
Profile Probe

Augering Manual

for PR2 and PR1



AUG-UM-2.0



Delta-T Devices Ltd

Notices

Copyright

All rights reserved. Under the copyright laws, this manual may not be copied, in whole or in part, without the written consent of Delta-T Devices Ltd. Under the law, copying includes translation into another language.

Copyright © 2005, Delta-T Devices Ltd.

Design changes

Delta-T Devices Ltd reserves the right to change the designs and specifications of its products at any time without prior notice.

User Manual Version: AUG-UM-2.0 July 2005

Delta-T Devices Ltd.
128, Low Road
Burwell
CAMBRIDGE CB5 0EJ
UK

Tel: +44 1638 742922
Fax: +44 1638 743155
E-mail: sales@delta-t.co.uk
Web: www.delta-t.co.uk

Contents

Introduction	4
Description	4
Why good installation matters	5
Equipment list	6
Safety instructions	8
Types of Soil	9
Lubricating the installation	10
Installation	11
Preparation	11
Augering	12
Setting up the stabilisation plate	12
Augering a pilot hole	13
Finishing auger	15
Inserting access tubes	16
Completing the installation	17
Extraction	18
Equipment list	18
Safety instructions	18
Extraction instructions	19
Equipment Maintenance	20
Troubleshooting	21
Is the augered hole the right diameter?	21
Is the hole deep enough?	21
Checking the access tube insertion	21
Coping with difficult installations	22
Technical Support	24

Introduction

Description



The Profile Probe measures the soil moisture profile when inserted into an access tube that has been installed in the soil.

This User Manual describes how to install access tubes in most soils using the Delta-T range of augering tools and equipment.

The equipment enables the correct size holes to be augered and access tubes to be inserted so that they are in good contact with the soil – essential for the PR2 Profile Probe to achieve its full accuracy.

This information applies to the installation of access tube for both PR2 and PR1 Profile Probes.

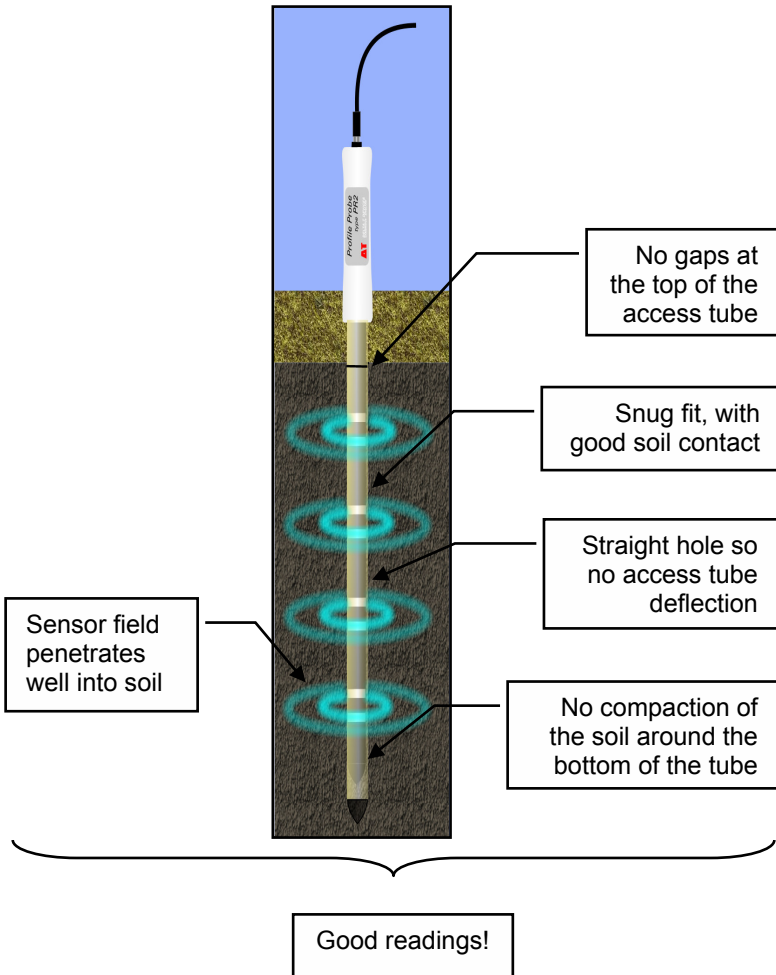
Advantages of the Augering Kits

- *Access tubes installed in good contact with the soil*
- *Rapid and consistent installation*
- *Simple system that adapts to most soils*
- *Easy to carry (in optional back pack bag)*
- *Robust*

Disclaimer

The augering equipment and instructions will enable you to install access tubes successfully into **most** soils, but we cannot guarantee that the installation will be successful in **all** situations.

Why good installation matters



To achieve this:

- *Use the correct equipment and installation method for your soil.*
- *Auger steadily and safely, avoiding any wobble.*
- *Lubricate the installation process with a little water.*

Equipment list

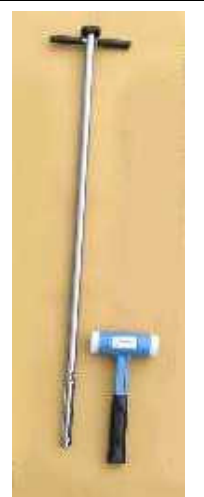
See the PR2 User Manual for description of probes, meters and data loggers.

Your augering equipment may have the following parts:

Starter Kit short PR-ASK1-S	
Part	Description
24mm pilot auger PR-AUG1	Gouge auger for production of pilot holes. Includes spatula and sharpening files.
Stabilisation plate AUG-SP1	Stabilisation plate for augers and access tube insertion. Includes stakes and 3 centring bushes.
Insertion rod AT-ROD1	For precise hammering of long and short access tubes into augered holes.



Starter Kit long PR-ASK1-L	
Includes all the items in PR-ASK1-S and in addition:	
Part	Description
Finishing auger PR-AUG4	Enlarges augered holes to optimum size for most soils.
Dead blow mallet DBM-1	For hammering access tube insertion rod – drives access tubes into augered holes.



Complete Kit PR-AKC1	
Includes all the items in PR-ASK1-L and in addition:	
Part	Description
Carrying bag AUG-CB1	Protective bag for augers and access tubes.
Flexicanes FLX-1	Set of 50 flexicanes and flags for marking access tube location.
Cleaning rod AT-CR1	Cleans and dries access tubes.



In addition to the augering kits, you may find the following equipment useful for a site visit:



[1] Access tubes

[2] Collars

[3] Black caps, or

[4] Red bungs for soil-surface insertions

[5] Flexicanes and pen

[6] Mist sprayer

[7] Stiff brush

[8] Cleaning cloths or paper towels

[9] Plastic sheet and bucket

[10] PR2 and

[11] HH2 meter for checking the readings after installation.

Safety instructions

Refer to the full **Health & Safety Instructions - Augering Kits for PR2**

In brief:



Procedures and equipment

- Ensure all personnel are fully trained in the augering procedures.
- Check that Personal Protective Equipment (PPE) is in good order.
- *As with most installation and outside procedures, it is good safety practice to work in pairs. This minimises health and safety risks and shares the workload appropriately.*

At preparation and setting out

- The equipment is heavy so minimise carrying distance. Ensure all equipment is correctly secured in the bag. Use handle or ruck-sack straps over shoulders.
- Wear appropriate clothing and footwear for outside installation.
- Use gloves when sharpening auger blades.
- Check emergency procedures and equipment: first aid box, mobile phone etc.
- Check site for dangers: uneven ground, pot holes, debris, overhead cables and underground services.

Augering and access tube insertion

- Wear PPE: gloves, boots and eye protection, especially when using mallet.
- Do not put excessive strain on back or arms.
- Use both hands, remain comfortable and relaxed, do not rush this procedure, auger the hole in small stages.
- Bend knees to keep back straight when removing the auger.
- Auger blades are sharp: use gloves when handling and when removing soil with spatula.

Finishing off

- Removing stakes: use gloves and avoid trapped fingers.
- Keep equipment clean and in good order.

Types of Soil

<i>Soil type</i>	<i>Example</i>	<i>Recommended augering method</i>
Normal	Uncultivated loam	Standard method described in manual
Cultivated	Ploughed field	For short access tubes, auger by standard method but use only gouge auger
Hard	Dry clay	Wet soil thoroughly then use standard method
Sandy	Sand	Use spiral auger in place of gouge. May need to wet the soil first.
Stony	Large stones	Auger an oversize hole (e.g. with a post hole borer) and repack around the access tube without the stones
	Smaller stones	Either repeat standard method until successful, Or repack as for large stones
Cracking	Shrink/swell soils	As for sticky when wet or hard when dry - but there is no completely satisfactory solution
Sticky	Damp clay	Wet the augers and outside of access tubes during insertion
Soft	Peat	Auger slightly undersize hole using only the gouge auger

Lubricating the installation

When soil is damp it can become sticky, and the augers will tend to bind to the soil during the augering process. This can result in hidden gaps and horizontal cracks forming during installation - and ultimately reduce the accuracy of your readings.

To minimise this problem:

- Always keep the augers very clean.
- Use water as a lubricant during augering.

Usually this requires only a small amount of water - as long as it can be applied to the surfaces of the augers as they are inserted. We suggest using a mist sprayer as illustrated.



Installation

This section describes the **standard augering method** in detail.

Soil types

Observations about how to modify the process for other soil types are included in shaded boxes.

Preparation

Site preparation

Hard soils

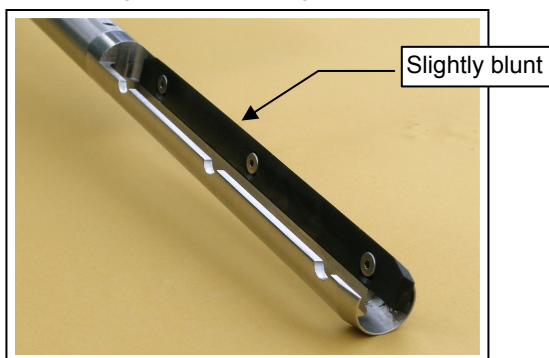
If the soil is exceptionally hard, it may not be possible to auger a hole without risking damage to the equipment. In that case you should **soak** the soil thoroughly before augering.

For hard clay soils it may be necessary to do this a day or two ahead of the intended work.

After soaking in this way it may take several days before the soaked soil re-equilibrates to the same soil moisture content as the surrounding soil.

Equipment preparation

- Assemble and check over the augering equipment.
- Sharpen the auger blades carefully – note that the blade for the finishing auger should be very slightly blunted so that it does not dig into the centring bush.



Augering

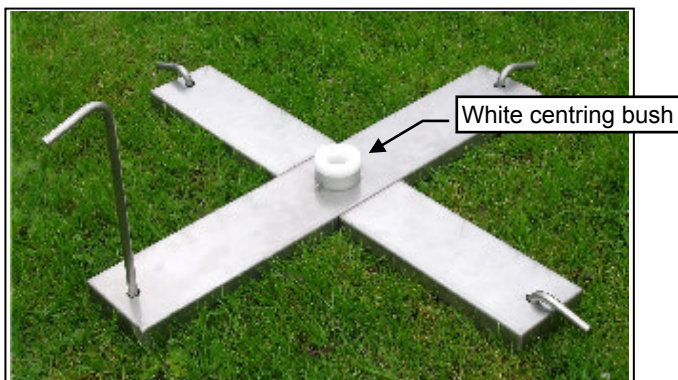
Stony soils

In soils with few large or small stones, we recommend that initially you follow the standard augering method - but be prepared to abandon the installation and **try again** if you hit a stone during the augering process.

If this is impractical because all your holes have to be abandoned then instead you will have to make an oversize hole (typically 100 to 150mm diameter), sieve the soil, insert the access tube and repack the sieved soil around the access tube. Preferably maintain the soil horizons by repacking the soil carefully into the same layers from which it was removed.

This method is often very effective, but cannot be generally recommended because it changes the structure of the soil surrounding the access tube. This will result in a permanent difference between the measured water content and that of the surrounding soil. However the Profile Probe can still be used to monitor changes in the diurnal pattern of water abstraction in order to schedule irrigation (see **Troubleshooting**)

Setting up the stabilisation plate



- Assemble the stabilisation plate (if not already done) using the hexagon socket wrench provided.
- Choose a patch of ground that is as level and free of stones as possible.
- Ensure the plate is stable before hammering in the 4 stakes.
- Fit the **white** centring bush.

Sandy soils

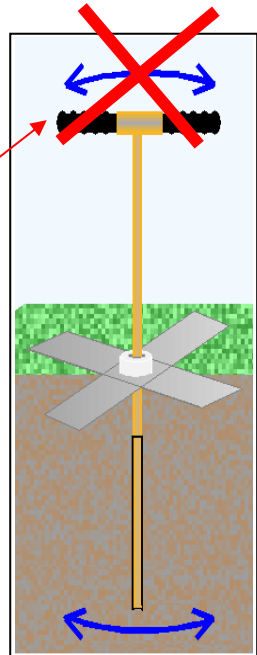
If the soil is dry and sandy and doesn't hold together, it will fall out the bottom of the auger as you lift it out of the hole. You may be able to avoid this by pre-dampening the soil, but for very sandy soils you should use the spiral auger **PR-AUG2** instead.

Note that:

- The spiral auger does not shear the soil as it is inserted, so even in sandy soils it can become firmly embedded after only a few turns. You may need to proceed in very small stages to avoid straining your back when pulling the auger out.
- The spiral auger produces a 26mm diameter hole. In sandy soils this is usually sufficient for access tube insertion, so the use of the finishing auger may not be necessary.

Augering a pilot hole

- Push the pilot auger straight down through the white centring bush by ~100mm.
- **Don't allow the top of the auger to wobble about.** The centring bushes are necessarily slightly oversize – they ensure consistent positioning of the augers but don't in themselves prevent wobble.
- Spray a little water on the sides of the auger as you insert it.
- If there is strong resistance, insert by smaller steps.
- Note that you can hammer gently on the top of the pilot auger if the soil is hard.
- It will help to rotate the auger every few cm in order to keep it on a straight path.
- Continue to rotate as you withdraw the auger carefully.



- Clean the extracted soil from the auger using the spatula.

Take care at this stage – hard soil may need to be loosened from the sides of the auger so that you do not have to apply undue force.

In some situations you may need to observe local soil hygiene regulations.



- You may also need to clean the auger more thoroughly using water and a brush to prevent any build-up of soil sticking to the outside of the auger.
- Continue in this way, taking great care to re-insert the auger exactly into the existing hole, until the hole is deep enough.

Required hole depth	Normal insertion	Soil-surface insertion
Short tubes	0.55m	0.60m
Long tubes	1.15m	1.20m

Cultivated soils and Soft soils

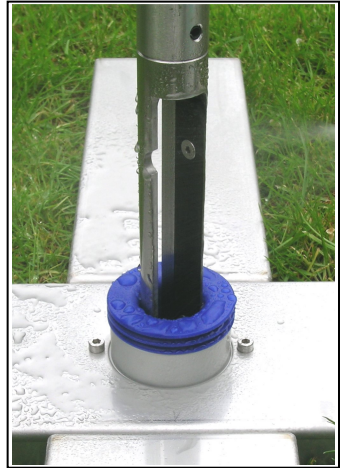
In recently cultivated soils where the soil is still unstructured, and in soft organic soils, it is often unnecessary to use the finishing auger - the access tube can be inserted straight into the pilot-augered hole. This only applies to installation of the short access tubes type ATS1.

Sticky soils

It is usually better to apply only a small amount of water as lubrication - so that the soil can re-equilibrate quickly with the surrounding soil. However some clay soils remain sticky with a little water, and you may achieve a better installation by applying a large quantity of water e.g. with a watering can.

Finishing auger

- Change over to the **blue** centring bush.
- Begin inserting the auger, rotating clockwise and applying a spray of water as lubrication all the time.
- Aim to auger 100 to 200mm at a time.
- Retract the auger while rotating anti-clockwise. In gritty soils the grit may cause the auger to jam when rotating anti-clockwise, so continue to rotate clockwise when withdrawing the auger.
- Clean out with the spatula (be very careful of all sharp edges). You may need to clean the auger more thoroughly using water and a brush to prevent any build-up of soil sticking to the outside of the auger.
- Continue in this way down to the required insertion depth.



Adjusting the finishing auger

The ideal hole is perfectly smooth and precisely 28mm in diameter but the heterogeneity of soil makes this difficult to achieve. The best practical hole diameter depends on the soil type. As a guide the diameter is about right when you can hammer the access tube all the way in by ~ 25mm at each blow with no more than moderate force.

The finishing auger can be adjusted to 2 different diameters by changing the spacing rod behind the blade. To adjust it in this way, follow these steps:

- Wear gloves.
- Clean the auger thoroughly, especially inside the hexagon socket screw heads.
- Undo the screws and remove the blade.
- Replace the adjustment rod with the smaller or larger diameter rod as required.
- Replace the blade and tighten the screws.

Inserting access tubes

- Check that the augered hole is deep enough – the table of depths on page 14 includes an important allowance for small amounts of soil dislodged to the bottom of the hole during insertion.
- Fit the **yellow** centring bush and start *pushing* the access tube into the soil using the insertion rod.
- As resistance increases you will probably need to start hammering, but hold the access tube steady to minimise wobble. Continue steadily until the top of the access tube is level with the top of the centring bush.
- Leave the insertion rod inside the tube (to prevent any material falling down inside the access tube), and remove the stabilisation plate.



If you are inserting access tubes level with the soil surface, continue hammering until the top of the tube is just level with the soil surface.

Remove the insertion rod.


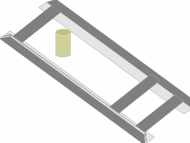

Note: *In hard soil you may have to hammer vigorously. However if you need to hammer extremely hard to achieve even 1 or 2mm access tube movement, the hole is undersized. Hammering in this way will almost always result in air gaps forming at the top of the tube and soil compaction lower down. **Don't proceed** – adjust the auger to a larger diameter (see previous page), extract the tube and start a new hole.*

Completing the installation

- If necessary, clean out the inside of the access tube with the cleaning rod and a short length of paper towel or cloth.
- Insert the PR2 and take 3 readings, rotating the probe through 120° increments (see **PR2 Quick Start Guide**).
Look for unexpectedly low readings – these may indicate air gaps or stones, and the need to re-install – see **Troubleshooting** section.
- Fit the collar and a black cap, or a red bung for surface installations.
- If required, label and insert the flexicane.
- Wash and dry the augers, then wipe them with a lightly oiled cloth, or use a water repellent spray.

Extraction

Equipment list

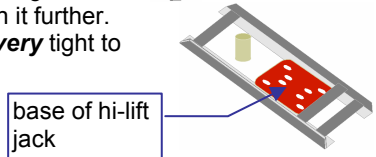
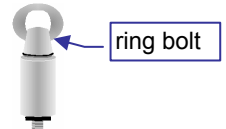
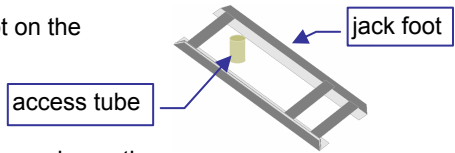
Extraction Kit PR-EXK1		
Part	Description	
Hi-lift jack	Heavy cast iron jack in a bag complete with chains	
Jack foot	Folding aluminium device to spread the load when lifting.	
Tube clamp	Silver-and-black clamp with lever bar for gripping top of access tubes.	

Safety instructions

Warning: you may need to use a lot of force in order to extract access tubes. The extraction kit is designed to be capable of these sorts of forces, but, as a result, the jack is a heavy piece of equipment and needs care in its handling. Please read the safety warnings in its manual and on its lever arm before attempting to use it.

Extraction instructions

- Place the jack foot on the ground over the access tube.
- Loosen the tube clamp by unscrewing anti-clockwise, and manoeuvre it down over the top of the access tube until it seats.
- Pull up very gently on the ring bolt, without unseating the clamp, and rotate clockwise by hand to tighten it. Use the lever bar to tighten it further. You may need to get this **very** tight to prevent it slipping later on.
- Fit the jack into the foot.
- Push down the reversing latch.



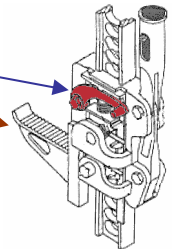
Warning: support the jack lifting arm before doing this, as it will be able to drop on your foot.

- Raise the jack lifting arm until it is about 200mm above the ring bolt, and then pull up the reversing latch.
- Support the jack while you attach the hooks on the lifting chain to the ring bolt.

You are now ready to start jacking the access tube out of the ground. Push the jack lever down until it clicks and then up until it clicks.

Continue in this way until either the tube has been pulled out of the ground, or it is so loose that it will be easy to pull out by hand using the lever bar.

Remember to support the jack lifting arm before pressing the reversing latch to take the pressure off.



Equipment Maintenance

The augers are designed to be extremely robust in order to survive the forces necessary to auger holes in hard soils. As a result some parts have to be constructed of tougher materials than stainless steel, so it is vital to look after them in order to prevent rust forming.

- Keep the equipment very clean.
- Store in a dry place.
- Use water-repellent spray or wipe them over with a lightly oiled cloth in between uses.
- Keep the pilot and finishing augers sharp – but note that the finishing auger should not be too sharp to prevent it from cutting into the centring bush.

Troubleshooting

Is the augered hole the right diameter?

The best practical hole diameter depends on the soil type. As a guide the diameter is about right when you can hammer the access tube all the way in by ~ 25mm at each blow with no more than moderate force.

For very hard soils this will require an augered hole of almost exactly the same diameter as the access tube (28mm outside diameter). For soft soils a diameter of 25 to 26mm is appropriate, and moderately hard soils fall somewhere between.

Is the hole deep enough?

Required hole depth	Normal insertion	Soil-surface insertion
Short tubes	0.55m	0.60m
Long tubes	1.15m	1.20m

If you mark the insertion rod to the required depth, it can be used as a depth check. If you use it in this way, take care to clean it thoroughly before inserting it into an access tube for hammering.

Checking the access tube insertion

Take readings with a PR2. The following conditions are indicative of **possible** problems:

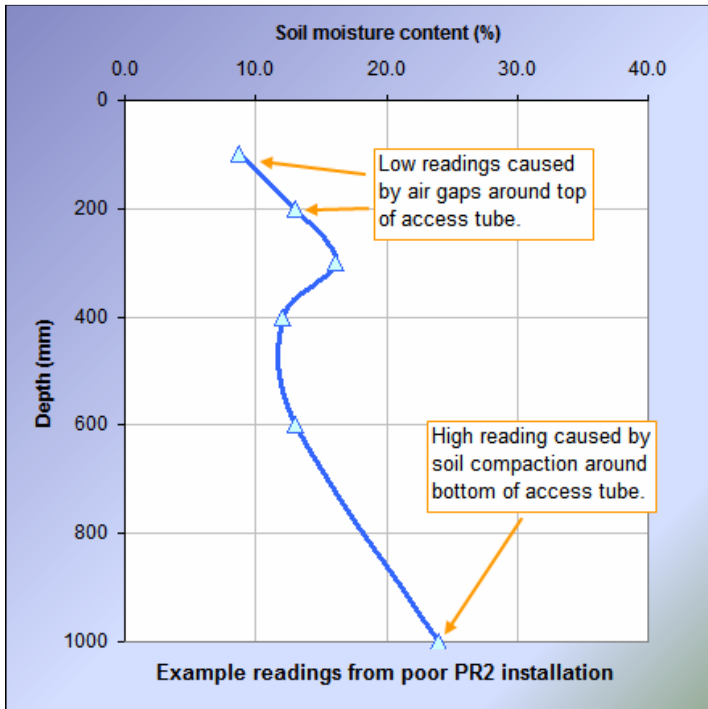
■ Uneven readings

Insert the PR2 fully, and take readings as you rotate the probe through 360°.

Variations in water content >5% at any one level as you rotate indicate possible problems such as gaps or stones.

■ S-shaped profile readings.

The following graph shows an exaggerated example created by hammering an access tube into an undersize hole. This has resulted in funnel-shaped air gaps around the top of the tube, and significant soil compaction lower down the tube:



Note these symptoms should only be taken as indications of possible problems, because sometimes soil moisture does have this profile.

Coping with difficult installations

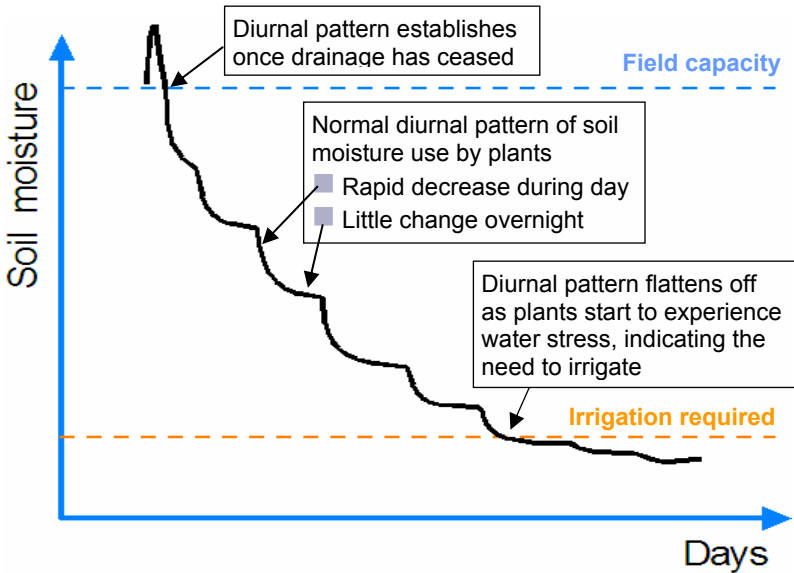
If you have followed these instructions carefully but still have problems installing access tubes, there are two ways to make the best of the PR2 readings:

■ **Compensate for reading errors by applying a soil specific calibration**

The PR2 User Manual provides information on how to determine a soil specific calibration from field data. Following this approach, different calibrations can be applied to the PR2 readings at different depths to compensate for the effects of gaps or soil compaction. However the results will not match the readings from a well-installed tube.

■ **Using the pattern of water abstraction to schedule irrigation**

If the PR2 readings are intended for irrigation scheduling then the daily pattern of soil moisture can provide useful indications of soil conditions even with very imperfect installations or repacking the soil around the access tube. Whenever the soil moisture is affected by plant activity you are likely to see this pattern of soil moisture readings:



The diurnal pattern is established once drainage has ceased after irrigation or heavy rainfall, indicating the field capacity of the soil. And the pattern flattens off when the plants experience water stress, indicating the need to irrigate.

Technical Support

Terms and Conditions of Sale

Our Conditions of Sale (ref: COND: 1/00) set out Delta-T's legal obligations on these matters. The following paragraphs summarise Delta-T's position but reference should always be made to the exact terms of our Conditions of Sale, which will prevail over the following explanation.

Delta-T warrants that the goods will be free from defects arising out of the materials used or poor workmanship for a period of **twelve months** from the date of delivery.

Delta-T shall be under no liability in respect of any defect arising from fair wear and tear, and the warranty does not cover damage through misuse or inexpert servicing, or other circumstances beyond our control.

If the buyer experiences problems with the goods they shall notify Delta-T (or Delta-T's local distributor) as soon as they become aware of such problem.

Delta-T may rectify the problem by supplying replacement parts free of charge, or by repairing the goods free of charge at Delta-T's premises in the UK, during the warranty period,

If Delta-T requires that goods under warranty be returned to them from overseas for repair, Delta-T shall not be liable for the cost of carriage or for customs clearance in respect of such goods. However, we much prefer to have such returns discussed with us in advance, and we may, at our discretion, waive these charges.

Delta-T shall not be liable to supply products free of charge or repair any goods where the products or goods in question have been discontinued or have become obsolete, although Delta-T will endeavour to remedy the buyer's problem.

Delta-T shall not be liable to the buyer for any consequential loss, damage or compensation whatsoever (whether caused by the negligence of the Delta-T, our employees or distributors or otherwise) which arise from the supply of the goods and/or services, or their use or resale by the buyer.

Delta-T shall not be liable to the buyer by reason of any delay or failure to perform our obligations in relation to the goods and/or services, if the delay or failure was due to any cause beyond the Delta-T's reasonable control.

Service and Spares

Users in countries that have a Delta-T Distributor or Technical Representative should contact them in the first instance.

Spare parts for our own instruments can be supplied from our works. These can normally be despatched within a few working days of receiving an order.

Spare parts and accessories for sensors or other products not manufactured by Delta-T, may have to be obtained from our supplier, and a certain amount of additional delay is inevitable.

No goods or equipment should be returned to Delta-T without first obtaining the agreement of Delta-T or our distributor.

On receipt at Delta-T, the goods will be inspected and the user informed of the likely cost and delay. We normally expect to complete repairs within a few working days of receiving the equipment. However, if the equipment has to be forwarded to our original supplier for specialist repairs or recalibration, additional delays of a few weeks may be expected.

Technical Support

Technical Support is available on Delta-T products and systems. Users in countries that have a Delta-T Distributor or Technical Representative should contact them in the first instance.

Technical Support questions received by Delta-T will be handled by our Tech Support team. Your initial enquiry will be acknowledged immediately with a "T number" and an estimate of time for a detailed reply. Make sure to quote our T number subsequently so that we can easily trace any earlier correspondence.

In your enquiry, always quote instrument serial numbers, software version numbers, and the approximate date and source of purchase where these are relevant.

Contact details:

Tech Support Team
Delta-T Devices Ltd
128 Low Road, Burwell, Cambridge CB5 0EJ, U.K.
email: tech.support@delta-t.co.uk
Web site: www.delta-t.co.uk
Tel: +44 (0) 1638 742922
Fax: +44 (0) 1638 743155