Narragansett Bay (NAR) National Estuarine Research Reserve Meteorological Metadata

January – December 2004

Latest Update: **October 12, 2023**

# I. Data Set & Research Descriptors

1. Principal investigator & contact persons:

Contact Persons:

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1. Entry verification

a) Data Input Procedure

The meteorological data are sampled at 5 second intervals under the control of a CDMO data logger program adjusted for this specific site (NBNERR\_4.csi). Data are output to memory in three arrays as appropriate: array 15 stores 15 minute average, sum (total), maximum, and minimum data; array 60 stores hourly average, sum (total), maximum, and minimum data; and array 144 stores daily average, sum (total), maximum and minimum data.

Data are uploaded from the CR10X data logger or storage module via PC208W software supplied by Cambell Scientific to a Personal Computer (IBM compatible) in a comma-delimited format (.DAT). These files are then opened in Microsoft Excel for pre-processing with the EQWin format macro that was developed by the CDMO to reformat the header columns, insert station codes, insert a date column (mm/dd/yyyy), correct the time column format and reformat the data to the appropriate number of decimal places. The pre-processed file is then ready to be copied into the EQWin weather.eqi file where the data are QA/QC checked and archived in a database.

EQWin queries, reports and graphs are used to discover data set outliers (values which fall outside the range that the instrument is designed to measure) and large changes in the data. EQWin is also used to generate statistics, view graphs, create customized queries and reports of the data, cross query the water, weather and nutrient data and finally export the data to the CDMO. Throughout the data review process, anomalous data are investigated and noted in the anomalous data section (see Section 11). If warranted, data were deleted and these corrections are noted in the deleted data section (see Section 12). Monitoring Technician Robin Weber and Research Coordinator Kenny Raposa were responsible for compiling and error checking the 2004 weather data.

b) Data Collection Schedule

For data collection, the CR10X datalogger was programmed to collect data in the following formats:

i) 15-minute data are collected instantaneously for Air Temperature (C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), and Wind Direction (degrees).

ii) 15-minute average, maximum and minimum data are averages of 5-second readings for Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb) and Wind Speed (m/s). 15-minute Precipitation (mm) and PAR (mmol/m^2) data are totaled from 5-second readings.

iii) Hourly average, maximum, and minimum data are averages of 5-second readings for Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), and Wind Direction (degrees). Hourly totals for PAR (mmol/m^2) and Precipitation (mm) are totals of 15-minute readings.

iv) Daily average, maximum and minumum data are averages of 5-second readings for Air Temperature (°C), Relative Humidity (%), Barometric Pressure (mb), Wind Speed (m/s), and Wind Direction (degrees). Daily totals for PAR (mmol/m^2) and Precipitation (mm) are totals of 15-minute readings.

c) Error/Anomalous Data Criteria

EQWin queries, reports, and graphs were based on the following anomalous data criteria:

Air Temp:

- Sample not greater than 50 C or less than –40 C

- 15 min averages not greater than max for the day

- 15 min averages not less than the min for the day

Relative Humidity:

- Sample not greater than 100% or less than 0%

- 15 min averages not greater than max for the day

- 15 min averages not less than the min for the day

Barometric Pressure:

- Pressure not greater than 1060 mb or less than 900 mb

- 15 min averages not greater than max for the day

- 15 min averages not less than the min for the day

Wind Speed:

- Wind speed not greater than 30 m/s

- Wind speed not less than 0.5 m/s for 12 consecutive hours

Wind Direction:

- Wind direction not greater than 360 degrees or less than 0 degrees

Rainfall:

- Precipitation not greater than 5 mm in 15 min

Solar Radiation (LiCor):

- Sample not greater than 5000 millimoles per meter squared (mmol/m^2)

- Sample not less than 0 millimoles per meter squared (mmole/m^2)

Time:

- 15-minute interval recorded (Checked in EQWinformat macro)

For all data:

- No duplicate data

1. Research objectives:

The principal objective is to record long-term meteorological data for Narragansett Bay in order to observe any environmental changes or trends over time. These data are also used in support of both water quality and biological sampling data.

1. Research methods:

The Campbell Scientific weather station samples every 5 seconds to produce both hourly and daily averages of those measurements of air temperature, relative humidity, barometric pressure, rainfall, wind speed and wind direction. An approximate sampling interval was chosen so that the CR10X datalogger would not run out of memory and overwrite data. The short haul modem link was inoperable so the data had to be downloaded periodically from the storage module to a desktop computer housed at the weather station. Sensors on the weather station are inspected periodically for damage or debris. If any is found, it is repaired and/or cleaned. There were no other analyses done on the meteorological data at present.

1. Site location and character:

The NBNERR consists of 4376 acres of diverse estuarine and terrestrial habitats ranging from open estuarine water to salt marshes to forested uplands. The land holdings include 60% of Prudence Island, most of nearby Patience Island, all of Hope Island off the west shore of Prudence Island, and Dyer Island located in the East Passage of Narragansett Bay. The reserve is located close to the geographic center of Narragansett Bay in Rhode Island. The bay has a drainage basin of 1,800 square miles.

The weather station is located on Prudence Island, south of Potter’s Cove (lat: 41 deg 38.335’N, long: 71 deg 20.362’ W). The Wind Sentry and the Temperature and Humidity sensor are located on an aluminum tower approximately 10m in height. The Licor sensor is located on a shorter (3m) aluminum tower. The tipping Bucket Rain gauge is located to the NE away from the tower and the platform. The barometer is located within the housing of the CR10X. All sensors were located in accordance with manufacturer recommendations to avoid the possible influence of shading, wind blocks, etc.

Descriptions of the specific sampling station follows:

The Potter’s Cove weather station is in a grassland area bordering the cove. This location is approximately 425 yards from a water quality monitoring station maintained by the NBNERR since 1995. The water quality in the cove is considered to be adversely affected by boater’s wastes and storm runoff from urban areas. Locating the weather station near this site might help to determine whether meteorological factors further influence water quality within the cove.

1. Data collection period:

Weather data has been collected at the Potter’s Cove weather station since 1992. The current datalogger, a CR10X, was installed February of 2002. Data reported this period was continuously collected throughout the year in 2004.

1. Distribution:

According to the Ocean and Coastal Resource Management Data Dissemination Policy for the NERRS System-wide Monitoring Program,

NOAA/ERD retains the right to analyze, synthesize and publish summaries of the NERRS System-wide Monitoring Program data. The PI retains the right to be fully credited for having collected and processed the data. Following academic courtesy standards, the PI and NERR site where the data were collected will be contacted and fully acknowledged in any subsequent publications in which any part of the data are used. Manuscripts resulting from this NOAA/OCRM supported research that are produced for publication in open literature, including refereed scientific journals, will acknowledge that the research was conducted under an award from the Estuarine Reserves Division, Office of Ocean and Coastal Resource Management, National Ocean Service, National Oceanic and Atmospheric Administration. The data set enclosed within this package/transmission is only as good as the quality assurance and quality control procedures outlined by the enclosed metadata reporting statement. The user bears all responsibility for its subsequent use/misuse in any further analyses or comparisons. The Federal government does not assume liability to the Recipient or third persons, nor will the Federal government reimburse or indemnify the Recipient for its liability due to any losses resulting in any way from the use of this data.

NERR weather data and metadata can be obtained from the Research Coordinator at the individual NERR site (please see Principal investigators and contact persons), from the Data Manager at the Centralized Data Management Office (please see personnel directory under the general information link on the CDMO home page) and online at the CDMO home page [http://cdmo.baruch.sc.edu/](http://cfcdmo.baruch.sc.edu/). Data are available in text tab-delimited format.

1. Associated researchers and projects:

The NERR Water Quality Monitoring Project has a station located nearby at Potter’s Cove. The principal objective of this study is to record long-term water quality data for Narragansett Bay in order to observe any physical changes or trends in water quality over time. Four sites were selected; one to represent an impacted site, two in open water (at both the surface and near-bottom), and one located in a salt marsh tidal creek. The Potter’s Cove site is located on Prudence Islands’ northeastern shore and is impacted by boat traffic and storm runoff from mainland urban and residential areas. Measurements are taken at least every 30 minutes over a roughly two week collecting periods at all water quality monitoring locations throughout the year.

A Physical Oceanographic Real-Time System (PORTS) meteorological station is housed in the NERRS weather station at Potter’s Cove and independently records wind speed, wind direction, atmospheric pressure, and air temperature. This is one of six PORTS meteorological stations in Narragansett Bay. The purpose of PORTS is to support safe and cost efficient navigation. Data is available real-time and the system is managed for quality control.

II. Physical Structure Descriptors

1. Sensor specifications, operating range, accuracy, date of last calibration

Parameter: Temperature

Units: Celsius

Sensor type: Platinum resistance temperature detector (PRT)

Model #: HMP45C Temperature and Relative Humidity Probe

Operating Temperature: -40°C to +60°C

Range: -40°C to +60°C

Accuracy: ± 0.2 °C @ 20°C

Date of Last calibration: 8-15-03 (installed)

Parameter: Relative Humidity

Units: Percent

Sensor type: Vaisala HUMICAP© 180 capacitive relative humidity sensor

Model #: HMP45C Temperature and Relative Humidity Probe

Range: 0-100% non-condensing

Accuracy at 20°C: +/- 2% RH (0-90%) and +/- 3% (90-100%)

Temperature dependence of RH measurement: +/- 0.05% RH/°C

Date of Last calibration: 8-15-03 (installed)

Parameter: Barometric Sensor

Units: millibars (mb)

Sensor type: Vaisala Barocap © silicon capacitive pressure sensor

Model #: CS-105

Operating Range: Pressure: 600 to 1060 mb; Temperature: -40°C to +60°C;

Humidity: non-condensing

Accuracy: ± 0.5 mb @ 20°C; +/- 2 mb @ 0°C to 40°C; +/- 4 mb @ -20°C to 45°C; +/- 6 mb @ -40°C to 60°C

Stability: ± 0.1 mb per year

Date of Last calibration: Unknown

Parameter: Wind speed

Units: meter per second (m/s)

Sensor type: 18 cm diameter 4-blade helicoids propeller molded of polypropylene

Model #: R.M. Young 05103 Wind Monitor

Range: 0-60 m/s (130 mph); gust survival 100 m/s (220 mph)

Accuracy: +/- 2%

Date of last calibration: 7-1-02 (installed)

Parameter: Wind direction

Units: degrees

Sensor type: balanced vane, 38 cm turning radius

Model #: R.M. Young 05103 Wind Monitor

Range: 360° mechanical, 355° electrical (5° open)

Accuracy: +/- 5%

Date of last calibration: 7-1-02 (installed)

Parameter: LI-COR Quantum Sensor

Units: mmoles m-2 (total flux)

Sensor type: High stability silicon photovoltaic detector (blue enhanced)

Model #: LI190SB

Light spectrum waveband: 400 to 700 nm

Temperature dependence: 0.15% per °C maximum

Stability: <±2% change over 1 yr

Operating Temperature: -40°C to 65°C; Humidity: 0 to 100%

Sensitivity: typically 5 µA per 1000 µmoles s-1 m-2

Date of last calibration: 6-11-03 (installed)

Parameter: Precipitation (specify if heated rain gauge)

Units: millimeters (mm)

Sensor type: Tipping Bucket Rain Gauge

Model #: TE525

Rainfall per tip: 0.01 inch

Operating range: Temperature: 0° to +/- 50°C; Humidity: 0 to 100%

Accuracy: +/- 1.0% up to 1 in./hr; +0, -3% from 1 to 2 in./hr; +0, -5% from 2 to 3 in./hr

Date of Last calibration: 2-6-02

Storage Module

Model #: SM192

Storage capacity: 192,896 bytes

Operating range: Temperature: -35° to +65°C

Processor: Hitachi 6303

Baud rates: 300, 1200, 9600, 76800

Memory type: user selectable for either ring style (default) or fill and drop.

Power requirements: 5 +/-0.4 VDC @ 100 mA

Storage Module

Model #: SM4M

Storage capacity: 2 million low-resolution data values

Program storage: stores up to 8 programs with a total capacity of 128 KB

Processor: Hitachi H8S

Operating system: 64 KB, flash memory based, user downloadable

Operating range: Temperature: -35° to +65°C

Baud rates: 9600, 76800

Memory type: user selectable for either ring style (default) or fill and drop.

Power requirements: 5 +/-0.3 VDC @ 100 mA

Campbell Scientific CR10X Wiring Panel has 128K of flash memory (EEPROM), in which it stores the operating system and its program (that it uses to run the weather station). Additionally, there is 128K of SRAM, which it uses to run the program and store its measurements and for final data storage.

1. Coded variable indicator and variable code definitions:

Sampling station: Sampling site code: Station code:

Potter’s Cove PC narpcmet

1. Anomalous/Suspect Data:

**Arrays:**

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at [www.nerrsdata.org/get/landing.cfm](http://www.nerrsdata.org/get/landing.cfm) throughout the fall of 2022.

January 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

Negative PAR values occurred on 1/6/04 at 19:30 and 1/28/04 at 3:15 which were outside the range of this sensor. Although out of range, the data was retained because it is suspected that slight sensor drift may have contributed to this value.

February 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

March 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

April 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

Rainfall in excess of 5 mm during a 15 minute sample occurred on 4/13/04 at 21:15. This data was considered to be valid and was retained in the data set.

May 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

Rainfall in excess of 5 mm during a 15 minute sample occurred on 5/23/04 at 19:15. This data was considered to be valid and was retained in the data set.

June 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

Rainfall in excess of 5 mm during a 15 minute sample occurred on 6/19/04 at 4:30, 5:45 and on 6/26/04 at 17:45. These data were considered to be valid and were retained in the data set.

July 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

Rainfall in excess of 5 mm during a 15 minute sample occurred on 7/19/04 at 5:00. This data was considered to be valid and was retained in the data set.

August 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

Rainfall in excess of 5 mm during a 15 minute sample occurred on 8/15/04 from 7:15 through 8:00. These data were considered to be valid and were retained in the data set.

September 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

October 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

Rainfall in excess of 5 mm during a 15 minute sample occurred on 10/16/04 at 1:00. This data was considered to be valid and was retained in the data set.

November 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

December 2004:

Negative PAR data have been observed during the night; small negative values are within range of the sensor and are due to normal errors in the sensor and the CR10X Datalogger. The maximum signal noise error for the Licor sensor is +/- 2.214 mmoles/m2 over a 15 minute interval. These data have been retained.

1. Deleted data:

**Arrays:**

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at [www.nerrsdata.org/get/landing.cfm](http://www.nerrsdata.org/get/landing.cfm) throughout the fall of 2022.

January 2004:

Anomalous PAR data were deleted on 1/28/04 at 4:00 in both the 15 minute and hourly arrays. The 15 minute data (-34.5 mmole/m2) clearly impacted the hourly total (-37.2 mmole/m2) and both values were considered suspect. The daily total PAR value was retained although this value may also be reduced due to this anomaly.

February 2004 – July 2004:

None

August 2004:

Anomalous PAR data were deleted on 8/12/04 at 22:00 in both the 15 minute and hourly arrays. The 15 minute data (-13.3 mmole/m2) clearly impacted the hourly total (-13.9 mmole/m2) and both values were considered suspect. The daily total PAR value was retained although this value may also be reduced due to this anomaly.

September 2004:

None

October 2004:

For unknown reasons Daily values (array 144) were recorded at 01:00 time stamps on the following dates: 10/9, 10/11, 10/12, 10/15, and 10/16 these 144 Arrays were deleted. There is no known explanation for this anomaly but it may be related to attempts to program the telemetry unit during this time period. Although the telemetry equipment had been installed, it was not yet functional, and various programming configurations were being tested to correct this problem.

November 2004:

None

December 2004:

Low wind values (< 0.5 m/s) persisted for a period of many days. It is suspected that the bearings failed at this time. The sensor was replaced at a later date when weather permitted climbing of the tower. All wind speed data (15 minute, hourly, and daily) were deleted from 12/28/04 at 11:15 through the end of the year.

12/28/2004 11:15, 12:00, 13:15, 13:45-14:30, 15:15, 16:15-24:00

12/29/2004 00:15-24:00

12/30/2004 00:15-24:00

12/31/2004 00:15-24:00

1. Missing data:

**Arrays:**

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at [www.nerrsdata.org/get/landing.cfm](http://www.nerrsdata.org/get/landing.cfm) throughout the fall of 2022.

Data are missing due to equipment or associated specific probes not being deployed, equipment failure, time of maintenance or calibration of equipment, or repair/replacement of a sampling station platform.  For more details on deleted data, see the Deleted Data Section (12.).  If additional information on missing data is needed, contact the Research Coordinator at the reserve submitting the data.

Note: Telemetry equipment hardware was installed at the weather station on 8/20/04. Data are missing for extended periods from that date until 10/15/04 while various programming and wiring configurations were tested. Although the telemetry equipment became marginally functional on 10/15/04, data would periodically be missing from the data set. This was considered to be the result of a programming error in the telemetry unit software, as this software would remove data that it flagged as outlier values. An unfortunate consequence was large gaps in the data. Data for the period 11/2/04 through 12/27/04 were not recoverable except through the direct download of data archived on the associated website. Data are missing from 15 minute, hourly, and daily data arrays. Unfortunately, the validity of the hourly and daily recorded values can not be confirmed.

1. Other Remarks/notes

**On 10/12/2023 this dataset was updated to include embedded QAQC flags for anomalous/suspect data.** System-wide monitoring data beginning in 2007 were processed to allow for QAQC flags and codes to be embedded in the data files rather than detailed in the metadata alone (as in the anomalous/suspect, deleted, and missing data sections above). Prior to 2007, rejected data were deleted from the dataset so they are unavailable to be used at all, but suspect data were only noted in the metadata document. Suspect data flags <1> were embedded retroactively in order to allow suspect data to be easily identified and filtered from the dataset if desired for analysis and reporting purposes. No other flags or codes were embedded in the dataset and users should still refer to the detailed explanations above for more information.

**Arrays:**

During 2022 all pre-2007 weather data were revisited by the CDMO. Historically those datasets included 15 minute, hourly (60), and daily data arrays (144). As directed by the NERRS Data Management Committee, the CDMO removed the hourly and daily data arrays leaving only the 15 minute data to make the entire NERRS SWMP weather dataset consistent in its reporting. All references to the 60 and 144 arrays were left in the metadata document as they may still provide valuable information, but users should be aware that they are largely no longer relevant. The updated datasets were uploaded to the database and made available through the various data applications at [www.nerrsdata.org/get/landing.cfm](http://www.nerrsdata.org/get/landing.cfm) throughout the fall of 2022.

**Precipitation:**

During the initial years of NERRS SWMP weather data collection the CR10X programming was inconsistent in how precipitation values were recorded. For most reserves, zeros were not recorded when rainfall had not occurred between 2001-2003, instead no rainfall was represented by a blank cell. The CDMO verified which datasets were impacted by this issue for the 2001-2006 datasets and inserted zeros when the metadata indicated that no precipitation occurred and data were not missing for other reasons. In some cases, zero values for precipitation data were evaluated and removed where the metadata confirmed that no rainfall should have been in the dataset. The pre-2007 data did not go through a thorough QAQC process again at that time (in addition to previous QAQC); however, if discrepancies were noticed between what was documented in the metadata and what was in the dataset, additional updates may have been made. The updated datasets were uploaded to the database and made available through the various data applications at [www.nerrsdata.org/get/landing.cfm](http://www.nerrsdata.org/get/landing.cfm) throughout early 2023.

**During precipitation edits mentioned above it was noted that the 01/01/2004 00:00 line of data was missing. Those data were found in an archived raw file and added back to the dataset.**

Note 1: Although wind speed often drops below 0.5 m/s, these low values are not recorded in the anomalous/suspect data section unless they persist for more than 12 consecutive hours. Short periods of calm air are not uncommon for this area, occurring almost daily and most frequently during the tide change.

Note 2: Rainfall amounts in excess of 5 mm for a 15 minute total, although checked, are generally not considered to be anomalous records. This event may often occur during intense storms.

Note 3: Many of the sensors were past due for calibration and/or replacement by the end of the year. The weather station building was scheduled to be replaced in late summer or fall of 2004. The replacement of sensors was expected to coordinate with the installation of the new building. Unfortunately, continued delays in construction planning had postponed the sensor replacement beyond an appropriate time period. Frozen ground then made sensor replacement impossible as much of the wiring is buried in underground conduit.