STANDARD OPERATING PROCEDURE No. 66.0
WELL DEVELOPMENT

R Squared Inc.
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Approved by: _____ **Date:** _____

Attachment A

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1.0 PURPOSE AND SCOPE

This Standard Operating Procedure (SOP) provides technical guidance and methods that will be used and procedures to be followed for developing groundwater monitoring wells. This SOP gives descriptions of equipment, field development procedures, field data collection, and personnel responsibilities.

The purpose of well development is to restore the hydraulic conductivity of the aquifer material surrounding the well to near pre-well installation conditions. This is accomplished by removing well drilling fluids, solids, or other particulates that may have been introduced or deposited on the borehole wall during drilling and well construction activities. Properly developed monitoring wells allow for the collection of representative groundwater samples.

2.0 RESPONSIBILITIES AND QUALIFICATIONS

The Project Manager or Field Manager has the overall responsibility for implementing this SOP. They will be responsible for assigning appropriate environmental staff to implement this SOP and for ensuring that the procedures are followed.

All personnel performing these procedures are required to have the appropriate health and safety training. In addition, all personnel are required to have a complete understanding of the procedures described within this SOP, and receive specific training regarding these procedures, if necessary.

All environmental staff and assay laboratory staff are responsible for reporting deviations from this SOP to the Project Manager or Field Manager.

3.0 RELATED STANDARD OPERATING PROCEDURES

The procedures set forth in this SOP are intended for use with the following SOPs:

SOP No. 5.0	Monitoring Well Installation
SOP No. 6.0	Water Elevation Measurements
SOP No. 8.0	Field Equipment Calibration
SOP No. 10.0	Decontamination of Sampling Equipment
SOP No. 13.0	Investigation Derived Waste Management
SOP No. 22.0	Purging and Sampling Monitoring Wells

4.0 EQUIPMENT LIST

The following items will be required to develop groundwater monitoring wells:

- Well completion logs
- Well development records (see Attachment A)
- Well keys

Attachment A

- Stainless steel, adjustable rate, submersible pump, controller, and power source (generator or battery)
- Surge block
- Teflon® or Teflon-lined polyethylene tubing
- Stainless steel or Teflon® bailer
- Mechanical reel or truck-mounted wireline rig (for deep wells)
- Water quality meters for temperature, conductivity, pH and turbidity
- Plastic sheeting
- Decontamination equipment and supplies (see SOP No. 10 Decontamination)
- Personal protective equipment (PPE) as outlined in the Health and Safety Plan (HSP)
- Organic vapor detector (on wells scheduled for volatile organics analysis)
- Graduated 5-gallon bucket
- Drums or other large container for storing development water
- Water-level probe
- Weighted tape measure
- Calculator
- New rope

5.0 MONITORING WELL DEVELOPMENT PROCEDURES

The initial static water level will also be measured before development begins and well purge volume requirements will be calculated.

Monitoring well development will be accomplished using a surge block and/or a bailer and a submersible pump to flush the screen, sand pack material, and borehole wall of drilling fluids and fine sediment resulting from well drilling and installation activities. This procedure also allows for the removal of fine sediment, which may have accumulated within the inner well casing.

The surge block will initially be operated with short, gentle strokes above the well screen intake. Development will begin at the static water level and move progressively downward to prevent the surge block from becoming sand locked. The surge energy shall be gradually increased at each depth. Surging shall be alternated with removal of the fines with a pump or bailer. Note that surging of low-permeability formations can result in a collapsed well screen. Development of fine-grained materials will be accomplished by a gentle action to avoid reducing the natural hydraulic conductivity.

Well development will begin no sooner than 24 hours after the well as been grouted and will consist of removing approximately 3 to 10 well casing volumes from the well, plus a volume of water equal to any additional potable water added to the borehole during drilling or well

installation. A well casing volume is determined by the following formula for 4-inch diameter wells:

(1) Well casing volume (gal) = Depth to bottom of well (ft) – Depth to water level (ft) x 0.65 (gal/ft)

(For a 2-inch diameter well, replace 0.65 with 0.16; and for a 6-inch diameter well, replace 0.65 with 1.48)

All depth measurements are taken from the top of the inner well casing at the designated measuring point. A weighted tape measure and electronic water-level indicator will be used to determine the depth to bottom of the well and depth to water level. These procedures are discussed in SOP No. 6.0 Water-Level Measurements.

Field parameters including pH, temperature, conductivity, and turbidity will be measured after each well casing volume has been evacuated. The calibration and operation of pH, conductivity and turbidity meters is discussed in SOP No. 8.0 Calibration of Field Instruments. The well will be developed until these field parameters have stabilized. Stabilized field parameters are defined as three consecutive readings where temperatures are within 1°C, pH readings are within 0.2 units, and conductivity and turbidity values are within 10%. If for any reason this cannot be accomplished, the well will be considered developed after being purged of 10 well casing volumes.

For slow producing wells (wells that do not fully recover within 8 hours), the wells shall be purged dry a minimum of three times. All purge water from the wells will be placed into an appropriate container and handled as IDW as discussed in the SAP.

All development equipment coming in contact with well water will be decontaminated in accordance with SOP No. 10.0 Decontamination, before each well is developed. Development equipment will be protected from the ground surface with clear plastic sheeting.

6.0 DOCUMENTATION

Documentation of observations and data acquired in the field will provide information on the activities concluded and also provide a permanent record of field activities. The observations and data will be recorded with waterproof ink in a permanently bound weatherproof field logbook with consecutively numbered pages, and on field data sheets.

6.1 WELL DEVELOPMENT RECORD

The following well development information will be recorded on the Well Development Form included as Attachment A.

- Well I.D. and location
- Date of well installation
- Date and time of well development
- Static water level from top of casing before and after development
- Total depth of well from top of casing

- Quantity of water used during drilling
- Volume of well casing volume
- Field measurements of pH, conductivity, turbidity, and temperature taken after each well casing volume has been evacuated
- Physical description of removed water throughout development
- Types of bailers/pumps etc. used to evacuate water
- Quantity of water removed and time of removal (incremental and total values)

6.2 FIELD NOTES

Field notes will also be kept during sampling activities. The following information at a minimum will be recorded in a bound field logbook using waterproof ink:

- Project name
- Names of personnel
- Weather conditions
- Well I.D. and location
- Date and times of well development

Attachment A: R Squared Inc.
Well Development Record

SHEET _____ of _____

Project Name:_____ Project No.:_____

Well ID:_____ Date Installed:_____

Casing Diameter:_____

METHOD OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe_____

Equipment decontaminated prior to development ☐ Yes ☐ No

Describe

_____

_____

CASING VOLUME INFORMATION

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION

Measured Well Depth (B)_____ft.

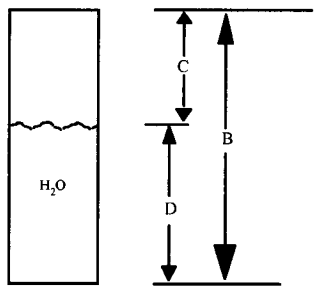
Measured Water Level Depth (C)_____ ft.

Length of Static Water Column (D)_____ - _____ = _____ft.
(B) (C)

Casing Water Volume _____ x _____ = _____gal
(A) (D)

Volume of Water Added to Well During Installation = _____gal

Total Purge Volume = _____ (gal)



Time	Pump Rate	Water Level Depth (ft)	Volume Removed (gal)	pH	Cond (mS/cm)	Temperature F or C	Turbidity (NTU)	Comments

Samplers Signature:_____ Date:_____

Table 2.3. Baseline Groundwater Sampling Plan - Final (1/4/08)
Centennial-Indian Springs -Powertech Uranium Corporation
R Squared, Inc.

Analytical Parameter	Maximum Contaminant Level (MCL, mg/L)	Secondary Drinking Water Standards	Analytical Method (a)	Reporting Limit, mg/L, unless otherwise specified (f)	Estimated Number of LAB QC Samples (b)		Estimated Number of FIELD QC Samples				Filter in field?	Preservation	Number of Container(s) Minimum Volume (d)	Sample Hold Time (from collection)
					MS	MSD or DUP	Field Dup	Trip Blank	Field Blank	Rinsate Blank (c)				
Dissolved Metals (mg/L) (e)														
Aluminum	none	.05 to .2	E200.7/E200.8	0.1	1 per 20 samples		1 per 20 samples	NA	0	1 per 20 samples	Yes	Filter (0.45 micron) then add HNO_3 to pH < 2	1-1 gallon poly with RAD analytes	6 months
Antimony, low level	0.006		E200.8	0.001										
Arsenic	0.01		E200.8	0.001										
Barium	2		E200.7/E200.8	0.1										
Beryllium	0.004		E200.7/E200.8	0.001										
Boron	0.75		E200.7	0.1										
Cadmium	0.005		E200.7/E200.8	0.001										
Calcium	none		E200.7	1										
Chromium	0.1		E200.8	0.01										
Cobalt	not listed													
Copper	1.3	1	E200.7/E200.8	0.01										
Iron	0.3	0.3	E200.7	0.03										
Lead	0.015		E200.8	0.01										
Lithium	not listed													
Magnesium	not listed		E200.7	1										
Manganese	0.05		E200.7/E200.8	0.01										
Mercury	0.002		E200.8	0.00025										
Molybdenum	not listed		E200.8	0.01										
Nickel	0.1		E200.7/E200.8	0.010										
Potassium	not listed		E200.7	1										
Selenium	0.05		E200.8	0.001										
Silver	not listed	0.1	E200.7/E200.8	0.05										
Sodium	not listed		E200.7	1										
Strontium	not listed													
Thallium	0.002		E200.8	0.001										
Vanadium	not listed		E200.7/E200.8	0.1										
Zinc	5	5	E200.7/E200.8	0.01										
Radiological (pCi/L)														
Gross Alpha	15		E900.0	1 pCi/L	1 per 20 samples		1 per 20 samples	NA	0	1 per 20 samples	Yes	pH < 2 with HNO_3	1-1 gallon poly with dissolved metals	6 months
Gross Beta	4 millirems/yr		E900.0	2 pCi/L										
Radon 222			SM-7500-RN B											
Radium 226	226Ra+228Ra=5		E903.0	0.2 pCi/L										
Uranium	0.03		E200.8	0.0003 mg/L - 0.2 pCi/L										
Organics														
BTEX	not listed													
TOC	not listed													
Non-metals (mg/L)														
Ortho phosphate, dissolved	not listed		E365.1	0.01	1 per 20 samples		1 per 20 samples	NA	0	1 per 20 samples	Yes	Filter (0.45 micron) then add H2SO4 to pH < 2	1 -250 ml poly	28 days (preserved)
Nitrate (as N), dissolved	10 (total)		E353.2	0.05	1 per 20 samples		1 per 20 samples	NA	0	1 per 20 samples	Yes	Filter (0.45 micron) then cool to 4°C	1-250 ml poly	28 days
Nitrite (as N)	1													
Total dissolved solids (TDS)	not listed		E160.1	10										7 days
Alkalinity (total as $CaCO_3$)	not listed			1										

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					MS	MSD or DUP	Field Dup	Trip Blank	Field Blank	Rinsate Blank (e)				
Bicarbonate (HCO_3)	not listed		EPA 310.1/A 2320B	1	1 per 20 samples		1 per 20 samples	NA	0	1 per 20 samples	No	Cool to 4 °C	1-500 ml poly	
Carbonate	not listed			1										14 days
Chloride	not listed	250	E300.0/ A4500 Cl B	1										28 days
Fluoride (mg/L)	4	2 mg./l	A 4500 F C	0.1										28 days
Hardness (total as $CaCO_3$)	Scale		A 2340 B	1										6 months
Silica	not listed		E200.7	0.1										28 days
Sulfate	not listed	250	E300.0/ A4500 SO4 E	5										28 days
Sulfide														
Total suspended solids (TSS)	none	500	E160.2	10										7 days

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					MS	MSD or DUP	Field Dup	Trip Blank	Field Blank	Rinsate Blank (c)				
Nitrate/Nitrite as N	11 (g)		E353.2	0.1	1 per 20 samples		1 per 20 samples	NA	0	1 per 20 samples	No	pH < 2 H2S04 Cool to 4 °C	1- 250 ml poly	28 days
Phosphate (PO4 as P)	none		E365.1/E200.7	0.01										28 days
Calculated Parameters/Data Quality														
Anions (meq/L)	none		Standard Methods 20th Edition & ASA Mono. #9, Part 2, Method 10-3.4 (SAR)	NA	NA									
Cations (meq/L)				NA										
Cation - Anion Balance (mg/L)				NA										
Hydroxide				NA										
Total dissolved solids				10										
Total dissolved solids - ratio				NA										
Sodium Absorption Ratio (SAR)				NA										
Field Parameters														
Depth to Water (ft)	NA		SOP 23.0	0.01	NA		NA	NA	NA	NA	NA	NA	NA	NA
Total Depth (ft)	NA			0.01										NA
Water Elevation (ft AMSL)	NA		SOP 6.0	0.01										NA
Temperature (°C)	none		SOP 8.0	0.1										Analyze immediately
Specific Conductance (mmhos/cm)	none		SOP 8.0	0.001 to 0.1 (range dependent)										Analyze immediately
pH (standard units)	6.5-9.0		SOP 8.0	0.01										Analyze immediately
Oxidation/Reduction Potential (mV)	none		SOP 8.0	0.01										Analyze immediately
Dissolved oxygen (mg/L)	none		SOP 8.0	0.01										Analyze immediately

Notes:

(a) Proposed/equivalent analytical methods may be used pending EPA approval.

(b) As applicable to the Method.

(c) Assumes no dedicated or disposable sampling equipment will be used and therefore, equipment blanks are necessary for groundwater, surface water and sediment samples.

(d) Parameters requiring the same preservation, similar container type and being analyzed by the same laboratory may be collected as one aggregate volume.

(e) MCLs are for total analyte concentrations only.

(f) The reporting limit (RL) is equivalent to the practical quantitation limit (PQL).

(g) Sum of MCLs for nitrate as nitrogen (10 mg/L) and nitrite as nitrogen (1 mg/L).

Total number of groundwater samples: 49 (26 existing RME wells + 23 new wells)

Refer to map XXX for monitoring well locations.