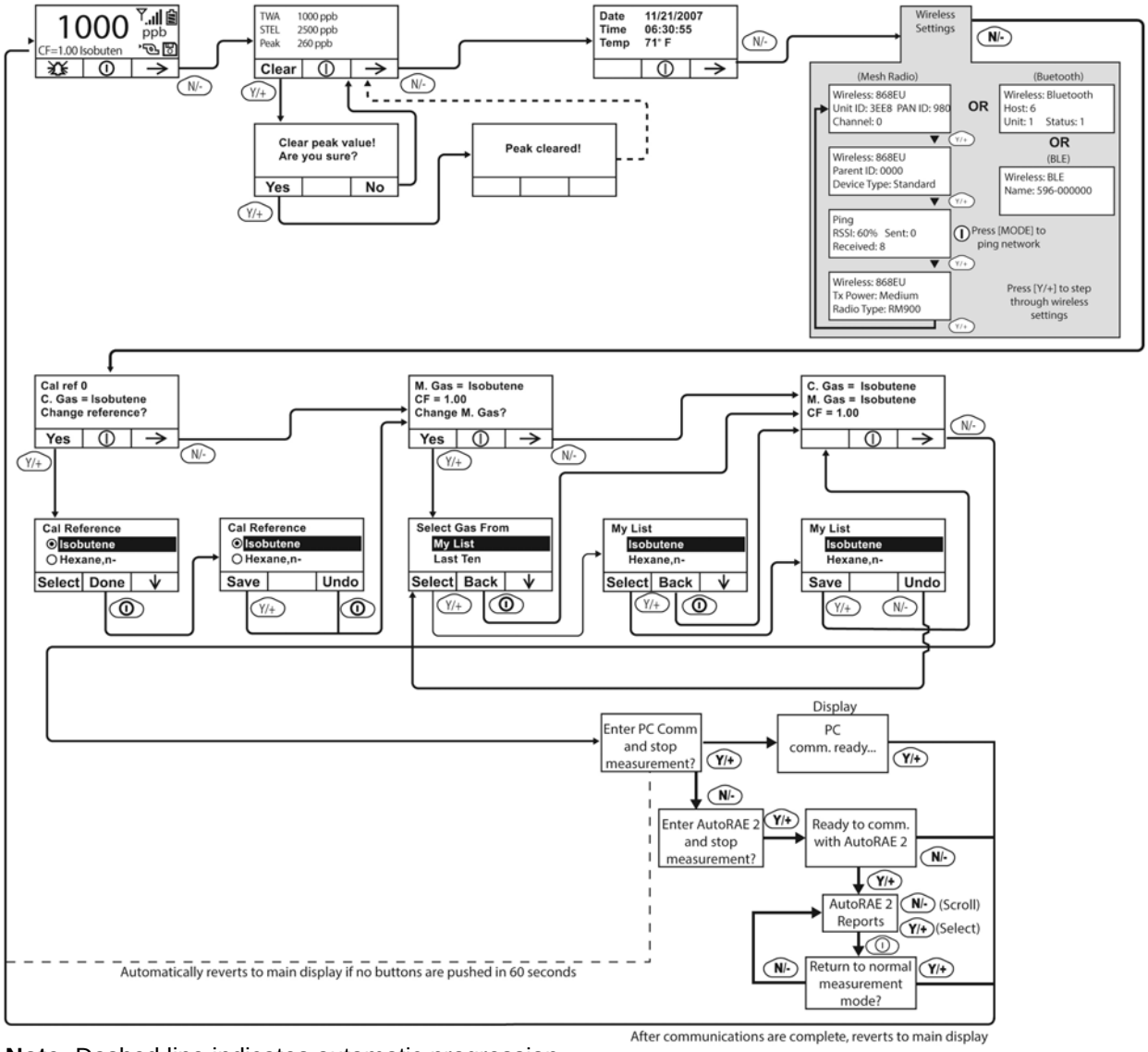
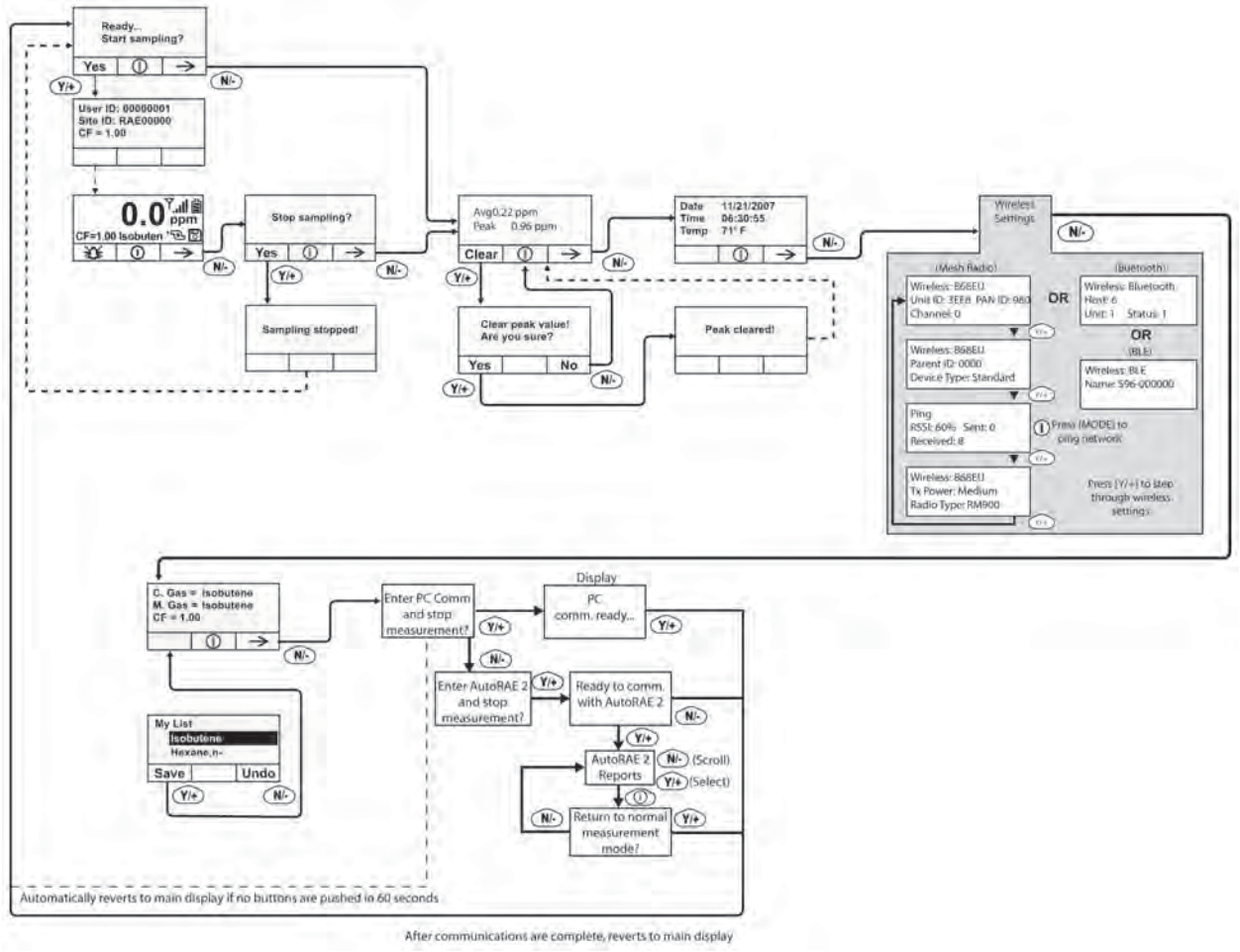


Note: Dashed line indicates automatic progression.

22.2. Basic User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Basic User Level (refer to the section called User Mode for instructions).

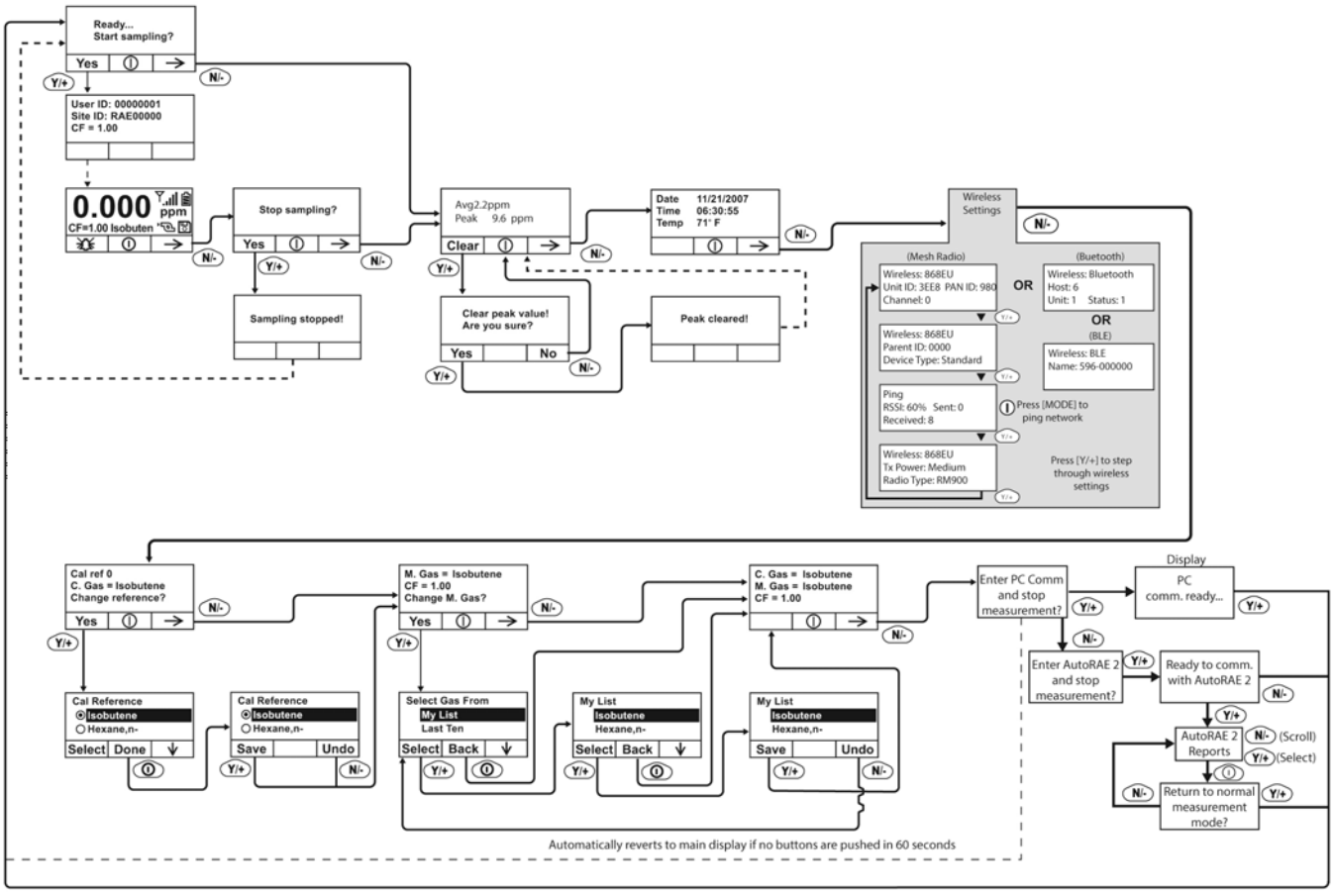
When the instrument is in Search Mode, it only samples when you activate sampling. When you see the display that says, "Ready…Start sampling?" press [Y/+] to start. The pump turns on and the instrument begins collecting data. To stop sampling, press [N/-] while the main display is showing. You will see a new screen that says, "Stop sampling?" Press [Y/+] to stop sampling. Press [N/-] if you want sampling to continue.



Note: Dashed line indicates automatic progression.

22.3. Advanced User Level & Search Mode

With the instrument in Operation Mode: Search Mode, enter User Mode and select Advanced User Level (refer to the section called Monitor Mode for instructions). Operation is similar to Basic User Level & Sampling Mode, but now allows you to change calibration and measurement reference gases. Refer to the section on measurement gases for more details.



Note: Dashed line indicates automatic progression.

23. Diagnostic Mode

IMPORTANT!

Diagnostic Mode is designed for servicing and manufacturing, and therefore is not intended for everyday use, even by advanced users. It provides raw data from sensors and about settings, but only allows adjustment of pump stall parameters, which should only be changed by qualified personnel.

Note: If the instrument is turned on in Diagnostic Mode and you switch to User Mode, datalog data remains in raw count form. To change to standard readings, you must restart the instrument.

23.1.1. Entering Diagnostic Mode

Note: To enter Diagnostic Mode, you must begin with the instrument turned off.

Press and hold [Y/+] and [MODE] until the instrument starts.

The instrument goes through a brief startup, and then displays raw data for the PID sensor. These numbers are raw sensor readings without calibration. The instrument is now in Diagnostic Mode.

Note: In Diagnostic Mode, the pump and lamp are normally on.

You can enter Programming Mode and calibrate the instrument as usual by pressing both [MODE] and [N/-] for three seconds.

You can enter Monitoring Mode by pressing [MODE] and [Y/+] together for three seconds.

Once the instrument is started up in Diagnostic Mode, you can switch between Diagnostic Mode and Monitoring Mode by pressing and holding [MODE] and [Y/+] simultaneously for two seconds.

In Diagnostic mode, you can step through parameter screens by pressing [MODE].

23.1.2. Adjusting The Pump Stall Threshold

If the gas inlet is blocked but the pump does not shut down, or the pump shuts down too easily with a slight blockage, the pump stall threshold value may be set too high or too low.

Use the following steps to adjust the pump stall threshold:

23.1.3. Pump High

In Diagnostic Mode, press the [MODE] key until "Pump High" is displayed. The display shows the maximum, minimum, and stall values for the pump at its high speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

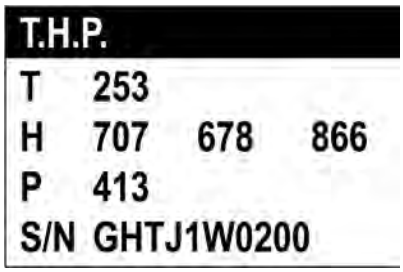
Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

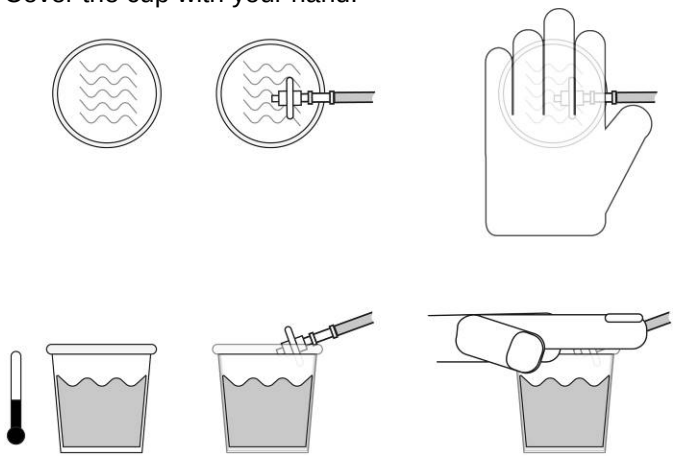
23.1.4. Testing The Humidity Sensor

1. Press [MODE] to step through the diagnostic screens until you reach a screen that says "THP" (for "temperature, humidity, pressure," although pressure is not supported) at the top.

   There are three numbers for the humidity reading ("H"). The first number is the current humidity reading from the sensor. The second is the reference number for 0% humidity, and the third number is the reference for 100% humidity.



2. Fill a cup with warm water (>25° C/77° F).
3. Put a filter on the UltraRAE 3000+'s inlet probe.
4. Place the inlet probe over the warm water.
5. Cover the cup with your hand.



25° C /
77° F

6. Wait a few seconds and check the high-humidity reading.
7. The humidity reading should be within ±10% of the 100% humidity reading. If it is not, then the THP Sensor (part number 023-3011-000-FRU) should be replaced.
8. Check the low-humidity reading by connecting the inlet probe to a tank of zero gas (air at 0% humidity).
9. Turn on the zero gas and wait a few seconds for the sensor reading to stabilize. It should read within 10% of the low-reference number. If it does not, replace the THP sensor.
10. Once you have finished testing the humidity sensor, exit Diagnostic Mode by shutting down the instrument (hold [MODE] through the countdown, and then release when it is off).

23.1.5. Pump Low

In Diagnostic Mode, press the [MODE] key until "Pump Low" is displayed. The display shows the maximum, minimum, and stall values for the pump at its low speed. Write down the "Max" reading.

Block the gas inlet and watch the pump current reading (labeled "I") increase. Write down its blocked reading. **Note:** If the pump current reading does not increase significantly (less than 10 counts), then there may be a leak in the gas inlet or the pump is weak or defective.

Add the two readings you wrote down. This is the average of the maximum block count and the maximum idle count. Divide that number by 2. Use the [Y/+] or [N/-] key to increase or decrease the stall value to equal that number.

Press the [MODE] key to exit this display.

23.1.6. Exiting Diagnostic Mode

You can exit Diagnostic Mode and go directly to Programming Mode or Monitor Mode as outlined above, or you can exit Diagnostic Mode completely.

To exit Diagnostic Mode so that it cannot be re-entered without a restart:

Shut down the instrument. When it is off, restart it by holding the [MODE] key. Diagnostic Mode cannot be entered until the instrument is restarted as outlined in "Entering Diagnostic Mode."

24. Transferring Data To & From A Computer

Once you have connected your instrument cradle to the PC, you can can transfer data, including a download of the datalog to the computer and updates of firmware to the instrument (should this ever be necessary).

24.1. Downloading The Datalog To A PC

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start ProRAE Studio II or Honeywell Safety Suite Device Configurator on your PC.
4. Select "Operation" and select Setup Connection.
5. Select the COM port to establish a communication link between the PC and the instrument.
6. To receive the datalog in the PC, select "Downlog Datalog."
7. When you see "Unit Information," click OK.

During the data transfer, the display shows a progress bar.

When the transfer is done, you will see a screen with the datalog information. You can now export this datalog for other use or printing.

24.2. Uploading Firmware To The instrument From A PC

Uploading new firmware to your instrument requires connecting the instrument and PC. Follow these steps to make the connection:

1. Connect the data cable to the PC and the cradle.
2. Place the instrument into its cradle. The charging LED should be illuminated.
3. Start ProRAE Studio II or Honeywell Safety Suite Device Configurator on your PC.
4. With ProRAE Studio II, click the "Firmware" icon on the left,side. Then click "Run programmer" to open
   RAEProgrammer 4000.
5. From RAEProgrammer 4000, select "Open" and select the firmware to upgrade
6. Select the COM port to establish a communication link between the PC and the instrument.
7. Click "Start" button

Once communication is established, follow the instructions that accompany RAEProgrammer 4000 and the firmware to upload the new firmware to your instrument.

Note: Check for the latest updates to ProRAE Studio II or Honeywell Safety Suite Device Configurator at www.raesystems.com.

25. Maintenance

The major maintenance items of the instrument are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

Note: Maintenance should be performed by qualified personnel only.

Note: The printed circuit board of the instrument is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the instrument. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

25.1. Battery Charging & Replacement

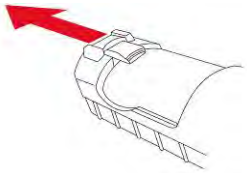
When the display shows a flashing empty battery icon, the battery requires recharging. It is recommended to recharge the instrument upon returning from fieldwork. A fully charged battery runs a instrument for 16 hours continuously. The charging time is less than 8 hours for a fully discharged battery. The battery may be replaced in the field (in areas known to be non-hazardous), if required.

WARNING!

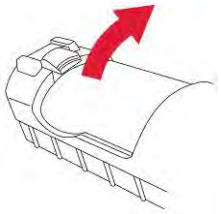
To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in areas known to be non-hazardous.

25.1.1. Replacing The Li-ion Battery

1. Turn off the instrument.
2. Located on the rear of the instrument is a battery tab. Slide it down to unlock the battery.



3. Remove the battery pack from the battery compartment by tilting it out.



4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment.

   Slide the capture tab back up to its locked position.

25.1.2. Replacing The Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500) and provides approximately 12 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Li-ion battery pack.

To insert batteries into the adapter:

1. Remove the three Philips-head screws to open the compartment.
2. Insert four fresh AA batteries as indicated by the polarity (+/-) markings.
3. Replace the cover. Replace the three screws.

To install the adapter in the instrument:

1. Remove the Li-ion battery pack from the battery compartment by sliding the tab and tilting out the battery.
2. Replace it with the alkaline battery adapter
3. Slide the tab back into place to secure the battery adapter.

IMPORTANT!

Alkaline batteries cannot be recharged. The instrument's internal circuit detects alkaline batteries and will not allow recharging. If you place the instrument in its cradle, the alkaline battery will not be recharged. The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the instrument.

Note: When replacing alkaline batteries, dispose of old ones properly.

WARNING!

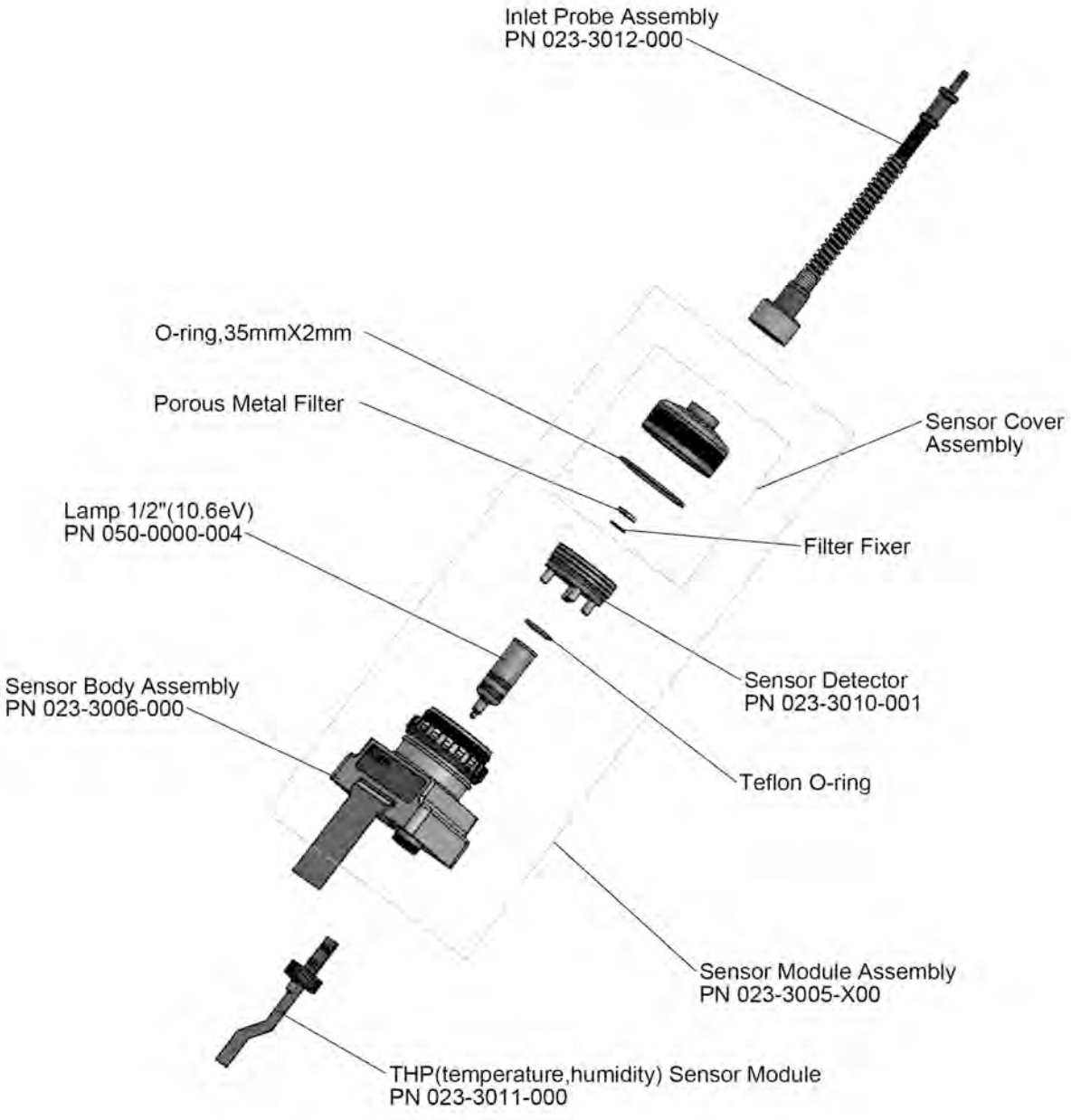
To reduce the risk of ignition of hazardous atmospheres, recharge the battery only in areas known to be non-hazardous. Remove and replace the battery only in areas known to be non-hazardous.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

25.2. PID Sensor & Lamp Cleaning/Replacement

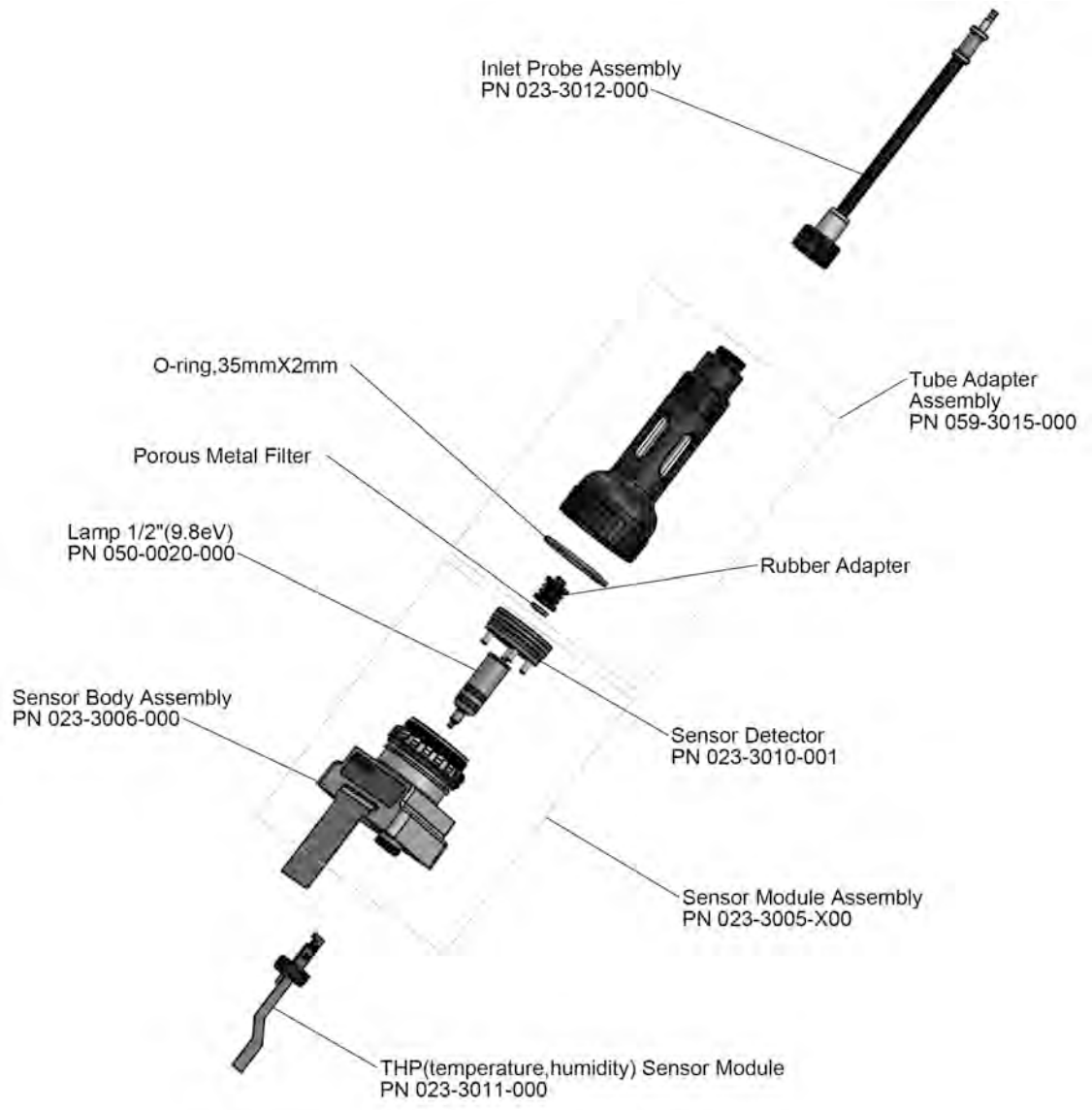
Sensor Components – MiniRAE 3000+, ppbRAE 3000+, MiniRAE Lite+

The sensor module is made of several components and is attached to the lamp-housing unit as shown below.



Sensor Components – UltraRAE 3000+

The sensor module is made of several components and is attached to the lamp-housing unit as shown below.



Note: The cleaning procedure is not normally needed. Clean the PID sensor module, the lamp and the lamp housing only when one of the following has happened:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A chemical liquid has been sucked into the unit and damaged the unit.

Use of the external filter helps to prevent contamination of the sensor.
To access the sensor components and lamp, gently unscrew the lamp-housing cap, remove the sensor adapter with the gas inlet probe and the metal filter all together. Then hold the PID sensor and pull it straight out. A slight, gentle rocking motion helps release the sensor.

25.2.1. Cleaning The PID Sensor

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor by hand.

Also use a methanol-soaked cotton swab to wipe off the lamp housing where it contacts the sensor when the sensor is installed.

Turn over the sensor so that the pins point up and the sensor cavity is visible. Examine the sensor electrodes for any corrosion, damage, or bending out of alignment. The metal sensor electrode "fingers" should be flat and straight. If necessary, carefully bend the sensor fingers to ensure that they do not touch the Teflon portions and that they are parallel to each other. Make sure that the nuts on the sensor pins are snug but not overtight. If the sensor is corroded or otherwise damaged, it should be replaced.

25.2.2. Cleaning The Lamp Housing Or Changing The Lamp

If the lamp does not turn on, the instrument will display an error message to indicate replacement of the lamp may be required.

1. If the lamp is operational, clean the lamp window surface and the lamp housing by wiping it with GC grade methanol using a cotton swab using moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Never use water solutions to clean the lamp. Dry the lamp and the lamp housing thoroughly after cleaning.

   CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.

2. If the lamp does not turn on, remove the lamp from the lamp housing. Place the lamp O-ring onto the new lamp. Insert the new lamp, avoiding contact with the flat window surface.
3. Reinstall the PID sensor module.
4. Tighten the Lamp Housing Cap.

25.2.3. Determining The Lamp Type

Note: This feature is not included on the MiniRAE Lite+.

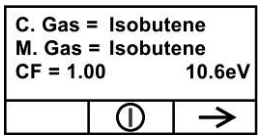
The monitor can accommodate two lamp values: 10.6eV (standard) and 9.8eV.

There are two ways to determine the lamp type.

1. Turn off the instrument and remove the lamp. Now look at the serial number. The following identify the lamp type:

   - 10.6eV SN:106 XXXXXXX
   - 9.8eV SN:098 XXXXXXX
   - 11.7eV SN:117 XXXXXXX

2. When the monitor is running, the lamp type is shown along with the calibration and measurement gas and Correction Factor:



3. **Note:** This screen can be accessed from the reading screen by pressing [N/-] four times.

Programming The Lamp ID

The correct measurement gas library is used by the instrument when you ensure that the right lamp value is programmed.

To manually select the Lamp ID:

1. Enter the Programming menu.
2. Select Monitor Setup.
3. Scroll down and select the Lamp ID sub-menu.
4. Press [N/-] to scroll down to the desired Lamp ID.
5. Press [Y/+] to select.
6. Press [MODE] to select Done.
7. Select "Save."
8. Return to the main menu.

Recalibrate the instrument before returning it to service.

25.2.4. Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.

If the pump is not working properly, refer the instrument to qualified service personnel for further testing and, if necessary, pump repair or replacement.

25.2.5. Cleaning The Instrument

Occasional cleaning with a soft cloth is recommended. Do not use detergents or chemicals.

Visually inspect the contacts at the base of the instrument, on the battery, and on the Charger Stand to make sure they are clean. If they are not, wipe them with a soft, dry cloth. Never use solvents or cleaners.

25.3. Special Servicing Note

If the instrument needs to be serviced, contact either:

1. The Honeywell distributor from whom the instrument was purchased; they will return the instrument on your behalf.

   or

2. The Honeywell Technical Service Department. Before returning the instrument for service or repair, obtain a Returned Material Authorization (RMA) number for proper tracking of your equipment. This number needs to be on all documentation and posted on the outside of the box in which the instrument is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.

25.4. Crash Recovery

3G Firmware Crash Recovery Procedure:

1. Press [Y/+] and [MODE] and [N/-] keys simultaneously. **Note:** The display will be blank and no LED will glow.
2. Use a USB cable to onnect the instrument to a PC using a Travel Charger or Charger Stand.
3. Connect the 12-volt DC power supply to the Travel Charger or Charger Stand.
4. Open RAEProgrammer 4000 in ProRAE Studio II.

   Option 1 (only applicable only to a 64-bit Operating System):
   - Verify correct COM Port prior to downloading
   - Local disk(C) >> Program Files(x86) >> RAE Systems by Honeywell >> ProRAE Studio II >> Programmer >> RAEProgrammer 4000 >> RAEProgrammer4000.exe.

   Option 2: Connect a known good instrument to the PC, open ProRAE Studio II, click on "Auto Detect," select "Firmware," and click on "Run Programmer" under "Application Firmware." Disconnect the instrument and then connect the instrument that requires recovery.

5. Load the Application Firmware.

Notes:
- On the instrument, no LEDs will turn on and the display will be blank during downloading.
- Firmware download is in process when Duration time in Processing Information section of RAE Programmer4000 is counting up.

When the instrument is turned on, RAEProgrammer 4000 will show a message that shows it has loaded the application firmware.

26. Troubleshooting

Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	**Reasons:** Discharged battery. Defective battery. **Solutions:** Charge or replace battery.
Lost password	**Solutions:** Call Technical Support
Reading abnormally High	**Reasons:** Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration. **Solutions:** Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:** Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration. **Solutions:** Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:** Bad buzzer. **Solutions:** Check that buzzer is not turned off. Call authorized service center.
Inlet flow too low	**Reasons:** Pump diaphragm damaged or has debris. Flow path leaks. **Solutions:** Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
"Lamp" message during operation	**Reasons:** Lamp drive circuit. Weak or defective PID lamp, defective. **Solutions:** Turn the unit off and back on. Replace UV lamp

27. Technical Support

To contact Honeywell Technical Support Team:

Brazil: +55 11 3309 1030

Canada: +1 800 663 4164

China: +86 21 5855 7305

Europe: +41 44 943 4380

India: +91 124 4752700

Japan: **+81 3 6730 7320**

Korea: +82 2 69090300

Latin America (Spanish): +57 1 64 0401 3

Middle East: +971 4 4505800

Russia/CIS: +7 495 796 9800

Singapore: +65 65803572

Taiwan: +886 3 5169284

USA: +1 888 749 8878

28. Controlled Part Of Manual

Intrinsic Safety:
US and Canada: Class I, Division 1, Groups A,B,C,D T4

Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb)
Sira 17ATEX2082X
Complies with EN60079-0:2013, EN60079-11:2012
IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb
Complies with IEC 60079-0:2011, IEC 60079-11:2011

Temperature: -20º C to 50º C (-4º to 122º F)
Humidity: 0% to 95% relative humidity (non-condensing)

29. Basic Operation

29.1. Turning The Instrument On

1. With the instrument turned off, press and hold [MODE].
2. When the display turns on, release the [MODE] key.

The instrument is now operating and performs self tests. Once the self tests are complete, the display shows a graph or numerical gas reading. This indicates that the instrument is fully functional and ready to use.

29.2. Turning The Instrument Off

1. Press and hold the Mode key for 3 seconds. A 5-second countdown to shutoff begins.
2. When you see "Unit off..." release your finger from the [MODE] key. The instrument is now off.

Note: You must hold your finger on the key for the entire shutoff process. If you remove your finger from the key during the countdown, the shutoff operation is canceled and the instrument continues normal operation.

30. Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn you of the alarm condition. In addition, the instrument alarms if one of the following conditions occurs: battery voltage falls below a preset voltage level, failure of the UV lamp, pump stall, or when the datalog memory is full.

30.1. Alarm Signal Summary

Message	Condition	Alarm Signal
HIGH	Gas exceeds "High Alarm" limit	3 beeps/flashes per second*
OVR	Gas exceeds measurement range	3 beeps/flashes per second*
MAX	Gas exceeds electronics' maximum range	3 beeps/flashes per second*
LOW	Gas exceeds "Low Alarm" limit	2 beeps/flashes per second*
TWA	Gas exceeds "TWA" limit	1 Beep/flash per second*
STEL	Gas exceeds "STEL" limit	1 Beep/flash per second*
Pump icon flashes	Pump failure	3 beeps/flashes per second
Lamp	PID lamp failure	3 beeps/flashes per second plus "Lamp" message on display
Battery icon flashes	Low battery	1 flash, 1 beep per minute plus battery icon flashes on display
CAL	Calibration failed, or needs calibration	1 beep/flash per second
NEG	Gas reading measures less than number stored in calibration	1 beep/flash per second

Preset Alarm Limits & Calibration

The instrument is factory calibrated with standard calibration gas, and is programmed with default alarm limits.

Cal Gas (Isobutylene)	Cal Span	unit	Low	High	TWA	STEL
MiniRAE Lite+	100	ppm	50	100	10	25
MiniRAE 3000+	100	ppm	50	100	10	25
ppbRAE 3000+	10	ppm	10	25	10	25
UltraRAE 3000+ (Isobutylene)	100	ppm	50	100	10	25
UltraRAE 3000+ (Benzene)	5	ppm	2	5	0.5	2.5
UltraRAE 3000+ (Butadiene)	10	ppm	5	10	2	5

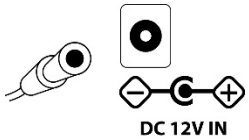
31. Charging The Battery

Always fully charge the battery before using the instrument. The instrument's Li-ion/NiMH battery is charged by placing the instrument in its cradle. Contacts on the bottom of the instrument meet the cradle's contacts, transferring power without other connections.

Note: Before setting the instrument into its Charger Stand or Travel Charger, visually inspect the contacts to make sure they are clean. If they are not, wipe them with a soft cloth. Do not use solvents or cleaners.

Follow this procedure to charge the instrument:

1. Plug the AC/DC adapter's barrel connector into the instrument's Charger Stand or Travel Charger.



2. Plug the AC/DC adapter into the wall outlet.
3. Place the instrument into the cradle, press down, and lean it back. It locks in place and the LED in the cradle glows.

Note: To release the instrument, press down and tilt the top out of the cradle and lift up.

The instrument begins charging automatically. The LED on the front of the cradle marked "Primary" blinks during charging. During charging, the diagonal lines in the battery icon on the instrument's display are animated and you see the message "Charging..."

When the instrument's battery is fully charged, the battery icon is no longer animated and shows a full battery. The message "Fully charged!" is shown and the Primary LED on the cradle glows continuously green.

Note: A spare Li-ion battery (059-3051-000) or NiMH(059-3054-000) can be charged by placing it directly in the charging port on the back of the cradle. It can be charged at the same time as the instrument. Press the battery in place, sliding it slightly toward the front of the cradle. This locks it in the cradle. To release the battery, slide it forward again and tilt it up.

Note: An Alkaline Battery Adapter (part number 059-3052-000), which uses four AA alkaline batteries (Duracell MN1500), may be substituted for the Li-Ion battery.

WARNING!

To reduce the risk of ignition of hazardous atmospheres, recharge and replace batteries only in areas known to be non-hazardous. **Remove and replace batteries only in areas known to be non-hazardous.**

31.1. Low Voltage Warning

When the battery's charge falls below a preset voltage, the instrument warns you by beeping once and flashing once every minute, and the battery icon blinks once per second. You should turn off the instrument within 10 minutes and either recharge the battery by placing the instrument in its cradle, or replace the battery with a fresh one with a full charge.

31.2. Clock Battery

An internal clock battery is mounted on one of the instrument's printed circuit boards. This long-life battery keeps settings in memory from being lost whenever the Li-ion, NiMH, or alkaline batteries are removed. This backup battery should last approximately five years, and must be replaced by an authorized RAE Systems service technician. It is not user-replaceable.

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in an area known to be non-hazardous.

31.3. Replacing Rechargeable Li-Ion or NiMH Battery

Caution: Turn off the instrument before removing or replacing the battery.

31.4. Alkaline Battery Adapter

An alkaline battery adapter is supplied with each instrument. The adapter (part number 059-3052-000) accepts four AA alkaline batteries (use only Duracell MN1500).

Do not mix old and new batteries or different type batteries.

31.5. Troubleshooting

Problem	Possible Reasons & Solutions	
Cannot turn on power after charging the battery	**Reasons:**	Discharged battery. Defective battery.
	Solutions:	Charge or replace battery.
Lost password	**Solutions:**	Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
Reading abnormally High	**Reasons:**	Dirty filter. Dirty sensor module. Excessive moisture and water condensation. Incorrect calibration.
	Solutions:	Replace filter. Blow-dry the sensor module. Calibrate the unit.
Reading abnormally Low	**Reasons:**	Dirty filter. Dirty sensor module. Weak or dirty lamp. Incorrect calibration.
	Solutions:	Replace filter. Remove Calibration Adapter. Calibrate the unit. Check for air leakage.
Buzzer Inoperative	**Reasons:**	Bad buzzer.
	Solutions:	Check that buzzer is not turned off. Call authorized service center.
Inlet flow too low	**Reasons:**	Pump diaphragm damaged or has debris. Flow path leaks.
	Solutions:	Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Call Technical Support at +1 408-752-0723 or toll-free at +1 888-723-4800
"Lamp" message during operation	**Reasons:**	Lamp drive circuit. Weak or defective PID lamp, defective.
	Solutions:	Turn the unit off and back on. Replace UV lamp

32. Specifications

32.1. MiniRAE Lite+ Specifications

Size:	9.25" L x 3.6" W x 2.9" H
Weight:	28 oz with battery pack
Detector:	Photoionization sensor with 10.6 eV UV lamp
Battery:	Rechargeable Lithium-Ion battery pack (snap in, field replaceable) Alkaline battery holder (for 4 AA batteries)
Battery Charging:	Less than 8 hours to full charge
Operating Hours:	Non-wireless Up to 16 hours continuous operation with rechargeable battery Up to 12 hours with alkaline battery Wireless Up to 13 hours continuous operation with rechargeable battery
Display:	Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0.1 ppm to 5,000 ppm	0.1 ppm

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	10 to 2000 ppm: ±5% at calibration point.
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Calibration:	Two-point field calibration of zero and standard reference gases Patented Reflex PID™ technology
Inlet Probe:	Flexible 5" tubing
Keypad:	1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout:	Instantaneous, peak value, and battery voltage
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc
Intrinsic Safety:	US and Canada: Class I, Division 1, Groups A, B, C, D Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb) Sira 17ATEX2082X Complies with EN60079-0: 2013, EN60079-11:2012 IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb Complies with IEC 60079-0: 2011, IEC 60079-11:2011 (IIC: 059-3051-000 Li-ion battery pack or 059-3054-000 NiMH battery pack; IIB: 059-3052-000 alkaline battery pack)
EM Interference:	Highly resistant to EMI/RFI.
Alarm Setting:	Separate alarm limit settings for Low Alarm and High Alarm
Alarm:	Buzzer 95dB at 30cm and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or automatic reset
Real-time Clock:	Automatic date and time
Communication:	Download instrument setup from PC via RS-232 with Travel Charger, or via USB with optional Charger Stand

	Upload data to PC and download instrument setup from PC via USB on charging station. Enhanced datalogging capability through BLE module and mobile app
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

32.2. MiniRAE 3000+ Specifications

Size:	25.5 cm x 7.6 cm x 6.4 cm (9.25" L x 3.6" W x 2.9" H)
Weight:	738 g / 28 oz with battery pack
Detector:	Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 3.7V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only) Alkaline battery holder (for 4 AA batteries)
Battery Charging:	Less than 8 hours to full charge
Operating Hours:	Non-wireless Up to 16 hours continuous operation with rechargeable battery Up to 12 hours with alkaline battery Wireless Up to 13 hours continuous operation with rechargeable battery
Display:	Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0 to 999.9 ppm 1,000 to 15,000 ppm	0.1 ppm 1ppm
9.8 eV	0.1 ppm to 5,000 ppm	0.1 ppm
11.7 eV	0.1 ppm to 2,000 ppm	0.1 ppm

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	10 to 2,000 ppm: ±3% at calibration point.
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration:	Two-point field calibration of zero and standard reference gases Patented Reflex PID™ technology
Calibration Reference:	Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe:	Flexible 5" tubing
Radio module:	BLE (2.4GHz),Bluetooth (2.4GHz) or RF module (, 868MHz or 915MHz)
Keypad:	1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout:	Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety:	US and Canada: Class I, Division 1, Groups A,B, C, D Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb) Sira 17ATEX2082X Complies with EN60079-0: 2013, EN60079-11:2012 IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb Complies with IEC 60079-0: 2011, IEC 60079-11:2011 (IIC: 059-3051-000 Li-ion battery pack

or 059-3054-000 NiMH battery pack;
IIB: 059-3052-000 alkaline battery pack)

EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC RE-D (RF Modules)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Hygiene or Search mode
Alarm:	Buzzer 95dB at 30cm and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or Automatic Reset
Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station. Enhanced datalogging capability through BLE module and mobile app
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Wireless Network:	Mesh RAE Systems Dedicated Wireless Network (or Wi-Fi network for Wi-Fi-equipped instruments) Bluetooth Low energy
Wireless Frequency:	ISM license-free band, 902 to 907.5 MHz and 915 to 928 MHz, FCC Part 15, CE RE-D, IEEE 802.11 b/g bands (2.4 GHz)
Modulation:	802.15.4 DSSS BPSK
RF Power (Tx):	10dBm
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

32.3. ppbRAE 3000+ Specifications

Size: 25.5 cm x 7.6 cm x 6.4 cm / 9.25" L x 3.6" W x 2.9" H
Weight: 738g /28 oz with battery pack
Detector: Photoionization sensor with 9.8eV or 10.6eV UV lamp
Battery: A 3.7V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only)
Alkaline battery holder (for 4 AA batteries)
Battery Charging: Less than 8 hours to full charge
Operating Hours: Non-wireless Up to 16 hours continuous operation with rechargeable battery
Up to 12 hours with alkaline battery
Wireless Up to 13 hours continuous operation with rechargeable battery
Display: Large dot matrix screen with backlight

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV	0 to 9999 ppb 10 to 99 ppm 100 to 99 ppm 1000 to 9999 ppm	1 ppb 0.01 ppm 0.1 ppm 1 ppm
9.8 eV	0.01 ppm to 5,000 ppm	10 ppb

Response time (T_{90}): 2 seconds
Accuracy (Isobutylene): 10 to 2,000 ppm: ±3% at calibration point.
PID Detector: Easy access to lamp and sensor for cleaning and replacement
Correction Factors: Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration: Two-point field calibration of zero and standard reference gases
Patented Reflex PID™ technology
Calibration Reference: Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe: Flexible 5" tubing
Radio module: BLE (2.4GHz) Bluetooth (2.4GHz) or RF module (868MHz, 915MHz)
Keypad: 1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout: Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety: US and Canada: Class I, Division 1, Groups A, B, C, D
Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb)
Sira 17ATEX2082X
Complies with EN60079-0: 2013, EN60079-11:2012
IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb
Complies with IEC 60079-0: 2011, IEC 60079-11:2011
(IIC: 059-3051-000 Li-ion battery pack or 059-3054-000 NiMH battery pack; IIB: 059-3052-000 alkaline battery pack)

EM Interference: Highly resistant to EMI/RFI. Compliant with EMC RE-D (RF Modules)
Alarm Setting: Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode: Hygiene or Search mode
Alarm: Buzzer (95dB at 30cm) and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type: Latching or automatic reset

Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station. Enhanced datalogging capability through BLE module and mobile app
Wireless Network:	Mesh RAE Systems Dedicated Wireless Network Bluetooth Low Energy (BLE) module
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Wireless Frequency:	ISM license-free band, 902 to 907.5 MHz and 915 to 928 MHz, FCC Part 15, CE RE-D
Modulation:	802.15.4 DSSS BPSK
RF Power (Tx):	10dBm
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

32.4. UltraRAE 3000+ Specifications

Size:	10" L x 3" W x 2.5" H (25.5 cm x 7.6 cm x 6.4 cm)	
Weight:	26 oz (738 g) with battery pack	
Detector:	Photoionization sensor with 9.8, 10.6, or 11.7 eV UV lamp	
Battery:	A 4.2V rechargeable Lithium-Ion battery pack (snap in, field replaceable, at non-hazardous location only) Alkaline battery holder (for 4 AA batteries)	
Battery Charging:	Less than 8 hours to full charge	
Operating Hours:	Non-wireless	Up to 16 hours continuous operation with rechargeable battery Up to 12 hours with alkaline battery
	Wireless	Up to 13 hours continuous operation with rechargeable battery
Display:	Large dot matrix screen with backlight	

Measurement range & resolution

Lamp	Range	Resolution
10.6 eV (TVOC)	0 to 99.99 ppm 100 to 999.9 ppm 1000 to 9999 ppm	10 ppb 0.1ppm 1ppm
9.8 eV (TVOC) **9.8eV (Benzene** butadiene;**)**	0 to 5000 ppm 10 ppb to 200 ppm	10 ppb 10 ppb (0.001 ppm)

Response time (T_{90}):	2 seconds
Accuracy (Isobutylene):	3% at calibration point
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Over 200 VOC gases built in (based on RAE Systems Technical Note TN-106)
Calibration:	Two-point field calibration of zero and standard reference gases Patented Reflex PID™ technology
Calibration Reference:	Store up to 8 sets of calibration data, alarm limits and span values
Inlet Probe:	Flexible 5" tubing (a short tube is also available) Separation tube housing with permanent VOC tube
Radio module:	BLE (2.4GHz), Bluetooth (2.4GHz) or RF module (868MHz , 915MHz,)

Wireless Network:	Mesh RAE Systems Dedicated Wireless Network Bluetooth Low Energy (BLE) module
Wireless Frequency:	ISM license-free band, 902 to 907.5 MHz and 915 to 928 MHz, FCC Part 15, CE RE-D
Modulation:	802.15.4 DSSS BPSK
RF Power (Tx):	10dBm
Keypad:	1 operation key and 2 programming keys; 1 flashlight switch
Direct Readout:	Instantaneous, average, STEL, TWA and peak value, and battery voltage
Intrinsic Safety:	US and Canada: Class I, Division 1, Groups A, B, C, D Europe: ATEX (2460 Ex II 2G Ex ia IIC/IIB T4 Gb) Sira 17ATEX2082X Complies with EN60079-0: 2013, EN60079-11:2012 IECEx CSA 10.0005 Ex ia IIC/IIB T4 Gb Complies with IEC 60079-0: 2011, IEC 60079-11:2011 (IIC: 059-3051-000 Li-ion battery pack or 059-3054-000 NiMH battery pack; IIB: 059-3052-000 alkaline battery pack)
EM Interference:	Highly resistant to EMI/RFI. Compliant with EMC RE-D (RF Modules)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Hygiene or Search mode
Alarm:	Buzzer 95dB at 12″ (30cm) and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure
Alarm Type:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on datalogged information
Datalogging:	260,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC via USB on charging station. Enhanced datalogging capability through BLE module and mobile APP
Sampling Pump:	Internally integrated. Flow rate: 450 to 550 cc/min.
Temperature:	-20º C to 50º C (-4º to 122º F)
Humidity:	0% to 95% relative humidity (non-condensing)
Housing (including rubber boot):	Polycarbonate, splashproof and dustproof Battery can be changed without removing rubber boot.

FCC Information

Contains FCC ID: SU3RMBLEB or SU3RM900

The enclosed device complies with part 15 of the FCC rules. Operation is subject to the following conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

Wireless Approval For UAE In Middle East

TRA REGISTERED No: ER36153/14 or ER36153/15
DEALER No.: HONEYWELL INTERNATIONAL MIDDLE EAST – LTD – DUBAI BR

Wireless Approval For QATAR In Middle East

ictQATAR
Type Approval Reg. No.: R-4466 or R-4635

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Instruction Manual

TN-100/T-100

Portable Turbidimeter

OAKTON®

EUTECH INSTRUMENTS

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ISO 9001 CERTIFIED

68X357701 Rev. 4 Apr 06

Certificate of Compliance

This is to certify that the TN100 Portable Turbidimeter complies with the specifications established by the ISO 7027 International Standard for Water Quality - Determination of Turbidity, Section 3: Quantitative Methods using Optical Turbidimeters.

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Preface

This manual functions in two ways: first as a step by step guide to help you operate the waterproof TN-100/ T-100 turbidimeter; second, it serves as a handy reference guide.

It contains basic instructions that you must follow during the operation, care and maintenance of the instrument. The safety protection provided by this equipment may be impaired if it is used in a manner not described in this manual. It is recommended that all operators should read this manual prior to working with this instrument.

Eutech Instruments/ Oakton Instruments cannot accept any responsibility for damage or malfunction to the meter caused by improper use of the instrument.

The information presented in this manual is subject to change without notice as improvements are made, and does not represent a commitment on the part of Eutech Instruments Pte Ltd/ Oakton Instruments.

Note: Eutech Instruments Pte Ltd/ Oakton Instruments reserves the right to make improvements in design, construction, and appearance of products without notice.

Table of Contents

1. Overview

Thank you for selecting the waterproof portable TN-100/ T-100 turbidimeter. The TN-100/ T-100 allows you to measure turbidity of an aqueous sample in the field. This instrument operates on the nephelometric principle of turbidity measurement and is designed to meet the criteria specified in ISO 7027 and DIN 27027 standards (see Measurement Principle on page 19).

1.1 Unpacking TN-100/ T-100 Meter and Accessories

The table below indicates the items that you should find in your turbidimeter shipment.

Item	Quantity
1. Portable TN-100/ T-100 Turbidimeter with 4 “AAA” batteries	1
2. Instruction Manual	1
3. Instrument Carrying Case	1
4. Light Shield Cap	1
5. Calibration Set (0.02, 20.0,100, 800 NTU Standards)	1
6. Empty Vials	3
7. Plastic bottle (empty – for collecting sample)	1
8. Silicone Oil	1
9. Lint free cloth	1

Remove TN-100/ T-100 turbidimeter from the packing carton. Carefully inspect all items to ensure that no visible damage has occurred during shipment. If the items you received do not match your order, please contact your nearest distributor immediately.

***WARNING**: Extra care should be taken when unpacking, opening, and handling the calibration standards and sample vials. Surface scratches or finger smudges on the vial surface may cause measurement errors. Handle these items by their caps only.*

Batteries provided with the meter package are to be installed prior to use. See Section 1.4 - Battery Installation on page 4.

Figure 1 depicts the meter. The three main components of the instrument are the sample well, the display, and the keypad. The following sections describe the functionality of the display and the keypad. The proper use of the instrument and the sample well are discussed in later sections.

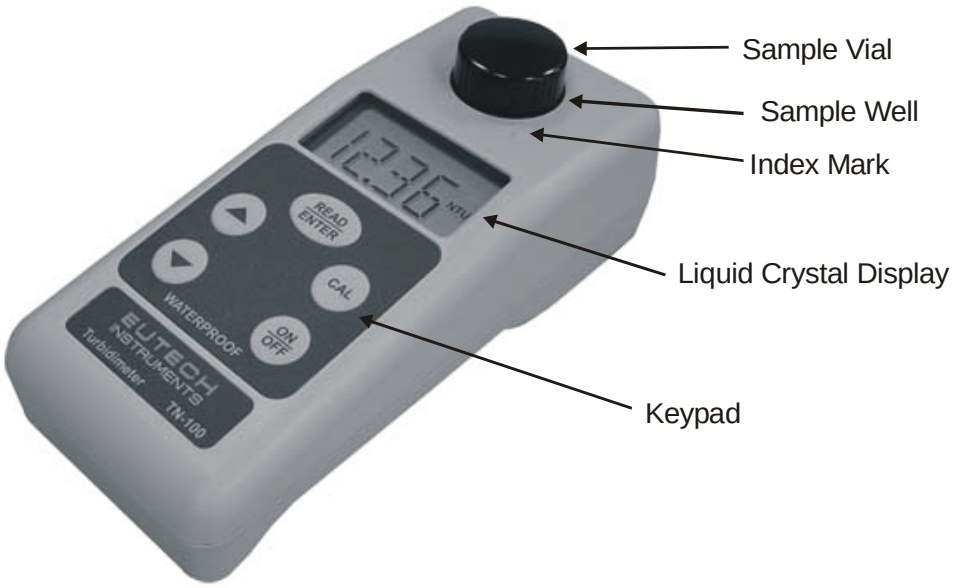


Figure 1: Parts of TN-100/T-100 Turbidimeter

1.2 Display

All the LCD segments and annunciators that can appear on the display are shown in Figure 2. The display is used for reporting the turbidity reading and to provide guidance for the operation of the instrument. In addition, the display has several other annunciators that are used to communicate error messages and provide user guidance.

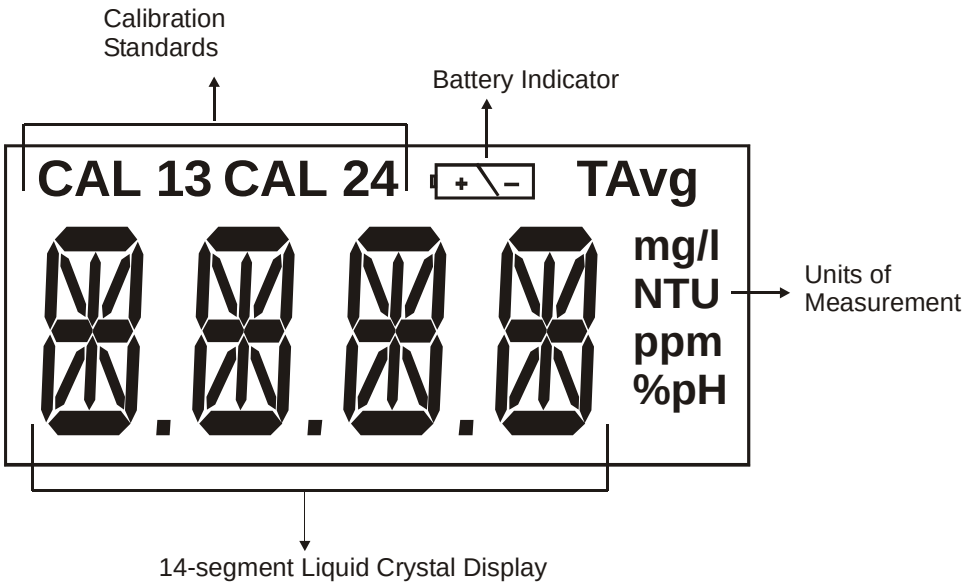


Figure 2: Customized LCD with all annunciators

1.3 Keys and Functions

The keypad has five keys: ON/OFF, CAL, ▲, ▼, and READ/ENTER.

Key	Functions
ON/OFF	Powers on and shuts off the meter. With the auto switch-off feature the meter automatically shuts off 20 minutes after last key press.
CAL	Initiates the calibration mode of the meter. When pressed, the meter is set to accept the first calibration standard. It is also used to exit the calibration mode if the user does not want to follow the complete calibration procedure.
READ/ENTER	When in measurement mode, the READ/ENTER key is used to perform a measurement. *Single-shot measurements*: When the key is pressed and released immediately (a quick key stroke of less than 0.3 seconds), the display will blink [-Rd-] for 10 times and then display the measured value. *Continuous measurements*: If the READ/ENTER key is pressed and held, the instrument will perform a continuous measurement during which the display is updated every 2 seconds. This can be used for indexing vials. (This function is not available in calibration mode). After the READ/ENTER key is released, the instrument will automatically perform a single-shot measurement.
▲ ▼	Active only during calibration mode. These keys are used to select the calibration point in an incremental/ decremental manner. *NOTE: This meter is fitted with an auto incrementing feature, i.e. after the successful calibration of one point it auto selects the next calibration point, or automatically exits the calibration mode after the fourth calibration point.*

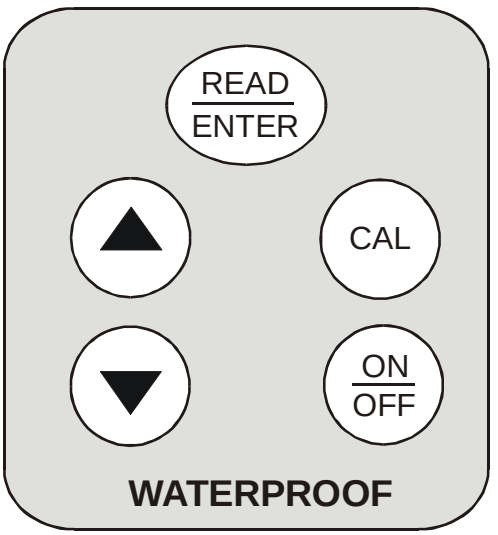


Figure 3: Keypad

1.4 Battery Installation

Four AAA-sized batteries are included in the packaging:

1. Use a Philips screwdriver to remove the two screws holding the battery cover. See Figure 4.
2. Remove the battery cover.
3. Insert the batteries. Follow the diagram inside the cover for correct polarity.
4. Replace the battery cover onto its original position using the two screws removed earlier.
5. The meter is now ready to operate.

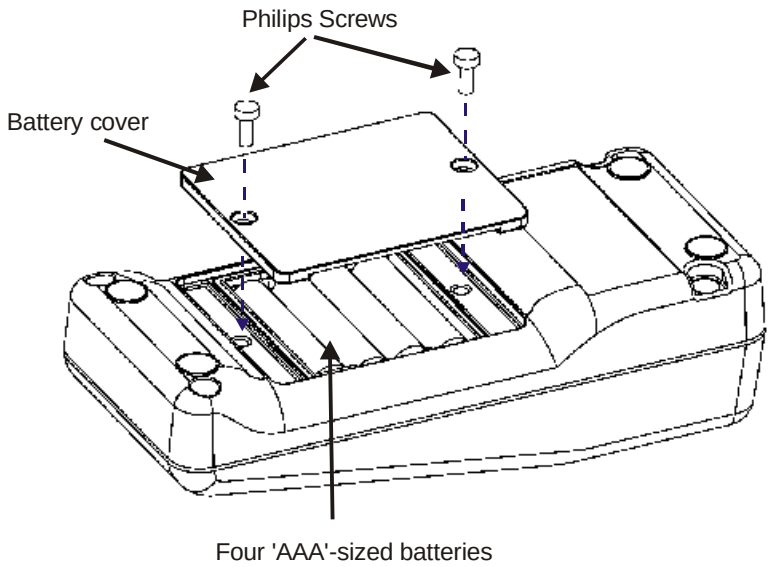


Figure 4: Battery Installation

NOTE: *Dispose used batteries in accordance with your local regulations.*

2. Turbidity Calibration

The TN-100/ T-100 turbidimeter was calibrated and tested prior to leaving the factory. Therefore, it is possible to use the instrument directly out of the box. However, re-calibration of the instrument is recommended to help you become familiar with the operation of the instrument and the calibration procedures. In addition, re-calibration is recommended at least once every month for optimum accuracy.

It is recommended that you perform a full calibration using all 4 standards provided to ensure full-range accuracy. However, the TN-100/ T-100 turbidimeter provides flexibility for you to calibrate at selected ranges suitable for your application.

In addition, the instrument comes with a light shield cap to shield off stray light during calibration and measurements.

2.1 Calibration Standards

We recommend that you use the following materials during calibration to achieve the accuracy stated in this manual:

- **CAL 1**: 800 NTU Calibration Standard
- **CAL 2**: 100 NTU Calibration Standard
- **CAL 3**: 20.0 NTU Calibration Standard
- **CAL 4**: 0.02 NTU Calibration Standard

It is well known that diluted Formazin is unstable. If you choose to use Formazin to calibrate the instrument, ensure that you are using a fresh stock suspension of Formazin to achieve the accuracy quoted for the instrument. Calibration standards offered are more stable than Formazin and have a limited shelf life of 12 months. If you use the supplied calibration standards to calibrate the instrument, review the expiration date (indicated on cap label) to ensure that the standards have not expired.

It is important that the calibration standards are not violently shaken or agitated because air entrapment in the fluid introduces an error factor during calibration which subsequently will lead to an inaccurate measurement. Also, do not store in freezing temperatures which causes irreversible shrinkage of the standards' particles thus resulting to inaccurate calibration and measurement.

2.2 Indexing

Due to the high quality of the glass vials provided, indexing is not required. You only need to align the mark on the vial with the mark on the meter. However, in order to achieve a better accuracy of the measurement, you can proceed with indexing of the vials. See Section 8.5 - Indexing a Vial on page 20 for more information.

2.3 Calibration Procedure

1. Place TN-100/ T-100 turbidimeter on a flat and level surface.
2. Insert the CAL 1 standard (800 NTU) into the sample well, aligning the mark on the vial with the mark on the meter. See **Figure 10** on page 12.
3. Press down vial until it snaps fully into the instrument.
4. Cover the vial using the light shield cap.
5. Press **ON/OFF** key to switch the on the meter. The meter goes to measurement mode after the power-up sequence.
6. Select the calibration function of the instrument by pressing the **CAL** key once. The "CAL" annunciator blinks momentarily and the meter prompt for the first calibration standard "CAL 1 800 NTU".
7. Press **READ/ENTER** key.
8. The "CAL 1 800 NTU" annunciator blinks for about 12 seconds while the instrument performs calibration of CAL 1 point. When the instrument has completed calibration for this point, it prompts you to insert the next calibration standard into the sample well "CAL 2 100 NTU".
9. Repeat the calibration for CAL 2, CAL 3 & CAL 4 calibration standards.
10. After you successfully calibrate the CAL 4 standard (0.02 NTU), the display shows "STbY".
11. The meter is now ready for measurement.

Figure 5 shows the complete calibration sequence.

NOTES:

1. *If you wish to exit the calibration mode you may do so at the end of any step by pressing the **CAL** key. The meter accepts only the values calibrated prior to exiting.*

2. *You can skip a calibration point by pressing ▲ or ▼ keys and move on to the next calibration point.*

3. *After a successful calibration of one point, the meter automatically selects the next calibration point. The meter automatically exits calibration mode after the fourth calibration point.*

4. *If an error occurs during calibration, the display shows an error message. The meter aborts calibration and returns to the measurement mode without saving the last calibration value.*

5. *For a list of error messages, refer to Section 4: Troubleshooting Guide on page 15.*

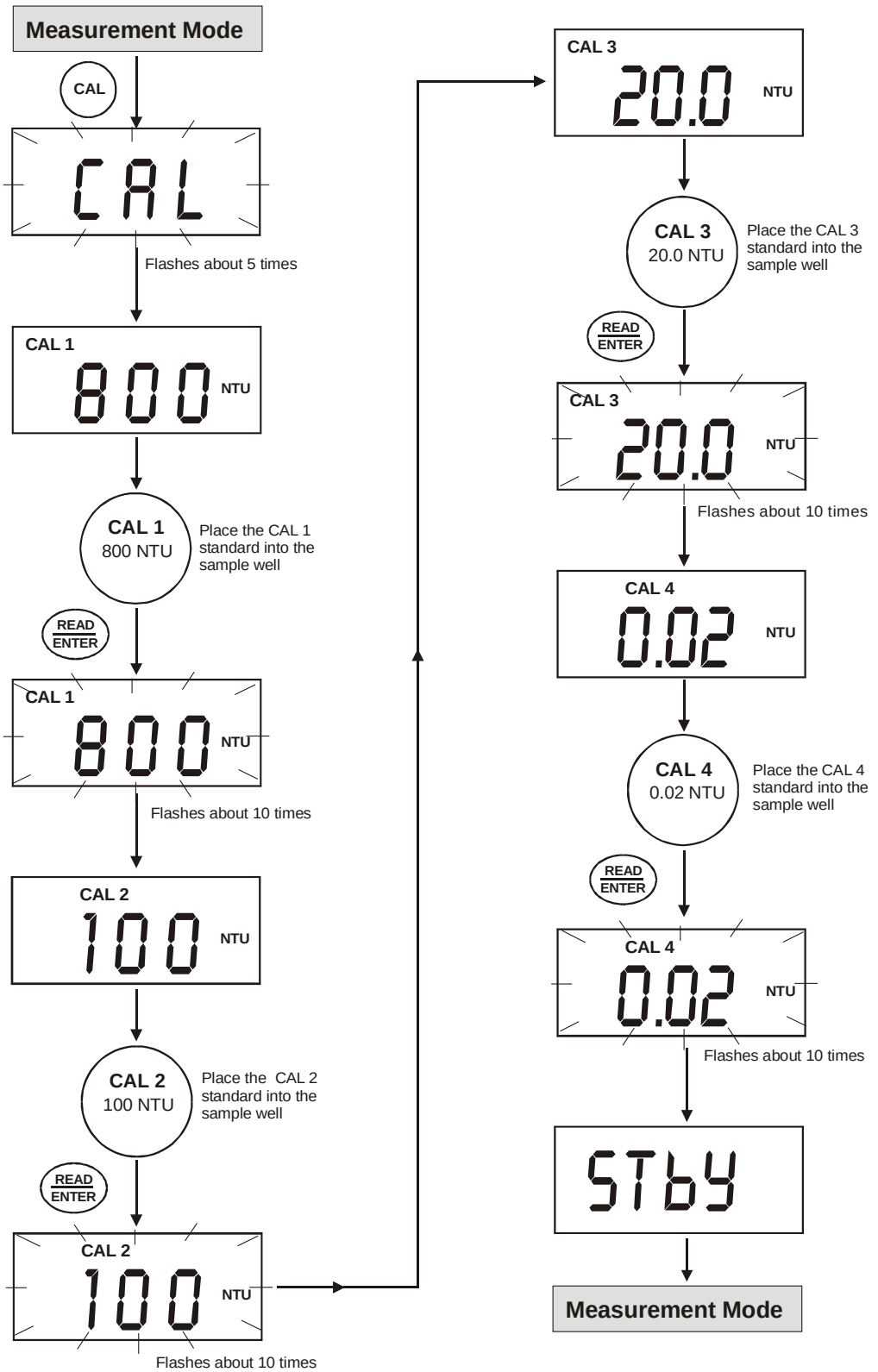


Figure 5: Calibration Sequence

2.4 Restoring Factory Calibration

The TN-100/ T-100 turbidimeter allows you to reset the meter back to the factory default calibration values. This feature is extremely useful when there are errors in calibration or when you have new calibration standards.

1. With the meter switched off, press and hold ▲ key.
2. Switch on the meter using **ON/OFF**. Release ▲ key when “URST” (User-Reset) appears in the display.
3. The display shows “URST” for about 2 seconds and then shows “No”.
4. Use ▲ or ▼ key to select between “YES” or “No”.
    - **YES** = To restore meter back to factory calibration values
    - **No** = To retain last calibrated values
5. Press **READ/ENTER** key to confirm your selection. The meter performs the reset if “YES” is selected.
6. The display flashes “--Rd—“about 10 times indicating that the meter goes to measurement mode.

Figure 6 shows the sequence for restoring factory calibration values.

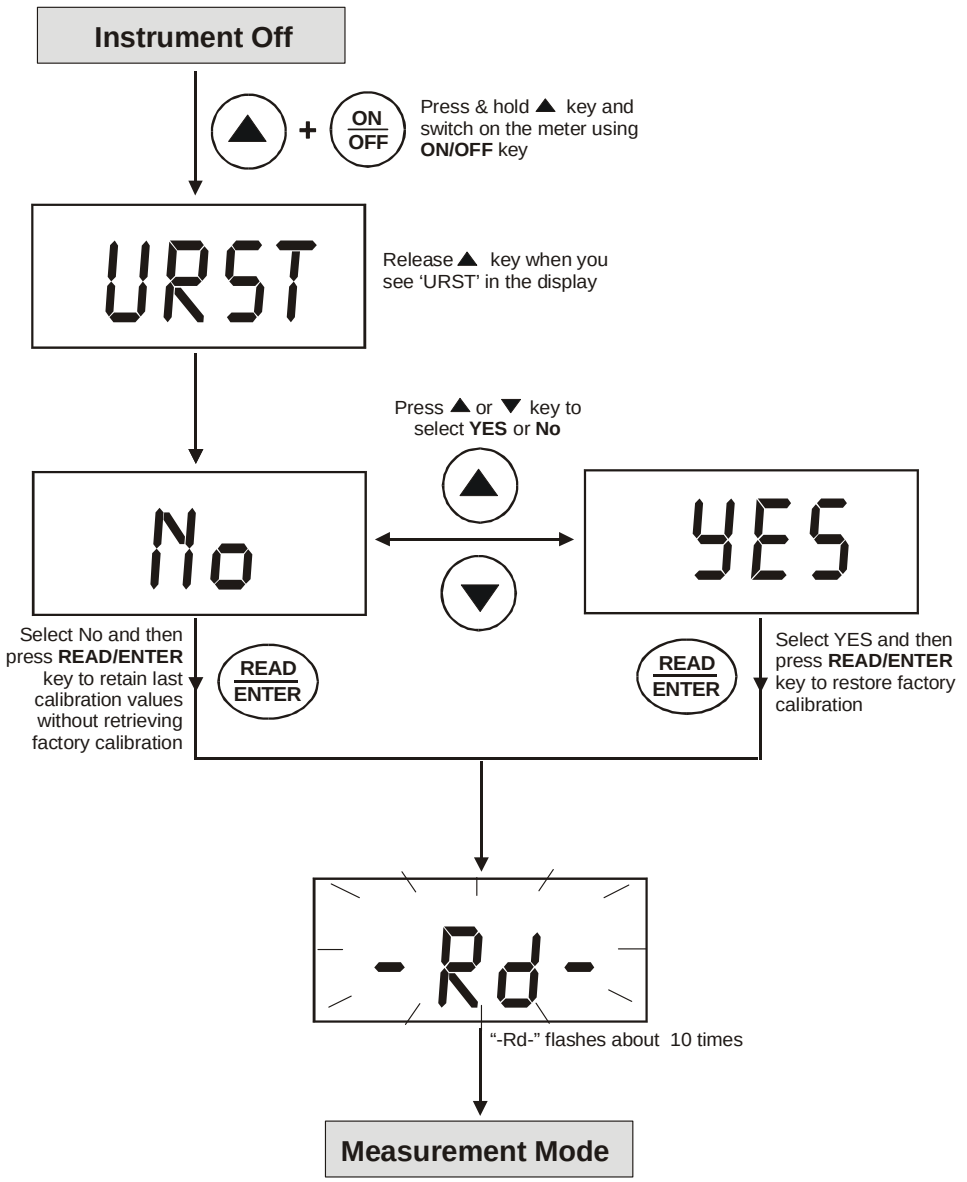


Figure 6: Restoring Factory Calibration

3. Turbidity Measurement

3.1 General Information

The waterproof TN-100/ T-100 turbidimeter allows you to measure the turbidity of a grab sample. The turbidity is reported in Nephelometric Turbidity Units (NTU). Readings above 1000 NTU are outside the range of this instrument.

NOTE: *Before switching on the TN-100/ T-100 turbidimeter, a sample vial MUST be placed in the sample well. You can use any of the calibration standards for this purpose.*

The light shield cap provided could be used to cover the vial during measurements.

When the **ON/FF** key is pressed to switch on the meter, it goes through the power-up sequence as shown in Figure 7 below.

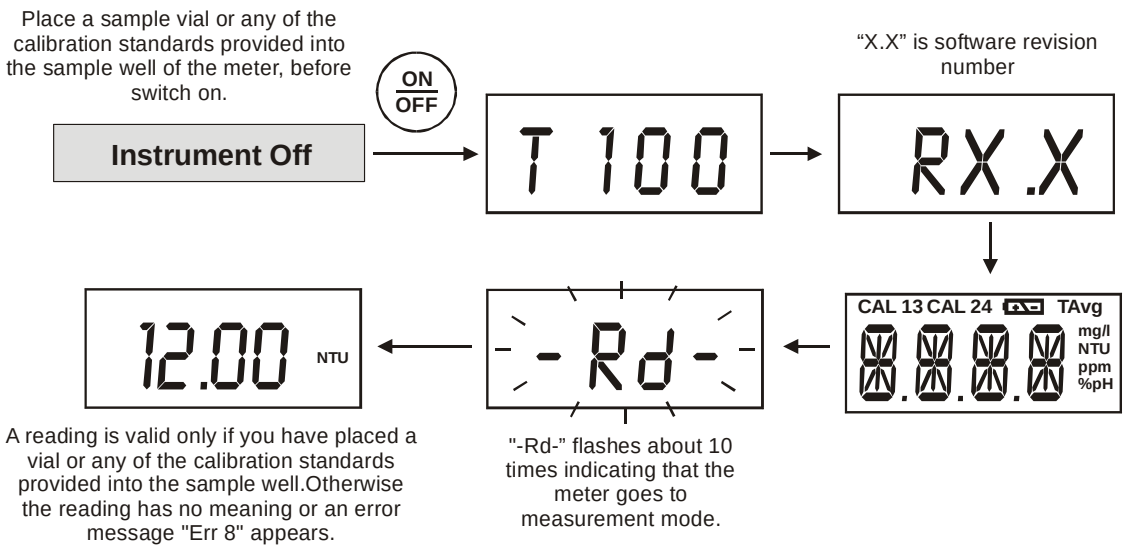


Figure 7: Power-up Sequence

3.2 Turbidity Measurement Procedure

An accurate turbidity measurement depends on good measurement techniques. Factors such as clean sample vials, positioning of vial in the sample well, covering the vial with the light shield cap, meter calibration, handling of meter, and others, have to be taken into consideration. Please see the following sections for more information.

Section 5.1: Vials – Handling, Cleaning and Care (page 16)

Section 9: Addendum 2:
Guide to Good Measurement Technique (page 21)

Preparation of Sample Vial

1. Obtain a clean and dry sample vial
2. Take care to handle the sample vial by the top.
3. Rinse the vial with approximately 10 ml of the sample water, capping the vial with the black screw cap and gently inverting it several times. Discard the used sample and repeat the rinsing procedure two more times.
4. Fill the rinsed vial with the remaining portion (approximately 10 ml) of the grab sample up to the mark indicated in the vial. Cap the vial with the supplied black screw cap.
5. Wipe the vial with the soft, lint-free cloth supplied. Ensure that the outside of the vial is dry, clean and free from smudges.

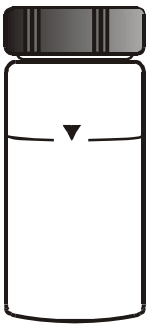


Figure 8: Sample Vial

6. Apply a thin film of silicone oil (supplied) on the sample vial (see Figure 9).
7. Wipe with a soft cloth to obtain an even distribution over the entire vial's surface.

NOTES:

1. *The purpose of oiling the vial is to fill small scratches and to mask the imperfection in the glass.*

2. *Do not apply large quantity of oil as this may collect dirt and dust*

8. The sample vial is now ready to be inserted into the sample well of the meter for measurement.

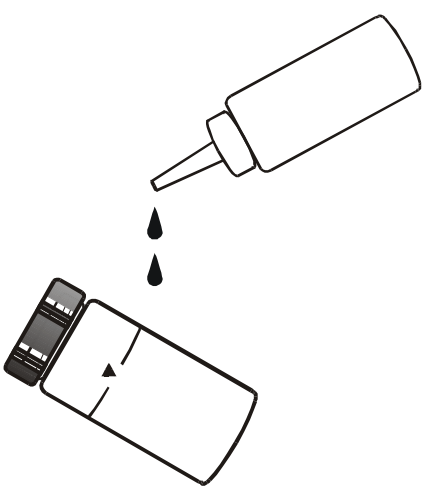


Figure 9: Apply a thin film of silicon oil

Measurement Procedure

1. Place TN-100/ T-100 turbidimeter on a flat and level surface.
2. Place the sample vial inside the sample well and align the vial's index mark with the meter's index mark. See **Figure 10**.

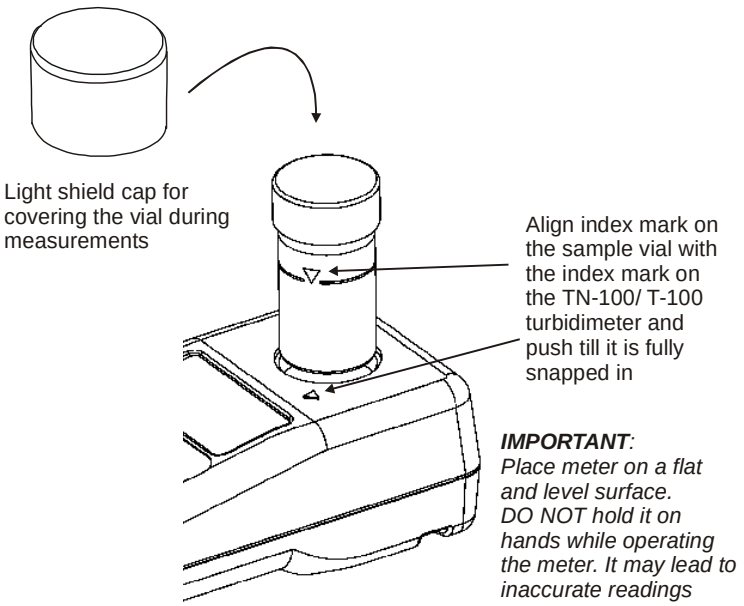


Figure 10: Align sample vial's index mark with meter's index mark

3. Push the vial until it is fully snapped in.
4. Cover the vial with the light shield cap.
5. Turn on the meter by pressing the **ON/OFF** key.
6. After the power-up sequence, the meter goes to measurement mode and the display blinks "--Rd--" for about 10 times. See Figure 11.
7. The measured reading appears in the display.
8. If necessary, place the second sample vial into the sample well. Remember to align the vial's mark with the meter's index mark.
9. Press **READ/ENTER** key. The display blinks "--Rd--" for several times and measured reading appears.
10. Repeat steps 2 through 9 for all of your samples.

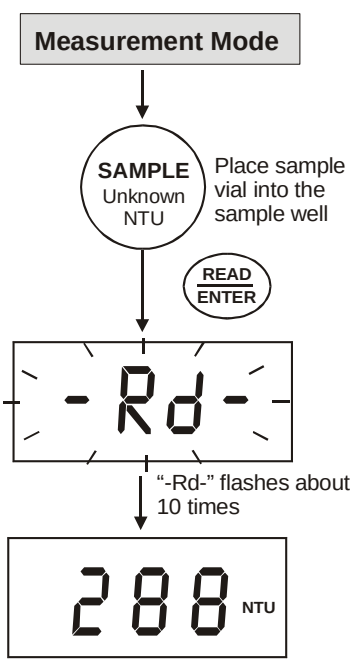


Figure 11: Reading Turbidity Value

NOTES:

1. *NEVER pour liquid directly into the sample well of the instrument. Always use a vial. The instrument will only accurately measure the turbidity of a sample when vials sealed with the black caps are used. The black cap serves as both seal and a light shield.*

2. *NEVER attempt to clean the sample well. The optics may be damaged.*

3. *For battery conservation, the instrument automatically powers off 20 minutes after the last key pressed.*

3.3 Single-Shot or Continuous Measurement

You can use TN-100/ T-100 turbidimeter to take a single reading or perform continuous measurement. The latter is only used for indexing the vials. See **Section 8.5** - Indexing a Vial on page 20 for more information.

For Single-shot Measurement:

1. Make sure the meter is sitting on a flat and level surface and is in measurement mode. The display shows the last measured value or “STbY” after exiting calibration mode.
2. Place sample vial in the sample well.
3. Cover the vial with the light shield cap.
4. Press **READ/ENTER** key and release immediately (<0.3 seconds). See Figure 12.
5. The display blinks “--Rd--“ for about 10 times and then display the measured value.

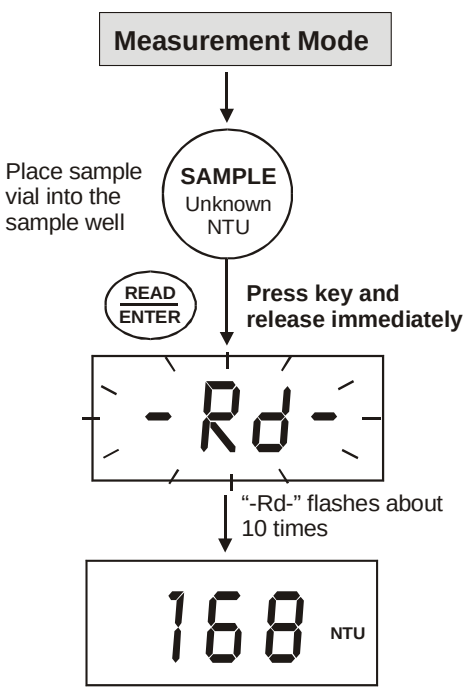


Figure 12: Single-shot Measurement

For Continuous Measurement:

1. Make sure the meter is sitting on a flat and level surface and is in measurement mode. The display shows the last measured value or “STbY”
2. Place the sample vial in the sample well.
3. Press **READ/ENTER** key and hold. See Figure 13
4. Wait for the reading to stabilize before rotating the sample vial.

NOTE: *During continuous measurement, the display is updated every 2 seconds. The displayed reading may not be the actual turbidity value. For accurate measurement, use single-shot measurement.*

You can rotate the sample vial for indexing purpose. See **Section 8.5** - Indexing a Vial on page 20 for more information.

5. Once you release **READ/ENTER** key, the meter automatically performs a single-shot measurement.

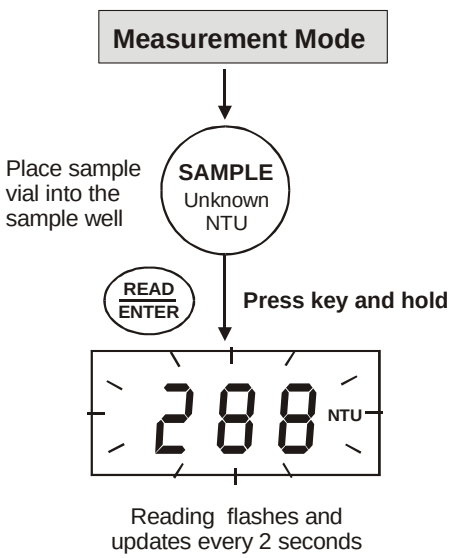


Figure 13: Continuous Measurement

NOTES:

1. *After a measurement is completed and the display is updated, a 4-second recovery time occurs before the meter can perform another function. If any key is pressed during the recovery time, the meter will perform the corresponding action at the end of the recovery period.*

2. *When performing a measurement, if the meter detects stray light exceeding the amount equivalent to 0.02 NTU in the low range, the measurement is immediately aborted and an error message [ERR 8] is displayed. Ensure the vial sits properly into the sample well. Press the ENTER/READ key to re-do the measurement.*

4. Troubleshooting Guide

The TN-100/ T-100 turbidimeter routinely performs self-diagnostics, and will automatically generate messages to provide you with specific diagnostic information. These messages are for your use and do not indicate a reduction in the performance of the instrument or a failure of any component in the instrument, unless otherwise stated in this list.

LCD Message	Description	Corrective Actions
ERR 1	Calibration Error. The meter is unable to recognize the 800 NTU Calibration Standard.	Ensure to use the correct 800 NTU calibration standard. *
ERR 2	Calibration Error. The meter is unable to recognize the 100 NTU Calibration Standard.	Ensure to use the correct 100 NTU calibration standard. *
ERR 3	Calibration Error. The meter is unable to recognize the 20.0 NTU Calibration Standard.	Ensure to use the correct 20.0 NTU calibration standard. *
ERR 4	Calibration Error. The meter is unable to recognize the 0.02 NTU Calibration Standard.	Ensure to use the correct 0.02 NTU calibration standard. *
ERR 5	Calibration Error. There is not sufficient signal to achieve the appropriate resolution in the 0-1000NTU range.	Re-do calibration with all 4 standards provided. *
ERR 6	General Calibration Failure. There is not sufficient signal to achieve the appropriate resolution in the 0-100NTU range.	Re-do calibration with all 4 standards provided. *
ERR 7	General Calibration Failure. There is not sufficient signal to achieve the appropriate resolution in the 0-20 NTU range.	Re-do calibration with all 4 standards provided. *
ERR 8	Excessive stray light detected.	Ensure the vial is fully snapped in the sample well.
	Attempting a measurement when low battery indicator is on.	Replace batteries.
ERR 9	Lamp Failure.	Return unit.
Or	When Turbidity value is above the measurement range(>1000NTU)	Dilute sample. See Section 9.7 on page 23.
	Low battery indication. The batteries need to be replaced.	Replace batteries.

* If an error message appears, take the appropriate corrective action and re-do the desired procedure. If the problem persists, contact Eutech Instruments or your dealer. See Sections on Warranty and Return of Items on page 24.

5. Routine Maintenance

The supplied carrying case is optimal for protecting the instrument. If you do not plan on leaving the instrument in the supplied carrying case, when not in use, ensure that the instrument has been turned off and that a clean sample vial fitted with a black cap has been placed in the sample well. This will ensure that a minimal amount of dust and/or debris will be able to settle on the optics of the instrument.

5.1 Vials – Handling, Cleaning and Care

Proper measurement of the turbidity of a sample requires the use of a vial that is free of marks, smudges, scratches and any bacterial growth.

Therefore, sample vials must be handled with absolute care to avoid contamination or damage, which might change the optical characteristics of the glass. Scratches, fingerprints, and water droplets on the sample vial or inside the sample well can cause stray light interference leading to inaccurate readings.

Cleaning the vial is accomplished by washing the interior and exterior of the vial in a detergent solution. Once cleaned, the vial should be rinsed thoroughly 8 to 10 times with clean distilled water to eliminate the possibility of detergent buildup and streaking.

Vials can also be acid washed periodically and coated with a special silicone oil to fill small scratches and mask the imperfections in the glass. Since the silicone oil required for this application should have the same refractive characteristics as glass, it is recommended that the oil be obtained from us. Care should be taken not to apply excessive oil that could attract dirt or contaminate the sample well of the meter. Once the oil has been applied to the vial, the excess oil should be removed with a lint-free cloth. The result should be a sample vial surface with a dry appearance, but with all imperfections filled with oil.

Sample vials should always be handled from the top or by the cap to avoid fingerprints or smudges. After a vial has been filled with a sample and capped, the outside surface should be wiped with a clean, lint-free absorbent cloth until it is dry. Cleaned and dried vials should be stored with the black caps on. The vials can be stored in the carrying case. During normal operation you may use any typical glass cleaner along with a lint free cloth or tissue (Kimwipes®), to clean the outside of the vials.

Condensation may appear on the vial when your sample is very cold and the relative air humidity is high. When this happens, the turbidity that you read may be higher than the actual turbidity due to the light scattered by the condensate on the vial. If you find yourself in this circumstance, you can alleviate the problem by either coating the vial with an anti-fogging agent, or by running warm water over the vial for a short period of time to warm the sample prior to measurement.

6. Accessories

The items shown below are recommended accessories and replacement parts for the instrument.

Item Description	Eutech Instruments Order Code	Oakton Instruments Order Code
Waterproof TN-100/ T-100 portable turbidimeter with set of 4 calibration standards (800, 100, 20.0 & 0.02 NTU), set of 3 sample vials, lint-free cloth, silicone oil, batteries – all in a rugged carrying case.	EC-TN100	35635-00
Calibration Set for normal operation (includes 800, 100, 20.0 & 0.02 NTU Standards)	ECTN100CALKT	35635-50
Sample Vials – pack of 3 vials	ECTN100CUVKT	35653-55
Silicone Oil – 10ml	ECSILICONEOIL	~

To order any accessory or replacement part, please contact the nearest distributor or Eutech Instruments/ Oakton Instruments.

7. Specifications

Parameter	Specification
Measurement Method	ISO 7027 compliant nephelometric method (90°)
Measurement Range	0 to 1000 NTU
Automatic Range Selection	0.01 – 19.99 NTU 20.0 – 99.9 NTU 100 – 1000 NTU
Resolution	0.01 NTU (0 – 19.99 NTU) 0.1 NTU (20 – 99.9 NTU) 1 NTU (100 – 1000 NU)
Accuracy	±2% of reading ± 1 LSD for 0 to 500 NTU; ±3% of reading ± 1 LSD for 501 to 1000 NTU.
Repeatability	± 0.01 NTU or ± 1% of reading, whichever is greater with gel samples
Response Time	< 6 seconds for full step change
Calibration Standards	0.02 NTU; 20 NTU; 100 NTU; 800 NTU
Standardization	EPA-approved polymer-based primary standards
Light Source	Infrared-emitting diode (850 nm wavelength)
Light Source Life	> 1,000,000 tests
Detector	Silicon photovoltaic
Stray Light	< 0.02 NTU
Display	4-digit 14-segments customized liquid crystal display with annunciators
Sample Cells (Vials)	Borosilicate glass with screw caps, fill line and indexing mark. 51 (H) x 25 (Dia) mm (2 x 1 in)
Sample Volume Required	10 ml (0.33 oz)
Operating Temperature Range	0°C to 50°C (32°F to 122°F)
Sample Temperature Range	0°C to 50°C (32°F to 122°F)
Operating Humidity Range	0-90% RH, non-condensing at 30°C (86°F)
Power Supply	4 x “AAA” Alkaline Batteries
Battery Life	> 1200 readings
Enclosure Type & Rating:	ABS Plastic / IP67 rated
Insulation Rating	Pollution Degree 2
Weight:	Meter: 200 g (7 oz) Meter with case: 1.25 kg (2.75 lb)
Dimensions	Meter: 6.8 (W) x 15.5 (L) x 4.6 (H) cm; (2.7 x 6.1 x 1.8 in) Meter with Case: 16 (W) x 35 (L) x 12 (H) cm; (6.3 x 13.8 x 4.7 in)

8. Addendum 1: Turbidity

8.1 Definition

Turbidity is defined as an "*expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample.*"[1] That is, turbidity is the measure of relative sample clarity, not colour.

Water with cloudy or opaque appearance will have high turbidity, while water that is clear or translucent will have low turbidity. High turbidity value is caused by particles such as slit, clay, microorganisms, and organic matter. By definition, turbidity is not a direct measure of these particles but rather a measure of how these particles scatter light.

8.2 Why Is It Important?

For drinking water application, a turbidity value may give an indication of presence of bacteria, pathogens, or particles that can shelter harmful organisms from disinfection process. Therefore, turbidity measurement is particularly useful for water treatment plants to ensure cleanliness.

In industrial processes, turbidity can be part of quality control measure to ensure efficiency in treatment or manufacturing process.

8.3 Measurement Principle

There are two internationally accepted standard specifications for turbidity measurement. These are the international standard ISO 7027 and the US EPA method 180.1.

Basically the ISO 7027 is a more stringent standard and requires the use of a monochromatic light source. It also governs the design of a turbidimeter in the following areas: (1) Light source's wavelength; (2) Light sources' spectral bandwidth; (3) Measuring angle; (4) Aperture angle in water sample; (5) Distance traversed by incident light and scattered light within the sample; (6) Calibration standard.

The TN-100/ T-100 turbidimeter follows the ISO 7027 standard whose specification allows for greater reproducibility of the measured values and greater agreement between other measuring instruments.

[1] Provided by "Standard Methods for the Examination of Water and Wastewater, APHA, AWWA and WPCF, 16th Edition, 1985.

Figure 14 shows the waterproof TN-100/ T-100 turbidimeter basic optical system. It includes a light source and a detector to monitor the light scattered at 90° with respect to the incident beam.

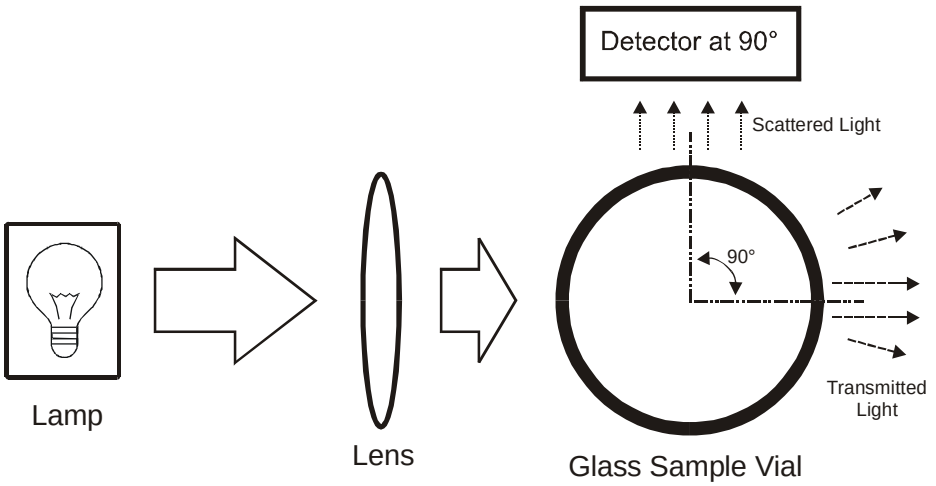


Figure 14: Basic Nephelometric arrangement for turbidity measurement

8.4 Nephelometric Turbidity Units (NTU)

Nephelometric Turbidity Units (NTU): Unit of measure used when relating the light scattered by a liquid media to the light scattered by a known concentration of a standard solution. This unit of measure is recognized as a measure of the optical clarity of an aqueous sample. NTU is the accepted unit of measurement for turbidity.

Another unit commonly used to measure turbidity is Formazin Turbidity Unit (FTU). The two units of measure of turbidity are equivalent: 1 NTU = 1 FTU.

8.5 Indexing a Vial

The United States Environmental Protection Agency (US EPA) recommends that vials used for turbidimeter calibration or sample measurement be indexed.

To index a sample vial, slowly rotate the vial throughout one complete revolution (360°). While rotating the sample vial, observe the display and locate the position that the vial is in which provides the lowest turbidity reading. This position is the indexed position of the vial.

Mark this position on the vial (not on the cap) against the mark on the meter.

After indexing a vial, make sure the vial will always be placed inside the sample well in the indexed position.

9. Addendum 2: Guide to Good Measurement Technique

Turbidity is a very complex analytical measurement which can be affected by many factors. Some are inherent in the instrument's design such as angle of detection, light beam aperture, incident beam wavelength and color sensitivity of the photocell.

However, there are other factors such as stray light, air bubbles and care of vial, which can be prevented through proper care of equipment and accessories, and in the operating procedure for measurement. Here are some points you may want to note:

9.1 Maintain sample vials in good condition

Sample vials must be meticulously clean and free from significant scratches. It should be treated on the outside with a thin coat of silicone oil. This is to mask minor imperfections and scratches that may contribute to stray light. Sample vials should be handled only by the top to avoid dirt accumulation (or deposits) and fingerprints that might interfere with the light path.

More information is found in Section 5.1 - Vials – Handling, Cleaning and Care on page 16.

9.2 Match Sample Vials

Best accuracy and repeatability of turbidity measurement are achieved using a single, indexed vial. However, for more convenience, different vials can be used for measurement provided their readings with the same solution are matched. That is, the meter gives identical readings or within the specified repeatability and accuracy of the meter.

Select a few vials. After the sample vials are cleaned, fill them with ultra-low turbidity water. Allow the sample vials to stand and for air bubbles to rise. Polish sample vials with silicone oil and take turbidity measurement at several points while rotating it in the sample well. Find the position where turbidity reading is the lowest and index it for each vial. Whenever these sample vials are used, use the indexed mark to position each vial into the sample well. Choose those vials that match the readings.

NOTE: *Not all vials can be matched because of some manufacturing variations.*

9.3 Degassing

Air or other trapped gases should be removed before measurement. Degassing is recommended even if no bubbles are visible. There are three methods commonly used for degassing:

- Addition of a surfactant: This involves adding a surfactant to the water samples to lower the surface tension of the water, thereby releasing trapped gasses.
- Application of a partial vacuum: Partial vacuum can be created by using simple syringe or vacuum pump. (This is only recommended for ultra-low turbidity measurement).
- Use of an ultrasonic bath: This may be effective in severe conditions or in viscous samples, but not recommended for ultra-low measurements.

Each of the method above has its own advantages and disadvantages. For instance, under certain sample conditions, the use of vacuum pump or ultrasonic bath may actually increase the presence of gas bubbles.

9.4 Timeliness of Sample

Samples should be measured immediately to prevent changes in particle characteristics due to temperature and settling. Temperature can affect particles by changing their behavior or creating new particles if precipitates are formed. Dilution water may dissolve particles or change their characteristics. It is recommended to take samples only when the turbidimeter is ready to be operated. Samples should not be drawn and allowed to sit while the instrument warms up or is being readied.

9.5 Other Important Sampling Techniques

1. Samples should not be violently shaken or agitated as particles can be broken apart or air may be entrapped into the fluid. Gentle agitation such as swirling the sample vial is advisable to reduce particle settling.
2. Sample vials should be used only with the instruments for which they were intended. Do not mix and match.
3. Perform a visual observation of the sample vial every time a measurement is made. Ensure that there are no visible bubbles in the sample and the vial is clean and free of scratches.
4. Samples entering the turbidimeter should be at the same temperature as the process flow samples. Changes in temperature can cause precipitation of soluble compounds and affect readings.
5. Sample vials should be evaluated with a low turbidity water (after cleaning) to determine if cells remain matched. If the evaluation determines that a cell is corrupted, discard the vial. It is recommended to conduct this evaluation weekly.
6. When in doubt or question about whether a sample vial is too scratched or stained, throw it away.

9.6 Calibration

1. Do not open the vials with calibration standards.
2. Check that the standards have not expired.
3. Make sure the calibration vials are free of dust, smudges and scratches before use.
4. Conduct the calibration in the same manner each time. Variations in how calibration is performed could yield inaccurate measurements.
5. It is very important that the user(s) who perform calibration have been trained to do so. Creating a Standard Operating Procedure (SOP) for the user(s) to read, learn, and practice may help to ensure accuracy.

9.7 Dilution

This dilution procedure is necessary only when your turbidity measurement is above 1000 NTU.

1. To measure the turbidity above 1000 NTU, dilute the sample with turbidity-free water.
2. Turbidity-free water can be obtained by filtering deionized water through a < 0.2µm filter membrane with precision-sized pores.
3. Measure the volume of the sample before dilution and record the value in ml (Vs).
4. Take a known volume (Vd) of dilution water and add it to the sample.
5. Pour 10 ml of the diluted sample in a clean vial and measure the turbidity of the diluted sample. Record this value in NTU (Td).
6. Calculate the true turbidity (T) of the original sample - in NTU - using the following formula:

$$T = Td * (Vs + Vd) / Vs$$

Example:

- Dilute 20 ml of the original sample (whose turbidity is above 1000NTU) with 50 ml of dilution water.
- Measure the turbidity of the diluted sample.
- If the reading is 300 NTU, the turbidity of the original sample is 1050 NTU. (In this case: Td=300NTU, Vs=20ml, Vd=50ml, so T = 300 * (20+50) / 20 = 300*70/20 = 21000/20 = 1050)

10. Warranty

The TN-100/ T-100 meter is supplied with a **2-year** warranty from manufacturing defects and calibration standards for **6 months**.

If repair or adjustment is necessary and has not been the result of abuse or misuse within the designated period, please return – freight pre-paid – and correction will be made without charge. Eutech Instruments/ Oakton Instruments will determine if the product problem is due to deviations or customer misuse.

Out of warranty products will be repaired on a charged basis.

Exclusions

The warranty on your instrument shall not apply to defects resulting from:

- Improper or inadequate maintenance by customer
- Unauthorized modification or misuse
- Operation outside of the environment specifications of the products

Waterproof Seal: Opening the instrument enclosure (excluding the battery compartment) may void the warranty.

11. Return of Items

Authorization must be obtained from our Customer Service Department or authorized distributor before returning items for any reason. A “Return Goods Authorization” (RGA) form is available through our Authorized Distributor. Please include data regarding the reason the items are to be returned. For your protection, items must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Eutech Instruments/ Oakton Instruments will not be responsible for damage resulting from careless or insufficient packing. A restocking charge will be made on all unauthorized returns.

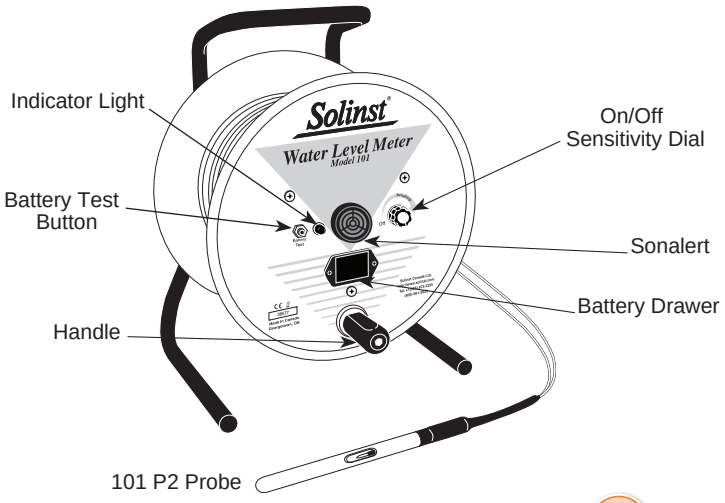
NOTE: *Eutech Instruments Pte Ltd/ Oakton Instruments reserve the right to make improvements in design, construction, and appearance of products without notice.*

For more information on Eutech Instruments/ Oakton Instruments' products, contact your nearest distributor or visit our website listed below:

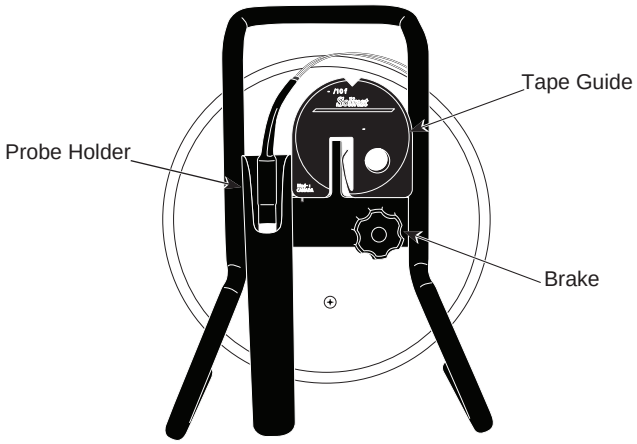
Oakton Instruments P.O Box 5136, Vernon Hills, IL60061, USA Tel: (1) 888-462-5866 Fax: (1) 847-247-2984 E-mail: info@4oakton.com Web-site: www.4oakton.com	**Eutech Instruments Pte Ltd** Blk 55, Ayer Rajah Crescent, #04-16/24 Singapore 139949 Tel: (65) 6778 6876 Fax: (65) 6773 0836 E-mail: marketing@eutechinst.com Web-site: www.eutechinst.com	**Distributed by:**

Solinst® Water Level Meter Operating Instructions

Model 101 P2



Front View



Back View

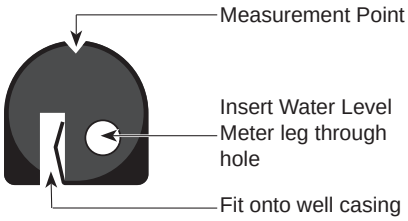
Equipment Check

1. Turn sensitivity dial **fully clockwise**.

> **Notes:** 1. Clockwise rotation of sensitivity dial turns meter on and increases sensitivity.
> 2. Always set switch to highest sensitivity position, then decrease if necessary.

2. Depress the Battery Test button to test the battery and main circuitry (does not test the tape or probe).
3. Submerse the probe in tap water. This completes the circuit and activates the buzzer and light.

The Tape Guide



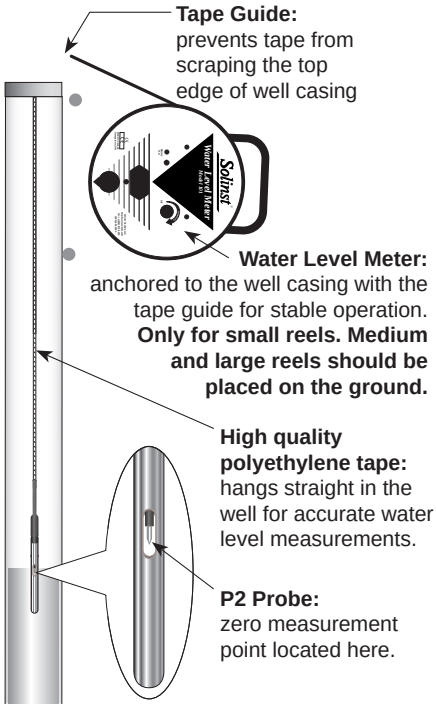
The Tape Guide has been designed to:

- Improve accuracy when reading water levels,
- Easily obtain repeatable measurements,
- Prevent tape being cut by well casing,
- Allow the tape and probe to hang straight from the side of the well.

1. Fit the small end of the Tape Guide onto the edge of well casing 2" (50 mm) diameter or larger.
2. For small reels only, insert the leg of the Water Level Meter into the hole on the Tape Guide and rest the Water Level Meter on the side of the well casing. (See diagram at right).
3. To store the Tape Guide, simply clip it onto the support bracket located on the back of the Water Level Meter.

Water Level Measurements

1. The P2 Probe zero measurement point is the tip of the needle in the center of the probe.
2. For ease of operation the Tape Guide can be used to support the Water Level Meter. (See diagram below).
3. Feed the tape into and out of the well using the groove in the top of the Tape Guide. The light and buzzer activate when the needle tip enters water. To ensure accuracy, lower and raise the probe a few times and then record the depth measurement from the tape at the top of the well.
4. When using the Tape Guide, the measuring point is offset from the top of casing. To adjust your measurements to the top of the casing, simply subtract the amount indicated on the front of the Tape Guide (i.e. 6 cm or 2/10 ft).



Routine Care

1. After the depth to water has been recorded, the tape should be carefully rewound onto the reel, the probe wiped dry and placed into the probe holder.
2. The probe, tape and reel can be cleaned with phosphate free (non-abrasive) detergent and warm water. Do not submerge the reel.
3. Use of a Water Level Meter Carrying Bag adds to the service life of the meter.
4. Use of the Tape Guide adds to the life of the tape.

Probe Care and Cleaning

1. The P2 Probe should be wiped clean after each use.
2. Remove any dirt or water from around the central sensor pin.
3. If the central sensor pin is corroded or coated, use emery cloth to polish it.
4. Check the P2 Probe seal/strain relief and replace the black heat shrink if there is any cracking or other damage.
5. After cleaning, place probe back in its holder.

Battery Replacement

- Battery type - alkaline, 9 volt.

1. The battery is housed in a convenient battery drawer located in the faceplate of the Water Level Meter.
2. To replace the battery, simply press the drawer in, lift then pull.
3. The battery drawer should slide out of the faceplate enough to pull it out.
4. Note the polarity (positive (+) terminal should be towards the small notch in the end of the drawer) and place new battery in the drawer and slide it back into the faceplate.

Replacement Parts

The following parts can be provided should they become lost or damaged.

1. Probes and seal kits
2. Splice kits
3. Lights, switches, etc.
4. Reels
5. Replacement tape with probe (Complete)
6. Assembled probes on shorter lengths of tape

Troubleshooting

SYMPTOM	CAUSE	REMEDY
No sound when probe immersed in water.	Dead battery.	Replace with 9V Alkaline.
	Water Conductivity is very low.	Increase sensitivity switch setting (turn clockwise) or call Solinst for assistance.
	Disconnected wires on circuit board.	Check all connections inside hub of reel for loose/disconnected wires - solder or reconnect.
	Broken wire in tape.	Locate break in tape - splice and seal, or replace. (Contact Solinst)
	Disconnected wire inside probe.	Contact Solinst to obtain parts/repair instructions.
Instrument continuously sounds after being immersed in water.	Water in probe. Probe may be dirty which could interfere with the circuit connection.	Contact Solinst for probe seal kit. Disassemble, clean and reassemble probe using the new seal kit.

For further information contact: Solinst Canada Ltd.
Fax: +1 (905) 873-1992; (800) 516-9081 Tel: +1 (905) 873-2255; (800) 661-2023
35 Todd Road, Georgetown, Ontario Canada L7G 4R8
Web Site: www.solinst.com E-mail: instruments@solinst.com

Solinst®

Redi-Flo 2® and Geotech Variable Frequency Drive Systems

Installation and Operation Manual

Rev 7/21/2020 Part # 21200175

Table of Contents

DOCUMENTATION CONVENTIONS

This uses the following conventions to present information:

WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.

CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.

NOTE

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

In order to ensure your Environmental Pump Variable Frequency Drive has a long service life and operates properly, adhere to the following cautions and read this manual before use.

This equipment contains voltages that may be as great as 1000 volts! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the start–up procedure or troubleshoot this equipment.

- **Disconnect from power source when not in use.**
- **Power input source must be within +/- 10% of ratings.**
- **Avoid spraying fluid directly at equipment.**
- **Never submerge equipment.**
- **Avoid pulling on wires to unplug equipment wiring.**
- **To prevent equipment damage, avoid dropping it.**

Do not operate this equipment if it has visible signs of significant physical damage other than normal wear and tear.

Notice for consumers in Europe:

This symbol indicates that this product is to be collected separately.

The following applies only to users in European countries:

- This product is designated for separate collection at an appropriate collection point. Do not dispose of as household waste.
- For more information, contact the seller or the local authorities in charge of waste management.

Section 1: System Description

Function and Theory

Variable Frequency Drive

The Geotech Variable Frequency Drive (VFD) is designed to operate and protect the Redi-Flo 2® (RF2) pump. Using the control interface, the operator can precisely control the RF2 pump discharge flow rate from 8GPM (30 LPM) to 100 milliliters per minute, to depths down to 280’ (85 m). In addition to providing precise control over the RF2 pump, the Geotech VFD protects the pump from adverse motor conditions such as over-and-under voltage, over-current, and ground fault. The Geotech VFD uses either 115V or 230V Single-Phase AC input power source for operation.

Dedicator®

The Dedicator® is a turnkey, dedicated sampling system designed for easy installation and operation. Each system is configured to meet site specifications, completely assembled, and tested prior to shipment. Dedicator® Systems include a low profile well seal, Happy Hose!® (integrated motor lead, safety cable and discharge tubing), a Grundfos Redi-Flo 2® MP1 2" electric submersible pump and all clamps and fittings. The well seal incorporates an access port for water level indicators when the sample tube is removed; low-clearance adapters are available to fit our standard 2" and 4" (5.08 and 10.2 cm) well seals in virtually any well pipe size.

Redi-Flo 2®/MP1 Pump

The Grundfos Redi-Flo 2® electrical submersible pump provides smooth, uninterrupted water flow during ground water sampling to depths down to 280’ (85 m). Both high flow rates needed for purging and low flow sampling are achieved with the same pump.

System Components

Variable Frequency Drive

The Geotech VFD System includes:

- Variable Frequency Drive in NEMA 4 carry case with water-tight cable seals mounting bracket.
- The carry case is designed for outdoor duty and is resistant to damage as a result of incidental exposure to rain.
- Power cable with standard NEMA 5-15P plug (115V supply model) or open-wire pigtail cable (230V supply model).

Geotech VFD features:

- UL Approvals: The Geotech VFD is UL Listed to U.S. and Canadian electrical safety standards.
- Torque Boost: The Geotech VFD is equipped with a torque boost (voltage boost) feature to aid in start-up under severe conditions.

- Optimized Volts/Frequency (V/HZ) Pattern: The Geotech VFD V/Hz pattern is specially optimized to allow the most efficient operation of the Redi-Flo 2® pump.

A complete system includes:

- Redi-Flo 2® (MP1) pump and motor lead.
- A discharge hose to connect to the pump.
- Safety cable and hardware for lowering and lifting the pump.

An electrical plug to connect the VFD power cord to your portable generator may be needed if the supplied plug is not compatible with your generator or in the case of a 230V supply model.

An extension pump cable may be needed depending on your pump cable configuration.

Dedicator® Systems

The Dedicator® includes:

- Grundfos Redi-Flo 2® MP1 2" electric submersible pump
- Happy Hose!® integrated motor lead, safety cable and discharge tubing
- Configured systems to meet site specifications
- Well identification tag
- In-the-well sample tube storage
- Fits 2" (5.08 cm) or larger wells
- UL rated weather-resistant electrical connection with cap
- Water level access port
- Well seal provides a liquid tight barrier (see details below)
- Ideal for purge and sample or low-sampling methods

Redi-Flo 2® Well Seal

- NEMA – 6P rated weather resistant electrical connection with cap for connecting the extension cable to the VFD.
- Discharge port for connection to the sampling tube assembly, and a stainless steel discharge fitting for 0.5” ID tubing.
- Storage/access port for storing sampling tube assembly, using a water level indicator, or other down hole device with an OD less than 0.5”.

Redi-Flo 2®/MP 1 Pump

RF2 features include:

- Chemically inert materials
- Maximum sample integrity and easy decontamination
- 1.8 inch (4.6 cm) diameter
- Easy access into 2" (5 cm) or larger wells
- Flow rates range from 8 GPM (30 LPM) to as little as 100ml⁄min
- Controlled with the simple push of a button

- Low velocities and agitation
- Ideal for sampling and purging
- Eliminates the need for control valves
- Continuous flow
- Dedicated or Portable configurations available

Designed for long-term reliability in dedicated monitoring wells, the Redi-Flo 2® provides optimal sample quality. Whether doing traditional purge and sample or low-flow sampling, when operated with the Geotech VFD (Variable Frequency Drive) flow control is easy.

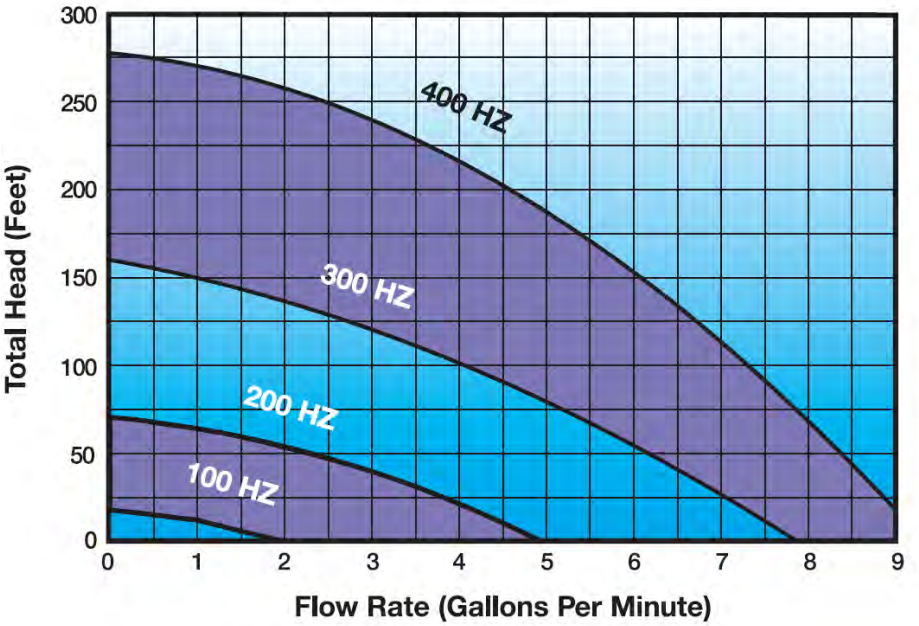


Figure 1-1: Flow Rate

Purging and sampling with the same pump is extremely efficient. The unique design and superior materials allow for easy operation, decontamination and maintenance, and disassembly and reassembly.

RF2 Accessories

Professional accessories make your job easier, your equipment last longer, and protect your investment.

Geotech offers a shroud specifically designed for use with the Grundfos Redi-Flo 2® in wells 4" (10cm) in diameter or larger. The Redi-Flo 2® electrical submersible pump is designed to stay cool by the action of water passing rapidly over the body of the stainless steel and PTFE pump. In 2" (5 cm) diameter wells, this is achieved automatically. In larger diameter wells, the pump may overheat causing permanent damage to the inner workings. The Geotech pump shroud can help to avoid damage to the Redi-Flo 2® pump.

If your site plan requires all the water passing through your pump be disposed of and not allowed to return to the well, ask your sales representative about our custom stainless steel check valve.

Figure 1-2: RF2 Accessory Options

Other Accessories

For portable systems, Geotech offers a variety of portable reels and well caps. Contact Geotech at 1-800-833-7958 for more information.

Section 2: System Installation

The pumping system is not approved as explosion-proof. Local authorities and regulations should be consulted if there is any doubt about its suitability for a certain application.

Reverse Rotation Test

Connect the motor lead to the Geotech VFD and test the rotation of the pump. Submerge the pump in water, start it at its slowest speed and make sure the pump shaft is turning counterclockwise (when viewed from the top).

Attaching the Pump to the Pipe

Use a wrench when connecting piping to the pump. After the first section of pipe has been attached to the pump, connect the safety cable to the pump.

Do not clamp to the pump.

When raising the pump, do not pick up pump from the pump end only. Picking up from the pump end only places bending stress on the pump. Geotech recommends attaching a safety cable to the pump (using special brackets and cables, sold separately, see *Section 7: Parts and Accessories*) anytime plastic pipe or flexible tubing is used.

A check valve may also be added to Redi-Flo 2® pumps to prevent fluid from flowing back into the pump after it is turned off (backflow prevention).

Always check to ensure joints are fastened securely. The use of a torque arrestor is not required when using the Geotech VFD.

Lowering the Pump into the Well

Ensure the electrical motor leads are not cut or damaged in any way when the pump is being lowered into the well.

Do not use the motor leads to support the weight of the pump.

To protect against surface water entering the well and contaminating the well, Geotech recommends using a locally approved well seal.

Secure the motor lead to the discharge pipe at frequent intervals to prevent sagging, looping and possible motor lead damage. PTFE wire ties are recommended for environmental applications.

Plastic pipe and tubing tend to stretch under load. This stretching must be taken into account when securing the motor lead to the riser pipe or tubing. Leave 3”-4” of slack between clipped points. This tendency to stretch will also affect the calculation of the pump setting depth. When plastic pipe or tubing is used, it is recommended that a safety cable be attached to the pump to raise and lower it.

Redi-Flo 2® pumps can be fitted with a safety cable bracket (See *Section 7: Parts and Accessories*)

Dedicator® Installation

The Dedicator® Dedicated Sampling System was designed to be installed by lowering the pump and Happy Hose® into the well then tightening the bolts on the well seal to accomplish a water-tight seal.

A 3/16” long-arm hex key is provided for installation.

1 . Check the water level and total depth of the well to verify the correct installation elevation.
   - Happy Hose!® lengths (“A”) are referenced from the bottom of the pump to the bottom of the well seal plate (see Figure 2-1 dimension “A”).
   - The well seal plate sits flush against the top of the well casing.

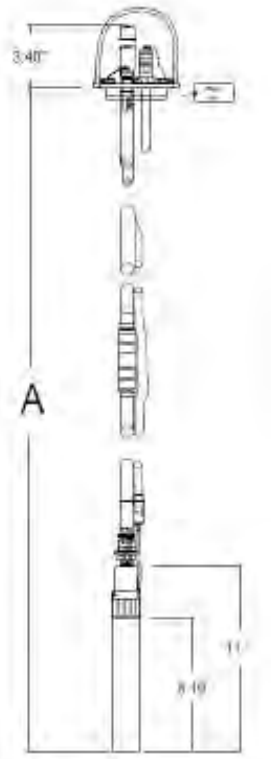


Figure 2-1: Reference Points for Dedicator® Installation

2 . Position the Dedicator® assembly over the well opening and lower the pump and Happy Hose® slowly into the well.
   - Be sure not to scrape the Happy Hose® on the edge of the well casing.

3 . Once the system is lowered, position the well seal onto the well casing until seated.

4. Tighten all the bolts on the well seal.

5 . To store the sample tube, feed the sample tube down into the well through the access port.
   - The sample tube was designed to be stored in the well when not in use.
   - The sample tube is included loose in the shipping box.

6 . Thread and tighten the sample tube end fitting into the port.

DO NOT OVER-TORQUE THE FITTING — it is only necessary to tighten the fitting until the O-ring is seated on the seal.

7. Thread and tighten the access port plug into the top of the sample tube fitting (see Figure 2-2).

The Dedicator® will operate only when used with the Geotech VFD Converter.

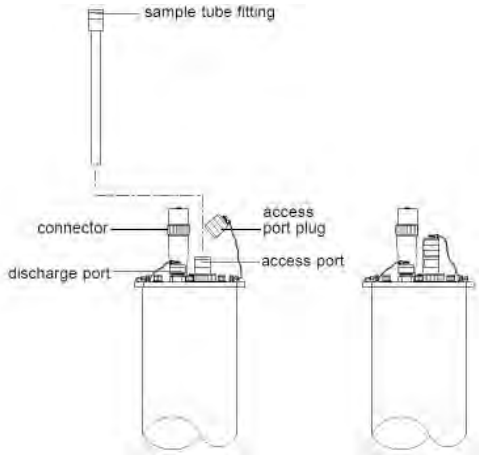


Figure 2-2: Reference Points for Dedicator® Installation

Installing the Well Seal

1) Determine the depth at which you'll install the MP1.

2) Connect the discharge hose to the MP1.
   - Refer to the Redi-Flo 2® Installation and Operating instructions (see *Section 3: System Operation*).
   - Do not connect the motor lead to the VFD.

3) Connect the discharge hose to the well seal.
   - The Redi Flo 2® pump Well Seal can only be connected to a hose with a 1/2" internal diameter.
   - To do so:
     a. Make an even cut through the hose at the desired length.
     b. Slide the clamp over the end of the hose.
     c. Push the end of the hose over the hose nipple.
     d. Secure the hose with the clamp.

4) Connect the Motor Lead to the Well Seal.
   - Motor leads are shipped with one end connected to the MP1 pump and the other to a well seal when system lengths are provided.
   - Connecting to Well Seal in the field by using the directions below:
     a. Use pliers to unscrew the retaining ring.

b. Use a small screwdriver (3 mm blade or smaller) to remove the screw holding the terminal block on the side of the housing and then loosen each wire from the electrical terminal block.
c. With the motor lead free from the connector cut across the leads diagonally to make it easier to push it through the well seal gasket.
d. Make sure to leave enough slack in the motor lead (2-3" of tubing length).
    - As the pump assembly is lowered into the well, the hose is sure to stretch.
    - Unless slack is put into the motor lead the entire weight of the pump will be borne by the lead, causing possible wire breakage or a bad connection.
e. Push the lead through the well seal gasket.
f. Strip 1/4" from the end of each wire and insert each back into its proper terminal slot at the back of the terminal block (yellow/green is ground; wire next to it is #3, then #2, then #1).
g. Tighten the screw down over each terminal to secure the wire.
h. Test each connection by pulling on it gently.
i. Insert the block into the well seal's electrical housing, lining up the screw hole in the housing with the one in the terminal block.
j. Secure them together with the screw you removed earlier (this also grounds the pump).
k. You may wish to connect the discharge hose and lead together (i.e. with a wire tie) just below the well seal to keep them together.

5) Install the sampling tube assembly
    - Install sampling tube assembly (provided separately) by removing the plug in the access port and inserting the sampling tube assembly through the port.
    - Seal the top of the sampling tube assembly with the plug.

6) Lower the pump into the well
    - Position the pump over the well opening and lower it slowly into the well.
    - Do not to scrape the motor lead or discharge tube on the edge of the well casing.

7) Secure the seal to the well casing –
    a. Insert the well seal into the end of the well casing until seated.
    b. Tighten the Allen screws on top of the seal forces the seal's rubber gasket to expand against the inside edges of the casing, thereby sealing it.
    c. Cover the electrical connection with the hood provided.

Redi-Flo 2® Installation

To ensure the Redi-Flo 2® Variable Performance Pumping system operates properly, follow these guidelines:

- The Redi-Flo 2® pump must be installed vertically with the discharge end pointed upwards.

- The electrical voltage supply to the Geotech VFD must always be within + or - 10% of the specified power supply.
- For best performance when operating on a generator, 115V generators should be set at 120V without load and 230V generators should be set at 240V without load.
- Use a separate meter to set voltage; do not rely on built-in meters found on generators.
- The pump and motor must always be completely submerged in fluid to ensure lubrication and cooling of the motor.
- The temperature of the fluid being pumped should be according to the technical specifications shown in the motor specifications.
- The installation depth of the pump should always be at least 3' (.9 m) below the maximum drawdown level of the well.
- Redi-Flo 2® pump is not recommended for well development or pumping fluid
- containing abrasives.
- Redi-Flo 2® pump is not recommended for continuous operation applications.
- The warranty of the Redi-Flo 2® pumps will be void if other than the Geotech VFD is used or if corrosive fluids are pumped.
- The service life of dedicated Redi-Flo 2® pumps may be compromised if the ambient water quality exceeds one or more of the following values:

pH<5 DO>2 ppm H2S>1 ppm CL->500 ppm TDS>1000 ppm

Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that grounds are connected. Electrical shock can cause serious or fatal injury.

A qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations should perform all electrical work.

Section 3: System Operation

When pumping water containing hazardous material, personal safety equipment must be used.

Quick Start Guide

1. Fully submerge RF2 in the water to be pumped.
2. Connect the motor lead to the VFD.
3. If using a generator, start the generator and allow sufficient time for it to warm up.
4. Ensure VFD knobs are in the following positions:
5. Plug VFD into generator or utility power supply; ensure incoming power is compatible with unit's configured power.

Figure 3-1: VFD Knobs

6. Turn the bottom "PWR" knob to the "ON" position.
    - Do NOT press down on the lockout button while turning.
    - "STOP" will be shown on the display.
7. Turn the middle knob to the "FWD" (right) position.
    - "Hz 0.0" will be shown on the display.
8. To begin pumping, use the top knob to increase or decrease speed.
9. Use the ▢ (Navigate) button to toggle speed in Hz and current in Amps.
10. When powering down, return all knobs to positions shown in step #4.
11. Unplug the VFD from the generator BEFORE removing the motor lead from the VFD or turning off the generator.

To ensure the Redi-Flo 2® and Geotech Variable Performance system operates properly, follow the guidelines listed in *Setion 2: System Installation.*

Incorrect wiring on the 115V or 230V terminal will damage the drive, double check that power source voltage matches VFD voltage.

Adherence to Environmental Regulations

When handling and operating the Redi-Flo 2® Pump system, all environmental regulations concerning the handling of hazardous materials must be observed. When the pump is taken out of operation, great care should be taken to ensure that the pump contains no hazardous materials that might cause injury to human health or to the environment.

Purging a Well

If the pump is used to purge a well, start the pump at minimum speed and gradually increase to desired speed. Redi-Flo 2® products are not recommended for well development.

Generator Usage

Minimum generator size (Redi-Flo2®)

For Generators With Voltage Regulation	2000 Watts at 115/230 VAC, single phase
For Generators without Voltage Regulation	5000 Watts at 115/230 VAC, single phase
Recommended for Optimal Performance w/voltage regulation	3000 Watts at 115/230 VAC, single phase

Generators and grid-power sources must have an outlet without a ground fault circuit interrupter (GFCI). VFDs, when powered from GFCI outlets cause the GFCI to trip due to leakage currents generated and harmonics associated with them.

Dedicator® Operation

Step 1

1. Remove top plug from access port.
2. Remove the sample tube from the access port, and then remove the discharge port cap.
3. Attach the sample tube fitting to the discharge port fitting and tighten.
   - Do not re-install access port top plug.
4. Port must be open during operation to vent the well.
   - It is okay for the top plug to rest in the access port, but DO NOT tighten it.

Step 2

1. Remove connector hood.
2. Attach the extension cable to the well seal connector.
3. Attach the other end of the extension cable to the VFD.

Step 3

Operate the pump and VFD per the pump and VFD specifications found in *Section 6: Technical Specifications*.

To start the pump see the “Quick Start Guide” at the beginning of this section.

The pump may become clogged if pumping suspended solids. Refer to the *Section 4: System Maintenance* to dismantle the pump end.

Step 4

1. When sampling is complete, turn off the VFD by moving the **Start/Stop** switch to the "Stop" position.
2. TURN THE POWER OFF AT THE GENERATOR before disconnecting the Dedicator® VFD cable from both the well seal and the VFD.
3. Disconnect the sample tube from the discharge port fitting and store the sample tube.

Step 5

1. Replace and tighten the discharge port cap and the access port top plug.
2. Replace the hood on the well seal connector.

Operating Conditions

- The electrical voltage to the VFD must always be + or - 10% of the specified power supply voltage.
    - For the 230V VFD: between 207 and 253 volts, single phase AC;
    - For the 115V VFD: between 104 and 126 volts
- The motor and pump must be completely submerged in fluid to ensure lubrication of the shaft seal and cooling of the motor.
- The pump is capable of producing a total head equivalent to 280' (85 m) of water.
    - Total head includes the distance from the ground level to the pumping level of the water in the well and all friction losses.
- If the pump is used in a well larger than 4" in diameter, a shroud should be used around it to ensure proper motor cooling — call Geotech for more details.
- The temperature of the water being pumped should be between 34°F and 86°F (1°C and 30°C).
    - If the temperature drops below freezing and your pump is frozen so the motor shaft cannot rotate.
    - Pull the pump out, lower it into water, and start it at the slowest speed possible.
    - Continue to operate the pump at this speed for about 10 minutes, at which time it should thaw and operate properly.

Preparing to Take a Sample

1) Loosen/remove the access port plug – this port **MUST NOT** be left open while the sample is being collected.

2) Attach the sampling tube assembly by remove the tube assembly from the access port and attaching it, finger tight, to the discharge port fitting.

3) Make the electrical connection by removing the hood from the electrical connection and attach it to the extension cable from the well seal to the VFD.

Important Do's and Don'ts

A Checklist to prevent the most common problems:

- ☐ **Do** lower the pumping system slowly down the well
- ☐ **Do** tighten all allen bolts before operating the system
- ☐ **Do** remove sample fitting from storage port and install on purge port before operating

- ☐ **Don't** leave the plug on the access port during operation
- ☐ **Don't** over-tighten the sampling tube assembly when installing in an access hole for storage. It is only necessary to tighten it until the O-ring is seated on the seal.
- ☐ **Don't** allow water to build up inside the well seal connector. If water build-up does occur, dry COMPLETELY before operation.

Section 4: System Maintenance

Per use maintenance:

1. Inspect extension cord for cuts, broken housings or connector pins.
2. Ensure VFD is securely mounted and inspect for cracks, dirt or other damage.

General maintenance

Clean VFD enclosure and case as needed with mild soap and water on a cloth. Do not use abrasive cleaners or solvents. Do not spray with water or any other liquid or pressured solvents.

Dedicator® Maintenance

The Dedicator® requires minimal maintenance due to the specially designed features. To properly care for the Dedicator®*:*

1. Replace all caps, plugs, and hoods on the well seal when wear is apparent to prevent contamination and corrosion of electrical connections.
2. Store the extension cable in a dry place with the VFD.
3. Make sure the well seal connector is completely dry before operating.

There is no recommended preventative maintenance for pump components. Reduced pump performance may be indicative of wear, especially if pumping suspended solids. See Redi-Flo 2® Maintenance later in this section. Disassemble the pump end impeller assembly and examine for wear according to the following:

- Impellers --- should show no visible wear
- Guide vane --- should show no visible wear
- Wear ring --- minimum thickness should never be less than 1.0mm

Replace any worn components using either a pump-end replacement kit or a PTFE pump-end replacement kit. See *Section 7: Parts and Accessories.*

Redi-Flo 2® Maintenance

Decontamination

If the pump is moved from well to well, it should be thoroughly decontaminated prior to being installed in the next well. In addition to cleaning the individual components inside and outside, the water in the pump motor should be replaced using a syringe (11200032). This can be accomplished through the following steps:

1. Shut the pump off by placing the Redi-Flo 2® VFD in the stop position.
2. Disconnect Redi-Flo 2® VFD from power supply or generator.
3. Disconnect the motor lead from the Redi-Flo 2® VFD.
4. Remove the discharge tubing and the pump end.

5. Turn the pump and motor upside down.
6. Use a flat blade screwdriver to remove the filling screw on the bottom of the motor.
7. Remove the three Allen head set screws at the bottom of the motor with a 2.5 mm Allen wrench.
8. Push gently on the motor shaft to move bearing housing out of the stator housing
9. Continue to remove bearing housing and motor shaft from stator housing.
10. Clean motor shaft with a brush.
11. Empty the water from the motor.
12. Clean inside of stator housing with a brush.
13. Replace motor shaft into stator housing.

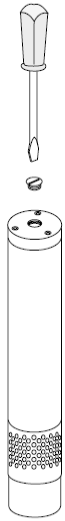


Figure 4-1: Disassembly

14. Refill motor using contaminant-free deionized water using a syringe (11200032).
15. Replace bearing housing and tighten Allen screws.
16. Continue to add water until the level is even with the bottom edge of the screw hole.
17. Replace and tighten the filling screw.
18. Turn the pump over several times, then remove the filling screw again to let any trapped air escape (if air is left inside the motor, the life of the motor will be shortened). Add more water, as necessary. Fluid should overflow when the fill cap is screwed back on the motor cavity.
19. Replace and tighten the filling screw.
20. Replace pump end and piping

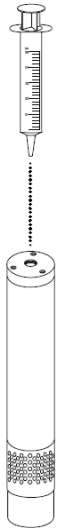


Figure 4-2: Motor Lubrication

Replacing the Motor Lead

To replace the motor lead, refer to the diagram and follow these steps:

Removing the Old Motor Lead

1. Make sure the Redi-Flo 2® VFD is turned OFF, and the motor lead is not connected to the Redi-Flo 2® VFD.

2. Loosen and remove the Set Screw from the Inlet Screen

3. Slide the Inlet Screen off the pump. If you plan to use this motor lead again, be careful not to scrape insulation from it as the Inlet Screen is removed.

4. Loosen and remove the Pump Housing. Remove the impeller assembly (impellers, guide vanes, etc.).

5. Use a 6mm wrench to loosen and remove the Motor Lead Screw for the ground lead (green/yellow wire).

6. Pull up on the ground lead to remove it. Using a small screwdriver and precision electronics pliers, pry up and remove the PTFE Washer and Brass Washers from inside the enlarged Ground Motor Screw Remove the 8mm Ground Motor Screw.

7. Use an Allen wrench (2.5 mm) to remove the two Motor Screws holding the Suction Interconnector in place. Remove the Suction Interconnector but be very careful to note which of its slots is lined up with which motor lead -- this will be very helpful during reassembly. You may wish to scratch a mark on both the Suction Interconnector and the motor to aid in matching them up later.

8. Refer to the illustration on the next page.

9. Use a 6mm wrench to loosen and remove the remaining Motor Lead Screws

10. Pull up on each of the leads to remove them. Make a note which lead comes out of each hole-- this is necessary when installing the new motor lead. Using a small screwdriver and precision electronics pliers, unscrew and remove the PTFE Washer and the Grommet

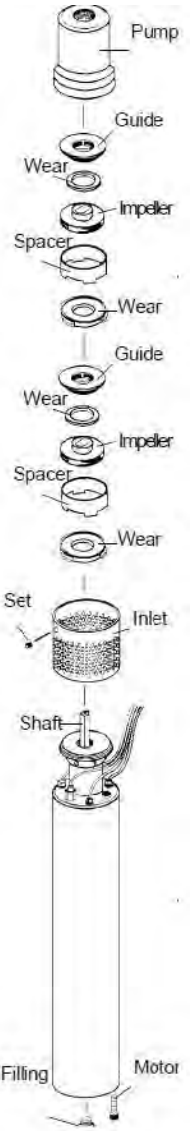


Figure 4-3: RF2 Components

Installing the New Motor Lead

1. Ensure the motor lead holes are clean and free of moisture.

2. String the Inlet Screen onto the motor lead.

3. String the motor lead components (shown at right) onto the end of each motor lead wire (except the striped green ground wire). Using a wire crimp tool, properly crimp each pin onto the lead wires.

4. For each wire, place the Crimped Pin down into the motor lead hole. Press the Grommet and PTFE Washer down around the lead. Be sure to reconnect the lead wires in their previous pattern described below.

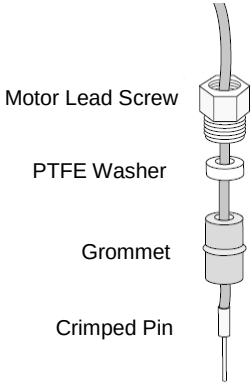


Figure 4-4: Power Conducting Motor Lead

- For motor lead, use the following wiring pattern: 1, 2, 3, clockwise from ground terminal (striped green)

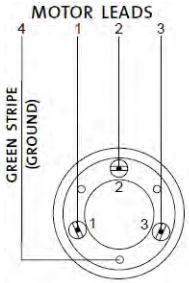


Figure 4-5: Motor Lead Connections

5. While pushing the lead down into the motor lead hole, use a 6mm wrench to tighten the Motor Lead Screw into place. Repeat for the other two lead wires.

6. Replace the Suction Interconnector. Replace the Ground Motor Screw. Since the ground wire will be attached to this screw, you will want to put it into the hole that will cause the least amount of twisting to the wire.

7. Replace and tighten the two Motor Screws with an Allen wrench.

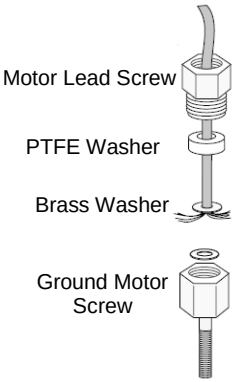


Figure 4-6: Ground Motor Lead

8. String the motor ground lead through the hex lead screw, PTFE washer and brass washers. Strip about 1/4 inch of insulation from the lead and fray the copper strands outward as shown.

9. Press the washers down into the ground screw and tighten the motor lead screw in place.

10. Return the impeller assembly to the top of the Suction Interconnector. Refer to Figure 4-3 for the proper sequence.

11. Screw the Pump Housing back onto the Suction Interconnector.

12. Position the motor lead in the recessed area of the Pump Housing.

13. Carefully push the Inlet Screen over the Pump Housing and the Suction Interconnector.

14. Line up the screw hole in the inlet screen with the screw hole in the pump housing.

15. Fit and tighten the set screw.

16. Connect the motor lead to the Redi-Flo 2® VFD and test the rotation of the pump.

17. Submerge the pump in water, start it at its slowest speed and make sure the pump shaft is turning counterclockwise (when viewed from the top). If the rotation is incorrect, switching any two power leads (with POWER OFF) will correct the problem.

Figure 4-7: Shaft Orientation

18. Reconnect the tubing or pipe.

Motor Inspection

If the pump is operating at a decreased capacity and the impeller assembly components (impellers, guide, vanes, etc.) do not appear to be the cause, the motor should be checked. A checklist of things to examine includes:

- Check the fluid level inside the motor. Replace and refill as necessary. See the section on “Decontamination” earlier in this section.
- Inspect the outside of the motor for cracks, dents, etc.
- Remove the Inlet Screen, Pump Housing, and the impeller assembly (see Figure 4-3).
    - Try to spin the motor shaft by hand.
        - It should spin freely.
        - If it does not, the motor must be replaced.

Motor Winding Test

This test checks for a short or open circuit in the pump and/or the motor leads. Place the pump in water. Using an Ohmmeter, measure resistance between any two power leads (see test below). The measurement should be 3 to 7 ohms depending on system length. The readings should be the same between any set of power leads. If the readings are zero, there is a short circuit in the pump or there is a set of nicked power lead wires. If the readings are greater, there is a cut motor lead.

Details of this test are as follows:

A. Turn off the power and unplug the *DEDICATOR*® from the VFD.
B. Using an Ohmmeter, set the scale to R X 1. Zero-adjust the meter and measure the resistance between any two power conducting leads (prongs on the motor lead plug). Compare the obtained reading to the value in the following table:

Lead Length	Ohm Value	Lead Length	
0 Feet	3.0 - 3.5	150 ft.	4.8 - 5.3
50 ft.	3.6 - 4.1	175 ft.	5.1 - 5.6
75 ft.	3.9 - 4.4	200 ft.	5.4 - 5.9
100 ft.	4.2 - 4.7	250 ft.	6.0 - 6.5
125 ft.	4.5 - 5.0	300 ft.	6.6 - 7.1

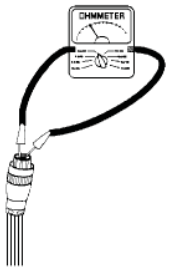


Figure 4-8: Ohmmeter Example

C. If the Ohm valve is too low, the motor may be shorted. If too high, the motor windings or the leads may be open.

Insulation Resistance Test

This test checks for a short to ground in the pump and/or the motor leads. Place the pump in water. Using an Ohmmeter, measure the resistance between the ground lead and each power lead (see Figure 4-9). The resistance to each power lead should be greater than 2 meg ohms. If the resistance is less than 2 meg ohms, the pump is defective or there is a nicked/cut motor lead.

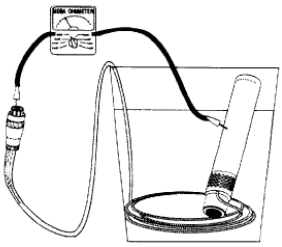


Figure 4-9: Using an Ohmmeter

Checking the Impellers for Wear

If pump performance decreases, the impellers may need to be replaced or cleaned. The Redi-Flo 2® can be dismantled and reassembled quickly and easily (see Figure 4-3).

Dismantling

Periodically, it will be necessary to check the pump for impeller wear.

1. Disconnect all power to the pump.
2. Remove the discharge hose.
3. Remove the Intake Screen Screw.
4. Carefully pull the screen up. Take care not to nick any motor leads.
5. Unscrew the pump housing.
6. The impeller components can now be inspected.

There is no recommended preventative maintenance for pump components. Reduced pump performance may be indicative of wear, especially if pumping suspended solids. Disassemble the pump end impeller assembly (see Figure 3-1) and examine for wear according to the following:

- Impellers --- should show no visible wear
- Guide vane --- should show no visible wear
- Wear ring --- minimum thickness should never be less than 1.0mm

Replace any worn components using either a pump-end replacement kit or a PTFE pump-end replacement kit (see *Section 7: Parts and Accessories*).

Checking the Extension Cable

To test the extension cable, use an Ohmmeter and check for continuity between connectors for each wire. To do this, select any one wire in the connector at one end of the cable and connect it to the Ohmmeter. Connect the other end of the Ohmmeter to the same wire at the other end of the cable. Do this for all four wires. The Ohmmeter will show if there is a short in any of the wires (see Figure 4-10).

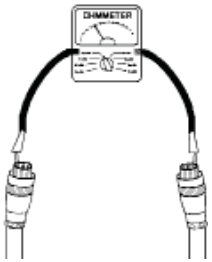


Figure 4-10: Checking the Extension Cable

Re-assembly (refer to Figure 4-3)

1. Make sure the system is not connected to the VFD.
2. Return the impeller assembly to the shaft in the proper order.
3. Screw the Pump Housing back onto the top of the pump.
    - If all the impellers and chambers were re-placed correctly, the Pump Housing should screw on easily.
4. Hand tighten.
5. Slip the Inlet Screen back over the Pump Housing.
6. Screw the Set Screw back into the Inlet Screen.

Section 5: System Troubleshooting

Fault Code Messages

Fault Code	Description	Corrective Action
STOP	Drive is READY and in a stopped condition. The motor is not energized. No enable signal is present to start the drive.	
O-I	Instantaneous Over current on the drive output. Excess load or shock load on the motor.	**Fault occurs immediately on drive enable or run command:** Check the output wiring connections to the motor and the motor for short circuits phase to phase and phase to earth. **Fault occurs during motor starting:** Check the motor is free to rotate and there are no mechanical blockages. If the motor has a brake fitted, check the brake is releasing correctly. Check for the correct star-delta motor wiring. **Fault occurs when motor operating at constant speed:** Investigate overload or malfunction.
O-uoLt	Over voltage on DC bus	Check the supply voltage is within the allowed tolerance for the drive.
U-uoLt	Under voltage on DC bus	The incoming supply voltage is too low. This trip occurs routinely when power is removed from the drive. If it occurs during running, check the incoming power supply voltage and all components in the power feed line to the drive.
I_t-trP	Motor thermal overload protection trip. The drive has tripped after delivering >100% of motor rated value in *9906* for a period of time to prevent damage to the motor.	Check for correct Star or Delta wiring configuration. Check to see when the decimal points are flashing (which indicates the output current > parameter ***9906*** value) and decrease motor load. Check the total motor cable length is within the drive specification. Check the load mechanically to ensure it is free, and that no jams, blockages or other mechanical faults exist
O-t O-hEAt	Heatsink over temperature	The drive is too hot. Check the ambient temperature around the drive is within the drive specification. Ensure sufficient cooling air is free to circulate around the drive. Increase the panel ventilation if required. Ensure sufficient cooling air can enter the drive, and that the bottom entry and top exit vents are not blocked or obstructed.
U-t	Under temperature	Trip occurs when ambient temperature is less than -10°C. The temperature must be raised over -10°C in order to start the drive.
h O-I	Hardware Over Current	Check the wiring to motor and the motor for phase to phase and phase to earth short circuits. Disconnect the motor and motor cable and retest. If the drive trips with no motor connected, it must be replaced and the system fully checked and retested before a replacement unit is installed.
th-FLt	Faulty thermistor on heatsink.	Refer to your local Geotech representative
OUt-F	Output fault	Indicates a fault on the output of the dirve, such as one phase missing, motor phase currents not balanced. Check the motor and connections

If you are experiencing faults other than those listed above, please call Geotech Technical Support for immediate assistance, (800) 833-7958.

Section 6: System Specifications

VFD Specifications

Electrical	
Input (115V model)	115V(+/-10%)/1PH/48-62Hz/23A
Input (230V model)	230V(+/-10%)/1PH/48-62Hz/23A
Output	1.1kW/400Hz/220V/3PH/5.5A
Acceleration Time (preset)	0 to 400Hz, 5 seconds
Deceleration Time (preset)	0 to 400Hz, 5 seconds
Recommended Input Protection (115V)	Fuse, 600V, 30A, Fast Acting, UL Class CC or J
Recommended Input Protection (230V)	Fuse, 600V, 25A, Fast Acting, UL Class CC or J
Power Cord	18AWG, 300V, 6ft
Minimum/Maximum Frequency	1Hz/400Hz
Dimensions and Weight	
Dimensions (L x W x D)	
Protective Case	19.2” x 15.2” x 9.0” (49 x 39 x 23cm)
VFD Only	10.12” x 7.40” x 7.16” (26 x 19 x 18.2cm)
Weight	
VFD, Cords and Case	18 (8.16kg)
VFD Only	8lbs (3.62kg)
Operations Conditions	
Ambient Temperature	-20°C – 50° C (4°F - 122°F)
Storage Conditions	
Ambient Temperature	-40 - 60degC (-40 - 140degF)
Maximum Humidity	95%, non-condensing
Protective Case Construction	
Case	Lightweight, Strong HPX® Resin, IP66/NEMA 4
Options	
Models:	115V Input
	230V Input

Submersible pump Grundfos MP 1/Redi-Flo 2® Specifications

Electric	
Full Load Rating	.5 HP/220V/3PH/400 Hz/5.5A
Maximum Current	5.5 amps
Motor Protection	Thermal Overload Thermik Geratebau, Series Sy6 (176°F/80°C)
Current Overload	Incorporated into Redi-Flo VFD (9.0A for 10 seconds)
Piping Connection	
Discharge Port	1/2" Female NPT
Operating Conditions	
Minimum Ambient Fluid Temp.	34°F (1°C)
Maximum Ambient Fluid Temp.	80°F (28°C)
Motor Fluid	
Motor Lubricating Fluid	Deionized (DI) Water
Dimensions & Weight (Pump & Motor)	
Dimensions	11.3" L X 1.81" D (28.7 cm L X 4.6 cm D)
Weight	5.5 lbs (2.5 kg), excluding motor lead
Lead Lengths	
Standard Lengths in Feet	30, 50, 75, 100, 125, 150, 175, 200, 250, 250, 300 (9,15, 23, 30, 38, 46, 53, 61, 76, 91 meters)
Custom Lengths	Available in 1' (0.3m) increments from 30' – 300' (9 m – 91 m)
Optional Cooling Shroud	
Dimensions	9.9" L X 2.375" OD (25 cm L X 6 cm OD)

2" and 4" Dedicator® Specifications

2" OD Dedicator® outside diameter:	3.90" (9.9cm)
4" OD Dedicator® outside diameter:	5.96" (15.1cm)
2" ID Dedicator® outside diameter:	2.38" (6cm)
4" ID Dedicator® outside diameter:	4.50" (11.4cm)
Minimum height clearance required:	3.41" (8.7cm)

Happy Hose!® Cable Specifications

PVC Happy Hose!®	
Happy Hose!® I.D.:	1/2" (1.3cm)
Happy Hose!® O.D.:	3/4" (1.9cm)
Hose Materials:	PVC clear, nylon reinforced
Cable Materials:	Yellow, PVC jacketed
Cable O.D.	0.46" (1.16cm)

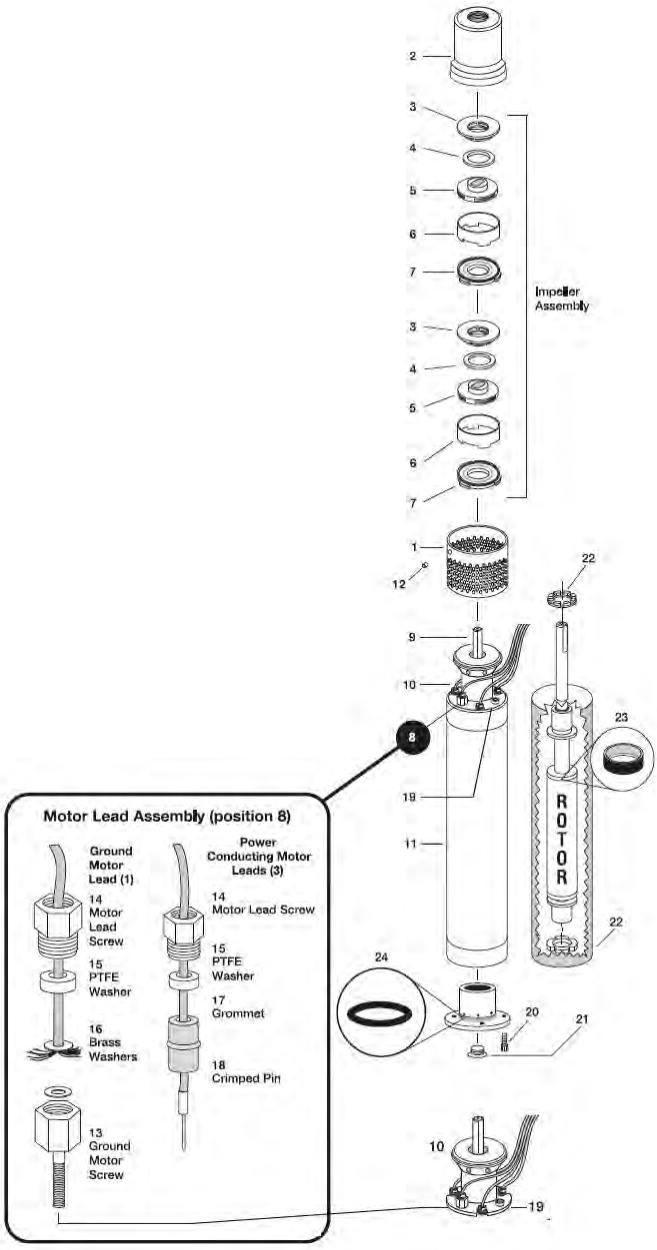
PTFE-lined Polyethylene Happy Hose!®

Happy Hose!® I.D.:	1/2” (1.3cm)
Happy Hose!® O.D.:	5/8” (1.6cm)
Hose Materials:	Polyethylene, PTFE-lined
Cable Materials:	Yellow, Polyethylene jacketed
Cable O.D.:	0.46” (1.16cm)

All Happy Hose!® Cable Specifications

Cable Construction:	includes: 4 each 16 EWG PVC jacketed, color-coated conductors, and 1 each of 0.094” (0.24cm) max dia., 7 x 7 stainless steel wire rope - PVC or PE jacketed to 0.125” (.32cm) dia.
Breaking Strength:	480 lbs. (218kg)
Weight:	0.22 lbs per foot (0.33 kg per meter)

Section 7: Parts and Accessories



Parts Number	Part Description

Redi-Flo 2® 2 Pump – Includes Pump, Lead, Male Elbow Harting Connector

11200001	PUMP,RF2,NO LEAD
11200417	PUMP,REDI-FLO 2,25 FT LEAD
11200130	PUMP,REDI-FLO 2,30 FT LEAD
11200002	PUMP,REDI-FLO 2,50 FT LEAD
11200003	PUMP,REDI-FLO 2,75 FT LEAD
11200004	PUMP,REDI-FLO 2,100 FT LEAD
11200005	PUMP,REDI-FLO 2,125 FT LEAD
11200006	PUMP,REDI-FLO 2,150 FT LEAD
11200007	PUMP,REDI-FLO2,175 FT LEAD
11200008	PUMP,REDI-FLO2,200 FT LEAD
11200009	PUMP,REDI-FLO2,250FT LEAD
11200010	PUMP,REDI-FLO2,300 FT LEAD

Service Kits and Spare Parts

Diagram #	Part #	Description
3 - 7	11200012	KIT,PUMP END SERVICE,RF2
4, 7	11200013	KIT,SERVICE,PTFE,PUMPEND,RF2
1	11200028	SCREEN,INLET,RF2
2	11200029	HOUSING,PUMP END, 1/2 NPT, RF2
12	11200016	KIT,SET SCREWS,RF2
10	11200030	SUCTION INTERCONNECTOR,RF2
22	11201055	KIT,MOTOR THRUST WASHER,RF2
13 - 18	11200014	KIT,TERMINATION,MOTOR LEAD,RF2
15, 17, 18	11200017	KIT,MOTOR LEAD SCREW,RF2
18	11200981	KIT,RF2,PIN,WASHER,GROMMET
15	11200018	KIT,PTFE MOTOR WASHER,RF2
16	11200019	KIT,BRASS MOTOR WASHER,RF2
17	11200020	KIT,MOTOR GROMMET,VITON,RF2
18	11200073	PIN,MOTOR,CRIMP,EACH,RF2
19	11200022	KIT,MOTOR SCREW (LONG),RF2
20	11200023	KIT,MOTOR SCREW (SHORT),RF2
21	11200024	KIT,MOTOR SCREW & O-RING,RF2
23	11200026	KIT,LIP SEAL,RF2,EACH
24	11200027	KIT,O-RING,BEARING HOUSING,RF2
9*	NA	SHAFT, ROTOR
11*	NA	STATOR HOUSING
Not Shown	22050255	GUIDE,TAPE,DELRIN
Not Shown	52050284	PUMP,HOLDER,GEOSUB / RF2
Not Shown	81200001	VALVE,CHECK,SS6,2",GF
Not Shown	17500026	BALL,PTFE,5/8"
Not Shown	11200360	SCREW,SS4,1/4-20x1/4",NYLOK

**Parts are not available for replacement.*

Happy Cable

81410008	HAPPY CABLE,PE,PER FOOT,16AWG
81410009	HAPPY CABLE,PVC,PER FOOT,16AWG
81410004	HAPPY HOSE,PE,1/2X5/8
81410067	HAPPY HOSE,PVC,1/2X3/4
81410006	HAPPY HOSE,TLPE,1/2X5/8"

Variable Frequency Drive

81200053	VFD,RF2,115V,GEOTECH WITH CASE
51200191	VFD,RF2,115V,GEOTECH NO CASE
81200055	VFD,RF2,230V,GEOTECH WITH CASE
51200193	VFD,RF2,230V,GEOTECH NO CASE

Accessories

(Maximum Motor Lead Length is 300')

87200001	CORD,EXT,MHRTG(S)XMHRTG(ELBOW) 15FT STANDARD
81201003	ASSY,BRACKET,SAFETY CABLE WITH LOOP, RF2
21400010	CABLE GUARD,UNIVERSAL FOR 2" OR 4" WELLS
81200001	VALVE,CHECK,SS6,2",GF
81200005	SHROUD,COOLING,SS,2"GF,W/SCREW AND ALLEN WRENCH FOR 4+" WELLS
11200142	CABLE,MOTORLEAD,TEFZEL,GEOTECH FLAT, 16-4, W/1/16" SAFETY CBL
17500065	CABLE,16-4,TEFZEL,FLAT CABLE
11201356	KNOB,CONTROL SWITCH,VFD GEOTECH
21200175	MANUAL,VFD

Service Tools

11200032	SYRINGE,MOTOR FILLING,RF2
11200033	TOOL,MOTOR PIN CRIMPING,RF 2

REVISION HISTORY		
PROJECT #	**DESCRIPTION**	**DATE**
1899	Release (previous manual #11201299 in legacy files) - StellaR	7/21/2020

The Warranty

For a period of one (1) year from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call our 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958.

Model Number: _____

Serial Number: _____

Date of Purchase: _____

Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used. Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate the equipment for a fee, which will be applied to the repair order invoice.

Geotech Environmental Equipment, Inc.
2650 East 40th Avenue Denver, Colorado 80205
(303) 320-4764 ● **(800) 833-7958** ● FAX (303) 322-7242
email: sales@geotechenv.com website: www.geotechenv.com

Redi-Flo 2

Stainless Steel Submersible Pumps for Environmental Purge & Sampling Applications

(USA) Installation and operating instructions

Please leave these instructions with the pump for future reference.

TABLE OF CONTENTS

Contents **Page**

Grundfos Stainless Steel Submersible Pumps

Your Grundfos Redi-Flo2 Environmental Pump is of the utmost quality. Combined with proper installation, your Grundfos pump will give you many years of reliable service.

To ensure the proper installation of the pump, carefully read the complete manual before attempting to install the pump.

⚠ SAFETY WARNING

Electrical Work

Before beginning installation procedures, these installation and operating instructions should be studied carefully. All electrical work should be carried out by a qualified electrician in accordance with the latest edition of the National Electrical Code (NEC), local codes and regulations.

Adherence To Environmental Regulations

When handling and operating the Redi-Flo Variable Performance Pump system, all environmental regulations concerning the handling of hazardous materials must be observed. When the pump is taken out of operation, great care should be taken to ensure that the pump contains no hazardous materials that might cause injury to human health or to the environment.

Returning a Pump for Service

Only pumps that are certified as uncontaminated will be accepted by GRUNDFOS for servicing. GRUNDFOS must receive this certification prior to receiving the pump. If not, GRUNDFOS will refuse to accept delivery of the pump. In these cases, all costs incurred in returning the product to the customer will be paid by the customer. Contact your distributor for details on returning Redi-Flo products for servicing.

Electrical Hazards

The Redi-Flo Variable Performance Pump system is not approved for Class 1, Division 1, Group D locations as specified by the National Electrical Code (NEC). Consult local authorities and regulations if you have any doubt about its suitability for a specific application.

Shipment Inspection

Examine the components carefully to make sure no damage has occurred to the pump-end, motor, cable or control box during shipment.

This Grundfos Redi-Flo2 Environmental Pump should remain in its shipping carton until it is ready to be installed. The carton is specially designed to protect it from damage. During unpacking and prior to installation, **make sure that the pump is not contaminated, dropped or mishandled.**

The motor is equipped with an electrical cable. **Under no circumstance should the cable be used to support the weight of the pump.**

Pre-Installation Checklist

Before beginning installation, the following checks should be made. They are all critical for the proper installation of this submersible pump.

A. Condition of the Well

If the pump is to be installed in a new well, the well should be fully developed and bailed or blown free of cuttings and sand. Dispose of discharged materials in accordance with the specific job site requirements. The stainless steel construction of the Redi-Flo2 Environmental Pump makes it resistant to abrasion; however, no pump, made of any material, can forever withstand the destructive wear that occurs when constantly pumping sandy groundwater.

The inside diameter of the well casing should be checked to ensure that it is not smaller than the size of the pump and motor.

B. Condition of the Water

Redi-Flo2 pumps are designed for pumping cold groundwater that is free of air or gases. Decreased pump performance and life expectancy can occur if the groundwater is not cold or contains air or gases.

C. Installation Depth

Pumping sand or well sediment can occur when the pump motor is installed lower than the top of the well screen or within five feet of the well bottom. This can reduce the performance and life expectancy of the pump and should be avoided.

D. Electrical Supply

The Redi-Flo2 motor is a 3 phase 220 VAC unit designed to be driven by the Redi-Flo2 VFD.

Wire Cable Type

The wire cable used between the pump and control box or panel should be approved for submersible pump applications. The conductor insulation should have a continuous Teflon® jacket with no splices and must be suitable for use with submersible pumps.

Installation

The riser pipe or hose should be properly sized and selected based on estimated flow rates and friction-loss factors.
A back-up wrench should be used when attaching a riser pipe or metallic nipple to the pump. The pump should only be gripped by the flats on the top of the discharge chamber. The body of the pump, or motor should not be gripped under any circumstance.

If Steel Riser Pipe is Used

An approved pipe thread compound should be used on all joints. Make sure the joints are adequately tightened in order to resist the tendency of the motor to loosen the joints when stopping and starting.

After the first section of the riser pipe has been attached to the pump, the lifting cable or elevator should be clamped to the pipe. Do not clamp the pump. When raising the pump and riser section, be careful not to place bending stress on the pump by picking it up by the pump-end only. A check valve may be added to the pump to prevent fluid from flowing back into the pump after it is turned off.

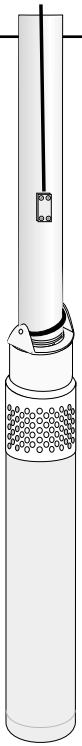
Make sure that the electrical cables are not cut or damaged in any way when the pump is being lowered in the well.

The drop cable should be secured to the riser pipe at frequent intervals to prevent sagging, looping or possible cable damage.

If Plastic or Flexible Riser Pipe is Used:

Use the correct compound recommended by the pipe manufacturer or specific job specifications. Make sure that joints are securely fastened.

Do not connect the first plastic or flexible riser section directly to the pump. Always attach a metallic nipple or adapter into the discharge chamber of the pump. When tightened, the threaded end of the nipple or adapter must not come in contact with the check valve retainer in the discharge chamber of the pump.



IMPORTANT - Plastic and flexible pipe tend to stretch under load. This stretching must be taken into account when securing the cable to the riser pipe.

Leave enough slack between tie points to allow for this stretching. This tendency for plastic and flexible pipe to stretch will also affect the calculation of the pump setting depth. If the depth setting is critical, check with the manufacturer of the pipe to determine how to compensate for pipe stretch.

When these types of pipe are used, it is recommended that a safety cable be attached to the pump to lower and raise it. A safety cable bracket is available from Grundfos (part # 001A0019)

Protect the Well from Contamination

While installing the pump, proper care should be used not to introduce foreign objects or contaminants into the well. To protect against surface water entering the well and contaminating the well, the well should be finished off utilizing a locally approved well seal.

Lowering the Pump Into the Well

Make sure the electrical motor leads are not cut or damaged in any way when the pump is being lowered into the well. Do not use the motor leads to support the weight of the pump.

Operating Conditions

To ensure the Redi-Flo Variable Performance Pumping system operates properly, follow these guidelines:

- The Redi-Flo2® pump must be installed vertically with the discharge end pointed upwards.
- The pump and motor must always be completely submerged in fluid to ensure lubrication and cooling of the motor.
- The temperature of the fluid being pumped should be according to the technical specifications.
- The installation depth of the pump should always be at least three feet below the maximum drawdown level of the well.
- Redi-Flo pumps are not recommended for well development or pumping fluid containing abrasives.
- Redi-Flo2® pumps are not recommended for continuous operation applications.
- The warranty of the Redi-Flo pumps will be void if other than the Redi-Flo VFD is used or if corrosive fluids are pumped.
- The service life of dedicated Redi-Flo pumps may be compromised if the ambient water quality exceeds one or more of the following values:
  pH<5 DO>2 ppm H2S>1 ppm CL->500 ppm TDS>1000 ppm

Electrical

WARNING: To reduce the risk of electrical shock during operation of this pump requires the provision of acceptable grounding. Refer to the Redi-Flo Variable Frequency Drive Instructions Manual (L-RF-IO-009) for proper wiring instructions.

All electrical work should be performed by a qualified electrician in accordance with the latest edition of the National Electrical Code, local codes and regulations.

Dismantling & Reassembling Pump End

The Redi-Flo2® pump can be dismantled and reassembled quickly and easily by referring to the diagram on page 12 and following these steps:

DISMANTLING

1. Shut the pump off by placing the Redi-Flo VFD in the stop position.
2. Disconnect Redi-Flo VFD from power supply or generator.
3. Disconnect the motor lead from the Redi-Flo VFD.
4. Remove the pipe or tubing connected to the pump (OPTIONAL).
5. Remove the Set Screw (position 12 in the diagram on page 12). Grasp the Inlet Screen (position 1) and slowly but forcefully pull it up over the Pump Housing (position 2).

DO NOT ALLOW THE INLET SCREEN TO SCRAPE THE INSULATION FROM THE MOTOR LEAD.

6. Unscrew and remove the Pump Housing (counterclockwise when viewed from the top). This will expose the impeller assembly (guide vanes, wear rings, etc.), which can now be removed by hand for extended cleaning or replacement.

REASSEMBLY

To reassemble the Redi-Flo2® pump, refer to the diagram on page 12 and:

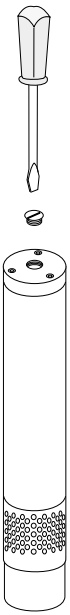
1. Make sure the motor lead is not connected to the Redi-Flo VFD.
2. Return the impeller assembly components (guide vanes, wear rings, etc.) to the shaft in the proper order per impeller assembly diagram.
3. Screw the Pump Housing (position 2) back onto the top of the pump. If all of the impellers and chambers were replaced correctly, the Pump Housing should screw on easily. Hand tighten.
4. Slip the Inlet Screen (position 1) back over the Pump Housing. Screw the Set Screw (position 12) back into the Inlet Screen.

MAKE SURE TO LINE UP THE MOTOR LEAD WIH THE RECESSED AREA IN THE PUMP HOUSING TO AVOID SCRAPING THE INSULATION FROM THE LEAD.

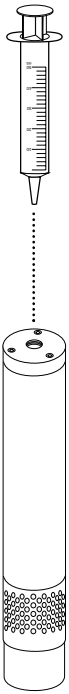
Dismantling & Reassembling Motor

If the pump is moved from well to well, it should be thoroughly decontaminated prior to being installed in the next well. In addition to cleaning the individual components inside and outside, the water in the pump motor should be replaced using the syringe that came with your pump. This can be accomplished through the following steps:

1. Shut the pump off by placing the Redi-Flo VFD in the stop position.
2. Disconnect Redi-Flo VFD from power supply or generator.
3. Disconnect the motor lead from the Redi-Flo VFD.
4. Remove the discharge tubing and the pump end (follow dismantling procedure page 5).
5. Turn the pump and motor upside down.



6. Use a flat blade screwdriver to remove the filling screw on the bottom of the motor.
7. Remove the three Allen head set screws at the bottom of the motor with a 2.5 mm Allen wrench.
8. Push gently on the motor shaft to move bearing housing out of the stator housing.
9. Continue to remove bearing housing and motor shaft from stator housing.
10. Clean motor shaft with a brush.
11. Empty the water from the motor.
12. Clean inside of stator housing with a brush.
13. Replace motor shaft into stator housing.



14. Refill motor using contaminant-free deionized water using the syringe that came with your Redi-Flo2® pump.
15. Replace bearing housing and tighten Allen screws.
16. Continue to add water until the level is even with the bottom edge of the screw hole.
17. Replace and tighten the filling screw.
18. Turn the pump over several times, then remove the filling screw again to let any trapped air escape (if air is left inside the motor, the life of the motor will be shortened). Add more water, as necessary. Fluid should overflow when the fill cap is screwed back on the motor cavity.
19. Replace and tighten the filling screw.
20. Replace pump end and piping (see reassembly page 6)

Replacing the Motor Lead

To replace the motor lead, refer to the diagram on page 12 and follow these steps:

REMOVING THE OLD MOTOR LEAD

1. Make sure the Redi-Flo VFD is turned **OFF**, and the motor lead is not connected to the Redi-Flo VFD.

2. Loosen and remove the Set Screw (position 12) from the Inlet Screen (position 1).

3. Slide the Inlet Screen off the pump. If you plan to use this motor lead again, be careful not to scrape insulation from it as the Inlet Screen is removed.

4. Loosen and remove the Pump Housing (position 2). Remove the impeller assembly (impellers, guide vanes, etc.).

5. Refer to the illustration on page 12. Use a 6mm wrench to loosen and remove the Motor Lead Screw (position 14) for the ground lead (green/yellow wire).

6. Pull up on the ground lead to remove it. Using a small screwdriver and precision electronics pliers, pry up and remove the Teflon® Washer (position 15) and Brass Washers (position 16) from inside the enlarged Ground Motor Screw (position 13). Remove the 8mm Ground Motor Screw.

7. Use an Allen wrench (2.5 mm) to remove the two Motor Screws (position 19) holding the Suction Interconnector (position 10) in place. Remove the Suction Interconnector but be very careful to note which of its slots is lined up with which motor lead -- this will be very helpful during reassembly. You may wish to scratch a mark on both the Suction Interconnector and the motor to aid in matching them up later.

8. Refer to the illustration on the next page. Use a 6mm wrench to loosen and remove the remaining Motor Lead Screws (position 14).

9. Pull up on each of the leads to remove them. Make a note which lead comes out of each hole-- **this is a MUST** when installing the new motor lead. Using a small screwdriver and precision electronics pliers, unscrew and remove the Teflon® Washer (position 15) and the Grommet (position 17).

Installing the New Motor Lead

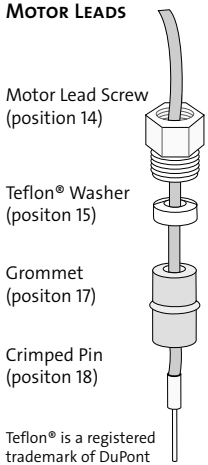
10. Ensure the motor lead holes are clean and free of moisture.

11. String the Inlet Screen (position 1) onto the motor lead.

12. String the motor lead components (shown at right) onto the end of each motor lead wire (except the striped green ground wire). Using a wire crimp tool, properly crimp each pin onto the lead wires.

13. For each wire, place the Crimped Pin (position 18) down into the motor lead hole. Press the Grommet (position 17) and Teflon® Washer (position 15) down around the lead. Be sure to reconnect the lead wires in their previous pattern described below.

Power Conducting Motor Leads



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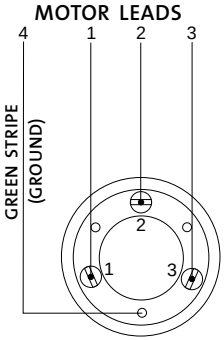
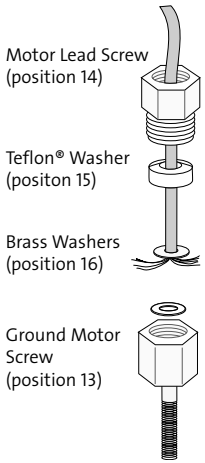


NOTE: For Tefzel motor lead, use the following wiring pattern: 1, 2, 3 clock wise from ground terminal (striped green).

Ground Motor Load



14. While pushing the lead down into the motor lead hole, use a 6mm wrench to tighten the Motor Lead Screw (position 14) into place. Repeat for the other two lead wires.

15. Replace the Suction Interconnector (position 10). Replace the Ground Motor Screw (position 13). Since the ground wire will be attached to this screw, you will want to put it into the hole that will cause the least amount of twisting to the wire.

16. Replace and tighten the two Motor Screws (position 19) with an Allen wrench.

17. String the motor ground lead through the hex lead screw, teflon washer and brass washers. Strip about 1/4 inch of insulation from the lead and fray the copper strands outward as shown. Press the washers down into the ground screw and tighten the motor lead screw in place.

18. Return the impeller assembly to the top of the Suction Interconnector (position 10). Refer to the diagram on page 12 for the proper sequence.

19. Screw the Pump Housing (position 2) back onto the Suction Interconnector.

20. Position the motor lead in the recessed area of the Pump Housing.

21. Carefully push the Inlet Screen (position 1) over the Pump Housing and the Suction Interconnector.

BE VERY CAREFUL TO AVOID SCRAPING THE INSULATION FROM THE MOTOR LEAD AS THE INLET SCREEN IS FITTED.

22. Line up the screw hole in the Inlet Screen with the screw hole in the Pump Housing. Fit and tighten the Set Screw (position 12).

23. Connect the motor lead to the Redi-Flo VFD and test the rotation of the pump. Submerge the pump in water, start it at its slowest speed and make sure the pump shaft is turning counterclockwise (when viewed from the top). If the rotation is incorrect, switching any two power leads (with POWER OFF) will correct the problem.

24. Reconnect the tubing or pipe.

Periodic Motor Inspection

If the pump is operating at a decreased capacity and the impeller assembly components (impellers, guide vanes, etc.) do not appear to be the cause, the motor should be checked. A checklist of things to examine includes:

- Check the fluid level inside the motor (refer to page 7). Replace and refill as necessary.
- Inspect the outside of the motor for cracks, dents, etc.
- Remove the Inlet Screen (position 1), Pump Housing (position 2), and the impeller assembly (guide vanes, wear rings, etc.). Try to spin the motor shaft by hand. It should spin freely. If it does not, the motor must be replaced.
- Check the winding and insulation resistance of the motor and lead as described on page 11.

Winding Resistance

Turn the power off and disconnect the motor lead from the converter. Using an ohmmeter, set the scale to R X 1. Zero-adjust the meter and measure the resistance between any two power conducting leads (prongs on the motor lead plug). If the ohm value is too low, the motor may be shorted. If too high, the motor windings or the leads may be open.

Lead Length	Ohm Value
0 ft	3.0 - 3.5 Ω
50 ft	3.6 - 4.1 Ω
75 ft	3.9 - 4.4 Ω
100 ft	4.2 - 4.7 Ω
125 ft	4.5 - 5.0 Ω
150 ft	4.8 - 5.3 Ω
175 ft	5.1 - 5.6 Ω
200 ft	5.4 - 5.9 Ω
250 ft	6.0 - 6.5 Ω
300 ft	6.6 - 7.1 Ω

Insulation Resistance

Turn the power off and disconnect the motor lead from the converter. Use a 500V megohmmeter or megger (1 Meg = 1 M = 1 million). Zero-adjust the meter and measure the resistance between any power conducting leads (prongs on the motor lead plug) and ground. If the pump has been removed from the well, a good way to test this (as shown above) is to submerge the motor lead and Redi-Flo2® pump in a bucket of water. Touch one lead of the megohmmeter to the pump and one to a motor lead.

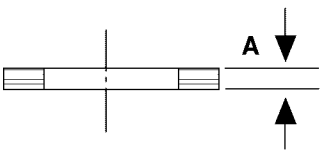
If the ohm value is lower than 1.5M Ω on any lead other than ground, the motor or lead is defective and must be replaced.

Checking Components For Wear

The pump components should be periodically checked to ensure they are still within their minimum operating tolerance (refer to the Assembly Diagram below).

Impeller (position 5) .....The impellers should show no visible wear.
Guide Vane (position 3).....The guide vanes should show no visible wear.
Wear Ring (position 4).....The minimum thickness ("A" in the illustration) should never be less than 0.04" (1.0 mm)

In addition, visually check all components for cracks, corrosion, or wear.



Storage Requirements

The pump should be thoroughly cleaned before storage to ensure no contamination is present. Both the pump and the converter should be stored in a clean and dry area in the following temperature range:

34°F (1°C) to 120°F (50°C)

Assembly Diagram — Redi-Flo2®

Pump Components

Pos. No.	Part Description	No. Used Per Pump	Part Number
1	Inlet Screen	1	1A0004
2	Pump Housing 1/2" NPT	1	1A0044
3	Guide Vane	2	see Service Kits
4	Wear Ring	2	"
5	Impeller	2	"
6	Spacer Ring	2	"
7	Wear Plate	2	"
8	Motor Lead Assembly	4	see Pos. 13 - 18
9	Shaft	1	not available *
10	Suction Interconnector	1	1A5004
11	Stator Housing	1	not available *
12	Set Screw	1	see Service Kits
13	Ground Motor Screw	1	"
14	Motor Lead Screw	4	"
15	Teflon® Washer	4	"
16	Brass Washer	2	"
17	Grommet	3	"
18	Crimped Pin	3	"
19	Motor Screw (long)	2	"
20	Motor Screw (short)	6	"
21	Filling Screw w/ O-Ring	1	"
22	Motor Thrust Washers	2	"
23	Lip Seal	1	ID5566
24	Bearing Housing O-Ring	2	see Service Kits

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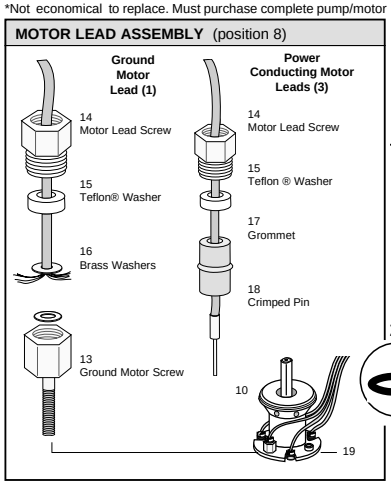
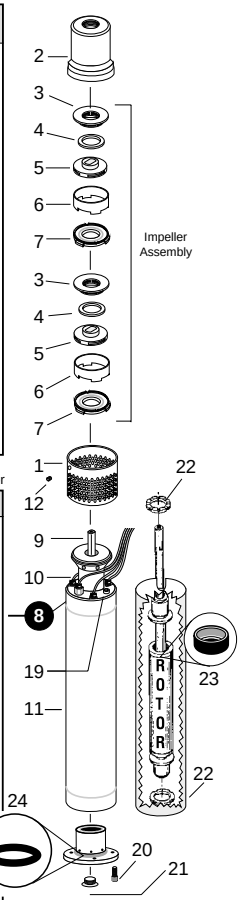
*Not economical to replace. Must purchase complete pump/motor





Redi-Flo2® Pump & Motor

ELECTRIC	
Full Load Rating	.5 HP / 220V / 3 PH / 400 Hz / 5.5A
Maximum Current (SFA)	5.5 amps
Motor Protection	Thermal overload - Thermik Geratebau, Series SY6 - (176°F [80°C]) Current Overload - Incorporated into Redi-Flo VFD
PIPING CONNECTION	
Discharge Port	½" Female NPT
OPERATING CONDITIONS	
Minimum Ambient Fluid Temperature	34°F (1°C)
Maximum Ambient Fluid Temperature	80°F (28°C)
MOTOR FLUID	
Motor Lubricating Fluid	Deionized (DI) Water
STORAGE CONDITIONS	
Minimum Ambient Temperature	34°F (1°C)
Maximum Ambient Temperature	120°F (50°C)
DIMENSIONS AND WEIGHT (PUMP AND MOTOR)	
Dimensions	11.3" length x 1.81" diameter
Net Weight	5.5 lbs., excluding motor lead
LEAD LENGTHS	
Standard Lengths in Feet	30, 50, 75, 100, 125, 150, 175, 200, 250, 300
Custom Lengths	Available in 1 ft. increments from 30 to 300 ft.

Redi-Flo2® Service Kits, Tools and Motor Leads

Replacement parts, service tools and motor leads are available using the following part numbers:

Position in Diagram	Part Description ..... No. In Kit	Park Number
	Service Kits	
3 4 5 6 7	Guide Vane ..... 2 Wear Ring ..... 2 Impeller ..... 2 Spacer Ring ..... 2 Wear Plate 2	125061
4 7	Wear Ring ..... 4 Wear Plate 4	1A5050
13 14 15 16 17 18	Ground Motor Screw ..... 1 Motor Lead Screw ..... 4 Teflon® Washer ..... 4 Brass Washer ..... 2 Grommet ..... 3 Crimped Pin 3	1A00028
5	Impeller 1	1A00018
12	Set Screws 25	1A00038
14	Motor Lead Screws 12	1A00048
15	Teflon® Washer 25	1A00058
16	Brass Washer 25	1A00068
17	Grommet 25	1A00078
18	Crimped Pin 50	1A00088
19	Motor Screw (Long) 25	1A00098
20	Motor Screw (Short) 25	1A00108
21	Filling Screw with O-Ring 5	1A00118
22	Motor Thrust Washers 4	1A00128
	Teflon® Motor Lead Replacement Kits	
	30 foot Length	1A5100
	50 " "	1A5102
	100 " "	1A5103
	125 " "	1A5104
	150 " "	1A5105
	175 " "	1A5106
	200 " "	1A5107
	250 " "	1A5108
	300 " "	1A5109
	Accessory List	
	Redi-Flo2® Safety Cable Bracket (Placed between the top of the pump and discharged piping connector)	1A0019
	Redi-Flo2® Cooling Shroud	1A004Z

LIMITED WARRANTY

All Redi-Flo products manufactured by GRUNDFOS are warranted to the original user only to be free of defects in material and workmanship for the following periods of time. Redi-Flo2® pumps; 24 months from date of installation, but not more than 30 months from the date of manufacture, whichever comes first.

GRUNDFOS' liability under this warranty shall be limited to repairing or replacing at GRUNDFOS' option, without charge, F.O.B. GRUNDFOS' factory or authorized service station, any product of GRUNDFOS manufacture. GRUNDFOS will not be liable for any costs of removal, installation, transportation, or any other charges which may arise in connection with a warranty claim. Products which are sold but not manufactured by GRUNDFOS are subject to the warranty provided by the manufacturer of said products and not by GRUNDFOS' warranty. GRUNDFOS will not be liable for damage or wear to products caused by abnormal operating conditions, accident, abuse, misuse, unauthorized alteration or repair, or if the product was not installed in accordance with GRUNDFOS' printed installation and operation instructions.

To obtain service under this warranty, contact the Distributor or Dealer from which it was purchased to obtain instructions. **Under no circumstances should defective product be returned to the Distributor, Dealer, or GRUNDFOS without a Return Materials Authorization (RMA).**

GRUNDFOS WILL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM INSTALLATION, USE, OR ANY OTHER CAUSES. THERE ARE NO EXPRESS OR IMPLIED WARRANTIES, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH EXTEND BEYOND THOSE WARRANTIES DESCRIBED OR REFERRED TO ABOVE.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages and some jurisdictions do not allow limitations on how long implied warranties may last. Therefore, the above limitations or exclusions may not apply to you. This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.

L-RF-IO-010 | Rev. 7/02
Printed in the U.S.A.

Environmental Equipment & Supply

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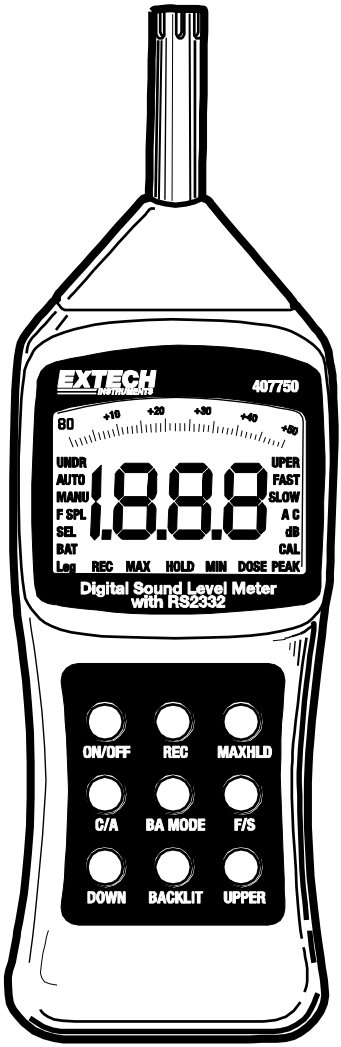
EXTECH®

User Manual

Digital Sound Level Meter

Model 407750



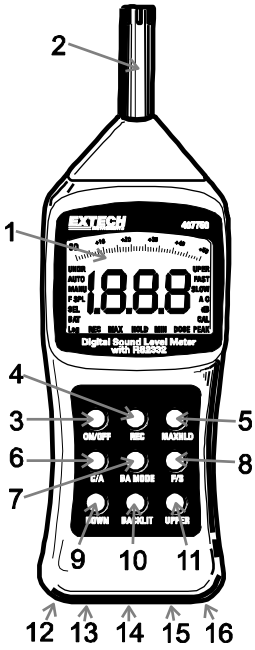
Additional User Manual Translations available at www.extech.com

Introduction

Congratulations on your purchase of the Extech 407750. This device measures sound level in dB and the measurement range can be set automatically or manually. The 407750 offers selectable frequency weighting ('A' and 'C') and Time Response (Fast and Slow). The built-in RS-232 PC interface allows the user to record readings onto a PC in real-time. Careful use of this meter will provide years of reliable service.

Meter Description

1. LCD Display
2. Microphone
3. ON/OFF key
4. REC (Record) key
5. MAXHLD (Max Hold) key
6. C/A Weighting Select key
7. BA (Background Absorber) key
8. F/S Fast / Slow Response select key
9. DOWN
10. Backlit (LCD backlighting) key
11. UPPER
12. AC adaptor jack
13. Calibration screw adjust
14. AC analog output jack
15. DC analog output jack
16. RS-232 output jack



Note: The Battery Compartment and the Threaded Tripod mount access are located on the back of the instrument (not pictured)

Operation

Quick Start

1. Power the meter by pressing the ON/OFF key.
2. The meter's LCD will count down to zero (99.9, 88.8, 77.7, etc.) and then begin measuring sound levels. If the LCD does not switch on after pressing the ON/KEY check the 9V battery.
3. Point the microphone toward the source of the sound level to be measured and view the reading on the meter's LCD.

'A' and 'C' Frequency Weighting

Select 'A' or 'C' weighting via the C/A key. The LCD will reflect the currently selected frequency weighting. Use 'A' weighting to have the meter respond as the human ear would with regard to frequency response (the human ear boosts and cuts amplitude over the frequency spectrum). 'A' weighting is used for environmental measurements, OSHA regulatory testing, law enforcement, and workplace design. Select 'C' weighting for flat responding measurements (less amplitude boost or cut across the frequency spectrum). 'C' weighting is used in applications where hearing conservation is not an issue; for example, in the diagnosis of malfunctions in electrical, electronic and mechanical devices.

FAST/SLOW Response Time

Select either FAST (125ms response) or SLOW (1 second response) measurements by pressing the F/S key. The LCD will reflect the currently selected mode. Selection of 'Fast' or 'Slow' is determined by the application and any directives or standards related to that application. For example, most hearing conservation or OSHA related testing is done using SLOW and A weighting.

MAX HOLD

The meter is capable of taking continuous measurements and only updating the LCD when a higher reading (than the one presently on the display) is detected. The bargraph display continues to change while the main LCD waits for a higher reading. Press the MAXHLD key to activate the MAX HOLD mode. The LCD will reflect the MAX HOLD function. Press the MAXHLD key again to return to normal operation.

Record (REC) Function

To Record the Maximum and Minimum sound level measurements over a programmable period of time, press the REC key. The REC indicator will appear on the LCD. Once the REC key is pressed, the meter begins tracking the highest (MAX) and lowest (MIN) readings. Press the REC again and the MIN indicator will appear on the LCD along with the lowest sound level reading since the REC key was pressed. Press the REC again and the MAX indicator will appear along with the highest reading the meter has encountered since the REC key was first pressed. Press and hold the REC until the REC indicator extinguishes to exit the RECORD mode.

BA (Background Noise Absorber) Mode

The Background Noise Absorber allows the user to accurately measure equipment noise by "eliminating" background noise. The Sound Level Meter first stores the background noise as a reference level. From there, when a sound is measured, the display will show the sound level measurement minus the background noise. To operate the meter in BA mode, follow these steps:

1. Power the meter.
2. Press the MAXHLD key (the MAX HOLD icon will appear on the LCD).
3. Press the BA key ('F" will appear to the left of the SPL display icon).
4. Press the MAX HOLD key again (the MAX HOLD icon will reappear on the LCD).
5. The meter is now displaying the background, reference noise.
6. Power the device under test and note the new sound level meter reading.
7. If the reading changes, the new reading is the sound level of the device. If the reading does not change, the noise produced from the device is either equal to or less than the background noise.
8. Press the BA key again to return to the normal mode of operation.

Auto and Manual Ranging

The meter powers up in the Automatic Range mode. In automatic mode the meter automatically finds the correct range in order to produce the best accuracy. However, if it is desired to set the range manually, follow these steps:

1. Power the meter
2. Notice the two (2) digit number to the immediate left of the analog bargraph. This number is the *low end* of the presently selected range (see the specifications for the ranges).
3. To change the range, press the UP key to raise the range or press the DOWN key to lower the range. The two digit number on the left of the bargraph will change with each key-press.
4. An advantage of Manual mode is that it takes less time for the meter to take a reading. In Auto Range mode the meter must first locate the correct range before displaying a measurement.

LCD Backlighting

Press the BACKLIT key to illuminate the LCD. The backlight will remain on for 5 seconds and then automatically switch off to preserve battery life.

Auto Power Off

To preserve battery life, this meter has an automatic power off feature. If the unit is not used for approximately 20 minutes, the meter shuts off. To override this function, follow these steps:

1. From a power OFF condition, press and hold the ON/OFF and MAX HOLD keys simultaneously.
2. When 'n' appears on the display, release the MAX HOLD and then the ON/OFF key.
3. The Auto Power Off feature is now disabled. Note that the Auto Power Off feature is re-activated the next time the meter is powered down.

RS-232 Output

The meter includes an RS-232 PC interface jack. This PC interface allows the meter to store and display readings on a PC as they are recorded. The interface cable and 407752 software for data acquisition are sold separately. Detailed instructions are provided with the software.

Analog Outputs

The meter includes an AC and a DC analog output. These outputs are proportional to the displayed sound level and are ideal for use with chart recorders and dataloggers.
The labeled 3.5mm output mini-plugs are located on the bottom of the instrument.

The DC output is 10mV per dB.
The AC output is 0.707V rms full scale.

Calculate the AC value per dB in the range $0.707*10^{(\text{dB - max dB of range})/20}$

Example: 30-80dB range

80dB = 0.707Vrms

70dB = $0.707 * 10^{(70-80)/20} = 0.707 * 10^{(-.5)} = 0.223$Vrms

50dB = $0.707 * 10^{(50-80)/20} = 0.707 * 10^{(-1.5)} = 0.022$Vrms

Calibration

To calibrate the meter, an external calibrator such as the Extech Instruments 407744 or 407766 is required in addition to a small screwdriver.

Turn the meter on and set the parameters of the 407750 to the following before proceeding:

Response: Fast

Function: A weighting

Range: 50 to +100 dB

Place the calibrator gently over the microphone of the meter. Set the calibrator to output 1kHz sine wave at 94.0dB. Adjust the calibration potentiometer, located at the bottom of the meter, until the display shows a reading of 94.0 dB.

Battery Replacement

When the low battery message appears on the LCD, the 9V battery has fallen to a critically low voltage level and should be replaced as soon as possible. The battery compartment cover resides at the rear of the meter. Remove the rear battery compartment screw and remove the battery compartment cover, change the battery, and replace the compartment cover.

Never dispose of used batteries or rechargeable batteries in household waste. As consumers, users are legally required to take used batteries to appropriate collection sites, the retail store where the batteries were purchased, or wherever batteries are sold.

Disposal: Do not dispose of this instrument in household waste. The user is obligated to take end-of-life devices to a designated collection point for the disposal of electrical and electronic equipment.

Specifications

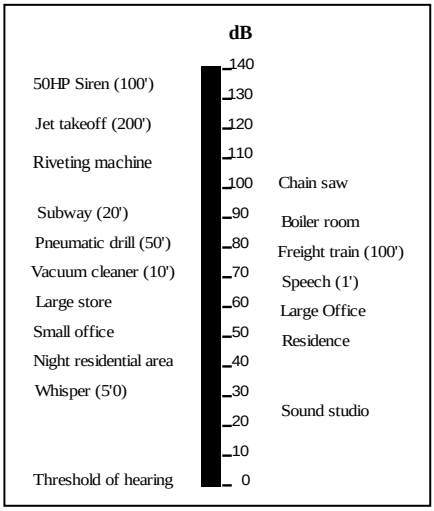
Display	Backlit 2000 count LCD with analog bargraph
Display update rate	Main LCD digits: 0.5 seconds; Bargraph: 50mS
Analog Bargraph	1dB steps with 50dB display range
Microphone	Electret condenser (0.5” diameter)
Measurement Bandwidth	31.5Hz to 8KHz
Measurement Range	A weighting: 30 to 130dB; C weighting: 35 to 130dB 6 ranges in 10 dB steps: 30 to 80dB, 40 to 90dB, 50 to 100dB, 60 to 110dB, 70 to 120dB, 80 to 130dB
Accuracy / Resolution	± 1.0dB / 0.1dB
Time response selections	Fast (125ms) and Slow (1 second)
AC and DC Analog outputs	0.707VAC rms at full scale; 10mVDC / dB; 3.5mm output jacks
Operating Temperature / Humidity	0~50C / <80%
Storage Temperature / Humidity	-20~50C / <90%
Standards	Meets ANSI and IEC Type 2
External Calibrator	Extech models 407766 or 407744
Power	9V Battery; 20 hour battery life (typical) with low battery indication
Dimensions/weight	80 x 256 x 38mm (3.2 x 10.1 x 1.5”) / 240g (8.5 oz.)

Reference Information

Frequency Weighting Characteristics

Frequency (Hz)	A Weighting	C Weighting	Tolerance (IEC 651 Type 2)
31.5	-39.4dB	-3dB	±3dB
63	-26.2dB	-0.8dB	±2dB
125	-16.1dB	-0.2dB	±1.5dB
250	-8.6dB	0dB	±1.5dB
500	-3.2dB	0dB	±1.5dB
1 k	0dB	0dB	±1.0dB
2 k	+1.2dB	-0.2dB	±2dB
4 k	+1dB	-0.8dB	±3dB
8 k	-1.1dB	-3dB	±5dB

Typical A-Weighted Sound Levels



Multilevel Groundwater Monitoring with the Westbay System

Abstract

Understanding groundwater conditions for any purpose (such as characterizing a contaminant plume, managing groundwater resources, choosing a location for a geologic repository, investigating and remediating the stability of a complex rock slope, characterizing or monitoring a mine site, etc.) requires a three-dimensional array of measurement/sampling points. Historically, such an array has commonly been installed by placing a single access tube and inlet screen in each of a series of boreholes. With this method, the number of sampling points at a given site is generally limited by the high cost of drilling. A preferred alternative is to install monitoring points at many levels in each borehole (multilevel monitoring). Multilevel monitoring can provide increased data density and therefore a significantly improved understanding of site conditions. This paper describes how the Westbay* System, one type of multilevel monitoring system, is installed and operated. Field quality control procedures, 1) to verify the integrity of the access tube, inlet valves, and borehole seals, and 2) to confirm the operation of measuring and sampling equipment, are also discussed.

Introduction

When groundwater levels (pressures) and/or chemistry are suspected of varying vertically as well as laterally, a three-dimensional array of monitoring points is needed to identify significant variations and characterize the hydrogeologic conditions. In fact, such vertical variations are more often the norm than the exception and thus groundwater data must be obtained from a number of different locations and from a number of different depths at each location. As a result, either a large number of boreholes are required, each with a separate instrument installed, or instruments must be combined and installed at multiple levels in each of a smaller number of boreholes.

Multilevel groundwater monitoring devices have been described by many writers, some discussing the technical benefits and others the advantages to schedules and costs which can result when multilevel monitoring devices are used to reduce the number of boreholes required. Most important, however, are the advantages that accrue from the increased data density and from the field verification procedures that can be available. The very fact that one is capable of accessing several different discrete zones in one monitoring well provides an ability to ‘view’ and understand groundwater conditions in a way that is not otherwise possible. Further, if the multilevel system allows hydraulic testing (application of hydraulic stresses to one or more zones while observing the response of those zones and others), the system provides a testing and

verification capability that is simply not possible in a single-level device such as a standpipe monitor well.

The basic requirements of any groundwater monitoring system are that it provide the user with the ability to measure fluid pressure, purge the monitoring zone, collect fluid samples, and undertake standard hydrogeologic tests, such as hydraulic conductivity tests and tracer tests. In addition, quality assurance plans for groundwater monitoring programs have led to a requirement for periodic testing and calibration of all aspects of groundwater monitoring devices.

Quality assurance plans normally require field verification tests immediately following installation and again at periodic intervals during the operating lifetime of the installation. In fact, few groundwater monitoring devices are designed to allow extensive field verification tests to be carried out. However, some types of multilevel monitoring instruments, such as the Westbay System, were designed with field verification tests in mind (Patton and Smith, 1986). With systems such as this, questions of data quality can be readily addressed.

General Description of the Westbay System

The Westbay System is a modular multilevel groundwater monitoring device employing a single, closed access tube with valved ports. The valved ports are used to provide access to several different levels of a borehole through a single well casing. The modular design permits as many monitoring zones as desired to be established in a borehole, within the limitation of the ability to fit the physical length of the components into the hole. In addition, at any time up to the moment of installation, zones may be added or modified without affecting other zones or significantly complicating the installation. As a result, the number and location of monitoring zones can be decided based on the information obtained during drilling. Only a broad scope of requirements need be defined in advance of drilling.

The Westbay System consists of casing components, which are permanently installed in the borehole, portable pressure measurement and sampling probes, and specialized tools. The casing components include casing sections of various lengths, regular couplings, two types of valved port couplings with different capabilities, and packers, which seal the annulus between the monitoring zones. The Westbay System has been used in many different geologic and climatic environments in boreholes ranging from a few feet to over 4,000 ft [1,200 m] in length. The 1.5-inch [38 mm] I.D. MP38 System has been used in the field since 1978, while the 2.25-inch [55 mm] I.D. MP55 System was developed in 1990-91.

Casing Components

The casing components of the MP38 System are made of plastic, while the MP55 System is available in either plastic or stainless steel. While the illustrations in this paper are of plastic components, the descriptions of operating principles that follow apply to both types of materials. Most of the components referred to are shown in Figures 1 and 2.

Casing

Westbay casing is supplied in a number of different lengths to provide flexibility in setting the position of monitoring zones and associated seals in the borehole. Common nominal casing lengths are 1 ft [0.3 m], 2 ft [0.6 m], 5 ft [1.5 m] and 10 ft [3.0 m]. The casing ends are machined to mate with Westbay System couplings incorporating a shear-rod connection and an o-ring seal.

Telescoping casing sections can be used to protect the casing string from damage when ground movements are anticipated or where measurements of axial displacements are desired.

Regular Couplings and End Caps

Regular couplings are used to connect casing lengths where valved couplings are not required. The couplings incorporate o-rings for a positive hydraulic seal. A flexible shear rod provides a tensile connection (no adhesives are used when joining casings and couplings). MP38 regular couplings incorporate an internal helical shoulder for the accurate location of probes and tools in the well. MP55 regular couplings do not incorporate a helical shoulder.

An end cap is placed on the bottom of each casing string. End caps also incorporate an O-ring seal so that the entire casing string is hydraulically sealed during installation. End caps are frequently used to seal the top of the Westbay casing between monitoring events.

Valved Couplings

There are two types of valved couplings: measurement ports and pumping ports. Measurement ports are used where pressure measurements (for water level) and fluid samples are required. In addition to the features of a regular coupling (plus the helical shoulder in the case of MP55), measurement ports incorporate a valve in the wall of the coupling, a leaf spring which normally holds the valve closed, and a cover plate which holds the spring in place. When the valve is opened, an access pathway is provided for the groundwater to enter the coupling.

Pumping ports are used where the injection or withdrawal of larger volumes of fluid is desired than would be reasonable through the relatively small measurement port valve (such as for purging or for hydraulic conductivity testing of moderate to high hydraulic conductivity materials). Pumping ports incorporate a sliding sleeve, sealed by o-rings, which can be moved to expose or cover slots that allow groundwater to pass through the wall of the coupling. A screen or slotted shroud is normally fastened around the coupling outside the slots.

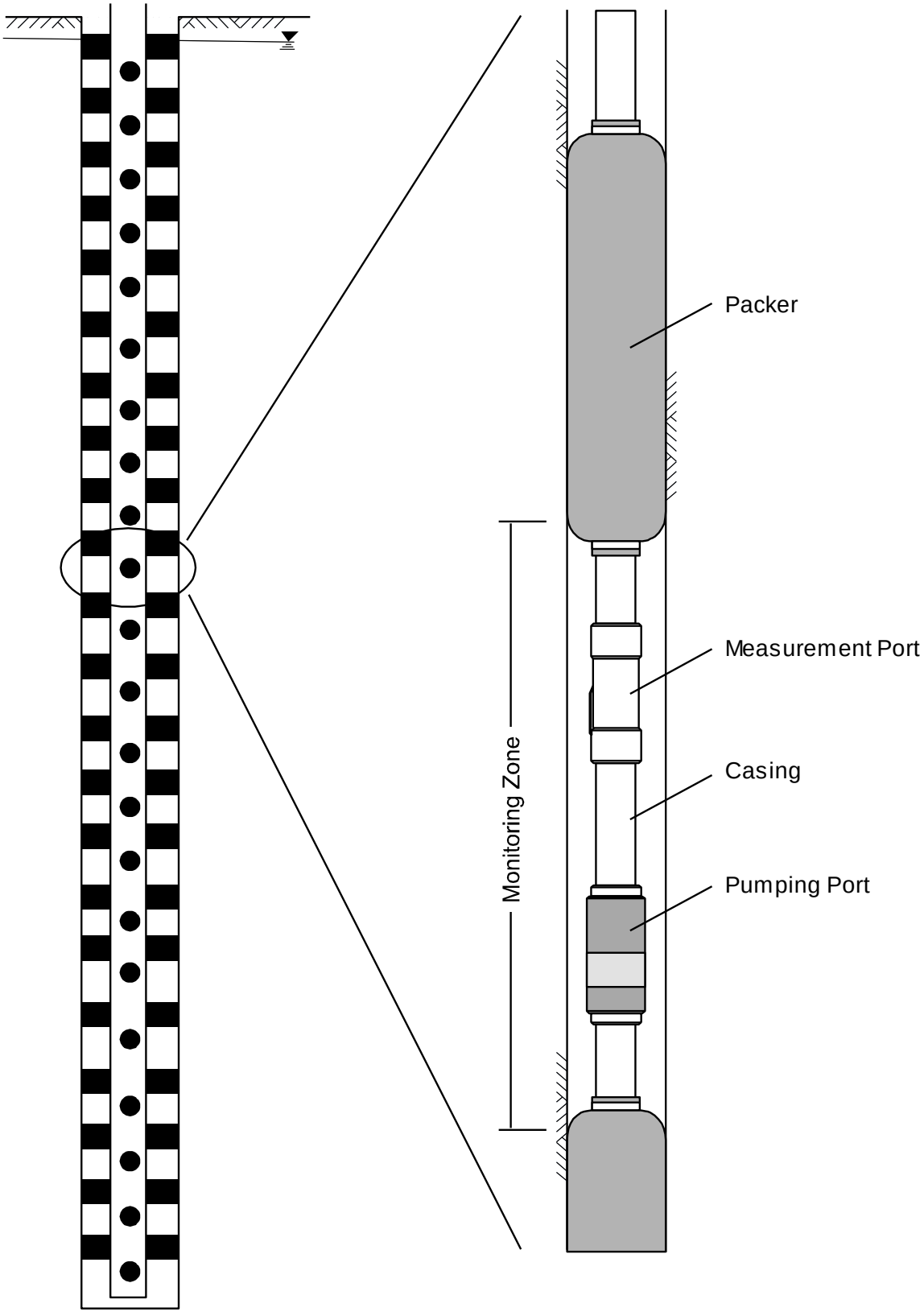


Figure 1. Westbay System with monitoring zones isolated by packers.

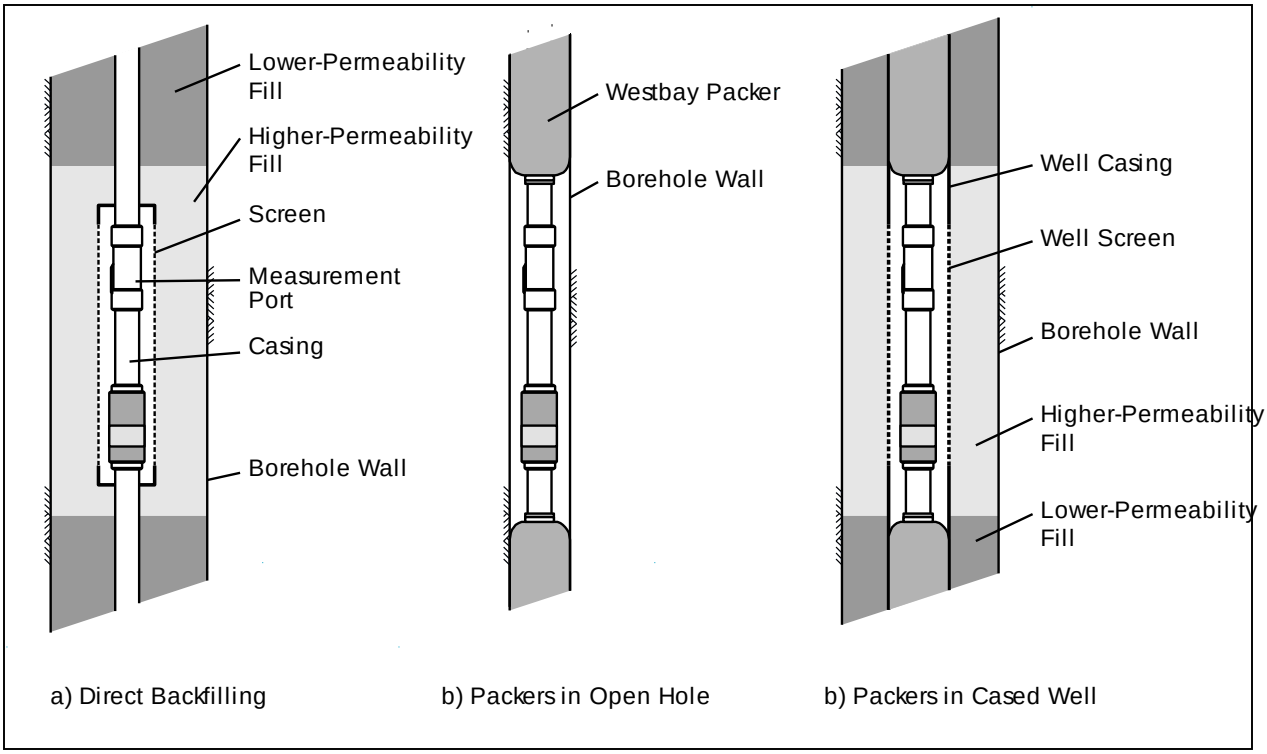


Figure 2. Common completion methods for the Westbay System.

Annulus Seals

When there are many monitoring zones in a single borehole, multiple seals are required to prevent fluid from flowing from one zone to another along the annular opening between the borehole wall and the casing. Placement of these seals can be difficult with any groundwater monitoring device. However, considerable success has been achieved with three types of well completion used with the Westbay System, provided each is combined with appropriate drilling and placement methods.

With the Westbay System, seals can be obtained by: a) backfilling with alternating layers of sand and bentonite or grout, b) using hydraulic (water) inflated packers or c) using packers inside a cased well with multiple screens. Figure 1 illustrates a borehole completed with the Westbay System with packers. Figure 2 illustrates a single measurement zone where the Westbay System is completed by each of the three common methods. Each sealing method is possible in most environments, but in many situations one method will stand out as the most advantageous.

Direct backfilling (Figure 2a) is recommended for: 1) large diameter boreholes, 2) shallow boreholes, 3) boreholes where little or no fluid circulation is anticipated in the hole during installation (i.e., when near-hydrostatic fluid pressures or low hydraulic conductivity is present over the length of the borehole), and d) where packer gland materials are incompatible with the chemistry of the fluids present.

When direct backfilling is considered and fluid sampling is required, a very clean drilling method must be employed. While the Westbay System does permit purging of monitoring zones,

the small size of the casing prevents sufficient energy being generated to develop the monitoring zone.

Backfill seals may include bentonite and/or grout slurries, bentonite chips or pellets, bentonite/sand mixtures or other materials with a lower hydraulic conductivity than the natural formations present.

Westbay packers incorporate an expandable gland mounted over a standard length of Westbay casing. The casing incorporates a one-way valve that allows fluid to travel through the wall of the casing into the packer and prevents this fluid from flowing back out of the packer. Gland lengths are typically 3 ft [~1 m].

Packers in an open borehole (Figure 2b) are typically recommended for: 1) small diameter boreholes (where the annular space is too small for good quality backfilling to be achieved), 2) deep boreholes, and 3) sealing against significant flows within the borehole. When packers are used, field time for the installation is usually reduced since packer inflation is generally much faster than backfilling. When using more than one packer between primary monitoring zones, additional measurement ports are installed between the monitoring zones. Such additional ports provide additional (secondary) fluid pressure data that can be valuable for quality assurance (QA) purposes and for understanding the hydraulic characteristics of the site.

Packers in a cased well (Figure 2c) is a completion method that has proven very successful for environments where available hole sizes are too large for packers and/or where drilling additives, such as mud, must be used for borehole support. This completion method involves drilling a large diameter hole, typically 12-inch [300 mm] and installing well casing with multiple screens (typically 4-inch [100 mm] nominal diameter for MP38 and 5- or 6-inch for MP55). The well screens are located at all of the desired monitoring levels, based on information gathered during and following drilling. Layers of select backfill material are placed to provide filters around the well screens and annular seals between. Each monitoring zone is then thoroughly developed through the well casing. Following development, Westbay casing, ports and packers are installed inside the well casing. The Westbay packers are inflated against the inside of the well casing, providing interior annular seals between the monitoring zones. This completion method provides the ability to properly develop mud from deep mud-rotary boreholes, as well as to service the Westbay System during the operating life of the monitoring well. When more than one packer is installed between adjacent well screens, additional measurement ports are installed between the monitoring zones for QA purposes. Measurements and tests carried out through these additional "QA ports" can enable easy evaluation of the effectiveness of the packer seals at any time throughout the operating life of the installation.

Screens and Filters

Where both pumping ports and measurement ports are being used and the ports are likely to be surrounded by sand fill or collapsed geologic material, a single well screen may be placed over both the measurement port and pumping port in each monitoring zone as shown in Figure 2a. The screen helps the zone influenced by pumping through a pumping port extend to and include the region surrounding the adjacent measurement port coupling. Screen slot size and length

should be chosen based on a knowledge of local site conditions. If only fluid pressure measurements are required, a simpler fabric filter tube can be placed over the measurement port coupling and fastened at either end. This filter will help maintain the length of the monitoring zone and protect the measurement port valve from fine particles. The filter material should be compatible with the chemistry of fluids present.

Magnetic Location Collars

A magnetic location collar is a plastic collar containing a circular array of magnets. When the collar is installed around the Westbay casing, a magnetic field is established across the axis of the casing. Probes and tools lowered into the casing can detect this magnetic field and transmit a signal to the operator, confirming the depth of location of the probe or tool. Magnetic location collars are installed at specific locations during the assembly of the Westbay System at the monitoring well and are held in place by a stainless steel clamp.

Installation Procedures

Selection of Casing Components

The valved couplings (measurement ports and pumping ports) allow many monitoring zones to be established in a single borehole. Horizons of hydrogeological interest are targeted on the basis of the best borehole geologic and geophysical logs available. An installation log is prepared showing the locations of the casing components. If only fluid pressures are needed, only a measurement port coupling is required in each monitoring zone. If sampling and/or hydraulic testing (i.e., fluid withdrawal or fluid injection) is anticipated, both a pumping port and a measurement port are recommended in each monitoring zone. This is the case illustrated in Figures 1 and 2.

The casing lengths are chosen based on the desired locations of the monitoring zones and sealing elements. This requires an interpretation of the hydrogeologic conditions anticipated in each borehole. Caliper logs and borehole video can be useful when selecting packer locations.

If movement is expected along the borehole axis (i.e., consolidation or heave), telescoping casing sections may be used to minimize the opportunity for compressional or tensile forces to damage the casing.

Westbay Casing Installation

The downhole Westbay System components - casing, couplings and packers- are laid out at the site of the proposed monitoring well in accordance with the casing installation log. At that time, any last minute adjustments required to make the positions of the monitoring zones and seals match hydrogeologic details of the borehole are completed and the appropriate revisions are made to the installation log.

Next, the required coupling is attached to the top of each length of casing. The casing layout is checked again for compliance with the installation log. Serial numbers of measurement ports, pumping ports and packers are recorded, indicating their position on the installation log. The length of all casing sections is measured and recorded on the log.

The casing string is then assembled by lowering the casing segments into the borehole and attaching each successive segment to the adjacent coupling one at a time. As each successive Westbay casing section is attached to the string in the well, the section number is checked and recorded on the installation log. The coupling joint is then subjected to an internal hydraulic pressure to verify its hydraulic integrity and the test result is recorded on the log. This is an important step in confirming that the system is sealed to prevent cross-contamination. Because the Westbay casing is sealed along its entire length, as the casing is lowered into water in the borehole, it will become buoyant. At intervals during lowering, clean water is added to the inside of the Westbay casing to reduce its buoyancy.

In collapsing soil and poor quality rock, Westbay casing with packers and screens may be installed through a temporary flush-jointed guide tube such as drill rods or casing. Table 1 provides ranges of borehole, casing and guide tube sizes for the MP38 and MP55 Systems. Figure 3 illustrates the major stages of installing through a guide tube: 3a) Following completion of drilling, the guide tube is positioned in the hole. All parts of the guide tube, including any shoe attached to the bottom, must be flush on the interior and of sufficient inside diameter to permit the Westbay components to pass through; 3b) The Westbay components are assembled and lowered into the guide tube in such a fashion that the packers and ports will be correctly positioned in the hole when the bottom of the Westbay casing is resting on the bottom of the borehole; c) The guide tube is pulled back to expose a packer and that packer is inflated. The pulling/inflating sequence is repeated until all of the packers have been inflated. More than one packer may be exposed during each pull of the guide tube, depending upon the stability of the borehole walls. If the Westbay casing does not extend to the bottom of the borehole, a sufficient number of packers must extend below the guide tube such that they can be inflated to support the weight of the Westbay casing and hold the assembly in the correct position before the guide tube can be removed.

System	I.D.		Max. Depth[1]		Borehole/Casing Size		Min. Guide Tube I.D.	
	in.	mm	ft	m	in.	Mm	in.	mm
Plastic MP38	1.5	38	4,000	1,200	3-6.25	75-160	3	75
Plastic MP55	2.25	55	4,000	1,200	4-6.25	100-160	4.75	120
Steel MP55	2.25	55	7,000	2,100	4-9.4	100-240	4	100

[1] Note: Maximum depth can vary case-by-case. Please consult Westbay technical support.

Table 1. Important dimensions for the Westbay System

Casing without packers can be placed in various sizes of boreholes, with or without protective casing, as long as the borehole diameter (and casing) is compatible with the backfilling method.

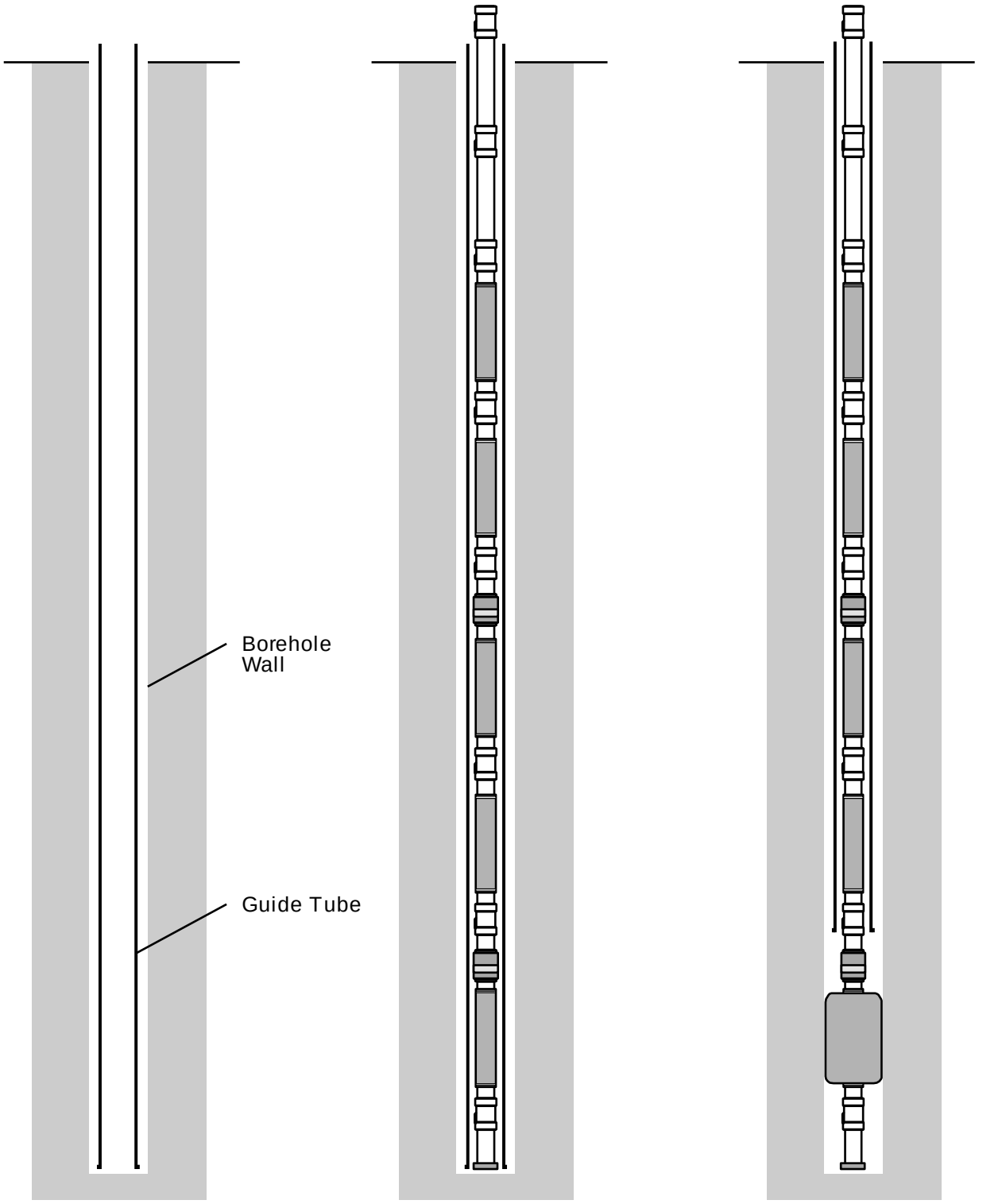


Figure 3. Installation of Westbay System through a temporary guide tube.

Good backfilling techniques involve the use of one or more tremmie pipes and frequent sounding to confirm the depth of the backfill materials.

Once the Westbay casing has been placed in the borehole, the packers are inflated (see Figure 3) or backfill is placed. If the Westbay casing was lowered inside a guide tube, the guide tube may be withdrawn all at once or in steps as the packer inflation or backfilling operation proceeds. Incremental withdrawal of the guide tube can reduce the opportunity for the borehole wall to loosen and cave prior to the placement of seals.

Packer Inflation

Figure 4a shows the appearance of a casing packer when it has been placed in a borehole before inflation. Figure 4b shows how the MP38 System casing packers are individually inflated using a packer inflation tool. This tool is lowered down the inside of the Westbay casing and is located in the correct position by the location arm seating in the coupling directly beneath the packer.

Two small packers (inflation tool packers) are inflated, isolating the short segment of the casing containing the valve for the casing packer. At a pre-set pressure, the tool injection valve opens and water is injected into the casing packer. If a measurement port is installed directly beneath the packer, the vent-head mechanism on the tool holds the measurement port open during inflation. This vents the pressure in the zone below the packer, allowing the packer to square-off without generating unnatural squeeze pressures. Figure 4c shows the inflated Westbay packer after the inflation tool has been removed. At increments of volume during the inflation process, pumping is stopped and the fluid pressure of the inflation system is measured and recorded. The pressure/volume data is plotted and kept for quality assurance purposes.

Packer inflation proceeds from the bottom of the hole to the top. There are no permanent inflation lines leading to each packer. As a result, there is no limit to the number of packers that can be placed in a borehole apart from the finite limitations of packer length and borehole length.

Purging Monitoring Zones

If purging is required following installation, the strategy for purging the monitoring zones may vary depending on site conditions. Once the casing and annular seals have been installed, it is usually desirable to remove the non-representative fluid trapped in the various zones during installation. This removal, or purging, can be done in one of two basic ways: 1) Purging by natural groundwater flow, or 2) Pumping to purge monitoring zones.

Purging by natural groundwater flow is attractive, particularly in environments where groundwater flow is understood to be relatively rapid. In such an environment, unnatural fluids introduced during drilling while the borehole was open may no longer be adjacent to the borehole by the time the monitoring system has been installed. In such a case, there may be little to be gained from the investment of time and resources to pumping an arbitrary volume of water from each monitoring zone. Rather, fluid samples might be collected over a period of time and

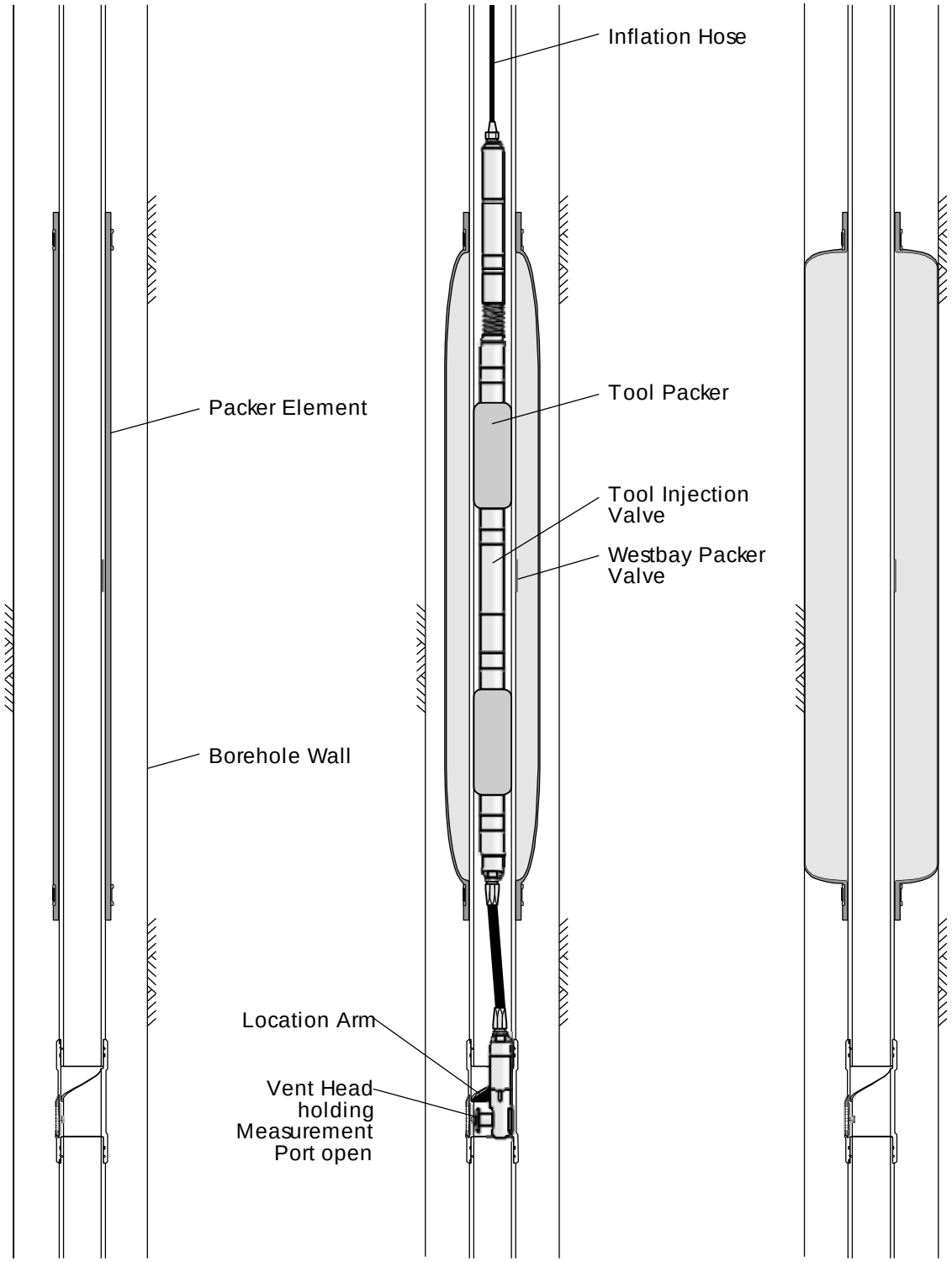


Figure 4. Steps in the inflation of a Westbay System packer.

analytical results compared in order to evaluate the stabilization of conditions in the monitoring zone.

When purging by natural flow is not acceptable, monitoring zones can be purged by pumping. Zones are typically pumped one-at-a-time to prevent cross-contamination. Individual hydrogeologists and hydrochemists may prefer different purging techniques depending upon local conditions. However, the purging procedures are essentially the same as would be used for a single standpipe piezometer. One procedure which has been successfully used is described below.

1. An acceptable and convenient tracer is added to the drill fluid during drilling.

2. After the casing has been installed and the packers have been inflated, an open/close tool is used to open the pumping port in one of the monitoring zones. With one pumping port open, the Westbay casing is hydraulically identical to a standpipe piezometer with its screen located at the same depth as the open pumping port.

3. Fluid from the inside of the Westbay casing is pumped out of the well. Either a set quantity of fluid may be pumped from inside the Westbay casing or pumping is conducted until some desired condition is met to complete the purging of this monitoring zone. Hydrogeologic testing of this zone and its adjacent casing seals can be done at this time. For example, slug tests can be undertaken to obtain hydraulic conductivity. The volume of fluid removed and the pumping time for purging will depend on many factors including: the drilling method, the length of time the hole was left open prior to completion, the hydrogeological conditions in the borehole, etc. The use of a tracer can be helpful in determining when the purging is completed.

4. Once purging of one zone has been completed, the open/close tool is used to close the pumping port, another pumping port is opened, and the process is repeated.

5. Once all desired zones have been purged, and the last pumping port is closed is closed, the interior of the Westbay System may be flushed with clean water and the water level adjusted as meets the specific needs of the project.

Following purging, the Westbay System is ready for sampling, pressure measurements, and further testing.

Operation of the Pumping Ports

To operate a mechanical pumping port, an open/close tool is used as illustrated in Figure 5. This tool has spring-loaded "jaws" which can be mechanically activated from the surface. The pumping port is shown closed in Figure 5a. To open the valve, the tool is lowered on a wireline with the jaws extended and pointing upward (i.e., so that they will catch on shoulders when the tool is raised). In this condition, the jaws will spring through each coupling as the tool is lowered

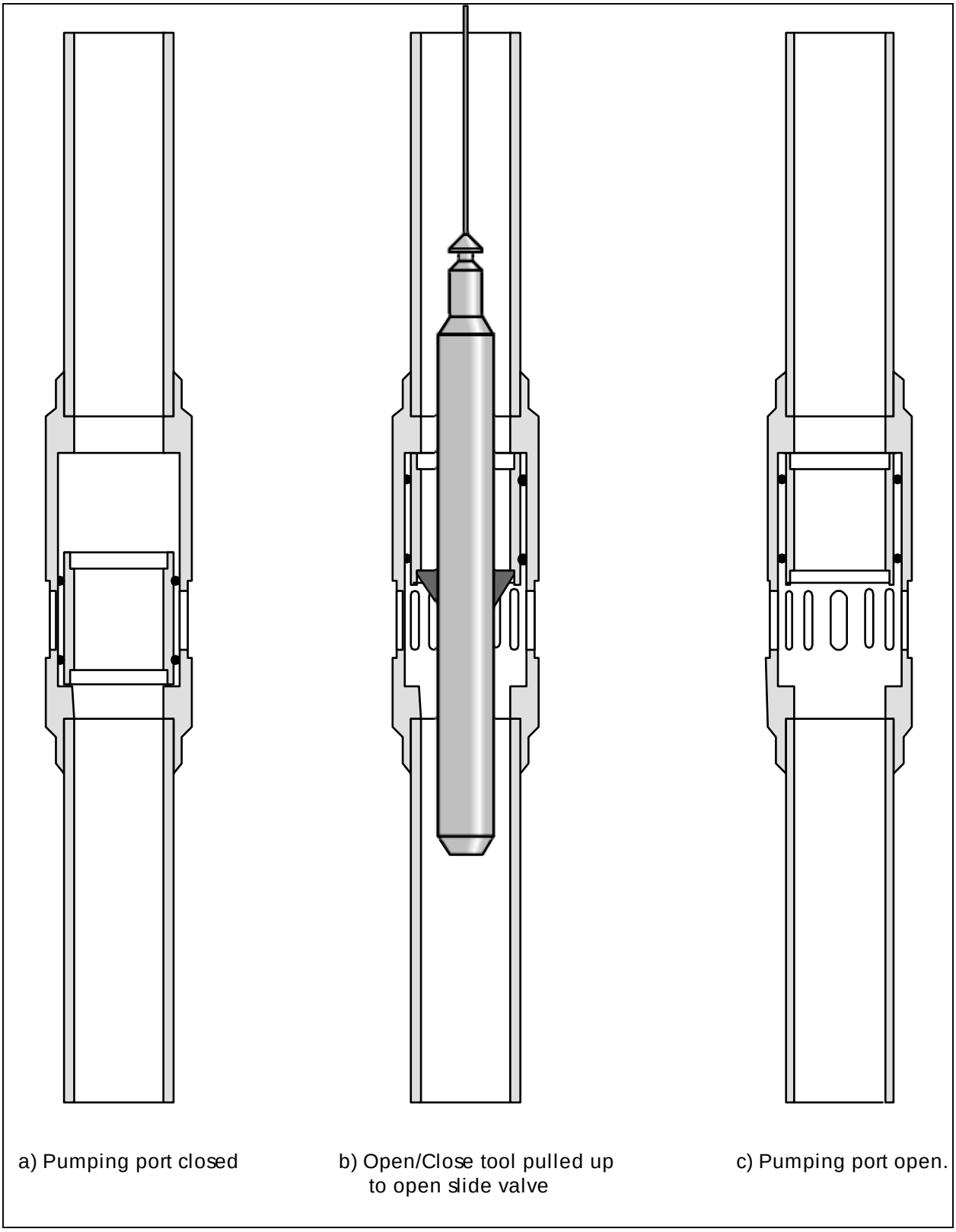


Figure 5. Operation of a Westbay mechanical pumping port.

to just below the desired pumping port coupling. The open/close tool incorporates a sensor to detect magnetic location collars and confirm the location of the tool in the well.

Once located in the desired pumping port, the open/close tool is pulled up so that the jaws engage the bottom shoulder of the sliding valve. By continuing to pull up on the wireline, the valve can be opened, as in Figure 5b. Once the valve is opened, the jaws can be collapsed into the housing and the tool recovered. With this one valve opened, fluids can be added to or removed from the monitoring interval by injecting into or pumping from the Westbay casing. Other zones may still be monitored in the normal manner using a pressure probe or sampling probe as they will not be hydraulically connected to the interior of the casing.

To close the pumping port coupling, the open/close tool is brought to the surface and the housing is reversed so that the jaws point downward (i.e., the tool will stop on exposed shoulders when the tool is lowered). The tool is lowered to the open pumping port with the jaws retracted into the housing. Once the tool is located near the pumping port, the jaws are released and the valve is closed by tapping on the top shoulder of the sliding valve with the tool.

Testing and Monitoring

Fluid Pressure Measurements

Fluid pressure measurements can be made at each location in a borehole where a Westbay measurement port has been installed. The measurement port incorporates a helical landing ring and a leaf spring valve which is normally closed. The fluid pressure is measured using a pressure probe or sampler probe which incorporates a location arm, a shoe, a face seal, and a fluid pressure transducer. These features are shown on Figure 6. The probe is operated on a wireline cable connected to an interface and (optional) portable computer at the top of the monitoring well. The interface displays the pressure and transducer temperature digitally plus some probe status information, while the computer displays the pressure both graphically and digitally, along with transducer temperature, well information and probe status.

The following procedure is used to make fluid pressure measurements. The probe is lowered to a point below the first measurement port to be accessed (usually the deepest) (Figure 6a). If a magnetic location collar has been installed near this port, the probe detects the magnetic field and transmits a signal to the interface where an audible tone is emitted, confirming the probe's location for the operator. The location arm is released from within the probe body. The probe is raised to just above the measurement port coupling and then lowered until the location arm rests on the helical landing ring in the coupling. The weight of the probe causes it to rotate into position at the correct depth and orientation to operate the valve (Figure 6b). At this point the pressure transducer is measuring the fluid pressure inside the Westbay casing at that depth. This reading will be displayed on the surface interface or computer and is recorded.

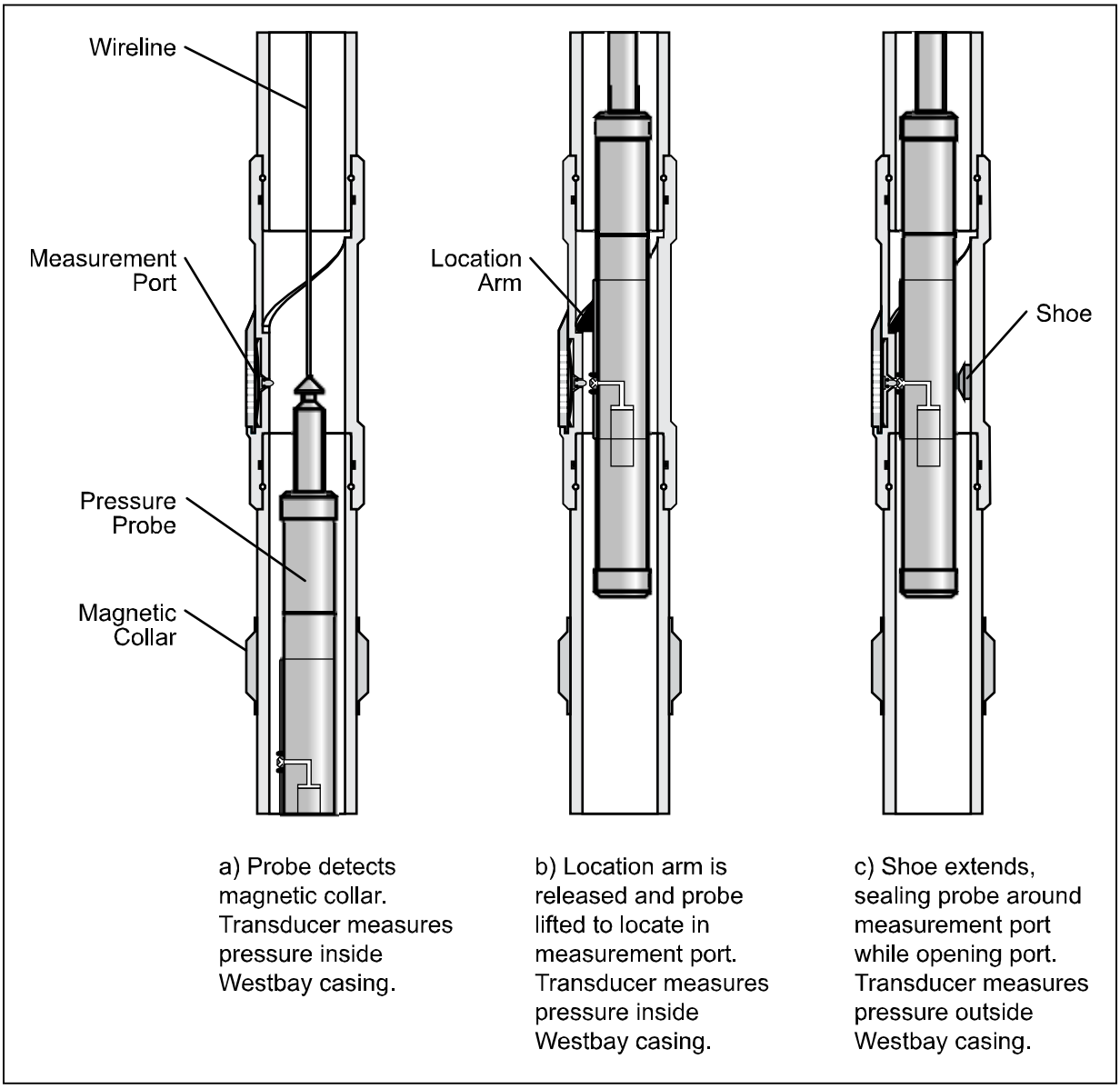


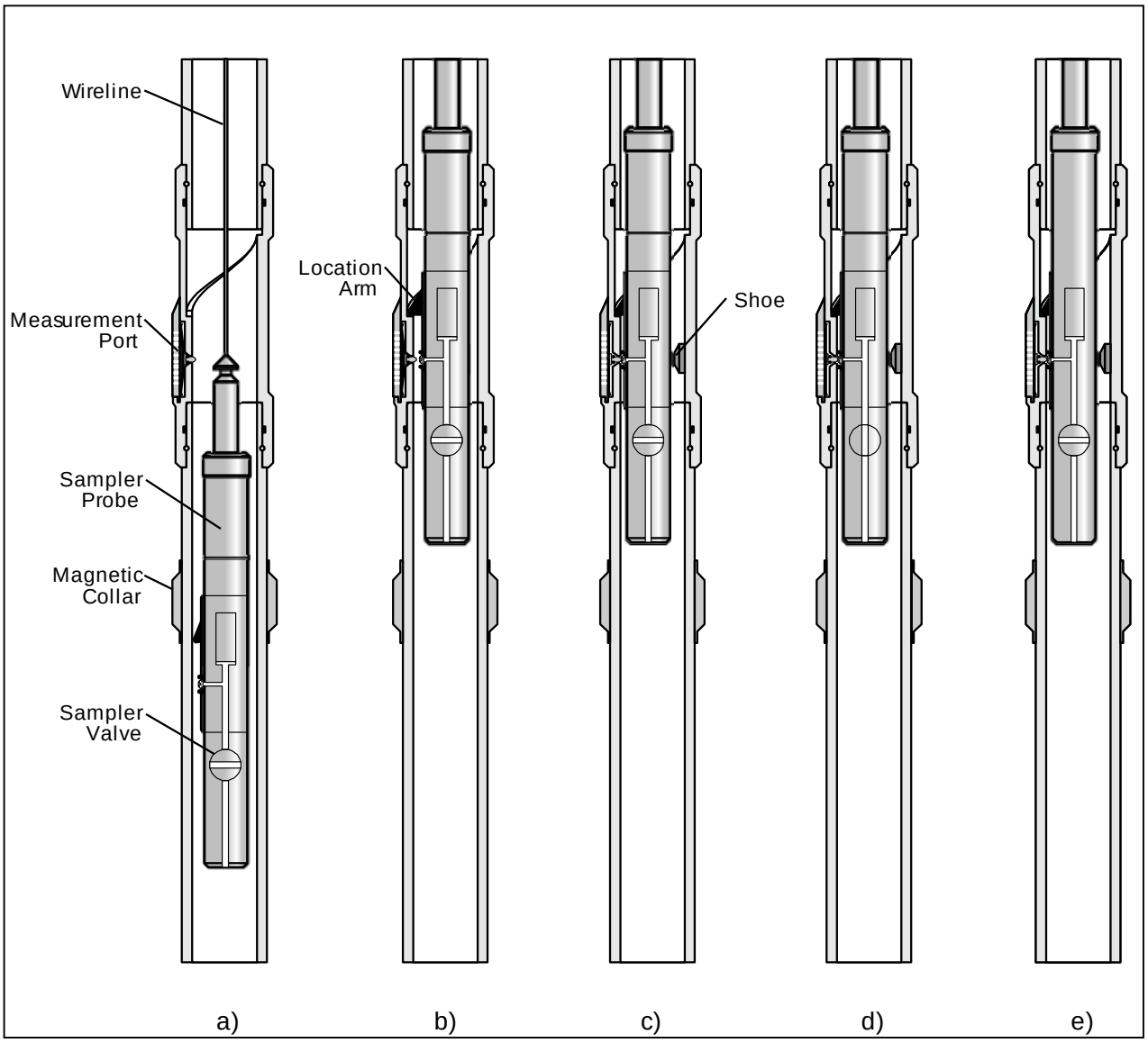
Figure 6. Operation of a pressure probe.

The shoe is then activated. It extends and pushes the probe against the wall of the measurement port so that the face seal on the probe seals around the measurement port valve at the same time as the face of the probe pushes the valve open. The transducer is now hydraulically connected to the fluid outside the port and isolated from the fluid inside the casing (Figure 6c). The reading displayed on the interface or surface computer will be the absolute fluid pressure in the formation outside the measurement port. The pressure outside the port can be observed as long as desired and recorded as often as desired. After the reading has been recorded, the probe shoe is retracted and the valve in the port reseals. The probe will again be measuring the fluid pressure inside the Westbay casing (Figure 6b). The pressure in the casing is again recorded, for quality assurance purposes. The probe may then be moved to another port or removed from the well.

Measuring Pressure in Low Permeability Environments

Very low permeability environments present a special challenge for measuring fluid pressures. When the routine profiling procedures described above are followed, a stable pressure may be observed through the measurement port. However, the act of opening the port may be sufficient to change the pressure in the monitoring zone, and if the zone is very tight, that pressure change may not dissipate quickly enough to be observed. In such an environment it is always difficult to determine the validity of a single manual measurement unless some form of dynamic test is carried out as well. In the case of the Westbay System, this is done through the use of a sampler probe. As illustrated in Figure 7a), the sampler incorporates all of the features of a pressure probe, plus a valved passage which is controlled via the surface interface or computer. With the

Figure 7. Using a sampler probe for testing hydraulic conductivity and verifying fluid pressure



measurements in low-permeability environments.

sampling valve closed the probe acts identically to a pressure probe and thus may be used for single-probe profiling. The difference is that once the probe is located and activated (Figure 7c), the fluid level inside the Westbay casing may be adjusted to a level slightly higher or lower than the piezometric level in the monitoring zone. The sampling valve can then be opened (Figure 7d), exposing the monitoring zone to the fluid pressure in the Westbay casing. In very low permeability environments, no water will flow during this time. The sampling valve may be kept open for a specified period of time (such as one minute). The sampling valve is then closed (Figure 7e) and the pressure recovery in the monitoring zone is recorded vs. time (Figure 8). Standard analytical methods can be applied to the pressure recovery data in order to determine the apparent pressure in the monitoring zone. The same procedure can be used for testing hydraulic conductivity in low-k zones. When groundwater does flow in through the sampler during such a test, the flow volume can be calculated by measuring the change in water level inside the Westbay casing, or by capturing the flow in a sample container.

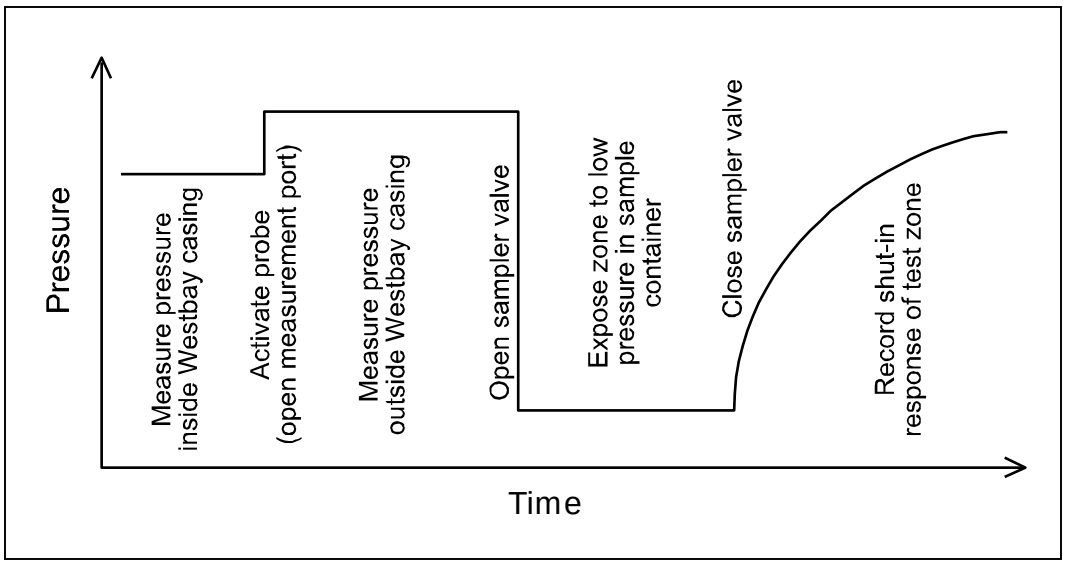


Figure 8. Typical data record from a test in a low-permeability zone using a sampler probe.

Pressure Monitoring Methods

The two principle methods of monitoring fluid pressure with the Westbay System are illustrated in Figure 9. Single-probe profiling (Figure 9a) involves an operator traveling to each well with a set of portable equipment including a pressure probe, cable and reel, interface and computer. The operator manually locates the probe at each measurement port and carries out fluid pressure measurements one at a time. When a computer is used, the MProfile software stores the data on disk with each record tagged as to the location of the probe in the well, date, time, and probe status. If the interface is used alone, measurements may be recorded manually. Single-probe profiling is generally adequate for monitoring fluid pressure up to a frequency of once per month.

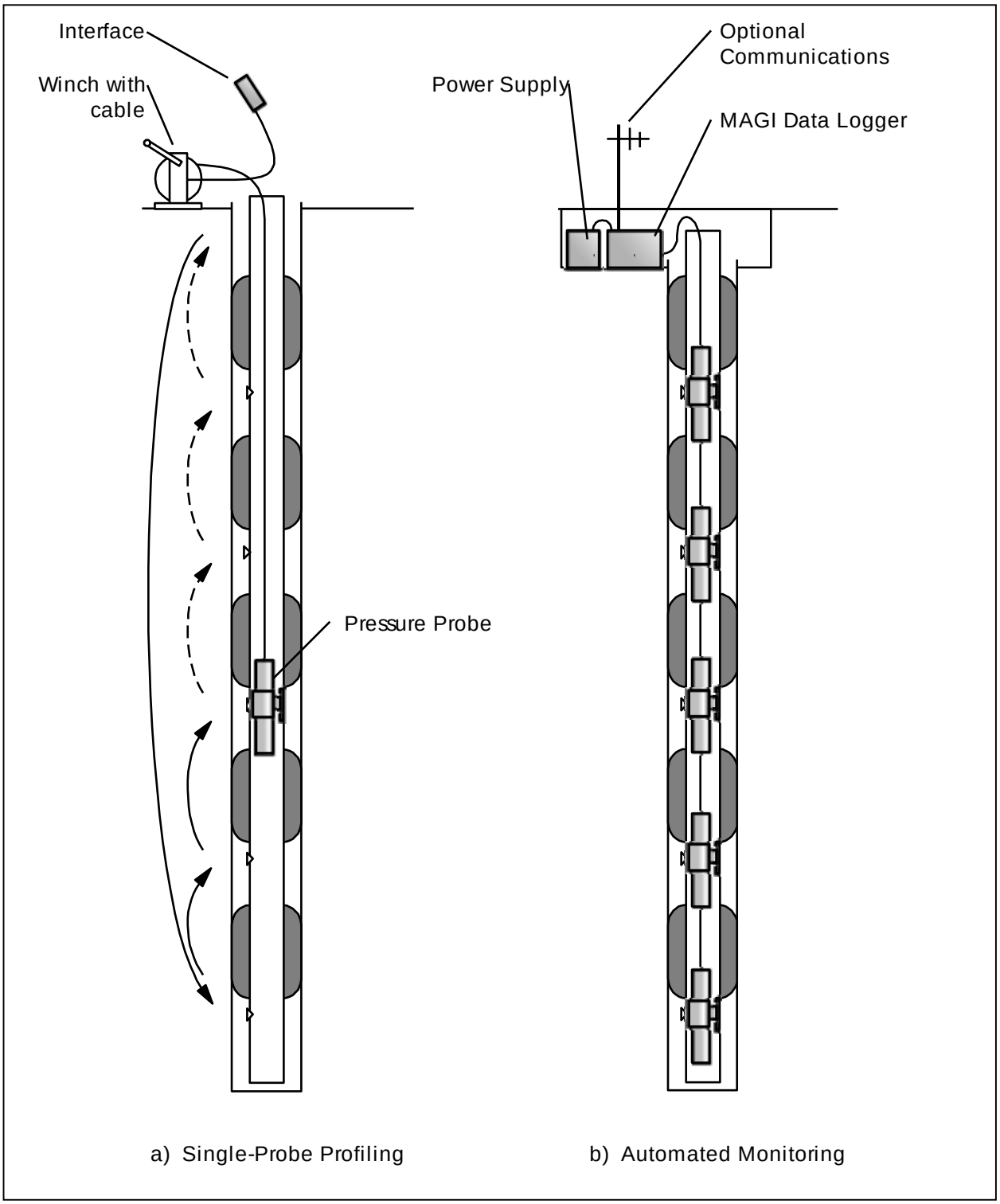


Figure 9. Schematic illustration of methods of monitoring fluid pressure with the Westbay System.

When pressure measurements are desired more frequently than is reasonable for single-probe profiling, continual observation and recording of unanticipated events is required, or site access is difficult, the monitoring well can be configured for automated monitoring (Figure 9b). Any or

all of the measurement ports in a well may be selected for automated monitoring. Lengths of cable are made up to span the distance between each probe and the next. The string of probes and cable is assembled and lowered into the well. The data logger and a computer running Westbay MLog software are attached at the surface and the lowermost probe is located and activated in the appropriate measurement port. The remaining probes are located and activated sequentially from the bottom of the well to the top.

Once all of the probes are activated, the computer is used to program the data logger. Pressure measurements may be recorded on a simple time basis (e.g., one reading per minute, hour or day, etc.), or the logger may be programmed to continually scan each probe and record pressures only if a specific threshold pressure change is exceeded. Each probe may be assigned an independent threshold (i.e., record data if Probe 1's reading changes by 5 ft of water, Probe 2 by 15 ft, etc.).

The data logger may stand unattended, in which case an operator would periodically visit the site to download the stored data, or the data logger may be connected to a telemetry system such as an RF modem, cellular system, or landline. When connected to a communication device, a second threshold can be designated for each probe which will cause the logger to transmit an alarm signal to the host computer. The host computer can also run a program to automatically connect with each data logger on a set schedule, download the newly-acquired data, convert the data files for use, store them on the specified server, and produce a report on the data obtained, instrument status, etc.

A unique aspect of monitoring with the Westbay System is that unusual pressure readings can often be verified by means of an in-situ calibration check. When an alarm condition is received, a natural first reaction would be to question the validity of the measurement ("Is it real, or is it the instrument?"). When datalogging with the Westbay System, if an alarm is received, the operator can log onto the well via remote communications, deactivate two or more probes including the one causing the alarm and compare their measurements of the fluid pressure within the Westbay casing. The column of fluid inside the Westbay casing is independent of all of the monitoring zones and thus serves as a reference pressure source. If the deactivated probes agree on the internal water level, the alarm condition can be taken to be valid and the probes can be reactivated to resume monitoring. If the probe causing the alarm did not agree with the others, instrument error might be suspected. In such a case, an operator could visit the well, remove the string of probes, replace the offending probe and reinstall the string to resume monitoring. The offending probe could then be calibrated and serviced in a laboratory.

Fluid Sampling

Fluid samples are obtained by lowering a sampling probe and sample container(s) to the desired measurement port coupling. As shown on Figure 10, the sampling probe operates in similar fashion to the pressure probe except that a groundwater sample is drawn through the measurement port coupling. Whenever the sampling probe is operated with the sampling valve closed, it is identical to a pressure probe and supplies the same data.

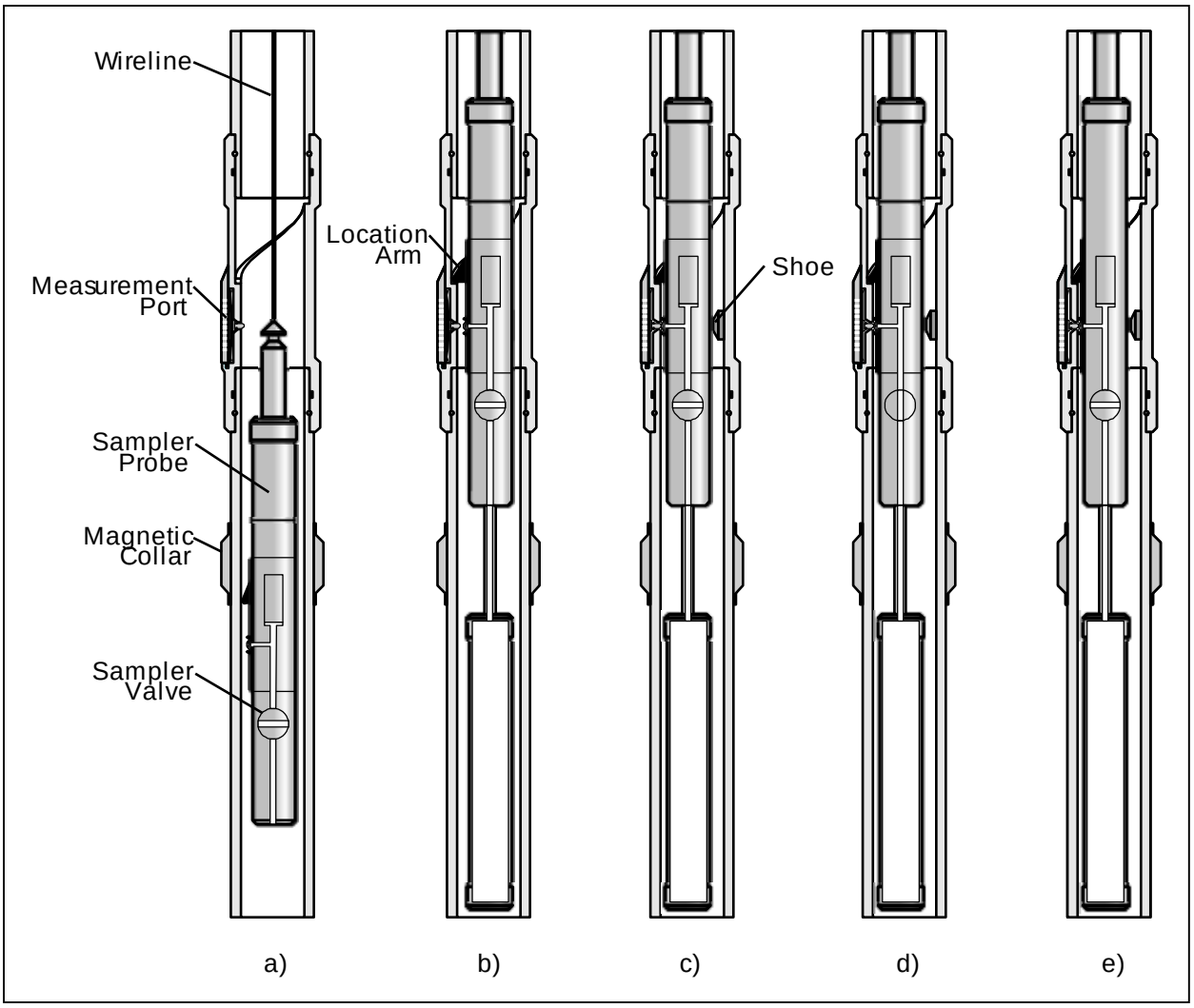


Figure 10. Operation of a Westbay sampler probe.

The procedure for collecting a groundwater sample is as follows:

A clean, empty sample container is attached to the sampling probe. The probe and container are prepared (e.g., cleaned and often evacuated) in a manner suited to the specific project and the sampling valve is closed to prevent the fluid inside the Westbay casing from entering the sample container. The probe and container are lowered to below the selected measurement port coupling. If a magnetic collar is present, the probe detects the magnetic field, confirming the location of the probe (Figure 10a). The location arm is released, the probe is positioned in the measurement port coupling and the fluid pressure inside the Westbay casing is recorded (Figure 10b).

The probe shoe is activated and pushes the probe against the wall of the coupling so that the face seal on the probe seals around the measurement port valve at the same time as the face of the probe pushes the valve open. The interior passage of the probe is now hydraulically connected to the fluid outside the coupling (Figure 10c), but no fluid movement takes place. During this operation the change in fluid pressure is observed at the surface and may be recorded.

The sampling valve in the probe is opened, allowing fluid from outside the measurement port to flow through the probe and enter the sample container (Figure 10d). The pressure displayed at ground surface drops and then recovers as the fluid in the container builds to formation pressure. Once the container is full, the sampling valve is closed (Figure 10e). The shoe is retracted (Figure 10b) and the fluid pressure inside the Westbay casing is once again recorded. The sampling probe and sample container are then pulled to the surface. The sample is typically transferred to alternate containers for transport and analysis, then the sampling probe and container(s) can be cleaned and the procedure repeated.

When using the standard non-vented sample container, the fluid sample is maintained at formation pressure while the probe and container are returned to the top of the well. Once recovered, there are a variety of methods of handling the sample:

- the sample may be depressurized and decanted into alternate containers for storage and transport,

- the sample container may be sealed and transported to a laboratory with the fluid maintained at formation pressure, or

- the sample may be transferred under pressure into alternate pressure containers for storage and transport.

The advantages of this discrete sampling method can be summarized as follows:

1) The sample is drawn directly from formation fluids outside the measurement port. Therefore, there is no need for pumping a number of well volumes prior to collecting each sample. Because there is no pumping prior to sampling, the sample is obtained with minimal distortion of the natural groundwater flow regime, the storage and disposal of large volumes of hazardous purge fluids is eliminated, and operator exposure to hazardous fluids is reduced.

2) The lack of pumping means samples can be obtained quickly, even in relatively low permeability environments.

3) The sample travels a short distance into the sample container, typically from 1 to 2 ft [30 to 60 cm], regardless of depth.

4) The risk and cost of storing and disposing of hazardous purge fluids is virtually eliminated.

Hydraulic Conductivity Testing

Using the Westbay System a variety of different test methods can be employed to evaluate the hydraulic conductivity of formation materials. These include variable head, constant head and pressure-pulse tests.

Variable head tests are the single well test method most commonly used with the Westbay System. Using these types of tests in the Westbay System, hydraulic conductivities between 10^{-2} and 10^{-8} cm/sec can be determined.

For variable head tests the pumping ports are used to provide the hydraulic connection between the interior of the Westbay casing and the test zone. In cases where monitoring zones are to be purged, it is convenient to carry out hydraulic conductivity testing just prior to or following purging. With all the port valves closed, the head (fluid level) inside the Westbay casing can be adjusted, then the selected pumping port can be opened in a controlled manner (pumping port operation is described in the discussion of purging). This allows accurate measurement of both the initial head change and the time at which the head change is applied (t_0). The pumping port valve is opened rapidly (in less than one second), which satisfies the theoretical requirement that an instantaneous head change be applied to the tested zone. The use of a transducer (such as the Westbay probe or a Diver*) inside the Westbay casing eases recording of the recovery of the water level during the test.

For rising head tests the water level inside the Westbay casing is bailed or pumped down to a pre-determined level below the static water level in the test zone. For falling head tests the water level is raised to a level above the static water level in the zone to be tested. Measurement equipment is set in place and the pumping port valve is opened. Recovery of the water level in the Westbay casing is measured and recorded vs. time. A pressure transducer is commonly used to record the water level changes. Figure 11 shows a typical record of water levels during a rising head hydraulic conductivity test.

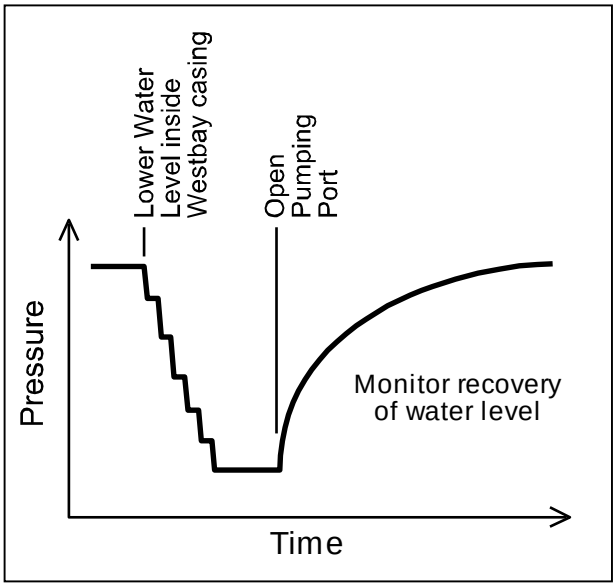


Figure 11. Typical data record from a rising-head test.

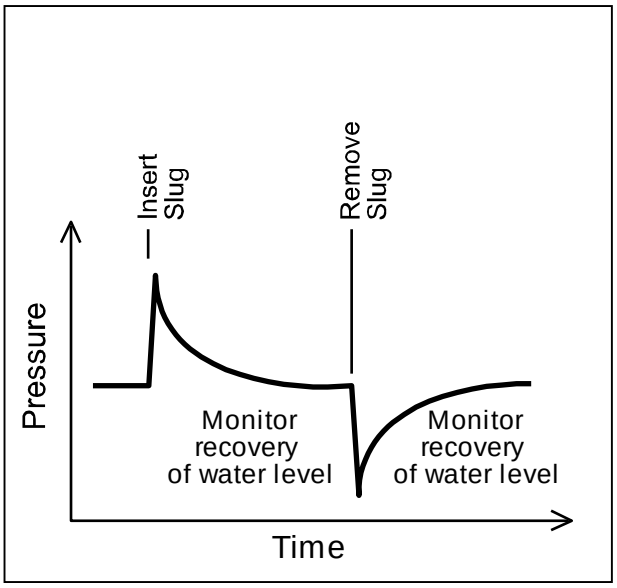


Figure 12. Typical data record from a slug test.

Slug tests are carried out by opening the pumping port coupling at the zone to be tested and allowing the water level in the Westbay casing to equilibrate to the static water level for that

zone with measurement equipment in place. The initial head change is then applied by rapidly lowering a displacement slug (a length of solid rod or sealed pipe) into the water. The recovery of the water level is measured and recorded vs. time. The slug test can be repeated and recorded again when the slug is removed from the water. Figure 12 shows a typical record of water levels during a slug test of hydraulic conductivity.

Data from variable head hydraulic conductivity tests may be analyzed using any preferred calculation method. The most commonly used methods are those of Hvorslev (1951), Cooper et al. (1967) and Bouwer and Rice (1976). Selection of these or any other analytical method should be based upon an assessment of how well the test conditions comply with the simplifying assumptions inherent in the analytical method. Software packages such as AquiferTest* provide a selection of analytical methods that can be applied.

In very low permeability environments (hydraulic conductivity less than 10^{-7} or 10^{-8} cm/sec) the formation fluid pressure can be changed with very little fluid movement. As a result, tests can be carried out through the measurement port valve rather than the pumping port valve. Using a sampler probe with a transducer the zone to be tested may be exposed to the fluid pressure inside the Westbay casing for a period of time (see Fig. 7 and discussion of measuring fluid pressure in low-k environments). The zone may then be shut-in and the recovery of fluid pressure over time measured and recorded. Figure 8 shows a data record from such a test.

Field Quality Control

There are two distinctive parts to any quality assurance program. The first involves manufacturing and testing procedures which avoid the production or installation of equipment that may result in the collection of erroneous data. The second involves field operating procedures which will ensure that erroneous data are not generated as a result of the failure of any component to function as intended. Although the first part is necessary to allow the installation of useful monitoring wells, the second must also be rigorously applied to identify sources of erroneous and misleading results.

The Westbay System has many unique features for field quality control which clearly separate it from other types of groundwater monitoring instrumentation. These features are the result of designing components in response to the stringent requirements of users in the fields of nuclear and hazardous waste management.

Quality control tests are carried out at various points during the field use of the Westbay System and tend to be grouped into three periods: during installation, following installation, and during routine monitoring.

During Installation

During installation of the Westbay System the following operations form part of the quality control procedures:

Drill core or cuttings and borehole geophysical logs are carefully checked to see that monitoring zones and annular seals are placed at the optimum positions. In cased wells, the well casing is inspected to verify that the interior surfaces are suitable for establishing good quality packer seals and backfill is placed under carefully controlled conditions with frequent measurements of material depths.

Westbay casing components are carefully inspected to see that critical surfaces are undamaged, sealing o-rings are clean and in place, and components are correctly oriented. Serial numbers are recorded along with component position in the installation. These operations link the field quality control to production test records.

As each section of Westbay casing is attached, the connection is pressurized with water and observed for any signs of leakage. Test results are recorded on the installation log.

Before inflating packers, a pre-inflation profile of pressure measurements is made through the measurement ports. This serves to verify the proper operation of components before being fixed in the well.

During inflation of each Westbay packer, incremental volumes and pressures are recorded and plotted. These data allow an evaluation of borehole conditions and provide the first indication of the quality of the annular seal obtained.

Following Installation

Immediately following installation further checks are carried out to verify the operation of the system. These include the initial post-inflation pressure profile which provides the first data on the vertical head distribution. Observed head differences across exterior casing seals directly indicate the seal effectiveness. Where such head differences are not observed, the annular seals can be artificially stressed by opening a pumping port in one monitoring zone and withdrawing or adding a slug of water from inside the casing while using a pressure probe or sampler probe to observe the pressure response in the monitoring zone on the other side of the seal. In cased wells and wells in low permeability environments, stresses can be applied through measurement ports in order to evaluate seal integrity.

Additional measurement ports are routinely installed between monitoring zones, further enhancing the ability to carry out thorough quality control tests.

Fluid can be added to packers at any time following installation and the pressure at which further fluid injection occurs can be compared with the injection pressures recorded during the initial inflation.

During Routine Monitoring

A number of quality control checks are built into the routine monitoring procedures.

When measuring fluid pressures, the pressures measured inside the Westbay casing at each measurement port are recorded immediately before and after the measurement made through the port. These inside casing values serve a number of purposes: 1) comparison of the two values confirms that the transducer was operating the same way before and after the reading, 2) comparison of the inside values from one set of measurements to the next confirms transducer stability over the intervening time period (assuming the water level inside the casing is the same), and 3) if the head of fluid inside the Westbay casing is known, an in-situ calibration check of head of water versus transducer output is obtained. Any unacceptable changes which show up during monitoring can be checked and corrected through laboratory calibration of the instrument.

Water sampling procedures with the Westbay System improve quality control because: 1) the short flow path between the formation and the container greatly reduces the surface area contacted by the sample, 2) the contacts between the water sample and the atmosphere are eliminated, 3) observing and recording the water level inside the Westbay casing during sampling confirms that the sample obtained is from outside the casing, and 4) sampling without purging reduces the disturbance of the natural system, minimizing unnatural changes in chemistry. Sampling methods can be varied to compare the effects of atmospheric contact versus no atmospheric contact and maintaining the sample under pressure versus allowing depressurization of the sample.

During water sampling, sample blanks and spikes may be collected using identical procedures for sampling, preservation, handling and shipping. Travel blanks and spikes may also be collected using identical procedures for handling, preservation and shipping. The chemical analyses of samples obtained using the Westbay System may be compared with those of samples collected from the same zone by alternate means.

Finally, the pumping port may be reopened should further purging appear to be desirable.

For both fluid pressure and water quality data, the Westbay System can provide corroborative data. That is, a high density of data can be obtained in a single installation so that significant changes in piezometric pressure and/or water quality can appear as transitions along a depth profile. Thus, neighboring values will corroborate one another rather than indicating abrupt changes which would cause one to question anomalous values.

Serviceability

In the event that quality control testing should reveal a component which is not operating properly, various steps can be taken to remedy the problem including, in certain cases, removing the Westbay casing string, replacing faulty components and reinstalling the string.

Summary

The modular nature of the Westbay System permits a large number of monitoring zones to be accessed through valves placed along a single closed tube or casing installed in a single borehole. Such a monitoring system can provide a detailed view of the variation of piezometric pressure, hydraulic conductivity, and water quality with depth. The valved couplings permit purging of the well following installation and allow all standard hydrogeologic tests to be carried out in each zone. Routine sampling is carried out without repeated purging, eliminating the need to store and dispose of large volumes of purge fluid and reducing operator exposure to hazardous fluids. The valves also permit an evaluation of the condition of exterior casing seals at any time after installation. Casing packers allow multiple seals to be established easily and quickly, providing the required hydraulic isolation of each monitoring zone. The modular design of the downhole components means the number and location of monitoring zones and seals can be modified on the basis of the best information available in the field at the time of installation. The exact depth of monitoring zones need not be known when equipment is purchased.

Figure 13 provides a schematic summary of the most common operations carried out in Westbay System monitoring wells. These include:

a) Purging and testing through open pumping ports;
b) Sampling and testing through measurement ports;
c) Pressure profiling using a single probe;
d) Automated monitoring using a string of pressure probes and a data logger; and
e) Vertical interference testing using a pressure probe and a sampler probe.

Other operations can also be carried out, such as cross-hole testing, vertical interference testing using strings of pressure probes, in-situ chemical analysis, tracer testing, etc.

Figure 14 provides a representation of the many types of data than can be collected from a single Westbay monitoring well. Among groundwater monitoring technologies, the ability to complete any number of monitoring zones in a single borehole and to carry out the variety of operations that permit the collection of data types represented here, all while maintaining high standards of quality assurance, is unique to the Westbay System.

Field quality control procedures have been established which permit the quality of a well installation and the proper operation of testing and sampling procedures and equipment to be routinely verified. Thus, groundwater data and the additional data required to define the quality of the field data can be routinely collected. Furthermore, when a high density of groundwater monitoring zones are installed by using multilevel monitoring wells, the redundant monitoring points can provide important corroborative field data to an extent which is not available with single level monitoring wells. The result is a monitoring system which provides data with a degree of defensibility unattainable with any other monitoring method, single or multilevel.

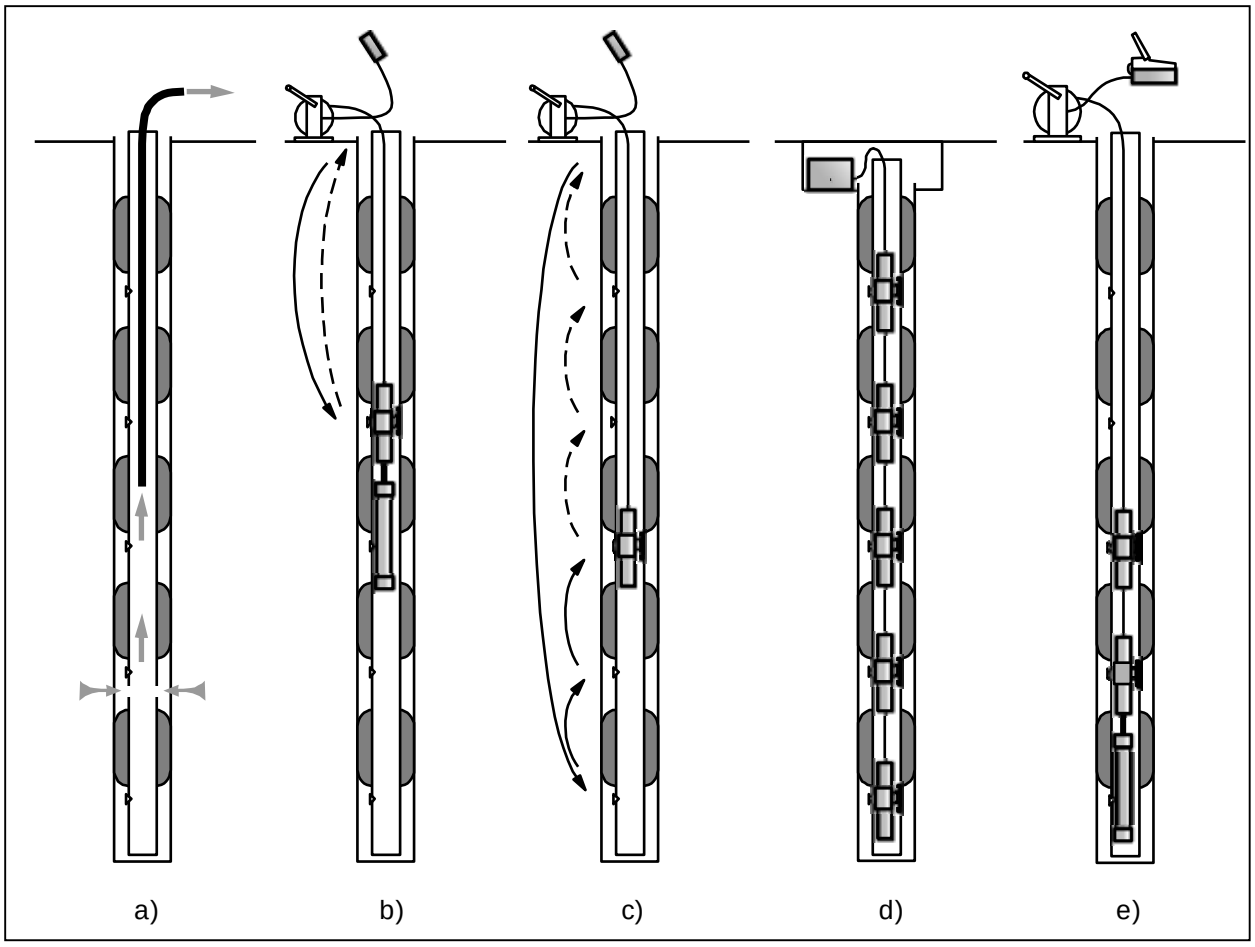


Figure 13. Schematic illustration of common operations with the Westbay System.

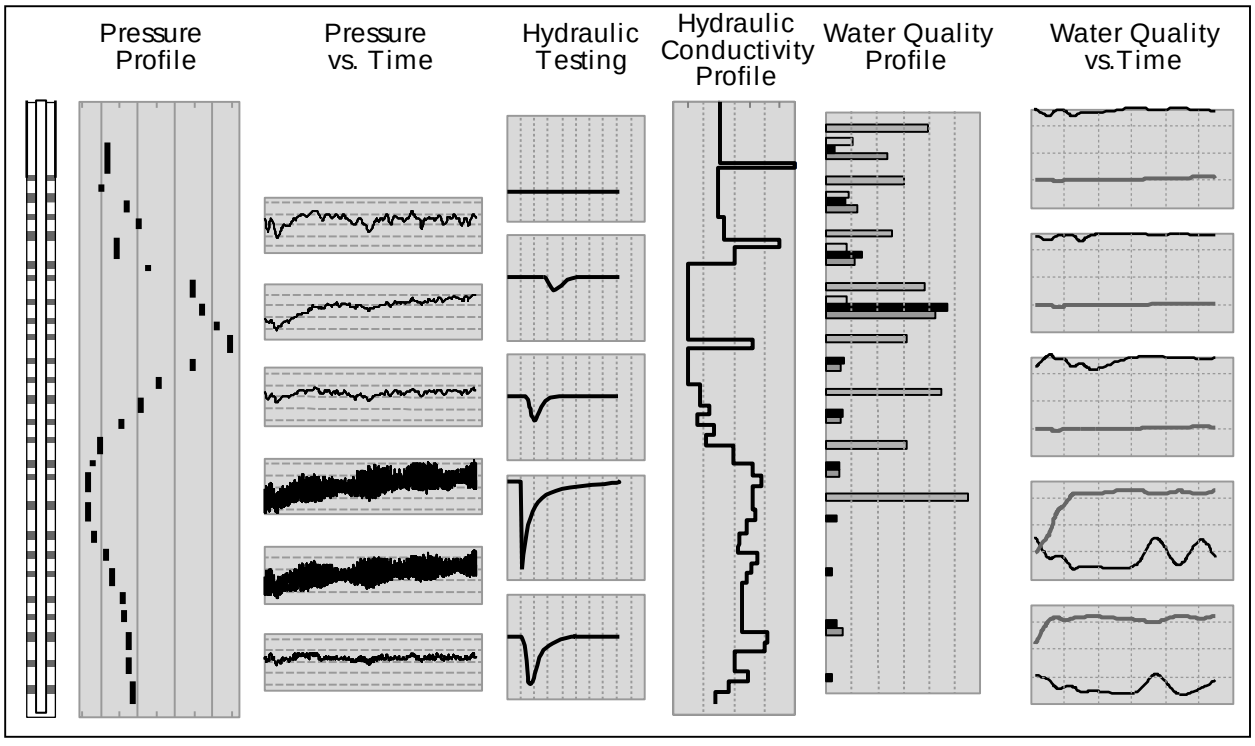


Figure 14. Schematic illustration of the types of data that can be collected with one Westbay well.

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* Mark of Nova Metrix Ground Monitoring (Canada) Limited, Westbay Division

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USER GUIDE

GeoExplorer® 6000 series

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GeoExplorer® 6000 series

Version 1.00
Revision A
February 2011

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This is the February 2011 release (Revision A) of the *GeoExplorer 6000 Series User Guide*. The GeoExplorer 6000 series handheld's operating system is based on the Microsoft Windows Mobile version 6.5 operating system.

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PLEASE NOTE: THE ABOVE TRIMBLE LIMITED WARRANTY PROVISIONS WILL NOT APPLY TO PRODUCTS PURCHASED IN THOSE JURISDICTIONS (E.G., MEMBER STATES OF THE EUROPEAN ECONOMIC AREA) IN WHICH PRODUCT WARRANTIES ARE THE RESPONSIBILITY OF THE LOCAL DEALER FROM WHOM THE PRODUCTS ARE ACQUIRED. IN SUCH A CASE, PLEASE CONTACT YOUR TRIMBLE DEALER FOR APPLICABLE WARRANTY INFORMATION.

Official Language

THE OFFICIAL LANGUAGE OF THESE TERMS AND CONDITIONS IS ENGLISH. IN THE EVENT OF A CONFLICT BETWEEN ENGLISH AND OTHER LANGUAGE VERSIONS, THE ENGLISH LANGUAGE SHALL CONTROL.

End User License Agreement for Product Software

IMPORTANT, READ CAREFULLY. THIS END USER LICENSE AGREEMENT ("EULA") IS A LEGAL AGREEMENT BETWEEN YOU AND Trimble Navigation Limited ("Trimble") and applies to the computer software provided with the Trimble product purchased by you (whether built into hardware circuitry as firmware, embedded in flash memory or a PCMCIA card, or stored on magnetic or other media), or provided as a stand-alone computer software product, and includes any accompanying written materials such as a user's guide or product manual, as well as any "online" or electronic documentation ("Software" or "Product Software"). This EULA will also apply to any Software error corrections, updates and upgrades subsequently furnished by Trimble, unless such are accompanied by different license terms and conditions, which will govern their use. You have acquired a Trimble Product ("Device") that includes Software, some of which was licensed by Trimble from Microsoft Corporation or its affiliates (collectively "Microsoft"). The Software licensed from Microsoft, as well as associated updates, supplements, internet-based services and support services, media, printed materials, and "online" or electronic documentation ("Microsoft Software"), are protected under this EULA. The Software is

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BY USING THE SOFTWARE, INCLUDING USE ON THIS DEVICE, YOU ACCEPT THESE TERMS. IF YOU DO NOT ACCEPT THEM, DO NOT USE THE DEVICE OR SOFTWARE. INSTEAD CONTACT TRIMBLE FOR A REFUND OR CREDIT. As described below, using some features also operates as your consent to the transmission of certain standard computer information for Internet-based services.

WARNING: If the Software contains voice operated technologies, then operating this Software requires user attention. Diverting attention away from the road while driving can possibly cause an accident or other serious consequence. Even occasional, short diversions of attention can be dangerous if your attention is diverted away from your driving task at a critical time. Trimble and Microsoft make no representations, warranties or other determinations that ANY use of this Software is legal, safe, or in any manner recommended or intended while driving or otherwise operating a motor vehicle.

This EULA does not grant you any rights with respect to the Windows Mobile Device Center, Microsoft ActiveSync or Microsoft Outlook 2007 Trial which are subject to the licenses accompanying those items.

1 SOFTWARE PRODUCT LICENSE

1.1 License Grant. Subject to the terms and conditions of this EULA, Trimble grants you a non-exclusive right to use one copy of the Software in a machine-readable form only as installed on the Device. Such use is limited to use with the Device for which it was intended, as set forth in the product documentation. The Device Software is licensed with the Device as a single integrated product. The Device Software installed in read only memory ("ROM") of the Device may only be used as part of the Device into which it was embedded. You may use the installation Software from a computer solely to download the Software to one Device. In no event shall the installation Software be used to download the Software onto more than one Device. A license for the Software may not be shared or used concurrently on different computers or Devices.

1.2 Scope of License. This EULA only gives you some rights to use the Software. Trimble and Microsoft reserve all other rights. Unless applicable law gives you more rights despite this limitation, you may use the Software only as expressly permitted in this EULA. In doing so, you must comply with any technical limitations in the Software that allow you to use it only in certain ways. Except as expressly provided in this EULA, rights to access the Software on this Device do not give you any right to implement Microsoft patents or other Microsoft intellectual property in software or devices that access this device. You may use remote access technologies in the software such as Remote Desktop Mobile to access the Software remotely from a computer or server. You are responsible for obtaining any licenses required for use of the protocols to access other software.

1.3 Proof of License. If you acquired the Software on the Device, or on a disc or other media, a genuine Certificate of Authenticity label with a genuine copy of the Software identifies licensed software. To be valid, this label must be affixed to the Device, or included on or in the software packaging. If you receive the label separately, it is not valid. You should keep the label on the device or packaging to prove that you are licensed to use the Software. To identify genuine Microsoft Software, see http://www.howtotell.com.

1.4 Connectivity Software. Your Device package may include Windows Mobile Device Center or Microsoft ActiveSync software. If it is included, then you may install and use it in accordance with the license terms that are provided with it. If no license terms are provided, then you may install and use only one (1) copy of the Software on a single computer.

1.5 Digital Certificates. The Software uses digital certificates in X.509 format. These digital certificates are used for authentication.

1.6 Phone Functionality. If the Device Software includes phone functionality, all or certain portions of the Device Software may be inoperable if you do not have and maintain a service account with a wireless telecommunication carrier ("Mobile Operator"), or if the Mobile Operator's network is not operating or configured to operate with the Device.

1.7 Upgrade Software. In the event that any upgrades to the Software, including Microsoft Software, are provided under this EULA, then the following shall apply: you may follow the applicable instructions accompanying this Software and install one (1) copy of the Software on one (1) Device presently containing a licensed copy of a predecessor version of the Software (unless this EULA indicates that this Software copy has been licensed for installation on multiple Devices). NO REPRESENTATION OR WARRANTY IS MADE BY TRIMBLE OR MICROSOFT WITH RESPECT TO THE COMPATIBILITY OF THIS SOFTWARE WITH ANY DEVICE OR ANY OTHER EXISTING SOFTWARE OR DATA OF ANY KIND CONTAINED ON SUCH DEVICES, AND NEITHER TRIMBLE OR MICROSOFT SHALL BE RESPONSIBLE IN ANY REGARD WITH RESPECT TO ANY LOSS, CORRUPTION, MODIFICATION OR INACCESSIBILITY OF ANY DATA, APPLICATIONS OR OTHER SOFTWARE RESULTING FROM THE INSTALLATION OF THE SOFTWARE ON ANY DEVICE.

1.8 Internet-Based Services Components. Microsoft provides Internet-based services with the software. Microsoft may change or cancel them at any time. The Microsoft Software features described below connect to Microsoft or service provider computer systems over the Internet. In some cases, you will not receive a separate notice when they connect. You may switch off some of these features or not use them. For more information about these features, visit http://go.microsoft.com/fwlink/?LinkId=81931. **By using these features, you consent to the transmission of this information.** Microsoft does not use the information to identify or contact you. You may not use these services in any way that could harm them or impair anyone else's use of them. You may not use the services to try to gain unauthorized access to any service, data, account or network by any means.

1.9 Device Information. The following features use Internet protocols, which send to the appropriate systems device information, such as your Internet protocol address, the type of operating system, browser and name and version of the Software you are using, and the language code of the Device where you installed the Software. Microsoft uses this information to make the Internet-based services available to you. a) Update Features: Windows Mobile Update feature provides you the ability to obtain and install Software updates on your Device if updates are available. You may choose not to use this feature. Trimble and/or your Mobile Operator may not support this feature or an update for your device. b) Security Updates/Digital Rights Management. Content owners use Windows Media digital rights management technology (WMDRM) to protect their intellectual property, including copyrights. This software and third party software use WMDRM to play and copy WMDRM-protected content. If the software fails to protect the content, content owners may ask Microsoft to revoke the software's ability to use WMDRM to play or copy protected content. Revocation does not affect other content. When you download licenses for protected content, you agree that Microsoft may include a revocation list with the licenses. Content owners may require you to upgrade WMDRM to access their content. Microsoft software that includes WMDRM will ask for your consent prior to the upgrade. If you decline an upgrade, you will not be able to access content that requires the upgrade.

1.10 **Additional Software/Services**. The Device Software may permit Trimble, Microsoft, their affiliates and/or their designated agent to provide or make available to you Software updates, supplements, add-on components, or Internet-based services components of the Software after the date you obtain your initial copy of the Software ("Supplemental Components").

1.10.1 If Trimble provides or makes available to you Supplemental Components and no other end user license agreement terms are provided along with the Supplemental Components, then the terms of this EULA shall apply.

1.10.2 If Microsoft, its affiliates and/or its designated agent makes available Supplemental Components, and no other end user license agreement terms are provided, then the terms of this EULA shall apply, except that the Microsoft entity or affiliate entity providing the Supplemental Component(s) shall be the licensor of the Supplemental Component(s).

1.10.3 Trimble, Microsoft and each of their affiliates and/or their designated agents reserve the right to discontinue any Internet-based services provided to you or made available to you through the use of the Device Software.

1.11 Links to Third Party Sites. If the Software provides links to third party websites, those links are provided to you only as a convenience, and the inclusion of any link does not imply an endorsement of the third party website by Microsoft or Trimble.

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1.13 Notice Regarding the MPEG-4 Visual Standard. The Software may include MPEG-4 visual decoding technology. This technology is a format for data compression of video information. MPEG LA, L.L.C. requires this notice: USE OF THIS PRODUCT IN ANY MANNER THAT COMPLIES WITH THE MPEG-4 VISUAL STANDARD IS PROHIBITED, EXCEPT FOR USE DIRECTLY RELATED TO (A) DATA OR INFORMATION (i) GENERATED BY AND OBTAINED WITHOUT CHARGE FROM A CONSUMER NOT THEREBY ENGAGED IN A BUSINESS ENTERPRISE, AND (ii) FOR PERSONAL USE ONLY; AND (B) OTHER USES SPECIFICALLY AND SEPARATELY LICENSED BY MPEG LA, L.L.C. If you have questions about the MPEG-4 visual standard, please contact MPEG LA, L.L.C., 250 Steele Street, Suite 300, Denver, CO 80206; www.mpegla.com.

1.14 If the Device Software is provided by Trimble separate from the Device on media such as a ROM chip, CD ROM disk(s) or via web download or other means, and is labeled "For Upgrade Purposes Only" you may install one (1) copy of such Device Software onto the Device as a replacement copy for the existing Device Software and use it accordance with this EULA, including any additional end user license agreement terms accompanying the upgrade Device Software.

1.15 If any software component(s) is provided by Trimble separate from the Device on CD ROM disc(s) or via web download or other means, and labeled "For Upgrade Purposes Only," you may (i) install and use one (1) copy of such component(s) on the computer(s) you use to exchange data with the Device as a replacement copy for the existing Companion CD component(s).

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1.17 U.S. Government Restricted Rights. The Software is provided with "RESTRICTED RIGHTS". Use, duplication, or disclosure by the United States Government is subject to restrictions as set forth in this EULA, and as provided in DFARS 227.7202-1(a) and 227.7202-3(a) (1995), DFARS 252.227-7013(c)(1)(ii) (OCT 1988), FAR 12.212(a) (1995), FAR 52.227-19, or FAR 52.227-14(ALT III), as applicable.

1.18 Microsoft has contractually obligated Trimble to include the following terms in this EULA:

Product Support. The Product support for the Software is not provided by Microsoft or its affiliates or subsidiaries. For product support, please refer to the Trimble support number provided in the documentation for the Device.

Not fault tolerant. The Software is not fault tolerant. Trimble installed the Software on the Device and is responsible for how it operates on the Device.

Restricted user. The Microsoft Software was designed for systems that do not require fail-safe performance. You may not use the Microsoft Software in any device or system in which a malfunction of the Microsoft Software would result in foreseeable risk of injury or death to any person. This includes operation of nuclear facilities, aircraft navigation or communication systems and air traffic control.

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LIABILITY LIMITATIONS. You can recover from Microsoft and its affiliates only direct damages up to fifty U.S. Dollars (U.S. $50.00), or equivalent in local currency. You cannot recover any other damages, including consequential, lost profits, special, indirect or incidental damages. This limitation applies to:

- Anything related to the Software, services, content (including code) on third party internet sites, or third party programs, and
- claims for breach of contract, breach of warranty, guarantee or condition, strict liability, negligence, or other tort to the extent permitted by applicable law.

It also applies even if Microsoft should have been aware of the possibility of the damages. The above limitation may not apply to you because your country may not allow the exclusion or limitation of incidental, consequential or other damages.

2 LIMITED WARRANTY FOR TRIMBLE PRODUCT SOFTWARE.

2.1 Limited Warranty. Trimble warrants that the Software, exclusive of the Microsoft Software, will perform substantially in accordance with the accompanying written materials for a period of twelve (12) months from the date of purchase. This limited warranty gives you specific legal rights; you may have others, which vary from state/jurisdiction to state/jurisdiction. The above limited warranty does not apply to Fixes, Minor Updates, or Major Upgrades of the Software after expiration of the twelve (12) month limited warranty period, all of which are provided "AS IS" and without warranty unless otherwise specified in writing by Trimble. Because the Software is inherently complex and may not be completely free of nonconformities, defects or errors, you are advised to verify your work. Trimble does not warrant that the Software will operate error free or uninterrupted, will meet your needs or expectations, or that all nonconformities can or will be corrected.

2.2 Software Fixes. During the limited warranty period described in section 2.1 above, you will be entitled to receive such Fixes to the Product Software that Trimble releases and makes commercially available and for which it does not charge separately, subject to the procedures for delivery to purchasers of Trimble products generally. If you have purchased the Product from an authorized Trimble dealer rather than from Trimble directly, Trimble may, at its option, forward the software Fix to the Trimble dealer for final distribution to you. Minor Updates, Major Upgrades, new products, or substantially new software releases, as identified by Trimble, are expressly excluded from this update process and limited warranty. Receipt of Software Fixes or other enhancements shall not serve to extend the limited warranty period.

For purposes of this warranty the following definitions shall apply: (1) "Fix(es)" means an error correction or other update created to fix a previous software version that does not substantially conform to its Trimble specifications; (2) "Minor Update" occurs when enhancements are made to current features in a software program; and (3) "Major Upgrade" occurs when significant new features are added to software, or when a new product containing new features replaces the further development of a current product line. Trimble reserves the right to determine, in its sole discretion, what constitutes a Fix, Minor Update, or Major Upgrade.

2.3 Customer Remedies. Trimble's and its suppliers' entire liability, and your sole remedy, with respect to the Software shall be either, at Trimble's option, (a) repair or replacement of the Software, or (b) return of the license fee paid for any Software that does not meet Trimble's limited warranty. This limited warranty is void if failure of the Software has resulted from (1) accident, misuse, abuse, or misapplication; (2) alteration or modification of the Software without Trimble's authorization; (3) interaction with software or hardware not supplied or supported by Trimble; (4) your improper, inadequate or unauthorized installation, maintenance or storage; or (5) if you violate the terms of this EULA. Any replacement Software will be warranted for the remainder of the original warranty period or thirty (30) days, whichever is longer.

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2.5 PLEASE NOTE: THE FOREGOING TRIMBLE LIMITED WARRANTY PROVISIONS MAY NOT APPLY TO SOFTWARE PRODUCT LICENSES PURCHASED IN THOSE JURISDICTIONS (SUCH AS COUNTRIES OF THE EUROPEAN UNION) IN WHICH PRODUCT WARRANTIES ARE OBTAINED FROM THE LOCAL DISTRIBUTOR. IN SUCH CASES, PLEASE CONTACT YOUR TRIMBLE DEALER FOR APPLICABLE WARRANTY INFORMATION.

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3.1 **LIMITATION OF LIABILITY**. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, IN NO EVENT SHALL TRIMBLE OR ITS SUPPLIERS BE LIABLE FOR ANY SPECIAL, INCIDENTAL, INDIRECT, CONSEQUENTIAL OR PUNITIVE DAMAGES HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY (INCLUDING, WITHOUT LIMITATION, DAMAGES FOR LOSS OF BUSINESS PROFITS, BUSINESS INTERRUPTION, LOSS OF BUSINESS INFORMATION, OR ANY OTHER PECUNIARY LOSS) ARISING OUT OF THE USE OR INABILITY TO USE THE SOFTWARE, OR THE PROVISION OF OR FAILURE TO PROVIDE SUPPORT SERVICES, EVEN IF TRIMBLE HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES AND NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY EXCLUSIVE REMEDY PROVIDED IN THIS EULA.

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4 GENERAL.

4.1 This EULA shall be governed by the laws of the State of California and applicable United States Federal law without reference to "conflict of laws" principles or provisions. The United Nations Convention on Contracts for the International Sale of Goods will not apply to this EULA. Jurisdiction and venue of any dispute or court action arising from or related to this EULA or the Software shall lie exclusively in or be transferred to the courts the County of Santa Clara, California, and/or the United States District Court for the Northern District of California. You hereby consent and agree not to contest, such jurisdiction, venue and governing law.

4.2 Section 4.1 notwithstanding, if you acquired this product in Canada, this EULA is governed by the laws of the Province of Ontario, Canada. In such case each of the parties to this EULA irrevocably attorns to the jurisdiction of the courts of the Province of Ontario and further agrees to commence any litigation that may arise under this EULA in the courts located in the Judicial District of York, Province of Ontario. If you acquired this product in the European Union, this EULA is governed by the laws of The Netherlands, excluding its rules governing conflicts of laws and excluding the United Nations Convention on the International Sale of Goods. In such case each of the parties to this EULA irrevocably attorns to the jurisdiction of the courts of The Netherlands and further agrees to commence any litigation that may arise under this EULA in the courts of The Hague, The Netherlands.

4.3 Trimble reserves all rights not expressly granted by this EULA.

4.4 Official Language. The official language of this EULA and of any documents relating thereto is English. For purposes of interpretation, or in the event of a conflict between English and versions of this EULA or related documents in any other language, the English language version shall be controlling.

Registration

To receive information regarding updates and new products, please contact your local dealer or visit the Trimble website at www.trimble.com/register. Upon registration you may select the newsletter, upgrade, or new product information you desire.

Notices

Class B statement- Notice to users This equipment has been tested and found to comply with the limits for a Class B digital device pursuant to Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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 communication.

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 the 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.

Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

The radios in this device have been designed and manufactured to not exceed stipulated emission limits for exposure to radio frequency (RF) energy as required by the Federal Communications Commission of the U.S. Government 47 C.F.R. § 2.1091 and 2.1093.

The FCC limits for Specific Absorption Rate (SAR) for general population / uncontrolled exposure for partial-body and extremities such as hands/wrists/feet and ankles are 1.6W/kg and 4W/kg respectively.

The greatest recorded FCC 10-g SAR value as determined at the highest certified power level of this device measured adjacent to the antenna was measured at 1.653 W/Kg; the applicable FCC 10-g SAR limit for handheld portable device is 4W/Kg.

Devices operating close to a base station operate at SAR levels well below the maximum value specified above.

The external antenna connector provided in this device is for GNSS antennas only.

Accessories

The following optional accessories have been approved for use with this device:

P/N 88014-00 GeoExplorer 6000 series AC Power Kit

P/N 88056-00 GeoExplorer 6000 Series Vehicle Power Supply

P/N 88049-03 USB to Serial Converter Cable

Canada

This Class B digital apparatus complies with Canadian ICES-003.

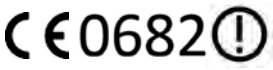
This digital apparatus does not exceed the Class B limits for radio noise emissions from digital apparatus as set out in the radio interference regulations of the Canadian Department of Communications.

Cet appareil numérique de la classe B est conforme à la norme NNB-003 du Canada.

Le présent appareil numérique n'émet pas de bruits radioélectriques dépassant les limites applicables aux appareils numériques de Classe B prescrites dans le règlement sur le brouillage radioélectrique édicté par le Ministère des Communications du Canada.

Europe

This product has been tested and found to comply with all requirements for CE Marking and sale within the European Economic Area (EEA). It is classified and marked as being Class 2 Radio Equipment under 2000/299/EC, as Bluetooth and wireless LAN approvals are country specific. Please consult your local distributor for more information.



EU – Restrictions for Use in the 2.4GHz band

This device may be operated indoors or outdoors in all countries of the European Community using the 2.4GHz band: Channels 1 – 13, except where noted below.

- In France outdoor operation is only permitted using the 2.4 – 2.454 GHz band: Channels 1 – 7.
- In Italy the end-user must apply for a license from the national spectrum authority to operate this device outdoors.
- In Norway, this unit may not be operated within 20 km of Ny Alesund

The Trimble GeoExplorer 6000 series has Bluetooth and wireless LAN approval in most EU countries and satisfies the requirements for Radio and Telecommunication Terminal Equipment specified by European Council Directive 1999/5/EC. These requirements provide reasonable protection against harmful interference when the equipment is operated appropriately in a residential or commercial environment.

GeoExplorer 6000 series handhelds equipped with wireless cellular modem radios are intended for connection to European Networks operating with GSM 900, or GSM 1800. A copy of the CE Declaration of Conformity for the GeoExplorer 6000 series can be accessed from http://www.trimble.com/support.shtml.

Australia and New Zealand

This product conforms with the regulatory requirements of the Australian Communications Authority (ACA) EMC and Radiocommunications framework, thus satisfying the requirements for C-Tick Marking and sale within Australia and New Zealand.

Additionally, GeoExplorer 6000 3.5G products that incorporate a modem also comply with the requirements for A-Tick Marking and sale in Australia.

Taiwan – Battery Recycling Requirements

The product contains an internal Lithium-ion battery. Taiwanese regulations require that waste batteries are recycled.

廢電池請回收

Notice to Our European Union Customers

For product recycling instructions and more information, please go to www.trimble.com/ev.shtml.

Recycling in Europe: To recycle Trimble WEEE (Waste Electrical and Electronic Equipment, products that run on electrical power.), Call +31 497 53 24 30, and ask for the "WEEE Associate". Or, mail a request for recycling instructions to:
Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL

Safety Information

Radio use

The Trimble® GeoExplorer® 6000 series handheld contains a Bluetooth® radio and Wi-Fi radio. Some models also include a cellular modem radio. In some situations, you may be required to turn off the radios. For example, aviation authority regulations restrict the use of wireless transmission devices on board aircraft.

To prevent the handheld from emitting radio signals, do one of the following:

- To turn off the handheld, press the **Power** button to display the Power menu then tap Shutdown.
- To turn off the Bluetooth, Wi-Fi, and wireless cellular modem radios only:
  a. Tap the title bar on the *Home* or *Start* screen, and then on the pull-down list, tap the  or  icon.
  b. In the *Connectivity* or the *Phone* dialog, select *Wireless Manager*.
  c. Tap **All** to turn off all radios. The status fields below the Wi-Fi, Bluetooth, and Phone buttons change to *Off*.

Deactivating the integrated Wi-Fi and Bluetooth radios

The GeoExplorer 6000 series handheld is shipped with Wi-Fi and Bluetooth wireless technology activated. To use the Wi-Fi or Bluetooth radio, you need to turn it on (see Turning on and turning off the integrated radios, page 80).

Note – *You may need to deactivate the Wi-Fi and/or Bluetooth radio in the handheld if the country in which you are working does not approve the use of Wi-Fi and/or Bluetooth wireless technology. If you are unsure about whether the GeoExplorer 6000 series handheld's radios are approved for use in your country, check with your Trimble reseller.*

Use the Radio Activation Manager software to deactivate the integrated Wi-Fi and/or Bluetooth radio, or to reactivate the radios if they have been deactivated. The Radio Activation Manager software runs on an office computer.

The latest copy of the software is available for download from the Trimble website. Go to www.trimble.com/support.shtml, click the link for your receiver type (*GeoXH*, or *GeoXT*), click *Downloads*, click *GeoExplorer 6000 Series* and then click *Radio Activation Manager*.

Exposure to radio frequency radiation from Bluetooth and Wi-Fi transmitters

This device is approved as a portable device with respect to Radio Frequency (RF) exposure compliance. The radiated output power of the internal wireless radio transmitters is less than 100 milliwatt, which results in exposure levels far below the FCC radio frequency exposure limits, even when operated in close proximity to the body. The internal wireless radios operate within guidelines found in international radio frequency safety standards and recommendations, which reflect the consensus of the international scientific community. Trimble therefore believes the internal wireless radios are safe for use by users. The level of electromagnetic energy emitted is hundreds of times lower than the electromagnetic energy emitted by wireless devices such as mobile phones. However, the use of wireless radios may be restricted in some situations or environments, such as on aircraft. If you are unsure of restrictions, you are encouraged to ask for authorization before turning on the wireless radios.

Exposure to radio frequency radiation from cellular wireless transmitters

GeoExplorer 6000 series handhelds equipped with wireless cellular modem radios have been designed and manufactured to meet safety requirements for limiting exposure to radio waves. When used in accordance with the instructions set forth in this manual, the equipment has been independently verified to not exceed the emission limits for safe exposure to radio frequency (RF) energy as specified by the Federal Communications Commission of the U.S. Government in 47 CFR §2.1093.

These limits are part of comprehensive guidelines and establish permitted levels of RF energy for the general population. The guidelines are based on standards that were developed by independent scientific organization through periodic and thorough evaluation of scientific studies. The standards include a substantial safety margin designed to assure the safety of all persons, regardless of age and health.

The exposure standard for all wireless devices employs a unit of measurement known as the Specific Absorption Rate, or SAR; the FCC limits for SAR for general population/uncontrolled exposure for partial-body and hands/wrists/feet and ankles are 1.6W/kg and 4W/kg respectively[1]. Devices operating close to a base station operate at SAR levels well below the maximum value specified above. Tests for SAR on the GeoExplorer 6000 series have been undertaken using the standard operating positions adopted by the FCC that test the device for SAR while it is transmitting at the highest certified power level in all tested frequency bands.

The FCC has granted an Equipment Authorization for this device on the basis that all reported SAR levels have been evaluated to be compliant with the FCC RF exposure guidelines.

1. In the United States and Canada, the SAR limit for mobile phones used by the public is 1.6 watts/kg (W/kg) averaged over one gram of tissue. The standard incorporates a substantial margin of safety .

SAR information on this device is on file with the FCC and can be found under the Display Grant section of http://www.fcc.gov/oet/fccid; search on FCC IDs:

- JUP 615 - for the GeoExplorer 6000 series standard edition handhelds
- JUP 616 - for the GeoExplorer 6000 series 3.5G edition handhelds

AC adaptor safety

To charge the handheld's battery, use the international adaptor kit provided with the GeoExplorer 6000 series handheld (see Powering the handheld, page 25).

WARNING – To use AC adaptors safely:
– Use only the AC adaptor intended for the GeoExplorer 6000 series handheld. Using any other AC adaptor can damage the handheld and may void your warranty. Do not use the AC adaptor with any other product.
– Make certain that the input voltage on the adaptor matches the voltage and frequency in your location.
– Make certain that the adaptor has prongs compatible with your outlets.
– Do not use the AC adaptor in wet outdoor areas; it is designed for indoor use only.
– Unplug the AC adaptor from power when not in use.
– Do not short the output connector.
– Be aware that there are no user-serviceable parts in this product.
– If the AC adaptor becomes damaged, replace it with a new Trimble AC adaptor.

Electrostatic discharge

WARNING – Static electricity can harm electronic components inside your handheld. To prevent static damage:
– Discharge static electricity from your body before you touch any of the electronic components inside your device, such as a memory module. You can do so by touching an unpainted metal surface.

The GeoExplorer 6000 series is designed for outdoor conditions; however under conditions of low humidity extremely high voltage discharge events are possible. Users are advised that the risk of causing discharge to sensitive electronics can be minimised by avoiding finger contact to the recessed connectors at the sides of the unit.

Battery safety

The removable rechargeable Lithium-ion battery is supplied partially charged. Charge the battery completely before using it for the first time (see Powering the handheld, page 25). If the battery has been stored for longer than six months, charge it before use.

WARNING – Do not damage the rechargeable Lithium-ion battery. A damaged battery can cause an explosion or fire, and can result in personal injury and/or property damage. To prevent injury or damage:
– Do not use or charge the battery if it appears to be damaged. Signs of damage include,

but are not limited to, discoloration, warping, and leaking battery fluid.
– Do not store or leave your device near a heat source such as near a fireplace or other heat-generating appliance, or otherwise expose it to temperatures in excess of 70 °C (158 °F) such as on a vehicle dashboard. When heated to excessive temperatures, battery cells could explode or vent, posing a risk of fire.
– Do not immerse the battery in water.
– Do not use or store the battery inside a vehicle during hot weather.
– Do not drop or puncture the battery.
– Do not open the battery or short-circuit its contacts.

WARNING – Avoid contact with the rechargeable Lithium-ion battery if it appears to be leaking. Battery fluid is corrosive, and contact with it can result in personal injury and/or property damage.
- To prevent injury or damage:
- If the battery leaks, avoid contact with the battery fluid.
- If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!
- If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.
- Do not open the battery or short-circuit its contacts.

WARNING – Charge and use the rechargeable Lithium-ion battery only in strict accordance with the instructions. Charging or using the battery in unauthorized equipment can cause an explosion or fire, and can result in personal injury and/or equipment damage.
To prevent injury or damage:
– Do not charge or use the battery if it appears to be damaged or leaking.
– Charge the Lithium-ion battery only in a Trimble product that is specified to charge it. Be sure to follow all instructions that are provided with the battery charger.
– Discontinue charging a battery that gives off extreme heat or a burning odor.
– Use the battery only in Trimble equipment that is specified to use it.
– Use the battery only for its intended use and according to the instructions in the product documentation.

Storage card use

The GeoExplorer 6000 series handheld provides a storage card slot, providing an alternative storage location to the storage memory in the handheld.

WARNING – Static electricity can harm electronic components inside your handheld. To prevent static damage:
– Discharge static electricity from your body before you touch any of the electronic components inside your device, such as a memory module. You can do so by touching an unpainted metal surface.

WARNING – The presence of any dust or moisture in the storage card slot may adversely affect the device and void your Trimble warranty. To prevent dust or moisture entering the storage card slot:
– Make certain that the storage card slot door is attached correctly when you are using the handheld outdoors.
– When inserting or removing a storage card, place the handheld on a dust-free indoor surface.

Contents

CHAPTER

1

Introduction

In this chapter:

The *GeoExplorer 6000 Series User Guide* describes how to set up and use the Trimble® GeoExplorer® 6000 series handheld. The information in this guide supplements the information in the *GeoExplorer 6000 Series Quick Start Guide*, which you received with the handheld.

This guide describes how to:

- use the Microsoft® Windows Mobile® version 6.5 operating system.
- use the handheld's integrated GNSS receiver.
- synchronize information between a computer and the handheld.
- exchange information between the handheld and other devices.
- connect to the Internet or to a computer network.
- use the integrated camera.

Even if you have used other Global Navigation Satellite System (GNSS) products before, Trimble recommends that you spend some time reading this guide to learn about the special features of the product. If you are not familiar with GNSS, go to the Trimble website (www.trimble.com) for more information.

About the GeoExplorer 6000 series handheld

The GeoExplorer 6000 series includes the GeoXH™ and GeoXT™ handhelds. These handhelds combine a Trimble GNSS receiver with a field computer powered by Microsoft Windows Mobile version 6.5 operating system.

The GeoExplorer 6000 series handheld has built-in Bluetooth® wireless technology for cable-free connection to other devices, and Wi-Fi connectivity for connections to networks. In addition, some GeoExplorer 6000 series handheld editions are equipped with a wireless cellular modem for downloading and transmitting data over the Internet.

The GeoXT handheld uses EVEREST™ multipath rejection technology to provide submeter accuracy. The GeoXH handheld uses both EVEREST and H-Star™ technology to provide decimeter (10 cm) accuracy, either in real time or after postprocessing. In addition, both the GeoXH and GeoXT handhelds are compatible with Trimble Floodlight™ satellite shadow reduction technology for improved productivity in conditions where sky view is obstructed by buildings, trees, or landscape features. For more information, see Chapter 5, Using the GNSS Receiver.

Supported GNSS field software

To collect GNSS data with the GeoExplorer 6000 series handheld, you must install GNSS field software onto the handheld. You can use the GeoExplorer 6000 series handheld with the following GNSS field software:

- Trimble TerraSync™ software, for configuring real-time differential correction options and for productive GIS data collection and maintenance.
- The Trimble GPScorrect™ extension for Esri ArcPad software, for configuring real-time differential correction options and for productive GIS data collection and maintenance.
- Trimble GPS Controller software, for configuring real-time differential correction options and NMEA output settings.
- Other GNSS field software that accepts NMEA messages. To use NMEA Output messages, you must purchase and activate the NMEA output option. See Activating the Floodlight technology and the NMEA output options, page 74

For more information, see Chapter 5, Using the GNSS Receiver.

What's in the box?

When you unpack the GeoExplorer 6000 series handheld, check that you have received all the components:

- GeoExplorer 6000 series handheld
- Carry pouch
- AC adaptor kit
- Microsoft Getting Started CD and licence
- Anti-reflection screen protector kit
- USB data cable
- Hand strap kit
- Spare stylus and lanyard
- A sheet of device ID labels
- Rechargeable battery pack

Inspect all contents for visible damage (scratches, dents) and if any components appear damaged, notify the shipping carrier. Keep the shipping and packaging material for the carrier's inspection.

Accessories

The following optional accessories are available:

- USB to serial converter cable
- Null modem cable[1]
- Hard carry case
- Range pole
- Range pole bracket
- Vehicle mounting bracket
- Tempest™ antenna[2]
- Tornado™ antenna[3]
- Pole-mountable ground plane
- Backpack kit
- Screen protectors (2 pack)
- Stylus kit
- GeoBeacon™ receiver (receives differential corrections from a beacon network)
- Replacement battery pack
- Replacement international AC adaptor
- Replacement carry pouch
- Replacement hand strap kit

[1]Requires USB to serial converter (sold separately)

[2]Compatible with GeoXH/XT handhelds for improved yield. Also improves accuracy for the GeoXT handheld only.

[3]Compatible with the GeoXH handheld for improved accuracy.

For more information, go to www.trimble.com/geoxh.shtml, or www.trimble.com/geoxt.shtml.

Use and care of the handheld

To protect the GeoExplorer 6000 series handheld when not in use, Trimble recommends storing the handheld in the pouch provided.

When using the handheld:

- To protect the touch screen from pressure and abrasive objects, Trimble recommends that you apply one of the screen protectors provided with the GeoExplorer 6000 series handheld.
- Protect the touch screen by using your finger or the stylus provided, and avoid using excessive pressure and sharp or abrasive objects.
- Keep the outer surface free of dirt and dust.
- Ensure that protective covers and doors are appropriately fitted to the external antenna port, SIM, and storage card areas, so that they are kept free from dirt, dust, fluid ingress & electrostatic discharge (see Storage cards, page 35).
- Protect the handheld from extreme temperatures. For example, do not leave the handheld on the dashboard of a vehicle.
- When the battery is removed, the handheld is not waterproof. Avoid exposing the internals of the handheld to dust and moisture when removing the battery. Trimble recommends that you only swap the battery indoors or from inside a vehicle.
- Use the handstrap provided with the GeoExplorer 6000 series handheld.

To clean the handheld, wipe it with a clean dry cloth. Do ***not*** immerse the handheld in water.

Storing the handheld

If you are not going to use the handheld for three months or more, Trimble recommends that you do not leave the handheld in Suspend mode (see page 31). Instead, partially charge the battery and then turn off the handheld.

To prepare the GeoExplorer 6000 series handheld for storage:

1. Transfer any data that you need to an office computer.
2. Charge the battery to approximately 30%.
3. Press the **Power** key for one second until the *Power* menu appears and then tap **Shutdown**.
4. Store the handheld at room temperature.

To use the GeoExplorer 6000 series handheld after storage:

1. Press the **Power** key to turn on the handheld.
2. Recharge the battery (see Charging the battery, page 27).

Technical assistance

Technical support

Go to the GeoExplorer 6000 series handheld technical support page (www.trimble.com/geoxh_ts.asp, or www.trimble.com/geoxt_ts.asp) on the Trimble website for the latest support information about the software, including:

- support notes detailing support issues
- documentation
- the latest files available for download

Additional help

If you still cannot find the information that you need, contact your Trimble reseller.

Windows error reporting

If for any reason a Microsoft Windows Error Reporting dialog appears, indicating that the handheld or Trimble GNSS field software has encountered a problem and needs to close, you are prompted to send an error report to Microsoft.

Trimble recommends that you click **Send** and then click any subsequent links that are used to obtain additional information.

Trimble can access the report that is sent to Microsoft and use it to improve the GeoExplorer 6000 series handheld.

Your comments

Your feedback about the supporting documentation helps Trimble to improve it with each revision. Email your comments to ReaderFeedback@trimble.com.

CHAPTER

2

Getting Started

In this chapter:

This chapter describes the main features of the GeoExplorer 6000 series handheld, and provides the information you need to get up and running with the handheld.

Parts of the GeoExplorer 6000 series handheld

The following diagrams show the main parts of the handheld.

Figure 2.1 Parts of the GeoExplorer 6000 series handheld

Keypad buttons

The GeoExplorer 6000 series handheld has a keypad for fast, easy access to common actions. LEDs provide visual notifications of system events.

Figure 2.2 GeoExplorer 6000 series handheld keypad area

The function of each key is described below:

Key	Description
Power key	Press briefly (less than one second) to turn on the handeld, or to turn off the handheld (put it into Suspend mode). To access other power options, or to reset the handheld, press and hold for one second until the *Power* menu appears (see Turning on and turning off the handheld, page 31, or see Resetting the handheld, page 33).
Left and right soft keys	By default these keys perform the same action as the left and right softkeys in the tile bar. Alternatively, program these keys to perform a selected action. To program the keys, use the Buttons control (see Buttons, page 46).
Camera Control key	Press to activate and operate the camera (see Chapter 7, Using the Camera).

Tip – To lock the screen and handheld keys without turning off the handheld, use the device lock option (see Device lock, page 49).

The function of each LED is described below:

Key	LED	Description
Battery status		Battery charging is complete.
		Battery is charging.
	... ...	Battery level is critically low (<5% remaining).
		Battery fault.
GNSS receiver status	... ...	Receiver is on, and GNSS positions are available.
	... ...	Receiver is on, but GNSS positions are not available.
Wireless radio status	... ...	A wireless radio is turned on.

Powering the handheld

The GeoExplorer 6000 series handheld contains a removable rechargeable Lithium-ion battery.

Note – *Charge the battery completely before using the handheld for the first time. If the battery has been stored for longer than six months, charge it before use. Trimble recommends charging the battery for five hours to recharge it fully.*

When fully charged, the handheld battery provides enough power for a full working day (10 hours) using the internal GNSS antenna and with the backlight on at the default settings.

Note – *Cold temperatures, or using Bluetooth wireless technology, Wi-Fi, or the wireless cellular modem consumes additional battery power and so shortens battery life between charges.*

AC adaptor safety

WARNING – To use AC adaptors safely:
– Use only the AC adaptor intended for the GeoExplorer 6000 series handheld. Using any other AC adaptor can damage the handheld and may void your warranty. Do not use the AC adaptor with any other product.
– Make certain that the input voltage on the adaptor matches the voltage and frequency in your location.
– Make certain that the adaptor has prongs compatible with your outlets.
– Do not use the AC adaptor in wet outdoor areas; it is designed for indoor use only.
– Unplug the AC adaptor from power when not in use.
– Do not short the output connector.
– Be aware that there are no user-serviceable parts in this product.
– If the AC adaptor becomes damaged, replace it with a new Trimble AC adaptor.

Battery safety

WARNING – Do not damage the rechargeable Lithium-ion battery. A damaged battery can cause an explosion or fire, and can result in personal injury and/or property damage.
To prevent injury or damage:
– Do not use or charge the battery if it appears to be damaged. Signs of damage include, but are not limited to, discoloration, warping, and leaking battery fluid.
– Do not store or leave your device near a heat source such as near a fireplace or other heat-generating appliance, or otherwise expose it to temperatures in excess of 70 °C (158 °F) such as on a vehicle dashboard. When heated to excessive temperatures, battery cells could explode or vent, posing a risk of fire.
– Do not immerse the battery in water.
– Do not use or store the battery inside a vehicle during hot weather.
– Do not drop or puncture the battery.
– Do not open the battery or short-circuit its contacts.

WARNING – Avoid contact with the rechargeable Lithium-ion battery if it appears to be leaking. Battery fluid is corrosive, and contact with it can result in personal injury and/or property damage.
- To prevent injury or damage:
- If the battery leaks, avoid contact with the battery fluid.
- If battery fluid gets into your eyes, immediately rinse your eyes with clean water and seek medical attention. Do not rub your eyes!
- If battery fluid gets onto your skin or clothing, immediately use clean water to wash off the battery fluid.
- Do not open the battery or short-circuit its contacts.

WARNING – Charge and use the rechargeable Lithium-ion battery only in strict accordance with the instructions. Charging or using the battery in unauthorized equipment can cause an explosion or fire, and can result in personal injury and/or equipment damage.
To prevent injury or damage:
– Do not charge or use the battery if it appears to be damaged or leaking.
– Charge the Lithium-ion battery only in a Trimble product that is specified to charge it. Be sure to follow all instructions that are provided with the battery charger.
– Discontinue charging a battery that gives off extreme heat or a burning odor.

– Use the battery only in Trimble equipment that is specified to use it.
– Use the battery only for its intended use and according to the instructions in the product documentation.

Inserting the battery

To insert the battery into the handheld:

1. Slide the battery into the cavity with the label facing upwards (as shown in Figure 2.3).
2. Push the battery in until it clicks into place.

CAUTION – Make sure that the battery is fully inserted and that both the left and right latches are fully engaged. If the battery is not properly inserted, it may fall out if the device is dropped.

Figure 2.3 Inserting the battery

Note – *Charge the battery completely before using the handheld for the first time. If the battery has been stored for longer than six months, charge it before use. Trimble recommends charging the battery for five hours to recharge it fully.*

Charging the battery

Charge the battery in the handheld, or, if you have a spare battery, you can charge it outside the handheld.

To charge the battery:

1. Connect one end of the AC adaptor cable to the battery and the other to an AC power outlet. An international adaptor kit is provided with the handheld.
2. Turn off the handheld or put the handheld in Suspend mode (see page 31).

Note – *Trimble recommends that you charge the handheld at or below normal room temperature (0 to 30 °C / 32 to 86 °F).*

3. Leave the battery to charge. It may take up to five hours for the handheld to charge completely.

   When the handheld is charging, the Power LED on the handheld is solid orange. If the Power LED changes to red, a battery charging fault has occured. For more information, see page 28.

   When fully charged, the Power LED is green.

The Power LED on the keypad on the handheld indicates the battery power or charging status, as shown below:

Power source	LED state	Handheld/battery state
Battery power	Off	Handheld is turned off or is in Suspend mode.
	Off	Handheld is turned on and battery level is good.
		Flashing red: Handheld is turned on and battery level is critically low (<5%).
External power		Solid orange: Battery is charging.
		Solid red: Charging fault - for example, there is a problem with the battery, or the temperature of the battery has exceeded the acceptable temperature range.
		Solid green: Charging is complete.

Note – *During normal charging, the battery may become hotter than the maximum temperature allowed (40 °C or 104 °F). If this happens, charging is automatically suspended until the battery cools and then charging automatically restarts. During this time the battery icon in the title bar shows*  *, to indicate that the handheld is running on external power. It may take about one hour for the battery to cool.*

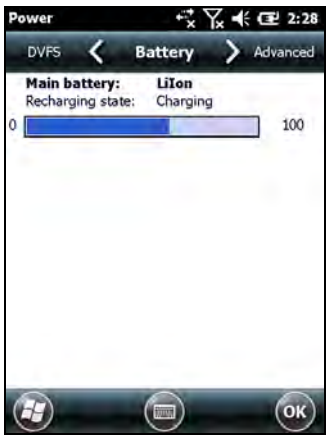
Avoid keeping the battery at full charge at high temperatures. For more information, see Storing the handheld, page 20.

Note – *The life of the battery can be significantly shortened if power is constantly supplied to the handheld. To avoid this issue, connect the handheld to an external power source only when the battery requires charging. Once fully charged, disconnect the external power source and allow the battery to discharge through normal use.*

Checking the level of battery power

To check the level of battery power remaining at any time while the device is running, tap the battery icon in the title bar of the *Home* screen and then tap  in the pull-down list.

The Power control appears, displaying the *Battery* tab.



When the handheld battery is recharging from an external power source, the battery icon in the *Home* screen changes to . You can still tap the icon to view the level of battery power.

To check the level of battery power remaining on a spare battery or one that is not inside the handheld, press the battery icon on the battery pack label. The level of charge indicator will light up with the approximate level of battery power remaining on the battery. Each LED represents a 20% increment in battery capacity.

Low battery indicators

When the battery level reaches:

- 15%, the battery icon in the title bar of the *Home* screen changes to .
- 10%, the Power LED on the handheld flashes red and the Main battery low message appears on the handheld.
- 5%, the Main battery very low message appears on the handheld.

Trimble recommends that you recharge the battery when any of these indicators appear.

Swapping the battery

If the battery runs low while you are working, you can swap the battery without the need to close files and shut down the handheld, and can resume working straight away.

1. Save any open files.
2. Ensure that you have a spare battery close by with sufficient charge to keep working (see Checking the level of battery power, page 28).
3. Turn off the handheld or put the handheld in *Swap Battery* mode (see page 32).

CAUTION – In Swap Battery mode, the battery LED shows as a red warning. When the device is ready, the red LED turns off, and the battery can be safely swapped. Generally the red LED will only display for half a second or less, but it may display for three seconds or so. Do not remove the existing battery until the red LED turns off. Removing the battery when the red LED warning light is still on will make the device reboot when the battery is swapped. Do not remove the existing battery until the red LED turns off.

4. Remove the old battery by pinching the battery latches together until the battery is ejected. Slide the battery out.

CAUTION – The handheld is not sealed from water and dust when the battery is removed. Trimble recommends only removing the battery for short periods of time and only removing the battery indoors or from inside the protection of a vehicle.

5. Insert the new battery (see Inserting the battery, page 27).

CAUTION – The handheld has enough power to keep the device running for approximately 30 seconds with the battery removed. If the power drains before the battery is restored the device will shut down. Trimble recommends saving open files before swapping the battery.

6. Press the **Power** key to resume your session.

Conserving power

Although the handheld battery can operate for a full day without recharging, Trimble recommends that you do the following to reduce power consumption:

- Set the handheld to automatically turn off when idle. For more information, see Suspend mode, page 31.
- Set the backlight to automatically turn off when the handheld is idle for a specified time. For more information, see Backlight, page 51.
- Turn off the integrated Bluetooth, Wi-Fi, and wireless cellular modem radios whenever you are not using them. For more information, see Turning on and turning off the integrated radios, page 80.
- Disconnect from the integrated GNSS receiver when GNSS data is not required, using the application's Disconnect or Deactivate GNSS command. When you disconnect from GNSS, the integrated GNSS receiver switches off and stops drawing power.

Note – *Do not disconnect from GNSS if you will be reconnecting within about five minutes. A GNSS application can take up to 30 seconds to reactivate the integrated GNSS receiver, so disconnecting to save power can cost time.*

Turning on and turning off the handheld

If the screen on the handheld is blank, the handheld is in Suspend mode or *Battery Change* mode (see page 31) or has been shut down. To turn on the handheld, press the **Power** key briefly (less than one second).

To turn off the handheld and put the handheld into Suspend mode, press the **Power** key briefly (less than one second). The handheld is placed in a very low power state, but the Bluetooth and wireless cellular modem radios may remain active (see Suspend mode, page 31)

To completely shut down the handheld, press the **Power** key for one second until the *Power* menu appears and then tap **Shutdown**. All running applications are shut down, and the handheld is completely turned off.

The options available from the *Power* menu are as follows:

Button	Used to...
Power Settings	quickly access the Power Settings menus.
Backlight Settings	quickly access the Backlight Settings menus.
Swap Battery	put the handheld into *Swap Battery* mode. This is a low-power mode. The handheld, the integrated receiver, and all wireless radios are turned off, and you cannot operate the handheld.
Shutdown	put the handheld into Shutdown mode. Applications are shut down and the handheld is completely turned off.
Reset	restart the handheld. If the handheld stops responding to the stylus, or if it does not respond when you press any of the keypad buttons, try a soft reset. For more information, see Resetting the handheld, page 33.
	access the Align Screen Sequence. You can also press the left application key to access the Align Screen Sequence. If at any time the touch screen does not respond correctly to stylus taps, start the screen alignment sequence and follow the on-screen instructions.

Suspend mode

When you press the **Power** key to turn off the handheld, the handheld goes into Suspend mode. This is a low-power mode that maintains the main memory contents and keeps applications running but does not allow you to operate any of the handheld's functions. The handheld appears to be turned off. The integrated GNSS receiver is turned off and any application using GNSS is disconnected.

If a wireless radio is turned on (the LED is flashing), the Wi-Fi radio will be turned off, and the Bluetooth and wireless cellular modem radios will remain turned on. The handheld is capable of receiving data via Bluetooth or the cellular modem radio while it is in Suspend mode. The handheld is able to automatically wake up to calendar alarms if it is in Suspend mode.

CAUTION – To save battery power, use the Wireless Manager to turn off the wireless radios before you place the handheld into Suspend mode.

To turn on the handheld when it is in Suspend mode, press the **Power** key. The handheld is immediately ready for operation. There may be a delay of up to 30 seconds while the integrated GNSS receiver and the Wi-Fi radio automatically reactivate.

You can configure the handheld to automatically enter Suspend mode when it has been idle for a specified time. By default, the handheld is set to enter Suspend mode if it is not used for one minutes.

To change the time before the handheld enters Suspend mode:

1. Tap the title bar of the *Home* or the *Start* screen and then tap . The Power control appears, displaying the *Battery* tab.
2. Tap the *Advanced* tab.
3. From the *On battery power* option, select the *Turn off screen if device not used for* check box and then select the idle time from the drop-down list.
4. Tap **OK**.

Swap Battery mode

Swap Battery mode is a low power mode that allows you to remove an empty battery and replace it with a fresh battery without closing files and applications; it maintains the main memory contents and keeps applications running but does not allow you to operate any of the handheld's functions. The handheld appears to be turned off. The integrated GNSS receiver is turned off and any application using GNSS is disconnected. All wireless radios are powered down and the device is unable to be automatically woken up.

When in Swap Battery mode, the handheld operates on backup power with the battery removed. From the time that the battery is removed, you have approximately 45 seconds to replace the battery before the backup power supply is consumed and the handheld shuts down.

To switch to Swap Battery mode, press and hold the **Power** key and then tap **Swap Battery** on the *Power* menu. The battery LED shows as a red warning. When the device is ready, the red LED turns off, and the battery can be safely swapped. Generally the red LED will only display for half a second or less, but it may display for three seconds or so. Do not remove the existing battery until the red LED turns off.

CAUTION – Removing the battery when the red LED warning light is still on will make the device reboot when the battery is swapped. Do not remove the existing battery until the red LED turns off.

To turn on the handheld when it is in Swap Battery mode, ensure that the battery is correctly installed and then press the **Power** key. The handheld is immediately ready for operation. There may be a delay of up to 30 seconds while the integrated GNSS receiver automatically reactivates.

The wireless radios will not automatically reactivate; use the Wireless Manager to manually turn on the wireless radios.

Resetting the handheld

If the screen on the handheld is blank, the handheld has turned off. Press the **Power** button to turn on the handheld.

If the handheld stops responding to the stylus, or if it does not respond when you press any of the keypad buttons, you may need to reset it by performing a soft or hard reset.

You can also reset the handheld to its factory default settings by performing a factory reset.

Performing a soft reset

A soft reset is similar to restarting a computer. A soft reset retains all settings and device data that you have previously saved on the handheld. The handheld saves any unsaved data, closes all open applications, and then restarts.

To perform a soft reset, press the **Power** key for one second until the *Power* menu appears and then tap the **Reset** button.

Performing a hard reset

A hard reset retains settings and data that you have previously saved on the handheld. However, any unsaved data may be lost.

Note – *Perform a hard reset only if a soft reset does not resolve the problem.*

To perform a hard reset, press and hold the **Power** key until the boot screen appears and then release the **Power** key.

Resetting to factory default settings

Reset the handheld to factory default settings to restore the handheld to it's original state, or only if a soft reset and then a hard reset does not resolve the problem.

CAUTION – Resetting the handheld to factory default settings erases ***all*** data, installed applications, and settings stored in the handheld, except for any data or applications that were pre-installed on the handheld or are stored on a storage card. It does not change the language of the operating system used on the handheld.

CAUTION – If you have encrypted files on a storage card and you reset the handheld to factory default settings, the encryption key on the handheld is deleted. This means that any files you have encrypted on a storage card are permanently locked and unreadable by any device. For more information, see Encrypting files on storage cards, page 36.

Tip – To quickly and easily restore data deleted by performing a factory reset, synchronize the handheld with a computer ***before*** you reset the handheld to the factory default settings. Once the handheld is reset then resynchronize the handheld with the computer.

To reset the handheld to the factory default settings:

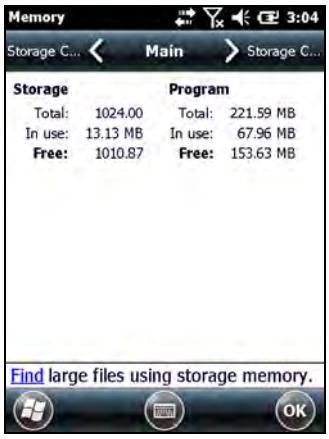
1. Press and hold the two application keys on the handheld.
2. While holding the application keys, press and hold the **Power** key until the device reboots.

3. Keep holding the two application keys until the factory reset screen appears.
4. Follow the on-screen instructions to continue the factory reset.

Storing data

The handheld has two types of memory:

- Storage memory is similar to the hard disk in a computer, and is used for storing programs and data.
- Program memory is similar to the RAM in a computer, and is used for running programs. You cannot use it to save data.



To check the storage capacity on the handheld, tap / *Settings* / *System* / *Memory*. The Storage and Program columns show the current memory available, and the memory that is already in use.

Pre-installed documents and program files are not affected by power loss or resetting. However, you can still lose data if you accidentally delete or overwrite it.

CAUTION – The Windows Mobile version 6.5 operating system does not include a Recycle Bin. When you delete files from the handheld, they are deleted permanently.

Trimble recommends that you regularly copy important data to an office computer. For more information, see Connecting to an Office Computer, page 55.

Storage cards

As an alternative to internal storage, you can save data to a removable card. Use either an SD or SDHC (high capacity SD) card to securely transfer data to and from another device that supports SD or SDHC cards.

Note – *The GeoExplorer 6000 series handheld does not support SDIO (Secure Digital Input/Output) or SDXC (Secure Digital Extended Capacity) cards.*

WARNING – The presence of any dust or moisture in the storage card slot may adversely affect the device and void your Trimble warranty. To prevent dust or moisture entering the storage card slot:
– Make certain that the storage card slot door is attached correctly when you are using the handheld outdoors.
– When inserting or removing a storage card, place the handheld on a dust-free indoor surface.

WARNING – Static electricity can harm electronic components inside the handheld. To prevent static damage:
– Discharge static electricity from your body before you touch any of the electronic components inside your device, such as a memory module. You can do so by touching an unpainted metal surface.

To insert an SD or SDHC card:

1. Place the handheld on a dust-free indoor surface.
2. Flip open the storage card slot door on the side of the handheld.

3. Insert the storage card into the storage card slot with the gold contacts facing down. Gently press the card until you hear a click, and the card is locked into place.
4. Close the storage card slot door.

When you select the *Save As* option in an application, the storage card appears in the list of available storage locations.

Note – *Do not store required data or applications to a storage card if the card will be removed. Data saved to a storage card is available only when the card is inserted in the handheld.*

To remove the storage card from the storage card slot, gently press the card in and then let go. The card pops out.

Encrypting files on storage cards

To prevent sensitive data on an SD or SDHC card from being used if the card is lost or stolen, files can be encrypted as they are placed on the card.

When encryption is enabled, an encryption key is stored on the handheld. Files are encrypted as they are copied or written to the storage card. Files already saved on storage cards before enabling encryption are not automatically encrypted.

Note – *Because the encryption key is stored on the handheld, encrypted files are only readable on the handheld on which they are initially encrypted. It is not possible to read encrypted files on the storage card with any other device, including another GeoExplorer 6000 series handheld or an office computer.*

CAUTION – If you reset the handheld to the factory default settings, the encryption key is deleted and the handheld is no longer able to read any encrypted files on a storage card. This means that any files you have encrypted are permanently locked and unreadable by any device. To avoid being unable to read previously encrypted files, Trimble recommends that you use another device, such as an office computer, as the primary location for storing important data and to control the encryption of important files.

To enable encryption of files as they are written to a storage card:

1. Tap / *Settings* / *System* / *Encryption*.
2. Select the *Encrypt files when placed on a storage cards* check-box.

Note – *Encrypted files appear as ordinary files on the handheld they were encrypted on. If the storage card is inserted in another device, the files appear with a .menc file extension and cannot be opened.*

To disable encryption, clear the *Encrypt files when placed on a storage cards* check-box.

Note – *Disabling encryption does not remove encryption from any existing files on the storage card, but ensures that new files placed onto the storage card are not encrypted.*

To encrypt files that are already stored on a storage card:

1. Copy the files to the handheld's internal storage or to an office computer.
2. Ensure encryption is enabled on the handheld.

3. Copy the files back to the storage card. The files are encrypted as they are written to the storage card.

To remove encryption from files so they can be read by other devices:

1. Insert the storage card in the handheld and then connect the handheld to an office computer using Microsoft ActiveSync® technology or the WMDC.
2. Copy the encrypted files from the storage card to the office computer.
3. To use the decrypted files on the handheld, copy the files from the office computer to the handheld's internal storage.
4. To store the decrypted files on a storage card, ensure encryption is not enabled on the handheld and then copy the decrypted files from the office computer to the storage card.

Installing and removing a SIM card

The GeoExplorer 6000 series 3.5G edition handhelds are equipped with a cellular modem. To use the integrated modem, the 3.5G edition handhelds require a SIM card.

CAUTION – The SIM card and its contents can be easily damaged by scratches or bending.

CAUTION – The presence of any dust or moisture in the SIM card slot may adversely affect the device and void your Trimble warranty. To prevent dust or moisture entering the SIM card slot:
- Make certain that the SIM card slot door is attached correctly when you are using the handheld outdoors.
- When inserting or removing a SIM card, place the handheld on a dust-free indoor surface.

CAUTION – Static electricity can harm electronic components inside the handheld. To prevent static damage, discharge static electricity from your body before you touch any of the electronic components inside your device, such as a memory module. You can do so by touching an unpainted metal surface.

To insert a SIM card:

1. Turn off the handheld.
2. Place the handheld on a dust-free indoor surface.
3. Flip open the SIM card slot door on the side of the handheld.
4. Insert the card into the SIM card slot with the gold contacts facing down. Gently press the card until you hear a click, and the card is locked into place.
5. Close the SIM card slot door.

To remove the SIM card:

1. Follow steps 1 to 3 above.
2. Gently press the card in and then let go. The card pops out.

3. Gently slide the card out of the slot.

Fitting the hand strap

The hand strap and screws are provided in the box with the handheld. To fit the hand strap:

1. Align the upper hand strap bracket with the two mounting holes and then use a coin or screwdriver to tighten the screws.
2. Stretch the hand strap to align the bottom hand strap bracket with the mounting hole and then use a coin or screwdriver to tighten the screw.

CHAPTER

3

Using the Windows Mobile Operating System

In this chapter:

The GeoExplorer 6000 series handheld is powered by the Windows Mobile 6.5 operating system.

This chapter describes the main features of this generation of the Windows Mobile operating system.

Parts of the screen

The main parts of the *Home* screen and the *Start* screen are shown below.

Title bar
Contains status icons for important system functions.

Home screen
Provides access to the key functions on your device. Scroll, and tap any item to open it.

Start button
Tap to open the Start screen, where you can access programs and system controls.

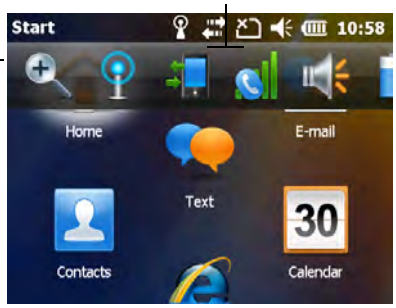
Tile bar
Contains touchable tiles providing access to applications, menus, and notifications.

Start screen
Tap any item on the menu to open it.

Lock device
Tap to lock the screen. Once locked, you have multiple points of unlock entry depending on the current status.

Connectivity icons
Tap either icon to access the Wireless Manager.

Pull-down list
Tap anywhere on the title bar to open the title bar pull-down list, where you can access connectivity controls (the Wireless Manager), battery information, time and date settings, and volume.



Status indicators

Status indicators that appear in the title bar at the top of the screen are as follows:

Battery status indicators

Icon	Description
	Battery has full charge
	Battery has high charge
	Battery has medium charge
	Battery has low charge
	Battery has very low charge (20% or less)
	Battery charging/using external power

The battery status icon on the title bar of the *Home* screen or the *Start* screen shows the status of the battery charge. Tap the title bar and then on the pull-down list tap the  icon to access the Power control dialog. See Checking the level of battery power, page 28.

Speaker status indicators

Icon	Description
	Speaker is on
	Speaker is off

The speaker status icon on the title bar of the *Home* screen or the *Start* screen shows the status of the speaker. Tap the title bar and then on the pull-down list tap the  icon to adjust the volume and to turn the speaker on or off.

Network and modem status indicators

Icon	
	Connected to ActiveSync or the Windows Mobile Device Center (WMDC) on a computer
	Connected to a Bluetooth-enabled phone
	Disconnected from ActiveSync or WMDC
	Disconnected from a Bluetooth-enabled phone
	Wi-Fi radio is on
	Wi-Fi is detected
	Connected to a wireless network
	Maximum cellular modem signal strength
	No cellular modem signal
	Cellular modem is turned off
	No cellular service
	Searching for cellular modem service
	Data is transferring using the cellular modem
	No SIM card
	UMTS network is available
	UMTS network is connecting
	UMTS connection is active
	3G+ network is available
	Analog network is available
	EDGE network is available
	EDGE network is connecting
	EDGE connection is active
	GPRS network is available
	GPRS network is connecting
	GPSR connection is active
	HSDPA network is available
	HSDPA network is connecting
	HSDPA connection is active

The network and modem status icons on the title bar of the *Home* screen or the *Start* screen show the status of each radio. Tap the title bar and then on the pull-down list tap the or icon. In the Connectivity or Phone dialog, select Wireless Manager and turn on or turn off the radio.

Pre-installed programs

Programs that are pre-installed on the GeoExplorer 6000 series handheld are as follows:

Program	Function
ActiveSync	Synchronize information between the handheld and a computer.
Adobe Reader LE	Read PDF documents.
Alarms	Set alarms.
Calculator	Perform basic arithmetic functions.
Calendar	Keep track of appointments and arrange meetings.
Contacts	Keep track of your friends and colleagues.
File Explorer	View and manage files.
Internet Explorer	Browse the World Wide Web.
Email	Write, send, and receive email messages.
Messenger	Send instant messages using Windows Live™ Messenger.
Notes	Create handwritten, typed, or recorded notes.
Office Mobile 2010	Provides access to these Office Mobile applications: Excel® Mobile 2010, PowerPoint® Mobile 2010, OneNote® Mobile 2010, SharePoint WorkSpace Mobile 2010, and Word Mobile.
Pictures and Videos	Take, view, and edit pictures, or record and launch video clips.
Search Device	Search for a file or item stored on the handheld.
Tasks	Keep track of your tasks.
Text	Send, receive, and organize text messages
Windows Live	Access Windows Live services, including email, instant messenger and Internet search.
Windows Media	Play Windows Media® or MP3 audio and video files.

Interacting with the handheld

To interact with the handheld, use the stylus or your finger to tap items on the touch screen, or to scroll up or down.

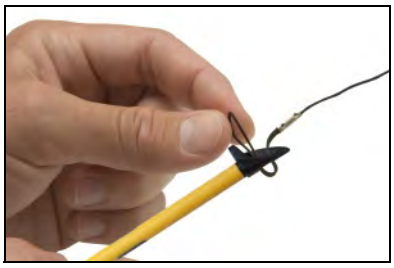
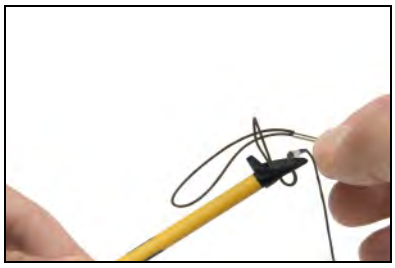
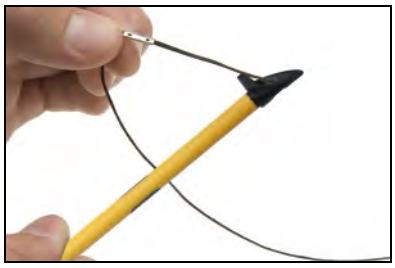
Action	Definition
Tap	Touch the screen once to open items and select options.
Tap and hold	Tap and hold the stylus on an item to see a list of actions available for that item. On the pop-up menu that appears, tap the action you want to perform.
Drag	Hold the stylus on the screen and drag across the screen to select text and images. Drag in a list to select multiple items.
Flick	Flick the stylus or you finger over the screen to scroll a page or a list up or down.

If at any time the touch screen does not respond correctly to stylus taps or your finger, realign it. For more information, see Screen, page 50.

The stylus is located on the rear of the handheld. To remove the stylus from its holder, slide the stylus downwards.

To attach a tether to the stylus:

1. Hold the stylus with the Trimble logo facing upwards and insert the end of the tether down through one of the two holes in the top of the stylus and then back up through the other hole.

2. Insert the other end of the tether through the loop and pull until the knot in the tether is tight.
3. Attach the tethered stylus to the handheld as described below.

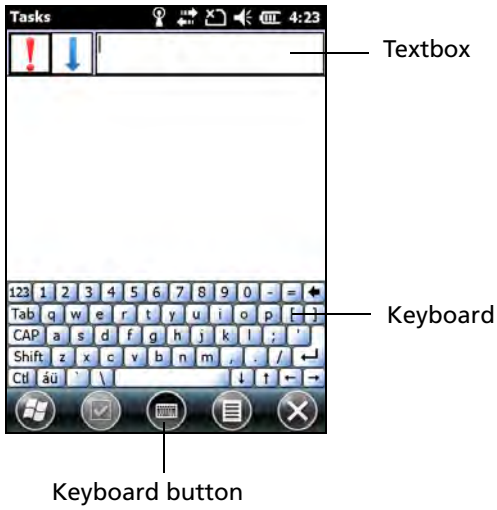
To attach a tethered stylus to the handheld, feed the end of the tether through the top of the stylus retainer on the rear of the handheld and then feed the end of the stylus through the loop until the knot in the tether is tight.

Entering information

Depending on the program you are using, you can enter information in several ways, as described below:

Input method	Description
Synchronizing	Use Microsoft connection management software to exchange information between the handheld and an office computer. For more information, see Chapter 4, Connecting to an Office Computer.
Typing	Use the Keyboard input panel to enter typed text by tapping keys on the on-screen keyboard.
Drawing	Use the stylus like a pen to draw (or write) directly on the screen.
Recording	Create a stand-alone recording or embed a recording into a note.

Using the on-screen keyboard



The keyboard button automatically appears in the tile bar of any application.

To display the keyboard, tap the keyboard button, or tap a text box in the application.

To enter characters, use your finger or the stylus to tap the keys on the keyboard. When you finish entering text in a field, tap Tab to accept the text you have entered and then move to the next field.

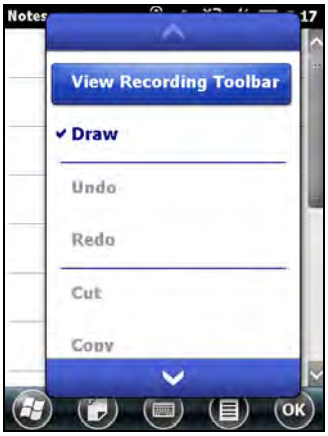
To enter special characters, tap 123 to display keyboards containing numbers and symbols. To switch back to the main keyboard, tap 123 again.

To hide the keyboard, tap the keyboard icon again.

Tip – To make the keys larger, tap / Settings / Personal / Input. In the *Input method* list, select Keyboard and then tap **Large Keys**.

Drawing and writing directly on screen

In some applications, for example Notes, you can draw (or write directly) on the screen using the stylus.



1. Tap and then tap the Notes icon.
2. Tap the Menu icon.
3. Select Draw.
4. Use the stylus to write or draw on the screen.

Making a recording

You can create a stand-alone voice note or you can add a recording to a note. Then you can work with voice notes in the same way that you work with notes.

To make a recording:

1. Tap and then tap the Notes icon.
2. Tap the Menu icon.
3. Do one of the following:
   - To create a stand-alone recording, in the screen displaying the list of notes, tap the Record button to begin recording.
   - To add a recording to a note, create or open a note and then tap the Record button to begin recording.

Note – *The GeoExplorer 6000 series handheld microphone is on the front of the handheld, in the keypad area. The microphone will capture voice notes when you are holding the handheld in front of you. In noisy environments, you may need to move the handheld closer to you or to the source of the sounds you want to record.*

4. When you finish recording, tap the Stop button .

   If you are creating a stand-alone recording, an icon appears in the note list.

   If you are recording in an open note, an icon appears in the note. Tap **OK** to return to the note list.

To play a recording, tap the recording in the note list or open the note and then tap the icon in the note.

Personalizing the handheld

Use the controls in the *Settings* area to customize the handheld. The following examples describe controls that are available.

Buttons

Use the *Buttons* control under *Personal* settings to assign the action you want to be performed when you press the left or right application key.

By default, these keys perform the same action as the left and right tiles in the tile bar. Alternatively, program these keys to perform a selected action.

Application buttons can be programmed to perform one of the following types of actions:

- Run a selected application, for example Messaging or Calendar.
- Act as a software button, for example an OK/Close button or a scroll button.
- View a selected screen, or part of a screen, for example return to the *Home* screen or launch the Context menu or Input panel.

To open the *Buttons* control:

- Tap / *Settings* / *Personal* / *Buttons*.

To specify an action for the button:

1. Tap the *Program Buttons* tab.
2. Tap a button in the list to select it.
3. From the *Assign a program* drop-down list, select the action you want to occur when you press the button or tap the softkey.
4. Tap **OK.**

Home

Use the *Home* settings to change the display theme that controls the appearance of the *Home* screen, and to customize how items appear on the *Home* screen.

Appearance

You can use a theme to customize the background picture on the *Home* screen, the color of the title and tile bars, menus, and messages.

To change the display theme:

1. Tap / *Settings* / *Home*.
2. Tap the *Appearance* tab.
3. Do one of the following:
   - To use a predefined theme, select it from the list.
   - To select the picture that you want to display in the *Home* screen background, select the *Use this picture as the background* check box. Then tap **Browse** to search for a file on the handheld.
4. Tap **OK**.

Items

You can choose between:

- the Windows default *Home* screen view, which allows you to flick through the list of entries, giving access to functions such as email, text messaging, current time, and Internet Explorer.
- customising which items appear on the *Home* screen and the order in which they appear.

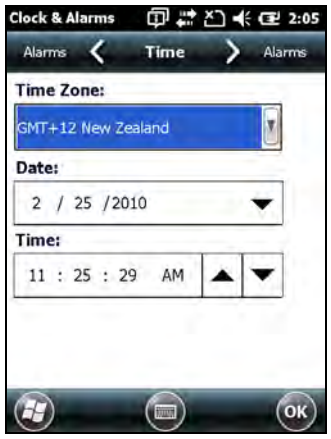
To use the default *Home* screen view:

1. Tap / *Settings* / *Home*.
2. Tap the *Items* tab.
3. Select the *Windows Default* check box.
4. Tap **OK**.

To customise the items which appear on the *Home* screen:

1. Tap / *Settings* / *Home*.
2. Tap the *Items* tab.
3. Select or clear the check boxes to show or hide the *Home* screen items.
4. Use the **Move Up** and **Move Down** buttons to change where the selected item appears on the *Home* screen.
5. Tap **OK**.

Set the time and date



1. On the *Home* screen, tap the clock item, or tap the title bar and then on the pull-down list, tap the clock icon . The *Clock & Alarms* screen appears.
2. Tap the *Time* tab.
3. In the *Time Zone* field, select the required time zone from the dropdown list.
4. In the *Date* field, tap the down arrow and then select the correct date.

Tip – On the calendar which appears, tap on the month or year to select the required value.

5. In the *Time* field, tap in turn the hour, minute, and second values and then tap the up or down arrows to set the correct time.

Device lock

Tap the *Device Lock* icon on the *Start* screen to lock the screen and keypad while the handheld remains turned on.

Once the handheld is locked, the screen and most of the keys do not respond until the handheld is unlocked. The exception is the **Power** key, which always respond when pressed.

Communication with external devices such as a GNSS receiver, or external sensors used by GNSS field software, is not interrupted by locking the handheld. This means that you can keep using the GNSS field software when the handheld is locked. For example, you could lock the device so that you can safely transport it between features, while keeping the software connected to the GNSS receiver so that you can continue recording GNSS positions.

The lock screen provides multiple unlock sliders for different applications, when there are new notifications. For example, if a new email has arrived, an email unlock slider takes you straight to the email.

To unlock the device, slide the *Unlock* icon for the required application to take you straight to that application.

You can help to keep your data secure by requiring a password each time the handheld is turned on. Tap / *Settings* / *Lock* to set a password or to change password settings.

Power

To open the *Power* control, do one of the following:

- Tap the title bar of the *Home* screen or the *Start* screen, and then tap .
- Tap / *Settings* / *Power*.

Tap the *Battery* tab to check the battery level (see Checking the level of battery power, page 28).

Tap the *Advanced* tab to set the time before the handheld turns off when idle (see Suspend mode, page 31).

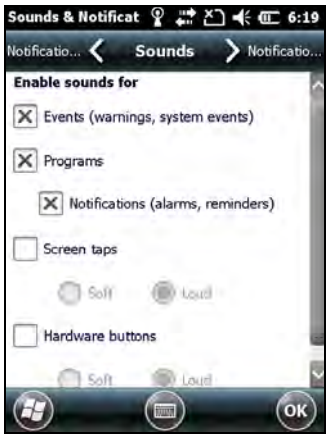
Sounds and notifications

Use the *Sounds & Notifications* control to set preferences for the speaker volume and system sounds. To open the *Sounds & Notifications* control:

- Tap / *Settings* / *Sounds & Notifications*.

To turn on or turn off sounds:

1. Tap the *Sounds* tab.
2. Select or clear the check boxes to enable or disable categories of sounds.
3. If you select the *Screen taps* or *Hardware buttons* check boxes, select the *Soft* or *Loud* option to control the volume of the sounds.
4. Tap **OK.**



You can use predefined schemes to customize sounds, or you can create your own sound schemes.

To specify a sound scheme:

1. Tap the *Notifications* tab.
2. From the *Event* drop-down list, select an event.
3. Select the type of notification you want to receive for that event.
4. Tap **OK.**

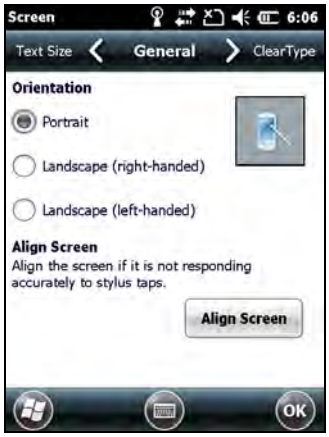
Screen

Use the Screen control to align the touch screen or to change the appearance of text on the screen. To open the *Screen* control:

- Tap / *Settings* / *System* / *Screen*.

To change the screen settings:

1. Tap the *General* tab.
2. To change the orientation of the screen, select an option in the *Orientation* group.
3. To start the alignment sequence for the touch screen, tap **Align Screen**.
4. Tap **OK.**



Note – *To align the screen at any time, press and hold the* ***Power*** *button for 1 second until the Power menu appears and then tap* .

Using ClearType font smoothing can make text easier to read on the screen.

To enable ClearType:

1. Tap the *ClearType* tab and then select the *Enable ClearType* check box.
2. Tap **OK.**

To change the size of text on screen:

1. Tap the *Text Size* tab.
2. Tap and drag the slider control to the left to make text smaller, or to the right to make text larger.

   The example text below the slider shows how the text will appear on screen.
3. Tap **OK.**

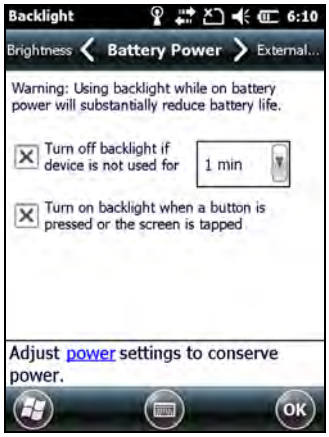
Backlight

The backlight makes the screen easier to read in low light, but uses extra power. Use the *Backlight* control to configure power-saving settings for the backlight. To open the *Backlight* control:

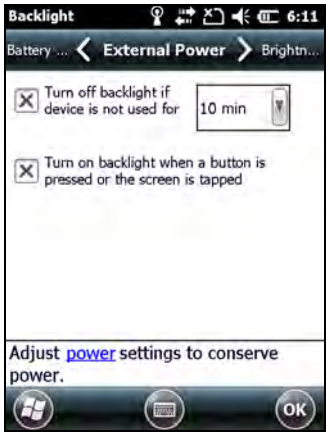
- Tap / *Settings* / *System* / *Backlight*.

To set the backlight to automatically turn off:

1. To automatically turn off the backlight when the handheld is idle and is using ***battery power***, tap the *Battery Power* tab. Select the *Turn off backlight* check box and then select a time from the drop-down list.

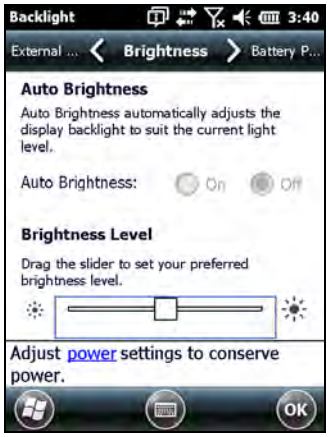


2. To automatically turn off the backlight when the handheld is idle and is using ***external power***, tap the *External Power* tab. Select the *Turn off backlight* check box and then select a time from the drop-down list.
3. Tap **OK**.



To change the brightness:

1. Tap the *Brightness* tab.
2. Tap and drag the Brightness Level slider control to the left to make the backlight darker, or to the right to make the backlight brighter.
3. Tap **OK**.



Messaging

Use Messaging to send and receive email messages using the GeoExplorer 6000 series handheld. Messaging is the equivalent of your email Inbox.

To use email, you can do one of the following:

- Synchronize email messages with Microsoft Exchange or Microsoft Outlook® on an office computer.
- Send and receive email messages by connecting directly to an email server through an ISP or a network.

Synchronizing email messages

You can synchronize email messages on the handheld and the computer.

CAUTION – When you delete a message on the handheld, it is deleted from the office computer the next time you synchronize the devices.

To synchronize email, you must enable Inbox synchronization in the Microsoft ActiveSync technology (for Windows XP) or the WMDC (for Windows Vista or Windows 7). For more information, refer to the *ActiveSync Help* or the *WMDC Help* on the office computer.

During synchronization:

- Messages are copied from the mail folders of Exchange or Outlook on the office computer to the Messaging folder on the handheld. By default, you will receive messages from the past 3 days only, the first 100 lines of each message, and file attachments of less than 100 KB in size.
- Email messages in the Outbox folder on the handheld are transferred to Exchange or Outlook, and then sent from those programs.
- Email messages in subfolders in other email folders in Outlook are synchronized only if they were selected for synchronization (using ActiveSync technology or the WMDC).

To send and receive email for a synchronized Exchange or Outlook account, connect the handheld to the office computer. Synchronization automatically begins, and the handheld sends and receives email.

Connecting directly to an email server

In addition to synchronizing email messages with an office computer, you can send and receive email messages by connecting to an email server.

Before you can send and receive email, you must create an email account in the Messaging software.

Note – *You must set up an Internet connection on the handheld before you can set up and use your email account. For more information, see* *Connecting to a Wi-Fi access point, page 85*, *Connecting to a Bluetooth-enabled device, page 87*, or *Connecting to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks), page 94*.

If you need to connect to different mailboxes, set up and name a different service for each connection.

Note – *The Messaging software supports only the POP3 and IMAP4 protocols for incoming mail, and SMTP for outgoing mail.*

To set up a mail service:

1. Tap / *E-mail*.
2. Tap *Setup E-mail*.
3. Enter the email address for your account.
4. Enter a password. Select *Save password* if you want the device to remember your password.
5. Tap **Next**.
6. To automatically get connection settings for your email account from the Internet, select the check box.
7. Tap **Next**.
8. Follow the steps in the Setup wizard. If the connection settings are not automatically downloaded from the Internet, you must enter them using the connection details supplied by your ISP or network administrator.

Note – *You cannot change the account name later.*

9. Tap **Finish**.
10. Tap **OK** to download mail immediately.

Tip – To receive TerraSync data files by email, edit the settings for the email account you have set up. To do this, tap **Menu** and then select *Options*. In the *Accounts* tab, tap the e-mail account you want to use to receive TerraSync files. The *Email Setup* wizard appears. Tap **Next** until you reach the last page of the wizard. From the *Message download limit* drop-down list, select ***Entire message***.

When you connect the handheld to the email server, new messages are downloaded to the Messaging folder, messages in the Outbox folder are sent, and messages that have been deleted on the email server are removed from the Messaging folder.

Messages received directly from an email server are linked to the email server rather than an office computer. When you delete a message on the handheld, it is also deleted from the email server the next time you connect the handheld to the email server.

You can work online or offline. When working online, you read and respond to messages while connected to the email server. Messages are sent as soon as you tap **Send**, which saves space on the handheld.

When working offline, you can disconnect from the email server after you download new message headers or partial messages and then decide which messages to download completely. The next time you connect, Messaging downloads the complete messages you have marked for retrieval and sends any messages that you have written.

CHAPTER

4

Connecting to an Office Computer

In this chapter:

Connect the GeoExplorer 6000 series handheld to an office computer to transfer information, settings, and files from one device to the other, or to install software onto the handheld.

You can connect the handheld to a computer using the USB cable or a Bluetooth wireless link.

To protect your data, Trimble recommends that you regularly copy important data to an office computer.

Connection management software

To install software onto a device powered by the Windows Mobile operating system, or to copy files between the handheld and a computer, you must connect the device to an office computer. If the computer is running:

- the Windows 7 or Windows Vista® operating system, use the Windows Mobile Device Center (WMDC) to manage the connection.
- the Windows® XP or 2000 operating system, use ActiveSync technology to manage the connection.

Note – *You must install the Windows Mobile Device Center or ActiveSync technology onto the computer* ***before*** *you connect the handheld.*

This connection management software also enables you to synchronize office applications on an office computer with the handheld.

CAUTION – The available space on the handheld is small compared to an office computer. To avoid accidentally synchronizing the handheld with a large amount of data on the office computer, Trimble recommends that you either connect to the handheld ***without forming a partnership***, or that you limit the information types and amount of data that is synchronized.

CAUTION – Synchronizing data is designed to keep the same data on both the office computer and the handheld. Exercise care when resynchronizing applications after deleting data from one computer, as resynchronizing will delete the same information from the other computer.

For more information see one of the following:

- Managing the connection using the Windows Mobile Device Center, page 57
- Managing the connection using ActiveSync technology, page 59.

Installing the Windows Mobile Device Center

The Windows 7 and the Windows Vista operating system include a basic connectivity driver for devices powered by a Windows Mobile operating system. This driver allows you to transfer files from the handheld to an office computer.

To install software onto a device powered by a Windows Mobile operating system, you must install Windows Mobile Device Center 6.1 onto an office computer.

A copy of the Windows Mobile Device Center is provided on the *GeoExplorer 6000 Series Getting Started Disc*. Alternatively, go to www.microsoft.com/windowsmobile/devicecenter.mspx to download the latest version from the Microsoft website.

Installing ActiveSync technology

A copy of ActiveSync technology is provided on the *GeoExplorer 6000 Series Getting Started Disc*. Alternatively, go to www.microsoft.com/windowsmobile/activesync/default.mspx to download the latest version from the Microsoft website.

Connecting the handheld to a computer

To connect the GeoExplorer 6000 series handheld to a computer:

1. Make sure that the handheld and the computer are switched on.
2. Make sure you have installed the appropriate connection management software onto the computer (see Connection management software, page 56).
3. To form a connection, do one of the following:
   - Use the handheld's integrated Bluetooth radio to establish a wireless serial link to a Bluetooth-enabled computer. For more information, see Connecting to an office computer using Bluetooth wireless technology, page 104.
   - Use a USB connection:
     a. Connect the USB data cable to the USB port on the handheld.
     b. Connect the other end of the USB data cable to a USB port on the computer.

   When the handheld and the computer are connected, you can manage the connection through a window that appears on the office computer. See one of the following:
   - Managing the connection using the Windows Mobile Device Center, page 57
   - Managing the connection using ActiveSync technology, page 59

Managing the connection using the Windows Mobile Device Center

1. Connect the handheld to the computer (see page 57).
2. If the Autoplay window appears, close the window.

3. The *Windows Mobile Device Center* window displays the message Connected:

Note – *If the connection is not made automatically, check that the connection is enabled in the Windows Mobile Device Center software and on the handheld. For more information, see* *Troubleshooting, page 117*.

4. Do one of the following:
   - To synchronize files and data between the handheld and a computer, click *Set up your device* and then follow the instructions on screen.
   - To transfer data between the handheld and the computer without synchronizing the devices, click *Connect without setting up your device*.
5. To transfer files between the computer and the handheld, click *File Management*. A Windows Explorer-type window appears, displaying files stored on the handheld. Copy and paste files to other locations on the computer, or from the computer to the handheld.
6. To install software onto the handheld, see Installing software onto the handheld, page 60.
7. To uninstall software from the handheld, click *Programs and Services* and then click *Add/Remove Programs*.

Tip – If the *Add/Remove Programs* option does not appear below *Programs and Services*, click *More*. The *Add/Remove Programs* option appears.

For more information, refer to the *Windows Mobile Device Center Help*.

Tip – If the GPS Pathfinder® Office software is installed on the office computer, you can configure the Connection Manager utility in the GPS Pathfinder Office software to automatically detect when you connect a GeoExplorer 6000 series handheld to the computer. This enables you to automatically transfer data from the TerraSync software, differentially correct the data, and then export it to a GIS. For more information, refer to the *GPS Pathfinder Office Software Help*.

Managing the connection using ActiveSync technology

1. Connect the handheld to the computer (see page 57). The *Synchronization Setup Wizard* appears:

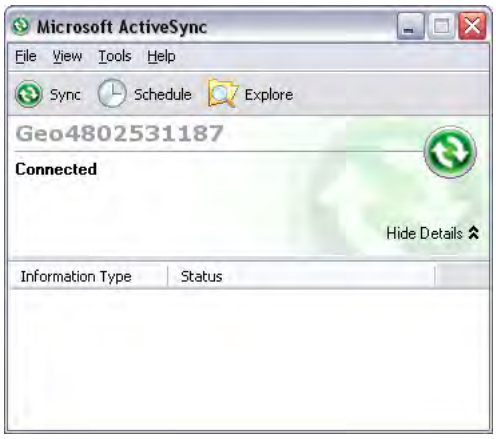
Note – *If the connection is not made automatically, check that the connection is enabled in the ActiveSync technology and on the handheld. For more information, see Troubleshooting, page 117.*

2. Do one of the following:

   – To synchronize files and data between the handheld and a computer, click **Next** and then follow the instructions in the *Synchronization Setup Wizard*.

   – To transfer data between the handheld and the computer without synchronizing the devices, click **Cancel** to close the wizard.

3. The *Microsoft ActiveSync* window displays the message Connected:



4. To transfer files between the computer and the handheld, click **Explore**. A Windows Explorer-type window appears, displaying files stored on the handheld. Copy and paste files to other locations on the computer, or from the computer to the handheld.
5. To install software onto the handheld, see Installing software onto the handheld, page 60.
6. To uninstall software from the handheld, select *Add/Remove Programs* from the *Tools* menu. Clear the check box beside the program you want to remove and then click **OK**.

For more information, refer to the *ActiveSync Help*.

Tip – If the GPS Pathfinder Office software is installed on the office computer, you can configure the Connection Manager utility in the GPS Pathfinder Office software to automatically detect when you connect a GeoExplorer 6000 series handheld to the computer. This enables you to automatically transfer data from the TerraSync software, differentially correct the data, and then export it to a GIS. For more information, refer to the *GPS Pathfinder Office Software Help*.

Installing software onto the handheld

Before you begin, refer to the installation instructions provided with the software.

Some software installations are specifically designed to run on a device powered by a Windows Mobile operating system. To install software that has a Windows Mobile installation setup:

1. Connect the handheld to a computer (see page 57).
2. Copy the installation files to a folder on the handheld.
3. Browse to the folder on the handheld. Tap and hold the installation setup file and then select Run.
4. If prompted after installation, perform a soft reset of the handheld (see page 33).

To install software that is provided on a CD, or as an installation setup that runs on an office computer:

1. Connect the handheld to a computer (see page 57).
2. If the software is provided on a CD, insert the software CD into the office computer.
3. Run the installation setup.
4. If prompted, select the install option for a device powered by a Windows Mobile operating system. Once the software is installed on the computer, it is automatically transferred to the handheld.

Note – *If a storage card is inserted in the handheld, the card appears as an installation location option. Trimble recommends that you install software to the handheld's internal storage, not to a storage card. If you install software to a card and then remove the card from the handheld, the software will not be available for use.*

5. If prompted after installation, perform a soft reset of the handheld (see page 33).

CHAPTER

5

Using the GNSS Receiver

In this chapter:

The GeoExplorer 6000 series handheld includes an integrated GNSS receiver that enables you to collect GPS and GLONASS data for incorporating into a GIS or for managing assets.

GPS (Global Positioning System) and GLONASS (GLObal NAvigation Satellite System) are Global Navigation Satellite Systems (GNSS). Each system consists of a constellation of satellites that orbit the earth. GNSS provides worldwide, all-weather, 24-hour time and position information.

Note – *To receive signals from GPS or GLONASS satellites, the handheld must have a clear view of the sky. GPS or GLONASS positions may not always be available, particularly in or near buildings, in vehicles, or under tree canopy.*

With the addition of the Trimble Floodlight satellite shadow reduction technology option, the GeoExplorer 6000 series handheld's integrated GNSS receiver can improve accuracy and productivity in difficult environments.

Note – *To track GLONASS satellites, you must have the Trimble Floodlight technology option installed and activated.*

Supported GNSS field software

You can use the GeoExplorer 6000 series handheld with any of the software products described below.

TerraSync software

You can install version 5.10 or later of the TerraSync software on a GeoExplorer 6000 series handheld. Use the software to collect and maintain GIS and GNSS data.

To install the TerraSync software, run the downloaded setup file. To obtain an installation code for installation, you must register the Proof-of-Purchase Number (POPN) that you received when you purchased the software. Detailed installation instructions are provided in the *TerraSync Software Getting Started Guide*.

Esri ArcPad software and the Trimble GPScorrect extension

You can install the Esri ArcPad software version 10 on a GeoExplorer 6000 series handheld. Use the software to collect and maintain GIS and GNSS data. Detailed installation instructions for Esri ArcPad software are provided in the ArcPad documentation.

To be able to differentially correct ArcPad GNSS data, install version 3.20 or later of the Trimble GPScorrect extension for Esri ArcPad software on a GeoExplorer 6000 series handheld.

You must install the ArcPad software ***before*** you install the GPScorrect extension.

Note – *Make sure your version of the GPScorrect extension is compatible with the version of ArcPad software you are using. For more information, go to www.trimble.com/gpscorrect_ts.asp, click Support Notes and then search for the Mapping and GIS Product Compatibility List Support Note.*

To install the GPScorrect extension, run the downloaded setup file. Detailed installation instructions are provided in the *Trimble GPScorrect Extension Getting Started Guide*.

GPS Controller software

You can install version 2.40 or later of the GPS Controller software on a GeoExplorer 6000 series handheld. Use the software to configure and monitor the status of the internal GNSS receiver, and to configure GNSS output settings for third party GNSS applications.

To install the GPS Controller software, go to www.trimble.com/support.shtml. Click GPS Controller and then click Downloads. Click the link for the version you want to install and then follow the instructions in the Installation wizard.

GNSS Connector software

You can install the GNSS Connector software on a GeoExplorer 6000 series handheld. Use the software to specify how the integrated GNSS receiver communicates with equipment that is connected to one of the handheld's external communications ports.

To install the GNSS Connector software, go to www.trimble.com/support.shtml. Click GNSS Connector and then click Downloads. Follow the instructions in the Installation wizard.

Other GNSS field applications

If you have purchased and activated the NMEA Output option, you can also use the GeoExplorer 6000 series handheld with any GNSS field software that accepts NMEA messages.

Configuring the GNSS field software to connect to the receiver

The first time you use GNSS field software on the handheld, you may need to specify which GNSS COM port to connect to.

GNSS COM ports

The integrated GNSS receiver has three COM ports for communicating with software on the handheld and with external devices. Two ports are for outputting GNSS data, and one port is for receiving real-time corrections into the receiver.

To use GNSS, open the appropriate GNSS COM port. The type of communication used for each port is described below:

Port	Function	Description
COM2	NMEA	Outputs NMEA-0183 message s. NMEA is a standard GNSS communication protocol used by many GNSS applications. The handheld outputs the following NMEA messages by default: GGA, GLL, GSA, GSV, RMC, VTG, ZDA. All messages are output at a one-second interval.
COM3	TSIP	Outputs and re ceives TSIP messages. TSIP (Trimble Standard Interface Protocol) is used by Trimble GNSS applications, and is also supported by some other GNSS applications.
COM4	Real-time corrections	Receives real-time correction messages. If you are using an external correction source connected to COM1 or a Bluetooth port, the corrections must be redirected to COM4. For more information, see Using real-time corrections from an external correction source, page 70.

Note – *NMEA messages can only be output if you have purchased and activated the NMEA Output option.*

Note – *COM1 is a standard serial port that connects to external devices. For more information, see* *Connecting to other devices using the USB to serial converter, page 111*.

Connecting to the COM port

Details of how to configure different types of GNSS field software to connect to the GNSS COM port are as follows:

GPS field software	Configuration details
GPS Controller	Run GPS Controller. The software automatically activates the integrated GNSS receiver on COM3.
TerraSync	Run Terrasync. The software automatically activates the integrated GNSS receiver on COM3.
ArcPad with the GPScorrect extension	When the Trimble GPScorrect extension is installed, the extension automatically configures the ArcPad software to use the integrated GNSS receiver on COM3 using the Trimble GPScorrect protocol. To connect to the receiver, tap the **GPS** button and then tap **Yes**. To configure a real-time Differential GNSS source, or to view status information, run the GPScorrect extension. To do this, tap the **GPScorrect** button in the Trimble toolbar.
ArcPad without the GPScorrect extension	1. In ArcPad, tap the **GPS** drop-down menu and then select *GPS Preferences* from the drop-down menu. Tap the *GPS* tab. 2. In the *Protocol* field, select NMEA 0183. 3. In the *Port* field, select COM2. 4. Tap **OK**. 5. Tap the **GPS** button and then tap **Yes**.
NMEA application	Configure the software to connect to GNSS on COM2 and then use the Connect or Activate GNSS command.
TSIP application	Configure the software to connect to GNSS on COM3 and then use the Connect or Activate GNSS command.

Using the GNSS field software

Depending on the GNSS field software you have installed, the default GNSS field software will be GPS Controller, TerraSync, or the Trimble GPScorrect extension for Esri ArcPad software.

The GPS Controller software enables you to check the current GNSS status, or to configure the integrated GNSS receiver.

Note – *You must first install the GPS Controller software. See* *GPS Controller software, page 62* *for details.*

Depending on the GNSS field software you have installed, you can use the software to configure settings such as GNSS, real-time correction, and antenna settings. You may also be able to use the software to connect to a real-time correction source, configure logging settings, and collect features. For more information, refer to the rest of this chapter and the documentation for the GNSS field software.

Starting the GNSS field software

Do one of the following:

- From the *Home* screen, tap the GeoXH (or GeoXT) item, then tap the GNSS Application Launcher item to launch the default GNSS field application.
- Tap / *Programs* and then select the GNSS field software, for example *TerraSync*.

When you first open any Trimble GNSS field software, the Skyplot section is displayed.

Viewing available GNSS satellites

Use the graphical Skyplot section or the Satellite Info section in the installed Trimble GNSS field software to view detailed GPS and GLONASS information.

Note – *To receive signals from GNSS satellites, the handheld must have a clear view of the sky. GNSS positions may not always be available, particularly in or near buildings, in vehicles, or under tree canopy.*

Filled (black) boxes represent satellites that the receiver is using to compute its current GNSS position. Unfilled (white) boxes represent satellites that the receiver is getting signals from but is not using because the signals are too weak. In the example shown here, eight satellites are being tracked and seven of these satellites are being used to compute GNSS positions.

Note – *Numbers with no box represent satellites that are available, but that the TerraSync software is not receiving signals from. Satellites that have an "R" prefix are GLONASS satellites. GLONASS satellites appear only if the receiver has the Trimble Floodlight satellite shadow reduction technology option activated. For more information, see* *Activating the Floodlight technology and the NMEA output options**.*

Your current GNSS position is displayed at the bottom of the screen.

Tip – For detailed information on satellite positions and signal strengths, use the Satellite information screen in the Status section.

Resetting the GNSS receiver

Trimble GNSS field applications all have options to reset the receiver to:

- delete the almanac
- delete information stored on the last known position
- restart the receiver
- reset the GNSS receiver to factory default settings

Improving GNSS productivity using Floodlight satellite shadow reduction technology

The productivity of high-accuracy GNSS receivers can be affected by satellite shadow. Satellite shadow occurs when the line of sight between a GNSS receiver and GNSS satellites is partially or fully blocked by obstructions such as buildings, trees, or even the landscape itself. The effect of satellite shadow is a reduction in the number of satellites that the receiver can track. In general, the quality of your data decreases when the number of satellites which is used to calculate the position is low, and in many cases when large portions of the sky are obstructed, it is impossible to generate any positions at all.

The Floodlight satellite shadow reduction technology option for the GeoExplorer 6000 series reduces the effects of satellite shadow to help deliver more positions and better accuracy in conditions affected by satellite shadow.

The Floodlight technology option improves GNSS productivity using three key technologies:

- it enables GLONASS satellite tracking, which greatly increases the number of satellites that the GNSS receiver can track. Tracking more satellites can help to improve satellite geometry and thereby improve accuracy.
- it utilizes barometric measurements to assist the GNSS receiver. The barometer measurements can assist by improving both the vertical and horizontal accuracy of positions, particularly in conditions where the satellite count is very low, for example under tree canopy.
- it improves the ability of the receiver to track weaker satellite signals which are common when working in the shadows of trees and buildings.

To achieve optimum Floodlight technology performance, it is important that the barometer is kept free of obstructions. Make sure that the Barometer seal located on the underside of the device is kept clear and is not covered by your fingers or any other covering.

Note – *If you are using Trimble field software, for example, the TerraSync software, make sure that you have selected the correct option for postprocessing data—if your base station(s) provide corrections for GPS and GLONASS satellites, select GPS + GLONASS. This affects the accuracy of the Predicted Postprocessed Accuracy (PPA). See* *Accuracy settings and using accuracy-based logging, page 68*.

To purchase the Floodlight technology option, contact your Trimble reseller.

After purchase, you must activate the Floodlight technology option on the receiver. See Activating the Floodlight technology and the NMEA output options, page 74.

Ensuring the accuracy of your GNSS data

GeoExplorer 6000 series handhelds are high performance GNSS receivers that calculate very accurate GNSS positions.

To correct errors in the collected data and to further improve the accuracy of the GNSS positions, use differential GNSS. Differential GNSS (DGNSS) requires one or more additional receivers, called ***base stations*** or reference stations, which are located at known points. Data collected at the base stations is used to determine GNSS measurement errors and compute corrections to these errors. These corrections are then applied to data collected in the field either in real time or during postprocessing. For more information, see Differential GNSS explained, page 75.

The different models in the GeoExplorer 6000 series offer two levels of DGNSS accuracy:

- The GeoXT handheld uses EVEREST multipath rejection technology to provide < 1 meter accuracy with real-time or < 0.5 meters postprocessed differential correction.
- The GeoXH handheld uses EVEREST multipath rejection technology as well as H-Star technology to provide 10 cm accuracy with real-time or postprocessed differential correction.

  For more information, refer to the datasheet for your model of handheld.

  Where the DGNSS infrastructure does not meet 10 cm accuracy requirements (for example, the base station provides L1 corrections only, or is at a distance greater than recommended), the GeoXH handheld typically achieves submeter accuracy.

The list below identifies the most important settings and techniques that you can use in the field to improve the accuracy of your data:

Note – *This list assumes that you are using Trimble GNSS field software, and lists items in order of most important to less important.*

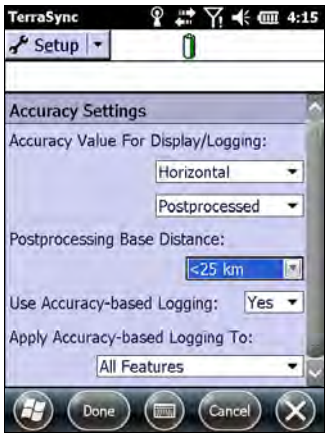
1. If you are using the TerraSync software to collect data, use accuracy-based logging. For more information, see page 68.
2. Use real-time differential corrections. If you are using a GeoXH handheld and have access to dual-frequency corrections from a VRS™ network, use the corrections from the VRS network. For more information, see page 69.
3. Configure the GNSS settings for the receiver to use Smart Settings to increase the precision of your data, and to minimize the effect of atmospheric interference and poor satellite geometry. For more information, see Using Smart Settings, page 71.
4. Connect to an external antenna, if you have one. For more information, see page 73.
5. Plan GNSS data collection around the times of the day when satellite geometry is best. For more information, see page 74.

Accuracy settings and using accuracy-based logging

If you are using the TerraSync software, use accuracy-based logging to ensure that only GNSS positions that meet the specified estimated accuracy are logged. GNSS positions that do not meet your accuracy requirements are not logged.

Note – *Accuracy estimates for streaming (dynamic) GNSS positions may not be as good as those for static GNSS positions.*

To configure accuracy-based logging in the TerraSync software:



1. In the Setup section of the TerraSync software, tap **Logging Settings**. The *Logging Settings* form appears.
2. Tap the **Setup** button below the *Accuracy Settings* field. The *Accuracy Settings* form appears.
3. In the *Accuracy Value For Display/Logging* fields, select the parameters that will be used to determine the estimated accuracy:
   - Select whether to use the horizontal or vertical accuracy of the current GNSS position.
   - Select *In the field* to use the current estimated accuracy (recommended if you are using a real-time correction source), or select *Postprocessed* to use the predicted estimated accuracy that will be achieved after the field data has been postprocessed.
4. If you selected *Postprocessed*:
   a. select the estimated distance to the base station that will be used for postprocessing from the *Postprocessing Base Distance* field. If you will use more than one base station (during H-Star processing), specify the estimated distance to the closest base station.
   b. select the type of data that your base station(s) will provide to ensure that PPA (Predicted Postprocessed Accuracy) values can be predicted accurately:
   - If your base station(s) are providing corrections for GPS and GLONASS satellites, select GPS + GLONASS.
   - For base stations with only GPS satellite corrections, select GPS.
   - If you don't know what base station data you will use, or what base data is provided by your base stations, select GPS.
5. Set the *Use Accuracy-based Logging* field to *Yes*. The settings fields for accuracy-based logging appear.
6. In the *Apply Accuracy-based Logging To* field, select the feature types that you want to log only if the GNSS positions meet your required accuracy.

7. In the *Required Accuracy* field, select the estimated accuracy that is required before GPS positions are logged.
8. Tap **Done**.

Note – *Accuracy settings do not affect GNSS positions that are used for navigation. GNSS positions are still calculated by the GNSS receiver and are available for navigation.*

Connecting to a real-time differential correction source

Use a real-time differential GNSS (DGNSS) source to give you better accuracy as you collect data. For more information about how real-time differential GNSS works, see Differential GNSS explained, page 75.

Using real-time corrections from an Internet source

DGNSS corrections are often broadcast over the Internet. For example, corrections generated by a VRS network are commonly broadcast over an Internet server. A VRS network uses data from several base stations to provide rover receivers with corrections that are generally more accurate than corrections from a single base station. Alternatively, you can connect to a server that provides DGNSS corrections from a single base station.

For information on how to connect to the Internet and receive real-time corrections from an Internet server, see Connecting to a Bluetooth-enabled device, page 87 or Connecting to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks), page 94.

Using SBAS corrections

The GeoExplorer 6000 series handheld has an integrated receiver that uses Satellite Based Augmentation Systems (SBAS) correction messages to improve the accuracy and integrity of GNSS data.

The default SBAS tracking mode is Auto. In Auto mode, the receiver tracks or locks onto the most powerful satellite signal. The GNSS receiver can track two SBAS satellites at the same time in Auto or Custom mode. It uses corrections from only one SBAS satellite at a time, but tracking two satellites can improve the availability of SBAS real-time corrections. For example, if you are working in environments where obstacles may block the direct line of sight to the SBAS satellite, there is less chance of signal loss if you are tracking more than one SBAS satellite.

Note – *To turn off multiple SBAS satellite tracking, select Custom mode and then deselect all other SBAS satellites except for the satellite you want to track.*

The receiver tracks SBAS satellites according to your geographical location:

- Wide Area Augmentation System (WAAS) satellites are tracked in the Continental United States including Alaska, and parts of Canada and Mexico.
- European Geostationary Navigation Overlay Service (EGNOS) satellites are tracked in Europe.

- MTSAT Satellite-based Augmentation System (MSAS) satellites are tracked in Japan.

To use SBAS corrections:

1. In the Setup section of the GNSS software, tap **Real-time Settings**. The *Real-time Settings* form appears.
2. In the *Choice 1* field, select Integrated SBAS.
3. To select particular satellites, tap the **Setup** button next to the *Choice 1* field. Select Custom tracking mode and then enable or disable tracking of particular satellites. Tap **OK** to return to the *Real-time Settings* screen.
4. In the *Choice 2* field, specify whether to use uncorrected positions, or to stop using GNSS positions, if corrections are not available.
5. Tap **Done.**

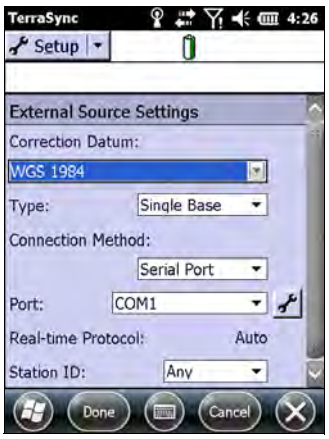
Using real-time corrections from an external correction source

You can improve the accuracy of your data by using real-time corrections from an external correction source, such as a GeoBeacon receiver or a DGNSS radio. Connect the external correction source to a Bluetooth port (see page 93). Use the GNSS field software to set up and monitor the real-time input source that you want to use.

The integrated GNSS receiver communicates only through its GNSS COM ports (COM2, COM3, and COM4). Trimble GNSS field software, such as TerraSync and GPS Controller, automatically redirects input from an external correction source connected to COM1 or to a Bluetooth port to the real-time GNSS COM port (COM4).

Note – *For information on configuring the GNSS field software to use corrections from a VRS network or single base station that transmits corrections over the Internet, see Step 3: Configuring the GNSS field software to use data received from the Internet source, page 97.*

To set up an external correction source—such as a GeoBeacon receiver or a DGNSS radio—in the Trimble GNSS field software:



1. In the Setup section of the GNSS software, tap **Real-time Settings**. The *Real-time Settings* form appears.
2. In the *Choice 1* field, select External Source.
3. Tap the **Setup** button next to the *Choice 1* field.
4. In the *Connection Method* field, select Serial Port.
5. In the *Port* field, select the COM port to use. If you are using:
   - the USB to serial converter, select COM 1.
   - a Bluetooth wireless connection, select the COM port you configured for the Bluetooth connection in the *COM Ports* tab of the Bluetooth manager.
6. Tap **Done.**

To set up an external correction source for use with non-Trimble GNSS field software:

1. In the Trimble GPS Controller software, configure the GNSS receiver to use real-time corrections on COM4. For more information, see the steps above.

Note – *You must first install the GPS Controller software. See* *GPS Controller software, page 62* *for details.*

2. In the GNSS Connector software, manually redirect the real-time correction source to COM4 by tapping **Setup** then select the real-time source from the drop down list.

Note – *You must first install the GNSS Connector software. See* *GNSS Connector software, page 63* *for details.*

3. Configure your data collection software to monitor and use real-time corrections as required.

Note – *To receive real-time corrections, the GNSS Connector software must remain running on the handheld.*

Using Smart Settings

Note – *Trimble recommends that you use accuracy-based logging (see* *Accuracy settings and using accuracy-based logging, page 68**) and Smart Settings to control the quality of the GNSS positions logged and let the TerraSync software manage the logging of positions based on your required accuracy.*

Using Smart Settings, the GNSS receiver generates the best possible position for any given environment, without the need for you to adjust receiver settings to match the conditions. Regardless of whether you are working under canopy, in wide open spaces, or somewhere in between, Smart Settings automatically generates the best solution possible.

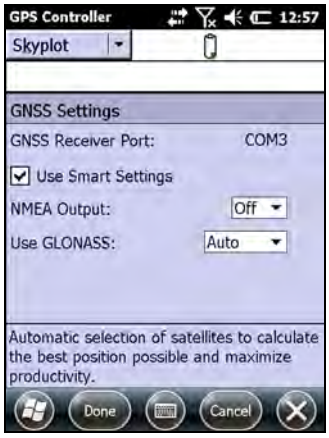
Using traditional mask techniques in open conditions, weak signals can accidentally degrade the accuracy of the position if masks are too relaxed, whereas in obstructed conditions, more satellites are needed to help maintain optimum accuracy if masks are set too strictly. Using Smart Settings, the receiver uses all available GNSS information to determine which combination of satellites to use to deliver the best position. Once you set the receiver to use Smart Settings, the receiver does the rest.

By default, the receiver is configured to use Smart Settings. In this mode, the receiver will track all visible satellites, and determine which to use in the position solution to automatically generate the most accurate position possible.

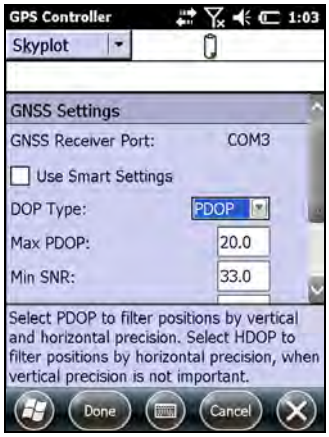
To open the *GNSS Settings* form, do one of the following:

- Tap **GNSS Settings** in the Setup section.
- Tap  in the Skyplot, Satellite Info, or Plan section.

To enable Smart Settings, select the *Use Smart Settings* check box.



To define custom GNSS settings, clear the *Use Smart Settings* check box. Editable fields appear enabling you to specify the required GNSS quality settings. Enter values in these fields.



Connecting to an external antenna

The GeoExplorer 6000 series handheld has an internal antenna, which is suitable for use in most conditions.

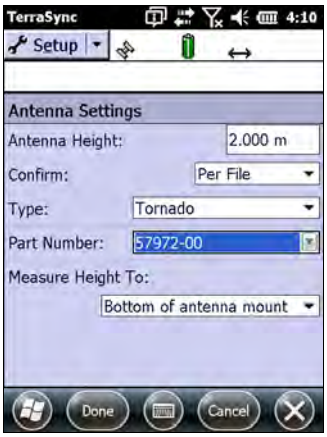
If you have a GeoXT handheld, you can also connect a Tempest or an external patch antenna for when you work in a vehicle. For improved yield under canopy, you can use a Tempest antenna, or a patch antenna with a ground plane.

If you have a GeoXH handheld, you can connect an external Tornado antenna for improved accuracy when you collect data for postprocessing using H-Star technology.

Configure antenna settings in the GNSS field software, once you have connected the external antenna to the handheld.

To configure antenna settings in the TerraSync software:

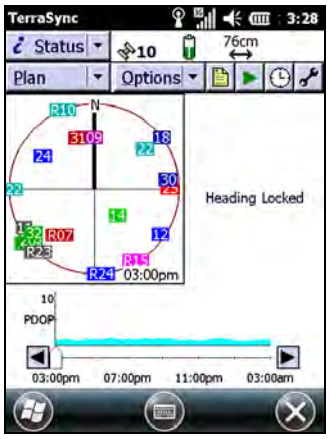
1. In the Setup section of the TerraSync software, tap **Logging Settings**. The *Logging Settings* form appears.
2. Tap the **Setup** button  next to the *Antenna Height* field. The *Antenna Settings* form appears.
3. In the *Height* field, specify the height of the GNSS antenna that is connected to the GNSS position.
4. In the *Confirm* field, select how often the software will ask you to confirm the configured antenna height during data collection.
5. In the *Type* field, select the type of antenna that is connected. The number in the *Part Number* field is automatically updated when you select the antenna type.
6. In the *Measure Height To* field, select the point on the antenna that you have measured the height to.
7. Tap **OK** to return to the *Logging Settings* form.



Planning a data collection session

To maximize productivity, plan GNSS data collection around the times of the day when satellite geometry is best. The TerraSync software and the GPS Controller software both include a Plan section with an animated skyplot and DOP (satellite geometry) graph for your position for the next 12 hours.

In the Plan section, you can check the planning skyplot as you play a session, then use the timeline to zoom in on times when geometry is poor. As you adjust GNSS settings, the Plan section is updated, so you can see the effect of different quality control settings.



Activating the Floodlight technology and the NMEA output options

Two options are available for use with the GeoExplorer 6000 series handhelds:

- the Trimble Floodlight satellite shadow reduction technology, which can increase the accuracy and likelihood of generating positions in environments affected by satellite shadow including canopy and near buildings.
- the NMEA Output option, which enables you to use the GeoExplorer 6000 series handheld's integrated GNSS receiver with any GNSS field software that accepts NMEA messages.

The Floodlight satellite shadow reduction technology is provided as standard with the GeoXH handheld.

For the GeoXT handheld, you will need to purchase the Floodlight satellite shadow reduction technology option.

The NMEA option must be purchased for both the GeoXH handheld and the GeoXT handheld if required. Contact you Trimble reseller for more information.

Both the Floodlight satellite shadow reduction technology option and the NMEA Output option must be activated on your handheld using the Option Activation Wizard. The wizard can either automatically retrieve an activation file over the Internet, or you can copy the file manually to the device using an external storage card or a USB cable. The activation wizard uses the file to determine which options to activate on the handheld.

To activate these options using the Option Activation wizard, do the following:

1. Tap / *Settings* / *System* / *System Information*, the *System Information* screen appears.
2. Select the *Options* tab and then tap **Activate Options.**
3. If you have received an activation file from your Trimble reseller, select *Manually activate purchased options*. Otherwise select *Automatically check and activate purchased options*.

4. Do one of the following:

- If you selected *Automatically check and activate purchased options:*
  a. Ensure that the device is connected to the Internet (using a USB cable and the ActiveSync technology, or a Wi-Fi connection or Bluetooth wireless connection using the modem—see Chapter 6, Getting Connected).
  b. Tap **Get Updates**.
  c. The Option Activation Wizard will run. When the wizard finishes, restart your device to complete the activate process.
- If you selected *Manually activate purchased options:*
  a. Copy the activation XML file that you reecieved from your Trimble reseller to a folder on the device.
  b. Tap **Get Updates**.
  c. Browse to the folder that contains the activation file.
  d. Tap the file to initiate the activation process.
  e. The Option Activation Wizard will run. When the wizard finishes, restart your device to complete the activate process.

Differential GNSS explained

Use differential GNSS to correct errors in your collected data. Differential GNSS (DGNSS) requires one or more additional receivers, called ***base stations*** or reference stations, which are located at known points. Data collected at the base stations is used to determine GNSS measurement errors and compute corrections to these errors. An unlimited number of mobile GNSS receivers, called ***rovers***, collect GNSS data at unknown locations within the vicinity of the base station. Errors common at both the base station and the rover receiver are corrected with DGNSS either in real time or during postprocessing.

Real-time DGNSS

In real-time DGNSS, the base station calculates and broadcasts the error for each satellite as each measurement is received, enabling you to apply corrections while in the field and collect accurate GNSS data. DGNSS corrections are available from a variety of public and commercial sources. They can be generated and broadcast in real-time by privately or self-owned GNSS base stations, or by a wide range of government agencies.

Real-time DGNSS sources include external beacon and radio sources, as well as Satellite Based Augmentation Systems (SBAS) such as WAAS in the US, EGNOS in Europe, MSAS in Japan, and VRS networks. SBAS and VRS networks use multiple base stations to calculate the DGNSS corrections that are then delivered to the user from a Geostationary satellite (SBAS) or from a radio or cellular phone (VRS networks).

Factors that affect real-time DGNSS accuracy include how often the corrections are updated, how far you are from the base station, and whether the coordinate system used by the correction source matches the coordinate system used by the GNSS receiver.

Postprocessed DGNSS

In postprocessed DGNSS, the collected GNSS data is transferred to an office computer, and measurements from the base station are downloaded. You can postprocess GNSS data collected with Trimble GNSS field software using:

- the GPS Pathfinder Office software version 5.10 (with the latest updates) or later.
- the Trimble GPS Analyst™ extension for Esri ArcGIS Desktop software version 2.40 (with the latest updates) or later.

Typically, postprocessed DGNSS uses only one base station. However, when differentially correcting data collected with GeoXH receivers using H-Star technology, you can select multiple base stations to correct the file against for improved accuracy.

Factors that affect the accuracy of postprocessed DGNSS include the type of receiver and antenna used at the base station, the distance between the base station and the location where the rover data was collected, the accuracy of the base station position, and the logging interval at the base station.

For more information, refer to the documentation provided with the postprocessing software.

Postprocessed real-time DGNSS

If you collected data with 10 cm accuracy in real time, you do not need to postprocess the data.

However, if your data files contain autonomous (uncorrected) positions as well as real-time corrected positions, Trimble recommends that you postprocess the data. During postprocessing, you can choose whether to correct only autonomous positions, or all positions.

If you collected data with submeter accuracy in real time, Trimble recommends that you postprocess the data, as postprocessed data is usually more accurate than data corrected in real time.

Outputting NMEA data to external equipment

Use the GNSS Connector software to specify how the integrated GNSS receiver communicates with equipment that is connected to one of the handheld's external communications ports.

Note – *You must first install the GNSS Connector software. See* *GNSS Connector software, page 63* *for details.*

To open GNSS Connector, tap  / *GNSS Connector*.

The GNSS Connector software lets you connect the NMEA GNSS COM port to COM1 or Bluetooth ports and configure port settings such as the baud rate for COM1.

Use the GNSS Connector software to output NMEA messages from the integrated GNSS receiver to another device, such as an external data collector.

Note – *If you are using a Bluetooth port, ensure that the Bluetooth radio is on and the handheld is visible to other devices. Use the GNSS Connector software to configure NMEA output to Bluetooth - COM9, which is the pre-defined Bluetooth Host Serial Port. For more information, see* *Providing Bluetooth services as a host, page 89*.

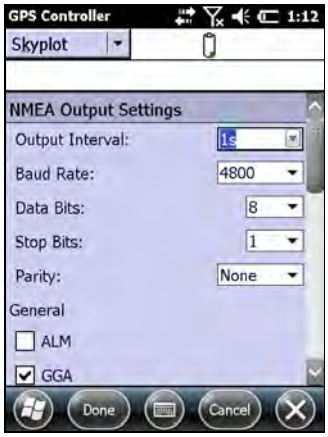
The connections that you create in the GNSS Connector software are active only while the software is running. Connections created by the GNSS Connector end when you exit the software.

For more information, go to www.trimble.com/support.shtml and refer to the GNSS Connector Help. Click GNSS Connector and then click Help.

Configuring NMEA output

You can use the GeoExplorer 6000 series handheld's integrated GNSS receiver with any GNSS field software that accepts NMEA messages, if you have purchased the NMEA output option and it has been activated on the handheld.

To configure the NMEA data output settings, use the GPS Controller software. The software is provided free from the Trimble website. For more information, see GPS Controller software, page 62.



To configure NMEA data output:

1. In the *GNSS Settings* form, set the *NMEA Output* field to ***On***.
2. Tap the **Setup** button that appears next to the *NMEA Output* field. The *NMEA Output Settings* appears.
3. Configure the NMEA message output settings.

CAUTION – NMEA standard dictates that a baud rate of 4800bps should be used for NMEA messages. Depending on the number of satellites being tracked (for example, if you are tracking GLONASS and GPS satellites) the amount of data being captured at once may often cause the 4800 bit limit to be exceeded.
Buffers have been added which allow the data to be stored and then sent when it is able to. This avoids data corruption, but may delay delivery of data, and positions may take as long as 8 seconds to be sent from the time at which they were originally recorded.
If you need 4800bps output, Trimble suggests that you try to minimise the effect by reducing the amount of NMEA data being sent, for example, by dropping out NMEA sentences from the NMEA stream.

4. Tap **Done**.

For more information, refer to the *GPS Controller Help*.

CHAPTER

6

Getting Connected

In this chapter:

The GeoExplorer 6000 series handhelds include a number of options for connecting to other devices. For wireless connections to networks or other devices, the options are:

- a 3.5G capable cellular modem (available on 3.5G editions only)
- an 802.11 b/g compatible Wi-Fi radio
- a Bluetooth radio

You can also connect to other devices using the USB to serial converter.

This chapter describes how to enable the wireless radios, and the main connectivity options available.

Use the table on page 83 to identify the wireless connection type you want to make and then follow the steps provided to connect to that device.

Wireless connection information

The GeoExplorer 6000 series handheld has an integrated Wi-Fi radio compliant with IEEE 802.11 b/g, and an integrated Bluetooth radio. 3.5G editions are also equipped with an integrated cellular modem. The handheld is shipped with Wi-Fi and Bluetooth wireless technology activated. To use Wi-Fi, the Bluetooth radio, or the cellular modem you need to turn it on (see Turning on and turning off the integrated radios below).

Note – *The integrated cellular modem is only installed on handheld models 88951-00 and 88951-20.*

Note – *You may need to deactivate the Wi-Fi and/or Bluetooth radio in the handheld (see below) if the country in which you are working does not approve the use of Wi-Fi and/or Bluetooth wireless technology.*

Using a data connection from your local cellular provider, the GeoExplorer 6000 series handheld's integrated cellular modem can be used to connect to the Internet to receive real-time corrections from a VRS network, send and receive messages (including email, SMS, or instant messages), or to send and receive files and other data to and from the office directly in the field.

You can also use the handheld's integrated Wi-Fi radio to connect to the Internet or a corporate network using a Wi-Fi connection.

Alternatively, you can use Bluetooth wireless technology to connect to the Internet using a cellular phone. You can also connect directly to other Bluetooth-enabled devices such as a GeoBeacon receiver, a laser rangefinder, or a barcode scanner.

You can also use the optional USB to serial converter to connect to a range of external devices using a cabled serial connection.

Deactivating the integrated radios

Note – *If you are unsure about whether the GeoExplorer 6000 series handheld radios are approved for use in your country, check with your Trimble reseller.*

Use the Radio Activation Manager software to deactivate the integrated Wi-Fi and/or Bluetooth radio, or to reactivate the radios if they have been deactivated. The Radio Activation Manager software runs on an office computer.

The latest copy of the software is available for download from the Trimble website. Go to www.trimble.com/support.shtml, click the link for your receiver type (*GeoXH*, or *GeoXT*), click *Downloads*, click *GeoExplorer 6000 Series* and then click *Radio Activation Manager*.

Turning on and turning off the integrated radios

You can use the Wireless Manager application to turn on and turn off the GeoExplorer 6000 series handheld's Wi-Fi, Bluetooth, and / or cellular modem radio (see Using the Wireless Manager, page 81).

You can also turn on or turn off the Bluetooth radio from within the Bluetooth application (see Turning on and turning off the Bluetooth radio from within the Bluetooth application, page 82).

To make the GeoExplorer 6000 series handheld visible to other Bluetooth-enabled devices and enable them to connect, see Making the handheld visible (discoverable) to other Bluetooth devices, page 82.

Using the Wireless Manager

You can use the Wireless Manager application to turn on and turn off the GeoExplorer 6000 series handheld's Wi-Fi, Bluetooth, and / or cellular modem radio. You can turn on and turn off all radios at the same time, or control each radio individually.

To open the Wireless Manager, do one of the following:

- Tap the title bar, tap any of the radio icons and then tap **Wireless Manager**.
- Tap  / *Settings* / *Connections* / *Wireless Manager*.

Turn on the Wi-Fi, Bluetooth, and / or cellular modem radio to be able to connect to other devices or networks.

Turn off the Wi-Fi, Bluetooth, and / or cellular modem radio to prevent the handheld from sending or receiving wireless signals.

Tip – To conserve power, turn off the Wi-Fi, Bluetooth, and / or cellular modem radio when not in use.

CAUTION – The Bluetooth and cellular modem radios remain active even when the device is in Suspend mode. Turn off the radios when they are not in use.

To turn on or turn off the radios using the Wireless Manager

1. Open the Wireless Manager (see above).
2. Do one of the following:
   - Tap **All** at the top of the screen to turn on all radios, or to turn off all radios if they are already on.
   - Tap **Wi-Fi**, **Bluetooth,** or **Phone** to turn on the radio that you want to use, or to turn off the radio if it is already on.

The status fields below the **Wi-Fi** button, the **Bluetooth** button, and the **Phone** button change from *Off* when the radios are turned on and show the current state of the radio. The Wi-Fi status field shows *Connecting* or *Available*, the Bluetooth status field shows *On* or *Visible*, and the **Phone** status field shows *On* or the name of the cellular network that you are connected to.

3. Tap to exit the Wireless Manager.

After you turn on the Wi-Fi radio, the Wi-Fi icon appears in the title bar to indicate that the Wi-Fi radio is enabled. A second icon appears if a Wi-Fi network is detected, and a notification for the detected network may appear in the left softkey.

Turning on and turning off the Bluetooth radio from within the Bluetooth application

1. Tap / *Settings* / *Bluetooth.*
2. Tap the *Mode* tab.
3. Select the *Turn on Bluetooth* check box to turn on the radio, or clear this check box to turn off the radio.
4. Tap **OK**.

Note – *If the integrated Bluetooth radio is deactivated, the message* Problem with Bluetooth hardware *may appear when you try to turn on the Bluetooth radio or discover devices.*

Making the handheld visible (discoverable) to other Bluetooth devices

To allow other Bluetooth-enabled devices to connect to the GeoExplorer 6000 series handheld, or if the handheld will not connect to or pair with another device you are attempting to connect to, you must make the handheld visible (this is sometimes referred to as "discoverable").

To make the handheld ***visible*** to other devices:

1. Tap / *Settings* / *Bluetooth.*
2. Tap the *Mode* tab.
3. Select the *Turn on Bluetooth* check box, if it is not already selected. This enables the integrated Bluetooth radio.
4. Select the *Make this device visible to other devices* check box.
5. Tap **OK**.

Connecting wirelessly to other devices and networks

You can use a connection to a cellular network using the integrated cellular modem, or a connection to a Wi-Fi access point using the integrated Wi-Fi radio, to connect to the Internet (at broadband speeds) or a corporate network to:

- browse the Internet or an Intranet and send and receive data (for example, to obtain real-time corrections from a VRS network)

- send and receive messages (for example, email, instant messages, or SMS messages)
- access files on the network

Wi-Fi access points are also known as “hotspots”.

You can use Bluetooth wireless technology to connect to other Bluetooth-enabled devices that are within range (typically within 5 m to 10 m of the handheld). You can connect to:

- Bluetooth-enabled devices such as cellular phones to access the Internet and receive data (for example, to obtain real-time corrections from a VRS network)
- computers and other handheld devices to exchange files
- other devices such as a GeoBeacon receiver, laser rangefinder, or barcode scanner

Note – *For information on connecting to external devices using the optional USB to serial converter, see* *Connecting to other devices using the USB to serial converter, page 111*

The following table lists devices you can connect to using the handheld, and where to find detailed information on how to achieve these connections.

Connection method	To...	See...
Cellular modem	Connect to a cellular network	page 84
Wi-Fi	Connect to a Wi-Fi access point	page 85
Bluetooth wireless technology	Connect to another Bluetooth-enabled device (paired and non-paired connections)	page 87
	Connect to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks)	page 94
	Connect to a Bluetooth-enabled serial device	page 101
	Connect to an office computer to use ActiveSync technology / WMDC	page 104
	Output GNSS data to other devices using Bluetooth wireless technology	page 107
	Enable other devices to transfer files using Bluetooth wireless technology	page 108
	Beam files to or from another device	page 109
Wi-Fi, Bluetooth wireless technology, or cellular modem	Access a corporate network through your Internet connection	page 110

Connecting to a cellular network from the modem

If your handheld is fitted with the optional cellular modem, use it to establish a connection to a cellular network.

Use this type of connection to browse the Internet or an Intranet and send and receive data (for example, to obtain real-time corrections from a VRS network), send and receive messages (for example, email, instant messages, or SMS messages), or access files on a corporate network.

Note – *The GeoExplorer 6000 series' cellular modem can only be used to send and receive data or text SMS messages. It does not support voice call functionality or sending and receiving MMS messages. Trimble recommends that you request a data-only plan from your cellular service provider and have a 'voice-restriction' placed on your line.*

To connect to a cellular network:

1. Configure the connection to the network. This can be Automatic or Manual.
2. Connect to the cellular network.

Before you begin the steps below, Trimble recommends that you:

- make sure that a SIM card is inserted in the handheld. See Installing and removing a SIM card, page 37.
- confirm that the modem can access the Internet directly. If necessary, contact your service provicer and confirm whether you must enter a user name, password, and domain details when connecting.
- make sure that you have the correct APN (Access Point Name) from your cellular provider.

Step 1: Configure the connection

To set up an automatic configuration

1. Tap  / *Settings* / *Connections* / *Wireless Manager*. If the Phone is Off, tap Phone to turn it on.
2. Tap  / *Settings* / *Connections* / *Connections*.
3. On the Connections screen, on the Tasks tab, tap *Automatically configure connection*.

   The device holds a database of the most common cellular providers and the correct connection settings. The handheld will attempt to identify the SIM vendor.
4. If the SIM vendor is recognised correctly, tap **Next** to continue. The connection settings are set up automatically. The process takes about 30 seconds.

   If the SIM is not automatically detected, or the vendor settings are not known you will need to set up the configuration manually. Go to To set up a manual configuration below.

To set up a manual configuration

1. Tap / *Settings* / *Connections* / *Wireless Manager*. If the Phone is Off, tap Phone to turn it on.
2. Tap / *Settings* / *Connections* / *Connections*.
3. Under Tasks, tap *Add a new modem connection*.
4. Enter a name for the connection, for example **My Connection.**
5. In the *Select a modem* field, select **Cellular Line (WWAN)** and then tap **Next**.
6. Enter the APN provided by your cellular provider (check with your provider first for correct settings, some providers have multiple APN settings).
7. Tap **Next**.
8. Enter a username password and domain if required (check with your provider, these are often not required). If not required, leave these fields empty.
9. Tap **Finished**.

Step 2: Connect to the cellular network:

1. Tap / *Settings* / *Connections* / *Wireless Manager*. If the Phone is Off, tap Phone to turn it on.
2. Tap / *Settings* / *Connections* / *Connections*.
3. Under Tasks, tap *Manage existing connections*. The configured connections are listed.
4. Tap and hold the connection that you want to use. Tap *Connect* from the pop-up menu.

   The task bar shows the "connecting" icon, for example . When the connection is open/established, the task bar shows the "connected" icon, for example . The icons shown depend on the network—see Network and modem status indicators, page 42 for full details.

Once connected, open an application, for example, Internet Explorer, to test the connection. Some applications automatically launch the connection when you start the application, if a current connection is not already established.

Connecting to a Wi-Fi access point

To connect to a Wi-Fi access point, you must:

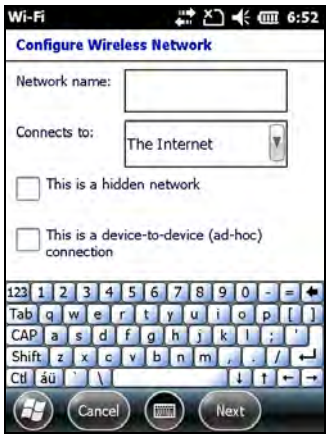
1. Set up the Wi-Fi connection.
2. Connect to the Wi-Fi network or access point.

Note – *If you have installed a personal certificate on the handheld, you do not need to set up the wireless connection manually as described in Step 1. To connect to the network or access point go to* *Step 2: Connecting to the network or access point*.

Step 1: Setting up the Wi-Fi connection

1. Make sure that the GeoExplorer 6000 series handheld's Wi-Fi radio is enabled (see page 80).
2. Tap / *Settings* / *Connections* / *Wireless Manager*.
3. Tap **Menu** and then select *Wi-Fi Settings*..

   Any networks that you have already configured are displayed in the list of preferred networks.
4. To add a new network, tap *Add New*. To change the settings for an existing network, tap the network.
5. Enter the name of the network and other connection details and then tap **Next**.
6. Do one of the following
   - To use authentication, select the authentication method from the *Authentication* list.
   - To use data encryption, select an encryption method from the *Data encryption* list.
   - To automatically use a network key, select the check box for *The key is automatically provided*. Otherwise, enter the *Network key* and the *Key index*.
7. Tap **Next**.
8. For increased security, select the *Use IEEE 802.1x network access control* check box and then configure additional authentication information.
9. Tap **Finish**.



Step 2: Connecting to the network or access point

1. Disconnect the USB data cable, as the handheld prioritizes a USB connection over a Wi-Fi connection.
2. Bring the handheld within range of the network or access point.

   When a Wi-Fi connectionis detected, the access point icon appears on the title bar, and a notification message appears on the left softkey.

   If the access point icon or the notification does not appear, use the Wireless Manager to turn off and then turn back on the Wi-Fi radio. When the Wi-Fi radio is turned on, any networks or access points within range are detected and the icon and notification appear.
3. Tap the access point icon on the title bar or tap **Notification** on the left softkey.

   A popup message shows the available networks.
4. Select the network you want to connect to and then tap **OK** on the left softkey.

5. Select *The Internet (or work via a VPN)* or *Work* and then tap **Connect** on the left softkey.
6. If a *Network Log On* screen appears, enter your user name, password, and domain information and then tap **OK** on the left softkey.

   When the handheld is connected to the network or access point, the Wi-Fi connected icon appears in the title bar.
7. Start using the program you want to use, for example Windows Explorer Mobile or Internet Explorer.

Note – *To disconnect from the network or an access point at any time, turn off the handheld's wireless radio. To do this, tap title bar, tap the Connectivity icon on the pull-down list, select* ***Wireless Manager*** *and then tap the* **Wi-Fi** *button.*

Tip – To delete a Wi-Fi connection, tap and hold the connection in the Wireless tab of the Wi-Fi Settings screen and then select Remove Settings.

Connecting to a Bluetooth-enabled device

The GeoExplorer 6000 series handheld has an integrated Bluetooth radio that you can use to establish a wireless connection to other Bluetooth devices that are within range.

Using a Bluetooth connection, you can communicate with devices such as cellular phones, office computers, other handhelds, and Bluetooth-enabled laser rangefinders and barcode scanners. You can also communicate with peripheral devices that use Bluetooth adaptors instead of serial or USB connections.

The GeoExplorer 6000 series handheld can act as a Bluetooth client device or a Bluetooth host device, and can act as both at the same time. The concepts of client and host devices are explained in detail below.

Connecting to a Bluetooth device as a client

You can use the GeoExplorer 6000 series handheld as a ***client*** device, which uses ***services*** offered by Bluetooth host devices that are within range. In general the ***host*** device provides information to the client device, but in some cases the client initiates the connection and also provides information to the host device.

The services used by a GeoExplorer 6000 series handheld when connecting as a Bluetooth client are:

Service	Description
Dialup Networking (DUN)	Connects the handheld to a cellular phone or modem for dial-up network or Internet access.
Personal Area Networking (PAN)	Connects to Bluetooth network access points or phones that support the Personal Area Network/Network Access (PAN) profile. The PAN service is only available on GeoExplorer 6000 series handheld models which do not have an integrated modem.
Serial Port	Emulates an RS-232 serial (COM) port on the handheld.

Service	Description
ActiveSync	Enables an ActiveSync connection to a computer. This service is also used for office computers which have the WMDC installed.
Input Device (HID)	Connects the handheld to a physical input device, such as a keyboard.
Wireless Stereo	Connects to Bluetooth A2DP (Advanced Audio Distribution Profile) headphones.

A client can connect to a number of different services provided by different hosts. The number of active connections at any one time affects the speed of the connections. Figure 6.1 shows the handheld connected to different types of host devices using Bluetooth wireless technology.

Figure 6.1 GeoExplorer 6000 series handheld Bluetooth client connections

In Figure 6.1, the dashed arrows indicate the client device—that is, the GeoExplorer 6000 series handheld—connecting to host devices. The Bluetooth profile (or service) used for the connection is shown between the arrows, for example, the ***DUN*** service is used for a connection to a cell phone, and the ***Serial Port*** service is used for a serial connection to a GeoBeacon receiver or laser rangefinder.

The solid arrows indicate the flow of information between devices. For example, when the GeoExplorer 6000 series handheld connects as a client to:

- a cellphone, the handheld uses the DUN or PAN host service provided by the phone to access the Internet and receive real-time differential corrections or background map data.

- a laptop computer or office computer, the devices use the ActiveSync technology to exchange information to and from either device.
- Bluetooth headphones, the handheld uses the Wireless Stereo host service provided by the headphones to play audio files and system sounds.

Providing Bluetooth services as a host

You can use the GeoExplorer 6000 series handheld as a Bluetooth host device, which provides services to Bluetooth client devices that are within range.

Host services provided by the GeoExplorer 6000 series handheld are:

Service	Description
Serial Port	Emulates an RS-232 serial (COM) port on the handheld. For more information, see Outputting GNSS data to other devices using Bluetooth wireless technology.
File Transfer	Allows a client to browse, copy, paste, and delete files and folders on the handheld.

Note – *You cannot transfer files between two GeoExplorer 6000 series handhelds, as the client file transfer profile is not supported. The handheld supports file transfers as a host device only. To transfer files between handhelds, you can beam them (see page 109).*

To provide a host service, you must turn on the Bluetooth radio and make both devices visible to other devices (see page 80 and page 82).

Figure 6.2 shows different client devices connecting to the handheld using Bluetooth wireless technology.

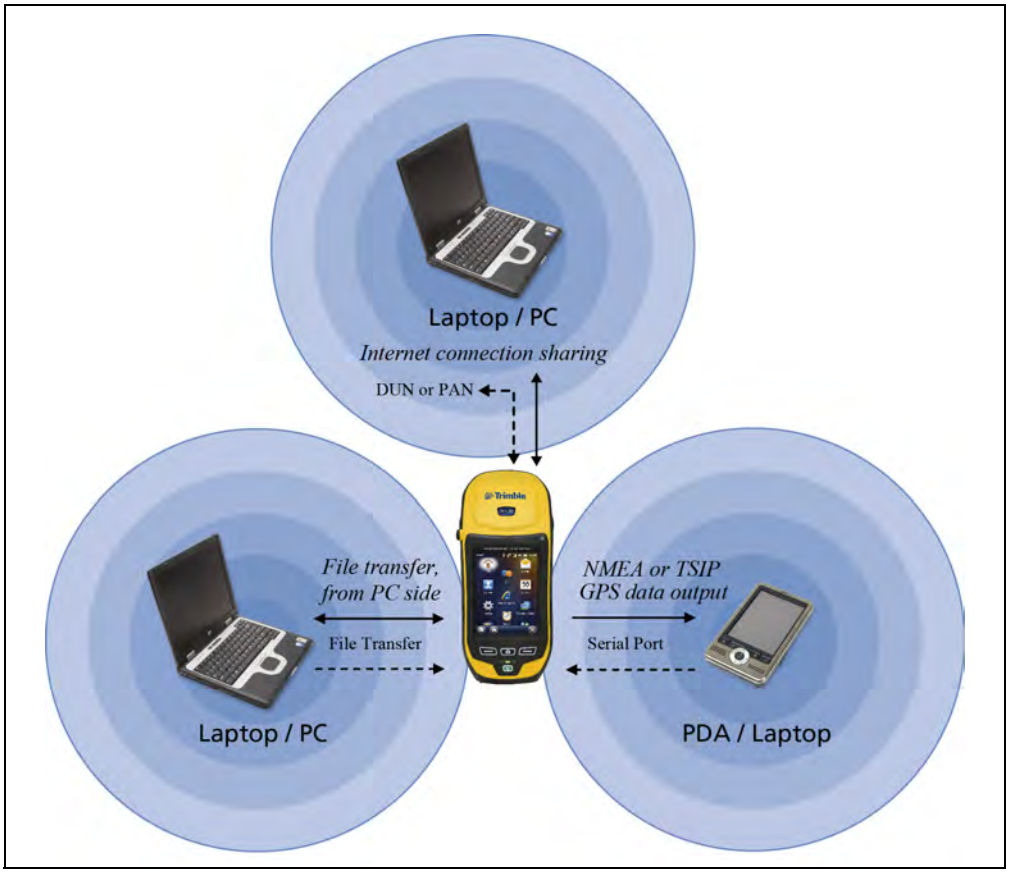


Figure 6.2 GeoExplorer 6000 series handheld Bluetooth host connections

In Figure 6.2 the dashed arrows indicate the client devices—for example, the laptop or PDA—connecting to the GeoExplorer 6000 series handheld, which is the host device. The Bluetooth profile (or service) used for the connection is shown between the arrows, for example the ***Serial Port*** service is used when outputting GPS data from the handheld to another device.

The solid arrows indicate the flow of information between devices. The GeoExplorer 6000 series handheld can output GNSS data to client devices that connect to the handheld using a Bluetooth serial port. When a laptop computer or office computer connects to the GeoExplorer 6000 series handheld and selects the File Transfer service, files and information can be exchanged to and from either device.

When a client device connects to the Serial Port service provided by the GeoExplorer 6000 series handheld, applications on the handheld can use the pre-defined host serial port on COM9 to provide host services to the client device. For example, to provide GNSS positions from the integrated GNSS receiver to another device, use the GNSS Connector software to redirect the NMEA output to COM9.

Setting up a Bluetooth connection

To use another Bluetooth-enabled device with the GeoExplorer 6000 series handheld, you must form a Bluetooth connection between the two devices, during which you select the type of service to use for the connection. This defines how the devices will communicate with each other.

After forming the Bluetooth connection between the devices you may need to configure settings for the connection such as the COM port for the field software to use, or the number for the phone to dial. You must then connect to the other device using the appropriate software application.

To connect the GeoExplorer 6000 series handheld to another Bluetooth-enabled device, you can use either a paired connection or a non-paired connection.

Note – *If you are connecting to a phone, skip this section and go to Connecting to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks) on page 94, where the pairing step is described as part of the procedure for connecting to a phone.*

Trimble recommends using a paired connection, if pairing is supported by the other device, as a paired connection creates a more secure connection and makes reconnecting to the device easier. For more information, see Pairing with a Bluetooth-enabled device below.

Some devices, such as a Trimble GeoBeacon receiver, do not support paired connections. Use a non-paired connection if the device does not have a keyboard, and if you know that the device does not automatically exchange a pre-programmed passkey during pairing. For more information, see Setting up a connection to a non-paired device, page 93.

Pairing with a Bluetooth-enabled device

Pairing the handheld with another Bluetooth-enabled device creates a permanent security bond between the devices, which helps to exchange information securely between the devices. The paired relationship is established when two devices create and exchange a link key. Once the relationship is established, the handheld and the other Bluetooth device only need to have their Bluetooth radios turned on to exchange information; they do not need to be visible to other devices.

To pair with a Bluetooth device:

1. Make sure that the handheld and the Bluetooth device you want to pair with are within five meters of each other, and that the Bluetooth radio in each device is turned on.
2. On the GeoExplorer 6000 series handheld, tap  / *Settings* / *Bluetooth*.

3. In the *Devices* tab, tap *Add new device*. The handheld searches for other Bluetooth devices and displays them in the list.

   If the device you are trying to connect is not displayed in the list, ensure that the device is on and within range and then tap **Retry** to search for devices again.

4. Tap the name of the device you want to pair with and then tap **Next**.
5. In the *Passcode* field, enter a passcode of between 1 and 16 characters. If you are connecting to:
   - a device with a keypad, enter a passcode of your choice.
   - a device without a keypad, but you know that the device has a pre-programmed passcode that will be exchanged, enter that passcode on the GeoExplorer 6000 series handheld.

Note – *Trimble recommends that you enter only numbers, as some devices do not support passcodes that include letters.*

6. Tap **Next**.
7. When prompted, enter the same passcode on the other device.
8. On the handheld, tap the name of other device. The *Partnership Settings* screen appears.
9. If required, change the name of the device in the *Display Name* field.
10. Select the service(s) you want to use with this device. For example, if you are connecting to:
    - a Bluetooth-enabled phone to connect to the Internet and receive real-time corrections or download background maps, select ***Dialup Networking (DUN)***.
    - a serial device, such as a GeoBeacon receiver or a laser rangefinder, select ***Serial Port***.
    - a computer to access ActiveSync technology (or WMDC), select ***ActiveSync***.

Note – *Only* ***ActiveSync*** *shows on the Windows Mobile device. Select* ***ActiveSync*** *even if you use the WMDC on the desktop computer.*

Note – *For more information on the types of devices that the GeoExplorer 6000 series handheld can connect to, and the supported Bluetooth services, see* *Connecting to a Bluetooth device as a client, page 87*.

11. Tap **Save**.
12. Tap **OK** to close the Bluetooth application.

13. Tap to close the *Settings* screen.

You have now created a partnership between the GeoExplorer 6000 handheld and the other Bluetooth-enabled device so that they can communicate. To start using the connection, you must complete the configuration steps for that type of connection and then connect to the device. For more information, see:

- Connecting to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks), page 94
- Connecting to a Bluetooth-enabled serial device, page 101
- Connecting to an office computer using Bluetooth wireless technology, page 104

Tip – You only need to pair the handheld with a device before you connect to the device for the ***first*** time.

Setting up a connection to a non-paired device

Setting up a connection to a non-paired device enables you to connect to a device that does not allow you to enter a passcode on the device, or that does not automatically exchange a pre-programmed passkey during pairing.

To set up a non-paired connection to a Bluetooth-enabled device:

1. Make sure that the handheld and the Bluetooth device you want to connect to are within five meters of each other, and that the Bluetooth radio in each device is turned on.
2. Tap / *Settings* / *Bluetooth*.
3. In the *Devices* tab, tap *Add new device*. The handheld searches for other Bluetooth devices and displays them in the list.
4. Tap the name of the device you want to connect to and then tap **Next**.

   The *Enter Passcode* screen appears.
5. Tap **Next** without entering a passcode.
6. If prompted to add the device to your device list, tap **No**.
7. On the handheld, tap the name of the other device. The *Partnership Settings* screen appears.

8. If required, change the name of the device in the *Display Name* field.
9. Select the service(s) you want to use with this device. For example, if you are connecting to:
   - a Bluetooth-enabled phone to connect to the Internet and receive real-time corrections or download background maps, select ***Dialup Networking (DUN)***.

- a serial device, such as a GeoBeacon receiver or a laser rangefinder, select ***Serial Port***.
- a computer to access ActiveSync (or WMDC), select ***ActiveSync***.

Note – *Only* ***ActiveSync*** *shows on the Windows Mobile device. Select* ***ActiveSync*** *even if you use the WMDC on the desktop computer.*

Note – *For more information on the types of devices that the GeoExplorer 6000 series handheld can connect to, and the supported Bluetooth services, see* *Connecting to a Bluetooth device as a client, page 87*.

10. Tap **Finish**.
11. Tap **OK** to close the Bluetooth application.
12. Tap  to close the *Settings* screen.

You have now created a partnership between the GeoExplorer 6000 handheld and the other Bluetooth-enabled device so that they can communicate. To start using the connection, you must complete the configuration steps for that type of connection and then connect to the device. For more information, see:

- Connecting to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks), page 94
- Connecting to a Bluetooth-enabled serial device, page 101
- Connecting to an office computer using Bluetooth wireless technology, page 104

Connecting to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks)

If your GeoExplorer 6000 series handheld does not include the integrated cellular modem, you can still connect to a cellular network using the Bluetooth radio to connect to a Bluetooth-enabled cellular phone. Use this type of connection to access a VRS network or other correction source from the Internet, a background map server, or for Internet and email access.

Note – *Some cellular phones support the Bluetooth PAN (Personal Area Networking) service as well as the Bluetooth DUN (Dialup Networking) service. Because DUN connections are more common, this section assumes you are making a dialup network connection with the Bluetooth-enabled phone. For information on setting up a PAN service, see* *Connecting to the Internet through a Bluetooth-enabled phone using the Bluetooth PAN profile, page 100*.

To connect to a Bluetooth-enabled phone using a Bluetooth DUN (Dialup Networking) connection, you must:

1. Connect the GeoExplorer 6000 series handheld to a Bluetooth-enabled phone and then configure the connection to the dialup network.
2. Connect to the Internet using the dialup network.

3. Configure the software to use the connection. For example, you must configure the GNSS field software to use real-time corrections or map data received from the Internet source, or you must set up the Messaging application to send and receive email using the connection.

Note – *Before you begin the steps below, Trimble recommends that you confirm that the phone can access the Internet directly. If necessary, contact the cellular phone provider and confirm whether you must enter a user name, password, and domain details when connecting an external device to the phone using Bluetooth dialup networking.*

Step 1: Connecting the handheld to the phone and configuring the connection to the dialup network

1. Make sure that the handheld and the Bluetooth device you want to connect to are within five meters of each other, and that the Bluetooth radio in each device is turned on. For more information, see Turning on and turning off the integrated radios, page 80.
2. On the handheld, tap  / *Settings* / *Connections* / *Connections*.
3. Below ***My ISP***, tap *Add a new modem connection*.
4. Enter the name for the connection. For example, enter the name of the phone or the VRS network that you will connect to.
5. From the *Select a Modem* dropdown list, select ***Bluetooth*** and then tap **Next**.
6. If the phone you want to connect to is:
   - listed, go to Step 7 below.
   - not listed:
     a. Tap *Add new device*. The handheld searches for other Bluetooth devices and displays them in the list.

        If the handheld's integrated Bluetooth radio is turned off, it is now automatically turned on.

     b. From the list of available devices, select the device you want to connect to and then tap **Next**.

     c. To pair with the phone, enter a passcode of your choice that you will easily remember onto the handheld and then tap **Next**.

     d. When prompted by the phone, enter the same password and then accept the connection.

     e. On the GeoExplorer 6000 series handheld, tap *Advanced* to open the Partnership Settings screen. Make sure that ***Dialup Networking (DUN)*** is selected and then tap **Save**.

You have now created a partnership between the GeoExplorer 6000 series handheld and the phone so that they can communicate.

7. From the *My Connections* list, select the phone that you want to configure the connection to.
8. Enter the GPRS access number for the Internet.

   Two of the common GPRS access numbers for cellular phones on GSM networks are *99***1# and *99#. If these access numbers do not work, contact the cellular phone provider to obtain the appropriate number to use.

Note – *You do not need to set up dialling rules or change the Internet connection settings on the phone. The connection settings you enter on the handheld are passed to the phone to use for this connection.*

9. Tap **Next**.
10. Unless the phone provider confirmed that you must enter user name, password, and domain settings to access the Internet, tap **Finish** without entering any information in this screen.

    Otherwise:

    a. Enter the required information.

    b. If the phone provider has told you that you need to change the baud rate or other settings for the connection, tap **Advanced**, configure these settings and then tap **OK**.

    c. Tap **Finish** .

    You are returned to the *Connections* screen.

    You have now configured the dialup networking connection.

Step 2: Connecting to the Internet using the dialup network

1. On the handheld, go to the *Connections* screen, if it is not already open (tap / *Settings* / *Connections* / *Connections).*
2. Below ***My ISP***, tap *Manage existing connections.*
3. Tap and hold the connection you want to use and then select *Connect.*
4. Unless the phone provider confirmed that you must enter user name, password, and domain settings to access the Internet, tap **OK** without entering any information in this screen. Otherwise, enter the required information and then tap **OK**.
5. If the phone prompts for confirmation to connect to the Internet, accept the connection.

   The phone dials the configured GPRS access number and then connects to the Internet.

A Connectivity notification appears on the handheld as the connection is being made.

After the connection is made you are returned to the *My ISP* screen.

To confirm that the GeoExplorer series handheld is connected to the phone, or to check the status of the connection at any time, tap the title bar and then tap the Connectivity icon on the pull-down list. The notification shows the name of the current connection, and the time elapsed since the connection was made. To hide the notification, tap **Hide**.

Note – *If you have an active Wi-Fi connection, the connectivity icon appears as*  *instead.*

6. Tap **OK** to close the *My ISP* screen.
7. Tap **OK** to close the *Connections* / *Tasks* screen.
8. Tap  to close the *Connections* screen.

To check the connection status at any time, tap the title bar and then tap the required status icon on the pull-down list.

To end the connection at any time, tap the title bar, tap the required status icon on the pull-down list and then tap **Disconnect**.

To connect to a corporate network or Intranet, see page 110.

To send and receive email messages, see Messaging, page 52.

Step 3: Configuring the GNSS field software to use data received from the Internet source

Now that you have connected the GeoExplorer 6000 series handheld to the Internet, you must configure the software to use the connection to receive data.

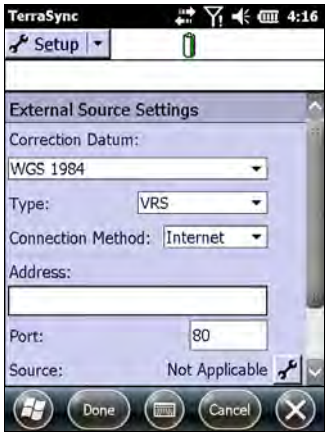
To use real-time corrections in Trimble field software, see Using real-time corrections from the Internet below.

To use background map data in the TerraSync software, see Downloading background map files from an Internet map server, page 99

Using real-time corrections from the Internet

1. Start the Trimble GNSS field software and then open the *Setup* section.
2. Tap **Real-time Settings**. The *Real-time Settings* form appears.
3. From the *Choice 1* field, select ***External Source***.
4. Configure the external source:

a. Tap the Setup button beside the *Choice 1* field. The *External Source Settings* form appears.



b. From the *Correction Datum* field, select the same datum as the VRS network coordinate system.

c. From the *Type* field, select:

- ***VRS*** if the real-time correction source is a VRS network.
- ***Single Base*** if the real-time correction source is a single base station that broadcasts its corrections over the Internet.

d. From the *Connection Method* field, select ***Internet***.

Typically, the IP address or URL of a VRS network has the format 10.3.123.456:1234, where the digits before the colon (:) are the address, and the digits after the colon (:) are the port number.

e. In the *Address* field, enter the IP address or URL of the VRS network or the server that is supplying the corrections from the VRS network.

f. In the *Port* field, enter the port number that you will use to connect to the server.

g. If you are connecting to a VRS network through a broadcast server, tap the Setup button beside the *Source* field. The GNSS field software attempts to establish a connection to the broadcast server. If the connection is successful, the *Select Server* form appears. Select the server that you want to use and then tap **Done** to return to the *External Source Settings* form.

h. If you selected a VRS network that requires authentication, the *Name* and *Password* fields appear. Enter the user name and password that you obtained from the service provider.

i. From the *Connection Control* field, select:

- ***Auto*** if you want the GNSS field software to automatically establish and end connections to the VRS network as necessary.
- ***Manual*** if you want to connect or disconnect only when you tap **Ext Source** in the *Setup* screen.

j. Tap **Done** to confirm the settings and return to the *Real-time Settings* form.

5. Tap **Done** to confirm the real-time settings and return to the main screen of the Setup section.

If you selected ***Auto*** in the *Connection Control* field, the **Ext Source** button is depressed and the software attempts to connect to the server.

6. If you selected ***Manual*** in the *Connection Control* field, tap the **Ext Source** button that appears below the Status bar in the Setup section to connect the Trimble GNSS field software to the Internet correction source.

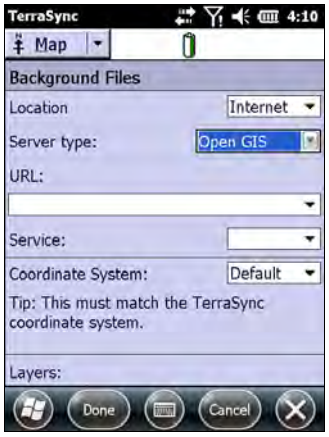
Tip – To disconnect or reconnect to the server at any time, tap **Ext Source**. To view the status of the real-time correction source, open the Status section, select the Real-time subsection and then select *External* from the **Summary** list button.

Downloading background map files from an Internet map server

1. Make sure that the coordinate system selected in the TerraSync software matches the coordinate system of the map server.
2. In the Map section of the TerraSync software, pan or zoom to make sure that the area for which you want a background image is displayed on the map.

   If the map server covers the area you are in, it will provide a background image that matches the current map extents.
3. Tap **Layers** and then select *Background files*. The *Background Files* form appears.
4. In the *Location* field select Internet and then use the fields that appear to specify the Map Server type, the URL of the server, the service, and the layers from that service that you want to download.
5. Tap **Done** to close the *Background File* form and download the selected background map.

   This may take some time. When a download is in progress, an icon appears in the top left corner of the map. Once the background file is downloaded, the hourglass icon appears until the downloaded image is rendered and becomes visible.



If you pan or zoom beyond the extents of the downloaded image, new images are downloaded automatically and displayed in the background of the map.

To stop automatic downloading of background files, either clear the address of the map server from the *URL* field, or set the *Location* field to Default and then clear the check box next to any files.

Reconnecting to the Internet

To reconnect to the Internet at any time after setting up the connection, repeat the steps listed under Step 2: Connecting to the Internet using the dialup network on page 96.

If you selected Auto in the *Connection Control* field of the Trimble GNSS field software, the software automatically connects to the Internet source that is providing real-time differential corrections.

To ***manually*** reconnect the Trimble GNSS field software to the Internet source that is providing real-time differential corrections, open the software and then tap the **Ext Source** button that appears below the status bar in the Setup section.

Connecting to the Internet through a Bluetooth-enabled phone using the Bluetooth PAN profile

This section describes how to set up a Bluetooth Personal Area Network (PAN) connection for Internet access, using Bluetooth-enabled cellular phone.

The PAN service is not available on GeoExplorer 6000 series handheld models which have an integrated modem.

Making a Bluetooth PAN connection with a Bluetooth-enabled cellular phone is similar to making a Bluetooth Dialup Networking (DUN) connection (see Connecting to a Bluetooth-enabled phone for Internet access or real-time corrections (including VRS networks), page 94), in that it enables the handheld to access the Internet. If PAN connections are supported by your cellular phone, the advantages of using a PAN connection rather than a DUN connection are:

- PAN connections are easier to set up.
- PAN connections automatically attempt to reconnect when the handheld is resumed from being suspended or shut down.

To access the Internet using a Bluetooth PAN connection to a Bluetooth-enabled cellular phone, you must:

1. Pair the GeoExplorer 6000 series handheld with a cellular phone that supports the Bluetooth PAN profile.
2. Enable the PAN connection on the handheld.

Step 1: Pairing with the cellular phone

1. Make sure that the handheld and the Bluetooth device you want to pair with are within five meters of each other, and that the Bluetooth radio in each device is turned on.
2. On the GeoExplorer 6000 series handheld, tap  / *Settings* / *Bluetooth*.
3. In the *Devices* tab, tap *Add new device*. The handheld searches for other Bluetooth devices and displays them in the list.

   If the device you are trying to connect is not displayed in the list, ensure that the device is on and within range and then tap Refresh to search for devices again.
4. Tap the name of the device you want to pair with and then tap **Next** on the right softkey.
5. In the *Passcode* field, enter a passcode of your choice (between 1 and 16 characters).

Note – *Trimble recommends that you enter only numbers, as some devices do not support passcodes that include letters.*

6. Tap **Next** on the right softkey.
7. When prompted, enter the same passcode on the other device.

On the handheld, the *Partnership Settings* screen appears.

8. If required, change the name of the device in the *Display Name* field.
9. Select the *Network Access Point* check box. The boxes for other Services offered by the phone can be unchecked.
10. Tap **Finish** on the right softkey.

Step 2: Enabling the PAN connection

1. In the PAN tab of the Bluetooth application on the handheld, select the cellular phone you just connected to from the drop down list and then select the *Enable PAN connection* check box.

   The status field in the PAN tab shows the progress of the connection. Wait until the Status field shows Connected.
2. Check the cellular phone and if prompted, allow the connection.

The  or  icon in the title bar changes to  .

3. Tap **OK** to close the Bluetooth application.
4. Tap  to close the Settings screen.
5. If the *Establishing Connection* popup message appears on the handheld, select *The Internet (or work via a VPN)* or *Work* and then tap **Connect**, or dismiss the message.
6. Start using the program you want to use, for example Windows Explorer Mobile or Internet Explorer.

To check the connection status at any time, tap the title bar and then on the pull-down list tap the required connection icon. The Bluetooth PAN connection appears as "Network Card".

To end the connection at any time, tap  / *Settings* / *Bluetooth*. In the PAN tab, clear the *Enable PAN connection* check box.

Connecting to a Bluetooth-enabled serial device

Use Bluetooth wireless technology to receive data from a Bluetooth-enabled serial device, such as a GeoBeacon receiver or a laser rangefinder.

To connect to a Bluetooth-enabled serial device, you must:

1. Connect to the Bluetooth-enabled serial device.
2. Configure the COM port on the handheld to use for the connection.

3. If necessary, configure the GNSS field software to use data received from the serial device.

Step 1: Connecting to the Bluetooth-enabled serial device

Connect the handheld to the Bluetooth-enabled device, selecting the ***Serial Port*** service if it is not already selected (see Connecting to a Bluetooth-enabled device, page 87).

Step 2: Configuring the COM port to use on the handheld

1. On the GeoExplorer 6000 series handheld, tap / *Settings* / *Bluetooth*.
2. Tap the *COM Ports* tab.
3. Tap *New Outgoing Port*.
4. Select the device you want to set up the connection to and then tap **Next**.
5. Select the COM port on the GeoExplorer handheld to use for the connection.

   The GeoExplorer 6000 series handheld has three COM ports (COM5, COM6, and COM7) available for connections out to Bluetooth-enabled serial devices.

6. Do one of the following:
   - To communicate with any device, for example if you have formed this connection without pairing to a device, clear the *Secure Connection* check box.
   - To communicate only with devices with which the handheld has a Bluetooth partnership, select the *Secure Connection* check box.
7. Tap **Finish**.
8. Tap **OK** to close the Bluetooth application.
9. Tap to close the *Settings* screen.

Step 3: Configuring the GNSS field software to use data from the serial device

Once you configure the connection between the GeoExplorer 6000 series handheld and the Bluetooth-enabled serial device, you must configure the software to use the connection to receive data.

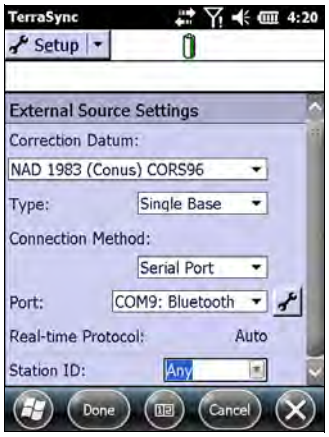
To use real-time corrections in Trimble field software, see Using real-time corrections from an external serial device below.

To use an Bluetooth-enabled external sensor such as a laser rangefinder or a barcode scanner in TerraSync software, see Using data from an external source in the TerraSync software, page 103.

Using real-time corrections from an external serial device

1. Start the Trimble GNSS field software and then open the *Setup* section.
2. Tap **Real-time Settings**. The *Real-time Settings* form appears.
3. From the *Choice 1* field, select ***External Source***.
4. Tap the Setup button beside the *Choice 1* field. The *External Source Settings* form appears.
5. From the *Correction Datum* field, select the datum used by the correction source to calculate corrections.

   Trimble recommends that you select NAD 1983 (Conus) CORS96 if you are using a US Coast Guard beacon service, or WGS84 for any other beacon service.
6. From the *Type* field, select ***Single Base***.
7. From the *Connection Method* field, select ***Serial Port***.



8. From the *Port* field, select the name of the COM port that you selected in the Bluetooth application when you set up the connection to the serial device.
9. Tap **Done** to confirm the external source settings and return to the *Real-time Settings* form.
10. Tap **Done** to confirm the real-time settings and return to the main screen of the Setup section.

    The real-time correction source is now set up for use. The TerraSync software automatically connects to the correction source when you run the software, and automatically disconnects from the source when you close the software.

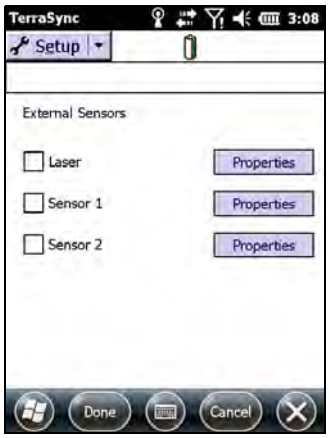
To manually disconnect from the correction source at any time, go to the *Real-time Settings* form and from the *Choice 2* field select Use Uncorrected GNSS.

To view the status of the real-time correction source, open the Status section, select the Real-time subsection and then select *External* from the **Summary** list button.

Using data from an external source in the TerraSync software

To configure the TerraSync software to use data from an external source, for example, a laser rangefinder or barcode scanner:

1. Start the TerraSync software and then open a data file.
2. In the *Setup* section, tap **External Sensors**. The *External Sensors* form appears.
3. If you are connecting to:
   - a laser rangefinder, select the *Laser* check box and then tap the **Properties** button beside the *Laser* check box. The *Laser Properties* form appears.
   - a barcode scanner or other external sensor, select the *Sensor 1* or *Sensor 2* check box and then tap the **Properties** button beside the appropriate check box. The *Sensor Properties* form appears.



4. If you are connecting to a barcode scanner or other external sensor, enter a name for the connection in the *Name* field.
5. From the *Port* drop-down list, select the name of the COM port that you selected in the Bluetooth application when you set up the connection to the device.
6. Tap **Done** to confirm the sensor settings and return to the *External Sensors* form.
7. Tap **Done** to confirm the settings and return to the main screen of the Setup section.
8. The external sensor is now setup for use and can be used to add data as attributes into an open file in TerraSync. The device is automatically connected and disconnected when data files in TerraSync are opened and closed.

   To check the status of the connection, select the Comms subsection in the Status section of the GNSS field software .

Connecting to an office computer using Bluetooth wireless technology

Instead of using a USB or serial cable to physically connect to an office computer, you can use Bluetooth wireless technology to connect to ActiveSync technology or the Windows Mobile Device Center (WMDC) on a Bluetooth-enabled office computer.

Note – *Not all Bluetooth devices and Bluetooth management software support ActiveSync technology or WMDC connections. Check with the manufacturer of the office computer for compatibility.*

Note – *The exact steps required may vary depending on the office computer.*

To connect to an office computer to use ActiveSync technology or WMDC with a Bluetooth connection, you must:

1. Set up the connection to the computer.
2. Connect to ActiveSync technology or WMDC using Bluetooth wireless technology.

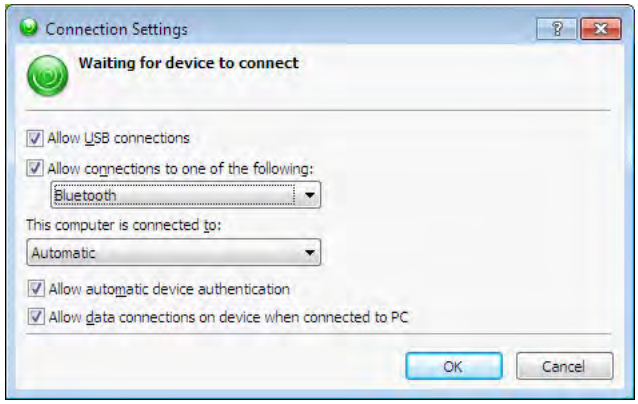
Step 1: Setting up the connection to the computer

1. From the Bluetooth user interface on the office computer, make sure that the computer allows itself to be discovered by other Bluetooth devices.
2. Configure ActiveSync technology or WMDC on the office computer to connect to the correct Bluetooth port. The steps required depend on the operating system installed on the office computer. If the office computer is using:

- the Windows 7 or Windows Vista operating system:

  a. From the *Start* menu on the office computer, select *Control Panel* / *Windows Mobile Device Center*.

     The *Connection Settings* dialog appears:



  b. Select the *Allow connections to one of the following* check box.

  c. From the list, select Bluetooth and then click **OK**.

- the Windows XP operating system:

  a. From the Bluetooth user interface on the office computer, identify the virtual COM port of the of the host Bluetooth Serial Port or Local Service and ensure that this is enabled. In this example, the virtual COM port is COM5.

  b. Start the ActiveSync technology on the office computer.

  c. Select *File* / *Connection Settings*.

The *Connection Settings* dialog appears:

d. Select the *Allow connections to one of the following* check box.

e. From the list, select the COM port that you selected in Step a and then click **OK**.

Note – *Before you try to form a Bluetooth connection from the GeoExplorer 6000 series handheld to the office computer, you must correctly configure the Bluetooth host serial port and ActiveSync technology on the office computer.*

3. On the handheld, tap / *Settings* / *Bluetooth*.
4. In the *Devices* tab, tap *Add new device*. The handheld searches for other Bluetooth devices and displays them in the list.
5. Tap the name of the computer you want to connect to and then tap **Next**.
6. When prompted, enter a passcode of your choice that you will easily remember on the handheld.
7. Enter the same passcode on the office computer.
8. On the handheld, select the ***ActiveSync*** check box in the list of services provided by the computer and then tap **Finish**.

Note – *The checkbox on the handheld still shows* ***ActiveSync****, even if the office computer is running the Windows 7 or Windows Vista operating system and you are using the WMDC.*

You have now created a partnership between the GeoExplorer 6000 series handheld and the office computer so that they can communicate.

9. Tap **OK** to close the Bluetooth application.
10. Tap to close the *Settings* screen.
11. To connect, go to Step 2 below. Note that the check box on the handheld shows ***ActiveSync*** even if the office computer is running the Windows 7 or Windows Vista operating system and you are using the WMDC.

Step 2: Connecting to ActiveSync using Bluetooth wireless technology

1. On the GeoExplorer 6000 series handheld, tap / *ActiveSync*.

Note – *Only* ***ActiveSync*** *shows on the Windows Mobile device. Select* ***ActiveSync*** *even if you use the WMDC on the desktop computer.*

2. Tap **Menu** and then select *Connect via Bluetooth*.

   On the GeoExplorer handheld, a message box shows the status of the connection as it is made.

3. When the connection to the office computer is successful, you are returned to the ActiveSync application on the handheld.

4. Tap to close.

   The connectivity icon in the status bar shows , or if WLAN is connected.

   To check the status of the connection, tap the title bar and then tap the connectivity icon on the pull-down list.

   To disconnect, tap / *ActiveSync* on the handheld and then select *Menu* / *Disconnect*.

Outputting GNSS data to other devices using Bluetooth wireless technology

To provide GNSS positions from the GeoExplorer 6000 series handheld to another device using a Bluetooth wireless connection, you must:

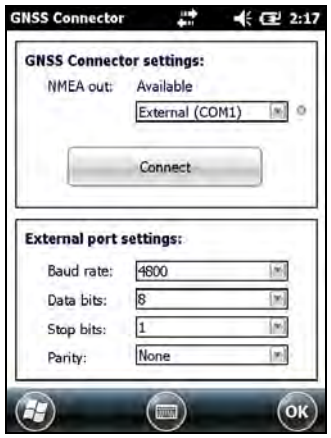
1. Connect the other device to the GeoExplorer 6000 series handheld.
2. Configure the handheld to output data to the other device. Make sure that the GNSS Connector software is installed on the handheld—see GNSS Connector software, page 63.
3. Configure the other device to receive data from the handheld.

Step 1: Connecting the other device to the GeoExplorer series handheld

1. Turn on the GeoExplorer 6000 series handheld's Bluetooth radio and make the handheld ***visible*** to other devices (see page 82).
2. On the other device, turn on the Bluetooth radio.
3. Use the Bluetooth management software on the other device to scan for other Bluetooth devices and then set up a serial port connection to the GeoExplorer 6000 series handheld.
4. If prompted to enter a passcode on the other device, enter a passcode of your choice that you will easily remember.
5. When prompted on the GeoExplorer 6000 series handheld, accept the connection to the other device.

6. Enter the same passcode on the GeoExplorer 6000 series handheld that you entered on the other device and then tap **Next** on the handheld.
7. On the handheld, tap **Finish**.

Step 2: Configuring the handheld to output data to the other device



1. On the GeoExplorer 6000 series handheld, tap *GNSS Connector* to open the GNSS Connector software.
2. Use the GNSS Connector software to output NMEA messages to ***COM9***. This is the GeoExplorer 6000 series handheld's Host Bluetooth serial port.
3. Use the Trimble GNSS field software to ensure NMEA output is set to *On*, to configure the NMEA output settings (output rate and messages), and to configure the GNSS settings.

CAUTION – NMEA standard dictates that a baud rate of 4800bps should be used for NMEA messages. Depending on the number of satellites being tracked (for example, if you are tracking GLONASS and GPS satellites) the amount of data being captured at once may often cause the 4800 bit limit to be exceeded.
Buffers have been added which allow the data to be stored and then sent when it is able to. This avoids data corruption, but may delay delivery of data, and positions may take as long as 8 seconds to be sent from the time at which they were originally recorded.
If you need 4800bps output, Trimble suggests that you try to minimise the effect by reducing the amount of NMEA data being sent, for example, by dropping out NMEA sentences from the NMEA stream.

Step 3: Configuring the other device to receive data from the handheld

1. On the other device, run the application that will use the data from the handheld.
2. Configure the application to connect to the COM port on the other device that you selected (or was assigned) when you created the serial port connection to the handheld.

Enabling other devices to transfer files using Bluetooth wireless technology

To transfer files to and from another device without connecting using ActiveSync technology or the WMDC, follow the general steps below:

Note – *The exact steps for transferring files will depend on the Bluetooth file management software that is installed on the other device.*

1. Turn on the GeoExplorer 6000 series handheld's Bluetooth radio and make the handheld ***visible*** to other devices (see page 82).
2. On the other device, turn on the Bluetooth radio.
3. On the other device, make sure that Bluetooth file transfer is enabled.
4. Use the Bluetooth management software on the other device to scan for devices and then set up a connection to the GeoExplorer 6000 series handheld.
5. Use the Bluetooth management software on the other device to locate the file and transfer it to the \My Documents folder on the handheld.

Beaming files to or from another device

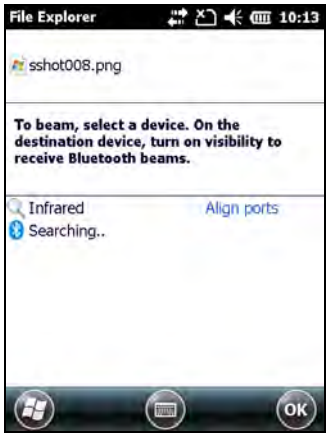
You can beam files, contacts, tasks, and appointments between the handheld and another device.

To ***receive*** beamed files from another device:

1. Make sure that the GeoExplorer 6000 series handheld's integrated Bluetooth radio is turned on (see page 82).
2. Tap / *Settings* / *Connections*/ *Beam*.
3. Select the *Receive all incoming beams* check box and then tap **OK**.
4. When another device attempts to beam a file, you are prompted to accept the file. To receive the file, tap **Yes**.

Note – *All incoming files are automatically saved in the My Documents folder on the handheld.*

To ***send*** beamed files to another device:



1. Make sure that the GeoExplorer 6000 series handheld's integrated Bluetooth radio is turned on (see page 82).
2. On the GeoExplorer 6000 series handheld, open File Explorer and go to the file you want to send.
3. Tap and hold the file and then select *Beam File*. The handheld scans for nearby devices.
4. Tap the device you want to send the file to. The file is sent to the device.

   A message reports Done or Failed, depending on the outcome of the file transfer.

Accessing a corporate network through your Internet connection

Use a Virtual Private Network (VPN) connection to access a corporate network or Intranet.

Before you begin, obtain the following information from your network administrator:

- user name and password
- domain name
- host name or IP address of the VPN server

To access a corporate network through your Internet connection, you must:

1. Set up an Internet connection on the handheld.
2. Set up a VPN connection.
3. Connect to the corporate network or Intranet.

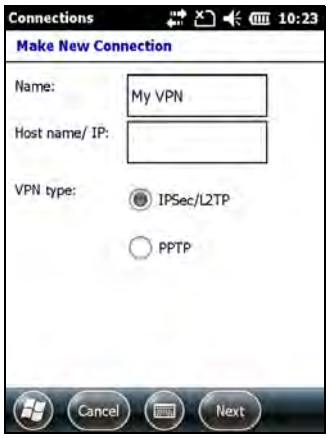
Step 1: Setting up an Internet connection on the handheld

Do one of the following:

- Set up a Wi-Fi connection to an access point. For more information, see page 85.
- Connect to the Internet using the internal cellular modem. For more information, see page 87
- Connect to the Internet using a Bluetooth-enabled phone. For more information, see page 94.

Step 2: Setting up a VPN connection

1. On the GeoExplorer 6000 series handheld, tap / *Settings* / *Connections* / *Connections*.
2. From the *My Work Network* list, tap *Add a new VPN server connection*.
3. Follow the instructions in the *Make New Connection* wizard.
4. Tap **Finish**.



Step 3: Connecting to the corporate network or Intranet

To connect to the corporate network or Intranet, simply start using Internet Explorer.

The Windows Mobile operating system automatically controls whether the VPN connection is used, depending on whether the URL contains a period. For example, the URL www.trimble.com contains periods, and so the connection to this web site is made without using the VPN connection. However, an address to a network computer or file server that does not contain periods automatically starts the VPN connection.

If you need to use the VPN connection to access URL addresses that contain periods, specify exceptions for the addresses that are within the corporate network. To do this:

1. Tap / *Settings* / *Connections* / *Connections*.
2. Tap the *Advanced* tab.
3. Tap **Exceptions**. The *Work URL Exceptions* screen appears.
4. Tap *Add new URL*.
5. Enter the URL and then tap **OK**.
6. Repeat Step 4 and Step 5 as required.
7. Tap **OK** to return to the *Advanced* tab of the *Connections* screen.
8. Tap **OK** to close the *Connections* screen.
9. Tap to close the *Settings* screen.

Connecting to other devices using the USB to serial converter

The optional USB to serial converter attaches to the USB port on the bottom of the handheld. When the USB to serial converter is attached, it adds a serial port (COM1) to the GeoExplorer 6000 series handheld.

You can use the USB to serial converter to:

- receive differential corrections from an external real-time correction source, such as a Trimble GeoBeacon receiver, or a DGPS radio (see Using real-time corrections from an external correction source, page 70)
- connect to other external devices, such as a laser rangefinder (see Using data from an external source in the TerraSync software, page 103, and select COM1 instead of a Bluetooth COM port)
- connect to a computer to supply GNSS data (see Outputting NMEA data to external equipment, page 76)

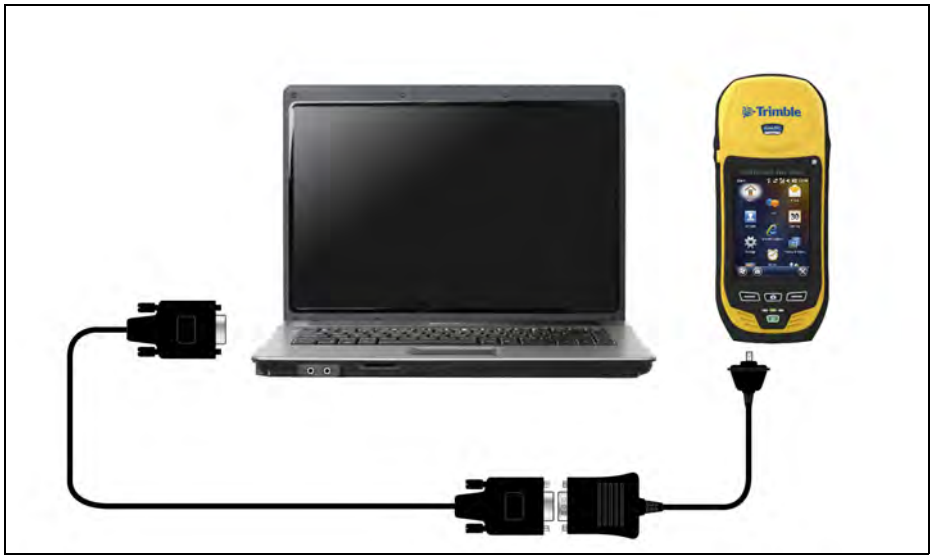
Connecting to external devices

You can use the USB to serial converter to connect to an external device that has a serial port, such as a computer.

Note – *When connecting to an office computer, you cannot use ActiveSync technology (or the WMDC) to establish the connection or synchronize data. To use ActiveSync (or the WMDC), you must use a USB cable or a Bluetooth connection (see* *Connecting the handheld to a computer, page 57**).*

To connect to an external device that has a serial port:

1. Attach the USB to serial converter to the handheld.
2. Plug the null modem cable into the serial (COM) port on the USB to serial converter.
3. Connect the other end of the cable to the serial port on the external device.



To connect to a serial device that does not have a standard 9-pin serial port, use a cable that has a DE9 connector on one end, and the appropriate connector for the other device on the other end. A suitable cable may be supplied with the external device.

CHAPTER

7

Using the Camera

In this chapter:

The GeoExplorer 6000 series handheld contains an integrated digital camera to capture photos or video.

Parts of the camera

Figure 7.1 GeoExplorer 6000 series camera controls

Use the **Camera** button to:

- Start the camera application
- Lock focus (press and hold the button)
- Capture photos (release the button)
- Start and stop recording a video (in *Video* mode, press the button)

Starting the camera application and capturing photos or video

To start the camera, do one of the following:

1. Press the **Camera** button in the center of the keypad.
2. Tap / *Pictures & Videos* / *Camera*.

When the camera application is started, it is by default in *Still* (photo) mode.

3. Do one of the following:

   a. To capture a photo:

   – Hold the handheld steady. Use the preview window to frame the subject in the centre of the frame.

   – To focus, press the **Camera** button down and hold. Focus and exposure are set and locked while the camera button is held in this position.

   – To capture the photo, release the **Camera** button and hold the camera steady until the review photo is shown.

   b. To capture a video:

   – Tap the menu **Menu** button and then select *Video*.

- Use the preview window to frame the start of the video.
- To start recording, press the **Camera** button and then release. Move the handheld to record the video.
- To pause recording, tap the **Pause** button. To stop recording, tap the **Stop** button or press the **Camera** button.

Note – *When the camera application displays the*  *icon, it is storing the photo or video file. Removing the battery or the memory card while recording may affect photos / videos or damage the memory card.*

To switch to *Still* mode from *Video* mode, tap the menu **Menu** button and then select *Still*.

Adjusting camera settings

To access the camera settings:

1. Start the camera application and then tap the **Menu** button.

   The available camera settings are displayed in a list.

2. Tap the required setting or change the current value. The list of available settings varies depending on whether you are in *Video* mode or *Still* mode.

Table 7.1 Camera settings

Mode	Setting	Options
Still & Video	Brightness	+3, +2, +1, 0*, -1, -2, -3
Video	Audio	On, Off
Video	Resolution	640x480, 320x240, 176x144
Still	Resolution	5MP, 3.2MP, 2MP, 1.3MP, 640x480, 320x240
Still & Video	Compression	Low quality, Medium quality, High quality
Still & Video	White Balance	Automatic*, Incandescent, Sunlight, Fluorescent
Still	DateStamp	On, Off
Still	Location	Off (no Geotagging), EXIF (Geotag in EXIF header of the file), WaterMark (Geotag on image), EXIF/WaterMark (both)
Still	Zoom	Varies according to resolution
Still & Video	Full Screen	Hides the tile bar
Still & Video	Options	Launches Camera and Video options

* = default setting

Note – *The larger the resolution, the larger the file size. Taking a photo with a larger resolution may take longer to capture; continue to hold the camera still until you see the photo review image (in Still mode) or until the preview screen reappears (in Video mode).*

Camera and Video options

To access the Camera options, tap  / *Pictures & Videos* / *Camera* / *Menu* / *Options*.

Use the camera options to customize where still photos and videos are stored, and to customize storage settings for still photos.

- Save files to: If you have a storage card installed you can choose to save photos in either the main memory of the device or to a folder on the storage card. Photos saved to the main memory are saved in the My Pictures folder.
- Still filename prefix: Use this option to give still photos a customized filename prefix.
- Video filename prefix: Use this option to give videos a customized filename prefix.
- Time limit for videos: To set the automatic time limit for videos, choose a suitable time limit from the list of options.

CHAPTER

8

Troubleshooting

In this chapter:

Use this section to identify and solve common problems that may occur when using the GeoExplorer 6000 series handheld. Please read this section before you contact technical support.

Power issues

Problem	Cause	Solution
The handheld does not turn on.	The battery is flat.	Recharge or swap the battery (see page 27 or page 29).
The screen is blank.	The handheld is turned off.	Press the **Power** button to turn on the handheld.
	The handheld has locked up.	Reset the handheld (see Resetting the handheld, page 33).
The handheld is not charging.	The internal temperature has risen above the allowed maximum (40 °C or 104 °F) for charging the battery.	Do one or all of the following: • Turn off the integrated radios before charging the handheld. • Suspend the handheld before charging. • Remove the handheld from any external heat sources (for example, sunlight). The handheld will automatically start charging again when the internal temperature has dropped below the range for charging the battery.
The battery power percentage bar does not appear in the Power control.	The battery has 0% power.	Recharge the battery (see page 25). Once the battery level is above 0%, the battery power percentage bar reappears. Tap / *Settings* / *System* / *Power* / *Battery* to view the level of power remaining in the battery.
Under some circumstances the AC adapter may be faintly audible at close proximity.	The AC adapter is a highly efficient Energy Star V adapter which is required to operate at very low audible duty cycles when unloaded so as not to waste energy.	There is no safety issue related to the faint noise. In the event of a disconcerting noise, disconnect the mains adapter from the mains as soon as a battery charge is complete.
The charge level of the battery drops when the handheld is turned off.	The handheld was left in Suspend mode or was left fully charged for a long duration.	Before storing the handheld, completely shut down the handheld (see Turning on and turning off the handheld, page 31). Then store the handheld as recommended (see Storing the handheld, page 20).
	The handheld was left in suspend mode with a wireless radio turned on.	Before suspending the handheld, use the Wireless Manager to turn off all wireless radios. Make sure that all the radios are turned off after suspending the handheld. If a radio is still active,the Wireless LED will flash once every four seconds.

Backlight issues

Problem	Cause	Solution
The backlight does not come on when you tap the screen or press a button.	The backlight is not set to turn on in the Backlight control.	Tap / *Settings* / *System* / *Backlight* to view the Backlight control, and make sure that: • the *Turn on backlight when a button is pressed or the screen is tapped* check box is selected. • the brightness is not set to *Dark* in the *Brightness* tab.
The screen is blank or hard to see.	The backlight is off.	Tap the screen or press a button.
	The backlight level needs to be adjusted.	Tap / *Settings* / *System* / *Backlight* to view the Backlight control and then adjust the slider in the *Brightness* tab.

Touch screen issues

Problem	Cause	Solution
The touch screen does not respond to finger or stylus taps.	The touch screen is incorrectly aligned.	Realign the screen (see page 50).
	The touch screen is locked.	To unlock the touch screen, slide the **Unlock** icon.
	The handheld has locked up.	Reset the handheld (see Resetting the handheld, page 33).
The screen is blank.	The handheld is turned off.	Press the **Power** button to turn on the handheld.
	The battery is flat.	Recharge or swap the battery (see page 27 or page 29).
	The handheld has locked up.	Reset the handheld (see Resetting the handheld, page 33).
The screen is hard to see.	The backlight level needs to be adjusted.	Open the Backlight control and then adjust the backlight level (see Backlight, page 51).
	The backlight is off.	Tap the screen to turn on the backlight.
	You are unable to see parts of an application windows when the screen is in landscape orientation.	Some applications are designed for portrait orientation only. To view the entire application window, change the screen display to portrait. See Screen, page 50
	The selected display theme does not have enough contrast.	Select the High-Contrast display theme. Tap / *Settings* / *Personal* / *Home*, select the High-Contrast theme and then tap **OK**.

Storage card issues

Problem	Cause	Solution
The handheld does not recognize a storage card.	The handheld does not support SDIO (SD input/output) cards.	Use an SD or SDHC card.
Files on the storage card are not visible or are not able to be opened.	Files have been encrypted on another device and have a .menc file extension.	Remove encryption from the files (see Encrypting files on storage cards, page 36).

Keypad issues

Problem	Cause	Solution
Pressing the application key does not activate the function shown on the tile above it.	The hardware application key has been programmed to run another program or to perform another action.	Do one of the following: • Tap the touchscreen tile to activate the function shown on the tile. • Re-program the application key to perform the same action as the touchscreen tile. To do this, tap / *Settings* / *Personal* / *Buttons*, select the button to reprogram and then select <Left Softkey> or <Right Softkey>.

Connection issues

ActiveSync technology

Problem	Cause	Solution
ActiveSync technology will not connect to the handheld.	The connection is not initiated automatically.	In the ActiveSync technology dialog on the office computer, select *File* / *Connection Settings* and then tap **Connect**.
	ActiveSync does not recognize the GeoExplorer 6000 series handheld.	Disconnect the handheld from the office computer. Restart the office computer. Reset the handheld (see Resetting the handheld, page 33) and then reconnect the handheld to the office computer.
	An incompatible version of ActiveSync technology is installed.	ActiveSync version 4.5 and later is compatible with the GeoExplorer 6000 series handheld. If version 4.5 or later of the ActiveSync software is not installed on the office computer, you can install it from the *GeoExplorer 6000 series Getting Started Disc*.You can also download the latest version from the Microsoft website at www.microsoft.com/windowsmobile/activesync/default.mspx.
	The connection is not enabled in ActiveSync on the computer.	In the ActiveSync technology dialog on the office computer, click *File* / *Connection Settings*. If you are using: • a USB cable, make sure that the *Allow USB connections* check box is selected from the drop-down list. • a Bluetooth connection, make sure that the correct port for Bluetooth is selected. Then open the Bluetooth control on the handheld. In the *Devices* tab, tap the partnership and in the services list make sure that the *ActiveSync* check box is selected.
	The connection is not enabled in ActiveSync on the handheld.	On the handheld, tap / *ActiveSync* / *Menu* / *Connections*. Make sure that the *Synchronize all PCs using this connection* check box is selected, and that the correct option is selected.
	The handheld connection settings conflict with network settings or VPN client software.	If you are using a USB cable, use the USB to PC utility to change the connection method the handheld uses to connect to ActiveSync on the computer. Tap / *Settings* / *Connections* / *USB to PC Utility*. Clear the *Enable advanced network functionality* check box. The handheld stops using the default RNDIS method to connect to the ActiveSync technology.

Windows Mobile Device Center

Problem	Cause	Solution
Windows Mobile Device Center will not connect to the handheld.	The connection is not initiated automatically.	In the Windows Mobile Device Center software on the office computer, select *Mobile Device Settings* / *Connection Settings*.
	The Windows Mobile Device Center software does not recognize the GeoExplorer 6000 series handheld.	Restart the office computer. Disconnect the handheld from the office computer, reset it (see Resetting the handheld, page 33) and then reconnect it to the office computer.
	The connection is not enabled in Windows Mobile Device Center on the computer.	In the Windows Mobile Device Center software on the office computer, click *Mobile Device Settings* / *Connection Settings*. If you are using: • a USB cable, make sure that the *Allow USB connection* check box is selected from the drop-down list. • a Bluetooth connection, make sure that the correct port for Bluetooth is selected. Then open the Bluetooth control on the handheld. In the *Devices* tab, tap the partnership and in the services list make sure that the *ActiveSync* check box is selected.
	The connection is not enabled on the handheld.	On the handheld, tap  / *ActiveSync* / *Menu* / *Connections*. Make sure that the *Synchronize all PCs using this connection* check box is selected, and that the correct option is selected.
	The handheld connection settings conflict with network settings or VPN client software.	If you are using a USB cable, use the USB to PC utility to change the connection method the handheld uses to connect to the Windows Mobile Device Center on the computer. Tap  / *Settings* / *Connections* / *USB to PC Utility*. Clear the *Enable advanced network functionality* check box. The handheld stops using the default RNDIS method to connect to the Windows Mobile Device Center.

Network connections

Problem	Cause	Solution
The connection with the cellular phone suddenly ends.	If you change the proxy settings of the handheld while connected to a cellular phone, the cellular phone ends the connection.	Make any changes to proxy settings before connecting to a mobile device.
Unable to connect to another GeoExplorer 6000 series handheld.	Data encryption settings are set incorrectly.	When setting up a peer-to-peer ad-hoc network with a WEP encryption, set a Network Key, rather than leaving the key blank to be provided automatically.

Bluetooth wireless technology

Problem	Cause	Solution
The handheld cannot discover a nearby Bluetooth device.	The integrated Bluetooth radio is not activated.	The handheld's Bluetooth radio has been deactivated. If Bluetooth wireless technology is allowed where you are working, use the Radio Activation Manager software to re-activate the radio (see Deactivating the integrated Wi-Fi and Bluetooth radios, page 9).
	The device is out of range.	Move the devices closer to each other and then scan again.
	Bluetooth wireless technology is not enabled on one or both devices.	Make sure that the Bluetooth radio is turned on, on both the handheld (see page 82) and the other Bluetooth device.
	The device has not been made Discoverable.	Make sure that the Bluetooth device has been made Discoverable.
The COM port that you assigned to a serial port service is not available in your application.	The application cannot recognize ports if they are added after the application opens.	Exit from the application, add the port and then run the application again.
The Bluetooth connection fails while in use.	The Bluetooth device has moved out of range.	Move the devices closer to each other. The devices should reconnect automatically. If they do not, select the Bluetooth device in the *Devices* tab. Tap and hold the device name and then select *Delete*. Tap *New* to discover the device again.
	The Bluetooth radio has lost the connection.	Turn off the Bluetooth radio on the handheld and then turn on the Bluetooth radio (see page 82).
	Bluetooth file transfer interrupts the connection.	When you transfer large image or data files, other Bluetooth connections may stop responding. To avoid problems, close other Bluetooth connections before transferring large files.
An error message reports "Problem with Bluetooth Hardware".	The integrated Bluetooth radio may have been deactivated.	Use the Radio Activation Manager to reactivate the Bluetooth radio (see Deactivating the integrated Wi-Fi and Bluetooth radios, page 9).

Wi-Fi connections

Problem	Cause	Solution
The "New Network Detected" notification does not appear automatically.	The Wi-Fi radio is off.	Tap the wireless icon in the *Home* screen or go to the Wireless Manager and make sure Wi-Fi is on.
	The handheld is out of range of the network.	Move to within range of the network, then tap / *Settings* /*Connections* /*Network Cards* and then set up the connection.
The handheld cannot connect to a secure site.	The date on the handheld is incorrect.	Check that the handheld has the date set correctly on the *Home* screen. If the date is incorrect, tap the clock icon on the *Home* screen and then adjust the date and time.
You cannot configure an Internet connection.		
Within range of more than one network, you are not connecting to the network you would prefer to use.	The radio is connecting to the first network signal it has received.	Tap / *Settings* /*Connections* /*Network Cards*. Tap and hold the network you would prefer to use and then select *Connect*.
The "New Network Detected" notification appears but the tile bar and tile options are not displayed.	Some applications are not fully compatible with all features of the Windows Mobile 6.5 operating system.	Use the application buttons on the keypad, as they map to the tiles in the tile bar: • To dismiss the notification, press the right application button on the keypad. • To connect to the network, press the left application button. Alternatively, select a Windows Mobile application from the *Start* screen, such as the *Home* screen or File Explorer, and the tile bar and soft keys will be displayed correctly.
Wi-Fi is unavailable in the Wireless Manager.	The integrated Wi-Fi radio has been deactivated.	Use the Radio Activation Manager to reactivate the Wi-Fi radio (see Deactivating the integrated Wi-Fi and Bluetooth radios, page 9).

Internal cellular modem connections

Problem	Cause	Solution
Can't download data.	Your account has no remaining credit.	Contact your cellular provider to ensure that your account has sufficient credit.
Can't connect.	The phone is turned off.	Turn on the phone using the Wireless Manager.
	The connection is incorrectly configured.	Check your APN and connection settings with your provider.
	Cellular service is unavailable.	Check that the phone is within range of receiving strong enough signals to connect. Move to a location with stronger cellular reception. Check with your cellular provider that coverage is available in your region.
Can't set up a connection.	SIM card is missing.	Insert SIM card.
	SIM card is locked.	Check the PIN security: tap / *Settings* / *Personal* / *Phone,* and select the Security tab.
	3G/GSM selection is incorrect for your cellular provider.	Check your settings: tap / *Settings* / *Personal* / *Phone,* and select the 3G tab. Set the 3G/GSM Selection to Auto.

GNSS receiver issues

Problem	Cause	Solution
The handheld is not receiving GNSS positions.	The integrated GNSS receiver is not activated.	Use the Connect or Activate GNSS/GPS command in the field software to open the GNSS COM port and activate the integrated GNSS receiver. For more information, see Using the GNSS Receiver, page 61.
	Incorrect configuration of serial COM port.	When supplying GNSS data to an external device using the COM1 USB to serial converter cable, set the baud rate to the high-speed TSIP setting: 38400, 8, 1, Odd.
	The GNSS COM port is already in use. Only one application at a time can have the port open.	Do the following • Exit the software that is using the GNSS COM port and then retry in your application. • Check that a GNSS application is not running in the background. Tap / Task Manager and then select and close (click **End Task**) any GNSS applications you are not using. • Make sure that connections are not left in use by the GNSS Connector software; close the application when you are not using the connections.
	The GNSS field software is using the wrong GNSS COM port.	Connect to COM2 if the GNSS field software uses NMEA messages, or COM3 for TSIP messages. For information on which protocol to use, check the documentation for the application.
	Not enough satellites are visible.	Move to a location where the receiver has a clear view of the sky and ensure the antenna is not obstructed. Alternatively, adjust the GNSS settings to increase productivity. For more information, refer to the Help provided with the GNSS field software. If you are using Trimble field software, use smart settings. See Using Smart Settings, page 71.
	The DOP (Dilution of Precision) value for the current position is above the maximum DOP setting.	Wait until the DOP value falls below the maximum DOP specified. Alternatively, adjust the GNSS settings to increase productivity. For more information, refer to the Help provided with the GNSS field software. If you are using Trimble field software, use smart settings. See Using Smart Settings, page 71
	Wait for real-time is selected in the GNSS field software and the integrated receiver is waiting to receive real-time corrections.	If you are collecting data for postprocessing, clear the wait for real-time selection. Check that the real-time correction source is setup correctly (see Connecting to a real-time differential correction source, page 69).
	External antenna connected but not receiving data.	The handheld can take up to two seconds to detect that an external antenna has been connected or disconnected.
NMEA data includes autonomous positions.	The integrated GNSS receiver outputs autonomous positions when real-time corrections are unavailable.	Configure the NMEA application to filter out non-DGNSS positions.

Problem	Cause	Solution
The GNSS Connector utility reports "Unknown".	The GNSS Connector software may report "Unknown" on COM3.	This should not interfere with operation of the handheld.
Error Code 5 appears.	A receiver timeout error has occurred, caused by issues with communications to the receiver, or when the receiver has taken too long to reconnect.	Close the dialog and if the handheld does not automatically connect to the receiver, try to connect to the receiver again. If repeated attempts to connect to the receiver fail, contact your Trimble reseller.

Real-time DGNSS issues

Problem	Cause	Solution
The handheld is not receiving SBAS real-time corrections	The SBAS satellite is obstructed from view.	Check the location of the SBAS satellite in the Skyplot section of the GNSS field software, and if possible move to a different location.
	You are outside the WAAS, EGNOS, or MSAS coverage area.	Wide Area Augmentation System (WAAS) satellites are tracked in the Continental United States including Alaska, and in southern parts of Canada. European Geostationary Navigation Overlay Service (EGNOS) satellites are tracked in Europe. MTSAT Satellite-based Augmentation System (MSAS) satellites are tracked in Japan. If you have selected satellites that are not available at your location, you cannot use SBAS corrections.
The handheld is not able to track a new or a specific SBAS satellite	You are not using the latest SBAS configuration (.ini) file.	1. To download the software, go to www.trimble.com/support.shtml, click the link for your receiver type (*GeoXH*, or *GeoXT*), click *Downloads*, click *GeoExplorer 6000 Series* and then click *SBAS.INI*. 2. To specify the satellites you want the receiver to track or to ignore, select the Custom option in the *Tracking Mode* field in the *Integrated SBAS Settings* form of the Trimble GNSS field software.
The handheld is not receiving real-time corrections from the external real-time correction source	There is no physical connection to the external source.	Connect the external real-time correction source to COM1 using the optional USB to serial converter, or to a Bluetooth port on the handheld.
	There is no Bluetooth wireless connection to the external source.	The Bluetooth external correction source is more than ten meters from the handheld, or is obstructed. Move the devices closer together, in a direct line of sight, to re-connect.
	The external source is incorrectly connected to the real-time COM port.	In the Real-time Settings section of the GNSS field software, select the COM port that the real-time source is connected to.
	The port settings are incorrect.	Change the port settings to match those used by the external source.
	No GNSS positions are available.	You cannot use real-time corrections until the GNSS receiver is computing positions. In the GNSS field software, make sure that the integrated GNSS receiver is activated, enough satellites are available, and that the satellite geometry (PDOP) is good enough to compute positions.
	Integrated SBAS is selected as the second choice source of real-time corrections.	If the SBAS status is Waiting, the integrated GNSS receiver may incorrectly change the status of the preferred real-time choice to Waiting as well. To avoid this, select Wait for real-time or Use uncorrected GNSS as your second choice.

Recommended GNSS settings for maximum precision and productivity

The following table lists some of the factors that affect the precision of your data, and describes how to minimize the effect of atmospheric interference and poor satellite geometry.

Factor	Description	To maximize precision and productivity
Satellite shadow	Satellite shadow is when the line of sight between the GNSS receiver and satellites is partially or fully blocked by obstructions such as buildings, trees, or land masses. The effect of satellite shadow is a reduction in the number of satellites that the receiver is able to track. In general, the quality of your data increases with the number of satellites being used to calculate the position.	Tracking more satellites can help to improve satellite geometry and thereby improve accuracy. Activate the Floodlight satellite shadow reduction technology option. See Activating the Floodlight technology and the NMEA output options, page 74. Ensure the integrated GNSS receiver gets a clear view of the sky as possible. Keep your body mass as far from the receiver as practical and do not crowd over the handheld. Use an external antenna if needed to elevate the position of the antenna.
Multipath	Multipath is when GNSS satellite signals are reflected off nearby objects, such as buildings or cars, causing an erroneous signal to be received by the GNSS antenna. This can cause errors of several meters.	To reduce multipath, where possible collect data in an open environment away from large reflective surfaces and with a clear view of the sky. Activate the Floodlight technology option on your handheld to increase the total number of satellites visible to the receiver, and reduce the risk of multipath affecting your solution. See Activating the Floodlight technology and the NMEA output options, page 74
Weak satellite signals	Signal-to-Noise Ratio (SNR) is a measure of the strength of the satellite signal relative to the background noise. GNSS quality degrades as the signal strength decreases. Weak signals may be caused by signals coming through vegetation, multipath signals, or low satellite elevation.	Use smart settings with Trimble field software to allow the receiver to determine maximum precision positions regardless of available satellite signal strength. See Using Smart Settings, page 71. Activate the Floodlight technology option on your handheld to increase the total number of satellites visible to the receiver, and reduce the risk of weak satellite signal affecting your solution. See Activating the Floodlight technology and the NMEA output options, page 74.
Poor satellite geometry	Dilution of Precision (DOP) is a measure of the quality of GNSS positions, based on the spread (geometry) of the satellites in the sky that are used to compute the positions. When satellites are widely spaced relative to each other, the DOP value is lower, and in general position accuracy is greater. If the view of the sky is partially affected by satellite shadow, or if all of the satellites are in one area of the sky, the geometry and DOP may be poor.	Use smart settings with Trimble field software to allow the receiver to determine maximum precision positions regardless of available satellite geometry. See Using Smart Settings, page 71. Activate the Floodlight technology option on your handheld to increase the total number of satellites that the receiver can track, and reduce the risk of poor satellite geometry affecting your solution. See Activating the Floodlight technology and the NMEA output options, page 74.

Factor	Description	To maximize precision and productivity
Satellite elevation	When a satellite is low on the horizon, satellite signals must travel farther through the atmosphere. This results in a lower signal strength and delayed reception by the GNSS receiver, which can cause errors in calculating the position.	Use smart settings with Trimble field software to allow the receiver to determine maximum precision positions regardless of available satellite elevation. See Using Smart Settings, page 71. Activate the Floodlight technolgy option on your handheld to increase the total number of satellites that the receiver can track, and the likelihood of being able to track more satellites at higher elevation. See Activating the Floodlight technology and the NMEA output options, page 74.
Occupation time at a point	Occupation time is the time spent at a point logging GNSS positions.	For point features, remain at the feature and log a number of GNSS positions to obtain an averaged position. When collecting line and area features, collect them using averaged vertices.

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10355 Westmoor Drive
Suite #100
Westminster, CO 80021
USA

EUROPE & AFRICA
Trimble Germany GmbH
Am Prime Parc 11
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GERMANY

ASIA-PACIFIC & MIDDLE EAST
Trimble Navigation
Singapore PTE Limited
80 Marine Parade Road
#22-06 Parkway Parade
Singapore, 449269
SINGAPORE

www.trimble.com

ATTACHMENT C

FIELD DATA COLLECTION FORMS

- Test Equipment Calibration Log
- Well Gauging Data Form
- Low Flow Monitoring Data Sheet
- Well Monitoring Data Sheet
- Westbay™ Groundwater Monitoring Well Water Level Measurement Log Sheet
- Westbay™ Groundwater Monitoring Well Field Data Log Sheet
- Wellhead Inspection Checklist
- APPL Chain of Custody Form

TEST EQUIPMENT CALIBRATION LOG

PROJECT NAME				**PROJECT NUMBER**			
EQUIPMENT NAME	EQUIPMENT NUMBER	DATE/TIME OF TEST	STANDARDS USED	EQUIPMENT READING	CALIBRATED TO: OR WITHIN 10%:	TEMP.	INITIALS

WELL GAUGING DATA

Project # _____ Date _____ Client _____

Site _____

Well ID	Well Size (in.)	Time Gauged	Sheen / Odor	Depth to Immiscible Liquid (ft.)	Thickness of Immiscible Liquid (ft.)	Volume of Immiscibles Removed (ml)	Depth to water (ft.)	Depth to well bottom (ft.)	Survey Point: TOB or TOC

LOW FLOW WELL MONITORING DATA SHEET

Project #:	Client:
Sampler:	Gauging Date:
Well I.D.:	Well Diameter (in.) : 2 3 4 6 8 ____
Total Well Depth (ft.) :	Depth to Water (ft.) :
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: PVC Grade	Flow Cell Type:_____

Purge Method: 2" Grundfos Pump Peristaltic Pump Bladder Pump
Sampling Method: Dedicated Tubing New Tubing Other_____

Start Purge Time:_____ Flow Rate: _____ Pump Depth:_____

Time	Temp. (^{o}C or ^{o}F)	pH	Cond. (mS/cm or µS/cm)	Turbidity (NTUs)	D.O. (mg/L)	ORP (mV)	Water Removed (gals. or mL)	Depth to Water (ft.)

Did well dewater? Yes No	Amount actually evacuated:
Sampling Time:	Sampling Date:
Sample I.D.:	Laboratory:
Analyzed for: TPH-G BTEX MTBE TPH-D	Other:
Equipment Blank I.D.: @ Time	Duplicate I.D.:

WELL MONITORING DATA SHEET

Project #:	Site:
Sampler:	Date:
Well I.D.:	Well Diameter: 2 3 4 6 8 ____
Total Well Depth (TD):	Depth to Water (DTW):
Depth to Free Product:	Thickness of Free Product (feet):
Referenced to: PVC Grade	Flow Cell Type **YSI**
DTW with 80% Recharge [(Height of Water Column x 0.20) + DTW]:	

Purge Method: Bailer, Disposable Bailer, Positive Air Displacement, Electric Submersible, Waterra, 2" Rediflo pump, Extraction Pump, Other_____

Sampling Method: Bailer, Disposable Bailer, Extraction Port, Dedicated Tubing, Other: _____

Flow Rate=_____

_____(Gals.) X _____ = _____Gals.
1 Case Volume Specified Volumes Calculated Volume

Well Diameter	Multiplier	Well Diameter	Multiplier
1"	0.04	4"	0.65
2"	0.16	6"	1.47
3"	0.37	Other	radius² * 0.163

Time	Temp (°F or °C)	pH	Cond. (mS or µS)	Turbidity (NTUs)	D.O. (mg/L)	ORP (mV)	Gals. Removed	Observations

Did well dewater?	Yes	No	Gallons actually evacuated:		
Sampling Date:		Sampling Time:		Depth to Water:	
Sample I.D.:			Laboratory:		
Analyzed for:				Other:	
EB I.D. (if applicable):	@ Time		Duplicate I.D. (if applicable):		
FB I.D. (if applicable):	@ Time		Analyzed for:		
D.O. (if req'd):	Pre-purge:	mg/L	Post-purge:		mg/L
O.R.P. (if req'd):	Pre-purge:	mV	Post-purge:		mV

WESTBAY™ GROUNDWATER MONITORING WELL
WATER LEVEL MEASUREMENT LOG SHEET

WELL ID: PROBE TYPE

DATE: SERIAL NO.

LOCATION: PROJECT

ELEV. TOP OF WASTBAY CASING OPERATOR(S)

WEATHER: ATM. PRESSURE (Patm): (start) (finish)

Port No.	Depth to Meas. Port Valve (ft)		Pressure Readings (psi)				Pressure Head Outside Port (ft) P(ft)=(P2-Patm)*2.307 ft/psi)	Depth to Water Outside Port (ft) DTW = Dp-P(ft)	True Port Depth (Dp) (ft)	Time
	From Log (Dp)	From Cable	psi Inside Casing	kg/cm^2 Outside Casing P2	mH^2O Inside Casing	Trans. Temp. (oC)				

Comments:

WESTBAY™ GROUNDWATER MONITORING WELL
FIELD DATA LOG SHEET

WELL ID:

PROBE TYPE

SAMPLING DATE(S)

SERIAL NO.

LOCATION:

PROJECT:

WATER LEVEL INSIDE CASING:

OPERATOR(S)

ATM. PRESSURE (PSI): (Start) (Finish)

WEATHER

Port Number	Run Number	Probe to Top Collar	Surface Function Tests / Position Sampler (probe in top of collar) / (lower probe to port)				Sample Collection Checks (probe at sampling port in MP casing)							Field Parameters					Sample	
		Arm out / Land Probe	Shoe Out/ Close Valve/ Check Vacuum	Open Valve/ Apply Vacuum (5 psi)	Close Valve/ Shoe In/ Arm In	Locate Port/ Arm Out/ Land Probe	Pressure in MP Casing (psi)	Shoe Out	Port Pressure (psi)	Open Valve	Port Pressure (psi)	Close Valve/ Shoe In	Pressure in MP Casing (psi)	Sample Temp (^{0}C)	SC (µS/cm)	pH	Turbidity (NTU)	Dissolved Oxygen (ppm)	Sample Time	Sample ID

Comments:

WELLHEAD INSPECTION CHECKLIST

Client _____ Date _____

Site Address _____

Job Number _____ Technician _____

Well ID	Well Inspected - No Corrective Action Required	WELL IS SECURABLE BY DESIGN (12"or less)	WELL IS CLEARLY MARKED WITH THE WORDS "MONITORING WELL" (12"or less)	Water Bailed From Wellbox	Wellbox Components Cleaned	Cap Replaced	Lock Replaced	Other Action Taken (explain below)	Well Not Inspected (explain below)	Repair Order Submitted

NOTES: _____

ELECTRONIC CHAIN OF CUSTODY RECORD

APPL, Inc. Phone: (559) 275-2175

908 N Temperance Ave Fax: (559) 275-4422 Clovis, CA 93611 C.O.C.

Report to: PLEASE PRINT	Invoice to: PLEASE PRINT
Company Name: _____ Phone: _____ Address: _____	Company Name: _____ Phone: _____ Address: _____
Fax: _____	Fax: _____
Attn: _____	Attn: _____

Project Name/Number	Sampler (Print)									Analysis Requested/Method Number												Date Shipped:
Purchase Order Number	Sampler (Signature)					Matrix																Carrier:
																						Waybill No.:
																						Comments:
Sample Identification	Location	Date Collected	Time Collected	Time Zone	No. of Containers	Aq	Sed.	Soil														

Shuttle Temperature:	Turnaround Requested: Check one Standard 2-3 wk One week 24/48 Hrs. Other			Sample Disposal: Return to client Disposal by Lab (30-day retention)			
Relinquished by sampler:	Date	Time	Received by:	Relinquished by:	Date	Time	Received by:
Relinquished by:	Date	Time	Received by:	Relinquished by:	Date	Time	Received at lab by:

White: Return to client with report Yellow: Laboratory Copy Pink: Sampler

Note: The first sampled date of the ARF will be used as the COC number unless indicated otherwise.

	Types of Samples	**Types of Preservatives**		**Requested Information:**
		Keep all Samples on Ice		The person responsible for sampling should fill out the section pertaining to the sampler. For each sampling event, the date and time of the sampling should be recorded in the space provided. If there are any additions or changes to the test descriptions indicated, please make the appropriate modifications on this form. The sampler should SIGN and DATE the Chain of Custody prior to the samples being relinquished to the transporter. A responsible party at the sampling site should retain the FIELD copy. The remaining Chain of Custody should be returned to APPL labs with the samples.
	Liquids	$H2SO_4$	Sulfuric Acid	
		HCI	Hydrochloric Acid	
DW	Drinking Water	NaOH	Sodium Hydroxide	
GW	Ground Water	Na_2SO_3	Sodium Thiosulfate	
MW	Monitoring Water	HNO_3	Nitric Acid	
SW	Surface Water		Zinc Acetate	
TB	Travel Blank			
WW	Waste Water	**Types of Containers**		
	Solids	A	Amber Glass	
		C	Clear Glass	
S	Soil	B	Brass Tube	
SLD	Solid	M	Metal Tube	
SL	Sludge	P	Plastic	
Oil	Oil	G	Bag	
M	Miscellaneous	AV	Amber Glass VOA	
W	Wipes	GV	Glass VOA	
SED	Sediment	O	Other _____	

ATTACHMENT D

NOTIFICATION LEVELS

•PFBS Notification Level Issuance (March 5, 2021)
•PFOA Notification Level Issuance (February 12, 2020)
•PFOS Notification Level Issuance (February 14, 2020)

NOTIFICATION LEVEL ISSUANCE

Contaminant(s):	perfluorobutane sulfonic acid (PFBS)
Notification Level:	0.0005 milligrams per liter
Response Level:	single or confirmed sample of 0.005 milligrams per liter (see finding 8)
Analytical Method:	EPA Method 537.1 or EPA Method 533
Toxicological Endpoint:	reduction of the thyroid hormone, thyroxine (T4), in pregnant female mice

FINDINGS:

1. Health and Safety Code section 116455 provides the State Water Resources Control Board (State Water Board) with the authority to issue notification and response levels for contaminants in drinking water delivered for human consumption before a maximum contaminant level has been set. Pursuant to subdivision (k)(2) of section 116271 of the Health and Safety Code, the Deputy Director of the Division of Drinking Water (DDW) is delegated the State Water Board's authority to issue notification and response levels.
2. Notification levels are nonregulatory, health-based advisory levels for contaminants that are established as precautionary measures for contaminants.
3. Response levels are established in conjunction with notification levels and represent the concentration of a drinking water contaminant at which additional steps, beyond notification, are recommended to reduce public exposure. For contaminants with non-cancer health risks, a level 10 times the toxicological endpoint is consistent with an acceptable margin of safety.
4. The establishment of notification and response levels does not require public water systems to monitor for the contaminant, except when water systems are subject to the recycled water regulations. Some water systems, however, will sample for constituents in addition to those contaminants for which there are MCLs, and if those monitoring results indicate that a notification level has been exceeded, the water system must comply with Health and Safety Code section 116455. In addition to those requirements, DDW recommends that a public water system inform its customers and consumers about the presence of the contaminant and any health concerns associated with exposure.
5. Since the early 1980s, notification levels (known as "action levels" through 2004) for 96 contaminants have been established. Of those, 40 have gone through the formal

regulatory process and now have MCLs and 24 chemicals have archived advisory levels. Currently there are 32 chemicals with notification levels. For more information: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/NotificationLevels.html

6. PFBS is a member of a large class of chemicals known as per- and polyfluoroalkyl substances (PFAS). The contamination of drinking water with PFAS has become an increasing concern due to the tendency of PFAS to accumulate in groundwater. PFBS is a four-carbon fluorocarbon with a functional group that acts as anionic surfactant that can be used in numerous commercial products to offer water- and stain-repellent properties. PFBS was developed and manufactured to replace toxic eight-carbon chain perfluorooctane sulfonate (PFOS).

7. Health and Safety Code section 116378 requires community water systems and nontransient noncommunity public water systems, when ordered to monitor, and where detected levels of perfluoroalkyl substances and polyfluoroalkyl substances exceed their notifications to provide public notification, or where they exceed response levels, to take the affected water sources out of use or provide public notification within 30 days of the confirmed detection.

8. Exceedance of the PFBS response level is determined by either a single sample or a confirmed sample. If laboratory analysis detects the presence of constituent in any sample above the response level, the water system will have an option to conduct a confirmation sample within 30 days of being notified of the result by the laboratory. If a confirmation sample is collected and analyzed, all results will be averaged within that quarter to determine if the confirmed detection is greater than the response level.

9. In February 2020, DDW requested that the Office of Health Hazard and Assessment (OEHHA) prepare a recommendation for a notification level for PFBS.

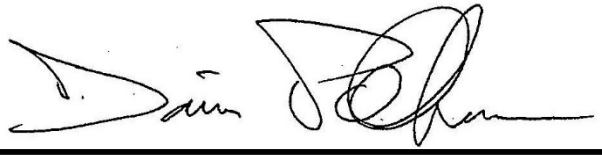
10. In January 2021, OEHHA provided a recommended notification level for PFBS in drinking water based on thyroid hormone reduction in pregnant mice. The level of 0.5 µg/L (microgram/liter) or parts per billion (ppb) represents the concentration of PFBS in drinking water that would not pose any significant health risk.

11. In accordance with section 116456 of the Health and Safety Code, DDW posted the proposed notification and response levels for PFBS on its website, along with OEHHA's recommendation and links to studies relied upon. DDW provided notice of the proposed notification and response levels, with supporting documentation, via email on January 29, 2021.

12. On March 2, 2021, DDW presented the proposed notification level of 0.5 ppb and a response level of 5 ppb for PFBS as an informational item during the regularly noticed meeting of the State Water Board.

Therefore, the Deputy Director of DDW establishes a PFBS notification level of 0.5 ppb and response level of 5 ppb.

Approved:



3/5/2021

Darrin Polhemus, P.E.
Deputy Director, Division of Drinking Water
State Water Resources Control Board

Date

NOTIFICATION LEVEL ISSUANCE

Contaminant(s):	perfluorooctanoic acid (PFOA)
Notification Level:	0.0000051 milligrams per liter
Response Level:	Calculated four-quarter running average of 0.000010 milligrams per liter (see finding 10.)
Analytical Method:	EPA Method 537.1
Toxicological Endpoint:	Pancreatic and liver tumors in male rats

FINDINGS:

1. Health and Safety Code section 116455 provides the State Water Resources Control Board's Division of Drinking Water (DDW) the authority to issue notification levels for contaminants in drinking water delivered for human consumption before a maximum contaminant level has been set.

2. Notification levels are nonregulatory, health-based advisory levels for contaminants that are established as precautionary measures for contaminants.

3. The establishment of a notification level does not require public water systems to monitor for the contaminant, except when water systems are subject to the recycled water regulations. Some water systems, however, will sample for constituents in addition to those contaminants for which there are MCLs, and if those monitoring results indicate that a notification level has been exceeded, the water system must comply with the statute's notification requirements.

4. The contamination of drinking water with perfluoroalkyl substances (PFASs) has become an increasing concern due to the tendency of PFASs to accumulate in groundwater. These manmade compounds have been used extensively in consumer products such as carpets, clothing, fabrics for furniture, paper packaging for food, and other materials *(e.g.*, cookware) designed to be waterproof, stain-resistant, or non-stick. In addition, they have been used in fire-retarding foam and in various industrial processes.

5. In August 2019, the Office of Health Hazard and Assessment (OEHHA) developed PFOA reference levels in drinking water associated with pancreatic and liver tumors. The level of 0.1 ng/L (nanogram/liter) or parts per trillion (ppt) represents the concentration of PFOA in drinking water that would not pose more than a one in one million cancer risk.

6. On August 22, 2019, DDW established a notification of 5.1 parts per trillion (ppt)

and a response level of 70 ppt for PFOA.

7. OEHHA's scientific review and recommendation has warranted the revision of the response level for PFOA.
8. Response levels are established at 100 times the established the 10^{-6} cancer risk level. A level 100 times the theoretical lifetime risk of up to one excess case of cancer in 10,000 people, the upper value of the 10^{-6} to 10^{-4} risk range typically allowed by regulatory agencies.
9. Based on the cancer risk, the response level for PFOA is being established at 10 parts per trillion.
10. Exceedance of a PFOA response level is determined by a quarterly running annual average (QRAA). The QRAA means the average of sample results taken at an individual source or entry point location during the previous four calendar quarters. The QRAA is re-calculated each quarter using the most recent four quarters of results. If sampling has just begun, such as the in the first quarter, then the other quarters will be considered to have a zero value, and the first quarter results would be divided by four. If any sample would cause the QRAA to exceed a response level, the water source would exceed the response level.
11. Health and Safety Code section 116378 require community water systems or a nontransient noncommunity public water systems, when ordered to monitor, and where detected levels of perfluoroalkyl substances and polyfluoroalkyl substances exceed their notification levels to provide public notification, or where they exceed response levels to take the affected water sources out of use or provide public notification within 30 days of the confirmed detection.

Approved:

2/6/2020

Darrin Polhemus, P.E. — Date
Deputy Director, Division of Drinking Water
State Water Resources Control Board

NOTIFICATION LEVEL ISSUANCE

Contaminant(s):	perfluorooctanesulfonic acid (PFOS)
Notification Level:	0.0000065 milligrams per liter
Response Level:	Calculated four-quarter running average of 0.000040 milligrams per liter (see finding 10.)
Analytical Method:	EPA Method 537.1
Toxicological Endpoint:	liver tumors in male rats and the structural and biological similarity to perfluorooctanoic acid (PFOA)

FINDINGS:

1. Health and Safety Code section 116455 provides the State Water Resources Control Board's Division of Drinking Water (DDW) the authority to issue notification levels for contaminants in drinking water delivered for human consumption before a maximum contaminant level has been set.
2. Notification levels are nonregulatory, health-based advisory levels for contaminants that are established as precautionary measures for contaminants.
3. The establishment of a notification level does not require public water systems to monitor for the contaminant, except when water systems are subject to the recycled water regulations. Some water systems, however, will sample for constituents in addition to those contaminants for which there are MCLs, and if those monitoring results indicate that a notification level has been exceeded, the water system must comply with the statute's notification requirements.
4. The contamination of drinking water with perfluoroalkyl substances (PFASs) has become an increasing concern due to the tendency of PFASs to accumulate in groundwater. These manmade compounds have been used extensively in consumer products such as carpets, clothing, fabrics for furniture, paper packaging for food, and other materials *(e.g.*, cookware) designed to be waterproof, stain-resistant, or non-stick. In addition, they have been used in fire-retarding foam and in various industrial processes.
5. In August 2019, the Office of Health Hazard and Assessment (OEHHA) developed PFOS reference levels in drinking water associated with liver tumors in male rats and the structural and biological similarity to perfluorooctanoic acid (PFOS). The level of 0.4 ng/L (nanogram/liter) or parts per trillion (ppt) represents the concentration of PFOS in drinking water that would not pose more than a one in one million cancer risk.

6. On August 22, 2019, DDW established a notification of 6.5 parts per trillion (ppt) and a response level of 70 ppt for PFOS.
7. OEHHA's scientific review and recommendation has warranted the revision of the response level for PFOS.
8. Response levels are established at 100 times the established the 10^{-6} cancer risk level. A level 100 times the theoretical lifetime risk of up to one excess case of cancer in 10,000 people, the upper value of the 10^{-6} to 10^{-4} risk range typically allowed by regulatory agencies.
9. Based on the cancer risk, the response level for PFOS is being established at 40 parts per trillion.
10. Exceedance of the PFOS response level is determined by a quarterly running annual average (QRAA). The QRAA means the average of sample results taken at an individual source or entry point location during the previous four calendar quarters. The QRAA is re-calculated each quarter using the most recent four quarters of results. If sampling has just begun, such as the in the first quarter, then the other quarters will be considered to have a zero value, and the first quarter results would be divided by four. If any sample would cause the QRAA to exceed a response level, the water source would exceed the response level.
11. Health and Safety Code section 116378 require community water systems or a nontransient noncommunity public water systems, when ordered to monitor, and where detected levels of perfluoroalkyl substances and polyfluoroalkyl substances exceed their notification levels to provide public notification, or where they exceed response levels to take the affected water sources out of use or provide public notification within 30 days of the confirmed detection.

Approved:

2/6/2020

Darrin Polhemus, P.E. Date
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State Water Resources Control Board