Date: May 10, 2017

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to describe the field methods to be used for conducting pneumatic slug tests in order to determine the hydraulic conductivity of the formation materials surrounding the screened interval of a monitoring well. This method involves measuring the response of a static water-level to either the injection or withdrawal of pressurized air or nitrogen from the well.

During testing, water-level changes from the static with time are measured and recorded. A pressure transducer and a data logger are to be used to collect slug test data as they provide a means for collecting substantial, meaningful data over a short period of time, which is needed for analysis.

The pneumatic slug tests will generate data that will be used to determine the hydraulic conductivity at each well. This data will be used for evaluation of groundwater flow beneath the Site.

Commented [SMC1]: Please prepare SOP outlining data analysis methodology.

2.0 CONSIDERATIONS

Pneumatic slug tests will be completed at existing monitoring wells distributed across the Site. The tests will be conducted on the new 2-inch diameter wells installed as part of the Phase I Site Characterization. In order for a pneumatic test to be conducted, the entire length of screen of the monitoring well must be submerged beneath the level of standing water in well. Based upon water levels measured in July and August 2016, it is anticipated that approximately 38 of the 44 newly installed wells will be tested; however, the final determination of wells to be tested will be made based upon water levels at the time the testing is to be performed. If the water level is below the top of the screen, mechanical slug testing will be performed.

Commented [SMC2]: Please prepare SOP outlining mechanical slug testing methodology.

3.0 EQUIPMENT AND MATERIALS

a. Safety first. Obtain the appropriate Job Safety Analysis (JSA) and personal protection equipment (PPE), as specified in the site Health and Safety Plan (HASP).

b. Field notebook, field forms (i.e., Daily Log and Pumping Test Form).

c. Electronic sounding device (water-level indicator).

d. Pneumatic Slug Test Manifold Assembly consisting of:

i. Inlet and release valves.

ii. Pressure regulator.

iii. Tubing: 250 psi gas lines.

iv. Pressure and vacuum gauge.

v. Air-tight transducer probe port.

vi. Metal band clamps.

e. Data loggers and pressure transducers.

f. Compressed air.

g. Power inverter for vehicle 12V outlet.

h. Teflon® tape.

i. Adapter to attach pneumatic manifold assembly to the well casing.

j. Portable personal computer with (PC) Aqtesolv and Win-Situ software downloaded and appropriate cables.

k. Extra batteries for meters.

l. Decontamination supplies (including: non-phosphate laboratory grade detergent, buckets, brushes, potable water, distilled water, plastic sheeting, etc.).

m. Disposable Nitrile sampling gloves and cut-proof gloves.

4.0 PROCEDURE

4.1. Study the well boring log to define the length of the screen, depth of well, well casing radius and well boring radius.

4.2. Measure water levels (the depth to water below the predetermined measuring point on the well casing) in the test well to an accuracy of 0.01 foot several times prior to the slug test. The entire length of screen must be saturated in order to continue the test. If the water level is below the top of the screen, mechanical slug testing will be performed.

4.3. Enter all pertinent data concerning the well to be tested on the Pumping Test form and Daily Log form, and in the field notebook.

4.4. Measure the total depth of the test well to an accuracy of 0.01 foot, document the measured depth. Compare the measured depth to the as-built total depth of the well to ensure no appreciable sanding or silting (clogging) has occurred. If appreciable clogging has taken place, then the well must be redeveloped to re-establish good hydraulic connection between the well and the aquifer. Wells must respond quickly to changes in water levels.

4.5. Install the Pneumatic Slug Test Manifold Assembly with an adapter on well casing. Use Teflon® tape to seal the connection.

Commented [SMC3]: It might be beneficial to supply a photographic/illustrative guide to installation.

4.6. Determine the length of pressure transducer cable needed so that the pressure transducer is a minimum of ~~1.5~~ 5 feet below the static water level. Connect the pressure transducer to the data logger and laptop computer. Zero the pressure transducer in air. Insert the pre-cleaned pressure transducer into the assembly unit while monitoring the pressure until the pressure transducer is about ~~1.~~5 feet below the static water level. Seal the pressure transducer cable and rezero the pressure transducer. The transducer must be placed so that when the water level is depressed with air pressure the transducer is always below the water and above the top of the screened interval. When performing the initial slug test, allow the pressure transducer to equilibrate in the well for approximately 15 minutes, then check the calibration and rezero if necessary. The pressure transducer must be rezeroed before each test.

Commented [SMC4]: The transducer should be placed farther below the static water level to allow for variable displacements. It should be anticipated that more than one test will be performed, and that more than one displacement length will be tested (i.e., minimum 2 tests performed at 1 foot of displacement; minimum 2 additional tests at 2 feet of displacement).

4.7. Set up the data logger with the correct recording intervals and time-steps for measurements. The data logger should be set to take measurements at the smallest increment possible, typically four measurements each second or every 0.25 seconds.

4.8. Tighten the airtight fitting on the transducer cable by hand to seal the connection. Attach the transducer cable to the data logger connected to a 115 volt power supply (such as the power inverter from vehicle 12V outlet).

4.9. Check to make sure the release valve is closed, inlet valve is opened and the pressure regulator is closed.

4.10. Attach the compressed air to the quick connect at the pressure regulator. Open the valve for the compressed air to pressurize the well headspace. Prior to performing the first two-test sequence, ~~While watching~~ watch the air pressure gauge~~,~~ and adjust the regulator to set the air pressure in the headspace to 1 foot below the static level. When performing the second sequence, watch the air pressure gauge

and adjust the regulator to set the air pressure in the headspace to 2 feet below the static level.

4.11. Close inlet valve and leak check system. Monitor transducer response on computer screen and air pressure on gauge to verify that the system is stable.

4.12. Start the data logger to begin recording the data directly before initiating the pneumatic slug test. Allow 5 to 10 seconds to pass before test initiation.

4.13. Quickly open the release valve to initiate the pneumatic slug test.

4.14. Observe on screen that the data logger is recording the water-level data while water levels rise and the aquifer returns to static or near-static conditions (within 5%).

4.15. Review the data to determine if a meaningful test has been conducted. Repeat the test ~~two more times to evaluate the test reproducibility if deemed necessary~~ once more at the appropriate displacement, then move on to the next displacement level. A minimum of four slug tests, two at each level of displacement, should be performed at each well.

4.16. Transfer the data from the transducer and data logger to the PC each day to ensure that the data is backed up.

4.17. Secure the test well prior to leaving (i.e., replace cap and/or cover, and lock).

4.18. All reusable sampling equipment must be thoroughly cleaned in accordance with the Roux SOP 9.1 decontamination procedures. Discard any gloves, plastic, etc. in an appropriate manner that is consistent with site conditions and regulatory requirements, and if applicable, in accordance with any site-specific investigation-derived waste management plan.

END OF PROCEDURE