CAHA 1222

December 13, 2006

L54(2380)
CAHA/General

Memorandum

To: Thayer Broili, Chief of Resource Management, Cape Hatteras National Seashore

From: Larry Martin, Hydrogeologist, Water Operations Branch, WRD

Subject: Issues related to water quality in the Cape Point area

Mr. Jim Luizer sent a couple of emails (May 1, 2006 and November 30, 2006; with attachments) to the superintendent raising concerns about water quality issues in the Cape Point area and potential impacts to groundwater resources of Hatteras Island. In this memo I will attempt to address Mr. Luizer's concerns and briefly present results of the water quality sampling conducted by NPS in the Cape Point area.

Total Trihalomethanes (TTHM)
The TTHM concentrations referred to in Mr. Luizer's letter are a result of the water treatment process at the Dare County water treatment plant at Frisco. Trihalomethanes are produced by a chemical reaction of chlorine and/or bromine with organic matter in water during the disinfection process. It has no relation to any activity or resource management action by NPS.

Ken Flatt, Dare Co. Director of Utilities, verified these conclusions with respect to TTHMs in an email to Thayer Broili (12/11/06). He stated, "The TTHM 'Notice of Violation' mailed out this quarter had absolutely nothing to do with the Dredge Pond issue Mr. Luizer is discussing in his email below. The high TTHM readings were caused by salt passage of the original reverse osmosis membranes, which were replaced December 2005. The TTHM issue has been completely resolved since the new membranes were installed. The TTHM readings, since the installation of the new membranes, are March 2006 0.037 mg/l, July 2006 0.017 mg/l, and September 2006 0.008 mg/l. All the readings are well below the .080 mg/l running annual average limits. This information was included in the "Public Notification mailed to our customers."

Mr. Flatt went on to write that, "(t)he Dredge Pond does not influence the brackish aquifer we utilize for the RO process at the Cape Hatteras Water Plant." Brackish water for the reverse osmosis plant is supplied from deep wells (greater than 200 feet deep) that are completed in a confined aquifer underlying the surficial Buxton Woods aquifer (Mallin and others 2006). The Buxton Woods aquifer is underlain by a 40-foot thick confining layer of silty-to-clayey sand (Anderson and others, 2000) that effectively isolates the deeper brackish aquifer from the Buxton Woods aquifer.

Thus it appears that Mr. Luizer has already been provided information regarding the cause for occurrence of trihalomethane in the public drinking water supply, the fact that the problem had been corrected, and that the presence of trihalomethane had absolutely no connection to any NPS activity.

Potable water for NPS facilities on Hatteras Island is supplied by the Dare County Water Department.

Groundwater Flow Directions

Mr. Luizer raised concerns about the potential for bacteria in the ponds in the Cape Point area to contaminate groundwater resources underlying Buxton Woods and other privately-owned areas on the north part of the island. This simply is not possible. Water table mapping by Winner (1975), Anderson (1999), and others clearly show that the groundwater system underlying the island forms a mound, with the high point of the mound near the center of the island, and that the groundwater flows from the center of the island in all directions toward the shorelines. An example of the water table maps produced by Dr. Anderson for his doctoral dissertation is shown below. It clearly shows that groundwater flow in the Cape Point area is to the nearby shore areas, generally in a southerly direction from the ponds at Cape Point.

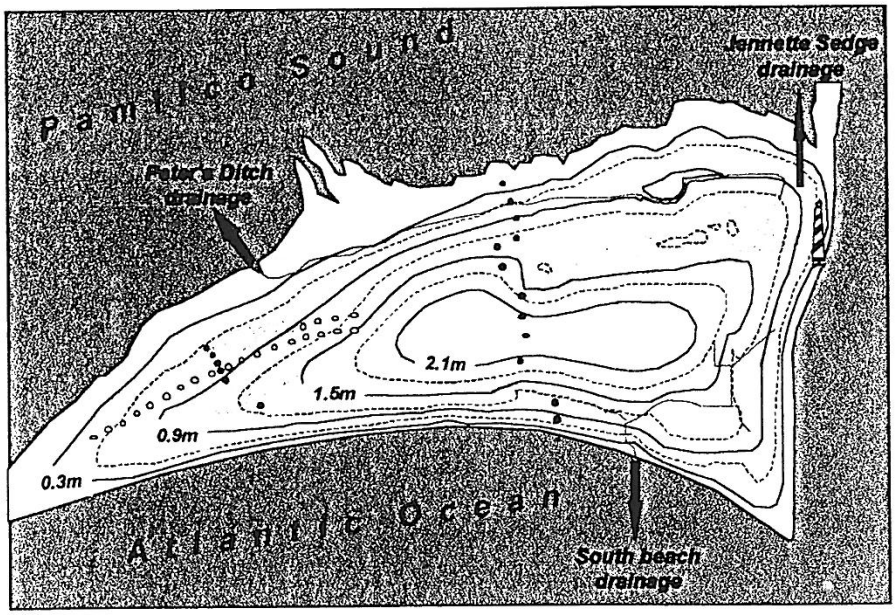

Figure 3.21. Water-table contours derived from the two-dimensional Dupuit Flow Model. Deflections in the contours at the two drained wetlands and the Frisco Wellfield show the effects of water removal on water-table elevations. Transect 1 and Transect 2 monitoring wells are shown as solid circles while the Frisco Wellfield wells are shown as open circles. Drainage locations are shown as arrows.

From Anderson (1999)

It is impossible for water from the ponds in the Cape Point area to flow uphill toward the center of the island and contaminate the groundwater underlying Buxton Woods or any other area of the island. Water in the ponds in the Cape Point area slowly drains to the south, southeast, and southwest through the sand sediments and discharges into the ocean at the shoreline.

Surface water and shallow groundwater on the island are part of the same water body. Ponds and other surface water bodies occur where land surface dips below the level of the water table. Much of the precipitation falling on the island infiltrates the sand sediments, recharging the groundwater resources. Groundwater then flows radially from the top of the mound toward the perimeter of the island. Since the flow of water is predominantly as groundwater flow, the process is rather slow and it takes a long time to drain the water. The water table rises following periods of high precipitation and then slowly recedes. That's why many people have the perception that there is a flooding problem. The real problem is that infrastructure has been built in low-lying areas that are flooded on a regular basis and are slow to drain.

Drainage of Cape Point Ponds

I have no information regarding past drainage practices for the ponds at Cape Point. We know that the system of drainage ditches in the vicinity of the campground was operated until 2003, with discharge to the ocean on the beach south of the campground. These ditches drained water from the campground and areas to the north of the campground. There is no evidence that this drainage system was ever connected to the ponds at Cape Point. In fact, the ponds at Cape Point are on the south side of the main dune system. Drainage of the ponds to the ditch system would have required that the water flowed uphill, as the elevation of the campground is higher than the ponds at the Cape.

Temporary drainage ditches might have been constructed from the ponds to the ocean at some time(s) in the past, although I have no record of this. My recollection from talking with park personnel is that it wasn't done, or at least it wasn't done within the tenure of anyone working there now. You might verify this by talking to Shelly Rollinson, John Wescott, or some of the other "old-timers" on the Buxton maintenance staff.

High Water Levels in Wetland Areas

"Flooding" in wetland areas in the interior part of the island (e.g. Buxton Woods and Jennette Sedge) is a natural occurrence in response to abundant rainfall. Surface water drainage on the island is poor to non-existent. The natural outflow of water from interior areas is by groundwater flow through the sand sediments. This is a slow process that results in the perception of an unduly long period of flooding. In fact, the drainage ditches that convey water from the Jennette Sedge and Buxton Woods area to discharge into Pamlico Sound lessen the period of inundation and are an unnatural perturbation of the natural hydrologic system.

The so-called "flooding problems" in the area of the campground, fish cleaning station, and beach access ramps are natural occurrences. There is little that can be done to alleviate the problem short of constructing a network of drainage ditches. NPS management policies, and state and federal laws prohibit drainage of water from wetlands. NPS may have drained floodwater from wetlands in the past, but that doesn't mean the practice is still acceptable.

NPS Water Quality Monitoring

NPS collected water samples from various surface water bodies in the Cape Point area in the Fall and Winter of 2005 and again in the Summer and Fall of 2006. In 2005, the sampling was designed to determine whether there was enterococci contamination of water in the drainage ditches in the vicinity of the campground. Enterococcus is a bacteria found in the intestines of warm-blooded animals, including humans. It is used as a bacterial indicator to determine the extent of fecal contamination in water. The thought was that effluent from the septic leachfields at the Cape Point campground could be a significant source of bacteria in nearby ponds and drainage ditches. In 2006, the sampling program was revised to determine if there was any significant difference in the presence of bacteria in surface water bodies in the Cape Point area compared to more developed areas near the park entrance and Frisco. The 2006 sampling was also designed to compare surface water bodies in developed and undeveloped areas. Since the sampling programs in 2005 and 2006 covered different areas and used different numbering systems for sampling stations, the results will be discussed separately.

2005 Data

In 2005, the monitoring program was primarily designed to determine whether water in the drainages ditches in the vicinity of the campground was contaminated by effluent from the septic leachfields in the campground. Samples were obtained from six sites (Figure 1) approximately every two weeks from late-September through mid-January (Table 1). Samples were analyzed for the number of enterococci colonies per 100 ml by the North Carolina Division of Environmental Health, Shellfish Sanitation and Recreational Water Quality Program. Results of the testing are presented in Table 1 and shown graphically on Figure 2.

Site S-2, the culvert at the main road ½ mile south of the ranger station consistently had the highest bacterial concentration. This site is "upstream" of the campground.

Enterococci concentration at Site S-6, the Salt Pond at the southern tip of the cape, seemed to show a correlation with the heavy rainfall in October 2005. There may be some mechanism by which bacteria are washed from the surrounding land surface into the pond during heavy rainfalls. Salt Pond is far from any potential impact from human use at the campground. Human influence in the vicinity of Salt Pond would probably be limited to occasional visits by birdwatchers and fishermen. The high concentration at S-6 on for the Oct 24 sample is anomalous. All other samples from that date showed decreased enterococci concentration, probably due to dilution by the large amount of rain that fell in the preceding 24 hours.

The remainder of the sampling sites (S-1, S-3, S-4, and S-5) are located in the system of drainage ditches "downstream" of the campground. All of these sites show similar variation in the concentration of enterococci. Enterococci concentrations for the first sampling period range from about 10-100 colonies per 100 ml. The concentration increases significantly for the second set of samples on Oct. 10, probably in response to rain the preceding 24 hours that may have flushed bacteria from the land surface into the ditches, or perhaps because there was enough rain to get stagnant water flowing through the system again. Enterococci concentrations decreased at the Oct. 24 sampling even though it also was preceded by heavy rainfall. Perhaps much of the

bacteria had been flushed through the system by the earlier rain or perhaps the large amount of rainfall effectively diluted the bacterial concentration. Enterococci concentrations remained within the 10-100 colonies per 100 ml range throughout the remainder of the fall and winter. Concentrations appear to decrease as the temperature got colder later in the year.

Enterococci concentrations at sampling sites "downstream" of the campground were generally the same or lower than the "upstream" and control sites. It appears that the septic leachfields in the campground are not a significant source of fecal indicator bacteria contamination to nearby surface water bodies.

2006 Data

The 2006 monitoring program was designed to determine whether there is a significant difference in the presence or concentration of bacteria in surface waters in the Cape Point area compared to surface waters near the park entrance in the Frisco area. Additionally, some of the sampling sites on the south part of the island are very remote and are not affected by human activities.

Seven sites were sampled. Site S-1, the drainage ditch near J loop in the campground was sampled every two weeks. This site was chosen as it is close and slightly "downstream" of the septic leachfields in the campgrounds. The other six sites were sampled approximately monthly as two groups of three sites. This allowed us to sample the ditch at J loop and three other sites every two weeks. Sample site locations are shown on Figure 3. Samples were analyzed for the number of enterococci colonies per 100 ml by the North Carolina Division of Environmental Health, Shellfish Sanitation and Recreational Water Quality Program. Results of the testing are presented in Table 2 and shown graphically on Figure 4.

The data for 2006 show very high concentrations of enterococci at two sites on August 21. Site S-2 is Horsehoe Pond, an area that is not affected by human activities. Site S-7 is St. Peters Ditch south of the intersection of Forest Road and Hwy 12. St. Peters Ditch drains heavily developed privately-owned areas and it's not unexpected to find high concentrations of enterococci at this location during the peak of the summer. The high concentration of enterococci in the sample from Horsehoe Pond can only represent natural contamination by birds or wildlife.

All of the samples from St. Peters Ditch (S-7) have higher concentrations (generally 250-300 colonies/100 ml) than what has been generally observed at other sites in 2005 and 2006. The higher concentrations of enterococci are likely due to the ditch draining heavily developed areas with many septic leachfields.

Two of the samples collected on Sept. 6 had elevated concentrations of enterococci. These higher concentrations coincided with rain in the 24 hours preceding sample collection. This continues the observations from 2005 of elevated enterococci concentrations immediately following rainfall events.

The remainder of the data fall in the range of 10-100 colonies per 100 ml that was observed as the general background level.

Conclusions

There is no evidence to indicate the septic leachfields at the Cape Point campground contribute to the presence or concentration of enterococci bacteria in adjacent surface water bodies. Most of the samples are within the range of 10-100 colonies/100 ml. Most of the higher concentrations are correlated to preceding rainfall that might contribute to flushing bacteria into the surface waters, or mobilizing bacteria already present. There are a few samples that appear to be anomalously high, for which no explanation is offered.

The only site that had bacteria concentrations consistently above background was St. Peters Ditch at the intersection of Forest Road and Hwy 12. St. Peters Ditch drains groundwater from heavily-developed, privately-owned areas having individual septic leachfields.

References Cited

Anderson, William P., Jr., 1999, *The Hydrology of Hatteras Island, North Carolina*, Ph.D. Dissertation, unpublished, North Carolina State University, Raleigh, NC, 293 pp.

Anderson, W.P., Jr., 2002, *Aquifer Salinization FromStorm Overwash*, Journal of Coastal Research, 18:413-420.

Mallin, Michael A., Matthew R. McIver, and Virginia L. Johnson, 2006, *Assessment of Coastal Water Resources and Watershed Conditions at Cape Hatteras National Seashore, North Carolina*, National Park Service Technical Report NPS/NRWRD/NRTR-2006/351, 75 pp.

Winner, Jr., M.D., 1975, *Ground-Water Resources of the Cape Hatteras National Seashore, North Carolina*, U.S. Geological Survey Hydrologic Investigations Atlas HA-540, 2 sheets.

If there are any questions regarding this report, please call me at (970)-225-3515.

cc: 2380 -- Joel Wagner, Bill Jackson
SER – Cherry Green
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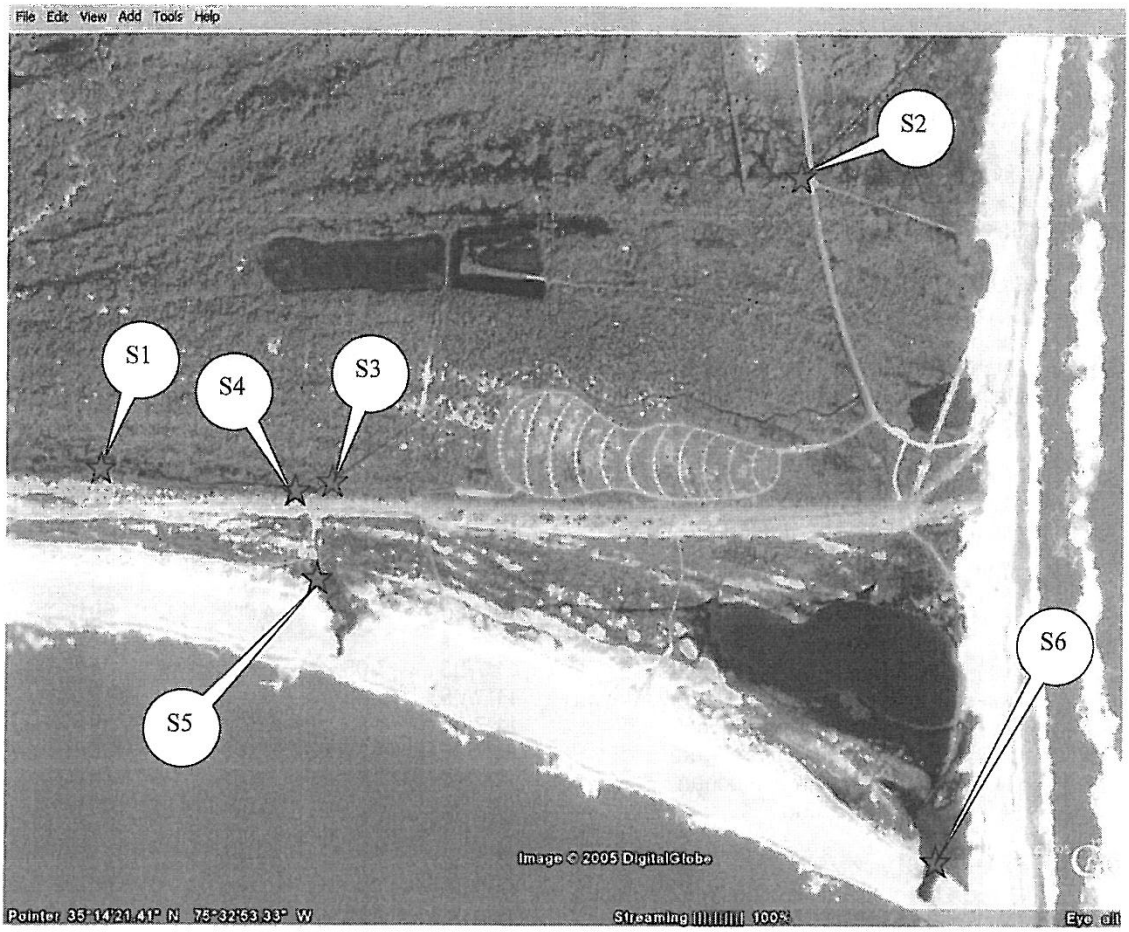

Figure 1. Location of sampling sites for the 2005 monitoring program.

Table 1. Results of 2005 Water Quality Monitoring.

Stn.No.	Location of Station	Date	Time	Precip last 24hrs	Enterococci (MPN)/100 ml
S1	Ditch -- 400 yards SW of floodgate	9/26/05	8:25	0.07"	53
S2	Culvert at road ½ mile S of Ranger Station	9/26/05	7:55	0.07"	1184
S3	Ditch -- 30 yards NE of floodgate	9/26/05	8:15	0.07"	75
S4	Ditch -- 30 yards SW of floodgate	9/26/05	8:17	0.07"	87
S5	Center of ditch draining to ocean	9/26/05	8:45	0.07"	10
S6	Salt Pond at south end	9/26/05	9:00	0.07"	<10
S1	Ditch -- 400 yards SW of floodgate	10/10/05	7:38	2.7"	207
S2	Culvert at road ½ mile S of Ranger Station	10/10/05	7:20	2.7"	697
S3	Ditch -- 30 yards NE of floodgate	10/10/05	7:35	2.7"	207
S4	Ditch -- 30 yards SW of floodgate	10/10/05	7:40	2.7"	344
S5	Center of ditch draining to ocean	10/10/05	7:52	2.7"	324
S6	Salt Pond at south end	10/10/05	8:00	2.7"	231
S1	Ditch -- 400 yards SW of floodgate	10/24/05	7:40	4.8"	53
S2	Culvert at road ½ mile S of Ranger Station	10/24/05	7:15	4.8"	111
S3	Ditch -- 30 yards NE of floodgate	10/24/05	7:30	4.8"	64
S4	Ditch -- 30 yards SW of floodgate	10/24/05	7:32	4.8"	53
S5	Center of ditch draining to ocean	10/24/05	7:45	4.8"	10
S6	Salt Pond at south end	10/24/05	7:50	4.8"	591
S1	Ditch -- 400 yards SW of floodgate	11/7/05	7:05	0.0"	75
S2	Culvert at road ½ mile S of Ranger Station	11/7/05	6:43	0.0"	192
S3	Ditch -- 30 yards NE of floodgate	11/7/05	6:55	0.0"	99
S4	Ditch -- 30 yards SW of floodgate	11/7/05	7:00	0.0"	20
S5	Center of ditch draining to ocean	11/7/05	7:23	0.0"	53
S6	Salt Pond at south end	11/7/05	7:27	0.0"	42
S1	Ditch -- 400 yards SW of floodgate	11/21/05	7:43	0.02"	10
S2	Culvert at road ½ mile S of Ranger Station	11/21/05	7:23	0.02"	99
S3	Ditch -- 30 yards NE of floodgate	11/21/05	7:35	0.02"	20
S4	Ditch -- 30 yards SW of floodgate	11/21/05	7:38	0.02"	10
S5	Center of ditch draining to ocean	11/21/05	8:00	0.02"	10
S6	Salt Pond at south end	11/21/05	8:14	0.02"	10
S1	Ditch -- 400 yards SW of floodgate	12/5/05	7:15	0.68"	20
S2	Culvert at road ½ mile S of Ranger Station	12/5/05	7:00	0.68"	87
S3	Ditch -- 30 yards NE of floodgate	12/5/05	7:10	0.68"	<10
S4	Ditch -- 30 yards SW of floodgate	12/5/05	7:20	0.68"	10
S5	Center of ditch draining to ocean	12/5/05	7:34	0.68"	10
S6	Salt Pond at south end	12/5/05	7:40	0.68"	<10
S1	Ditch -- 400 yards SW of floodgate	12/19/05	8:00	0.93"	<10
S2	Culvert at road ½ mile S of Ranger Station	12/19/05	7:40	0.93"	10
S3	Ditch -- 30 yards NE of floodgate	12/19/05	7:58	0.93"	10
S4	Ditch -- 30 yards SW of floodgate	12/19/05	7:55	0.93"	12
S5	Center of ditch draining to ocean	12/19/05	8:25	0.93"	31
S6	Salt Pond at south end	12/19/05	8:35	0.93"	10

Table 1 (cont). Results of 2005 Water Quality Monitoring.

Stn.No.	Location of Station	Date	Time	Precip last 24hrs	Enterococci (MPN)/100 ml
S1	Ditch -- 400 yards SW of floodgate	01/03/06	7:38	0.86"	<10
S2	Culvert at road ½ mile S of Ranger Station	01/03/06	7:17	0.86"	64
S3	Ditch -- 30 yards NE of floodgate	01/03/06	7:31	0.86"	10
S4	Ditch -- 30 yards SW of floodgate	01/03/06	7:33	0.86"	10
S5	Center of ditch draining to ocean	01/03/06	7:53	0.86"	10
S6	Salt Pond at south end	01/03/06	8:05	0.86"	10
S1	Ditch -- 400 yards SW of floodgate	01/16/06	7:45	trace	<10
S2	Culvert at road ½ mile S of Ranger Station	01/16/06	7:27	trace	10
S3	Ditch -- 30 yards NE of floodgate	01/16/06	7:39	trace	<10
S4	Ditch -- 30 yards SW of floodgate	01/16/06	7:40	trace	<10
S5	Center of ditch draining to ocean	01/16/06	8:08	trace	10
S6	Salt Pond at south end	01/16/06	8:15	trace	<10

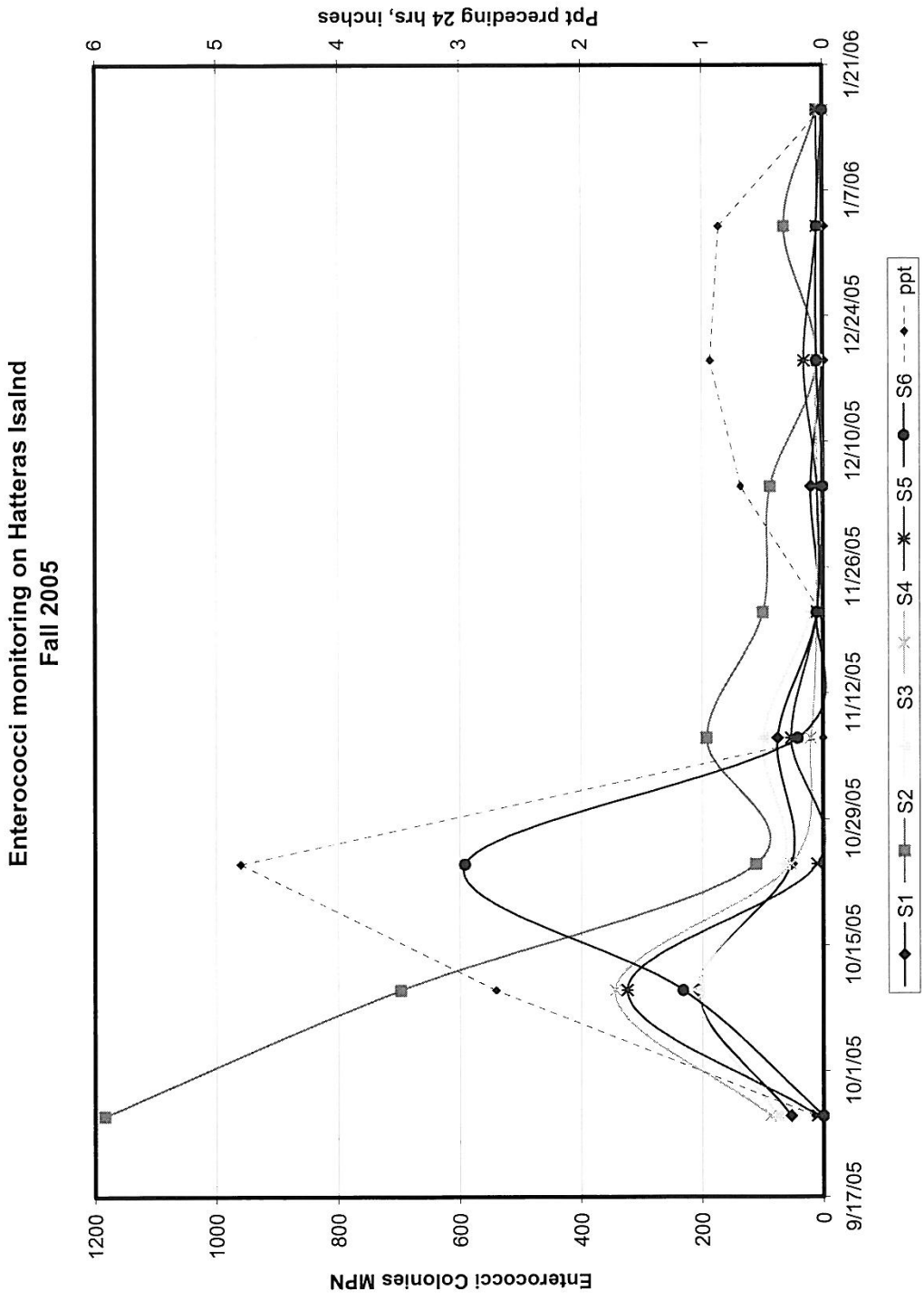

Figure 2. Results of Enterococci monitoring in the Cape Point area, Fall and Winter 2005.

Figure 3. Location of sampling sites for the 2006 sampling program.

Table 2. Results of 2006 Water Quality Monitoring

Site #	Location of sample station	Date	Time	Precip last 24 hrs	Enterococci (MPN)/100 ml
S-7	Ditch @ Forest Rd & H12	8/21/06	6:52	0.00"	831
S-1	Campground ditch "J" loop	8/21/06	6:37	0.00"	<10
S-2	Horseshoe Pond	8/21/06	6:30	0.00"	1298
	Air temp: 79 F				
S-1	Campground ditch "J" loop	9/06/06	7:40	0.64"	364
S-2	Horseshoe Pond	9/06/06	7:43	0.64"	10
S-3	South Beach drain pond	9/06/06	7:25	0.64"	31
S-4	Fish cleaning station pond	9/06/06	7:15	0.64"	384
	Air temp: 73 F				
S-1	Campground ditch "J" loop	9/18/06	9:54	0.00"	<10
S-5	Pond @ Open Ponds Rd	9/18/06	9:20	0.00"	137
S-6	Entrance Rd Pond	9/18/06	8:56	0.00"	10
S-7	Ditch @ Forest Rd & H12	9/18/06	8:59	0.00"	254
	Air temp: 76 F				
S-1	Campground ditch "J" loop	10/02/06	9:10	0.00"	31
S-2	Horseshoe Pond	10/02/06	9:15	0.00"	20
S-3	South Beach drain pond	10/02/06	9:35	0.00"	31
S-4	Fish cleaning station pond	10/02/06	8:55	0.00"	<10
	Air temp: 72 F				
S-1	Campground ditch "J" loop	10/16/06	9:33	0.00"	30
S-5	Pond @ Open Ponds Rd	10/16/06	9:10	0.00"	<10
S-6	Entrance Rd Pond	10/16/06	8:51	0.00"	<10
S-7	Ditch @ Forest Rd & H12	10/16/06	8:54	0.00"	271
	Air temp: 62 F				
S-1	Campground ditch "J" loop	10/30/06	9:04	0.00"	31
S-2	Horseshoe Pond	10/30/06	9:00	0.00"	10
S-3	South Beach drain pond	10/30/06	9:23	0.00"	42
S-4	Fish cleaning station pond	10/30/06	9:37	0.00"	31
	Air temp: 65 F				
S-1	Campground ditch "J" loop	11/13/06	9:28	0.51"	87
S-5	Pond @ Open Ponds Rd	11/13/06	9:06	0.51"	31
S-6	Entrance Rd Pond	11/13/06	8:50	0.51"	20
S-7	Ditch @ Forest Rd & H12	11/13/06	8:48	0.51"	288
	Air temp: 51 F				
S-1	Campground ditch "J" loop	11/27/06	7:47	0.00"	75
S-2	Horseshoe Pond	11/27/06	7:43	0.00"	<10
S-3	South Beach drain pond	11/27/06	8:04	0.00"	10
S-4	Fish cleaning station pond	11/27/06	7:29	0.00"	31
	Air temp: 57 F *heavy rain & flooding 11/21 – 11/23				

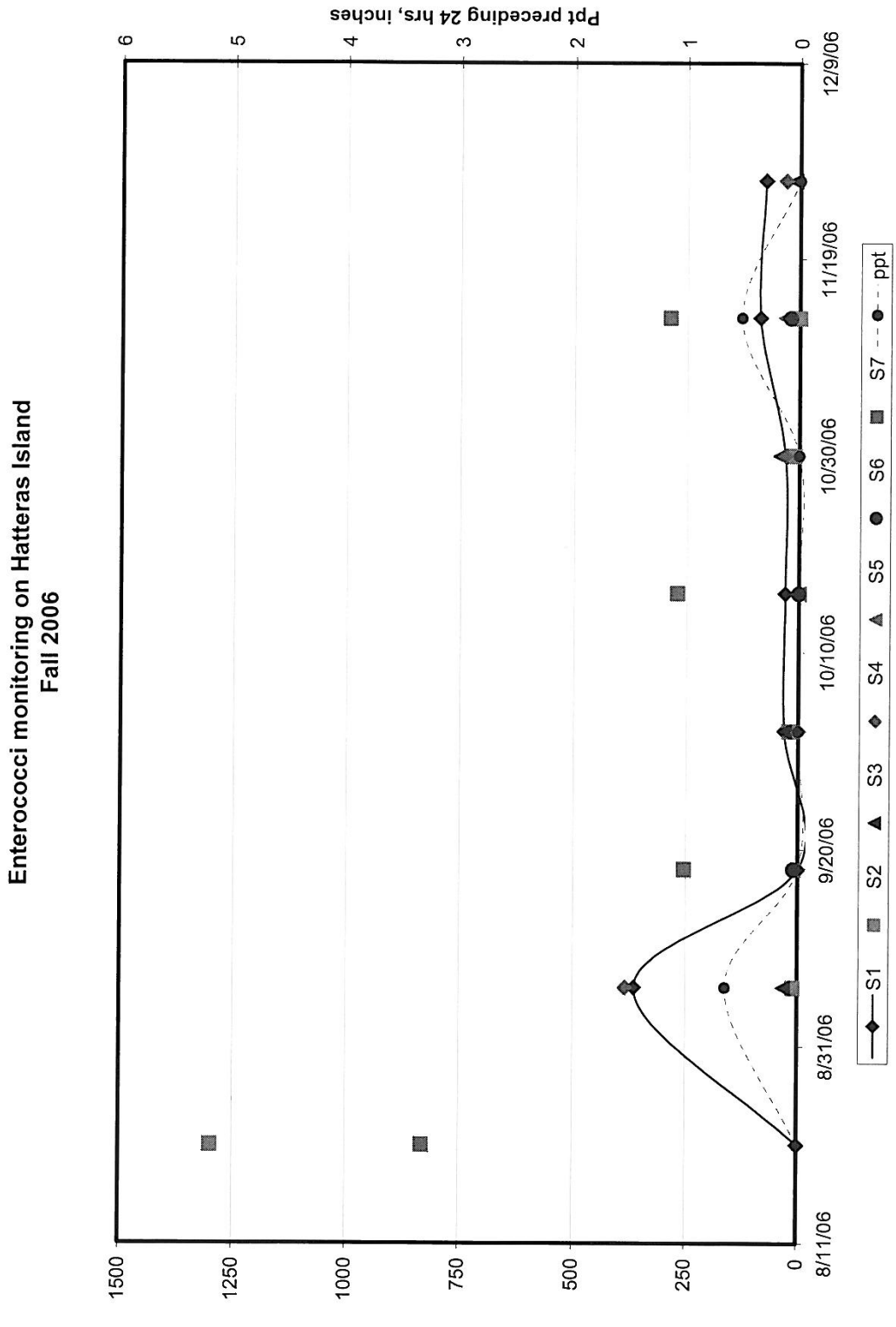

Figure 4. Results of Enterococci monitoring in the Cape Point area, Summer and Fall 2006