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MEMORANDUM
March 5, 1981

To: John Bernhardt

From: Tim Determan TJD

Subject: Effects of Tamoshan STP Outfall on Water Quality at Silver Spit, Budd Inlet

Introduction

In response to concern over past operational conditions at the Tamoshan sewage treatment plant (STP) and suspected impacts on Budd Inlet receiving waters, the Marine Intensive Survey Unit was requested to carry out a brief bacteriological survey of the marine waters surrounding the Tamoshan discharge point, to locate the outfall, and to evaluate the role of the outfall in bacterial pollution in the area.

Background

The Tamoshan development is located about eight kilometers north of Olympia on the western shore of Budd Inlet in Thurston County (Figure 1). The development presently consists of two housing increments that lie on ridges above a short ravine within which flows a spring-fed stream. The mouth of the stream enters Budd Inlet on the north end of Silver Spit. During higher tide levels, marine waters flow into a large pond behind the spit, forming a small estuarine system. During lower tides the pond drains seaward.

The east and north faces of Silver Spit have been stabilized by a bulkhead and on the west by riprap. A small recreational park has been constructed on the spit.

Marine nearshore circulation appears to be tidally dominated. Tidal Current Charts (NOAA, 1973) show velocities ranging from slack to 0.9 knot (to the south) during rising tides and 0.5 knot (to the north) during falling tides.

Wastewater from the Tamoshan development is collected and treated at a small 35,000 gallon-per-day (GPD) capacity aeration sewage treatment plant located on the north side of the stream about 200 m inland of the shoreline. Wastewater from the northwest part of the development is piped to the plant along the beach access road.

The southeast part of the development is served by an exposed PVC line that leads down the bank facing Budd Inlet. The line is buried from this point to a small lift station at the southeast corner of the park. Several manholes are reported to provide access to the buried section of line. These were not visible so they are likely to be buried beneath the sediments and submerged during extremely high tides. The covers have been sealed in order to control seawater intrusion (Victor Berule, Thurston County Public Works, personal communication). The lift station pumps the sewage westward to the plant.

Following treatment and chlorination, the plant effluent collects in a wet well. The wet well volume is about 2,300 gallons according to dimensions shown on design drawings (Godat and Assoc.). When the wet well becomes full, the contents are pumped into the outfall line. A review of NPDES records for the Tamoshan facility (Permit No. WA-003729-0) shows an average discharge of 13.4 $\pm$ 0.9 thousand GPD during the past year. This means that the pump cycle occurs about six times a day at a frequency related to plant flows and time of day. The engineering drawings show the outfall line to be made of six-inch PVC pipe and is buried in a trench that is two feet deep. The line is shown to extend 225 m into Budd Inlet and at the end, a 16 m diffuser with four nozzles is shown.

The effluent limitations of the NPDES permit impose discharge limits on fecal coliform levels such that monthly averages of 200 colonies per 100 ml, or weekly averages of 400 per 100 ml are not to be exceeded (arithmetic or geometric means were unspecified).

The NPDES file for Tamoshan STP indicated several design problems including lack of a flow meter, improper bar screen, elevation problems with a newly installed aeration unit, and the presence of the beach sewer line and lift station. From November 1979 through November 1980, monthly discharge monitoring reports by plant personnel show fecal coliform arithmetic averages ranged from 43 to 67,000 counts per 100 ml. Seven of nine monthly reports indicated violations of the NPDES permit. These results are from samples obtained inside the plant. No data exist to show the expected values at the actual discharge point or in the dilution zone adjacent to the diffuser.

In March 1979 a survey was conducted by DOE to determine the sanitary quality of the Tamoshan beach swimming area (Cunningham, unpublished data). Six points along shore were sampled from 10 m north of the stream mouth to 250 m south of the mouth. An additional three stations were sampled eastward from center beach to 175 m offshore. The data showed highest counts closest to beach center (36 to 120 FC per 100 ml). The stations close to the creek mouth were 4 to 12 FC per 100 ml. The southerly station and offshore points showed values ranging from 2 to 14 FC per 100 ml. The most distant offshore station showed the lowest value. Data on tide stand, plant operations, and a specific location of the discharge point were not determined during the brief survey so correlations could not be inferred.

Methods

The assigned task was to evaluate the possibility of beach pollution resulting from wastewaters discharged from the Tamoshan STP outfall. In order to achieve this end, it was necessary to identify the water mass directly over the discharge point, sample the mass during a discharge cycle, and follow the mass in time and space to evaluate rates of change of bacterial densities. Ideally, this scheme should be performed at critical moments such as slack flows during high and low tide.

Two sampling surveys were conducted during higher high and mean low tide stands. These surveys were carried out on separate days. Weather conditions were similar on both occasions. Rainfall and surface runoff were minimal; skies were partly cloudy and winds were very light. Station locations are shown on Figure 1. Near-shore stations were sampled on both occasions. During higher high tide, the salt pond was full and a sample was taken near its upper end. During mean low tide drain period, a sample of the pond outflow was taken at the mouth.

In order to locate the outfall and tag the receiving water mass, 250 mls of Rhodamine WT dye were dumped into the outfall line through a manhole downstream from the wet well. The dye was then entrained in the discharge during the next pumping cycle. During higher high tide, we did not observe the emergence of any dye into Budd Inlet. We located a section of white plastic outfall line in shallow water during a search for the dye. We followed the line seaward until it appeared to end in approximately 3 m of water. We marked the spot with a buoy (A in Figure 1), shot bearings into order to fix the location, and dropped a patch of dye under the assumption that we had located the outfall. We sampled over time while we followed the dye patch. Unfortunately, the assumed site of the outfall was not correct. However, the dye data are summarized in Figure 1.

On another day during mean low tide, the procedure was repeated. In this case, the dye emerged approximately 20 minutes following onset of the STP discharge cycle. The point was marked, initial sample taken, and bearings taken on the location (B in Figure 1). In addition, a drift drogue was launched into the dye cloud. Samples and bearings were taken from the drogue at 15-minute intervals for one hour. Current observations are shown in Figure 1. We found good agreement between dye cloud and drogue behavior.

Results

Table 1 summarizes fecal coliform data collected during the two surveys. On each occasion, the near-shore stations were sampled before and after the discharge zone was sampled. A large number of the results were estimates because the 100 ml sample tested did not provide the extremely low limits required for this study (APHA, 1976). In order to assure counts in the required low range, a 500 ml sample would have been required.

The overall geometric mean of pooled shoreline stations is 22 FC per 100 ml if estimated values are neglected. The median value is approximately the same. Half the shoreline values exceeded 54 FC per 100 ml. The state water quality standard for marine waters classified as "A" specifies maximum median FC values of 14 per 100 ml and that not more than 10 percent of the samples should exceed 43 per 100 ml. Clearly the near-shore stations exceeded the standard.

On the other hand, the time-series samples in the discharge zone showed no violations of standards. They also are based on samples taken at mean low tide stage only since we could find no evidence of a discharge during the higher high tide survey.

Discussion

In order to evaluate the ultimate fate of treated effluent from Tamoshan STP, we attempted to track a moving mass of receiving waters during two critical tide levels. We made two attempts to locate dye clouds at higher high tide and found no dye cloud anywhere in the area. On the other hand, a distinct dye patch was clearly visible on the surface at the discharge point at mean low tide level. Our observations suggest also that the discharge cycles of the STP are of brief duration at infrequent intervals. Therefore, it appears likely that effluent is retained within the submerged section of outfall line when the tide is above a critical level and released during subsequent pump cycles. Below that critical tide level, release of effluent through the diffuser occurs within the same cycle. It should be noted that surface receiving waters over the discharge point appear to meet state standards. This is understandable considering the depth of the discharge and its intermittent nature.

Figure 1 shows results of current data obtained during higher high and mean low tide stands. The higher high tide data were taken about one hour after slack flow conditions and northward flow was about 0.14 m per second. The data taken at mean low tide show tidal flow reversal. The initial flow was northward at 0.07 m per second. After 45 minutes the flow reversed and passed close to the discharge point after 120 minutes. After an additional hour, measurements showed a current speed of about 0.1 m per second. A definite shoreward component was evident.

The highest bacterial counts were noted near shore by Cunningham and this study. Displacement of surface water by a strong wind from the east could bring surface waters shoreward from the discharge zone. However, water quality violations by this mechanism appears unlikely within the immediate area of the park, given the water quality at the point of discharge and the distance of the discharge offshore. On the other hand, there is a clear contamination source somewhere along the shoreline. The source is not apparent.

One possible source of contamination is the small stream. Two of three samples taken exceeded the standards. The geometric mean was higher than any other site along the beach (Table 1). The stream may be a significant contributor to high near-shore bacterial values.

Another possible source is direct or indirect discharges from disposal systems from the several shoreside residences in the area. The high values at stations four and five may be explained by this source.

Other possible sources of contamination are the manholes on the buried sewer line south of the park or the lift station located in the southeast corner of the park. However, it is doubtful that these factors contribute significant contamination. When the manholes are submerged, the pressure of the seawater above the manhole would force seawater into the sewer line. Under these conditions, it would be impossible for sewage to leak out unless the manhole and sewer line were completely filled with seawater. Under these conditions, however, the STP would be hydraulically overloaded and the dissolved salts would interfere with treatment. There is nothing in the NPDES monitoring data to suggest this has happened. If a failure of the lift station at the park occurred, we might expect surcharge through the manholes and massive contamination. However, there is no evidence that any recent surcharge has occurred.

Another source may be a broken line near the exposed pipe at the foot of the bank. Damage is possible because of floating logs and other debris. Damage of this kind would result in contamination at low tides. The only sure verification of this problem would be excavation and inspection of the line at this point.

According to the plot of our field bearings, the location of the discharge appeared to be about 100 m offshore or nearly half the distance shown in the design drawings. The high density and compact nature of the emergent dye patch suggested lack of a diffuser. The outfall line may be broken at this point, or the absence of a diffuser altogether.

Conclusions

1. The data appear to rule out contamination of the shoreside park by the outfall line or diffuser. Initial dilution of the effluent at the point of discharge seems to be sufficient to bring about compliance with water quality standards for fecal coliform within the discharge zone.

2. The role of the beach lift station was not evaluated specifically in this study. This component of the collection system appeared to be functioning normally. On the other hand, the buried line along the beach may be broken and contributing to high bacterial levels observed near shore. This line should be inspected.

3. The several beachside residences may contribute contamination from household waste disposal practices or systems. This question is open to further evaluation.

TAD:cp

Attachments

Table 1. Bacteriological data (FC per 100 ml) collected during two tide states conducted at Silver Spit, Budd Inlet (replicate results separated by a diagonal line).

Station Number	Location	Tide Stand Higher High (10/28/80)	Tide Stand Mean Low (11/5/80)	Geometric Mean
1	STP (before chlorination)	38,000	10,000	
2	River Mouth (or Pond)	60/13	56/--	32
3	Beachfront	25/<1	54/10	11
4	South End	1,100/2	20/10	26
5	North End	4/400	15*/<5	19
6 (surface)	Discharge Zone	--	1*	--
6	Drogue after 15 minutes	--	1*	--
6	Drogue after 30 minutes	--	1*	--
6	Drogue after 45 minutes	--	1*	--
6	Drogue after 60 minutes	--	1*	--

*Estimated values

Figure 1. Sampling stations and drogue tracks obtained during two tide stands at Silver Spit, Budd Inlet. Also shown are beachside residences and sewer collection and outfall lines of the Tamoshan STP.