FIELD PROCEDURE. INSTALLATION OF GROUNDWATER MONITORING WELLS

1. APPLICABILITY

This document describes the standard field procedures used to install groundwater monitoring wells.

Additional requirements can apply to groundwater wells that are required for pumping purposes (whether for testing, remediation or for water supply), and these should be determined on a project-specific basis.

2. OBJECTIVE

The reasons for installing groundwater monitoring wells include long-term monitoring of water levels, establishing the presence of aquifers, aquicludes and aquitards, measurement of hydraulic gradient, collection of representative samples of groundwater for chemical analysis or field testing, and to enable testing of the properties of the formation in which the well is installed (e.g. hydraulic conductivity, transmissivity).

Prior to well installation, the objectives of the project and the environmental conditions at the site must be taken into account in order to establish a suitable well location plan and well design.

3. WELL DESIGN

Potential well designs should be pre-determined as required by the specific objectives of the work and the conceptual model. The conceptual model and well designs should be constantly reviewed and updated.

Prior to mobilisation, the well design and installation materials required must be communicated to (and understood by) the well installation contractor.

The primary materials commonly used in monitoring well construction are:

- well screen (slotted pipe which enables infiltration of groundwater),
- casing (solid walled pipe),
- end caps,
- filter pack,
- bentonite,
- cement grout and
- well covers.

All materials should be free of contaminants that could affect the quality of the groundwater system. The materials to be used should be stored in an uncontaminated environment and should be inspected on site (and decontaminated as required) prior to installation.

Screen and Casing Materials

The well depth, construction techniques, material strength, and end use of the well should be considered prior to selecting the type and diameter of well screen and casing. PVC is used in preference, as it is resistant to most contaminants and corrosion.

Threaded pipe fittings will be used instead of glues (which have the potential for solvent cross contamination) or push fit (which have the potential to break / leak).

Watertight well caps (preferably secure screw-threaded) should be fitted at both ends of the installation to prevent sediment ingress at the base and ingress of surface spills or precipitation at the surface.

Screen Slot Size and Filter Pack Size

The well screen slot size, filter pack size and in situ geological grain size are all inter-related. Slot size and filter pack size should be selected to increase well efficiency and reduce the potential for the well to silt up. The well screen slot size is 0,2 mm and the filter pack size is 3-6 mm.

Screen Length

For groundwater monitoring wells, screens should generally be relatively short (e.g. 3 m) so that the aquifer properties and groundwater quality of a discrete vertical interval are tested. However, the screen length and placement must also take account of any likely tidal or seasonal fluctuations in groundwater level. Longer screen lengths may be required for pumping wells.

Unless deeper wells are required for whatever reason, groundwater monitoring wells should be screened across the groundwater table to enable the detection of LNAPLs.

Filter Pack

Filter pack is required for all monitoring wells, except those drilled in competent hard rock free from degradation or slaking.

Filter pack is placed in the annular space surrounding the well screen to prevent the ingress of sediment from the formation. Filter pack should be uniform, washed, granular material, preferably composed of non-reactive silica pea gravel. Calcareous material is not suitable because of the risk of it becoming clogged due to carbonate precipitates.

Filter pack should extend up 0,5 m above the well screen.

Annular Seal

In order to prevent the migration of vapours, water (or contaminants) from the ground surface and from overlying or adjacent formations into the monitoring well, an impermeable seal is required in the annulus surrounding the well pipe. Seals should extend as a minimum for 1 metre and also through any low permeability horizons. Ideally, seals should extend up to within 0,5 to 1,0 m of the ground surface.

Annular seals typically consist of bentonite clay / cement mix. Care should be taken with the use of pellets to avoid bridging in the annulus. Bentonite pellets should preferably be of the coated type,

to slow down hydration during installation and reduce the risk of 'bridging'. All dry bentonite (pellets) where installed should be suitably hydrated during/after installation, by addition of clean water.

It is preferable to have a minimum of 2 m long bentonite seals that are either placed using a tremmie pipe or, if pellets are used, that are well hydrated in the hole.

Headworks

Well headworks are the surface completions to the installations and will vary according to well location and design. Protective, lockable well covers should be installed to protect the monitoring well from surface contamination, vandalism and accidental damage.

All headworks could be slightly raised relative to their surroundings and well head chambers should be free draining to prevent collection of surface water within the chamber (permeable base or drain holes).

The concrete into which the well headworks are set should be sufficiently thick (e.g. 0,3 to 0,5 m of concrete in heavily trafficked areas) and extensive to minimise the potential for them to be damaged (e.g. upright covers may be knocked over if insufficiently supported, concrete around flush covers may crack due to traffic load, flush covers may subside below the surrounding ground level causing ponding of water around the well head).

The provision of protective bollards or guard rails around upright well covers should also be considered.

4. INSTALLATION

Suitably experienced professional contractors should be used to install monitoring wells, as the quality of the materials and installation is critical to the quality of monitoring data collected and the longevity of the well installation. The AECOM site representative should make sure that careful monitoring is maintained of groundwater strikes and changes in strata during drilling, as this information may be needed to determine the appropriate placement of the well screen. Particular care should be taken to avoid the following:

- Connection of aquifer units that are separated by intervening low permeability horizons. If more than one aquifer unit is encountered during drilling, this should be discussed with the Project Manager and the well design amended as appropriate. This may involve sealing of one or other permeable horizon, depending on the investigation objectives.

- Collapse of borehole prior to well installation. This should be avoided by the use of temporary well casing that is then gradually withdrawn after the well pipe is in place and as the annular materials (gravel or sand pack, bentonite) are installed.

- Well pipe and annular materials getting stuck in temporary casing and raised as the temporary casing is withdrawn from the well. This can be avoided by making sure the bottom of the temporary casing is kept above the top of the annular materials as they are gradually installed.

- Bridging of annular materials, creating voids into which formation or annular materials may later collapse, reducing the integrity of the well. To avoid this:

  - Install granular materials (gravel, sand, coated bentonite pellets) slowly and carefully, allowing time for particles to fall to the correct depth.

  - Monitor the volumes of annular materials being used and check that they are consistent with what would be expected given the annular volume being filled.

- Breakage of the well casing during installation. This can happen if the strength of the casing joints is insufficient to hold the weight of the casing string for the well depth. It can also happen if the driller attempts to connect up the well casing in a single length on the ground and then to feed it into the well in an arc but the casing does not have sufficient flexibility. These can be avoided by careful design of well materials of sufficient strength and by pre-planning of how to install the well screen and casing.

- Objects (for example, gravel, bentonite, pens) falling down the inside of the monitoring well. To avoid this, make sure a (temporary) top cap is placed on the well casing while the annular materials are installed.

The AECOM site representative should carefully measure and record the drilled diameter, installation diameter, well depth, position of filter pack and grouting in relation to the in situ geology. He/she should also record the lengths of casing used (e.g. 3 m), the lengths of slotted and unslotted sections (including adjacent to joins), the pipe connection method, and the quantities and types of annular materials used (bentonite, sand, gravel, grout). However, the AECOM site representative should not interfere or get in the way of the drilling foreman during installation.

During drilling of the borehole, the borehole atmosphere should be monitored at 1 m intervals using a landfill gas analyser and PID.

5. POST-INSTALLATION

Groundwater monitoring wells must be developed after installation.

The well location and elevation must also be accurately recorded by reference to GPS co-ordinates, detailed surveying and/or by reference to a detailed site plan. Ideally, the cover of each well should be marked on site with its reference number.