Site Setup and Installation
Standard Operating Procedures

Background

Each BEMP study site is set up as a rectangle with a north/south length of 200 meters and an east/west width of 100 meters. Sites, typically located between the river and the levee, should be representative of the forest composition in the area. To minimize disturbances and the potential for vandalism, study sites should be selected in areas of low human impact, though this is not always possible. Some sites are set up to monitor specific land management practices, treatments, or other aspect; these areas are predetermined and may not conform to the above criteria.

Study sites are set up using the same design; this makes it possible to make valid comparisons among sites. All sites are monitored using the same methods and during the same week on a monthly basis. Following standard procedures is critical to the success of the program.

Each study site is comprised of 10 vegetation plots, 10 litterfall tubs, 20 pitfall traps, five wells and two rain gauges (see image 1). Some sites have three temperature loggers.

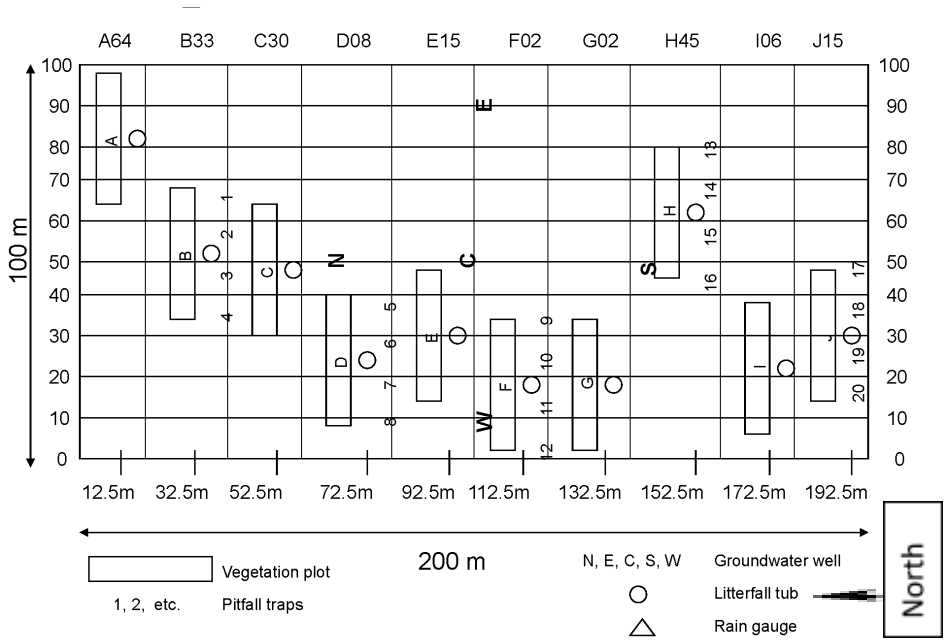

Image 1: Example of a standard BEMP site setup. Numbers next to the letters along the top are the random numbers that determine the distance from the western edge of the site (in meters) that the plot begins. (These numbers are unique for each site.) The north arrow suggests that the top of the site is always oriented towards the north, although in many cases the site is rotated slightly one way or the other in order to fit between the river and the levee.

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Permits

There are a variety of permits that BEMP must obtain for installing and monitoring sites. Permits needed vary with site location. Necessary permits include: Office of the State Engineer permit for drilling and maintaining groundwater monitoring wells; Middle Rio Grande Conservancy District permit for monitoring sites (renewed every 1 to 4 years); City of Albuquerque Open Space permit (renewed annually); Sevilleta National Wildlife Refuge permit (renewed annually); Albuquerque Metropolitan Arroyo Flood Control Authority permit (renewed annually); Valle de Oro National Wildlife Refuge permit (renewed annually); Pueblo of Santa Ana permit (new permit needed for each visit/monthly); Pueblo of Sandia permit (renewed annually). Permission to monitor at Pueblo of Santo Domingo is obtained at the Natural Resources office before each visit and an escort is required. A current Memorandum of Understanding is needed to monitor at the Pueblo of Ohkay Owingeh.

Materials needed:

- six 50 m tapes and four 100 m tapes
- at least two compasses
- several copies of initial map
- clipboards and pencils
- at least 40 blue flags, 20 orange flags, 20 white flags, 10 green flags and 5 yellow flags
- Sharpies
- 60 pieces of 1 ft x 5/8 in-long rebar
- blue and orange spray paint
- hammer
- Impress-O-Tags
- 10 rubber litterfall tubs, drilled and labeled
- 30 1 ft-long wooden stakes
- 20 16 ounce (oz) Solo cups (TP16) with holes
- 20 solid 16 oz Solo cups (TP16)
- 20 lids (626TP) for Solo cups
- 20 pitfall trap wooden lids
- trowels
- two rain gauges
- two posts with metal brackets installed so that top of rain gauge is at least an inch above top of wood
- shovel
- auger with 3 in-wide bucket
- vegetable oil
- screwdriver

Additional materials (not at all sites)

- temperature data loggers and cases
- screwdriver
- laptop computer and cable
- data logger software

Pre-field prep

Before going to the field, some work must be done in the lab to prepare field equipment.

- 10 rubber litterfall tubs: Circular horse feed bins with a 35 cm diameter bottom, 42 cm diameter top and 10 cm depth that need at least three 1 in. diameter holes drilled into them so water can drain out. Tubs are labeled with the tub letter on the inside at least twice, and "research, do not disturb" is written on the inside lip if needed. White out and white paint pens work well for this.

- 20 pitfall traps: drill a ¼-in hole into the bottom of a number of cups. Also, cut ½-in thick 5 x 5-in square wooden pieces and drill four 8 x 2 ½-in deck screws into each corner. Spray paint these to help preserve the wood and camouflage them.

- 2 rain gauges: install a metal mounting bracket to each 8-foot-long pressure treated wooden posts so that when rain gauge is inserted into bracket, top of gauge is about 2 inches above top of post. The gauge itself is a Tru-Chek rain gauge that measures down to less than 1 mm.

- Finally, use a random number generator or random number table to obtain 10 random numbers between 0 and 70 (if site width is 100 m [because of 30 m veg plots]) and create a preliminary site map showing relative locations of vegetation plots and wells (see image 1).

General Directions

Select an area fitting the criteria outlined in the background section above. Measure out the site's shape to see if it will fit in the proposed location. Note: some sites are required by the funder to be in a certain area, regardless of a perfect fit, in order to capture specific information. Using compasses and tapes, determine the top 100 m and the side 200 m boundaries, leaving tapes on the ground. Check angles by laying out all four boundaries if possible. Write this angle down as it will be necessary to know for the entire site setup.

*In the following instructions, we mention moving directly north, south, east, or west. This is **only** if the site is oriented directly north-south. In many cases, the site is tilted and so appropriate adjustments must be made. Make sure everyone knows the angle of the site, and measure everything on that angle!*

<u>Marking locations:</u>

1. Mark off the side boundaries with white flags at 12.5 m, 32.5 m, 52.5 m, 72.5 m, etc. to 192.5 m (see image 1). (The ten divisions of each site are in 20 m increments. Vegetation transects are based 7.5 m off of these lines, so using 12.5m, 32.5m, etc. shortcuts one step.)

Vegetation transects:
2. Go to the white flag at 12.5 m along the western boundary. Use the first number from your random number list to determine the distance of how far into the study site to proceed for the 'A veg plot' (in this case, 64 m).

3. Carefully, using a compass to maintain the correct angle, head east and place a blue pin flag at the location determined by the random number. Label this flag with its transect letter corner of veg plot it represents (for example "A SW"). Measure out 5 m north (or at the appropriate angle if the site is slanted) and mark your NW corner of the veg plot with a blue flag labeled "A NW."

4. Maintaining the correct angle using a compass, walk 30 meters east to place your SE corner of the vegetation plot, marking it with a blue flag labeled "A SE." Measure out 5 m north and mark your NE corner with a blue flag labeled "A NE." Leave your measuring tape on the ground.

Litterfall tubs:
5. At the 15 m mark of your tape, go 1 m south and install a green flag with the letter tub on it ("A" in this case).

6. Return to western boundary and move to the white flag at 32.5 m. Note the second random number and repeat steps outlined in "Vegetation transects" and "Litterfall tubs." Be careful to maintain the correct east-west angle using a compass!

Pitfall traps: Install flags for pitfall traps along transects B, D, F, H and J, noting the trap numbers (see image 1).
7. For transect B, with your 30 m tape on the ground for the south vegetation line, go 1 m south of the "B SW" blue flag and place an orange flag labeled "4."
8. Walk east 10 meters along your 30 m line, head 1 m south and place a second orange flag here labeled "3." Go another 10 m along your 30 m line, head 1 m south and put another orange flag labeled "2." Install the fourth and orange flag labeled "1"1 m south of the "B SE" corner.

Groundwater wells:

Site Setup and Installation
Standard Operating Procedures

1. The center well is usually at the center of the site, at the 100 m mark on the north/south boundary and 50 m mark on the east/west boundary (see image). Using tapes and compasses, measure out this location and mark with a yellow flag with a “C” on it.
2. Again, using tapes and compasses, measure out 40 m north, south, east and west for the four additional wells. Mark these locations with yellow flags labeled with the appropriate letter of the well (N, S, E, W). Move location of the well slightly (up to 2 m away) if necessary.

Installing equipment

Rebar:

1. Pound 1 ft x 5/8 in-long rebar where each blue or orange flag has been placed.
2. Paint rebar blue or orange (according to flag color) and tag blue rebar according to what corner you are at (e.g. “A NE”) using Impress-O-Tags. Bury tags in dirt.

Litterfall tubs: Install litterfall tubs where green flags are located.

1. Place litterfall tub on ground.
2. Pound in three 1-foot long wooden stakes around tubs to secure its location.

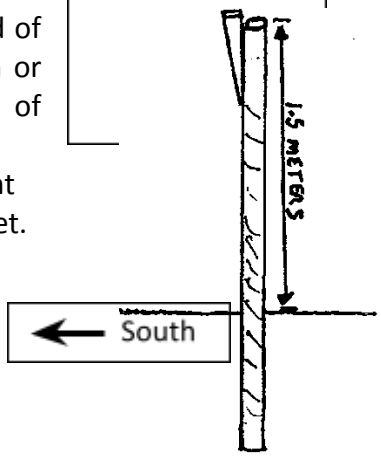
Pitfall Traps:

1. Within six inches of the orange rebar, dig a hole with a trowel so the lid of the cup is flush with the surface of the soil.
2. Install the cup with the hole in the bottom into the hole in the ground and place the solid one into that one.
3. Place the plastic lid on the top cup. If the soil does not come right up to the edge of the lid, re-dig the hole.
4. Cover the closed cups with the appropriate wooden lid. Ensure the correct number is on the underside, labeled with a Sharpie.
5. Press the wooden lid down into the ground.

Rain gauges:

1. Under a dense canopy, use the auger to dig a hole so that 1.5 m of the post will remain above ground once it is set (see image 2).
2. Set post securely in ground and pack soil around post with the end of the shovel. Ideally, install the post so that the gauge will face south or southeast so that in winter months, ice will have a better chance of melting.
3. Place rain gauge in bracket and pour vegetable oil in gauge (to prevent water from evaporating out of gauge). Record that amount on data sheet.
4. Repeat process for rain gauge to be placed in open area.

Image 2: Installation of a rain gauge



Groundwater Wells:

The following pages include instructions on how to install a well (by Jim Thibault, UNM Department of Biology). In addition to these directions, be sure to mark the inside of the well cap with the letter corresponding to which well it is (N, S, C, E, or W), and fill in the space between the notches at the top of the well with black Sharpie.

BOSQUE PVC GROUND WATER MONITORING WELLS JRT June 02

I. Introduction

Shallow ground water (GW) wells are used in the bosque to monitor water table (WT) elevations and to provide representative water chemistry samples from the saturated zone. Networks of wells can be used to determine shallow subsurface flow paths and spatial and temporal biogeochemical characteristics of the GW.

The wells are composed of 2-inch internal diameter PVC pipe with a solid upper casing and an intake that intersects the WT. The intake is the screened segment of the well through which GW flows. In the shallow, mostly unconfined aquifers typical of the bosque research sites, the water level in the well is a good indicator of the depth to the water table (DWT).

Piezometers differ from monitoring wells in that they are constructed with a very short intake and are designed to measure hydraulic head from pressure head and elevation head. The water level in a piezometer generally does not give the direct position of the WT. Nested piezometers set at various depths are used to measure GW gradients and to construct flow nets. However, they are less suited for biogeochemical sampling than monitoring wells because the short intake restricts yield and represents a limited region of the saturated zone.

If possible, the well intake should be of sufficient length to encompass the range of expected WT elevations (Fig. 1). This may not be possible during flooding and high flows or during very dry periods with low flows.

The optimal time to install wells is during baseflow when low WT elevations facilitate hole boring in the bosque. Baseflow conditions depend of course on weather conditions, and vary in time and space along the Middle Rio Grande. We have observed low flows during:

1. April, when irrigation begins but prior to peak snowmelt runoff.
2. Late June, post snowmelt peak and prior to summer monsoon season.
3. Late September/early October, post monsoon season but before the end of irrigation season.

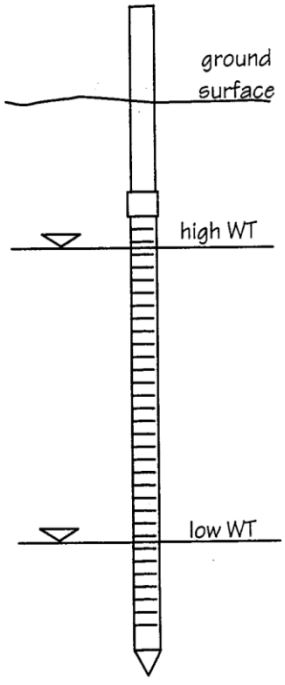


Figure 1. Intake screen should capture range in WT elevations if possible.

II. Supplies, Tools and Equipment

A. Supplies (available at Rodgers & Co., Inc., Isleta SE, ABQ--UNM POs accepted)

- PVC pipe--2" ID Sch 40, screened (0.01" or 10-slot, $30.30/10') for intake and solid ($5.60/10') for casing. Amount depends on DWT, flooding vs. non-flooding site, etc. Pipes come in various lengths, are sold by the foot, and come with male and female threaded ends. Solid pipe ends are also sold unthreaded, some with built-in coupling. Unthreaded solid pipes w/coupled joints are less likely to break during well insertion.
- 2" PVC drive points, male and female threaded ($7.50 ea) depending on your screened pipe ends. Slip-type points that are inserted into non-threaded screen pipe are also handy for cut lengths of screened PVC, but may not be available at Rodgers. 1/well.
- 2" slip couplers to join pipes as needed--depends on # of solid PVC ends w/built-in coupling, but slip couplers are handy for extending well lengths, etc. ($1.40 ea).
- 2" PVC well caps--slip type ($1.10 ea). 1/well. Locking types available, $15-20 each.
- PVC primer and cement for some joint connections, e.g. slip points w/cut screen pipe.
- Bentonite--to seal annular space near surface, sold in 50# bags ($7.40) as Hole- or Kwik-Plug. Go w/3/8" chips vs. pellets (costly) or powder. Enough for several wells.
- Silica sand--size 10-20 ($6.20/50# bag), for the well filter pack. Plan on ~ 1 bag/well.

B. Tools/Equipment

- Soil auger w/4" bucket and extensions, 2 adj. wrenches and strap wrench
- San Angelo rod w/spade end for breaking up roots, hard soils
- Steel rods for packing sand--1-2, 1 long enough to reach near depth of well if possible
- Fence post driver that fits over PVC pipe
- Sledgehammers--1 large (10-12-lb. head), one small (for packing rods, etc.)
- Sledgehammer blocks--~15" L 4"x4" blocks w/hole bored part way through that fits over the 2" PVC pipe (also bring pieces of 2x4 wood)
- Pipecutter--for ≥ 2" pipe
- 10 m graduated ½" PVC pole for measuring depths in bore hole
- Water level indicator (beeper)
- Tape measure (w/metric highly preferable)
- Well bailer
- Duct tape, hacksaw, large screwdriver, WD-40, pipewrench, shovel
- Spray paint--cans of gray and brown spray paint to camouflage wells as needed
- Compass (or GPS unit), 100 m tape, flagging, loppers, and bow saw for siting well locations
- Sediment sampling materials--Whirli-bags, dumping bin, trowel
- 5 gal bucket--for supplies and to stand on if necessary, e.g. starting the well driving

C. Misc--head protection (hard hats/goggles), work gloves, site keys & permits, fieldbook, pencil, calculator, black sharpie, drinking water, bug spray

III. Well Installation

A. Bore Hole

- Auger down to WT, collecting sediment samples for texture analysis if desired. The seds should be sloppy-wet at the WT. If just damp you may have only reached the capillary fringe--keep digging.

- At the WT the hole will collapse and boring deeper will be limited. Use the auger to try to work (loosen) the seds at the WT and advance the hole as best you can (Fig. 2). This will facilitate driving in the well. Estimate DWT using the PVC rod or beeper.

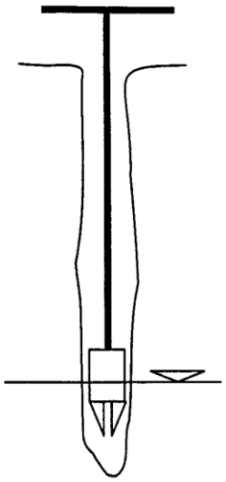


Figure 2. Work the seds with the auger to to advance the hole.

B. Assemble the Well

- Determine the intake length based on the DWT. Try to extend the well ~ 75 cm below the WT (more if WT is not near baseflow). The intake should end up ~ 25 cm below ground. So, cut the screened PVC to the DWT plus 50 cm (Fig. 3) It's best to use the pipecutter to ensure that connections are tight.

- Attach a drive point and a length of solid PVC for the casing to the intake screen. Use male/female or slip-type points and slip couplings as necessary. Use PVC primer and cement if necessary. The solid PVC should be long enough to cover the 25 cm below ground depth and to fit the fence post driver (150 cm is a good length).

- Now that the well is assembled, measure the effective screen length (Fig. 4), correcting for sections covered by couplings, etc. For example, a slip-type drive point inserted into a cut piece of screened PVC pipe will eliminate ~3.3 cm of intake.

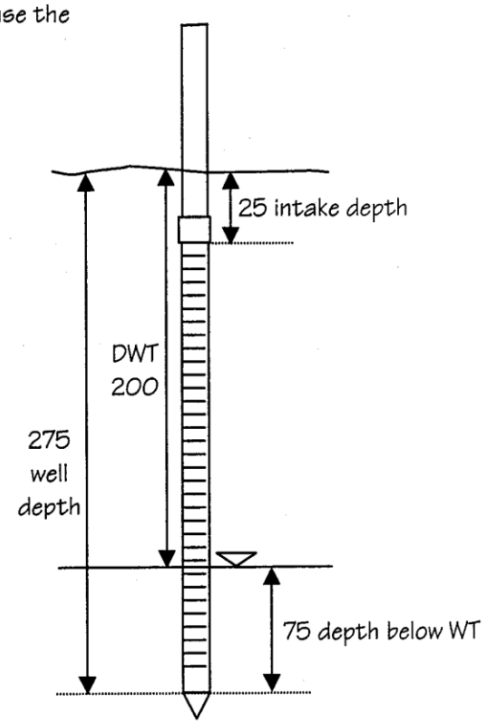


Figure 3. Determine intake length. For example, if DWT = 200 cm, cut 250 cm of screen length.

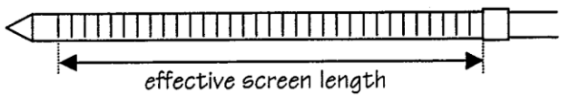


Figure 4. Measure effective screen length.

- Measure the well from the bottom, marking the casing at convenient intervals (e.g. 10 cm, Fig. 5). Also mark the casing at the point at which the well driving should stop, i.e., ~25 cm above the intake.

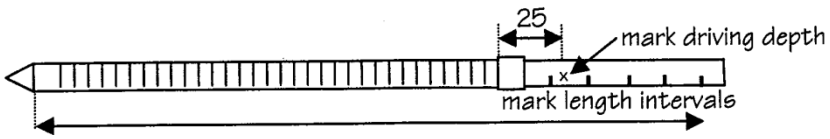


Figure 5. Mark length intervals and the endpoint on the casing before driving the well into the ground.

C. Insert the Well

- Drive the assembled well into the bored hole, working it in by hand as deep as possible.

- Cover the top of the well casing with a couple of strips of duct tape.

- Drive the well to the desired depth using the fence post driver or by placing a wood block atop the casing and striking it with the sledgehammer (the block will need to be held in place by a crewmember--wear your hard hat, goggles and gloves). The sledgehammer can also be used to advance the fence post driver if it becomes too difficult to advance by hand--use a 2x4 scrap atop the post driver. With either method, don't slam too hard or you risk shattering the well, particularly the intake. This is the main reason that it's best to install wells at baseflow, since the hole can be bored deeper and pounding the well is minimized. Hammering may require a bucket or stepladder to stand on.

- When the well is at the desired depth, record the depth to intake, e.g. 25 cm. If the well was driven to a point above or below the mark you made on the casing, compute the difference.

D. Pack the Well

- Temporarily cap the well.

- Fill the annular space around the well with the filter pack (silica sand). The filter pack enhances well yield and helps filter out fine materials that can accumulate in the well and clog the intake. Pour some sand, pack, and repeat as necessary (see next step).

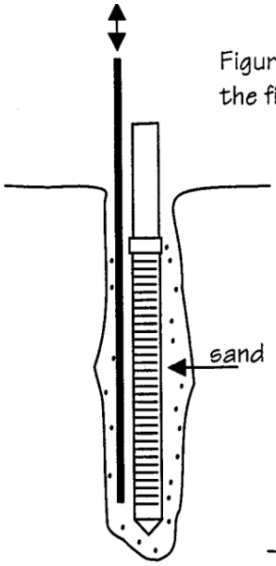


Figure 6. Tamp the filter pack.

- Tamp the sand with steel rods (Fig. 6) to eliminate gaps and make a tight packing. Wiggle the well to help move sand down the borehole. Fill and pack to just above the coupling between the intake and the casing. The well should be packed tight, difficult to spin by hand.

- Next, fill and pack with some of the extracted bosque sediments to within ~ 10 cm of the ground surface, then add a thin layer (~2-3 cm thick) of bentonite around the casing (Fig. 7). Pour a couple of bailers' worth of water onto the bentonite and allow to soak in. Fill the remainder of the hole with more of the extracted sediments and pack tightly around the base of the well with a short blunt object, e.g. the end of a hammer or wrench. Don't use the long rod, which could trash your bentonite layer.

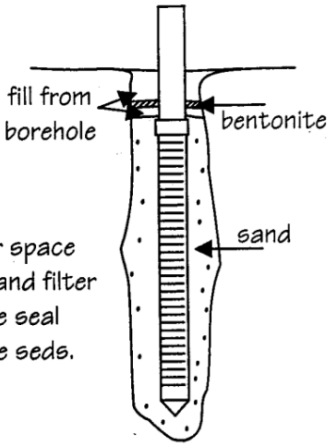


Figure 7. The annular space should include the sand filter pack and a bentonite seal sandwiched by native seds.

E. Well Specs

- Adjust the casing height to the desired length by cutting or extending with a coupler, e.g. ≤ 20 cm in non-flooding sites, above potential flood level in flooding sites. A pipecutter makes a more level cut than a hacksaw and eliminates PVC shavings.

- Cut 2 notches in the casing ~ ½" apart with a hacksaw (Fig. 8). This area serves as the tape position when beeping the well.

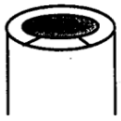


Figure 8. Cut two notches at top of casing to locate beeper tape.

- Label the well on the inside and outside of the casing.

- Beep the well. Measure the casing height, the distance from the base of the well at the ground surface to the rim at the top of the casing between the 2 notches. Calculate and record the well specs in your fieldbook (see next page). It is helpful to sketch the well and fill in some of these data, similar to Fig. 9, next page.

- Effective screen length (measured before you installed well): _____
- Intake depth (determined before you packed the well): _____
- Casing height (CH): _____
- Total well length (TWL, measure from marked intervals on casing): _____
- Well depth (TWL - CH): _____
- Beep: _____
- DWT (beep - CH): _____
- Depth below WT (TWL - beep): _____

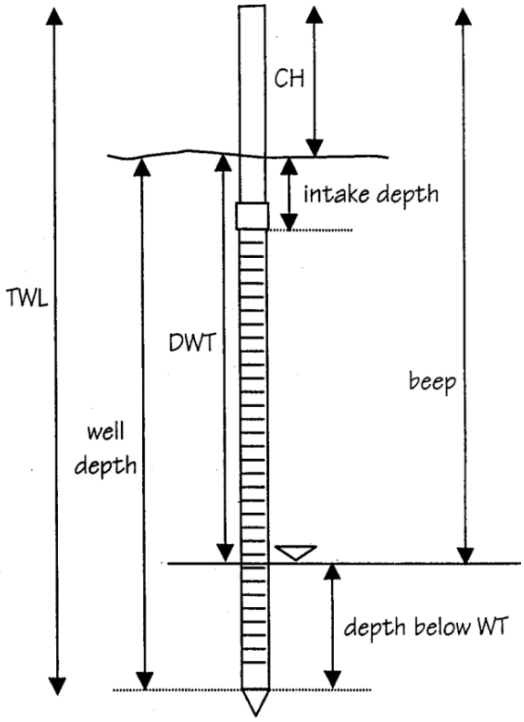


Figure 9. Well specs.

- Other info that might be useful to hydrogeology types:

-Auger/borehole diam.: 10 cm (4")
-Intake diam.: 5 cm (2")
-Casing diam.: 5 cm (2")
-Screen slot size: 0.25 mm (0.01")
-Filter pack: 10-20 mesh silica sand
-Surface seal: 3/8" bentonite chips

F. Work the Well

- Wells should be worked extensively after they are installed to clear fine materials and leach solvents if used (PVC cement).

- Elevate and drop the bailer several times to flush fines, etc. out of the well and filter pack annular space. Also bail the well several times. Cap the well LOOSELY.

- Wells should be worked regularly, especially prior to GW sampling.

- Make the well inconspicuous if it is in area susceptible to vandalism. Dry off the well casing and apply a coating of gray spray paint, then a few splotches of brown spray paint. Try to hide the well with branches, leaves, etc.

This procedure document has been approved by _____Kim Eichhorst_____

Date ____9/29/2017_____