A Department of Ecology Report

WASHINGTON STATE DEPARTMENT OF ECOLOGY

ASSESSMENTS FOR GROUND WATER CONTAMINATION POTENTIAL FORT FLAGLER AND SEQUIM BAY STATE PARKS

SUMMARY

The potential for ground water contamination was assessed at two municipal wastewater land application sites: Fort Flagler State Park and Sequim Bay State Park. The assessments consisted of a review of existing pertinent literature and limited on-site soil and effluent sampling. Information from these assessments will be used to modify waste discharge permits for the facilities.

The potential for ground water contamination at Fort Flagler State Park is high. Shallow ground water underlies the discharge areas. Ground water monitoring is recommended.

The potential for ground water contamination at Sequim Bay State Park is low. However, wastewater should not be applied when shallow soils are saturated and application rates should not exceed the capacity of the vegetative cover for nutrient uptake. Recommendations for Sequim Bay State Park are:

1) determine effluent application rates based on infiltration capability of the soil and nutrient uptake of the cover vegetation, and
2) limit effluent application season to May through September.

INTRODUCTION

Purpose

This study assessed the ground water contamination potential at two land application facilities: Fort Flagler State Park and Sequim Bay State Park. The information from these assessments will

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be used to determine ground water monitoring requirements for each facility. The requirements will be included in updated waste discharge permits. This work was conducted for Ecology's Water Quality Program, Southwest Regional Office.

Study Tasks

The assessments consisted of five tasks: 1) site reconnaissance; 2) effluent and soil sampling; 3) review of pertinent geologic, hydrogeologic, and soil science literature and Ecology files; 4) evaluation of the susceptibility of ground water to contamination; and 5) document preparation. The site reconnaissance, effluent sampling and soil sampling were conducted July 12, 1994 at both facilities. The investigation team consisted of Dick Schroeder, Cyronose Spicer, and Kathy Cupps from Ecology's Southwest Regional Office and Denis Erickson and Barbara Carey from EILS.

Document Organization

The facility descriptions, results and conclusions, and recommendations are discussed separately in each section below. Study methods are described in Appendix A. Laboratory reports and a quality assurance review of laboratory data are in Appendix B.

FACILITY DESCRIPTIONS

Fort Flagler State Park

Fort Flagler State Park is located on the northern tip of Marrowstone Island about four miles east of Port Townsend. Figure 1 shows the site and vicinity. Municipal wastewater from the permanent residences and rental homes is discharged to a facultative lagoon and a non-overflow infiltration lagoon. The facility operates under the requirements of a State Waste Discharge Permit (No. 6029) which expired June 24, 1990, but was extended indefinitely. The maximum discharge occurs in the summer from up to 280 people. The permit authorizes a discharge of up to 500,000 gallons per day from the facultative lagoon to the infiltration lagoon. The infiltration lagoon is designed to have a minimum retention time of 17 days. During the winter, the infiltration lagoon may discharge to an "evaporation/ infiltration" area otherwise known as a percolation bed (Giersh, 1994). A narrow ditch on the west side of the primary lagoon leads from the infiltration lagoon to the percolation bed. The ditch was dry during the site visit in July 1994. Discharge to the ditch is not measured.

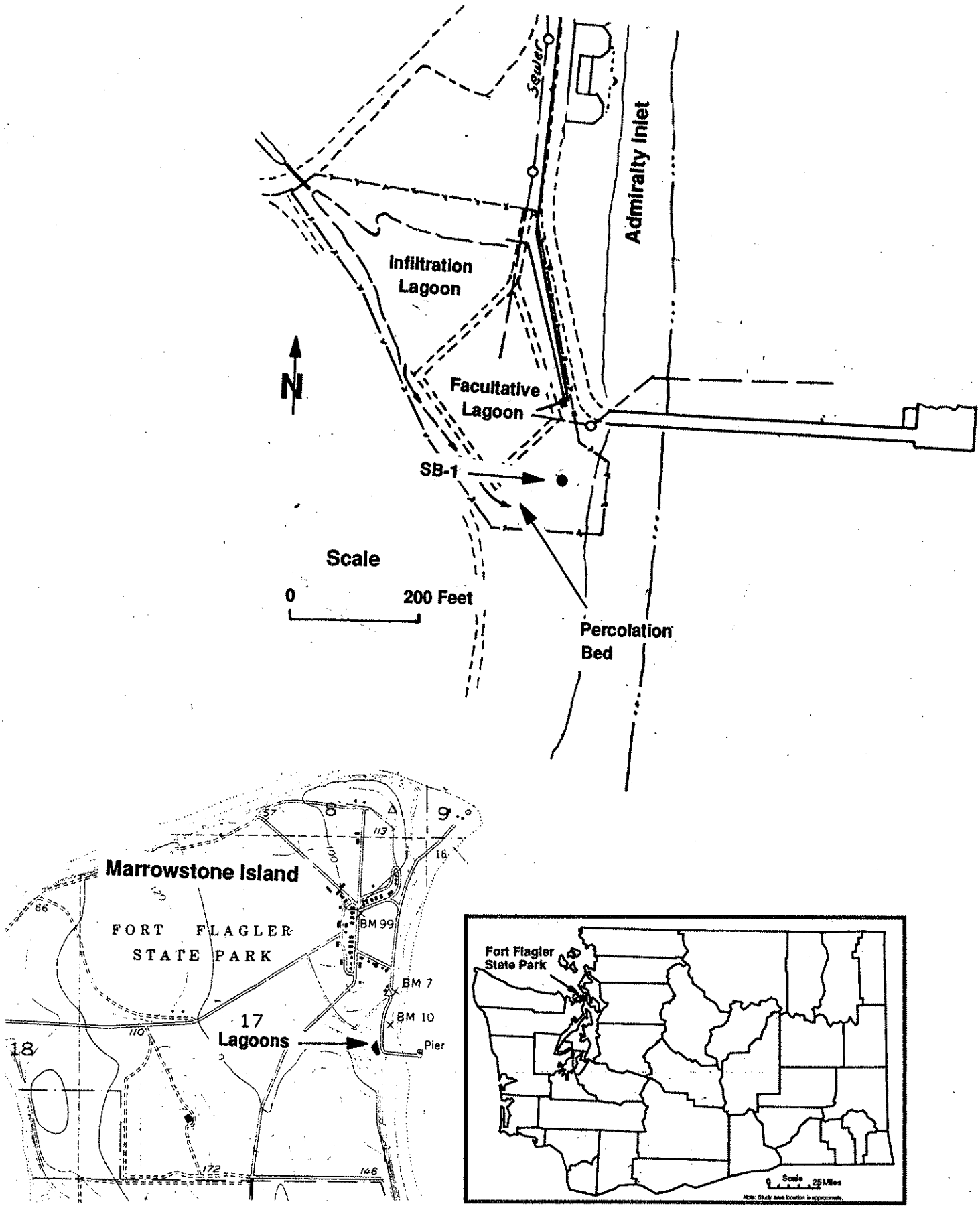

Figure 1. Fort Flagler State Park Site and Location Maps.

Sequim Bay State Park

Sequim Bay State Park is located on the Olympic Peninsula about five miles southeast of Sequim. Figure 2 shows the site and vicinity. The wastewater treatment system consists of a primary pond, a polishing pond and a 1.25-acre, forested, land application area. The facility operates under a State Waste Discharge Permit (No. 6006) which expired June 1990 but was extended indefinitely. Effluent from the ponds is applied to the land application area with 12 fixed sprinklers on about 80-foot centers (40-foot radii circles). The maximum permitted discharge is 35,000 gallons per day. However, Ecology, after reviewing the Engineering Report, suggested that the maximum discharge to the spray field should be 14,000 gallons per day (Anderson, 1993). Effluent from the pond is discharged to the spray field when the park ranger judges that the fluid level is high.

FORT FLAGLER STATE PARK
RESULTS AND CONCLUSIONS

Hydrogeology

The geology consists of unconsolidated glacial deposits that overlie sedimentary bedrock (Grimstad and Carson, 1981). The unconsolidated deposits listed in order of increasing age are: 1) modern beach deposits 2) Vashon Till, 3) Vashon advance outwash, 4) undifferentiated glacial and non-glacial deposits.

The existing beaches are underlain by the modern beach deposits which consist of sand and gravel. Vashon Till consists of a compacted, unsorted mixture of silt, sand and gravel up to boulder-sized particles. Vashon Till underlies most of the park and ranges in thickness from about 20 to 30 feet.

Advance outwash deposits which consist of interlayered gravel and sand with some silt and clay underlie the Vashon Till. Advance outwash deposits are exposed in the bluffs south of the treatment lagoons and directly underlie the land application area (Grimstad and Carson, 1981). Grimstad and Carson report that the advance outwash deposits in the vicinity are typically about 10 to 30 feet thick.

Undifferentiated, unconsolidated deposits underlie the advance outwash deposits. The lithology of the undifferentiated unconsolidated deposits beneath the park is unknown. A well drilled at the site to a depth of 1,462 feet showed that the unconsolidated deposits are about 175 feet thick (Grimstad and Carson, 1981). The well which tapped water from two depth intervals (145-175 feet and 667 feet) produced saline water and eventually was abandoned. I did not find any well logs in Ecology files for the area within a mile of the site.

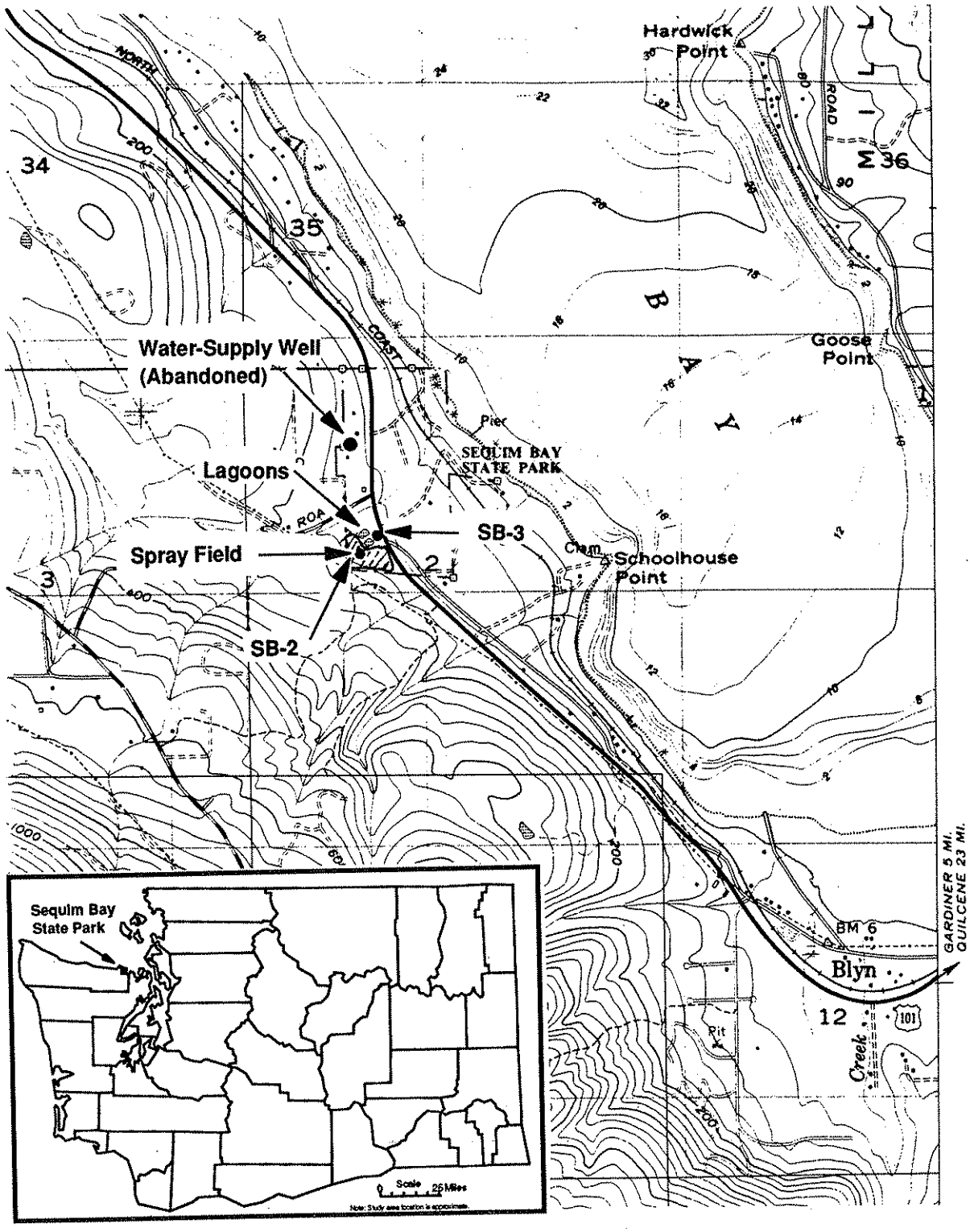

Figure 2. Sequim Bay State Park Vicinity Map.

Surficial Soils

During the site visit we drilled one soil boring, SB-1, to a depth of 7.0 feet. We located SB-1 at the south end of the primary lagoon adjacent to the infiltration/evaporation area. The log of SB-1 is shown in Figure 3. The soil consisted of sand and silty sand separated by a silty clay layer at a depth of 3.6 to 5.5 feet below the ground surface. The soil appeared to be similar to the advance outwash deposits exposed in the bluff about five hundred feet south of the site. The water table was observed at a depth of 3.7 feet.

Uppermost Aquifer

The uppermost aquifer consists of the saturated portions of the advance outwash deposits and, for this report, is designated as the advance outwash aquifer. The advance outwash aquifer is shallow (less than four feet deep) and unconfined. It is probably hydraulically connected to the modern beach deposits. Ground water in the advance outwash aquifer flows southeast and discharges into Admiralty Inlet about 300 feet from the facility. The advance outwash aquifer in the vicinity of the ponds is not used for drinking water.

Ground Water Contamination Potential

Because of the permeable surficial soils and shallow water table, the advance outwash aquifer is susceptible to ground water contamination from surface discharges. Potential sources of contamination are: 1) leakage from the infiltration pond, 2) infiltration from the percolation bed, and 3) leakage from the primary pond.

Dissolved contaminants in the advance outwash aquifer will move laterally and eventually discharge to Admiralty Inlet. The effects of the discharge are unknown; no effects were observed during the site visit in July.

Constituents of Concern

An effluent sample was obtained from the primary lagoon to identify constituents of concern. The results of the effluent sample testing are shown in Table 1. The constituents of concern are nitrogen (as ammonia and nitrate), organics (total organic carbon and biochemical oxygen demand) and arsenic. Chloride, present in the effluent at about 42 mg/L, would be a good indicator of ground water contamination. Total coliform and fecal coliform bacteria, although reported in high concentrations in the effluent, do not readily migrate in ground water and are not included as constituents of concern.

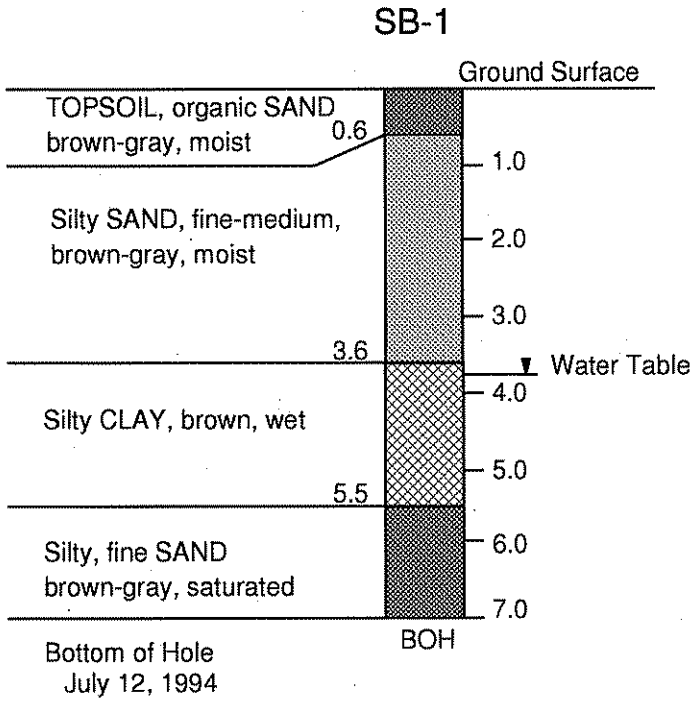

Figure 3. Fort Flagler State Park, Soil Boring 1 (SB-1).

Table 1. Water Quality Results for Fort Flagler and Sequim Bay State Parks.

Analyte	Fort Flagler Effluent 28-8010	Sequim Bay Effluent 1 28-8011	Sequim Bay Effluent 2 28-8012	Reporting Limit	Relative Precent Difference (-8011 and -8012)
Total Suspended Solids, mg/L	3	16	14	1	13
Biochemical Oxygen Demand, mg/L	7.0	13.0	14.0	2	7
Total Organic Carbon, mg/L	24.3	41.7	43.5	1	4
Ammonia-N, mg/L	23.7	13.6	13.7	0.01	1
Nitrate+Nitrite-N, mg/L	0.01 U	0.01 U	0.01 U	0.01	--
Total Persulfate N, mg/L	21.7	15.9	15.2	0.01	5
Chloride, mg/L	41.9	184	177	0.1	4
Arsenic, Total, ug/L	18.0 P	4.1 P	3.5 P	3	16
Cadmium, Total, ug/L	3 U	3 U	3 U	3	--
Chromium, Total, ug/L	5 U	5 U	5 U	5	--
Copper, Total, ug/L	32.8 B	21 PB	22 PB	3	5
Lead, Total, ug/L	20 U	20 U	20 U	20	--
Mercury, Total, ug/L	0.05 U	0.05 U	0.05 U	0.05	--
Nickel, Total, ug/L	10 U	10 U	10 U	10	--
Zinc, Total, ug/L	8.7 PB	29 PB	33 PB	4	13
Total Coliform Bacteria, 1 CFU/100mL	48000 X	670000 PX	160000 X	1	123
Fecal Coliform Bacteria, 1 CFU/100mL	13000 X	260000 JX	150000 X	1	54

U= Analyte not detected at or above the reported result.

P= Analyte was detected above the instrument detection limit but below the established minimum quantitation limit.

B= Analyte was also found in the analytical method blank indicating the sample may have been contaminated in the laboratory.

X= Many background organisms.

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

FORT FLAGLER STATE PARK
RECOMMENDATIONS

The state waste discharge permit for Fort Flagler State Park, when re-issued, should be modified to include the following:

1. Ground water monitoring should be initiated at the site. At a minimum, the monitoring network should consist of an upgradient well and two downgradient wells: one south of the primary pond and one south of the percolation bed. The wells should be completed in the advance outwash deposits and should comply with the Minimum Standards for the Construction and Maintenance of Wells (Chapter 173-160 WAC). The elevations of all wells should be surveyed relative to Mean Sea Level to 0.01 feet

2. A sampling and analysis plan should be prepared describing sampling methods, field instrument calibration, equipment cleaning, analytical test methods, and quality assurance.

3. The monitoring wells should be sampled quarterly and tested for the following parameters: ammonia-N, nitrate+nitrite-N, total organic carbon, total dissolved solids, chloride, dissolved iron, dissolved manganese, dissolved arsenic.

4. The following field parameters should also be tested quarterly: water level, pH, temperature, and specific conductance.

5. Discharge rates and volumes should be measured: 1) from the primary pond to the infiltration pond, and 2) from the infiltration pond to the ditch leading to percolation bed.

SEQUIM BAY STATE PARK
RESULTS AND CONCLUSIONS

Hydrogeology

The site is underlain by Vashon till which overlies sedimentary bedrock (Othberg and Palmer, 1981). Vashon till typically consists of lodgement till (overridden by glacial ice) that is characterized by compact, poorly sorted, non-stratified, pebbly, sandy silt with occasional boulders. Ablation till may be present locally which is characterized by loose, non-stratified, pebbly, silty sand. A water-supply well drilled at the park about 1500 feet north of the spray field to a depth of 492.5 feet showed 20 feet of unconsolidated deposits (probably till) overlying 472 feet of bedrock (shale and conglomerate). Water was obtained from two intervals in the bedrock: 78-84 feet and 108-111 feet (Noble, 1960). This well is no longer used (Reichner, 1994).

Ground water near the park has a low water-supply potential. Ecology files contain 27 well logs reported to be within a one-mile radius of the park. Nearly all of these wells were completed in bedrock. Typical yields from these wells were less than one gallon per minute. The maximum reported yield was 12 gallons per minute. Typical specific capacities were also low ranging from 0.005 to 0.16 gallons per minute/feet for one to four-hour tests. (Specific capacity is the ratio of well discharge in gallons per minute divided by drawdown.) Three of the 27 wells, ranging in depths from 280 to 340 feet, were reported to be dry. Water in four of the wells was reported to be saline or had a high chloride concentration.

Surficial Soil

The surficial soil consists of Yeary gravelly loam (Halloin, 1987). The Yeary gravelly loam formed in reworked marine sediment which is underlain by dense, compact till. The permeability of the Yeary soil is slow to moderate when saturated. Typically the soil above the till is saturated from January through April (Halloin, 1987).

We drilled two soil borings at the site: one in the spray field (SB-2) and one about 20 feet south of the pump house (SB-3). The soil boring logs are shown in Figure 4. We drilled SB-2 (in the spray field) to a depth of 7.6 feet and observed three feet of silty sand with some pebbles overlying four feet of brown clayey silt. We observed a thin layer of wet soil immediately above the clayey silt. Till (hard, silty sand) was present below seven feet. We drilled SB-3 (near the pump house) to a depth of five feet and found a veneer of sandy gravel (probably fill) overlying fine to coarse sand. The water table was not observed in either of the borings.

Uppermost Aquifer

Based on well logs from the area, the uppermost regional aquifer occurs within the bedrock. Ground water occurs primarily within fractures of the bedrock. The lateral extent of specific water-bearing zones and rates of ground water movement are not known. Ground water in the bedrock aquifers probably flows westward and discharges to Sequim Bay most of the year.

In the winter this situation changes, however. In response to increased precipitation between October and April, the permeable sediments overlying the till likely become saturated (Halloin, 1987). These saturated sediments become the uppermost aquifer. The sediments could also become saturated by high wastewater application rates. This sediment aquifer is transient and water levels probably change rapidly in response to changing recharge. Preferred pathways for water and contaminants are dependent on the occurrence of sandy soil like the soil observed in SB-2 to a depth of three feet. The lateral and vertical extent of the sandy soil is probably variable and discontinuous. The aquifer discharges locally to on-site ditches and drainage areas. The ground water flow direction in the sediment aquifer probably mimics topography which generally slopes to the east.

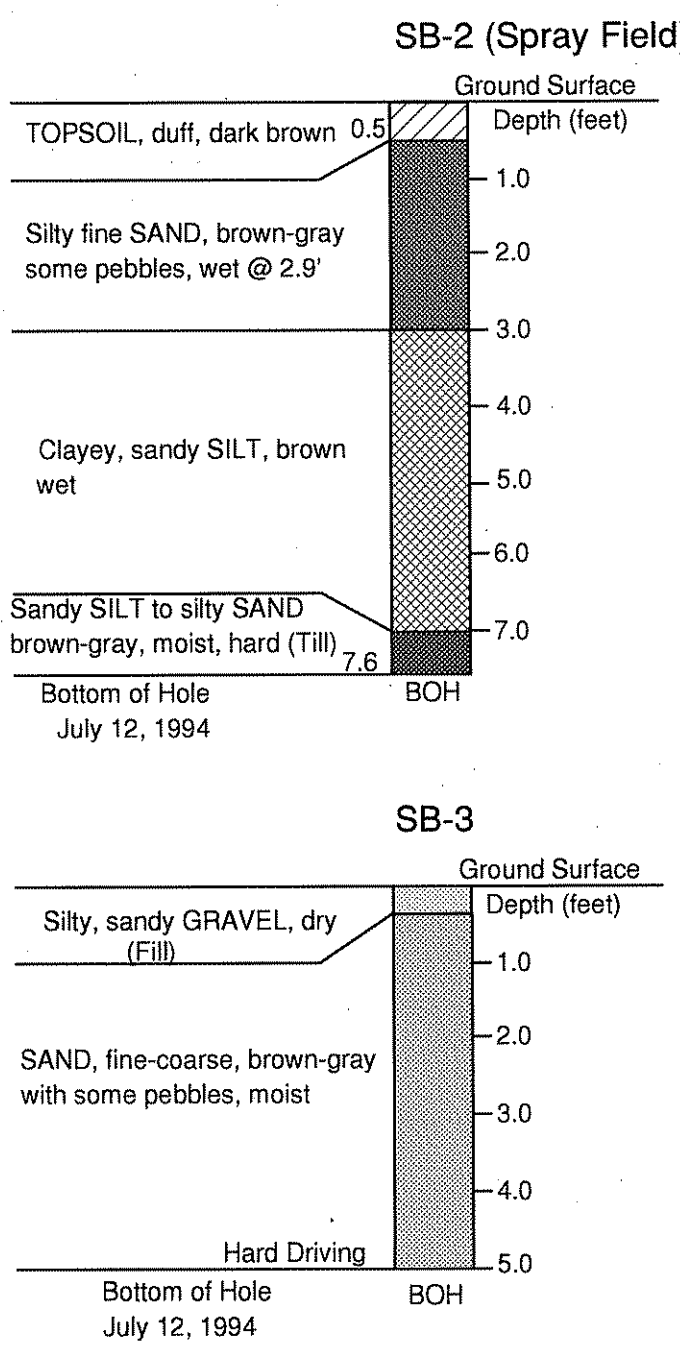

Figure 4. Sequim Bay State Park, Soil Boring Logs.

Ground Water Contamination Potential

The potential for contamination of the regional bedrock aquifers is low. Typically bedrock in this area is overlain by a substantial thickness of compact till and fine-grained (silt and clay) deposits. These deposits have low hydraulic conductivities which limit downward movement of water and potential contaminants. Provided wastewater is not applied at rates far greater than evapotranspiration rates, it is unlikely waste constituents from the facility will migrate to the regional bedrock aquifers.

During the winter, or in response to heavy hydraulic loading, there is a high potential for contamination of the saturated sediments above the till. Contaminants could be transported laterally downslope through the sediment aquifer to ditches and natural drainage areas. From the ditch and natural drainages contaminants could be transported to Sequim Bay. In the winter the potential for contamination is especially high, because nutrient uptake by plants is negligible.

Overland transport is another potential contaminant migration pathway of concern. Overland transport would occur when wastewater application exceeds the infiltration rate of the surficial soil. The potential for overland transport is highest during the winter when surficial soils are normally saturated. However, overland transport could also occur due to heavy applications of effluent.

Constituents of Concern

An effluent sample was obtained from the sump in the pump house to identify constituents of concern that may be applied to the spray field. The results of the effluent sample testing are shown in Table 1. The constituents of concern are nitrogen (as ammonia and nitrate), organics (total organic carbon and biochemical oxygen demand), arsenic, and chloride. Total coliform and fecal coliform bacteria, although reported in high concentrations in the effluent, do not readily migrate in ground water and are not included as constituents of concern. However, bacteria can be readily transported in runoff.

SEQUIM BAY STATE PARK RECOMMENDATIONS

Recommendations for Sequim Bay State Park are listed as follows:

1. Establish application rates based on the infiltration capability of the surficial soil and nutrient uptake of the cover vegetation.

2. Specify in the permit that wastewater should only be applied between May through September.

3. Prepare a map of updated sprinkler locations.

4. Verify that methods for measuring and reporting discharge rates and volumes to the spray field are accurate.

REFERENCES

Anderson, Gerald, 1993. Letter to Mr. Joe J. Giustino, Facilities O & M Specialist, Washington State Parks and Recreation Commission, June 11, 1993.

Giersh, Al, 1994. Fort Flagler State Park Ranger. Personal communication, July 12, 1994.

Grimstad, Peder and Robert J. Carson, 1981. "Geology and Ground-Water Resources of Eastern Jefferson County, Washington." Washington State Department of Ecology Water Supply Bulletin 54. 125p.

Halloin, Louis J, 1987. Soil Survey of Clallam County Area, Washington. Soil Conservation Service, US Department of Agriculture and Washington State Department of Natural Resources. 213p.

Noble, John B. 1960. "A Preliminary Report on the Geology and Ground-Water Resources of the Sequim-Dungeness Area, Clallam County, Washington." Washington State Division of Water Resources Water Supply Bulletin No.11. 43p.

Othberg, K. and P. Palmer, 1979. Preliminary Surficial Geologic Map of the Sequim Quadrangle, Clallam County, Washington. Washington Division of Geology and Earth Resources Open-File Report OF79-18.

Reichner, Mike, 1994. Sequim Bay State Park Ranger. Personal communication, July 12, 1994.

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Appendix A. Methods

Laboratory Test Methods

Parameters, test methods and quantitation limits for this project are listed in Table 2.

Table 2. Parameters, Test Methods, and Quantitation Limits for Fort Flagler and Sequim Bay State Parks Assessments.

Parameter	Test Method	Quantitation Limit
Total Persulfate N	Std Method 4500	0.01 mg/L
Ammonia-N	Std Method 4500 NH3 D	0.01 mg/L
Nitrate+Nitrite-N	Std Method 4500 NO3 F	0.01 mg/L
Biochemical Oxygen Demand/5-Day	Std Method 5210B	2 mg/L
Chloride	Std Method 4110B	0.1 mg/L
Total Organic Carbon	Std Method 5310B	1 mg/L
Total Coliforms	Std Method MF 9222B	1CFU/100mL
Fecal Coliforms	Std Method MF 9222D	1CFU/100mL
Total Suspended Solids(TSS)	Std Method 2540D	1 mg/L
Total Metals:	EPA 600/4-79-020	
Arsenic	Graphite Furnace AA, EPA 206.2	1.5 ug/L
Cadmium	ICAP	2.0 ug/L
Chromium	ICAP	5.0 ug/L
Copper	ICAP	3.0 ug/L
Lead	ICAP	20 ug/L
Mercury	Cold Vapor AA, EPA 245	0.05 ug/L
Nickel	ICAP	10 ug/L
Zinc	ICAP	4.0 ug/L

ICAP= Inductively Coupled Argon Plasma.
AA= Atomic Absorption.
CFU= Colony Forming Unit.

Soil Sampling

Soil samples were obtained using a JMC Soil Probe. All downhole equipment was washed with a Liquinox/tap water solution and rinsed with tap water prior to use. A three-foot long, 1-inch diameter stainless steel barrel was driven into the ground using a JMC Soil Probe and 12.5-pound slide hammer. The barrel was fitted with a removable vinyl acetate liner. After driving the length of the barrel, the barrel and liner were jacked to the ground surface. The liner was extracted from the barrel so that the soil could be observed, classified and logged. Caps were taped on each end of the liner. The barrel, fitted with a new liner and equipped with extensions, was re-inserted in the hole and driven another three feet into the ground. The process was repeated until the desired depth was reached.

Appendix B. Laboratory Results and Quality Assurance Review

The quality of the data is good. Laboratory quality assurance samples consisted of standards, replicates, blanks, spikes, and spike duplicates. All data met QA/QC limits and are acceptable for use except as qualified in Table 1 and discussed below.

Copper and zinc results are qualified due to laboratory blank contamination. Arsenic concentrations were below the quantitation limit and are considered to be estimates. Interference from numerous background organisms may have affected coliform bacteria concentrations.

Attached are: 1) laboratory reporting sheets,
2) memorandum describing the quality assurance review of metals results, and
3) laboratory bench sheets for general chemistry parameters.

Field quality assurance consisted of one blind duplicate, Sequim Bay samples -8011 and -8012. Relative percent differences, the ratio of the difference and mean for duplicate sample results, were less than 16% with the exception of the total and fecal coliform bacteria. RPD's for total and fecal coliforms were 123% and 54%, respectively. The is probably due to interference from background organisms.