

Installing Monitoring Wells & Piezometers

Steven Sprecher

June 6, 2007

steven.sprecher@in.usda.gov

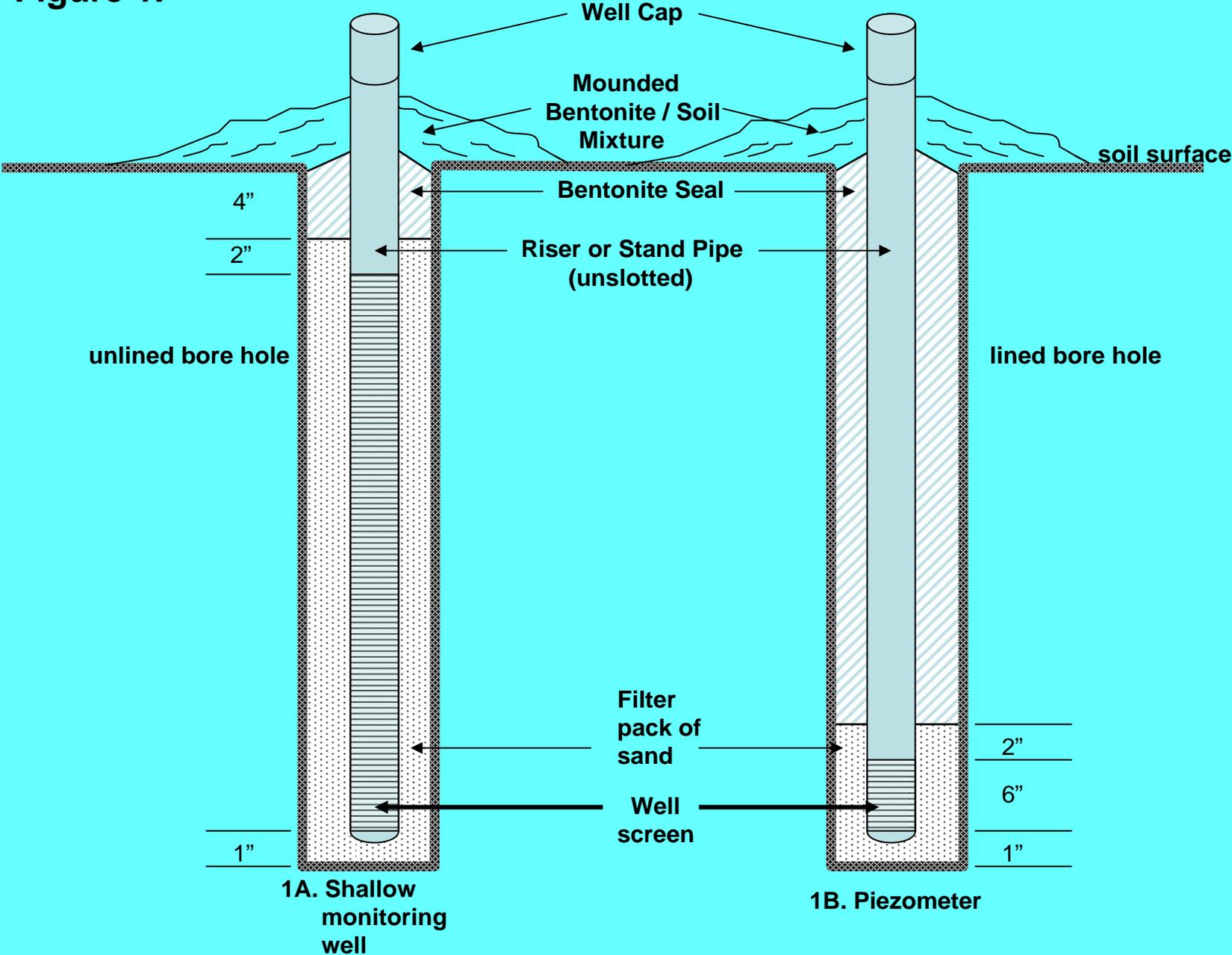
Acknowledgements

- Jim Richardson for inviting my participation
- Wes Miller for sharing his years of experience and still taking an interest in these, even after retirement

Applications

- Soil Survey Technical Guidance
- Hydropedology Research

Figure 1.



Overview

- **Wells**

- Unlined Boreholes

 - no bentonite seal

- Slotted full profile

- Used for

 - max ht of free water over intake length

- **Piezometers**

- Lined Boreholes

 - bentonite seal

- Slotted 1 horizon

- Used for

 - free water pressure at intake depth

 - presence of free water at intake depth

Overview, cont

Wells

- **fill from top**
 - **Ksat high**
- **drain from bottom**
 - **Ksat low**
- **Reservoir effect common**

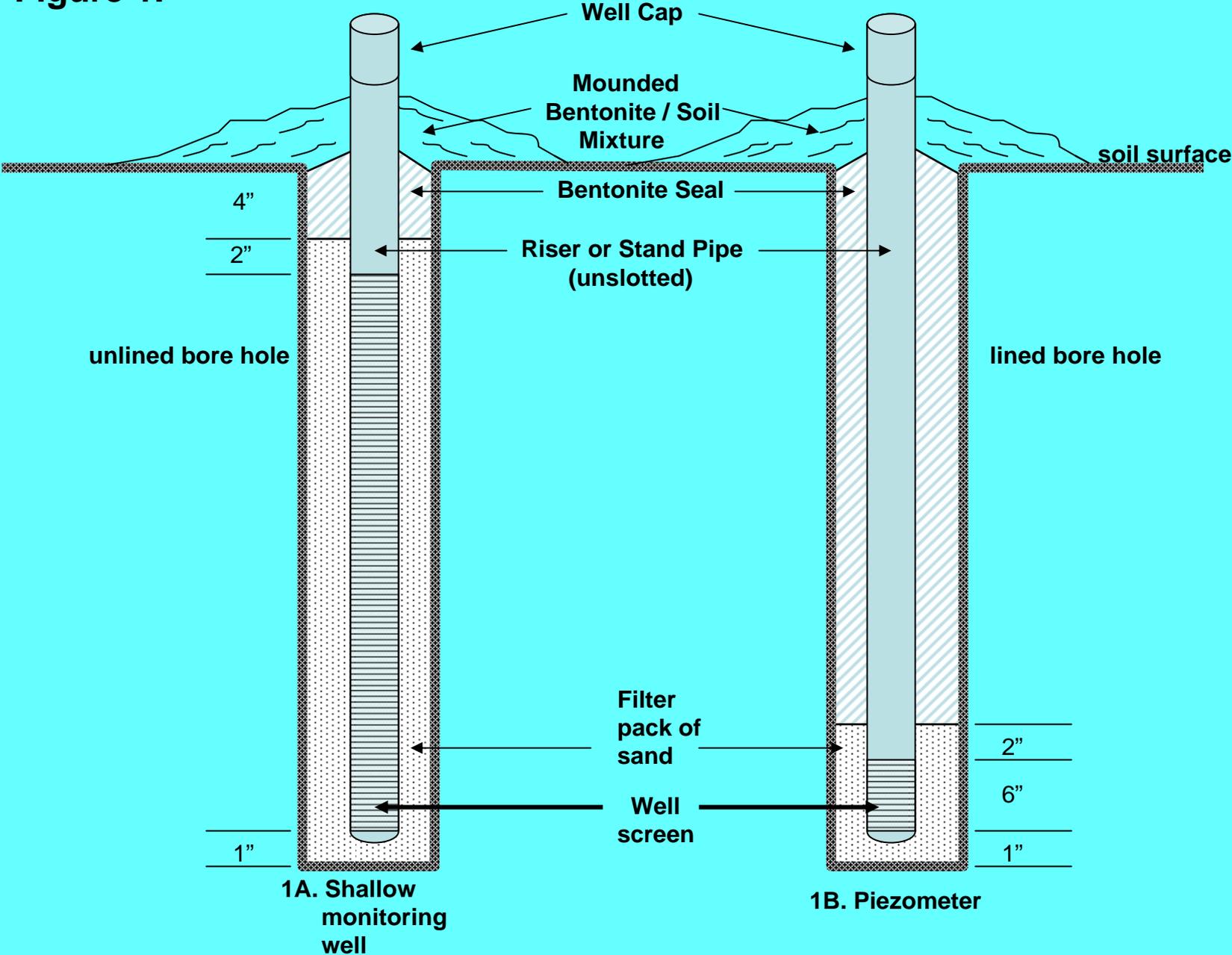
Piezometers

- **fill & drain from same horizon**
- **Minimal reservoir effect**

Installation

- See Figure 1 at end of draft

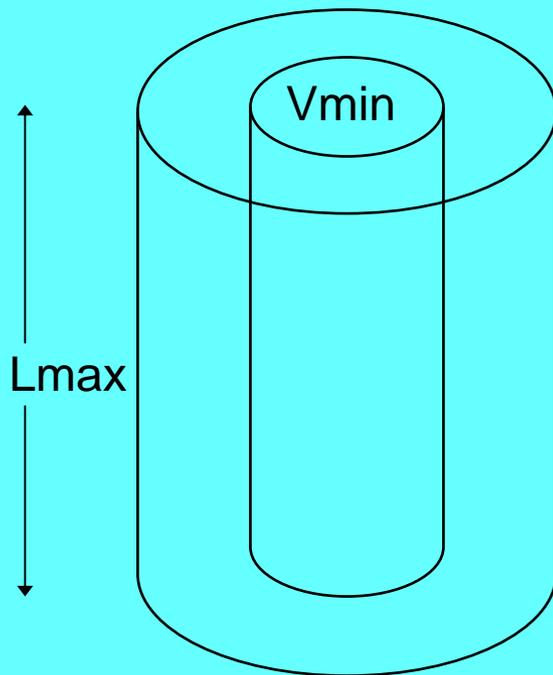
Figure 1.



QUESTIONS

1. Slotted vs drilled intake screen
 1. How many drill holes?
 2. How big drill holes?
 3. How long is the screen? 6"? 4"?

Wetlands 21:412-421, 2001, Hanschke & Baird



RESPONSE-TIME THEORY

The theory of piezometer response time was first elucidated by Hvorslev (1951). Hvorslev's theory assumes a rigid soil in which Darcy's Law describes the flow of water below the water table. For simplicity, Hvorslev (1951) considered a hydrostatic situation in which the water level in the piezometer was initially in equilibrium with pore-water pressures around the piezometer intake. He then assumed that pore-water pressures in the real system changed instantaneously to a new constant level. Following the notation given in Figure 2, he noted that the instantaneous discharge of water into the piezometer is given by

$$Q = A \frac{dH}{dt} = FK h \quad (2)$$

where A is the inside cross-sectional area of the piezometer standpipe (L^2), H is now the water level in the piezometer (L) (compare with equation (1)), t is time (T), h is the difference in head between the piezometer and the soil around the intake (i.e., $P - H$) (see Figure 2; when h is negative, Q is also negative and water flows *from* the piezometer; when h is positive, water flows *into* the piezometer), and F is the shape factor of the piezometer intake (L), which is a function of the size and shape of the piezometer intake and the pattern of flow around the intake. Hvorslev

Wetlands 21:412-421, 2001, Hanschke & Baird

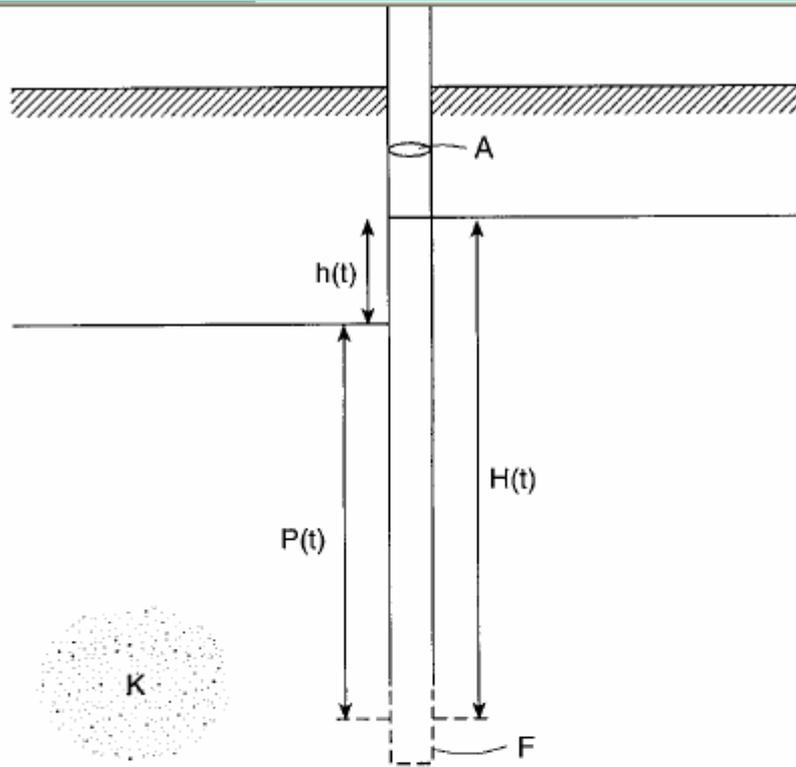


Figure 2. Piezometer notation.

(cf. Hvorslev 1951, Anderson and Kincaid 1987).

F for closed bottom, cylindrical intakes can be calculated using the empirical formula of Hvorslev (1951) as modified by Brand and Premchitt (1980) (see also Brand and Premchitt 1982):

$$F = \frac{2.4\pi l}{\log_e(1.2l/d + \sqrt{1 + (1.2l/d)^2})} \quad (6)$$

where d is the o.d. of the intake and l is the length. The efficient piezometer had a standpipe inside di-

(1951) showed that if a new variable, the basic hydrostatic time lag, T , is defined by

$$T = \frac{Ah_0}{FKh_0} = \frac{A}{FK} \quad (3)$$

where h_0 is the initial difference in heads between the

NOTE

Equation (5) was coded in a Visual Basic (v.3) program, which allows the user to change F , K , and A and enter any series of $P(t)$ data. The program is available free of charge from the second author.

QUESTIONS, cont

2. Well Stock

How narrow is practical for automatic recorders?

3. Automatic Recorders

Solinst, Georgetown, Ontario

Slope Indicator, Mukilteo, WA (vibrating wire)

Geotech, Sweden

RST Instruments, Coquitlam, BC (pneumatic piezometers)

QUESTIONS, cont

4. Automatic Recorders

Solinst, Georgetown, Ontario

Slope Indicator, Mukilteo, WA (vibrating wire)

Geotech, Sweden

RST Instruments, Coquitlam, BC (pneumatic
piezometers)

Model 615 Stainless Steel Drive-Point Piezometers

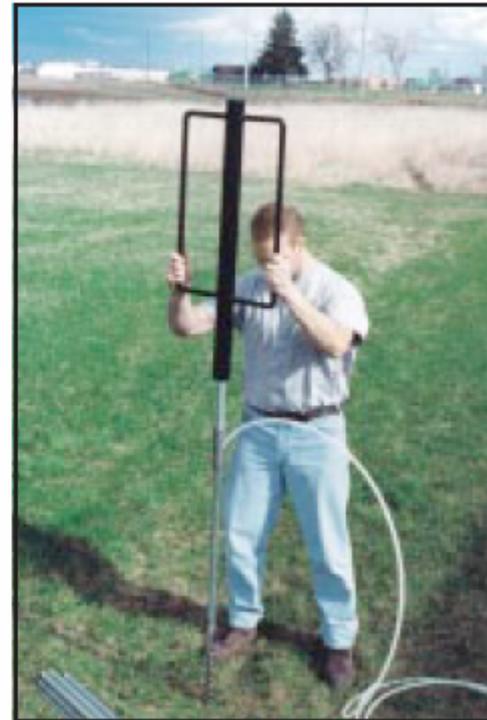
The Model 615 Drive-Point Piezometer is designed to give field personnel a truly inexpensive method to monitor groundwater in suitable conditions.

Solinst 615 Drive-Points attach to inexpensive 3/4" NPT steel drive pipe which is widely available through local plumbing and hardware stores.

Solinst Drive-Point Piezometers are most often installed permanently as wells, for short-term or long-term monitoring of groundwater level and quality. They can also be used once and removed. Drive-point, tubing and pipe alternatives are available to suit almost every situation.

High quality samples can be obtained as polyethylene or Teflon® lined tubing is attached to the stainless steel drive point. A shielded version is available which avoids clogging or smearing of the screen during installation. Sampling and head measurements are taken within the tubing with small diameter equipment, as described overleaf.

Solinst Drive-Point Piezometers can be driven into the ground, or the soil at the bottom of a borehole with any direct



Manual Slide Hammer

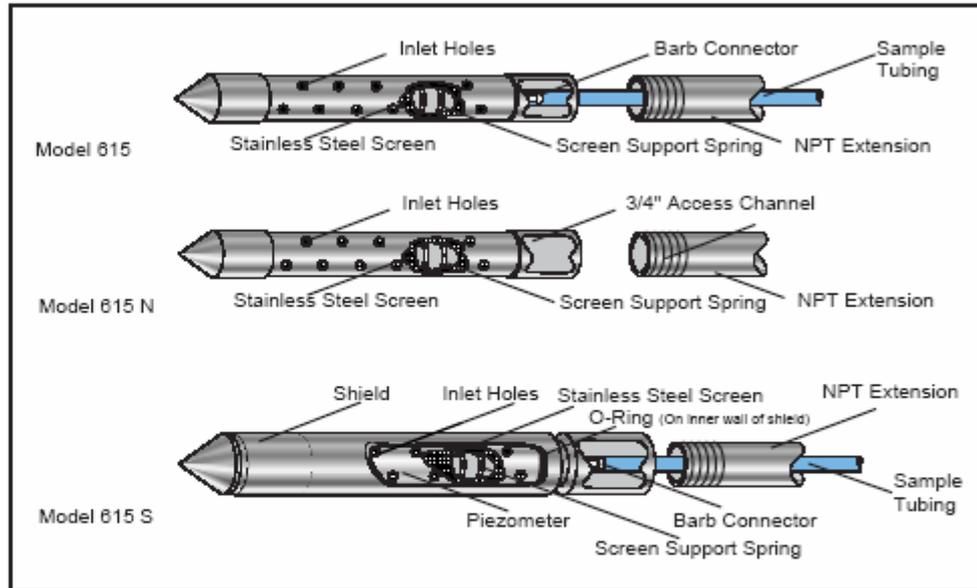


Sampling Within Narrow Diameters

Direct push sampling has quickly become a popular way to obtain groundwater samples; however, sampling within drive-points requires a narrow diameter sampler. Solinst offers several options for this specific sampling application.

Single Valve Pump

To sample from within Solinst Model 615 Drive-Point Piezometers, the integral tubing can be converted easily



Hydraulic Head

Water levels can be measured in any of the drive-points described, using a Solinst Model 102, or the Narrow Tape Solinst Model 101 Water Level Meter for the most accurate hydraulic head measurements.

Vibrating Power Hammer

615 Piezometers can be installed using a variety of vibrating 'rock breaker' type hammers.

A two piece drive head assembly has a hardened steel adaptor to suit the threads

Vibrating Wire Piezometer

Applications

The VW piezometer is used to monitor pore-water pressure. Typical applications include:

- Monitoring pore water pressures to determine safe rates of fill or excavation.
- Monitoring pore water pressures to determine slope stability.
- Monitoring the effects of dewatering systems used for excavations.
- Monitoring the effects of ground improvement systems such as vertical drains and sand drains.
- Monitoring pore pressures to check the performance of earth fill dams and embankments.
- Monitoring pore pressures to check containment systems at land fills and tailings dams



Installation Overview

Grout-In Method: The piezometer is

Advantages

Groutable: The VW piezometer can

19 mm od



Web Site for Geotechnical Field Equipment



- Home
- About Geotech
- Our Products
 - CPT
 - Rigs
 - Rig accessories
 - Sounding equipment
 - Sounding accessories
 - Rods & drill points
 - Augers
 - Electric piezometer
 - Tech. spec
 - Images
 - GSM-interface
 - Piston sampler ST:1
 - Piston sampler AH55
 - Barrel sampler
 - Fill perforator
 - Open standpipe
 - Piezometer
 - Software
- Downloads
- Contact us

Electric piezometer



The newly developed Geotech Piezometer is a precision gauge and still very price competitive compared to vibrating wire instruments. At each measurement the user gets the serial number of the gauge, the pore pressure, temperature, date and time. The piezometer contains parts of the new Geotech electronics for the CPT probes and can therefore be delivered with or without a programmable memory (the standard version capacity is of over 2 000 measurements points). The piezometer can be read with a PSION Workabout handheld

Geotech

Datavägen 53
436 32 ASKIM
SWEDEN

Phone: +46 31 289920
Fax: +46 31 681639

E-mail info@geotech.se
sales@geotech.se

NEWS

2007-03-14

Transportation case for CPT cone and sound transmitter



Geotech can now offer a very good transportation case for your cone and sound transmitter. For more information please contact Christina Örtendahl at sales@geotech.se

1.3" diameter

“pneumatic piezometer, 0.5” o-d

atic Piezometers

P-102-5S Pneumatic Wellpoint Piezometer

P-100 Mini Pneumatic Piezometer

P-100-1 Piezometer

Specifications may change without notice. PFB0001D

rst
INSTRUMENTS

RST Instruments Ltd.
200 - 2050 Hartley Ave., Coquitlam, BC Canada V3K 6W5
Telephone: +1-604-540-1100 • Facsimile: +1-604-540-1005
Toll Free (USA & Canada): 1-800-665-5599
Email: info@rstinstruments.com
www.rstinstruments.com

The RST Instruments Management System is certified to ISO 9001:2000



Pneumatic Piezometers, such as Slope Indicator

gauge with inoperative indicator memory in the same way piezo piezometer

Slope Indicator's pneumatic piezometers employ a simple and reliable transducer that is free from zero drift. Long term performance is enhanced by corrosion-resistant plastic construction, polyethylene tubing, and in-line filters in all connectors. Compatible with both flow and no-flow reading techniques.

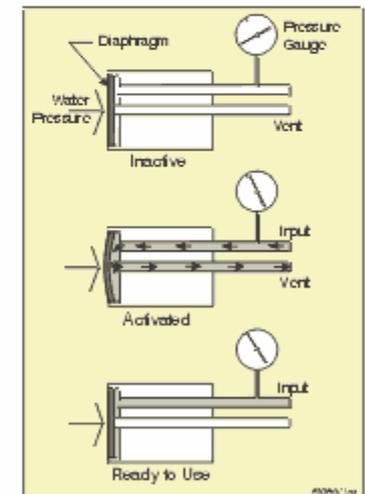
Operating Principle

In a typical installation, the piezometer is sealed in a borehole, embedded in fill, or suspended in a standpipe. Twin pneumatic tubes run from the piezometer to a terminal at the surface. Readings are obtained with a pneumatic indicator.

The piezometer contains a flexible diaphragm. Water pressure acts on one side of the diaphragm and gas pressure acts on the other. When a reading is required, a pneumatic indicator is connected to the terminal or directly to the tubing. Compressed nitrogen gas from the indicator flows down the input tube to increase gas pressure on the diaphragm.

When gas pressure exceeds water pressure, the diaphragm is forced away from the vent tube, allowing excess gas to escape via the vent tube. When the return flow of gas is detected at the surface, the gas supply is shut off.

Gas pressure in the piezometer decreases until water pressure forces the diaphragm to its original position, preventing further escape of gas through the vent tube. At this point, gas pressure equals water pressure, and the [pneumatic indicator](#) shows the reading on its pressure gauge.



[For more information](#)

QUESTIONS, cont

4. Bentonite vs Grout

most commercial instructions require grout, but
most pedology studies use bentonite

5. Wells vs Piezometers

Is there a K_{sat} threshold for wells because of
the reservoir effect?

6. Install into sand

Jetting?

Vibrating?

QUESTIONS, cont

7. Filter cloth vs Sand pack

How attach cloth (epoxy? hardware ties?)

Filter fabric vs Filter sock

What common mistakes should be noted?

8. Slotted screen (0.006 vs 0.010 inch)

Does it make a difference?

If so, does 40-60 sand pack make a difference?

9. Install in rocky soil

Driving methodology?

What common mistakes should be noted?

How prevent bypass flow?

Figure Driven Well-a

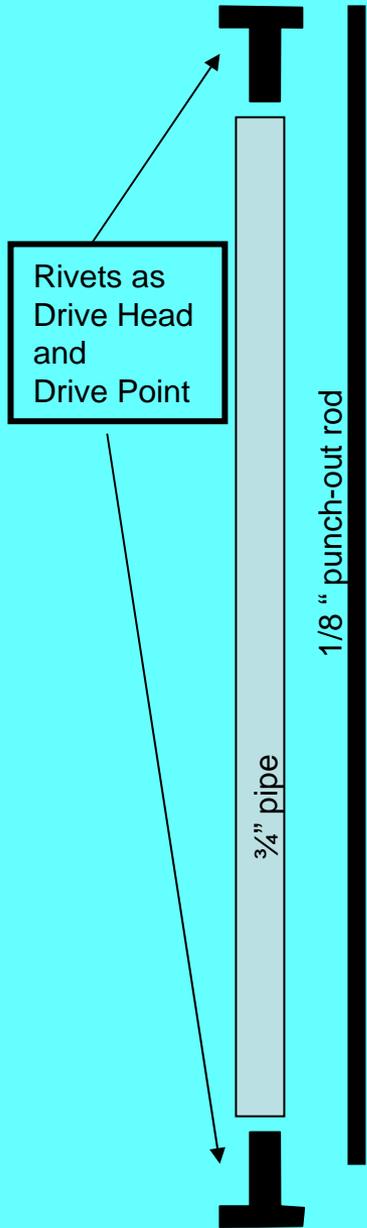


Figure Driven Well-b

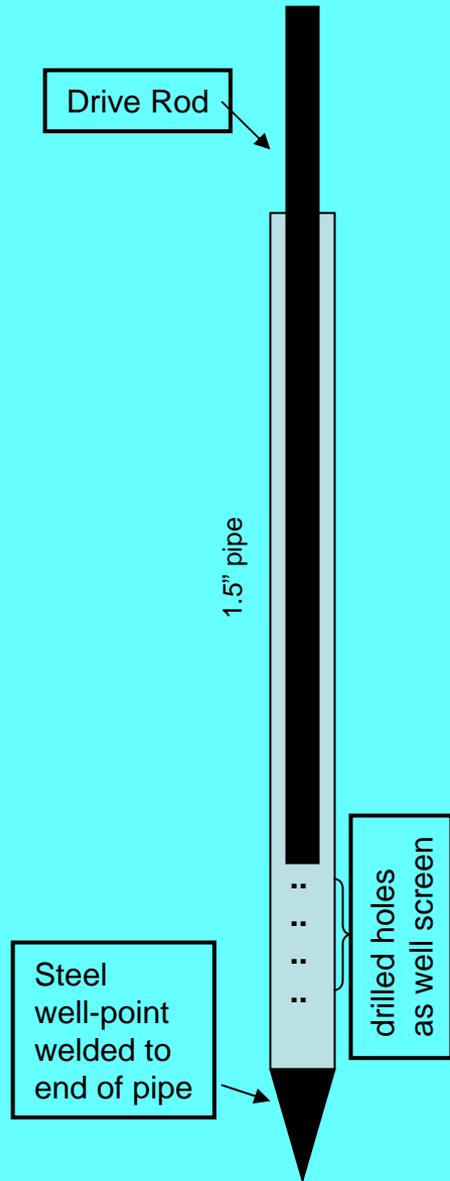
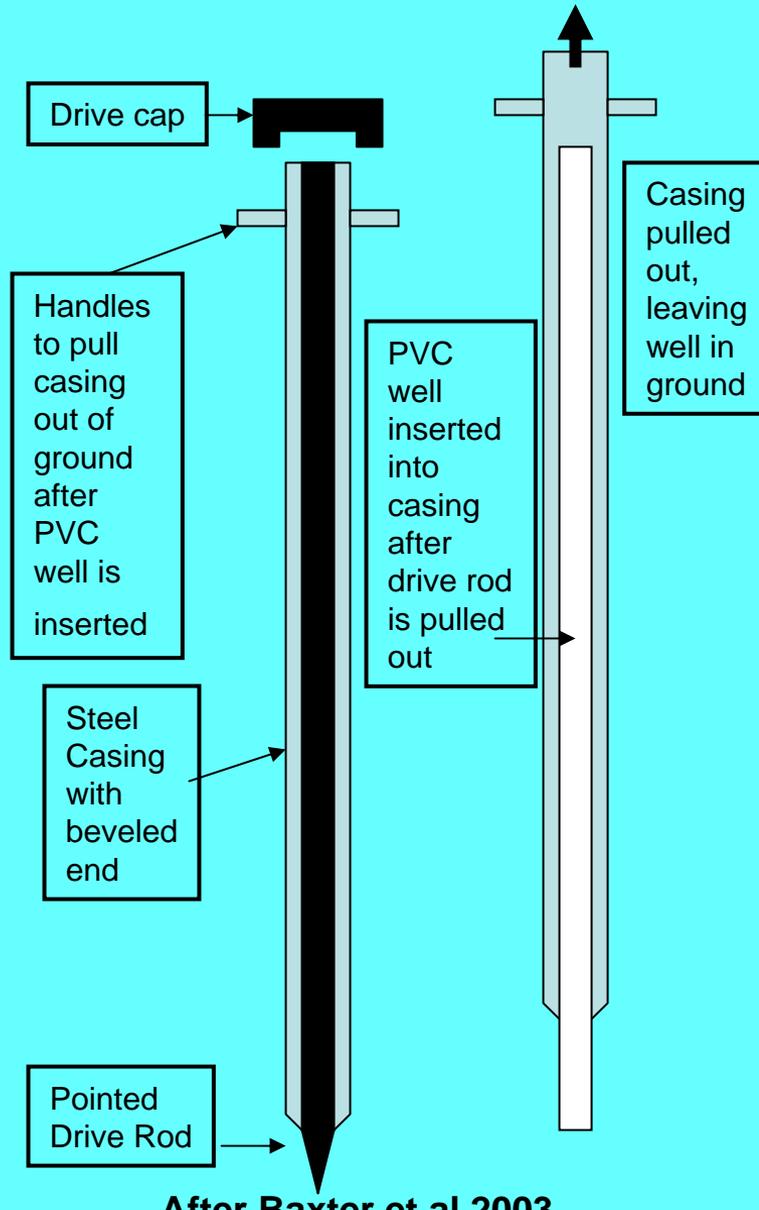


Figure Driven Well-c



QUESTIONS, cont

9. Install in rocky soil

Driving methodology?

What common mistakes should be noted?

How prevent bypass flow?

10. Other Technical Guidance protocols

USGS

USFS

other countries

QUESTIONS, cont

11. Packing material at ground surface

Any need to specify technique beyond having a mound, not a cavity around the riser?

12. Bore hole and annular space

How minimize volume yet fill fully?

QUESTIONS, cont

13. Local laws and concrete pads

Is this really an issue?

14. Manual reading

How frequently?

How does missing data get skewed?

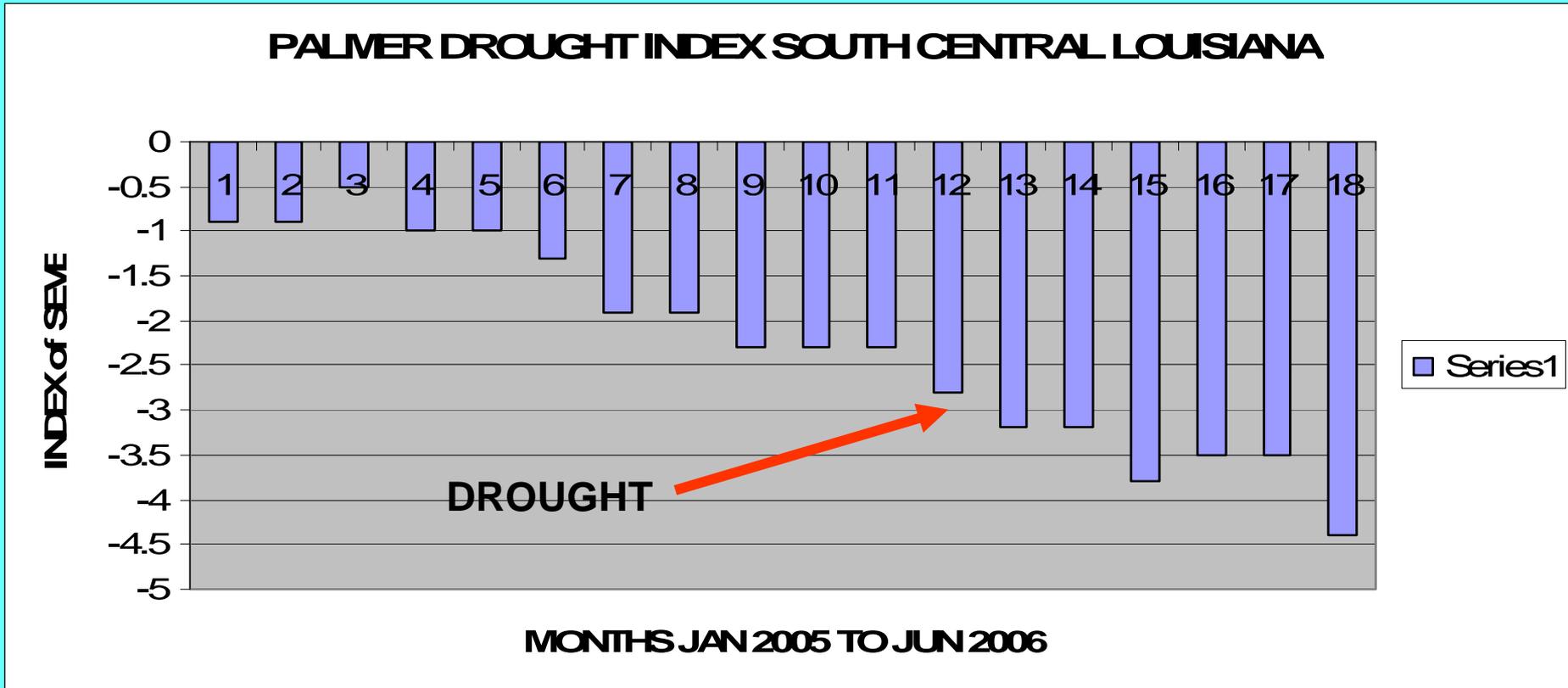
15. Other issues???

LANDSCAPE FACTORS to CONSIDER



How does the water flow?
DUNDEE SITE NEEDED MORE
THAN ONE NEST.

PALMER DROUGHT SEVERITY INDEX SOUTH CENTRAL LOUISIANA



**EASIEST WAY OF KNOWING WHERE ONE IS IN THE DROUGHT
PLUVIAL CYCLE IS THE PALMER INDEX.**