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FINAL PRODUCT

Final Report for the program entitled:

Intertidal Oyster Reefs as a Tool for Estuarine Rehabilitation and Rejuvenation of the Virginia Oyster Fishery: Instrumentation for Environmental Monitoring

submitted to:

The Commonwealth of Virginia
Department of Environmental Quality
Chesapeake Bay and Coastal Programs
Virginia Coastal Resources Management Program, P.O. Box 10009
629 East Main Street
Richmond, VA 23240-009
attn.: Ms. Laura McKay
Coastal Projects Coordinator

by

The School of Marine Science and Virginia Institute of Marine Science
The College of William and Mary
Gloucester Point, VA 23062

Investigator: Dr. Roger Mann, Professor of Marine Science

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Intertidal Oyster Reefs as a Tool for Estuarine Rehabilitation and Rejuvenation of the Virginia Oyster Fishery: Instrumentation for Environmental Monitoring

Introduction

The Virginia Marine Resources Commission Shellfish Replenishment Program began, in May 1993, a program to build intertidal oyster reefs in the Piankatank River in an area devoted exclusively to shellfish replenishment efforts. In collaboration with the Virginia Institute of Marine Science a research and monitoring program was initiated to examine oyster settlement, survival, growth, and disease incidence on the constructed reefs in comparison to adjacent, subtidal shell plants as used in traditional replenishment efforts. Since construction we have proceeded with a long term monitoring and manipulative experimental program to examine temporal and spatial recruitment at differing exposure levels/depths. This is accompanied by temporal sampling at each station to oyster record growth and eventual destructive sampling for examination of disease incidence and intensity. Sampling began in June of 1993 and continues at this time. The major biological portion of this program will continue until December 1995 and will be the subject of a dedicated final report to the Department of Environmental Quality early in 1996. This report addresses a component of the program that was funded after its initiation and as a separate item: namely field instrumentation to more accurately assess tidal and other environmental parameters at the experimental site in order to correctly interpret observed data.

Field instrument description and specification.

The purchased instrument package is a comprehensive tide height and environmental sensing and recording system. It was deployed by attachment to a major piling adjacent to the intertidal oyster reef in the center of the Piankatank waterway at least 100 yards from the shoreline and is accessible only by boat. The instrumentation is sufficiently robust and protected to function in an environment that typically encounters, over annual deployment, temperatures from -20 to +55 C, and winds up to 45 mph. Due to these harsh environmental conditions, the cost of a weathertight enclosure and watertight cable entry grips is included in the project specification.

All component systems, described in detail in the following section in terms of specification, are linked to a central datalogger. Periodicity of data collection is user programmable and data downloading is possible to a laptop computer in the field. Appropriate software for data downloading was included in the bid price. The lap top computer was not purchased with the instrument package, but computer hardware to enable data collection and analysis was included in the project budget.

The instrumentation package is serviceable in the field in terms of battery replacement. Battery power supply is sufficient to provide for a minimum of 14 days unattended monitoring. A solar power recharging system is deployed with the instrumentation. This recharging system is regulated to prevent over-charging damage to batteries. All electronics included in the data collection system operate from this battery/solar recharging unit.

Component instruments are capable of recording information on tidal height, wind velocity and direction, relative humidity, air temperature, water temperature, and net radiation. All component instruments are capable of transmitting data for storage in the accompanying datalogger. The instruments was delivered as a coherent, compatible package pre-tested by the supplier. Final assembly was effected at the Virginia Institute of Marine Science by project personnel under direction of a engineer from the supplier. Appropriate manuals and documentation to assist users in deployment and recording were supplied.

Datalogger:

The datalogger is capable of acquiring and storing data from a variety of sensors. The datalogger unit has a detachable terminal blocks for ease of system wiring and an integrated display and keypad for programming and field testing. The datalogger has a RS-232 port for interfacing with a personal computer or external modem, and enough internal non-volatile memory to log at least 55,000 time-stamped data samples. The data logger contains the following:

-Six 0-5 Volt Analog inputs;
-Analog to Digital Resolution (at least 12 bits);
-Accuracy +/- 2 bits over temperature range;
-Precision 5,000 Volt sensor excitation;
-Switched battery to sensors;
-Programmable warm-up time;
-Logging interval programmable from 1 per minute to 1 per day;
-Two Digital Counters, programmable for either frequency or accumulated count;
-Four Open-Collector control outputs, capable of sinking at least 100 mA;
-SDI-12 sensor interface;
-Internal transient protection on all sensor inputs;
-Time keeping: +/- 1 minute per month.

Although our immediate needs do not include a remote sensing component, the data logger is able to accommodate the future addition of either line of site radio or GOES satellite telemetry.

Furthermore, the datalogger is expandable and allows for the addition of one or more analog and digital data acquisition circuits.

Tidal Height Measurement:

The water level measurement device is made be of 100% solid state digital low power circuitry and incorporates an absolute means of detecting the water surface relative to a fixed point. It is preferable for such instruments to be devoid of floats or submerged sensors and be electrically isolated from the water. The measurement is automatically and concurrently calibrated for ambient temperature and barometric pressure.

All measurements is controlled by an integral microcontroller which is programmable on-site to produce processed data. The instrument is capable of producing tide data under the accepted NOS algorithm, averaging multiple measurements or obtaining single discreet measurements, and outputting data in ASCII printable characters. All data is available for either automated collection by the datalogger or manual collection by a personal computer. The instrument specifications are as follows:

Measurement		
-Range:	20 m	
-Response:	3 m/sec	
-Resolution:	1mm or .001 ft, selectable	
-Rate:	1 per second	
-Average:	1 to 255 measurements, selectable	
Calibration		
-Accuracy:	99.97%	
-Linearity:	99.98%	
-Repeatability:	99.99%	
-Stability	over time:	100%
	over temp:	±1ppm/deg C
Physical		
-Exposed Sensor:	Less than 100 mm diameter x 200 mm	
-Material:	100% non-corrosive, UV resistant	

Wind Speed and Direction:

The wind sensor is a sturdy, propeller-type instrument capable of measuring both wind speed and direction in harsh, corrosive sea air environments. The sensor is mountable to a pipe and crossbar and compatible with the data logger unit. The sensor specifications are as follows:

-Working range:	0 to 130 mph, 0 to 360 degrees mechanical
-Survival range:	winds up to 220 mph
-Propeller threshold:	2.2 mph
-Vane threshold (10):	2.0 mph
-Power:	switch excitation voltage supplied by datalogger

Relative Humidity:

The relative humidity probe is rugged and compatible with the datalogger. The sensor specifications are as follows:

-Range:	0 to 100%
-Accuracy:	$\pm$ 2 % RH (0 to 90 % RH), $\pm$ 3 % RH (90 to 100 % RH)
-Response time:	15 seconds or less

Air Temperature:

The air temperature sensor specifications are as follows:

-Range:	-35 to 50 C
-Accuracy:	$\pm$ .4 C worse case, $\pm$ .2 C typical
-Linearity:	0.3 C

Water Temperature:

The water temperature sensor is submersible, provided with at least 25 ft. of cable, and meet or exceed the following specifications:

-Range:	-10 to 40 C
-Accuracy:	$\pm$ .25 C
-Linearity:	0.5 C

Net Radiometer:

The net radiometer measures net solar radiation, defined as the total incoming radiation minus total outgoing radiation. Incoming radiation consists of short-wave radiation (from direct beam and diffuse solar radiation) and ion-wave sky radiation. Outgoing radiation consists of reflected solar radiation and terrestrial radiation.

Accessory instrumentation

In addition to purchase and installation of the field instrument the grant also supported purchase of computing hardware for data retrieval and analysis, and a color video camera for image analysis of time series photographs of oyster populations on the reef as used in generating growth and survival data.

Report of activity.

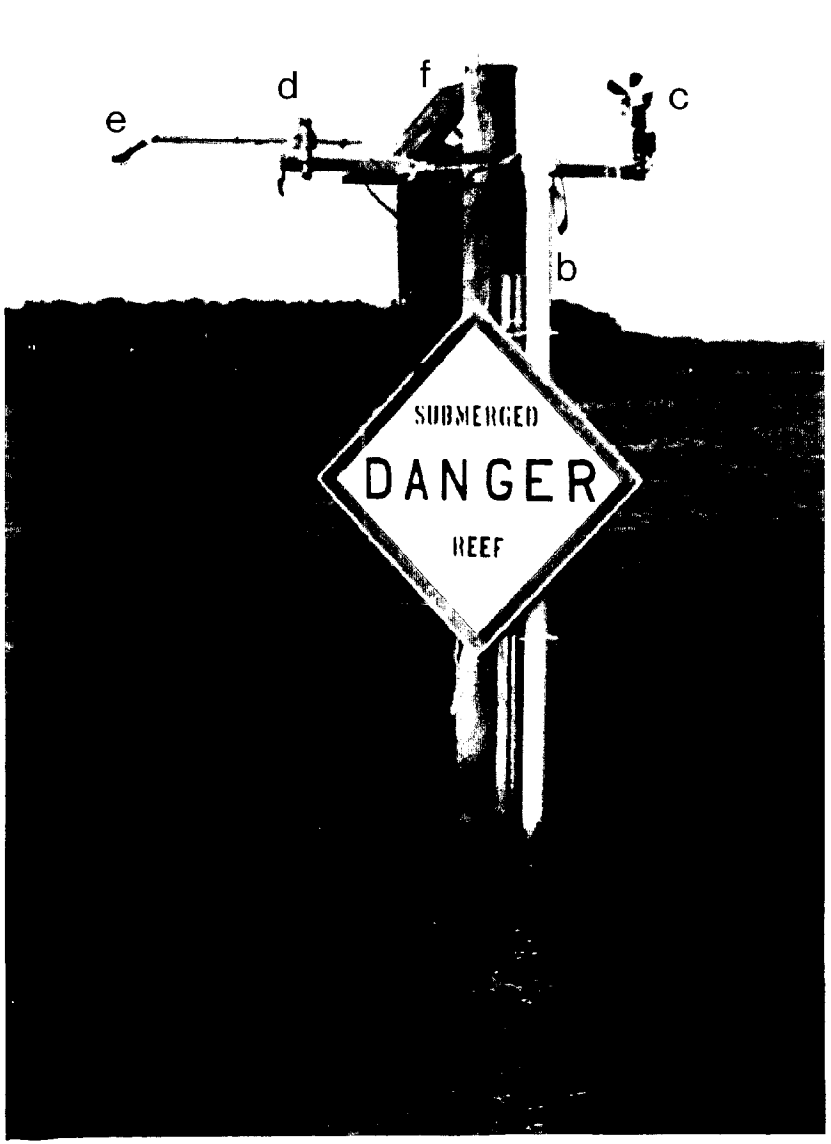
Vitel Inc. of Manassas VA was selected as supplier of the field instrument package after invitations for bid. The instrument was delivered as individual sensor units to the Virginia Institute of Marine Science and subsequently assembled by project personnel during an on site visit by Vitel engineers. The assembled unit was then installed on a piling in the Piankatank River immediately adjacent to the constructed reef. The location of installation is given in Figures 1 and 2. The instrument package is illustrated in the accompanying photographs. Minor teething problems were experienced with the water temperature sensor (mostly caused by ambiguity in the original manufacturer specifications on required immersion depth of the thermistor sensor - this has now been rectified and the sensor is to be reinstalled shortly) and battery charging system (a loose fuse connection!); however, these have been rectified and are not cause for long term concern. Typical raw data output is illustrated in Figures 3 and 4 for net radiometer data from Julian days 205 through 207 and relative humidity data for Julian days 187 through 196. The installation has been serviced regularly (with assistance of local travel and boat support funds provided by this grant) and will continue to be visited as required for data collection. We fully expect this to be a long term monitoring station that contributes directly to our understanding of reef related processes, but also contributes to a wider network of Chesapeake Bay observing stations in that this is the only such comprehensive weather and tide station in the Piankatank River.

The video camera was purchased and is in use for the intended and other projects related to continuing investigations of oyster settlement, growth and survival in the Piankatank River reef systems (now plural in that three other reefs have been constructed since the first reef was completed in 1993).

Acknowledgments

Design, assembly, installation, testing and operation of the field instruments involved a steep learning curve for this investigator. Thanks are due to John Koval and Fred Bechert of Vitel Inc. for patience in all aspects of this process, and to Ian Bartol and Kenneth Walker for many hours of effort in both the laboratory and the field, often under less than ideal conditions.

Plate 1: The final installation of the tide meter and environmental instrumentation in the Piankatank River. The instruments are attached to a large piling at the eastern end of the reef. All data is logged on a datalogger housed in a watertight box (a) mounted under a spray roof. The box also contains the back up battery power source. The tide meter is housed in a vertically mounted PVC tube (b) attached to the piling and extending below the water surface. The water temperature sensor is a thermistor on a sealed conductor that is attached behind this tube (it is about 6mm in diameter and hidden behind the tube in these photographs.) Wind direction and velocity are recorded by the directional propeller / weather vein assembly (c) while air temperature and relative humidity sensors are attached to the opposite end of the mounting arm in a ventilated "beehive" housing (d). Solar radiation is assessed by a end mounted unit (e). A solar panel (f) provides continued charging in daylight hours to the battery power supply.


e
d
f
c
b
SUBMERGED
DANGER
REEF

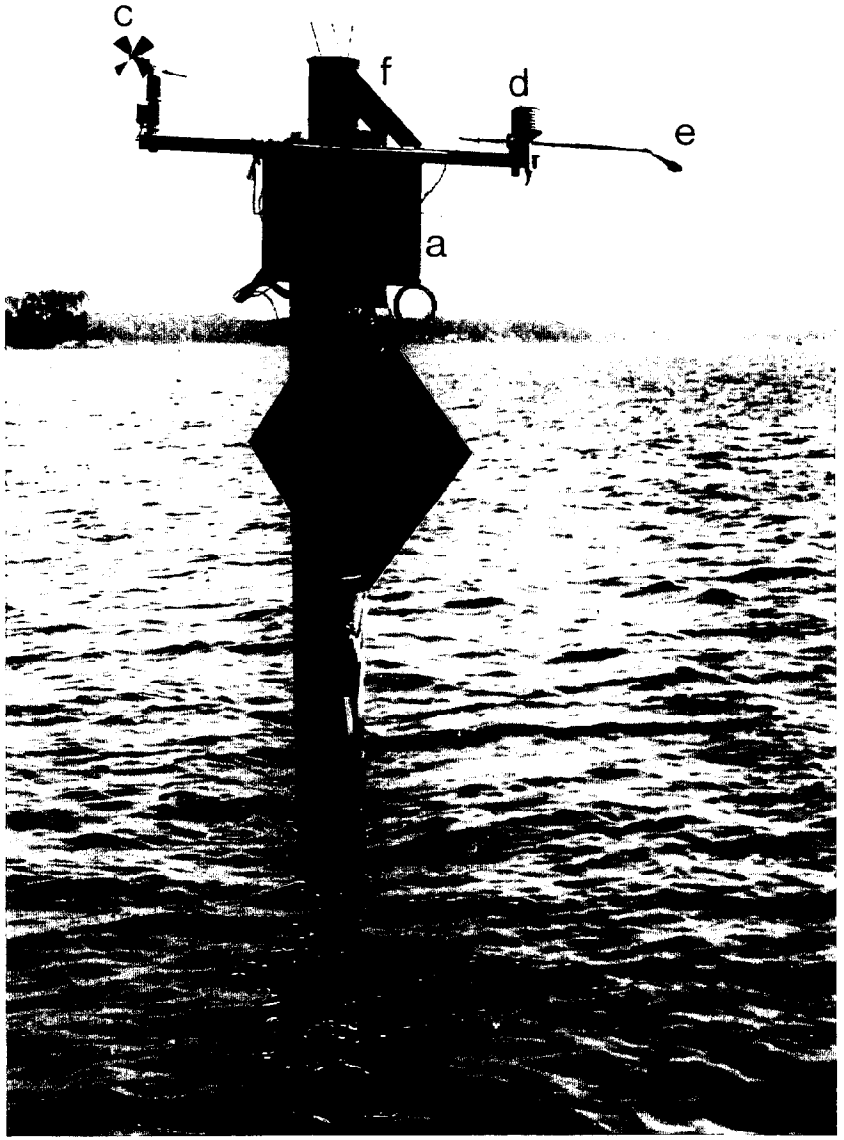
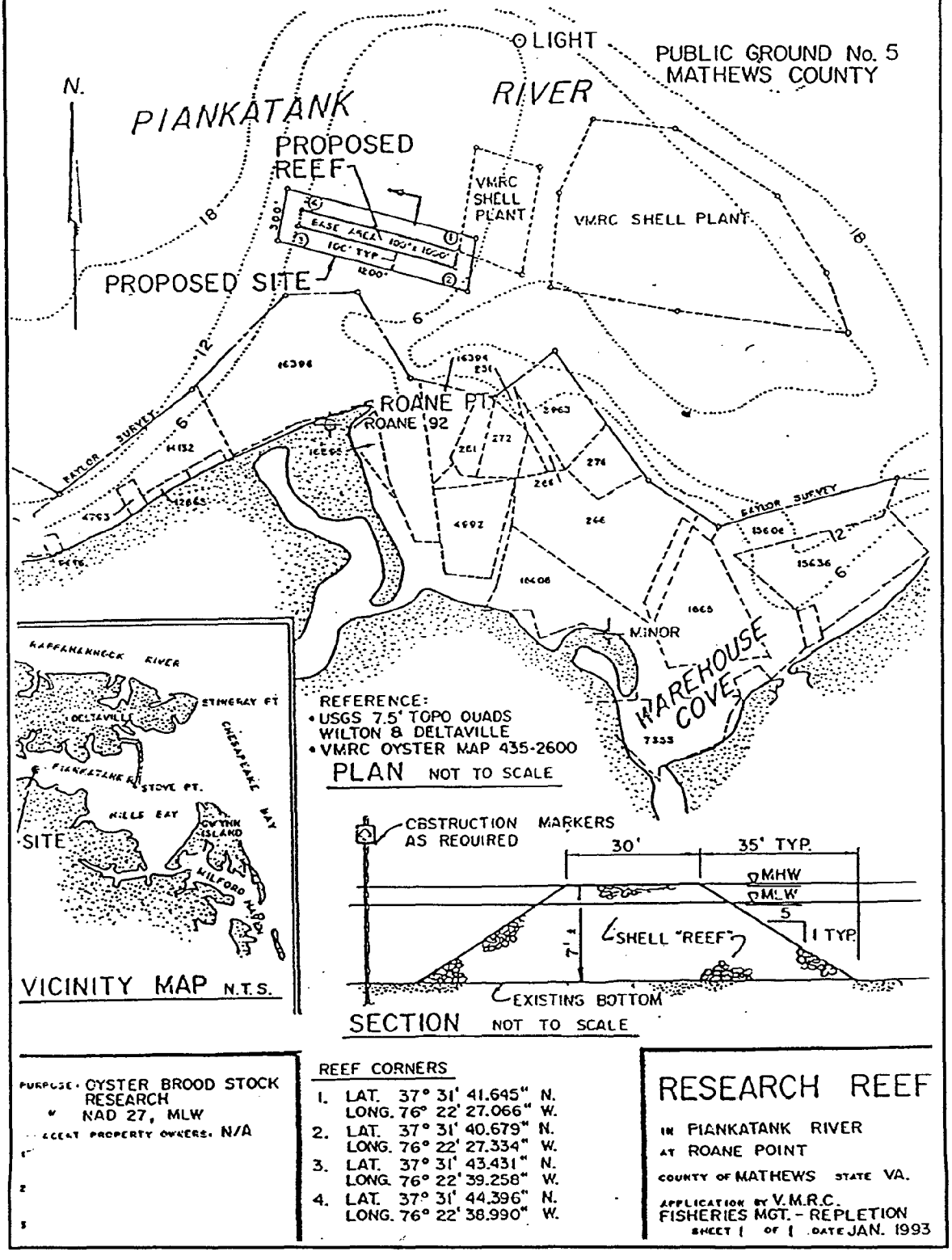

c
f
d
e
a

Figure 1: Location and description of constructed intertidal reef within the Piankatank River. This is as provided to the VMRC, U.S. Army Corps of Engineers, Coast Guard, and local Wetlands Boards for permitting purposes in relation to reef construction. The eventual reef occupies the described location, although the exposed surface is not flat as depicted in the bottom graphic. Rather, it is rounded in response to tidal action and ice scour during the winter of 1993 - 1994.



PURPOSE: OYSTER BROOD STOCK RESEARCH
NAD 27, MLW
ADJACENT PROPERTY OWNERS: N/A

REEF CORNERS

1. LAT. 37° 31' 41.645" N.
   LONG. 76° 22' 27.066" W.
2. LAT. 37° 31' 40.679" N.
   LONG. 76° 22' 27.334" W.
3. LAT. 37° 31' 43.431" N.
   LONG. 76° 22' 39.258" W.
4. LAT. 37° 31' 44.396" N.
   LONG. 76° 22' 38.990" W.

RESEARCH REEF

IN PIANKATANK RIVER
AT ROANE POINT
COUNTY OF MATHEWS STATE VA.
APPLICATION BY V.M.R.C.
FISHERIES MGT. - REPLETION
SHEET 1 OF 1 DATE JAN. 1993

Figure 2: General location of all extant oyster reefs and shell plantings (effected by the VMRC Replenishment Program) within the Piankatank River. The location of the constructed reef, immediately north of Roane Point, is marked R. The instrument package is at the eastern tip of the reef. The remaining reefs, progressing in a downstream direction, are A: Ginney Point, B: Island Bar, C: Palace Bar, D: Blands Point, E: Herring Rock, F: Cape Toone, G: Stove Point, H: Cape Toone inshore (small lumps). Oyster spatfall monitoring stations are located at Ginney Point, Palace Bar, Burtons Point (labelled I, traditionally used as shell plant on hard sand but not a a natural reef), and Three Branches (labelled J in the lee of Gwynns Island on a former shell plant).

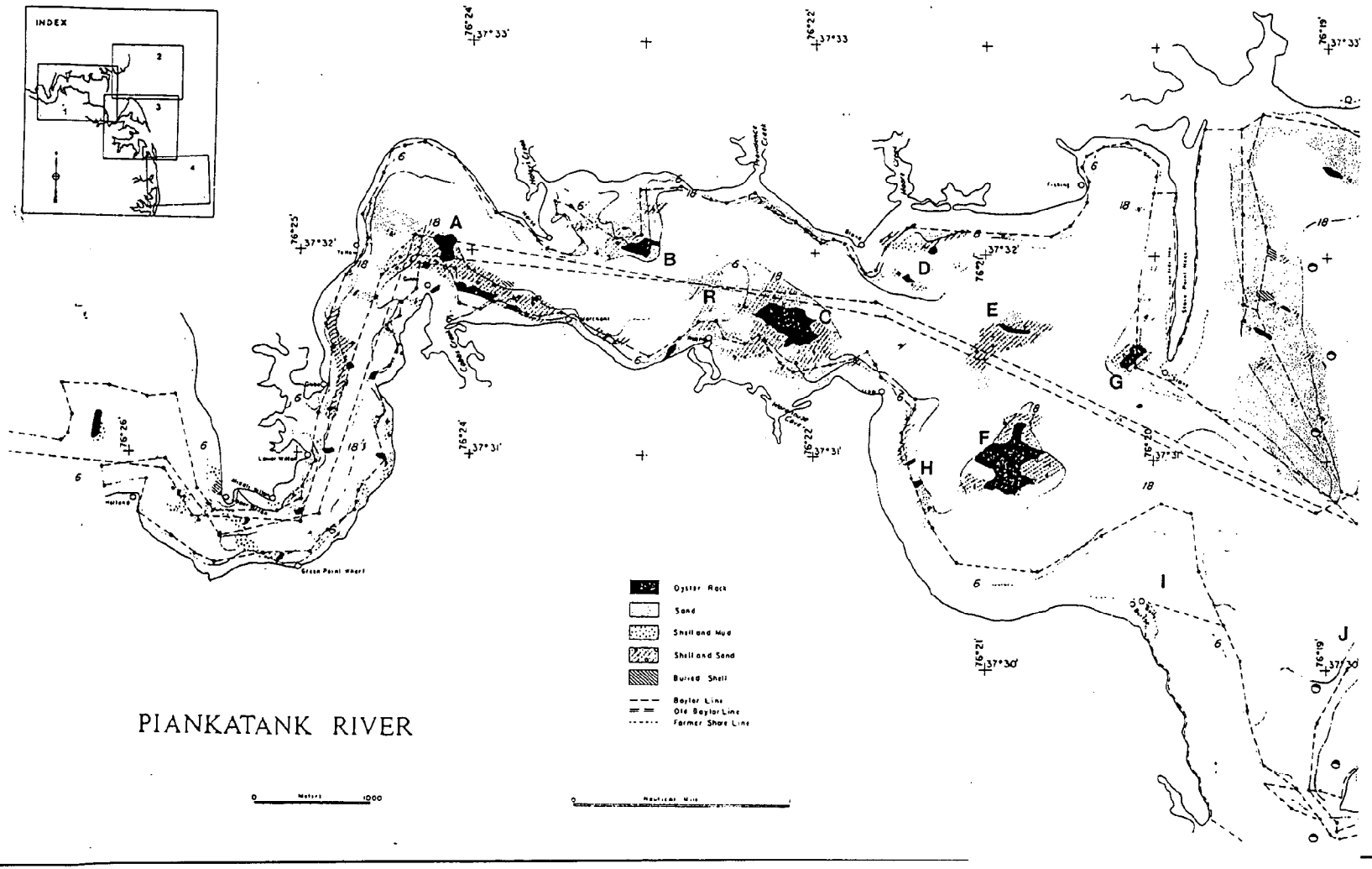


Figure 3: DEQ Instrumentation document

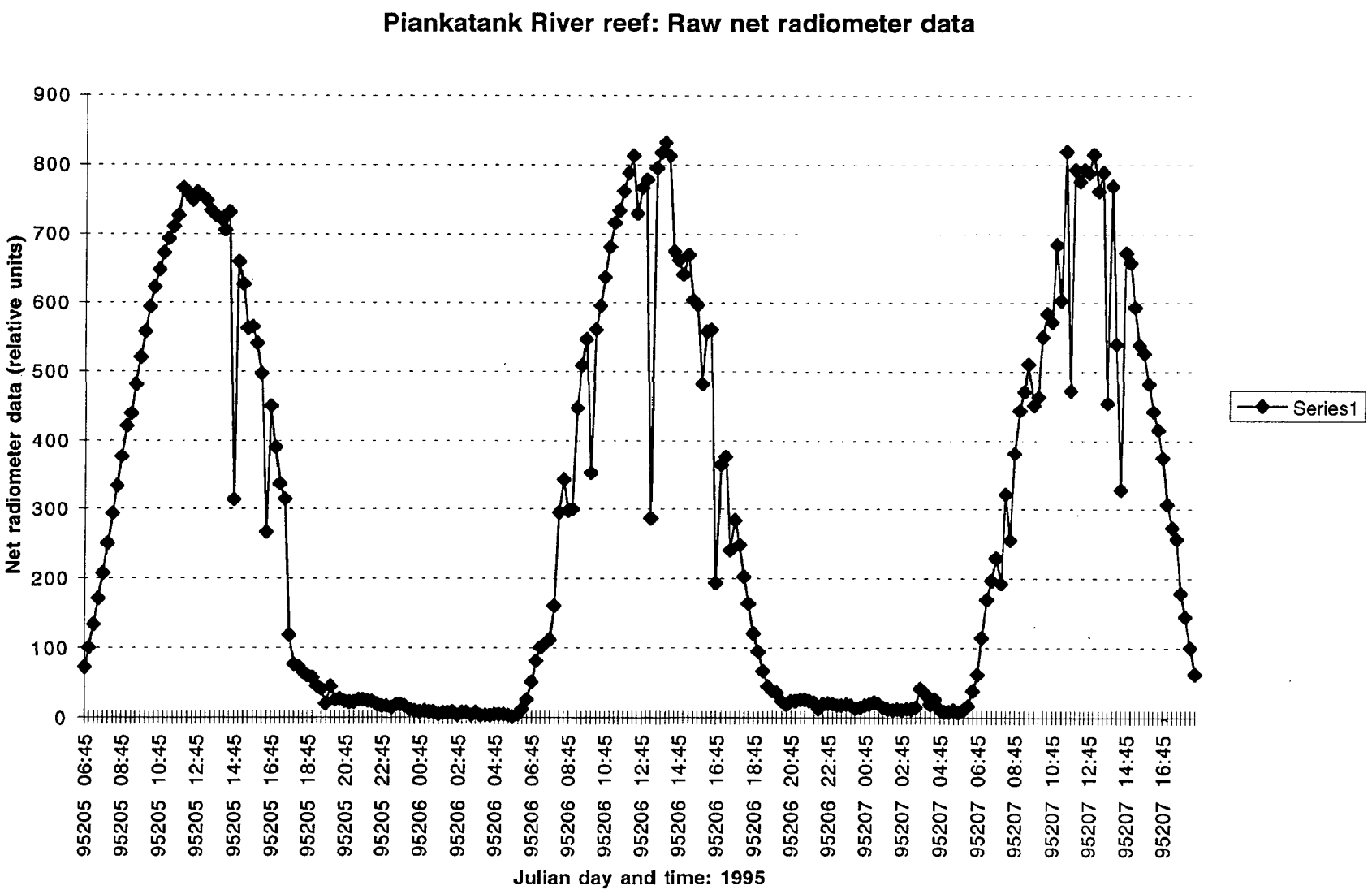


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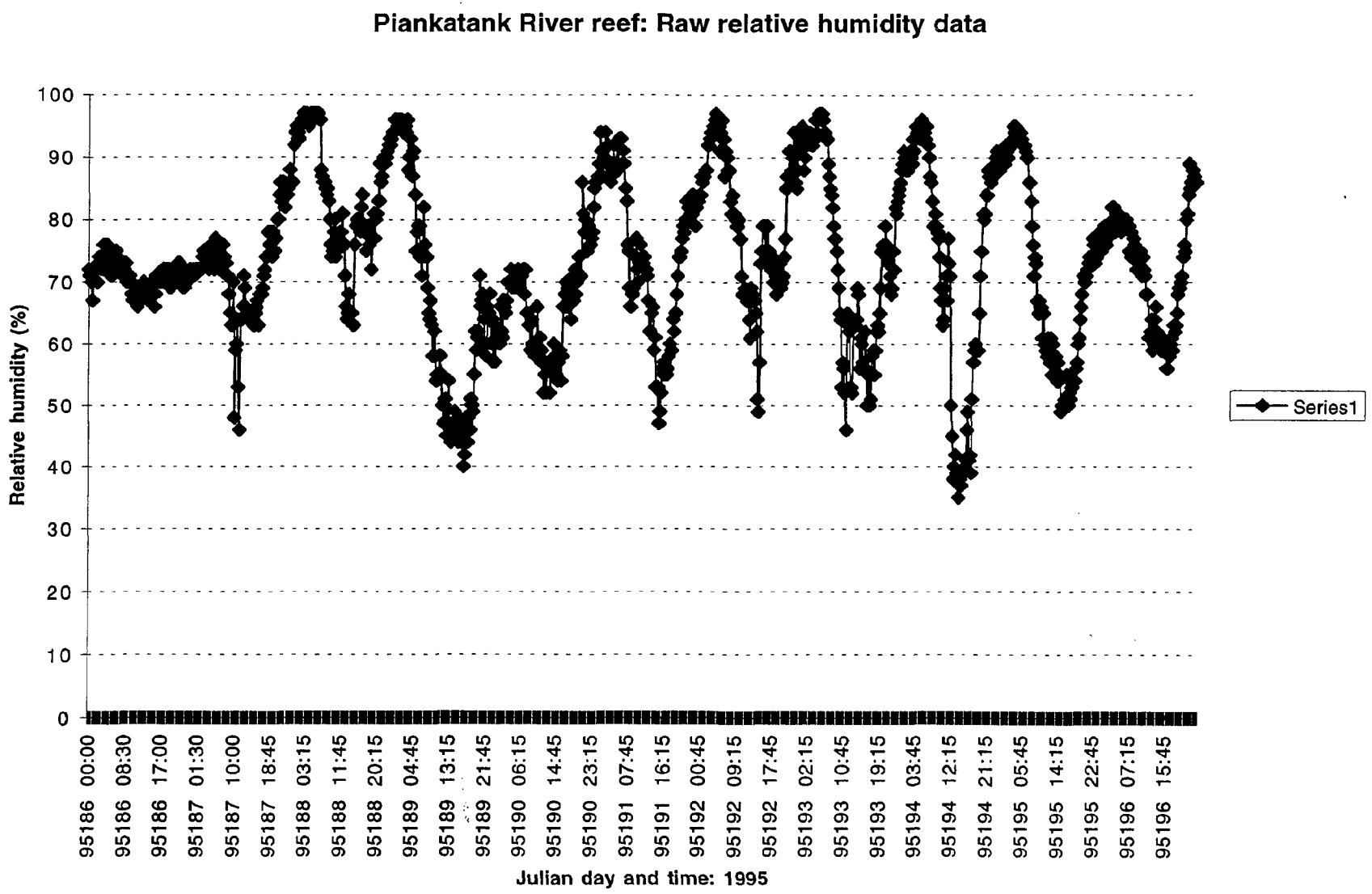
Figure 4: DEQ Instrumentation document



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