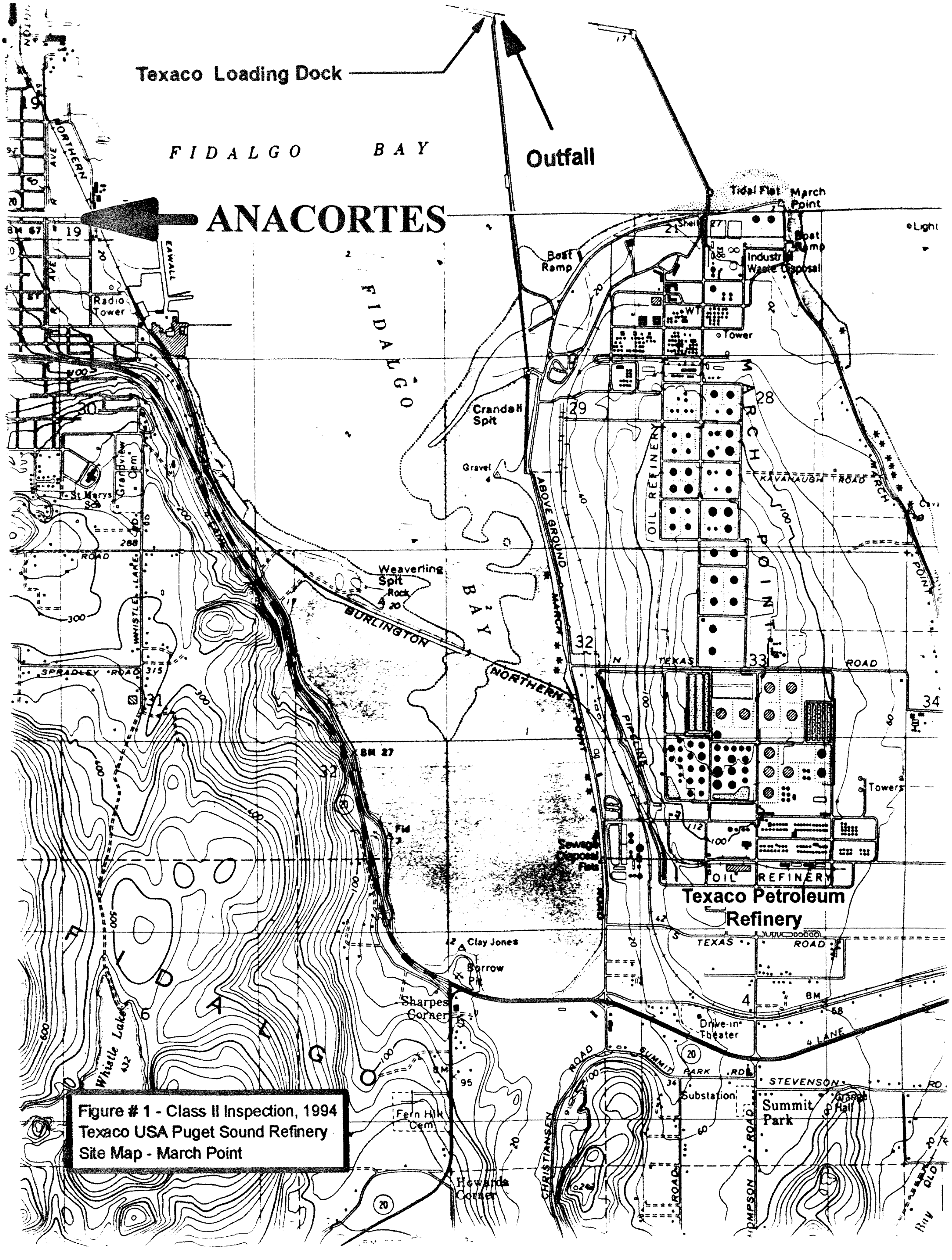

Figure # 1 - Class II Inspection, 1994
Texaco USA Puget Sound Refinery
Site Map - March Point

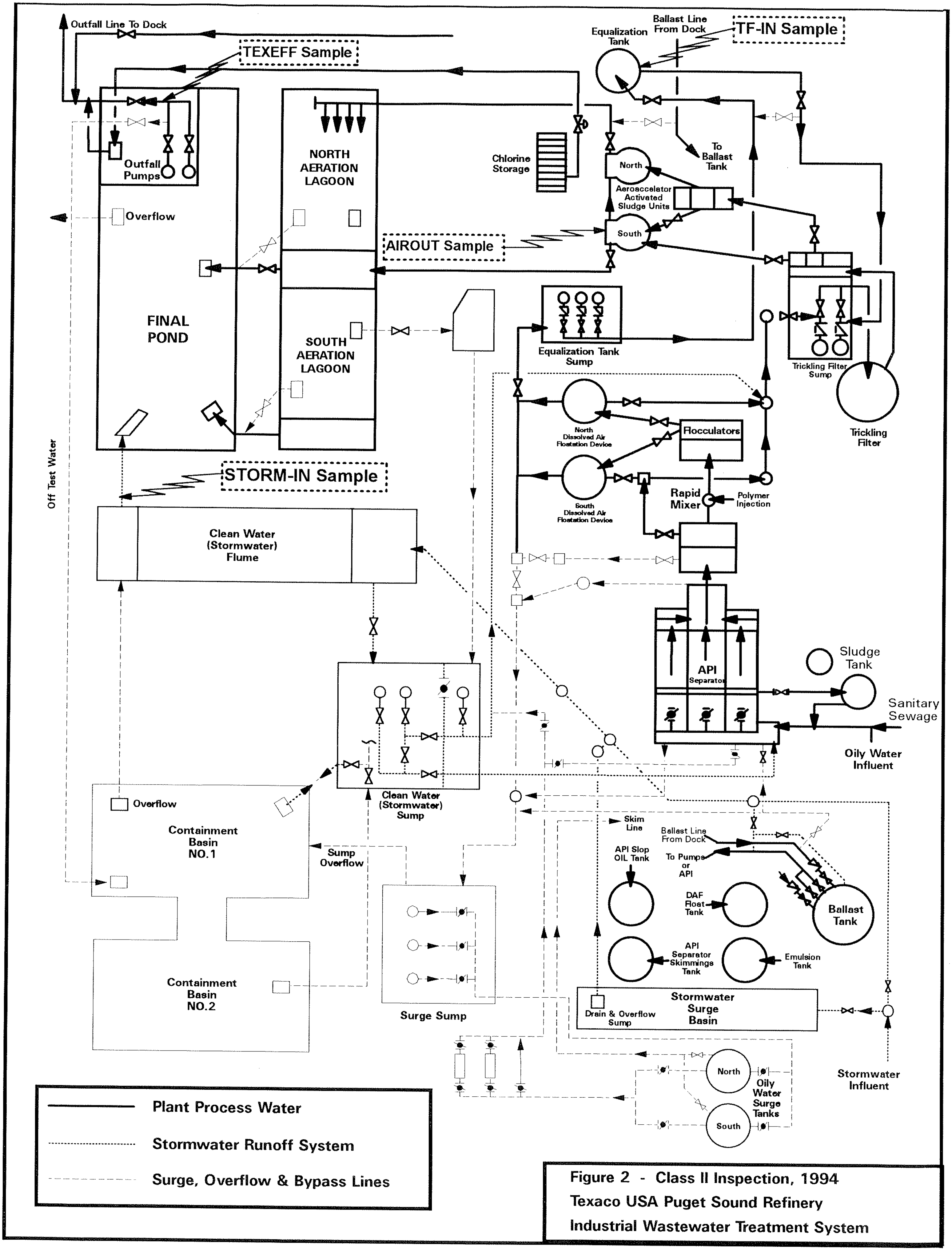

Figure 2 - Class II Inspection, 1994

Texaco USA Puget Sound Refinery

Industrial Wastewater Treatment System