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MEMORANDUM
December 3, 1982

To: Dave Wright, Northwest Regional Office, WDOE

From: Timothy A. Determan, Intensive Survey Unit, Water Quality Investigations Section, WDOE

Subject: The Effects of the Mukilteo STP Discharge on Possession Sound Receiving Waters

INTRODUCTION

At your request, we surveyed nearshore marine waters in the vicinity of the Mukilteo sewage treatment plant (STP). A Class II inspection was conducted by the Ambient and Compliance Monitoring Unit at approximately the same time (Heffner, 1982). The purpose of the joint effort was to assess operating conditions of the plant, estimate the quality of the discharge, and evaluate the effects of the discharge on receiving waters.

LOCATION AND DESCRIPTION

Mukilteo is a small community located approximately 7.5 km (4.6 mi.) southwest of Everett on Elliot Point which juts into Possession Sound (Figure 1). The city is backed by steep bluffs approximately 60 m (200 ft) high. The bluffs tend to encroach upon the shoreline between Mukilteo and Everett, and are dissected in a number of places by narrow ravines, some of which contain small creeks.

Tides in Possession Sound are classified as mixed semidiurnal; that is, two highs and two lows occur each tidal day of 24 hours and 50 minutes (Lincoln, 1974).

Although the tide induces oscillatory motion to surface waters in the area, dye studies have shown a net movement of water as longshore drift southeasterly from Everett toward Mukilteo. CH_2M Hill (1974) estimated the speed of this coastwise transport to be 2.5 km (1.6 miles) per day.

Shoreside land use between Everett and Mukilteo is severely restricted by the coastal bench. The Burlington Northern Railroad right-of-way occupies much of the bench. The remainder is an uninhabited recreational area. Within the limits of Mukilteo, the shoreline is occupied by restaurants, apartments, marine repair facilities, and the Washington State Ferry System's terminal. A federal reservation is located at the northeast end of the community which includes fuel handling and storage. Also, the National Marine Fisheries Service laboratory occupies a building and a small T-shaped dock close to the town on a federal reservation. Mukilteo State Park occupies the shoreline at the southeast end of the town.

The marine waters of Possession Sound in the vicinity of Mukilteo share two specific classifications, as follows (WDOE, 1980):

> "Possession Sound, Port Susan, Saratoga Passage, and Skagit Bay east of Whidbey Island and state highway 20 bridge at Deception Pass latitude 47°57'N. (Mukilteo) and latitude 48°27'20"N. (Similk Bay), except as otherwise noted.
>
> - Class A

and;

> "Possession Sound, south of latitude 47°57'N."
>
> - Class AA

The boundary between the two classifications is shown on Figure 1.

OBJECTIVES

Three tasks were performed. First, reconnaissance was conducted to locate the STP discharge and determine a range of values to be expected for the water quality variables sampled intensively later. Next, the intensive sampling was carried out within the discharge zone and at several nearshore stations. Finally, shellfish were sampled at several intertidal sites located near the discharge and at a central site.

METHODS

A list of variables sampled during the three survey phases, methods of analysis, the rationale for variable selection, and the relevant water and shellfish quality standards are shown in Table 1. All analyses conformed to procedures outlined in APHA (1977) and EPA (1979). These variables are as follows: fecal coliform in water and shellfish, pH, turbidity, total suspended solids, nutrients, salinity, temperature, dissolved oxygen (concentration and percent saturation), and chlorine residual in water.

RESULTS

Reconnaissance

Prior to carrying out a complete water quality survey, a reconnaissance was performed on February 22, 1982, during rising tide. Rhodamine WT fluorescent dye was added to the discharge line downstream of the STP chlorine contact chamber, at 1120. At the same time, duplicate samples for fecal coliform analysis were taken of the chlorinated effluent. The sample bottles contained sodium thiosulfate ($Na_2S_2O_3$) to prevent the chlorine from reducing bacterial levels prior to laboratory analysis.

After 34 minutes, dye emerged in the surface waters near the southwest end of the T-shaped NMFS service dock (Figure 2). A second dye patch from the same dose emerged at the same location ten minutes later. Emergence of dye at one point indicated the discharge line lacked a diffuser. Both dye patches were carried northeasterly by the prevailing longshore current. After the STP discharge was located, duplicate samples were taken 10m upstream and downstream from the discharge and at a control station located about 1.1 km (1200 yds) offshore (Figures 1 and 2). Results of the sampling are shown in Table 2.

The data showed little evidence of receiving water effects. Samples of chlorinated STP effluent contained 10,000 FC/100 ml. Fecal coliform levels at the point of discharge and downstream were higher than the other two shoreside stations; however, neither station exceeded state water quality standards. Ammonia levels were low and quite variable with the highest level at the point of discharge. The control site showed ammonia levels not unlike those at the downstream site. The means and standard deviations did not appear to be significant among stations.

Water Quality Sampling

Intensive sampling of the discharge zone and nearshore waters in the vicinity of the discharge was carried out on March 2, 1982, during ebb tide in conjunction with the Class II STP inspection (Heffner, 1982). A strong longshore current was flowing southwesterly during the survey. In order to characterize mixing processes within the discharge zone, a sampling grid was created by anchoring a line with three surface floats attached such that the "upstream" float was suspended at the point when the effluent plume (dye) first surfaced. The remaining two floats trailed downstream at 5m intervals (Figure 3). Samples were taken at each float. Sample depth was controlled using a meter wheel. An additional station was sampled the same way immediately upstream from the plume buoy. Surface samples only were taken at nearshore sites. These sites were sampled as close to shore as possible, given the depth of the bottom of the boat used in sampling.

Intensive sampling of the discharge zone was scheduled to commence at 1400. However, the Rhodamine WT dye injected into the STP chlorine contact chamber at 1330 did not emerge in concentrations sufficient to be seen. As an alternative, dye was dropped into a manhole located above the beach within 50 m of the shoreline at 1515. The dye appeared in the surface waters 12 minutes later, the tethered line was set, and sampling commenced.

Sampling was done with a Van Dorn sampling bottle. In addition to the variables taken during the reconnaissance survey, temperature, dissolved oxygen, and chlorine residual measurements were also taken. Fecal coliform samples were taken from the least to the greatest likely concentrations in order to minimize contamination between samples. Substantial flushing time was provided before the bottle was closed. Each point in the sampling grid was sampled twice (Figure 4). The results are summarized in Table 3.

The highest mean value for fecal coliforms was observed at the point where the effluent plume first reached the surface (Station 1S). One of two replicates was 21 FC/100 mL, which exceeded the standard (Table 1). Elevated fecal coliform and ammonia levels were detected at mid-depth "upstream" at 1S, Station 4M. Surface ammonia at 4S was also elevated, although fecal coliform levels were not. These results may be due to effects of slack current at the time of sampling or waters at depth moving in an opposite direction relative to the surface.

Results for fecal coliform densities from the STP in Table 3 are for samples taken during intensive sampling. Chlorine residual in the effluent was 2.2 mg/L. However, the following day, chlorine dosage stopped after the chlorine tank emptied. At that time, fecal coliform densities were 2.1 x 10^6 FC per 100 mL. A single receiving water sample was taken off the end of the public fishing dock near Station F5 (William Yake, WDOE, Ambient and Compliance Monitoring Unit, personal communication). At the time of sampling, the prevailing current was southwesterly. The sample contained 24 FC per 100 mL, a violation of the water quality standard. This level, which was about twice the result obtained the previous day (Table 3), may show the effects of elevated FC densities in the discharge. However, separation of these effects from the rather high background is not possible because samples could not be taken at additional points between the fishing dock and the point of STP discharge.

Salinity within the discharge zone showed a vertical gradient with a surface layer of low salinity. It is unlikely that the low salinity is attributable to the discharge because this relationship was evident at all of the stations sampled, including the offshore control station. The gradient is an area-wide phenomenon typical of the Puget Sound estuarine systems. The lowest salinities were observed at the nearshore stations.

Dissolved oxygen levels showed a vertical gradient at all discharge locations. The higher levels of oxygen at the surface may be the result of higher primary production at the surface and higher oxygen demand at depth. Oxygen levels at surface stations within the discharge zone and elsewhere were comparable. There was no evidence of a discharge-induced downstream oxygen reduction.

The highest fecal coliform level detected during the study was found at Station F6 near the NMFS laboratory (Figure 4). The sample was taken of freshwater flowing from a culvert before the flow entered the receiving waters. This station also had the highest turbidity, nitrate, and dissolved oxygen. However, since the sample was taken differently than the other nearshore stations, no comparisons can be made.

High nitrates were also found at F2. Other nutrient forms were not particularly high. On the other hand, at F3, ammonia was highest although other nutrients and fecal coliform were not much different than elsewhere.

Total ammonia results given in Tables 2 and 3. Total ammonia is composed of un-ionized (NH_3) and ionized (NH_4^+) species. The un-ionized form is more toxic than the ionized form. The concentation of un-ionized ammonia in solution is dependent on pH, salinity, temperature, and total concentration of ammonia (Hazel, *et al.*, 1971). Increased temperature and pH results in increased levels of un-ionized ammonia. Increased salinity tends to reduce the un-ionized species. Hazel, *et al.* (1971) show by graph that at 25°C and pH of 8.0, the fraction of un-ionized ammonia ranges from five percent (0 o/oo) to 2.5 percent (35 o/oo). Under these conditions, a high estimate for un-ionized ammonia at F3 would be five percent of 0.11 mg/L total ammonia, or 0.006 mg/L. EPA (1976) recommends that un-ionized ammonia in freshwaters not exceed 0.016 mg/L (NH_3-N). There are no recommended criteria for marine or estuarine waters. Thurston, *et al.* (1979) suggest that the toxicity of ammonia may decrease with increasing salinity up to about 20 o/oo. Above this, toxicity increases. There are at present no clear answers to the question of ammonia toxicity in saltwater. However, there is little reason to suspect that the Mukilteo STP is contributing significant risk from un-ionized ammonia judging from the levels calculated.

Shellfish Analysis

Although one sample taken within the mixing zone during the intensive sampling violated the state water quality standards for fecal coliform bacteria, the levels were generally not very high and did not provide evidence that the discharge is a more important pollutant source than the small streams along shore. This may, in part, be explained by the time of sampling. The STP records show that the discharge was less than normal (20 percent of the 0.25 MGD design flow) during sampling of the mixing zone (Heffner, 1982). The flow varies considerably. Thus, concentrations within the mixing zone were probably less than normal. Variations in plant flow, tide state, and current velocities may cause substantial short-term increases in fecal coliform densities over what was detected during our survey. In order to provide an estimate of long-term effects of the discharge, samples of *Mytilus edulis* (the bay mussel) were taken. Bay mussels are mid-intertidal bivalves that are found near the surface of the water during most low tides and would thus be exposed to sewage effluent during slack tide when surface concentrations would tend to increase. *Mytilus*, like other bivalves such as oysters and clams, are filter feeders that remove suspended organic material from the water. They can also remove fecal coliform organisms and accumulate them in their tissue. Thus, *Mytilus* may serve as a sample integrator for longer-term periods (several weeks) during various tide states, runoff conditions, and STP flows. (It is probably unwise to use shellfish data for periods longer than a season because temperature changes affect filtering rate and thus fecal coliform densities.)

Mytilus samples were taken on March 29, 1982, at three locations along the Mukilteo shoreline and a control site at Gedney Island 8 km (5 mi) north of Mukilteo. Fifteen specimens of similar size were removed and placed in a sterile plastic bag, kept on ice, and returned to the laboratory as quickly as possible. Results of the tissue analysis are shown in Table 4. Sampling locations are shown in Figures 1 and 4.

The lowest fecal coliform densities were found in *Mytilus* from Gedney Island and from pilings located northeast of the discharge zone. The highest value occurred on pilings from the ferry dock. A slightly lower density occurred in tissue from the NMFS dock at minimum distance from the point of discharge. The highest value was 10 percent of the maximum allowable level for marketing (U.S. Public Health Service, 1965, Table 1). The higher FC density at the ferry dock could be due to the STP discharge. However, since the FC level was somewhat higher than that nearest the discharge, it is much more likely to be the result of a contamination source much closer to the ferry landing.

CONCLUSIONS

The data show that slightly elevated levels of fecal coliform associated with the Mukilteo STP discharge were observed in the dilution zone. Fecal coliforms slightly exceeded the state water quality standard, but were not very different from either the nearshore stations or the offshore control site. The incident on March 3 during the failure to chlorinate the STP effluent suggests that a high potential to violate water quality standards exists under these conditions. Neither shellfish sample in the vicinity of the STP discharge was in violation of the 230 colonies per 100 grams of tissue shellfish standard. However, the levels were higher than either the other shoreside station or the control site on Gedney Island.

TAD:cp

Attachments

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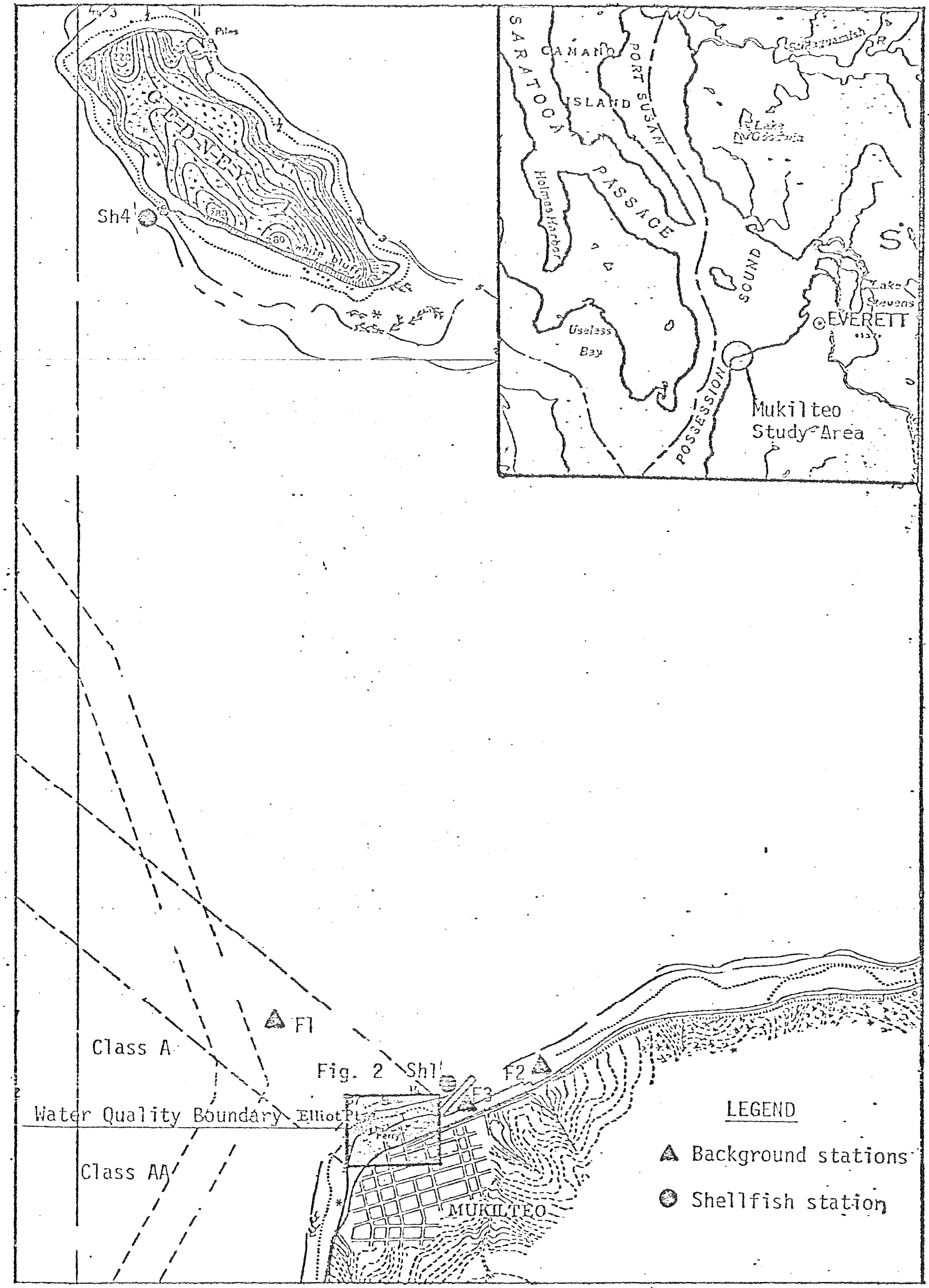

Figure 1. Overview of Mukilteo STP study area. The most distant sampling stations are shown. Nearfield sampling sites are shown in Figures 2 and 4.

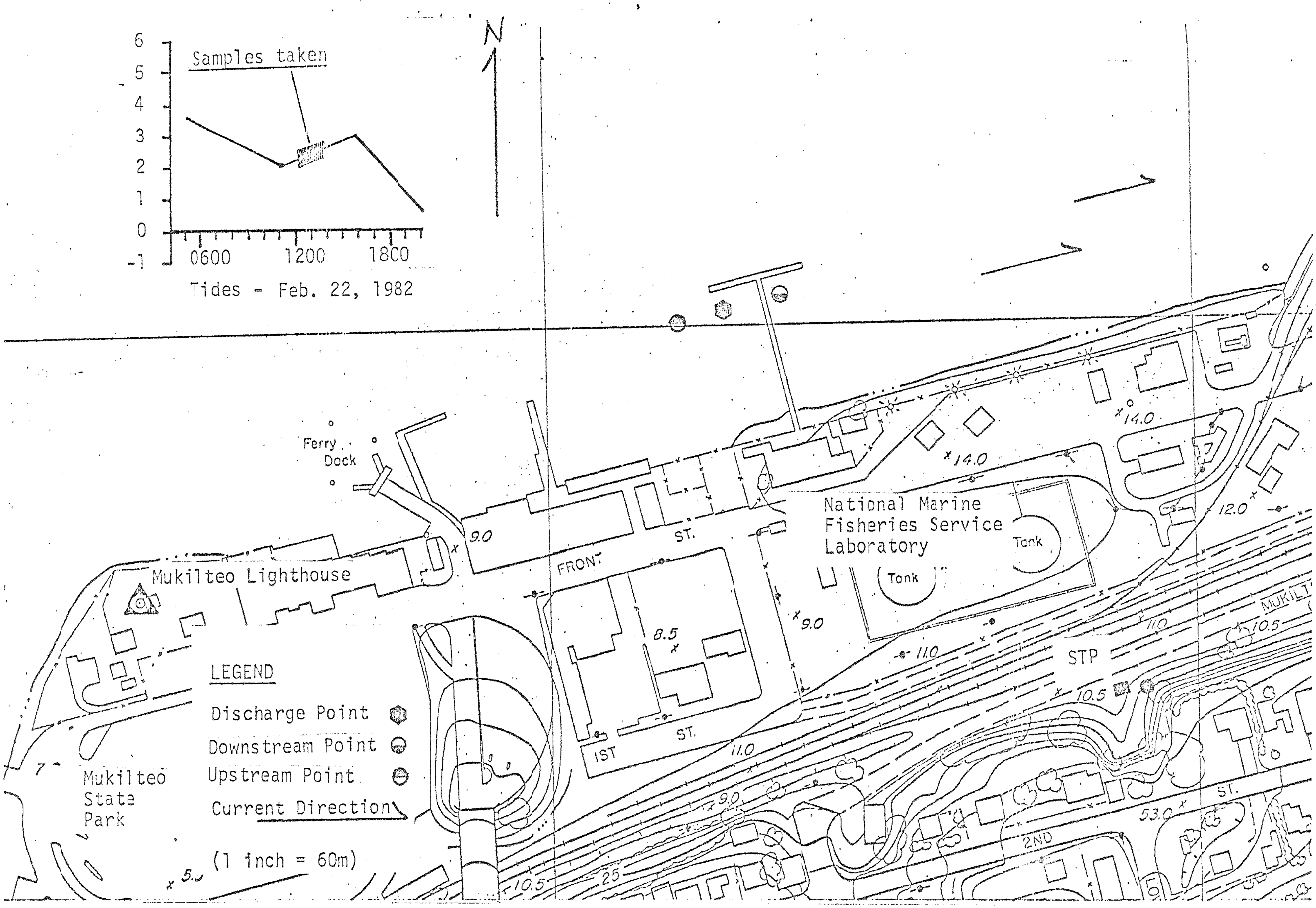

Figure 2. Location of Mukilteo STP discharge with upstream and downstream sites samples during an initial reconnaissance. An offshore control site is shown in Figure 1. (Map from Walker and Associates, 1981, for the City of Mukilteo.)

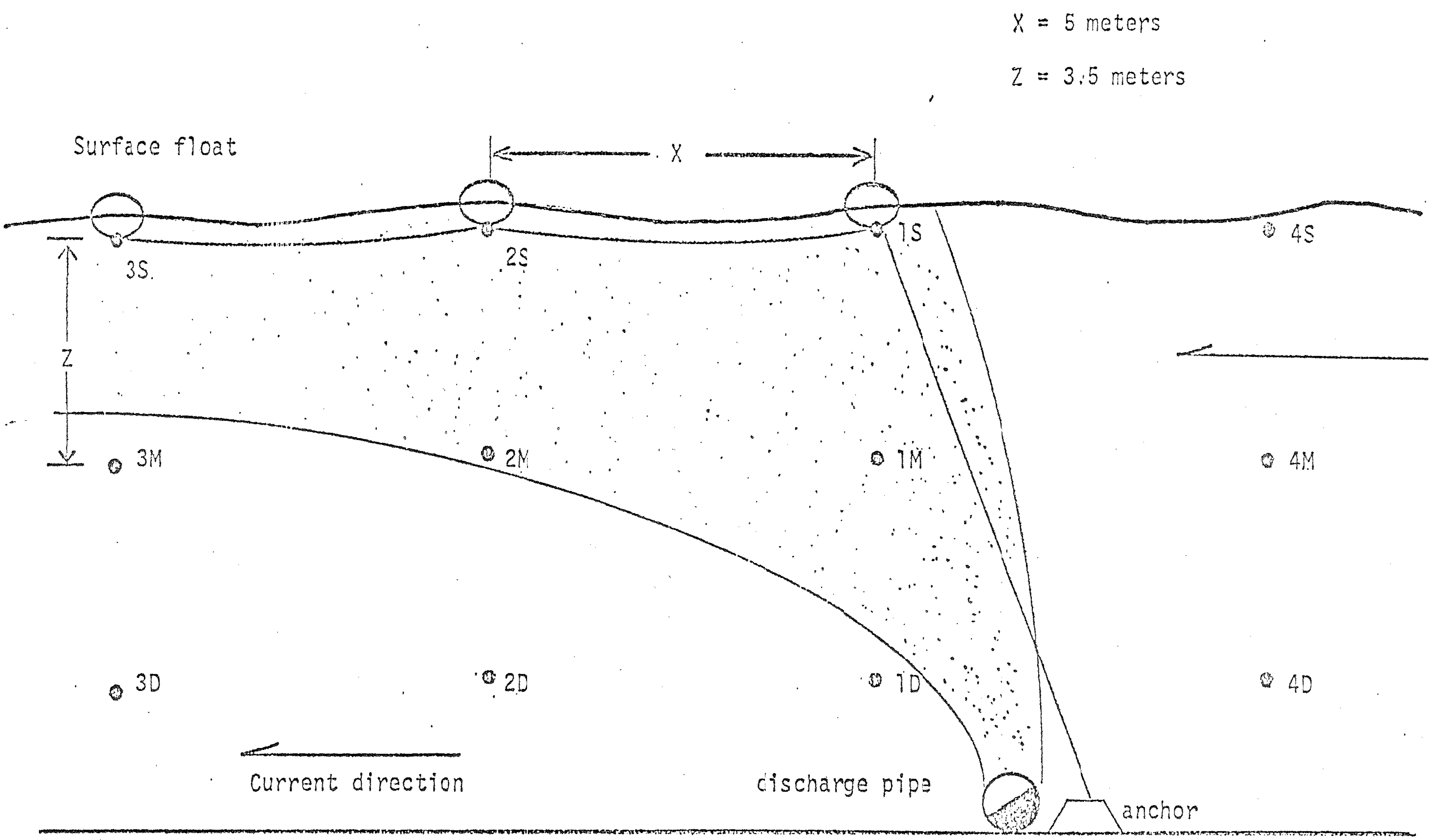

Figure 3. Schematic view of two-dimensional sampling grid created with a tethered string of floats to provide position control during intensive sampling of the discharge at the Mukilteo STP.

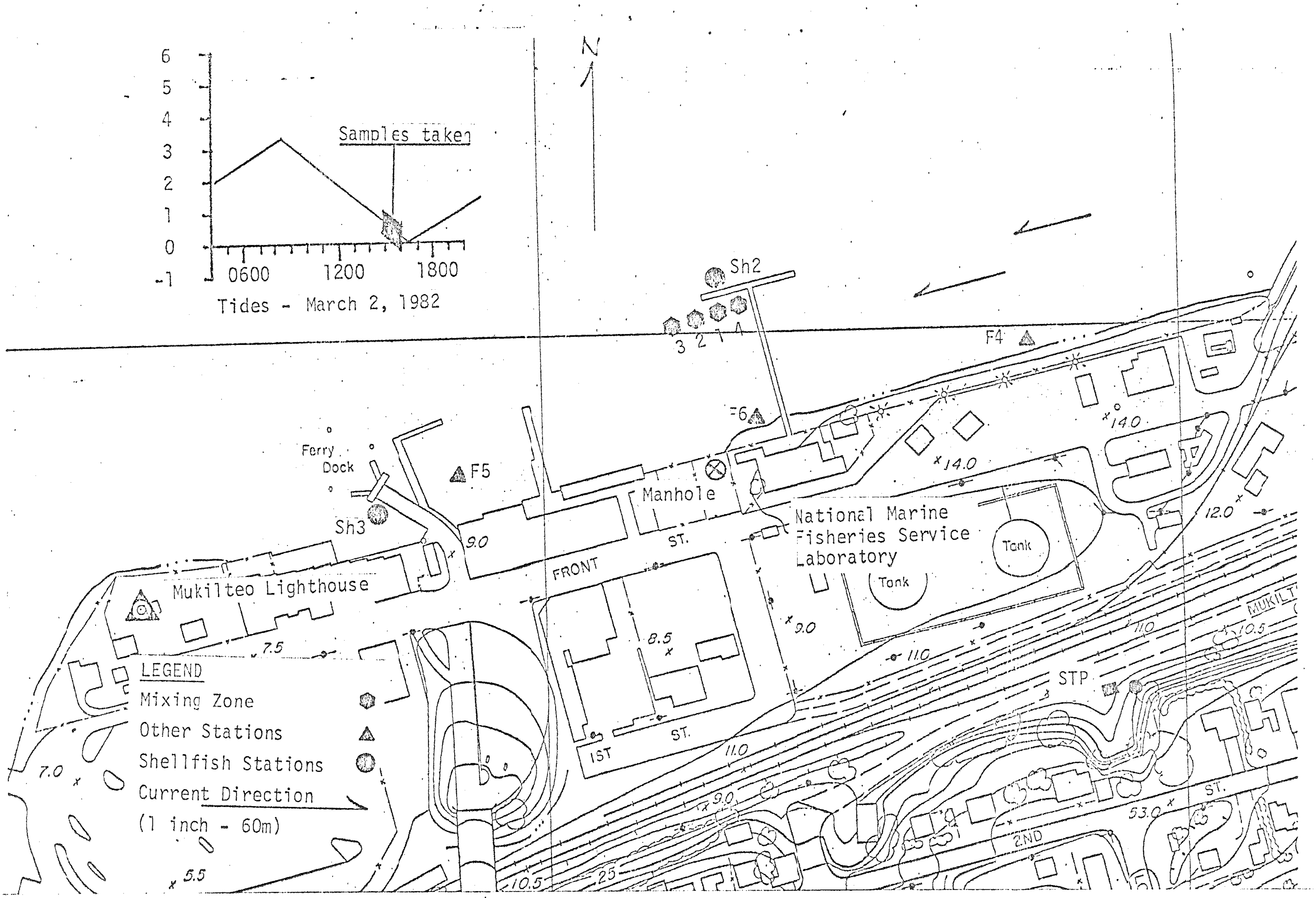

Figure 4. Nearfield view of Mukilteo. Locations of mixing zone, other and shellfish sampling stations are shown. Control sites for water (F1) and shellfish samples (Sh4); water site (F3) and shellfish site (Sh1) are shown in Figure 1. (Map from Walker and Associates, 1981, for the City of Mukilteo.)

Table 1. Parametric coverage and rationale for measuring each during field surveys to evaluate the effects of the Mukilteo STP.

Parameter	Location	Method	Reason for Sampling	Water Quality Standard (Class A)	Water Quality Standard (Class B)
Fecal Coliform in Water (FC/100 ml)	All stations	APHA (1976); EPA (1979	Indicator of presence of sewage wastes from humans and other animals.	Not to exceed 14 FC per 100 ml; not more than 10% of samples to exceed 43 FC/100 ml.	Not to exceed 100 FC per 100 ml; not more than 10% of samples to exceed 200 FC/100 ml.
Fecal Coliform in Shellfish (FC/100 gr)	Selected stations	APHA (1970)	Indicator of the presence of sewage wastes from humans and other animals in marketable shellfish.	Not to exceed 230 colonies per 100 gr tissue (MPN) to be marketable (DSHS shellfish sanitation program applies this standard to commercial harvesters and public shellfish collection areas).	
pH (S.U.)	All stations	Reference electrode pH meter	pH affects the carbonic acid-carbon dioxide balance in seawater. pH also affects the activity of un-ionized ammonia and sulfide. EPA (1976) recommends pH values be within 6.5 to 9.0 pH units.	Within range of 7.0 to 8.5 with man-caused variations within a range of 0.5 unit.	Shall be within the range of 7.0 to 8.5 with a man-caused variation within a range of less than 0.5 unit.
Turbidity (NTU)	All stations	Hach Turbidimeter	Measures water column transparency, light availability, and is an estimate of suspended material in water column. Sufficient light is essential to marine plant growth. Excessive suspended material may stress bottom-dwelling plants and animals by interference in filter feeding, and by light reduction, or smothering. Turbidity is a function of quantity and light scattering characteristics of the suspended material.	Not to exceed 5 NTU over background if background is 50 NTU or less or have more than a 20% increase in turbidity when the background turbidity is more than 50 NTU.	Not to exceed 10 NTU over background if background is 50 NTU or less or have more than a 20% increase in turbidity when the background turbidity is more than 50 NTU.

Table 1. Parametric coverage and rationale for measuring each during field surveys to evaluate the effects of the Mukilteo STP.- Continued

Parameter	Location	Method	Reason for Sampling	Water Quality Standard (Class A)	Water Quality Standard (Class B)
Total Suspended Solids (TSS) (mg/L Volatile Solids (mg/L)	Discharge zone, all receiving water stations	Oven dry @ 105°C to determine TSS further analysis at higher temp (550°C) in a muffle furnace determines volatile solids and non-volatile solids (APHA, 1975).	Determine the effect on aquatic system as a result of reduced light for photosynthesis of plants and the adverse affects to aquatic organisms such as reduction of food availability, reduction in growth rate, prevention of successful early development.	No standard.	No standard.
Nutrients (mg/L) NO_3-N; NO_2-N; O-PO_4-P; T-PO_4-P; NH_3-N	All stations	APHA (1976); EPA (1979	Inorganic nutrients are most readily available for assimilation by marine plants. Excessive levels with abundant light may lead to massive algae production at the expense of other plants and animals. Ammonia (NH_3-N) is an immediate byproduct of the breakdown of urine and is therefore useful to trace animal wastes in water. Excessive levels of unionized ammonia (at 0.02 mg/L, EPA [1976]), are toxic to aquatic organisms. But toxic levels in marine waters are controversial (EPA, 1976; Thurston et al., 1979). Toxic levels are a function of pH, temperature, and salinity.	No numerical standard.	No numerical standard.

Table 1. Parametric coverage and rationale for measuring each during field surveys to evaluate the effects of the Mukilteo STP. - Continued

Parameter	Location	Method	Reason for Sampling	Water Quality Standard (Class A)	Water Quality Standard (Class B)
Salinity (o/oo)	All stations	Kahlisco Model RS5-3 induction salinometer or Beckman laboratory induction salinometer	Used to trace passage of fresh-water through marine waters; affects mixing rates, and density distribution in water column and solubility of dissolved oxygen.	In brackish waters of estuaries, where the fresh and marine water quality criteria differ within the same classification, the criteria shall be interpolated on the basis of salinity, except that the marine water quality criteria shall apply for dissolved oxygen when the salinity is one part per thousand or greater and for fecal coliform organisms when the salinity is ten parts per thousand or greater.	
Temperature (°C)	All stations	Thermometer	Used with salinity to determine water density; temperature also affects gas solubility and rates of biological processes.	Not to exceed 16°C due to human activities. (t = 12/[T-2]) Note: "T" represents the highest existing temperature in these water classifications outside of or thermomeany dilution zone.	Not to exceed 19°C due to human activities. (t = 16/T)
Dissolved O_2 (mg/L or % saturation)	All stations	Winkler - azide modification (APHA, 1976; EPA, 1979)	Elevated, relatively constant oxygen levels are essential for stable marine communities. Highly variable levels downstream from a source may be indicative of an organic load in excess of the ability of the system to assimilate it.	Shall exceed 6.0 mg/L, except where upwelling occurs; natural D.O. may be degraded by up to 0.2 mg/L by man-caused activities.	Shall exceed 5.0 mg/L or 70% saturation whichever is greater, except when the natural phenomenon of upwelling occurs. Natural D.O. levels can be degraded by up to 0.2 mg/L by man-caused activities.
Total Residual Chlorine (mg/L)	Stations 1 & 2	LaMotte-Palin DPD field test kit (0.1 ppm minimum detectable level).	Chlorine is used as a bleaching agent in the paper pulping process for sulfite mills and is discharged in the wastewater stream. It is also toxic to marine organisms. EPA (1976) recommends an upper limit of 2.0 ug/L for salmonid fish and 10.0 ug/L for other freshwater and marine organisms. AFS (1979) suggests that 20 ug/L for total oxicants is the best marine criterion at present.	Toxic, radioactive, or deletrious material concentrations shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.	Toxic, radioactive, or deletrious material concentrations shall be below those which adversely affect public health during characteristic uses, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect characteristic water uses.

Table 2. Summary of results obtained during a reconnaissance at the Mukilteo STP discharge and nearby marine receiving waters. Means and standard deviations are computed from duplicate samples.

Site Description	F. Coliform (org/100 mls) $\overline{X}$ S	pH (units) $\overline{X}$ S	Turb. (NTU) $\overline{X}$ S	TSS (mg/L) $\overline{X}$ S	NO_3-N (mg/L) $\overline{X}$ S	NO_2-N (mg/L) $\overline{X}$ S	NH_3-N (mg/L) $\overline{X}$ S	O-PO_4-P (mg/L) $\overline{X}$ S	T-PO_4-P (mg/L) $\overline{X}$ S	Salinity (o/oo) $\overline{X}$ S
Mukilteo STP (chlorinated eff.)	$<10^4$	--	--	--	--	--	--	--	--	--
Discharge Point	4 ± 1	7.9 ± 0.1	4.0 ± 1.4	4.0 ± 0.0	0.35 ± 0.01	0.01 ± 0.00	0.18 ± 0.19	0.05 ± 0.01	0.06 ± 0.01	22.4 ± 0.1
30m Downstream from Discharge	6 ± 2	7.9 ± 0.0	3.5 ± 0.7	5.0 ± 1.4	0.42 ± 0.04	0.01 ± 0.00	0.08 ± 0.08	0.05 ± 0.00	0.07 ± 0.00	21.8 ± 0.5
30m Upstream from Discharge	2 ± 1	7.9 ± 0.0	3.0 ± 0.0	5.5 ± 0.7	0.35 ± 0.01	0.01 ± 0.00	0.03 ± 0.01	0.05 ± 0.00	0.07 ± 0.00	22.4 ± 0.1
Control; 1.1 km Offshore	2 ± 1	7.9 ± 0.0	4.0 ± 1.4	3.5 ± 2.1	0.35 ± 0.01	0.01 ± 0.00	0.06 ± 0.09	0.05*	0.06 ± 0.01	22.1 ± 0.1

*Duplicate sample result invalid.

Table 3. Summary of results obtained during an intensive sampling survey at the Mukilteo STP discharge zone and nearby marine receiving waters. Means and standard deviations are calculated from duplicate samples.

Stations	Site Descripton	F. Coliform (org/100 mls) $\bar{X}(S)$	pH (units) $\bar{X}(S)$	Turb. (NTU) $\bar{X}(S)$	TSS (mg/L) $\bar{X}(S)$	NO_3-N (mg/L) $\bar{X}(S)$	NO_2-N (mg/L) $\bar{X}(S)$	NH_3-N (mg/L) $\bar{X}(S)$	O-PO_4-P (mg/L) $\bar{X}(S)$	T-PO_4-P (mg/L) $\bar{X}(S)$	Salinity (o/oo) $\bar{X}(S)$	Temp. (°C) $\bar{X}(S)$	D.O. (mg/L) $\bar{X}(S)$	D.O. (% Satur.) $\bar{X}(S)$	Cl_2 Resid. (mg/L) $\bar{X}(S)$	BOD_5 (mg/L)
MIXING ZONE																
STP	Mukilteo STP (chlorinated eff)[2/]	110	7.1	100	93	0.60	<0.10	10.0	3.3	6.8	--	--	--	--	2.2	230
MH	Outfall Manhole	--	7.5	90	--	--	--	--	--	--	--	--	--	--	--	--
1S	Discharge point; surface	14(10)	7.8(0.1)	2(0)	4(1)	0.39(0.02)	0.01(0.00)	0.02(0.00)	0.04(0.00)	0.05(0.01)	18.139(0.308)	7.4(0.0)	10.60[1/]	98.3[1/]	0	--
1M	Discharge point; 3.5m depth	4(3)	7.8(0.0)	2(0)	6(1)	0.38(0.01)	0.0(0.00)	0.02(0.00)	0.05(0.00)	0.05(0.00)	22.510(0.344)	7.6[1/]	9.95[1/]	95.8[1/]	--	--
1D	Discharge point; 7.0m depth[1/]	3	7.9	3	6	0.37	0.01	0.01	0.04	0.06	21.052	7.5	10.21	96.9	--	--
2S	5m Downstream from discharge; surface	6(1)	7.9(0.0)	2(0)	4(0)	0.39(0.00)	0.01(0.00)	0.02(0.01)	0.04(0.00)	0.05(0.00)	18.578(0.023)	7.5(0.1)	10.60[1/]	99.2[1/]	0	--
2M	5m Downstream from discharge; 3.5m depth	4(1)	7.9(0.0)	3(0)	5(1)	0.37(0.00)	0.01(0.00)	0.02(0.01)	0.05(0.00)	0.06(0.00)	23.090(0.770)	7.6(0.1)	9.90(0.08)	96.4(0.1)	--	--
2D	5m Downstream from discharge, 7.0m depth	4(1)	7.9(0.0)	2(0)	6(1)	0.39(0.07)	0.01(0.00)	0.01(0.00)	0.06(0.01)	0.07(0.01)	27.302(0.203)	7.9[1/]	9.35(0.0')	93.3[1/]		--
3S	10m Downstream from discharge; surface	6(0)	7.9(0.0)	2(1)	5(0)	0.38(0.00)	0.01(0.00)	0.02(0.01)	0.04(0.00)	0.06(0.01)	18.488(0.028)	7.4(0.0)	10.50(0.06)	98.0(0.5)	0	--
3M	10m Downstream from discharge; 3.5m depth	6(1)	7.9(0.0)	4(2)	6(1)	0.39(0.00)	0.01(0.00)	0.01(0.00)	0.06(0.01)	0.06(0.00)	22.321(0.120)	7.6(0.0)	10.08(0.08)	96.8(0.8)	--	--
3D	10m Downstream from discharge; 7.0m depth	4(1)	7.9(0.0)	4(1)	6(1)	0.38(0.01)	0.01(0.00)	0.02(0.01)	0.06(0.00)	0.08(0.01)	27.374(0.166)	7.9[1/]	9.38(0.02)	93.8(0.14)	--	--
4S	5m Upstream from discharge; surface	3(2)	7.9(0.0)	4(1)	4(1)	0.40(0.01)	0.01(0.00)	0.05(0.03)	0.04(0.00)	0.05(0.00)	18.723(0.093)	7.4 ± (0.')	10.53(0.00)	98.4(0.2)	0	--
4M	5m Upstream from discharge; 3.5m depth	9(1)	7.9(0.0)	2(1)	5(1)	0.39(0.01)	0.01(0.00)	0.06(0.03)	0.04(0.00)	0.06(0.00)	20.178(0.023)	7.6(0.1)	10.36(0.06)	98.1(0.4)	--	--
4D	5m Upstream from discharge; 7.0m depth	6(1)	7.9(0.0)	2(1)	6(1)	0.37(0.00)	0.01(0.00)	0.01(0.00)	0.06(0.01)	0.06(0.01)	25.900(1.372)	8.0(0.1)	9.61(0.18)	95.2(0.71)	--	--
OTHER STATIONS																
F1	Control; 1.1 km offshore	8(1)	7.8(0.1)	4(0)	4(0)	0.40(0.01)	0.01(0.00)	0.02(0.01)	0.04(0.00)	0.06(0.00)	18.984(0.059)	7.4(0.1)	10.53(0.04)	98.5(0.6)	--	--
F2	Seaward of small creek NE of military fuel docks	16(16)	7.9(0.0)	10(6)	12(5)	0.77(0.31)	0.02(0.01)	0.07(0.06)	0.05(0.01)	0.08(0.01)	16.522(2.726)	7.8(0.2)	10.67(0.18)	99.1(0.42)	--	--
F3	Seaward of drain near shore terminus of fuel dock	4(1)	7.9(0.0)	4(2)	8(0)	0.44(0.01)	0.01(0.00)	0.11(0.02)	0.05(0.00)	0.06(0.01)	19.828(0.327)	7.8(0.0)	10.41(0.01)	98.1(0.1)	--	--
F4	Beach between fuel dock and NMFS dock	4(1)	7.8(0.1)	2(1)	6(1)	0.42(0.01)	0.01(0.00)	0.02(0.00)	0.05(0.00)	0.06(0.00)	20.656(0.013)	7.8(0.1)	10.26(0.01)	97.6(0.1)	--	--
F5	Seaward of bayside restaurant beside ferry dock	12(3)	7.8(0.0)	6(0)	13(0)	0.76(0.29)	0.01(0.00)	0.07(0.01)	0.06(0.01)	0.12(0.06)	17.412(2.439)	7.8(0.1)	10.47(0.21)	97.8(0.2)	--	--
F6	Culvert near NMFS dock[1/]	36	7.7	--	12	2.7	0.02	0.03	0.05	0.07	0.292	--	11.62	--	--	--

[1/] One observation only.

[2/] One observation only (Heffner, 1982), taken on day of intensive sampling.

Table 4. Results of tissue analysis of mussels (*Mytilus edulis*) collected at several sites in Possession Sound.

Station* Number	Site Description	Fecal Coliform (org/100 gr)
Sh1	Pilings supporting military fuel dock	2
Sh2	Pilings supporting NMFS dock (outfall site)	17
Sh3	Pilings supporting ferry landing	23
Sh4	Pilings on abandoned pier on south side of Gedney Island (control site)	<2