WELLS (WEL) NERR Water Quality Metadata Form
January-December 1997
Latest Update: December 5, 2001

I. Data Set & Research Descriptors

1. Principal investigator(s) & contact persons:

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2. Entry verification:

The data are directly downloaded in the YSI-PC6000 format (as a .dat file) and the Comma & " " Delimited format (as a .csv file) from the dataloggers to an IBM compatible lap-top (Epson Equity LT-286e). The data are reviewed using the PC6000 software. Graphs and basic statistics are then generated with the PC6000 program and the information is printed out for each data file. These graphs are used to determine any obvious data outliers and sonde and/or probe malfunction. All downloaded data files from the dataloggers (both raw unedited .dat and .csv files) are then transferred via disk to a Power Mac 7100, where all files are reviewed and formatted for CDMO and stored. Here the raw unedited .csv data files are imported into Microsoft Excel 5.0. After a complete month of data has been recorded, each file is ready to review, which requires several steps. The NERR CDMO QA/QC Excel macros are used for all data. A data file is created (from the merged raw unedited .csv data files) in Excel format with a full month of data. The first step is to make sure that the parameter columns are in the correct order, specified by the NERR CDMO. If any parameters are not collected due to probe failure or other causes, the cells with this missing data are

filled in with periods (.) and documented and explained in the appropriate section of the metadata. Secondly, missing dates and times are inserted in the data file where data were not collected due to maintenance, sonde failure, etc., and the cells with this missing data are filled in with periods (.) and documented and explained in the appropriate section of the metadata. The first NERR CDMO QA/QC Excel 5.0 macro is then run to determine if there are any missing dates and times; and if so these missing dates and times are inserted.
Next, the second NERR CDMO QA/QC Excel 5.0 macro is used to find and filter all data readings outside the sonde specification measuring range for each parameter. Here the "outlier" data generated by the second macro are examined and determined as either explained or unexplained anomalies, as specified by NERR CDMO Operations Manual. All anomalous data (explained and unexplained) are documented and explained in the appropriate sections of the metadata. The explained anomalous data are then removed from the data file and replaced by periods. The unexplained anomalous data are investigated for validity based on weather data, field observations, instrument diagnostics, and PC6000 printouts.
If these data are rejected from the file then these are removed and replaced by periods. Lastly, the third and final NERR CDMO QA/QC Excel 5.0 macro is used to reformat all the columns in the data file to the correct number of significant digits. After this last step, once the file has been completely formatted and edited as specified by NERR CDMO, the file is saved as a Tab delimited (.txt) text file and sent by FTP to the CDMO. The metadata form is also submitted with the data file to the CDMO, sent also as a text file (text only with line breaks). Scott Orringer is responsible for this task of entry verification with the analyses of suspect and anomalous data. Michele Dionne supervises, proofs and answers questions with the evaluation of suspect and anomalous data.

3. Research objectives:

The Webhannet River estuary is located in proximity to heavily used beaches in Wells, Maine. It has a shoreline that is highly developed with

residential and commercial structures. The estuary receives water from a 14-sq. mi. watershed that is well forested. We are measuring variations in hydrologic variables in the Webhannet River estuary at the head of tide and at the inlet. Data from head of tide will integrate surface and ground water inputs (from both point and non-point sources) from the freshwater watershed into the estuary. Data from the inlet will integrate surface and ground water inputs from the freshwater watershed and the estuarine watershed. Differences in data between the head of tide and the inlet will indicate inputs from the estuarine portion of the watershed (on the ebb tide), and inputs from the Gulf of Maine on the flood tide. The instruments will track runoff events via salinity, and will measure pollutant-carrying sediment particles via turbidity. Our working hypothesis is that the freshwater watershed is the primary source of sediment and therefore potential NPS pollutants in the estuary. These two variables will indicate the potential for non-point source pollutants to enter the estuary, and whether they are of upland, estuarine or Gulf of Maine origin. Other variables measured by the data loggers (DO, temperature, pH, specific conductivity, and water level) will provide important baseline data to track changes in the estuary's physico-chemical parameters over the long term. These variables can be affected by changes in human water use, and by natural or human induced changes in inlet and river channel morphology, climate, and organic loadings. The inlet site is heavily impacted at the Wells Harbor dock and is our long-term monitoring site. The head of tide site is relatively unimpacted, located just east of the Route One bridge, and is our "roving" site.

Efforts are underway to restore tidal flow in New England salt marshes that were negatively impacted by tidal restrictions (Burdick et. al. 1997). The Wells NERR has been instrumental in identifying and measuring the damaging effects of tidal-restriction, due to roads and culverts, on salt marsh ecosystems. The second area of monitoring is known as Drakes Island Marsh, a barrier island salt marsh in Wells, Maine, that was impounded with a road and

culvert by farmers in the late 1800's. The Wells NERR began monitoring the natural restoration of this degraded marsh in 1988 after a neglected flapper valve failed and partial restoration of tidal flow occurred. Vegetation data including biomass and percent coverage and environmental data including salinity, water table, and tidal heights have been collected in several locations in the marsh since that time (Hoffman 1997).At the northern-most branch of the Webhannet River estuary in Drakes Island Marsh, two more data loggers have been deployed above (upstream) and below (downstream) a culvert in a road crossing that greatly restricts tidal flow. We want to determine if tidal restriction does influence water quality of the tidally restricted (upstream) marsh acreage, since changes in hydrology are also considered to be a type of non-point source pollution. The upstream site is the impacted or treatment site, and the downstream site is the control or reference site.

4. Research Methods

The Wells NERR YSI monitoring program began in April 1995 at one site and May 1995 at a second site in the Webhannet River estuary. Two more sites were added in April 1996. All four data loggers are installed with bottom moorings, as described below. All data loggers have 1/4 inch vector mesh placed on the outside (using rubber bands) and outside bottom (using cable ties) of the sonde guard to prevent fouling and unwanted animals. All deployment structures (PVC tubes) described below are labeled with the Wells NERR information.

The inlet site (IN) uses a 50 lb. mushroom anchor as a bottom mooring, with 15 ft of rope slack clipped and tied to the pier. The inlet site sonde is secured at 1.0 meter (3.28 ft) off the bottom using a stainless steel link attached to the rope. The probe-end of the data logger was attached to this link with stainless steel clips (the buoys attached to other end of the housing). The data logger is placed in a 4 inch diameter, 2 1/2 ft. long high grade PVC pipe housing for protection. There are three stainless steel bolts drilled into the PVC housing to hold the data logger in place. Two bolts near

the top allow the YSI to hang by its bail and one bolt near the bottom is placed
just under the sonde guard. Several holes were cut out all around the bottom of
the PVC pipe to allow free water flow to the probes. The PVC housing uses an
underwater float and a surface buoy attached to the outer top bolt with one
foot of rope. This allows the top end of the data logger to float freely while
the probe-end is fixed to the bottom mooring. Before deployment, duct tape is
used to keep bolt nuts secure and clean.

The inlet site (IN) deployment methods changed starting on 12/19/97 at
10:30. The YSI telemetry unit was installed to this site. A 23 foot, 4 inch
diameter high grade PVC tube was installed against a dock piling. Four steel
flat bars with bolts were used to attach this 23 foot PVC tube against the dock
piling. A 3 by 1.5 inch PVC transducer was glued on the inside bottom of the
PVC tube to allow the sonde to sit exactly 1.0 meter (3.28 ft) off the bottom.
Several vertical holes, representative of the sonde guard, were cut out the
circumference near the bottom of the PVC pipe to allow water flow to the
probes.
An "L" shaped steel bar with two end-holes is placed through two created slits
about a half of foot from the top of the PVC tube. A stainless steel wire
(1/16") is attached to the sonde bail using two stainless steel clips; and to
one end of the "L" shaped steel bar for sonde deployment and retrieval. A
marine lock is attached through the other end of the "L" shaped steel bar to
hold the bar, wire, and sonde in place and for security. A PVC threaded cap
screws in to the threaded top of the PVC tube, also for security. A hole was
created in the PVC cap to allow the sonde to hook up with the telemetry unit
using the 50 foot cable. The collection of data parameters at the inlet (IN)
site are slightly different then at the three (HT, UP, DN) other sites, due to
the telemetry unit installation. This is explained in the Wells 1998 metadata,
as we didn't actually begin the telemetry unit data collection until 1998; we

just installed the new 23 foot PVC tube (see YSI's Eco-Watch Users Guide).
Thus, the actual data parameter collection from 12/19/97 10:30 to 12/31/97 23:30
was the same as prior to that.

The other three sites, head of tide (HT), Drakes Island upstream (UP), and
Drakes Island downstream (DN) are all deployed similarly, except for sonde
height off the bottom (see below). These sites each use a 5 foot, 4 inch diameter high grade PVC tube. The PVC tubes are attached to 12 foot, heavy
steel sign posts using stainless steel bolts at the bottom of the tube, stainless steel cable wraps at the top, and several thick electrical cable ties
in between. The steel sign posts were pounded in about 7 feet into the river
bottom, such that the bottom of the PVC tube was flat on the river bottom. Each
PVC tube has one 3 by 1.5 inch PVC transducer glued on the inside bottom of the
PVC tube to allow the sonde to sit exactly at a certain height off the bottom
(see below). Several vertical holes, representative of the sonde guard, were
cut out the circumference near the bottom of the PVC pipe to allow water flow to
the probes. An "L" shaped steel bar with two end-holes is placed through two
created slits about a half of foot from the top of the PVC tube. A stainless
steel wire (1/16") is attached to the sonde bail using two stainless steel
clips; and to one end of the "L" shaped steel bar for sonde deployment and
retrieval. A marine lock is attached through the other end of the "L" shaped
steel bar to hold the bar, wire, and sonde in place and for security. A flotation buoy is tied to each of the three sites PVC tubes incase the deployment structure ever gets dislodged. The deployment depths for these three
sites off the bottom are as follows:

The head of tide site (HT) has the probe-end of the data logger secured
0.30 meters (1.0 ft) off the bottom.

The Drakes Island upstream site (UP) has the probe-end of the data logger
secured 0.30 meters (1.0 ft) off the bottom.

The Drakes Island downstream site (DN) has the probe-end of the data
logger secured 0.23 meters (0.75 ft) off the bottom.

Two to four week variable sampling periods were chosen for all data sondes due to limitations created by the life of the dissolved oxygen membrane, probe fouling, and limited battery power. Measurements of temperature, specific conductivity, salinity, percent saturation, dissolved oxygen, depth, pH, and turbidity are recorded at 30 minute intervals throughout the deployment period.

After the deployment period, the data loggers are brought back into the Wells Reserve Laboratory for downloading, cleaning, and calibration. These procedures are carried out to the methods described in the YSI Operating Manual. Calibration standards are needed and used for only specific conductivity (10 mS/cm), pH (buffer solutions of pH 4, 7, and 10), and turbidity (0.0 and 200 NTU). Conductivity and pH standards are purchased from Fisher Scientific. Turbidity standards are purchased from Advanced Polymer Systems, Inc. (Redwood City, CA). The 200 NTU standard is diluted with distilled water to create 100 NTU standard. The dissolved oxygen membranes are replaced and sit 6-24 hours before each deployment. After approximately 6-24 hours of down time for cleaning, maintenance and recalibration, the YSI Data loggers are redeployed for another sampling period. Also, with our extra data sonde, we have been reducing the amount of time of missing data from calibrations and maintenance for all sites.

5. Site location and character

The Wells National Estuarine Research Reserve is located in York County, within the Town of Wells, on the coast of southern Maine and faces the Atlantic Ocean. The Wells NERR is approximately 31 km (20 miles) south of Portland, Maine and 110 km (70 miles) north of Boston, Massachusetts. The Reserve encompasses 1,690 acres along the Gulf of Maine coastline of tidally-flushed wetlands, riparian and transitional upland fields and forests within the Little River Estuary and the larger Webhannet River Estuary. Both estuaries arise in the sandy glacial outwash plain about eight miles inland. Both rivers empty

into Wells Bay, a sandy basin stretching for approximately ten miles along the Atlantic coast. Bordering each river's inlet are double spit barrier beaches attached to the mainland. The backbarrier system is approximately 5 sq. km and is composed of large intertidal marshes (predominantly S. patens and S. alterniflora), intertidal sand and mud flats, and tidal channels. The watershed for the Webhannet River estuary covers an area of 35 sq. km and has a total of 6 streams, brooks or creeks which enter the estuary. These tributaries flow across sand and gravel deposits near the headwaters and the impermeable sandy muds of the Presumpscot Formation in the lower reaches. The Webhannet River is connected to the ocean via Wells Inlet, which has a spring tidal prism of 28,200,000 cub. m (Ward 1993). The force and volume of tidal action affect the salinity level of both rivers. In the Wells region, the annual mean wave height is almost 20 inches. The estuarine system is dominated by semi-diurnal tides having a range of 8.5 to 9.8 feet. The volume of freshwater influx into both estuaries is moderate to low (on the order of 0.5 cubic meters/second), especially in the summer, because of the rivers' relatively small drainage areas and the presence of deep glacial deposits. The relatively low flows from these two rivers taken in with the 20 inch per year average runoff of the area surrounding the estuaries combine to form a fresh water flow which is dwarfed by tidal flushing. Twelve-foot tides dwarf the freshwater flow into the Webhannet estuary, which has a drainage area of 14.1 square miles. The Webhannet estuary, fed by both Blacksmith and Depot Brooks, is adjacent to the harbor and greatly developed land. It offers a valuable opportunity for comparison with the relatively pristine Little River estuary. The land use of the Webhannet estuary include a total of 15% for wetland, fresh water, and tidal marsh; a total of 63.7 % for woodland; and a total of 18.6% for developed land (compared to a total of 5.7% development in the Little River estuary) (WNERR RMA 1996; Holden 1997).

There are four sampling sites in the Webhannet River estuary. These are located at the head of tide and at the inlet, and two sites at the northern-most

branch of the Webhannet River estuary in Drakes Island Marsh, above (upstream) and below (downstream) Drakes Island Road. The tidal range at all of these sites is 2.6-2.9 meters.

The head of tide site is located 4 miles south of the Wells Reserve, just downstream of the Webhannet Falls (freshwater) and 10 feet east of Route One (43 deg 17' 00" Latitude, 70 deg 35' 30" Longitude). Route One is used heavily with traffic all year, especially during the summer tourist months. This site has soft mud, sand, and a rocky substrate, and the low and high tide depth is relatively shallow. The salinity range here is 0-31 ppt, with a mean of 3.6 ppt. These head waters of the Webhannet are relatively undeveloped. This site is located just 10 feet east of the Route One bridge, and is our "roving" site.

The inlet site is located 1.5 miles south of the Wells Reserve, at the Wells Harbor pier (43 deg 19' 12" Latitude, 70 deg 33' 50" Longitude). The mouth of the Webhannet estuary forms an extensive wetland/salt marsh area which is surrounded by development. Wells Harbor, which was most recently dredged in 1971, has moorings for approximately 200 commercial fishing and recreational boats. The mouth of the river flows between two jetties to the Atlantic Ocean. This channel was dredged in 1974. This site has a predominately sand substrate and is characterized by strong current during incoming and outgoing tides. The salinity range here is 7-35 ppt, with a mean of 31 ppt. The inlet site is heavily impacted at the Wells Harbor dock and is our long-term monitoring site.

The second area of monitoring is known as Drakes Island Marsh, a barrier island salt marsh in Wells, Maine, that was impounded with a road and culvert by farmers in the late 1800's. The Wells NERR began monitoring the natural restoration of this degraded marsh in 1988 after a neglected flapper valve failed and partial restoration of tidal flow occurred. Salt intolerant vegetation was soon killed across 40 percent of the 40 hectare (upstream) site. Both sites are composed of large intertidal marshes (predominantly S. patens and S. alterniflora), intertidal sand and mud flats, and tidal channels.The marsh

formed landward of a barrier beach system in a lagoon estuary. Use of the 40 hectare upstream marsh as a pasture led to hydrographic manipulations since 1848 when a dike was built. A road providing access to the Drakes Island beach and running parallel to the dike had a box culvert with a water control structure that operated from the 1920s to the 1950s. Another beach access road was built at the north end of the marsh, preventing spring tides entering the marsh from the Little River estuary. The sedimentary record indicates that the impacted area (upstream) was originally dominated by high marsh, and was similar to the adjacent salt marsh found downstream (reference area) of the road today (Burdick et. al. 1997).Drakes Island Marsh is located at the northern-most branch of the Webhannet River estuary, and the data loggers have been deployed above (upstream) and below (downstream) this 1.2 meter diameter culvert in Drakes Island road that greatly restricts tidal flow. Both sites are located 1.0 miles south of the Wells NERR. The upstream site is 43 deg 19' 50" Latitude, 70 deg 33' 25" Longitude, with the salinity range 9-35 ppt, with a mean of 30 ppt. The downstream site is 43 deg 19' 45" Latitude, 70 deg 33' 45" Longitude, with the salinity range 5-35 ppt, with a mean of 29 ppt.

6. Data collection period:

The Webhannet River head of tide (HT) site data collection was re-deployed (after being pulled in December 1995 and December 1996) on March 31, 12:00 and pulled December 19, 11:00 for the winter months to prevent ice damage. This site gets a large amount of ice coverage from December through late March.

The Webhannet River inlet (IN) site data collection began May 29, 1995, 13:00. The IN datalogger is ongoing throughout the year and is considered our long-term monitoring site, as this site remains relatively ice-free.

The Drakes Island upstream impacted site (UP) data collection was re-deployed (after being pulled in December 1996) on March 31, 11:30 and pulled

December 17, 10:30 for the winter months to prevent ice damage. This site gets a large amount of ice coverage from December through late March.

The Drakes Island downstream control site (DN) data collection was re-deployed (after being pulled in December 1996) on March 31, 11:30 and pulled December 17, 8:30 for the winter months to prevent ice damage. This site gets a large amount of ice coverage from December through late March.

7. Associated researchers and projects

Ongoing research at the Wells Reserve is designed to address issues of concern to the Gulf of Maine management community; sea level rise, beach erosion, coastal water quality and nutrient enrichment, coastal habitat value, habitat restoration of shellfish and finfish, marsh plant community dynamics, and plant-soil-nutrient relationships. Active research topics include:

- rates of accretion of salt marsh peat
- hydrologic and ecological response of impounded marshes to restoration
- assessment of shellfish resources in the Webhannet River flats
- assessment of resident and migratory fish use of Little River estuary
- use of large wading birds as indicators of salt marsh habitat health
- watershed nutrient loading to Little and Webhannet River estuaries
- linkage between estuarine nutrient enrichment and oxygen dynamics throughout coastal Maine
- climatic versus competitive control of salt marsh plant communities
- effects of climate on salt marsh plant phenology and phenotype
- associations between marsh plant distribution, soil nutrients, and soil type

Although many of these projects are ongoing some of the findings to date are:

- Impounded salt marshes can respond quickly to restored tidal flow, with early colonization by salt marsh vegetation and by resident and migratory marsh fishes.
- Seed clam density declines with distance from the Webhannet River inlet, indicating an external as opposed to an internal source of recruitment to the

clam population. There is a small but significant relationship between density
and sediment organic matter.
• Juvenile striped bass utilize the Little River estuary as a food resource;
diet analysis indicates a preference for sand shrimp.
• The Reserve's estuaries appear to be nitrogen limited; primary nitrogen source
is ocean water. Nutrients from fresh surface water influence nutrient
concentrations in the upper estuary. Ground water may be a significant source
of nitrogen in the upper Webhannet River estuary.
• Maine's estuaries and embayments show no serious oxygen depletion, with a few
exceptions. Dissolved oxygen and nitrogen levels are related to freshwater
runoff, indicating that activities in the watershed can influence the estuaries
even in the face of the high tidal flushing rates typical of Maine's estuaries.•
Salt marsh plant phenology varies significantly between Wells NERR and Prudence
Island NERR; trends suggest possible genetic variation within species.• Soil
nitrogen concentrations are directly related to forbe distribution on the
Reserve's salt marshes.

The Research Program's volunteer water quality monitoring program (W.E.T.)
has been monitoring fecal coliform contamination and other water quality
parameters in the estuaries since 1991. W.E.T. (Watershed Evaluation Team) was
established to characterize and monitor the aquatic environment of the Little
and Webhannet River estuaries. This program allows students from local schools
and volunteers to participate in "hands-on" scientific research and management
activities at the Reserve. Information yielded by this effort is valuable as
baseline data for research conducted at the Reserve and may help in guiding
current management priorities. Reserve staff with W.E.T. volunteers and
students, working with the Town of Wells and the Maine Department of Marine
Resources (DMR), have recently opened selected shellfish beds in the Webhannet
River after seven years of closure. This was a direct result of monitoring
fecal coliform contamination (and other water quality parameters), which is the

major source of non-point source pollution in southern Maine. W.E.T. is part of a National Monitoring Program called Estuary-Net. This program allows students to share their data and compare their results with other monitoring groups via the web.

University of New Hampshire researchers completed a year long monitoring project measuring the volume, nutrient concentrations, and total suspended solids of freshwater discharge into the Webhannet River estuary, relating these inputs to precipitation, and measuring their effects on estuarine water quality; using a hydrolab. Research staff and students have completed a four year study of hydrology and vegetation of a degraded Webhannet River marsh recovering from roadway impoundment after restoration of tidal flow. In June of 1994, Reserve research staff and students completed an 18 month survey of larval fish distribution and abundance in the Wells Reserve's estuaries and in the near-shore waters of Wells Bay. University of New Hampshire researchers are working with eelgrass beds in Wells Embayment to develop criteria for siting and evaluating eel grass restoration projects. Both salt marsh and eelgrass are thought to be important habitats for many Gulf of Maine fishes. University of Maine Machias is collaborating with Reserve staff to determine the status of the soft-shell clam resource in the Reserve's estuaries. Reserve staff are working with the Maine Dept. of Environmental Protection to survey the dissolved oxygen status of 25 estuaries throughout Maine, using data sondes to measure oxygen depletion as an indicator of non-point source pollution (Coastal Hypoxia Study).

-Other publications/reports including the above sited ones:

Bryan, R., M.Dionne, R. Cook, J. Jones and A. Goodspeed (1997) Maine citizens guide to evaluating, restoring, and managing tidal marshes. Maine Audubon Society, Falmouth, ME.

Burdick, D., M.Dionne, R.Boumans and F.Short (1997) Ecological responses to tidal restoration in two New England salt marshes. Wetlands Ecology and Management 4:129-144.

Hoffman, C. 1997. Drakes Island Marsh Restoration Project Report. Contracted
out by the Wells NERR.

Holden, W.F. 1997. Fresh water, suspended sediment and nutrient influx to the
Little River and Webhannet River Estuaries, Wells, Maine. Ph.D. dissertation,
Boston University. pp 1-179

Ward, L. G. 1993. Precipitation, streamflow, and water characteristics (physical and chemical) of the Webhannet River Estuary, Wells, Maine. Draft
final report by UNH, Jackson Estuarine Laboratory,Durham, NH. NOAA Technical
Memorandum, pp. 1-13.

WNERR RMA 1996. Wells NERR Management Plan. Prepared by the WNERR Management
Authority (RMA) and NOAA, SRD Division. pp. 1-120.

II. Physical Structure Descriptors

8. Variable sequence, range of measurements, units, resolution, and accuracy:

YSI 6000 datalogger

Variable	Range of Measurements	Resolution	Accuracy
Date	1-12, 1-31, 00-99 (Mo,Day,Yr)	1 mo, 1 day, 1 yr	NA
Time	0-24, 0-60, 0-60 (Hr,Min,Sec)	1 hr, 1 min, 1 s	NA
Temp	-5 to 45 (c)	0.01 C	+/- 0.15C
Sp COND	0-100(mS/cm)	0.01mS/cm	+/-0.5% Of reading + 0.001mS/Cm
Salinity	0-70 Parts per thousand (ppt)	0.01 ppt	+/- 1% of Reading or 0.1 ppt, (whichever is greater)
DO	0-200 (% air saturation)	0.1% @air sat	+/-2% @air Saturation
DO	200-500 (% air saturation	0.1% @ air sat	+/- 6% @ Saturation
DO	0-20 (mg/l)	0.01 mg/l	+/- 0.2mg/l
DO	20-50 (mg/l)	0.01 mg/l	+/- 0.6mg/l
Depth (shallow)	0-9.1 (m)	0.001m	+/- 0.018m

PH	2-14 units	0.01 units	+/- 0.2units
Turb	0-1000 NTU	0.1 NTU	+/- 5% of Reading or 2 NTU (whichever is greater)

Data columns are separated by tabs.

9. Coded variable indicator and variable code definitions:

Site definitions:HT = Head of Tide of Webhannet River
IN = Inlet at Webhannet River Mouth
UP = Drakes Island Upstream Impacted Site
DN = Drakes Island Downstream Control Site

File definitions: YSI deployment site/month/year (ex.: IN0795 = Webhannet Inlet data from July 1995).

10. Data anomalies:

January, 1997 Sampling Period
Head of Tide: None to report; sonde not deployed until March.
Inlet:
The following were small negative turbidity values (logging period recorded 5 anomalies), possibly due to a small calibration error. These data were not deleted.

1/1 16:00-16:30
1/2 5:30
1/7 9:30
1/9 10:30

No temperature, specific conductivity, salinity, percent saturation, dissolved oxygen, and pH data from 1/9 10:30 to 1/16 6:30 due to a malfunction of the temperature probe. There was a sharp jump in temperature data on 1/9 11:30 (100.0 degrees) from previous normal readings. In accordance with the YSI manual, all values except depth and turbidity should be viewed as suspect and eliminated from the record, because of the ubiquity of temperature compensation. Depth and turbidity data were not deleted. There was one high positive turbidity spike on 1/28 of 52.5 NTU; it is not consistent with the overall data record. This suspect datum was not deleted, as we are not absolutely sure that this value is bad.
Drakes Island Upstream: None to report; sonde not deployed until March.
Drakes Island Downstream: None to report; sonde not deployed until March.

February, 1997 Sampling Period
Head of Tide: None to report; sonde not deployed until March.
Inlet: None to report.
Drakes Island Upstream: None to report; sonde not deployed until March.
Drakes Island Downstream: None to report; sonde not deployed until March.

March, 1997 Sampling Period
Head of Tide: DO data deleted from 3/31 13:00 to 4/24 08:30. Values started out high and then Dropped to an average of 70%. Probe appears to be faulty or else there was a membrane puncture that occurred right before sonde was put in the water.
Inlet: None to report.
Drakes Island Upstream: None to report.
Drakes Island Downstream: None to report.

April, 1997 Sampling Period
Head of Tide:
DO data deleted from 3/31 13:00 to 4/24 08:30. Values started out high and then Dropped to an average of 70%. Probe appears to be faulty or else there was a membrane puncture that occurred right before sonde was put in the water.
There were two high positive turbidity spikes on 4/19 3:30 of 112.3 NTU and 4/19 6:30 of 306.7 NTU; they were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values are bad.
The following were a range of high positive turbidity spikes (<100.0 NTU, not including the two high positive values listed above that are within this time frame) that were not consistent with the overall data record. These 62 turbidity anomalies were observed from 4/18 11:00 (29.6) continuous through 4/19 18:30 (32.5), with a mean of 53.3 and a range from 16.4 to 90.7. The dates and times of each anomaly are not listed due to the high number (62) of readings. These suspect data were not deleted, as we are not absolutely sure that these values were bad.
There was one high positive turbidity spike on 4/28 22:30 of 67.5 NTU; it is not consistent with the overall data record. This suspect datum was not deleted, as we are not absolutely sure that this value is bad.
Inlet:

There were two high positive turbidity spikes on 4/4 19:30 of 47.9 NTU and 4/15
5:00 of 26.8 NTU; they were not consistent with the overall data record. These
suspect data were not deleted, as we are not absolutely sure that these values
are bad.
The following were small negative turbidity values (logging period recorded 52
anomalies), possibly due to a small calibration error. These data were not
deleted.

4/9 12:30, 13:30, 23:30
4/10 0:00-2:00, 10:30, 12:00-15:00, 22:30
4/11 0:00-2:30, 11:00-12:00, 13:00-15:30
4/12 0:30, 2:30, 3:30-4:00, 12:00, 14:30-15:00
4/13 3:30
4/16 6:00-7:30, 18:30-19:00
4/17 7:00-8:00, 19:00, 20:00
4/18 8:30

Drakes Island Upstream:
None to report.
Drakes Island Downstream:
The following were small negative turbidity values (logging period recorded 26
anomalies), possibly due to a small calibration error. These data were not
deleted.

4/26 2:00-2:30, 14:00-14:30, 15:30
4/27 3:00, 15:30-16:00
4/28 1:30-3:00
4/29 16:30, 17:30-18:00
4/30 4:30-5:00, 6:00-6:30, 16:00-19:00

There were three high negative turbidity spikes on 4/6 8:00 (-756.2), 4/16 6:00
(-927.4), and 4/20 9:30 (-753.7); these were not consistent with the overall
data record. These suspect data were not deleted, as we are not absolutely sure
that these values were bad.
The following were a range of high positive turbidity spikes that were not
consistent with the overall data record. These 10 turbidity anomalies were
observed from 4/28 6:30 continuous through 11:00, with a range from 40.0 to
107.5 NTU. The dates and times of each anomaly are not listed due to the high
number (10) of readings. These suspect data were not deleted, as we are not
absolutely sure that these values were bad.

May, 1997 Sampling Period
Head of Tide: None to report.

Inlet:
Dissolved oxygen and DO saturation data are suspect from 5/1 0:00 to 5/19 14:00,
as readings steadily decreased to a value of 7.8 when logging period terminated.
There is a possible probe malfunction, or the probe came out of calibration.
These data were not deleted, as we were not sure if this was in fact a probe
malfunction. There was one high positive turbidity spike on 5/23 12:30 of 27.2
NTU; this was not consistent with the overall data record. This suspect datum
was not deleted, as we are not absolutely sure that this value is bad.
Drakes Island Upstream:
There was one high positive turbidity spike on 5/26 15:00 of 67.0 NTU; it is not
consistent with the overall data record. This suspect datum was not deleted, as
we are not absolutely sure that this value is bad. There is possible suspect
percent saturation and dissolved oxygen data from 5/8 9:30 to 5/9 12:00.
Percent saturation and dissolved oxygen data increased from values of 88.3 and
8.5, respectively, on 5/8 9:00 to values of 133.3 and 12.8, respectively, on 5/8
9:30. From 5/1 0:00 to 5/8 9:00, the percent saturation and dissolved oxygen
data had average values of 92.7 and 8.9, respectively (355 values each). From
5/8 9:30 to 5/9 12:00 (last data value before calibration), the percent
saturation and dissolved oxygen data had average values of 133.1 and 12.3,
respectively (54 values each).
These data are possibly suspect because after 5/8 9:00 these data remained at
these increased values. The data were not deleted.
Drakes Island Downstream:
The following were small negative turbidity values (logging period recorded 268
anomalies), possibly due to a small calibration error. These data were not
deleted.

5/1 4:30, 5:30-8:00, 17:30-20:00
5/2 5:00, 6:30-8:30, 18:00-21:30
5/3 7:00-10:00, 20:30-21:00
5/4 20:00-21:00, 22:00-22:30, 23:30
5/5 8:00-11:30, 21:00-21:30, 23:30
5/6 9:30-12:00, 20:30
5/7 10:00-11:00, 12:00, 21:30-23:30
5/8 0:00-2:00, 11:00-14:30, 22:30-23:30
5/9 0:00-1:00, 2:00-2:30, 11:30-14:30, 23:00
5/10 0:00-2:30, 3:30, 12:00-14:30, 15:30-16:30
5/11 0:00-4:30, 13:00-16:00

5/12 1:00-4:30, 14:00-15:00, 16:00-17:00
5/13 2:00-5:30, 14:30-17:00, 18:00-18:30
5/14 2:30-5:00, 6:00, 16:00-16:30, 17:30-19:30
5/15 4:30-7:30, 17:00-20:00
5/16 6:30, 7:30, 8:30, 17:30, 18:30-19:00, 20:00
5/17 18:30, 19:30-21:30
5/18 7:00-9:00, 19:00-22:30
5/19 7:30-11:30, 19:30-23:30
5/20 0:00, 9:00, 21:30-22:00, 23:00-23:30
5/21 0:00, 9:00-10:30
5/24 11:00, 12:00, 23:30
5/25 1:00, 2:30, 13:00-14:00, 15:30
5/26 0:30, 1:30-2:30, 12:30, 13:30-14:00, 15:00
5/27 2:00-2:30, 14:00, 16:30
5/28 1:30-2:00, 4:00

The following were high positive turbidity spikes that were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values were bad.

5/2 10:00 to 11:00 (range 22.0-45.1)
5/13 23:00 (137.4) to 23:30 (57.5)
5/25 7:30 (56.0) to 8:00 (30.8)

June, 1997 Sampling Period

Head of Tide:

There were three high positive turbidity spikes on 6/21 6:30 (587.9), 7:00 (577.9), and 7:30 (510.0 NTU); they were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values are bad.

The following were a range of high positive turbidity spikes (<500.0 NTU, not including the three high positive values listed above from 6/21 6:30 to 7:30) that were not consistent with the overall data record. These 368 turbidity anomalies were observed from 6/14 14:30 (32.5) continuous through 6/22 1:30 (28.6), with a mean of 72.0 and a range from 8.9 to 418.5 NTU. The dates and times of each anomaly are not listed due to the high number (368) of readings. These suspect data were not deleted, as we are not absolutely sure that these values were bad.

There were two high positive turbidity spikes on 6/25 5:30 of 84.9 NTU and 23:30 of 139.1 NTU; they were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values

are bad.
Inlet:
The following were small negative turbidity values (logging period recorded 84
anomalies), possibly due to a small calibration error. These data were not
deleted.

6/26 15:00-17:30
6/27 0:30, 2:30-5:30, 15:00-17:30, 18:30-19:00
6/28 2:00-7:00, 14:30-19:30
6/29 3:30-9:00, 16:00, 17:00-20:30
6/30 4:00, 5:00-9:00, 17:00, 18:00-21:30

Drakes Island Upstream:
None to report.
Drakes Island Downstream:
The following were small negative turbidity values (logging period recorded 10
anomalies), possibly due to a small calibration error. These data were not
deleted.

6/26 15:30
6/27 4:00-4:30, 16:30-17:00, 18:00
6/28 17:30-18:30
6/29 17:30

July, 1997 Sampling Period
Head of Tide:
The following were two ranges of high positive turbidity spikes that were not
consistent with the overall data record. The first range had 7 turbidity
anomalies observed from 7/9 15:30 (66.8) continuous through 18:30 (30.6), with a
range from 28.7 to 66.8 NTU. The second range had 18 turbidity anomalies
observed from 7/15 5:30 (40.9) continuous through 14:00 (30.9), with a range
from 20.4 to 65.3 NTU.
The dates and times of each anomaly are not listed due to the high number (25
total) of readings. These suspect data were not deleted, as we are not
absolutely sure that these values were bad.
Inlet:
The following were small negative turbidity values (logging period recorded 652
anomalies), possibly due to a small calibration error. These data were not
deleted.

7/1 6:00-10:30, 17:30-18:00, 19:00-22:30
7/2 6:00-12:30, 17:30, 18:30, 19:30-23:00
7/3 0:00, 3:00, 7:00, 8:00-12:00, 20:00-23:30
7/4 0:00-0:30, 5:00, 9:30-14:00, 16:30, 23:00-23:30
7/5 0:00-2:00, 4:00-4:30, 6:00, 7:30, 11:00-14:30, 16:30, 17:30-18:00,
19:00, 22:30, 23:30

7/6 0:00-3:00, 5:00, 6:00, 7:00-9:00, 11:00-16:00, 18:30-19:30, 20:30-
23:30
7/7 0:00-2:30, 3:30-4:00, 6:00-8:30, 9:30-16:30, 19:00-23:30
7/8 0:00-4:30, 6:30, 7:30-8:30, 10:00-17:30, 19:30, 21:30-23:30
7/9 0:00-2:30, 3:30-5:30, 9:30-17:30, 20:00-20:30, 21:30, 23:30
7/10 0:00-6:00, 8:30-9:00, 10:00, 13:30-18:30, 19:30-20:30, 22:00-22:30,
23:30
7/11 0:00-7:00, 8:30, 10:00, 11:00, 12:00-13:30, 14:30-20:00, 21:30,
23:00-23:30
7/12 0:30-7:30, 9:00-10:30, 11:30, 12:30-21:30, 22:30-23:30
7/13 0:30-8:30, 9:30, 10:30-21:30, 22:30, 23:30
7/14 0:30-1:00, 2:00-8:30, 9:30, 10:30, 12:00-12:30, 13:30-22:30
7/15 2:30-9:30, 15:00-16:30, 17:30-22:00
7/16 4:00-8:30, 9:30-10:30, 14:30, 16:00-23:00
7/17 5:30, 6:30-7:30, 8:30-11:00, 16:30-17:00, 20:00-23:00
7/18 5:30, 6:30, 7:30-12:30, 15:30, 18:00, 21:00-23:30
7/19 0:00, 7:00, 10:00-13:00, 21:00-23:30
7/20 0:00-0:30, 9:30-13:30, 14:30, 19:30, 22:30-23:30
7/21 0:00-0:30, 11:30-14:30, 20:30, 22:30-23:00
7/22 0:00-1:00, 11:00, 12:00-12:30, 13:30-14:30, 23:30
7/23 1:30-2:00, 11:30-15:00, 23:00
7/24 0:30-1:00, 2:00-3:30, 12:30-16:30
7/25 0:00, 1:00-4:30, 16:00
7/26 13:00
7/27 5:00-5:30
7/31 12:00-23:30

Drakes Island Upstream:

No dissolved oxygen data or percent saturation data from 7/5 14:00 to 7/19 7:00
due to a suspected DO membrane puncture and probe malfunction. All DOmg and
DOsat data, after the next reading after 7/5 13:30 (where readings were normal),
decreased sharply until reaching values of 0.0 followed by negative values. These data were suspect and deleted.

No data on 7/19 7:30 to 7/31 23:30 due to a battery crash.
There were three high positive turbidity spikes on 7/12 1:30 (113.5), 7/14 7:30
(49.3), and 7/16 4:00 (235.5 NTU); these were not consistent with the overall
data record. These suspect data were not deleted, as we are not absolutely sure
that these values were bad.

Drakes Island Downstream:

The following were a range of high positive turbidity spikes (=100 NTU), with an
average of 400.4 that were not consistent with the overall data record. These
213 turbidity anomalies were observed from 7/3 4:30 interspersed throughout 7/28

6:00, with a mean of 400.4 and a high value of 1145.0 (range 100.1-1145.0). The dates and times of each anomaly are not listed due to the high number (213) of readings. These suspect data were not deleted, as we are not absolutely sure that these values were bad.

The following were a range of high positive turbidity spikes (=20 and <100 NTU), with an average of 49.3 that were not consistent with the overall data record. These 203 turbidity anomalies were observed from 7/1 18:00 interspersed throughout 7/29 14:00, with a mean of 49.3 and a high value of 99.7 (range 20.1-99.7). The dates and times of each anomaly are not listed due to the high number (203) of readings. These suspect data were not deleted, as we are not absolutely sure that these values were bad.

The following were a range of high negative turbidity spikes (with an average of -855.6) that were not consistent with the overall data record. These 35 turbidity anomalies were observed from 7/22 3:00 interspersed throughout 7/23 18:30 with a mean of -855.6 and a high value of -1159.9 (range -223.6 to -1159.9). The dates and times of each anomaly are not listed due to the high number (35) of readings. These suspect data were not deleted, as we are not absolutely sure that these values were bad.

August, 1997 Sampling Period

Head of Tide:

There was one high negative turbidity spike on 8/4 2:00 of -729.7 NTU; it is not consistent with the overall data record. This suspect datum was not deleted, as we are not absolutely sure that this value is bad.

There was one shallow negative depth datum on 8/17 6:00 (-0.01 m), but sonde probes suspected to be underwater as other parameters check out normal. This datum was not deleted.

There are shallow positive depth data on 8/17 0:30 to 5:30 (range of 0.0 to 0.007 m) and 7:00 to 8:00 (range of 0.001 to 0.005 m). Sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted.

Inlet:

The following were small negative turbidity values (logging period recorded 1196

anomalies), possibly due to a small calibration error. These data were not
deleted.

8/1 0:00-23:30
8/2 0:00-23:30
8/3 0:00-23:30
8/4 0:00-23:30
8/5 0:00-23:30
8/6 0:00-6:30, 8:00, 9:00-23:30
8/7 0:00-23:30
8/8 0:00-23:30
8/9 0:00-23:30
8/10 0:00-23:30
8/11 0:00-23:30
8/12 0:00-23:30
8/13 0:00-23:30
8/14 0:00, 1:00-2:00, 3:30-23:30
8/15 0:00-17:00, 18:00-23:30
8/16 0:00-0:30, 1:30-23:30
8/17 0:00-23:30
8/18 0:00-2:00, 3:00-6:00, 7:00-14:00, 15:00-23:30
8/19 0:00-6:00, 7:00, 8:00-19:00, 20:00-23:30
8/20 0:00-7:30, 9:00-20:00, 21:00-23:30
8/21 0:00-7:30, 8:30, 9:30-16:30
8/22 19:00, 20:00-21:00, 22:00
8/23 6:30-10:30, 17:00-23:00
8/24 2:30-11:30, 12:30-23:30
8/25 0:00-23:30
8/26 0:00-23:30
8/27 0:00-23:30
8/28 0:00-3:30, 4:30

No data on 8/28 5:00 to 8/31 23:30 due to a battery crash. Battery voltage
decreased to 6.0. Data were collected in several spurts during this crash
(after 8/28 5:00), but these data were deleted as they were not consistent with
the overall data record.

Drakes Island Upstream:

The following were high positive turbidity spikes (>50.0 NTU) that were not
consistent with the overall data record. These suspect data were not deleted,
as we are not absolutely sure that these values were bad.

8/14 19:00 (85.6)
8/15 18:00 (224.5)
8/16 20:00 (52.5)
8/23 20:00 (78.0)
8/25 4:30 (81.2); 5:30 (65.9); 6:00 (96.8)
8/26 6:30 (66.4); 7:00 (61.1); 19:30 (71.8)
8/30 21:30 (102.7)

Drakes Island Downstream:

The following were small negative turbidity values (logging period recorded 179

anomalies), possibly due to a small calibration error. These data were not
deleted.

8/1 8:00-10:30, 11:30, 19:30-23:30
8/2 9:00-12:00, 20:30-23:30
8/3 0:00-0:30, 9:30-13:30, 22:00-22:30, 23:30
8/4 0:00-1:00, 11:00-14:00, 23:00
8/5 0:00-2:00, 11:00-15:00, 22:30-23:30
8/6 0:00-2:30, 11:30-14:30, 23:30
8/7 0:00-3:00, 13:00-15:30
8/8 0:30-3:30, 13:00-14:30, 15:30-16:30
8/9 2:00-3:30, 13:30-16:30
8/10 3:00-5:00, 14:30-17:30
8/11 3:30-5:30, 15:30-18:30
8/12 5:00-5:30, 6:30-7:00, 16:00-19:30
8/13 6:00-7:30, 18:30, 20:00
8/14 7:00-8:30, 18:30-19:30, 21:30
8/15 7:00-7:30, 21:00, 22:00-22:30

The following were a range of high positive turbidity spikes that were not
consistent with the overall data record. These 7 turbidity anomalies were
observed from 8/21 19:30 continuous through 22:30, with range of 45.6-
697.4).
The dates and times of each anomaly are not listed due to the high number (7) of
readings. These suspect data were not deleted, as we are not absolutely sure
that these values were bad.
The following were high positive turbidity spikes that were not consistent with
the overall data record. These suspect data were not deleted, as we are not
absolutely sure that these values were bad.

8/22 5:30 to 7:00 (range 33.3-116.5), 13:00 (536.3)

There are suspect dissolved oxygen (<3.0 mg/l) and percent saturation (<37.0%)
data from 8/26 17:30 interspersed throughout 8/31 22:30 due to a gradual
decrease and increase of fluctuating values (69 readings). All DOmg (range 0.6-
2.9 mg/l)) and DOsat (7.5-35.7%) data, after a certain point, decreased
steadily while fluctuating until reaching low values of 0.6 and 7.5,
respectively. These data were not deleted, however, since values did not
decrease to negative values; and during these low readings there were
fluctuations to normal values. Also, other parameter readings were
normal.

September, 1997 Sampling Period
Head of Tide:
The following were small negative turbidity values (logging period recorded 95
anomalies), possibly due to a small calibration error. These data were not
deleted.

9/13 15:00-17:00, 18:00-23:30
9/14 0:00-8:30, 9:30-20:30
9/15 1:30-9:00, 14:00-20:30
9/16 7:30-9:00, 19:00-20:00

No dissolved oxygen data or percent saturation data from 9/8 13:30 to 9/30 23:30 due to a suspected DO membrane puncture and probe malfunction. All DOmg and DOsat data, after the first reading after deployment (9/8 13:00), decreased sharply until reaching values of 0.0 followed by negative values. These data were suspect and deleted.

The following are shallow negative depth data, but sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted:

9/25 22:30-23:30
9/26 0:00-0:30
9/29 3:30-8:00, 12:00-20:30
9/30 0:00-9:00, 12:30-21:00

There are 135 shallow positive depth data (<0.10 m) dispersed from 9/20 4:00 throughout 9/29 11:30. Sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted.

Inlet: None to report.

Drakes Island Upstream:

There were three high positive turbidity spikes on 9/1 13:00 (78.0), 9/2 0:00 (62.1), and 9/8 17:30 (43.7); these were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values were bad.

The following were small negative turbidity values (logging period recorded 397 anomalies), possibly due to a small calibration error. These data were not deleted.

9/9 9:00-10:30, 12:00-12:30, 14:30-22:00, 23:00-23:30
9/10 5:30-13:30, 15:30, 16:30-17:00, 18:00-22:30
9/11 0:00, 4:00, 6:00, 7:00-14:00, 15:00, 16:00-17:00, 18:30-22:00, 23:00-23:30
9/12 0:00-0:30, 21:00-23:30
9/13 0:00-5:00, 8:00-13:00, 14:00-15:30, 19:30, 21:30-23:30
9/14 0:00-1:30, 3:30, 4:30-5:00, 8:30-12:30, 13:30-18:00, 21:00, 22:00-23:30
9/15 0:00-4:30, 8:30, 10:00-18:30, 22:30-23:30
9/16 0:00-20:00, 22:30-23:30
9/17 0:00-9:30, 10:30-20:00, 21:30
9/18 0:30-4:30, 5:30-8:30, 9:30, 10:30, 12:00-22:00
9/19 2:30-6:30, 7:30-10:00, 14:00-21:00
9/20 3:00-7:00, 13:00-18:00, 19:00-19:30

9/21 16:00-16:30, 18:30, 19:30
9/22 7:00, 8:00, 19:00-19:30
9/23 20:30
9/25 9:30-10:30, 12:00, 13:00-13:30
9/27 8:00
9/28 11:30, 14:30
9/29 1:00, 5:00, 6:30, 11:30, 12:30, 13:30
9/30 13:30-14:30, 15:30, 16:30, 17:30-18:00, 19:30

Drakes Island Downstream:
There are suspect dissolved oxygen (<3.0 mg/l) and percent saturation (<37.0%) data (a continuation from 8/26 17:30) from 9/1 10:00 interspersed throughout 9/2 13:00 due to a gradual decrease and increase of fluctuating values (8 readings).
All DOmg (range 0.8-2.9 mg/l)) and DOsat (10.7-36.8%) data, after a certain point, decreased steadily while fluctuating until reaching low values of 0.8 and 10.7, respectively. These data were not deleted, however, since values did not decrease to negative values; and during these low readings there were fluctuations to normal values. Also, other parameter readings were normal.
There were two high positive turbidity spikes on 9/7 22:30 (213.6) and 9/12 2:00 (576.0); these were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values were bad.
The following are shallow negative depth data (22 values), but sonde probes suspected to be underwater as other parameters check out normal. These data were not deleted:
9/29 5:00, 14:30-17:30
9/30 3:00-6:00, 15:00-18:00
There are 47 shallow positive depth data (=0.10 m) interspersed from 9/3 5:00 throughout 9/30 18:30.
Sonde probes suspected to be underwater as other parameters check out normal.
These data were not deleted.

October, 1997 Sampling Period
Head of Tide:
The following were small negative turbidity values (logging period recorded 255 anomalies), possibly due to a small calibration error. These data were not deleted.
10/2 6:00-6:30, 7:30-8:00, 9:00-12:00, 13:00, 15:30-16:00
10/3 2:30, 6:00, 7:30-9:30, 10:30-11:00, 19:00-19:30, 20:30, 21:30, 22:30-

23:30
10/4 0:30-2:00, 5:00-6:00, 7:00-12:00, 21:30, 22:30-23:30
10/5 0:00, 1:00-3:30, 4:30, 17:00, 18:00-18:30, 19:30-23:30
10/6 0:00-2:30, 3:30-4:30, 5:30-6:00, 11:30-23:30
10/7 0:00-1:00, 2:00-10:30, 12:00-13:30, 15:00-18:30, 19:30-23:30
10/8 0:00-2:00, 3:00, 4:00, 5:00-5:30, 6:30-8:30, 9:30-10:00, 11:00,
12:00-13:00, 14:00-23:30
10/9 0:00-1:30, 2:30-6:30, 7:30-11:30, 12:30, 13:30-15:00
10/10 2:00-16:30
10/11 5:30-6:30, 12:00, 15:30-17:00
No dissolved oxygen data or percent saturation data from 10/1 0:00 to 10/18
13:00 due to a suspected DO membrane puncture and probe malfunction. All DOmg
and DOsat data, after the first reading after deployment (9/8 13:00), decreased
sharply until reaching values of 0.0 followed by negative values.
These data were suspect and deleted (this malfunction was a continuation from
9/8 13:30).
Inlet:
The following were small negative turbidity values (logging period recorded 145
anomalies), possibly due to a small calibration error. These data were not
deleted.
10/23 5:30-6:00, 13:00, 16:30-18:30, 22:00-23:30
10/24 5:30-7:30, 10:00, 11:00, 12:00-12:30, 14:00, 19:00, 22:00, 22:30
10/25 0:00-1:30, 2:30, 5:00-10:00, 11:30, 12:30-13:30, 14:30-15:30, 17:30-
22:30
10/26 0:00-1:00, 2:00-2:30, 4:30-13:30, 14:30, 17:00-23:00
10/29 14:30, 17:00, 22:00-23:30
10/30 1:00, 5:00-5:30, 10:00-12:00, 15:30-16:00, 17:00-18:00, 22:00-23:30
10/31 0:00-0:30, 2:30, 3:30-4:00, 5:00-6:30, 9:30-15:00, 16:00-16:30,
18:30, 23:00
There were suspect percent saturation and dissolved oxygen data from 10/22 14:30
to 19:30, where the first reading after deployment was 286.3 % and 25.7 mg/l,
respectfully, and then continued to decrease sharply to values of 100.8 % and
9.3 mg/l on 10/22 19:30 before reading acceptable values. I did not allow the
DO membrane sufficient time to calibrate (to pulse several times) before
deployment because of a time crunch. The DO probe seemed to be calibrating
immediately after deployment, therefore these 11 suspect data values (22 total)
that were not consistent with the overall data record were deleted.

Drakes Island Upstream:
The following were small negative turbidity values (logging period recorded 482
anomalies), possibly due to a small calibration error. These data were not
deleted.

10/1 0:30-5:00, 6:00, 11:00-11:30, 12:30-18:00, 23:30
10/2 0:00-5:30, 11:00-12:30, 13:30-14:30, 15:30-18:30
10/3 0:00-2:30, 3:30-5:30, 8:00, 11:30-18:00, 19:00-22:00
10/4 0:00-9:00, 10:00, 11:00, 12:30-13:00, 14:00-20:30, 21:30-22:30
10/5 1:00-5:00, 6:00-11:00, 14:30-16:00, 17:00-17:30, 18:30-19:00, 21:00,
23:00-23:30
10/6 0:00-0:30, 3:00-4:00, 5:00-10:00, 12:30, 13:30, 14:30-18:00, 19:00,
20:30
10/7 3:00-3:30, 4:30-7:00, 8:00, 13:30-15:30, 16:30-19:00
10/8 2:30-3:30, 4:30-5:30, 14:30-15:00, 16:00-17:00, 18:00
10/9 5:00, 7:00, 15:30-18:00, 19:00
10/10 4:00-4:30, 6:00-6:30, 7:30, 8:30-9:00, 10:30-11:00, 17:30-22:00
10/11 7:00, 8:00-11:00, 12:00-13:30, 15:00-17:00, 18:00, 19:30-23:30
10/12 0:00-0:30, 2:00-2:30, 7:30-13:30, 14:30-15:30, 16:30, 17:30-19:00,
20:00-23:30
10/13 0:00-5:30, 6:30-7:30, 8:30-19:00, 20:30, 21:30-23:30
10/14 0:00-5:00, 6:00, 7:00, 9:00-20:00, 21:00, 22:00-23:30
10/15 0:00-3:00, 4:00-5:30, 7:00-7:30, 9:30-19:30, 20:30, 23:00-23:30
10/16 0:00-5:00, 6:00-8:00, 11:00, 12:00-18:30, 19:30-20:00
10/17 2:00-3:30, 4:30-7:00, 14:00-15:00, 17:00-19:00, 20:30-21:00
10/18 3:30, 15:00-15:30, 16:30

The following were high positive turbidity spikes that were not consistent with
the overall data record.
These suspect data were not deleted, as we are not absolutely sure that these
values were bad.

10/1 12:00 (108.9)
10/5 12:00 (33.0)
10/11 6:00 (28.3)
10/14 5:30 (20.4)
10/23 12:30 (56.7)

The following were a range of high positive turbidity spikes that were not
consistent with the overall data record. These 6 turbidity anomalies were
observed from 10/27 4:30 continuous through 7:00, with a range from 19.5 to 51.4
NTU. The dates and times of each anomaly are not listed due to the high
number (6) of readings. These suspect data were not deleted, as we are not
absolutely sure that these values were bad.

Drakes Island Downstream:
There were two high positive turbidity spikes on 10/5 5:30 (132.8) and 6:00
(113.6); these were not consistent with the overall data record. These suspect
data were not deleted, as we are not absolutely sure that these values were bad.

November, 1997 Sampling Period
Head of Tide:
There was one high positive turbidity spike on 11/2 7:30 of 158.6 NTU; it is not
consistent with the overall data record. This suspect datum was not deleted, as
we are not absolutely sure that this value is bad.
Inlet:
The following were small negative turbidity values (logging period recorded 143
anomalies), possibly due to a small calibration error. These data were not
deleted.

11/1 0:00, 15:30, 17:30
11/6 23:30
11/7 10:30
11/11 3:00, 14:30-15:30
11/12 1:00-2:00, 3:00-3:30, 16:30-17:00
11/13 2:00-2:30, 5:00, 9:30-10:30, 15:00-16:00, 17:30-18:00, 21:00, 22:00-
23:00
11/16 20:30
11/17 1:00, 7:30, 18:00-19:30, 21:00-21:30
11/18 1:30-2:30, 8:00, 18:30-22:00
11/19 1:30-4:00, 6:00, 7:00-10:00, 12:30-17:00, 18:00-18:30, 19:30-22:30,
23:30
11/20 0:00-5:30, 6:30-7:00, 8:30-9:00, 10:00, 11:00-18:00, 19:30, 20:30-
23:30
11/21 0:30-8:00, 9:30

The following were a range of high negative turbidity spikes (range from -81.2
to -391.0 with an average of -238.2) that were not consistent with the overall
data record. These 15 turbidity anomalies were observed from 11/21 14:00 (-
347.6) continuous through 21:00 (-107.8). The dates and times of each anomaly
are not listed due to the high number (15) of readings. These suspect data were
not deleted, as we are not absolutely sure that these values were bad.
The following were a range of high positive turbidity spikes (range from 47.2 to
179.2 with an average of 101.4) that were not consistent with the overall data

record. These 437 turbidity anomalies were observed from 11/21 21:30 (72.3)
continuous through 11/30 23:30 (99.1). The dates and times of each anomaly are
not listed due to the high number (437) of readings. These suspect data were
not deleted, as we are not absolutely sure that these values were bad.
Drakes Island Upstream:
The following were small negative turbidity values (logging period recorded 40
anomalies), possibly due to a small calibration error. These data were not
deleted.

11/21 18:00, 19:30
11/22 19:00, 20:00-20:30
11/27 11:00
11/28 10:30, 12:30-13:30, 15:00, 16:00-16:30, 17:30-19:00
11/29 1:00, 2:00, 3:00-3:30, 6:00, 7:30, 13:00
11/30 0:30, 2:00, 6:00, 8:00, 11:30-12:30, 13:30-14:30, 15:30, 17:00,
18:30-19:00, 20:00, 21:30

The following were a range of high positive turbidity spikes that were not
consistent with the overall data record. These 6 turbidity anomalies were
observed from 11/1 21:30 continuous through 11/2 0:00, with a range from 20.3 to
39.4 NTU. The dates and times of each anomaly are not listed due to the high
number (6) of readings. These suspect data were not deleted, as we are not
absolutely sure that these values were bad.
There were two high positive turbidity spikes on 11/7 13:00 (20.9) and 11/25
21:30 (29.4); these were not consistent with the overall data record. These
suspect data were not deleted, as we are not absolutely sure that these values
were bad.
Drakes Island Downstream:
The following were two ranges of high positive turbidity spikes that were not
consistent with the overall data record. The first range had 6 turbidity
anomalies observed from 11/1 18:00 continuous through 20:30, with a range from
21.7 to 93.2 NTU. The second range had 3 turbidity anomalies observed from
11/2 4:30 continuous through 5:30, with a range from 25.9 to 40.8 NTU. The dates
and times of each anomaly are not listed due to the high number (25 total) of
readings. These suspect data were not deleted, as we are not absolutely sure
that these values were bad.

The following were high positive turbidity spikes that were not consistent with the overall data record. These suspect data were not deleted, as we are not absolutely sure that these values were bad.

11/4 21:00 (38.6)
11/9 10:00 (137.4), 10:30 (82.0), 11:00 (181.5)
11/24 22:00 (65.0)
11/25 14:30 (44.1)

The following were small negative turbidity values (logging period recorded 18 anomalies), possibly due to a small calibration error. These data were not deleted.

11/24 19:00
11/26 9:00, 21:30-22:00
11/27 8:00-9:30, 22:30
11/28 9:00, 11:30, 22:00, 23:00-23:30
11/29 0:00
11/30 10:30-11:00, 12:00

December, 1997 Sampling Period
Head of Tide: none to report
Inlet:
The following were a range of high positive turbidity spikes, continued from 11/21 21:30, (range from 75.9 to 113.5 with an average of 89.6) that were not consistent with the overall data record. These 886 turbidity anomalies were observed from 12/1 0:00 (100.8) continuous through 12/19 10:00 (83.0). The dates and times of each anomaly are not listed due to the high number (886) of readings. These suspect data were not deleted, as we are not absolutely sure that these values were bad.
The following were small negative turbidity values (logging period recorded 135 anomalies), possibly due to a small calibration error. These data were not deleted.

12/19 11:30, 13:00-13:30, 14:30-17:00
12/20 0:00-1:00, 2:30-4:00, 5:00-5:30, 6:30, 12:00-12:30, 13:30-18:00, 21:00-22:30, 23:30
12/21 0:00-6:30, 8:30-9:30, 10:30-19:30, 22:00-23:30
12/22 0:00-20:30, 22:30-23:30
12/23 2:30-8:00, 9:00, 14:00

Drakes Island Upstream:
The following were small negative turbidity values (logging period recorded 306 anomalies), possibly due to a small calibration error. These data were not

deleted.
12/1 1:00-2:00, 3:30-4:30, 6:00-7:30, 8:30, 13:00-18:00
12/4 3:00-5:00, 6:00-8:30, 9:30, 14:00-16:00, 17:00-23:30
12/5 0:00-0:30, 3:30-4:30, 5:30-10:30, 12:00, 14:30-23:30
12/6 3:00, 4:00-6:00, 18:00-18:30, 19:30-20:30, 22:00
12/7 1:00-1:30, 5:30-6:00, 7:00-8:00, 9:00, 17:30-18:00, 19:30
12/8 6:00-9:00, 11:00-11:30, 12:30-13:00, 14:00, 15:30, 18:30-19:30,
20:30-22:30, 23:30
12/9 1:30, 6:00-13:30, 15:00-16:30, 20:30-21:00, 22:00, 23:00-23:30
12/10 0:30-2:00, 3:00, 4:00, 7:00-16:00, 17:00, 20:00-23:30
12/11 0:00-3:00, 4:00-4:30, 7:00, 9:00-16:30, 17:30-18:00, 19:00-19:30,
20:30-23:30
12/12 0:00-5:30, 6:30-7:00, 8:00, 9:00-14:30, 15:30, 16:30, 17:30-18:00,
19:30, 20:30-21:00, 22:00-
23:30
12/13 0:00, 2:30-4:30, 6:00, 7:00, 8:00-8:30, 10:30, 12:00-13:30, 14:30-
15:30, 17:00, 19:30-20:00
12/14 0:30-1:00, 3:30, 12:30-13:00, 14:30
12/15 12:30-13:00, 14:30
12/16 0:30, 12:30-13:00, 14:00, 20:30
12/17 3:00, 5:30
Drakes Island Downstream:
The following were small negative turbidity values (logging period recorded 3
anomalies), possibly due to a small calibration error. These data were not
deleted.
12/2 0:00
12/4 3:00
12/7 17:30

11. Missing data:

January, 1997 Sampling Period
Head of Tide: No data in January; sonde not deployed until March.
Inlet:
No data on 1/7 11:00 to 1/9 10:00 due to downtime for calibration, maintenance
and downloading.
No temperature, specific conductivity, salinity, percent saturation, dissolved
oxygen, and pH data from 1/9 10:30 to 1/16 6:30 due to malfunction of temperature probe.
No data on 1/16 7:00 to 12:30 due to downtime for calibration, maintenance and
downloading.
Drakes Island Upstream: No data in January; sonde not deployed until March.
Drakes Island Downstream: No data in January; sonde not deployed until March.

February, 1997 Sampling Period
Head of Tide: No data in February; sonde not deployed until March.
Inlet:
No data on 2/25 11:30 to 12:30 due to downtime for calibration, maintenance and
downloading.
Drakes Island Upstream: No data in February; sonde not deployed until March.
Drakes Island Downstream: No data in February; sonde not deployed until March.

March, 1997 Sampling Period
Head of Tide:
No data on 3/1 0:00 to 3/31 12:30; this was the first logger deployment (3/31 at
13:00) at this site for 1997.
DO data deleted from 3/31 13:00 to 4/24 08:30. Values started out high and then
Dropped to an average of 70%. Probe appears to be faulty or else there was a
membrane puncture that occurred right before sonde was put in the water.
Inlet:
No data on 3/31 12:00 to 13:00 due to downtime for calibration, maintenance and
downloading.
Drakes Island Upstream:
No data on 3/1 0:00 to 3/31 11:30; this was the first logger deployment (3/31 at
12:00) at this site for 1997.
Drakes Island Downstream:
No data on 3/1 0:00 to 3/31 11:30; this was the first logger deployment (3/31 at
12:00) at this site for 1997.

April, 1997 Sampling Period
Head of Tide:
DO data deleted from 3/31 13:00 to 4/24 08:30. Values started out high and then
Dropped to an average of 70%. Probe appears to be faulty or else there was a
membrane puncture that occurred right before sonde was put in the water.
No data on 4/24 9:00 due to downtime for calibration, maintenance and downloading.
Inlet:
No data on 4/24 12:00 due to downtime for calibration, maintenance and downloading.
Drakes Island Upstream:
No data on 4/25 9:00 due to downtime for calibration, maintenance and downloading.
Drakes Island Downstream:
No data on 4/25 7:00 to 7:30 due to downtime for calibration, maintenance and
downloading.

May, 1997 Sampling Period
Head of Tide:
No data from 5/18 2:30 to 5/19 12:00 due to downtime for calibration, maintenance and downloading.
Inlet:
No data on 5/19 14:30 due to downtime for calibration, maintenance and downloading.
Drakes Island Upstream:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 5/20 10:00).
Drakes Island Downstream:
No data on 5/20 7:00 to 7:30 due to downtime for calibration, maintenance and
downloading.

June, 1997 Sampling Period
Head of Tide:
No data on 6/25 13:30 due to downtime for calibration, maintenance and downloading.
Inlet:
No data on 6/26 14:30 due to downtime for calibration, maintenance and downloading.
Drakes Island Upstream:
No data on 6/26 12:30 due to downtime for calibration, maintenance and downloading.
Drakes Island Downstream:
No data on 6/11 3:00 to 6/26 8:00 due to a battery crash; and due to downtime
for calibration,
maintenance and downloading.

July, 1997 Sampling Period
Head of Tide:
No data on 7/29 14:00 to 7/31 11:00 due to downtime for calibration, maintenance
and downloading.
Inlet:
No data on 7/29 14:30 to 7/31 11:30 due to downtime for calibration, maintenance
and downloading.
Drakes Island Upstream:
No dissolved oxygen data or percent saturation data from 7/5 14:00 to 7/19 7:00
due to a suspected DO membrane puncture and probe malfunction. All DOmg and
DOsat data, after the next reading after 7/5 13:30 (where readings were normal),
decreased sharply until reaching values of 0.0 followed by negative values.
These data were suspect and deleted.
No data on 7/19 7:30 to 7/31 23:30 due to a battery crash; and due to downtime

for calibration, maintenance and downloading.
Drakes Island Downstream:
No data on 7/29 14:30 to 7/31 23:30 due to downtime for calibration, maintenance
and downloading.

August, 1997 Sampling Period
Head of Tide:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 7/31 10:30).
Inlet:
No data on 8/28 5:00 to 8/31 23:30 due to a battery crash.
Drakes Island Upstream:
No data on 8/1 0:00 to 8/1 7:00 due to a battery crash; and due to downtime for
calibration, maintenance and downloading (continuation from 7/19 7:30).
Drakes Island Downstream:
No data on 8/1 0:00 to 7:00 due to downtime for calibration, maintenance and
downloading (continuation from 7/29 14:30).

September, 1997 Sampling Period
Head of Tide:
No data on 9/3 23:00, 9/4 3:00 to 9:00, and from 9/4 12:00 to 9/8 13:30 due to a
battery crash; and due to downtime for calibration, maintenance and downloading.
There were time gaps on 9/3 23:00, 9/4 3:00 to 9:00, due to the low battery
voltage and battery crash.
No dissolved oxygen data or percent saturation data from 9/8 13:30 to 9/30
23:30.
Inlet:
No data from 9/1 0:00 to 9/8 17:00 due to a battery crash, and due to downtime
for calibration, maintenance and downloading.
Drakes Island Upstream:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 9/9 8:30).
Drakes Island Downstream:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 9/9 13:30).

October, 1997 Sampling Period
Head of Tide:
No dissolved oxygen data or percent saturation data from 10/1 0:00 to 10/18
13:00.
No data from 10/18 13:30 to 10/23 7:00 due to downtime for calibration,
maintenance and downloading.

Inlet:
No data from 10/18 16:30 to 10/22 14:00 due to downtime for calibration, maintenance and downloading.
There were suspect percent saturation and dissolved oxygen data from 10/22 14:30
to 19:30, where the first reading after deployment was 286.3 % and 25.7 mg/l,
respectfully, and then continued to decrease sharply to values of 100.8 % and
9.3 mg/l on 10/22 19:30 before reading acceptable values. I did not allow the DO membrane sufficient time to calibrate (to pulse several times)
before deployment because of a time crunch. The DO probe seemed to be calibrating immediately after deployment, therefore these 11 suspect data values
(22 total) that were not consistent with the overall data record were deleted.
Drakes Island Upstream:
No data from 10/18 20:00 to 10/23 12:00 due to downtime for calibration, maintenance and downloading.
Drakes Island Downstream:
No data from 10/19 10:00 to 10/23 12:30 due to downtime for calibration, maintenance and downloading.

November, 1997 Sampling Period
Head of Tide:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 11/20 13:30).
Inlet:
No data on 11/21 10:00 due to downtime for calibration, maintenance and downloading.
Drakes Island Upstream:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 11/21 10:30).
Drakes Island Downstream:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 11/24 16:00).

December, 1997 Sampling Period
Head of Tide:
No data from 12/19 11:00 to 12/31 23:30. This datalogger was pulled for the
year (winter months) to prevent ice damage.
Inlet:
No missing data. Deployed extra calibrated sonde within a non-collection time
of existing sonde (replaced sonde on 12/19 10:30).
Drakes Island Upstream:
No data from 12/17 10:30 to 12/31 23:30. This datalogger was pulled for the
year (winter months) to prevent ice damage.

Drakes Island Downstream:
No data from 12/16 8:00-9:30, due to a data collection skip from low battery
voltage (6.0 volts).
No data from 12/17 8:30 to 12/31 23:30. This datalogger was pulled for the year
(winter months) to prevent ice damage.

12. Other Remarks/Notes:

-The inlet site (IN) deployment methods changed starting on 12/19/97 at 10:30.
The YSI telemetry unit was installed at this site. The collection of data
parameters at the inlet (IN) site are slightly different then at the three (HT,
UP, DN) other sites, due to the telemetry unit installation. This is explained
in the Wells 1998 metadata, as we didn't actually begin the telemetry unit data
collection until 1998; we just installed the PVC tube (see YSI's Eco-Watch Users
Guide). Thus, the actual data parameter collection from 12/19/97 10:30 to
12/31/97 23:30 was the same as prior to that. See Research Methods for more
details.

- With our extra data sonde, we have been reducing the amount of time of missing
data from calibrations and maintenance for all sites. Some months have no
missing data from the use of this extra sonde.