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14 May 2013

**RE: Groundwater and Ground Heat Exchanger – South East Regional Hospital, Bega NSW.**
**GeoExchange Project ID: GXA12-NSW-08**

Dear Chris,

GeoExchange Australia Pty Ltd (GXA) is pleased to provide the following response to questions about the interaction with the local aquifer and the Ground Heat Exchanger (GHX) proposed for the South East Regional Hospital in Bega, NSW.

**Background**
GXA has specialised in the design and installation of GHXs since 2006 and some of our design team have been working with the technology for over fifteen years. We are the leading providers of the technology in Australia.

We have installed a test borehole at the above site to a depth of 120 metres below ground level (mbgl) and so are familiar with the site. Further, my particular background is in hydrogeology and I have previously worked as a senior consultant in this field.

We have been asked to respond to the following:

Firstly, a brief description of the GHX itself and the materials of which it consists. In accordance with the International Ground Source Heat Pump Association (IGSHPA) (2011) guidelines, polyethylene (PE) or cross-linked polyethylene (PEX) pipe are the only materials permissible in the construction of a GHX. Further, the IGSHPA only permit in-ground fittings to be joined using thermal fusion methods, of which electrofusion is now the most commonly adopted in Australia. Mechanical or compression fittings are not permitted.

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The use of PE or PEX pipe that is joined by thermal fusion is considered international best practice in the installation of GHXs and is largely responsible for the large uptake of the technology internationally. Thermal fusion is a melting of the pipe to the fitting and thus produces a joint that is stronger than the original pipe.

Each borehole is grouted in place from the 'bottom-up' to eliminate air pockets and ensure thermal contact between the loop and the surrounding formation. The highly impermeable grout also serves to eliminate the infiltration of surface water into the aquifer and movement between aquifers.

**How are the loops tested for leaks after installation and upon commissioning?**

The QA procedure adopted during the installation of the test borehole identifies the measures taken to ensure that any pipework installed below ground is of appropriate integrity. A very similar process is adopted for the header manifold used to join the boreholes to the main plant room.

The QA procedure consists of a pressure test that is undertaken on the pipework before insertion into the borehole and again after installation. A similar test is then undertaken on each set of boreholes via their header manifold and thus the boreholes themselves are pressure tested on a minimum of three (3) separate occasions.

An independent witness sign-off from the Head Contractor, Client or appropriate representative is required on each pressure test. The standard pressure test requires a pressure of 100 psi to be maintained for a minimum period of thirty (30) minutes. It is noted that typical operating pressures in a GHX range from 30-70psi.

This testing regime is international best practise in accordance with guidelines developed by the International Ground Source Heat Pump Association (IGSHPA).

**How are leaks detected once the system is operating? Is there a need for a testing regime, or are leaks evident by a drop in pressure?**

Leak detection once the system is operational can be undertaken in a number of ways. Pressure drop is one indicator but is complicated by the typical presence of an automatic water top-up as well as seasonal variations in loop pressure as a function of heating and cooling cycles (*ie* pressure will reduce in summer as the loop gets warmer and the polyethylene stretches and vice-versa in winter).

Regular water testing as part of the standard system maintenance will indicate any dilution in the water treatment chemicals as a result of additional (tap) water added to the system. This dilution in any water treatment chemicals is the simplest and most reliable method. An alternative non-polluting indicator or tracer substance could be added to the system if required as a secondary way of determining the presence of a leak through dilution. However, regular testing of the corrosion inhibitor is considered sufficient and is part of the standard maintenance protocols.

**What is the repair/mitigation strategy if there is an underground leak detected? (fix if possible, otherwise cap off borehole?)**

The PE or PEX pipe loop in each borehole has either a single electrofusion fitting at the bottom of the borehole or is a pre-manufactured loop that does not have a fitting. Although slightly more expensive, the pre-manufactured loops eliminate the presence of any fitting down the borehole.

Each header set of boreholes can be valved off and isolated for any investigative works. Further investigative works can be undertaken to isolate the exact area of leakage without impacting the performance of the system. Decreasing the number of boreholes per header manifold will increase redundancy in the event of isolation but add to install cost. A system of this capacity would typically have 6 to 10 boreholes per header set.

**What is the liquid in the pipes? Can it be just plain water? What is the risk to the aquifer if it leaks (does it contain nasty chemical, what quantity of water/chemicals are involved?)**

It is understood that the mechanical specification requires standard scale and corrosion inhibitors that are molybdate-based and at a concentration of 1-2% of the total system water volume.

The system will be designed to not require anti-freeze agents by ensuring the minimum loop temperatures do not approach 0C. Insulation of any exposed pipework will further negate the requirement for an anti-freeze solution.

Thus the liquid in the pipe will be a water solution with a small percentage of corrosion inhibitor.

If you have any questions or require further information please do not hesitate to contact the undersigned.

Yours sincerely

Yale Carden
GeoExchange Australia Pty Ltd