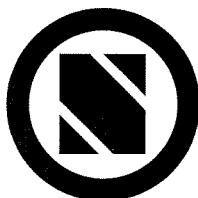

NU-METRICS®

A QUIXOTE COMPANY

UNIONTOWN, PA 15401

Traffic Recording System
via Permanent Count Station (PCS) Systems

PRELIMINARY



nu-metrics®

A QUIXOTE COMPANY

SEPTEMBER 2003

OPERATIONAL MANUAL: HARDWARE

Prepared by the:
Engineering Department

Nu-Metrics, Inc.

Authorized for Distributors, Administrator and Installers Only
Other requests for this document shall be referred to Nu-Metrics, Inc.

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DISCLAIMER

An attempt has been made to insure the accuracy of the material in this manual. It is supplied without warranty or representation of any kind. Nu-Metrics assumes no responsibility and shall have no liability of any kind arising from the use of this publication or the material contained herein. Nu-Metrics reserves the right to add, delete and/or change the material at any time. Since the conditions or methods of installation, operation, use and maintenance of this equipment are beyond its control by following these procedures, Nu-Metrics does not assume responsibility and expressly disclaims liability of loss, damage, or expense arising out of the installation, operation or maintenance not performed by a Nu-Metrics authorized field technician.

OBJECTIVE OF THIS GUIDE

The primary objective of this guide is to introduce the major components of the Permanent Count Station (PCS) manufactured by Nu-Metrics and identify their primary functions. The Permanent Count Station (PCS) is a wireless system that can count vehicle volume, speed, and length as well as determine the surface conditions for the roadway, and relay this information to a polling station. Located in areas of interest, Departments of Transportation (DOTs), Military Bases, local public authorities, airports, train stations, manufacturers, event halls, and speedways can all track the traffic and weather information as it relates to their particular location.

After completing this guide one should be able to identify each component of the PCS system, identify its purpose, know its location within the system and be able to conduct some basic troubleshooting.

SAFETY CONSIDERATIONS

Important notations regarding personal and equipment safety are denoted by the following headings:



NOTE: Used to call attention to a special feature or instruction that must be followed in order for equipment to operate correctly.



CAUTION: Used to call attention when concern for potential equipment damage or personal injury may occur.



WARNING: Used to call attention when there is a serious concern for personal injury or death unless safety procedures are followed.

SYSTEM SAFETY PRECAUTIONS

The Nu-Metrics Permanent Count Station (PCS) has been programmed, tested and delivered after passing factory quality testing. Any attempt to modify equipment could result in the loss of programmed settings and render the system inoperable.



CAUTION: Never replace or substitute systems components with third party devices. Only replace components with Nu-Metrics authorized equipment.



WARNING: The electrical power connection must be installed by a certified electrician because of the potential for electrical shock.



WARNING: Avoid power lines! Use extreme caution when performing overhead work. Contact with power lines or other circuits could cause serious injury.

When following the instructions in this guide to install, connect or repair any equipment, use extreme caution to avoid contact with overhead power lines, lighting and power circuits. Contact with power lines, lighting and circuits may be fatal.

COMPLIANCE WITH FCC PART 15 CLASS A

This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference when this equipment is operated in a commercial installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

COMPLIANCE WITH NATIONAL ELECTRICAL CODE (NEC)

This manual contains some instructions on how to make the installation in compliance with the NEC. Any wiring should either be placed in a conduit that is sunlight resistant and conforms to Article 351 of the NEC, or the wiring should be type UF cable rated sunlight resistant. If additional local installation codes apply, contact local inspection authorities. Before installing the Wireless System, check the electrical code guidelines in your area.

ELECTRICAL GROUNDING

The outdoor equipment used in the Wireless Groundhog System is required to comply with local installation codes and the appropriate sections of the NEC, especially Article

810 and 820. These codes require proper grounding of the metal structure of the outdoor tower, tripod, antenna mast and any connecting cable at a point where it enters a building. At the point of entrance, the installation contractor must provide a connection to the nearest properly grounded rod, steel structures or any other metallic surface per NEC Article 250. In addition, the installer must follow any local codes or regulations when connecting ground circuits.



CAUTION: The PCS must be properly grounded for protection from lightning strikes and power surges.

SYSTEM OVERVIEW

The Groundhog Permanent Count Station (PCS) provides accurate and essential data for effective traffic analysis, control and management. The PCS system consists of three key components to provide traffic data. These three components are the Groundhog roadway sensor which is installed in each traffic lane, the Radio Frequency Module (RFM) located at the polling location and the data collection computer located at the office. The RFM receives radio messages from Groundhogs and processes the information for transmission to a central location where the information is displayed. Typically, the traffic data is passed via phone lines, but cellular, wireless, fiber optic and microwave communication systems may also be used.

GLOSSARY OF TERMS

85th PERCENTILE – 85% of the vehicles counted are slower than this speed.

AADT – Average Annual Daily Traffic, normalizes traffic data to 24 hours in a standard day.

BIN – Storage location for counts of a specific speed and classification designation. When measuring traffic, the Groundhog determines the speed and length of each vehicle. The Groundhog then sums the counts for periods into bins.

FREQUENCY HOPPING – Spread spectrum transmission method that switches the transmission frequency based on a random pattern.

GROUNDHOG® - Wireless in-pavement sensor.

HEADWAY – Interval (in time) between individual vehicles measured from bumper to bumper.

LBU – Local Base Unit (synonymous with the components at the polling location).

LENGTH – For a Groundhog, the amount of time the magnetic disturbance of a vehicle is present multiplied by the vehicle's speed. This is the length of the vehicle.

MPT – Maintenance and Protection of Traffic (MPT) is a plan for providing safety to motorist and workers when closing a normally open lane of traffic.

PERCENT OCCUPANCY – This is the ratio of the time a vehicle is over the sensor to the study time period. i.e. If the period were 15 minutes and there were vehicles over the sensor for a total of 3 minutes out of the period, then the % occupancy would be $3/15 = 20\%$.

PERIOD – The interval over which data is summarized inside the Groundhog®.

RF – Radio Frequency

RFM – Radio Frequency Module, the device that gathers and decodes Groundhog messages, stores them to local memory.

SPREAD SPECTRUM - Radio transmission method that spreads the signal over a wide bandwidth.

VMI – Vehicle Magnetic Imaging, a method of using a very small magnetic sensor to measure the magnetic disturbance of a vehicle passage through the earth's magnetic field.

WDM – Wireless Data Management® (Nu-Metrics' communication software)

FUNCTIONAL DESCRIPTIONS

This section provides a broad functional description of the PCS.

The Permanent Count Station is a system of components used for traffic management applications, although many variations have been used for:

- Airports and Toll Booths
- Parking Lots and Garages
- Malls and Shopping Centers
- Military Bases and Border Crossings
- Stadiums and Casinos
- Construction Areas

The description in this section describes a standard PCS used for highway application where the primary power source is 120VAC electrical power, and the primary communication is dial-up via telephone lines. The key components of this PCS system are the roadway sensor, antenna, RFM, and landline modem.

GROUNDHOG® MODEL G-4 IN-PAVEMENT SENSOR

The beginning of communication and the most significant device in the PCS system is the Groundhog. The Groundhog Model G-4 is a traffic monitor that is installed into the pavement for analysis of an individual lane. The G-4 is a battery operated device that is controlled by a single microprocessor. The low power microprocessor controls all traffic monitoring functions, data storage functions, and Spread Spectrum Radio Transmission.

Traffic detections and measurement are accomplished by Vehicle Magnetic Imaging (VMI) technology. This measures the magnetic influence of a motor vehicle disturbing the Earth's magnetic field immediately above and around the unit. Each Groundhog accumulates data pertaining to the vehicle count, speed classification, length classification, and percentage of road occupancy. The microprocessor compresses the data in packets and transmits the stored information for each programmed period. The period is the reoccurring time for data collection. For example, setting the Groundhog for a 15 minute periods will group all traffic data into bins and transmit the information to the RFM 4 times per hour. (**The RFM must be located within 600 feet of each Groundhog that receives a data packet for every Groundhog at the site**). The period must be preprogrammed and is configurable from 1 to 120 minutes.

The G-4 traffic analyzer employs Spread Spectrum Radio Frequency (RF) data transfer technology in the 908-922 MHz frequency range. Spread Spectrum Technology allows multiple Groundhogs to transmit simultaneously without interference. When a Groundhog transmits stored data, it sends three redundant data packets to the RFM.

MAGNETIC SENSING

Magnetic sensing used by the Groundhog detects disturbances in the Earth's magnetic field. These disturbances create a signature pitch. Based on this signature, the length of a vehicle can be determined. By using two sensors within a single Groundhog, an algorithm is used to compare two signatures and the space between the pitches to determine speed.

CALCULATING CHEMICAL INDEX (OPTION)

Chemical indexing is achieved by measuring the conductivity of substances on the sensor surface. For instance, water can conduct an electrical current. In the Groundhog's case, the sensor measures the conductivity of a solution on its surface. Salt water will be more conductive than purified water. Other chemicals added to water change the conductivity of the solution. This can be determined through algorithms in software what these levels mean to the end user. Therefore, a Department of Transportation (DOT) can monitor what effect an anti-icing solution is having on the road surface. Combine this information with road temperature and the end user can determine what action may need to be taken.

SENSING ROAD TEMPERATURE (OPTION)

Road temperature is measured by a small probe mounted on the top or side of the Groundhog canister. The probe is mounted onto the circuit board of the Groundhog series G4 via a small snap on connector. Located on the board is a small thermostat responsible for measuring temperature.

VEHICLE COUNT

The Groundhog measures traffic volume and transmits this information to the RFM every period. The volume transmitted from the unit is a running total of raw traffic count.

SPEED CLASSIFICATION

The Groundhog measures vehicle speeds and transmits this information to the RFM every period. Speed classification is reported in predefined speed bins representing a range of speeds. For example, the first speed bin represents vehicles traveling between 0 and 10 mph. The Groundhog also calculates the average speed for all vehicles classified for the period. The Groundhog carries a total of twelve speed bins and custom bins are available upon request.

LENGTH CLASSIFICATION

The Groundhog measures vehicle length and transmits this information to the RFM every period. Length classification is based on vehicle length and stored in bins similar to the speed classification. The length bins are used to group vehicles into six predefined length ranges. For example, length bin one stores the number of vehicles that are measured by the Groundhog between 0 and 20 feet long. Length bin 2 represents the number of vehicles classified within 21 to 28 feet. Custom bins available upon request.

OCCUPANCY

The Groundhog determines a percentage of the reporting period when vehicles were over the sensor. The percentage is called occupancy and it is based on vehicle presence. The Groundhog measures the amount of time each vehicle is over the sensor. At the end of the report period, the total time each vehicle was over the sensor is divided by the total time in the period. In slow traffic conditions, the occupancy will be higher even though the number of vehicles that passed over the counter is relatively low. When vehicle speeds are high, the percentage of occupancy may be quite low even though the number of counts is high. This data field is also used by the system to mark a unit that misses a period message. An occupancy percentage over 100 indicates no data packet was received for that sensor. Normally, this out of tolerance percentage is 128.



NOTE: When an RFM reports a Groundhog message with an occupancy reading of greater than 100, this means that the period message from that Groundhog was not received by the RFM.

RFM RADIO FREQUENCY MODULE (RFM)

The Radio Frequency Module (RFM) is the central processing unit for the PCS system. Groundhog messages can be sent simultaneously to a single RFM from up to 16 Groundhogs. The data that is received by the RFM is processed for accuracy, organized into bins, prepared for communication and sent out via the RFM's serial port. Normally, a modem is attached to the serial port and polled from a central location. The RFM can store several hours of data from Groundhogs before its memory becomes full. For example, if the RFM is not frequently polled by a modem or other device, the oldest data will be overwritten until the buffer is relieved. An Extended Memory Module (EMM) is used for an application that requires long-term data storage periods.



CAUTION: Continually poll the RFM to retrieve its data to avoid quick memory fill resulting in a data gap.

The RFM is typically located on the side of the road, mounted to a pole, approximately 20 feet high. The RFM, power supplies, and surge protection devices are mounted and contained inside an equipment enclosure. The antenna at this location is designed to communicate with the Groundhog sensors. The RFM's receiver has its own

microprocessor to handle the complexity associated with direct sequence decoding. Upon receipt of valid data from transmitting Groundhogs, the information is stored and transmitted to the ultimate destination (traffic headquarters, extended memory module, etc.).

The RFM is responsible for the following functions:

- Receiving the radio information from the Groundhog
- Processing the information and giving the data a timestamp
- Storing the data (With a system of 4 Groundhogs reporting in 5 minute periods the RFM can store approximately 24 hours of data. An EMM or RPU can be added to store more information.)
- Uploading requested data to a polling computer through a modem

TYPES OF RFMs (Radio Frequency Modules)

The RFM can be built with 915 MHz or a 2.45 GHz radio. The RFM can be equipped to receive and send messages. A transmitter can be mounted to a circuit board if the RFM must relay information to another RFM. When requesting replacement equipment, it is important that the installer know which model is required. For ease of installation Nu-Metrics will program the appropriate unit and ship it to the installer.

COMPONENTS OF THE RFM

As previously mentioned the RFM will have a radio receiver with the option of a radio transmitter. Additional physical makeups are the antenna connection, modem data port, ID-3 power port, primary power and the data link. The RFM stores data in a RAM-like memory chip. Once power is stopped or removed from the RFM, all the data contained will be lost but the unit's program settings remain.

INSTALLATION OF THE RFM

Installation of the RFM is simple. The unit's electronics are protected by a hardened metal housing that can be handled easily. An incorrect connection to the RFM is unlikely with the exception of the Primary and Auxiliary power ports. However, the cabinet wiring is labeled to rule out any confusion. The only major consideration when replacing an RFM is relaying the proper location and unit information to Nu-Metrics to receive proper replacement equipment. This will ensure that Nu-Metrics programs the unit according to site specifications.

IMPORTANT!

Once the RFM is polled from the polling computer, the data CAN NOT be retrieved again if lost during the connected download. Also, if power is lost to the RFM at any point, all data will be lost.

MEMORY STORAGE LIMITS

When RF messages are transmitted from Groundhog roadway sensors, the information is received, processed and stored by the RFM. The RFM uses 64 kilobytes of RAM for storing data from each Groundhog. When a polling computer connects to the RFM from a phone line or other communication method, the data is downloaded to the polling computer. However, if the polling computer fails to connect with the RFM, the RFM's memory begins to fill up. The memory capacity of the RFM depends on the period intervals and the number of Groundhogs for a particular location. **The table below** shows the relationship between the number of Groundhogs and the polling period for several configurations and how long data can be stored by the RFM and/or Extended Memory Module (EMM). For example, if four Groundhogs were installed at fifteen minute periods, the RFM would retain 64 hours of data. After 64 hours, the newest data would start replacing the oldest data.

Also, it is important to recognize the factors that affect the data storage of the RFM. Always configure the polling software to connect with the RFM and download information before the data is replaced. Use **the table below** to help determine appropriate polling intervals. Since the RFM uses RAM to store data, a continuous power source must be applied, or data may be lost. Solar and backup batteries are options for systems requiring a higher level of data consistency. In other applications, an EMM and compact flash card can be used to extend the storage limits of the RFM to days, months, or years.

Memory Storage Limits				
Period (min)	Number of Groundhogs®	Hours of Storage (RFM Only)	Days of Storage (w/EMM & 8MB Compact Flash Card)	Days of Storage (w/EMM & 32MB Compact Flash Card)
1	1	9.5	34	137
	2	6.8	23	91
	4	4.3	14	55
	6	3.1	10	39
	8	2.5	8	30
5	1	47.6	171	683
	2	33.8	114	455
	4	21.3	68	273
	6	15.6	49	195
	8	12.3	38	152
10	1	95.2	341	1365
	2	67.5	228	910
	4	42.7	137	546
	6	31.2	98	390
	8	24.6	76	303
15	1	142.9	512	2048
	2	101.3	341	1365
	4	64.0	205	819
	6	46.8	146	585
	8	36.9	114	455

Memory Storage Reference Table

SOFTWARE

This page covers the installation of the Wireless Data Management (WDM) software designed to collect, store and display information from the PCS System.

The PCS system software is comprised of several modules, each providing a different function. Each module performs a unique task and functions independently.

THE MODULES INCLUDED ARE:

Communication Module: An application that communicates to the Count Station equipment, collecting and storing data.

Viewer Module: An application that views traffic data.

Configuration Module: An application that configures sensor information reported to each site.

OPTIONAL MODULES AVAILABLE ARE:

Diagnostics Module: An application that communicates with field equipment, diagnoses problems and verifies communication.

Notifications Module: An application to notify the user of system warnings or alerts.

MINIMUM REQUIREMENTS

- Pentium 233 MHz Processor
- 128 MB RAM
- 5 GB Hard Drive
- Video Card 800 x 600 with 256 Colors

INSTALLATION OF WDM

- Insert the CD
- Select Start / Run
- Select Browse to locate the CD ROM Drive
- Select Setup.exe
- Select OK
- Follow the Instructions on the Screen

RUNNING WDM

- Select Start / Programs / Wireless Data Management
- Select the Appropriate Module

TROUBLESHOOTING PERMANENT COUNT STATION

Tools Required: Analog telephone Voltmeter

THIS CHECKLIST APPLIES TO A SITE POWERED BY AC POWER!

1. CHECK POWER STATUS OF THE CABINET

- Verify the site has AC electrical power.
- Verify the circuit break has not tripped.
- Reset the circuit breaker, switch OFF then back ON.
- Check the green status LED is ON for the surge arrestor (the surge arrestor has a bright yellow front with an LED in the center).
- Use a voltmeter to check the AC power.
- Place the voltmeter test leads across the 2 terminals where the label reads "connect incoming power here", the voltage should be between 100 and 130 volts.
- If the AC voltage is not between 100 and 130 volts, the AC is not functioning properly. Consult a certified electrician to troubleshoot the malfunction.
- When the AC power is between 100 and 130 volts, it is working properly.
- Verify the equipment cabinet has DC power.
- Locate the 4 position terminal block near the center of the back panel.
- Use a voltmeter to check the DC voltage level.
- Place the voltmeter test leads across the two terminals where the red and black wires are connected. (Be sure to change your voltmeter from AC to DC voltage)
- The voltage should be between 11 and 13 volts.

2. CHECK RFM STATUS

- View the RFM and verify that the power LED is ON.
- Check the modem connection to make sure that it is securely connected to the port marked (Data B).
- Check antenna connection to verify it is tight.
- Check code in the RFM (technician must be familiar with this operation) and verify correct code for the site number.

3. CHECK AND VERIFY CURRENT PHONE LINE STATUS

- Check for dial tone.
- Locate the modem inside the equipment enclosure.
- Plug a standard analog telephone into the port marked "PHONE" on back of modem.
- Listen for a dial tone and/or excessive noise conditions (clear tone with no buzzing or crackling noise on the line).

4. CHECK THE ANALOG DATA MODEM

- Check the connection from the modem to the RFM (make sure the connection cable is securely fastened to the modem).
- Check the power connection to the modem (make sure the connection is securely fastened to the modem).
- Verify the power button on the modem is "pushed in" (this is the ON position).
- Check for status LED's on the front of the modem.
- While the modem is idle, verify that are three LED's are lit. The LED's marked "TR" (red), "CS" (red), and "MR"(green) are needed for proper operation.

LIMITED WARRANTY

GENERAL COVERAGE:

This Nu-Metrics system, but not items or computer products covered by other manufacturers warranty, is warranted to the owner for a period of one year from the date of original purchase against defects in manufacture or workmanship. This limited warranty is given by Nu-Metrics and not by the distributor or representative from whom the equipment was purchased.

WHAT NU-METRICS WILL DO:

If this system develops a defect in manufacture or workmanship within the one year period, it will be repaired or replaced at our option, providing you supply proof of purchase, date of purchase, and cover all cost of shipping and handling. Nu-Metrics return policy is a 25% restocking fee if returned within 30 days. All equipment must be received in "new" condition, in the original shipping containers, and an RMA (Return Merchandise Authorization) Number must be obtained from Nu-Metrics Customer Service before any return is made.

THE LIMITED WARRANTY DOES NOT COVER:

Nu-Metrics will not repair defects or failures related to servicing not performed by Nu-Metrics or a Nu-Metrics Authorized Service Center. Warranty service will not be provided if your instrument or equipment shows evidence that it has been disassembled, tampered with, damaged, misused, abused, or altered. Nu-Metrics will not provide any warranty service and is not responsible for damages or personal loss due to improper installation or operation. Warranty does not cover vandalism, Acts of God, such as but not limited to lightning damage. Loss of programming, software or data is not covered by this warranty.

LIMITATION OF LIABILITY:

In no event will Nu-Metrics or its developers, directors, officers, employees or affiliates be liable to you for any consequential, incidental or indirect damages (including damages for loss of business profits, business interruption, loss of business information, and the like) arising out of the use of or inability to use the software or hardware or accompanying written materials, even if Nu-Metrics or an authorized Nu-Metrics representative has been advise of the possibility of such damages. Because some states do not allow the exclusion or limitation of incidental or consequential damages, the above limitation may not apply to you.

LIMITED WARRANTY ON MEDIA:

Nu-Metrics warrants the disks on which the software is recorded to be free from defects in materials and faulty workmanship under normal use for a period of ninety (90) days from the date of delivery as evidenced by a copy of the sales invoice. Nu-Metrics will, at its option, replace the diskette at no charge to you, provided you return the faulty diskette with a copy of the sales invoice to Nu-Metrics or an authorized Nu-Metrics Distributor or Representative. Nu-Metrics shall have no responsibility to replace or refund the purchase price of a diskette damaged by accident, abuse, or misapplication. Any implied warranties on the disks, including implied warranties of merchantability and fitness for a particular purpose, are limited in duration to 90 days from the date of delivery.

DISCLAIMER OF WARRANTY ON SOFTWARE:

Nu-Metrics software is provided "as is" without warranty of any kind, and Nu-Metrics expressly disclaims all implied warranties, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Nu-Metrics does not warrant, guarantee, or make any representations regarding the use or the results of the use of the software or any accompanying written materials in terms of their correctness, accuracy, reliability, currentness, or otherwise. The entire risk as to the results and performance of the software and written materials is assumed by the user. Nu-Metrics does not warrant that the software will work correctly in your multi-user or network environment. If the software is defective, you (the user), and not Nu-Metrics or its dealers, distributors, agents, or employees, assume the entire cost of all necessary servicing, repair, or correction. Some states do not allow the exclusion of implied warranties, so the above exclusion may not apply to you.

SERVICE OF YOUR EQUIPMENT:

If your equipment should ever need servicing, please call for a Return Merchandise Authorization (RMA) Number (please have serial numbers and purchase dates available) and then send it, (freight prepaid), to:

Nu-Metrics, Inc.
ATTN: Customer Service Dept.
518 University Drive
Uniontown, PA 15401 U.S.A.

Phone: 724-438-8750
Fax: 724-438-8769
www.nu-metrics.com

SELECTING A LOCATION



WARNING!

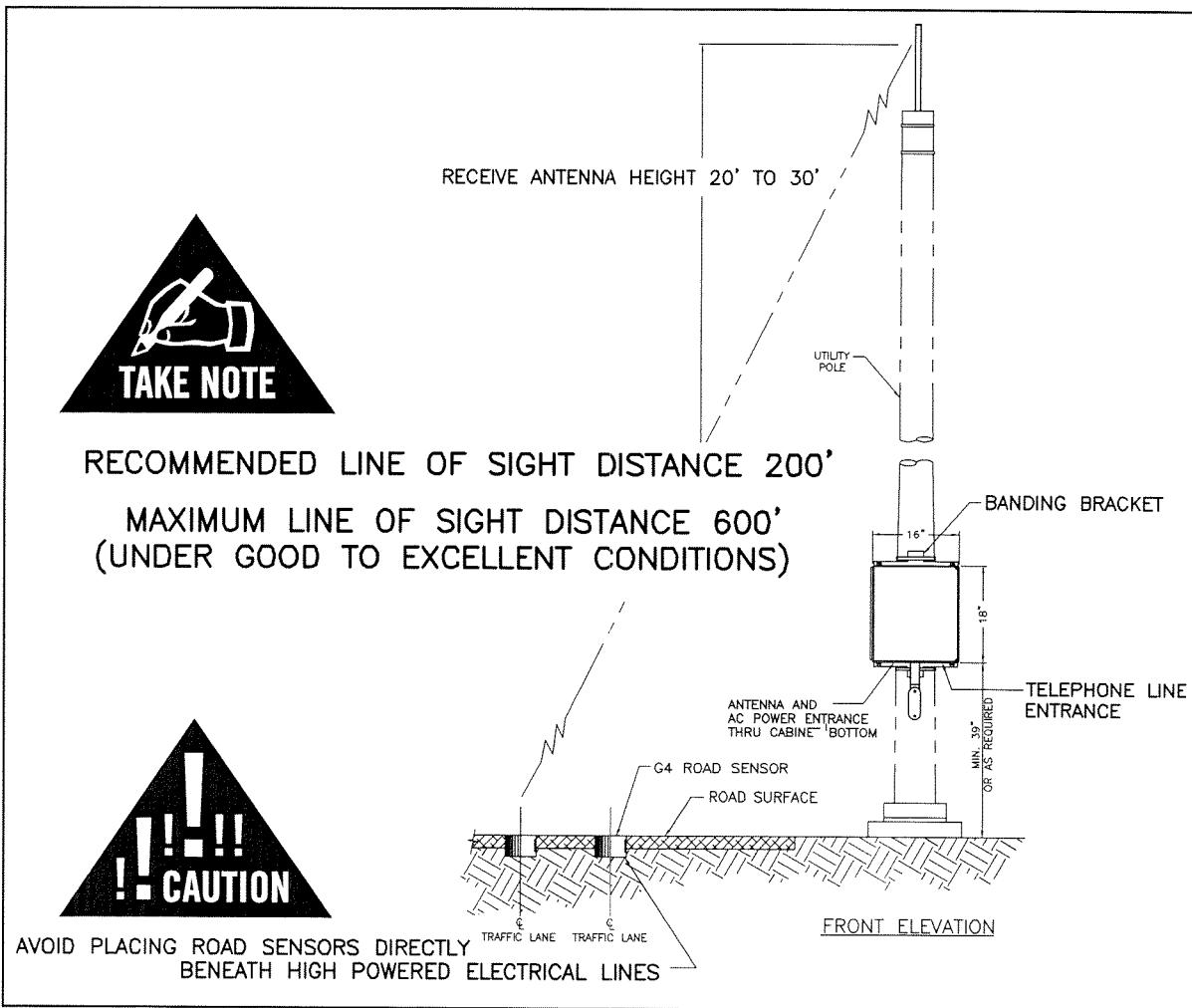
1. Select locations for installing Groundhogs that do not interfere with embedded loops, underground cable, conduit, pipes or other obstructions.
2. Close the selected traffic lane after checking appropriate state and local ordinances for proper procedures and requirements. States often require acceptance of an approved Maintenance and Protection of Traffic (MPT) plan before closing a traffic lane. This is to ensure the safety of the workers and motorists. Usually, the MPT plan includes a documented arrangement of safety devices including: lights, signs, flags, arrows, crash trucks and roadway detour signs.

BEGINNING THE GROUNDHOG® SENSOR INSTALLATION

The installation lane must be closed for the duration of the procedure.

Total installation time is approximately 30 minutes per Groundhog.

THE LINE-OF-SIGHT BETWEEN SENSOR AND POLE...



INSTALLATION OF THE GROUNDHOG SENSOR

Installing the Groundhog is a very simple process when compared to many of the industry alternatives. However, there are a few important tips to remember during installation.

-  Ensure that line of site exists between the sensor & the local base unit (see p12).
- Be knowledgeable about the surface to be drilled. Concrete is considerably harder to drill through. As a result the core is also hard to remove. (**NOTE:** An impact hammer will help the speed of core removal).
- Verify that the potential for AC interference does not exist. This can be done with an EMI 80 unit manufactured by Nu-Metrics.

IMPORTANT GROUNDHOG INSTALLATION TIPS

1. TIMING YOUR GROUNDHOG HOOK UP

The Groundhog works on a scheduled broadcast. Typically in 5 minute periods, the unit broadcasts its stored information three times in rapid succession to the LBU. If all the Groundhogs are plugged in at the same time, the possibility that the units will 'walk on' each other exists. What does this mean? Think of a turnstall entrance. Then picture twelve people trying to get through at the same time. The recommended method is to plug in the batteries and wait 5 to 10 seconds before plugging in the next unit. This will allow each unit to broadcast its message uninterrupted.

2. MOISTURE IN THE CANISTER

Any exposure to moisture can cause erratic behavior during the Groundhog's operation. High vehicle counts could be one result.

3. HANDLING OF ELECTRONICS

The Groundhog is an electronic item. Although it is industrialized, some of the simple handling instructions that apply to electronics should be applied to the Groundhog. Excessive handling of the electronics on the chip areas or other component areas of the Groundhog could transfer static charges the installer will not even feel. Over time, these charges could degrade the functionality of the Groundhog.

4. THE GROUNDHOG LID

It is important that the threads of the lid are lubricated. Petroleum jelly works well. Additionally, any time a lid is removed a new set of o-rings should be installed. The o-rings keep moisture out of the canister. Constant removal of a lid with the same set of o-rings will stretch the o-rings and void the watertight seal.



NOTE: Before installing a Groundhog, be sure the configuration of the Groundhog and RFM match. If the Groundhog configuration must be changed, the unit must be physically removed from the roadway and reprogrammed.

The following hardware is needed for a PCS installation.

PRACTICE ALL ROUTINE SAFETY PROCEDURES FOR INSTALLATIONS.

GROUNDHOG SENSOR INSTALLATION:

- Core drill machine (i.e. Milwaukee Dymodrill, Amps – 20, Volts 120 US)
- Water and water valve attachment for the wet core drill system
- Core drill bit in ONE of the following diameters:
 - WITH** weather option 6.75 inches
 - WITHOUT** weather option 6.5 inches
- A powered generator able to generate 5 kilowatts
- Propane torch and tank (used to dry the core hole)
- Groundhog lid removal tool
- Groundhog canister tool ("spider" tool)
- Wet/dry vacuum (for cleaning)
- Adhesive template (supplied with canister)
- Paper towels or rags
- 3 lb. sledge hammer
- Chisel and handle holder
- Sand (5 pound bag for four units)
- Silicone (for keeping out debris)
- Scissors or utility knife
- Spray paint (for marking road)
- Surgical gloves (for handling epoxy)
- Measuring tape
- Rubberbands (for core drill position)
- Putty knife
- Plastic bag (protects canister tool from epoxy)
- Small bucket for mixing two part epoxy. **WARNING:** the epoxy is chemically active and becomes quite hot when mixed and may melt some plastic containers.
- Bondo # 7084 2-part epoxy sealant (mix ratio is 1:1)

POLE AND COMMUNICATION BOX (AT LOCATION):

- Tin snips
- Screw driver set
- Flashlight
- Hammer
- Multi-meter
- Wire cutters
- Wire strippers
- Socket set (Standard and Metric)
- Metal Banding
- Banding Tool and Clamps

THE POLLING COMPUTER:

The computer must meet the requirements for WDM

- Intel Processor
- 128 MB RAM depending on the operating system (suggest 256 MB for XP systems)
- Minimum 5 GB hard drive (10 GB for XP)
- Contains two modems (if using cellular modems, only one additional will be necessary, if there are any questions please contact a Nu-Metrics representative)
- PC Anywhere®

(An additional modem or virtual private network connections is required if remote support is required.)

- Microsoft Office Professional or Microsoft Access

The operating system is:

- Windows® 98se
- Windows® NT 4.0
- Windows® 2000
- Windows® XP

Other: _____

Network access, IP address _____

Analog phone line, Phone Number _____

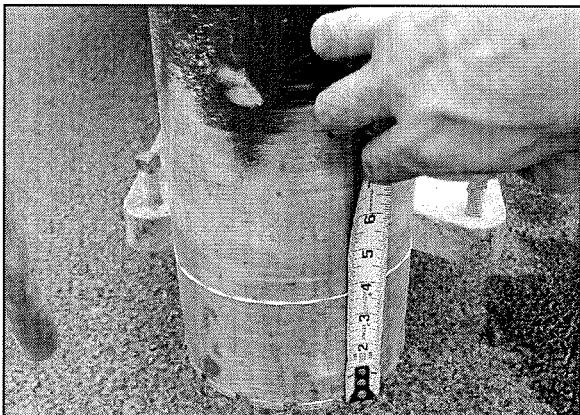
REVIEW ALL STEPS BEFORE BEGINNING INSTALLATION.



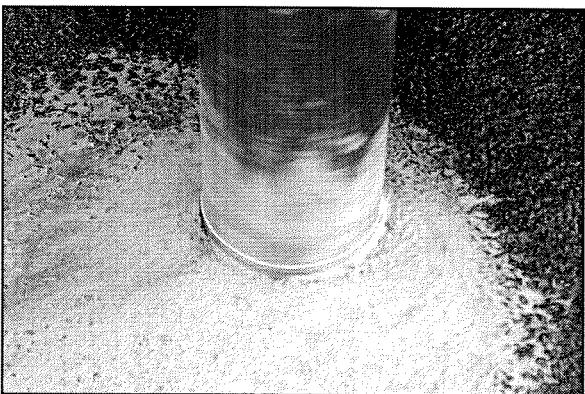
CHECKLIST! - Verify that you have all of the equipment needed for the Nu-Metrics' Groundhog Installation.



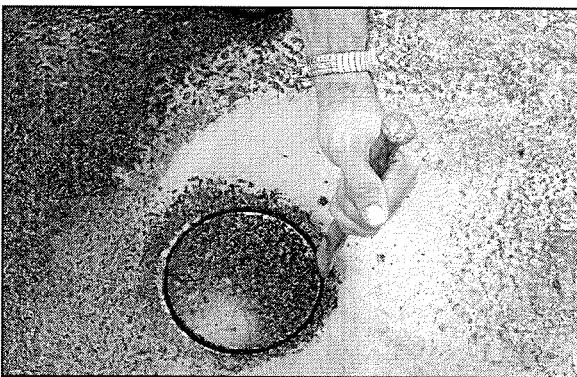
STEP 1 - Locate the center of the traffic lane and mark the road with paint. This will be the location (center of lane marking) of the Groundhog canister.



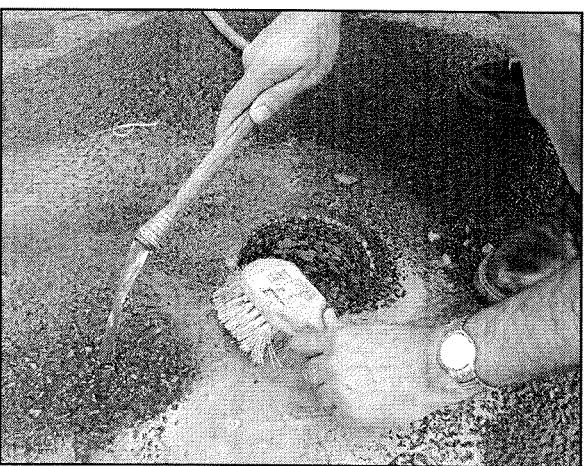
STEP 2 - Mark the drill bit to a depth of 3-3/4". Nu-Metrics suggests placing a tight rubberband around the measurement. Take note that the rubberband may shift during drilling!



STEP 3 - Place the core drill over the center of the lane mark and prepare to drill. Before proceeding, verify that the core drill bit is either 6-1/2" or 6-3/4" in diameter. Start drilling. Be sure to drill to a depth of at least 3-3/4".

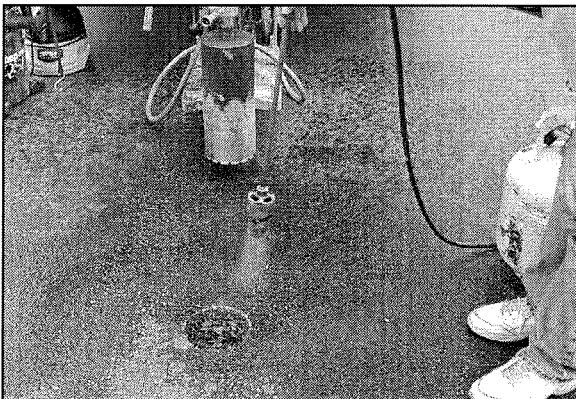


STEP 4 - Once the drill bit has reached a depth of 3-3/4", remove the drill bit and insert a chisel into the cut. Using a hammer and chisel, snap the core at the base of the drilled area. Remove the core, and chisel any fragments left behind at the bottom of the hole.

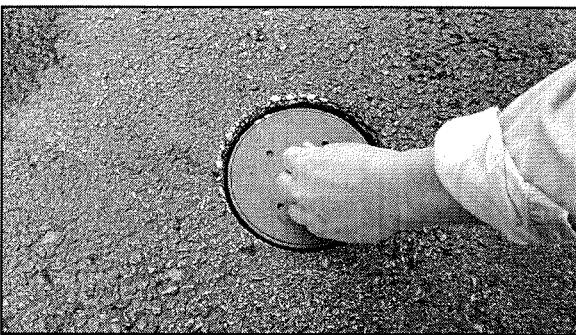


STEP 5 - Remove all loose particles from the bottom of the hole. If available, use water and a brush to clean an area 2 feet in diameter.

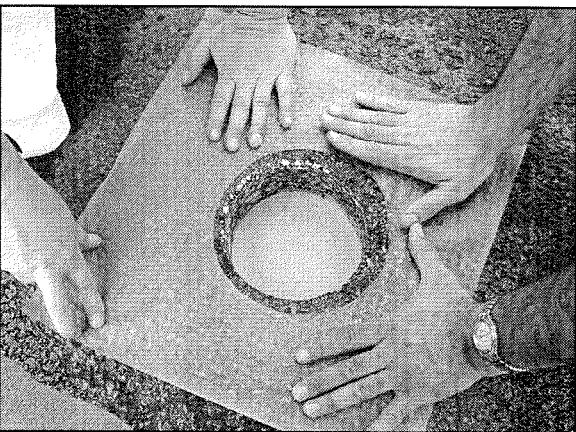
Installation Procedure for the Groundhog® G-4 Permanent Traffic Analyzer



STEP 6 - Since there is water in and around the work area, you will need to use a propane torch to dry the area to proceed. *You could also let the area dry naturally (this will add considerable time to the installation).

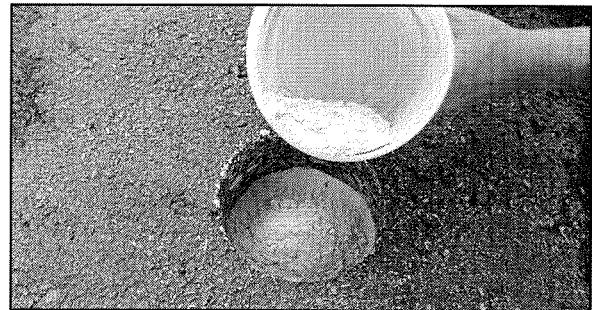


STEP 8 - Measure the hole again to check for the 3 1/8" depth. The canister can be used to verify the correct canister depth and fit. Place the canister inside the core-drilled hole, and verify that the canister does not protrude above the road surface, and that it is not recessed below the road surface more than 1/8"

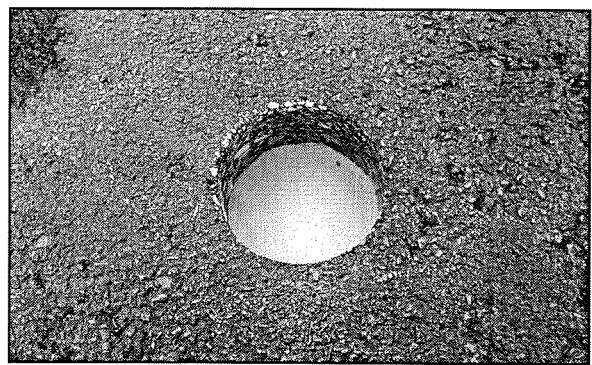


STEP 9 - Lay the pre-cut, adhesive template around the cored hole. Be sure to press the adhesive template firmly to the pavement surface around the core-drilled hole.

IMPORTANT: Make sure the work area is clean a minimum of 2 feet around the hole. Remove all debris using a broom, wet/dry vacuum, hose, or other method. Once the surrounding area is clean and dry, you may proceed.



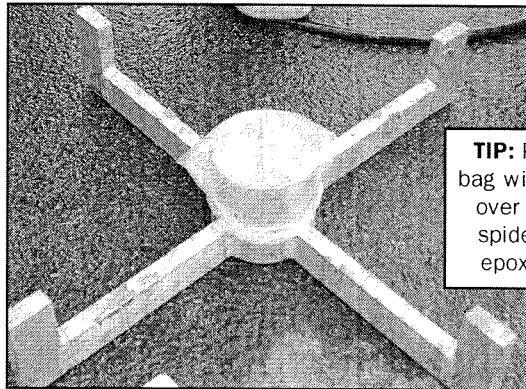
STEP 7 - Pour sand into the hole until you achieve a uniform depth of 3 1/8" inches.



NOTE: If the canister is raised above the road surface, snow plows will damage the unit during the winter months. If the canister is recessed more than 1/8" stagnant water will collect on the lid producing a wet condition when the road is dry.



THIS TOOL IS REFERRED TO AS A "SPIDER" TOOL.



TIP: Place a plastic bag with a rubberband over the end of the spider to eliminate epoxy on the tool.



NOTE: Use the canister installation tool to apply pressure to position the canister just below the road surface. (The canister must not be positioned more than 1/8" below the road surface).