Appendix A

Water Monitoring Plan for the Sevier Playa Potash Project

June 4, 2019

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Sign-off Sheet

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Tom Suchoski/Rich White

Reviewed by ____

(signature)

Rich White

Approved by ____

(signature)

Tom Suchoski

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Abbreviations

ac-ft	acre-feet (ac-ft)
AF/yr	Acre Feet per year
AO	Authorized Officer
bgs	below ground surface
BLM	U.S. Bureau of Land Management
CPM	Peak Minerals Inc. (DBA “Crystal Peak Minerals”)
FCZ	Fat Clay Zone
HSU	hydrostratigraphic unit
MCZ	Marl Clay Zone
mg/L	Milligrams per liter
Plan	Water Monitoring Plan
Project	Sevier Playa Potash Project
SCZ	Siliceous Clay Zone
SITLA	State of Utah School and Institutional Trust Lands Administration
SOP	Sulfate of potash
Stantec	Stantec Consulting Services Inc.
SWCA	SWCA Environmental Consultants
t/ft^2	tons/square feet
TDS	total dissolved solids
TMDL	total maximum daily load
UDWQ	Utah Division of Water Quality
USGS	U.S. Geological Survey
UGWQS	Utah Groundwater Quality Standard
WDWQ	Utah Division of Water Quality
XRD	X-ray Powder Diffraction

1.0 INTRODUCTION

1.1 Background

Crystal Peak Minerals ("CPM") is proposing to construct and operate the Sevier Playa Potash Project ("Project") on federal, state, and private lands in Millard County, Utah (Figure 1-1). The Project would be designed to produce an average of approximately 328,500 tons per year of potash in the form of potassium sulfate (K_2SO_4), also known as sulfate of potash ("SOP"), as well as other associated minerals. CPM owns as lessee, or through agreement, controls the right to develop and operate potassium mineral leases on approximately 118,000 acres of land on and adjacent to the Sevier Playa administered by the U.S. Bureau of Land Management ("BLM"), and controls through agreement potash mineral leases on an additional approximately 6,400 acres of state lands administered by the State of Utah School and Institutional Trust Lands Administration ("SITLA").

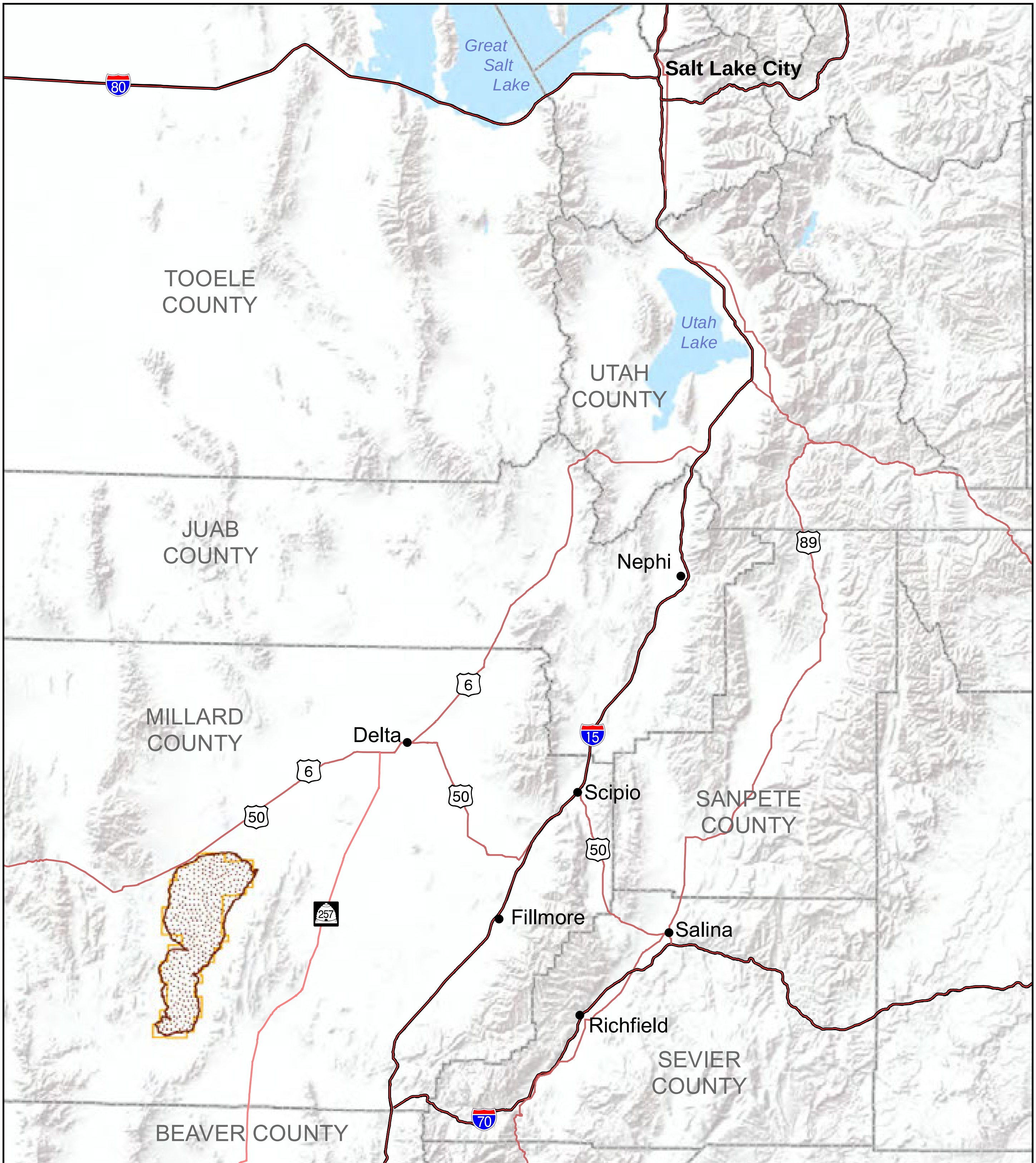
In general, the on-lease mining design for the Project would consist of the following three major features: 1) a brine extraction system consisting of canals, trenches, and wells; 2) a recharge system consisting of canals and trenches; and 3) a series of evaporation ponds consisting of preconcentration and production ponds (Figures 1-2 and 1-3). Details regarding the proposed activities are presented in the Mining Plan and Plan of Development. The brines extracted from below the surface of the Sevier Playa would be concentrated by solar evaporation in a series of Preconcentration Ponds. The brines would be further evaporated, and the potassium-rich salts precipitated in the Production Ponds would be harvested and transported to an on-lease Processing Facility. The salts would be processed at the Processing Facility to produce saleable SOP, as well as other associated minerals.

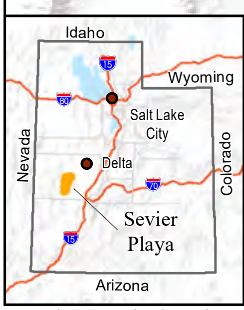
Infrastructure to support the Project would include: 1) access roads; 2) communication towers; 3) power and communications lines; 4) a natural gas pipeline; 5) a rail loadout facility and associated rail spur; and 6) water supply facilities (Figure 1-4). These components would all be located on off-lease lands.

The Utah Division of Water Quality ("UDWQ"), as the regulatory agency with jurisdiction over groundwater within the state, requires that a baseline assessment of the groundwater resources in the area be prepared as part of an anticipated Groundwater Discharge Permit application. Further, the federal lease held by CPM contains two special lease stipulations that require monitoring of surface and groundwater in the vicinity of the Project (BLM, 2011).

Special Stipulation 8 of the federal leases states:

> "The lessee at his expense, will be responsible to replace any water resources (that contain in a base line analysis of <10,000 mg/L TDS [total dissolved solids]), that are lost or adversely affected (quality or quantity) by their mining operations. . . . If replacement is required, the lessee shall replace the sources with an alternate source in the same quantity and quality to maintain existing uses. . . . The lessee/operator shall obtain sufficient baseline data and monitoring in order to establish parameters to show whether water resources are affected."





Sevier Playa Boundary

BLM and SITLA Lease Boundary

N

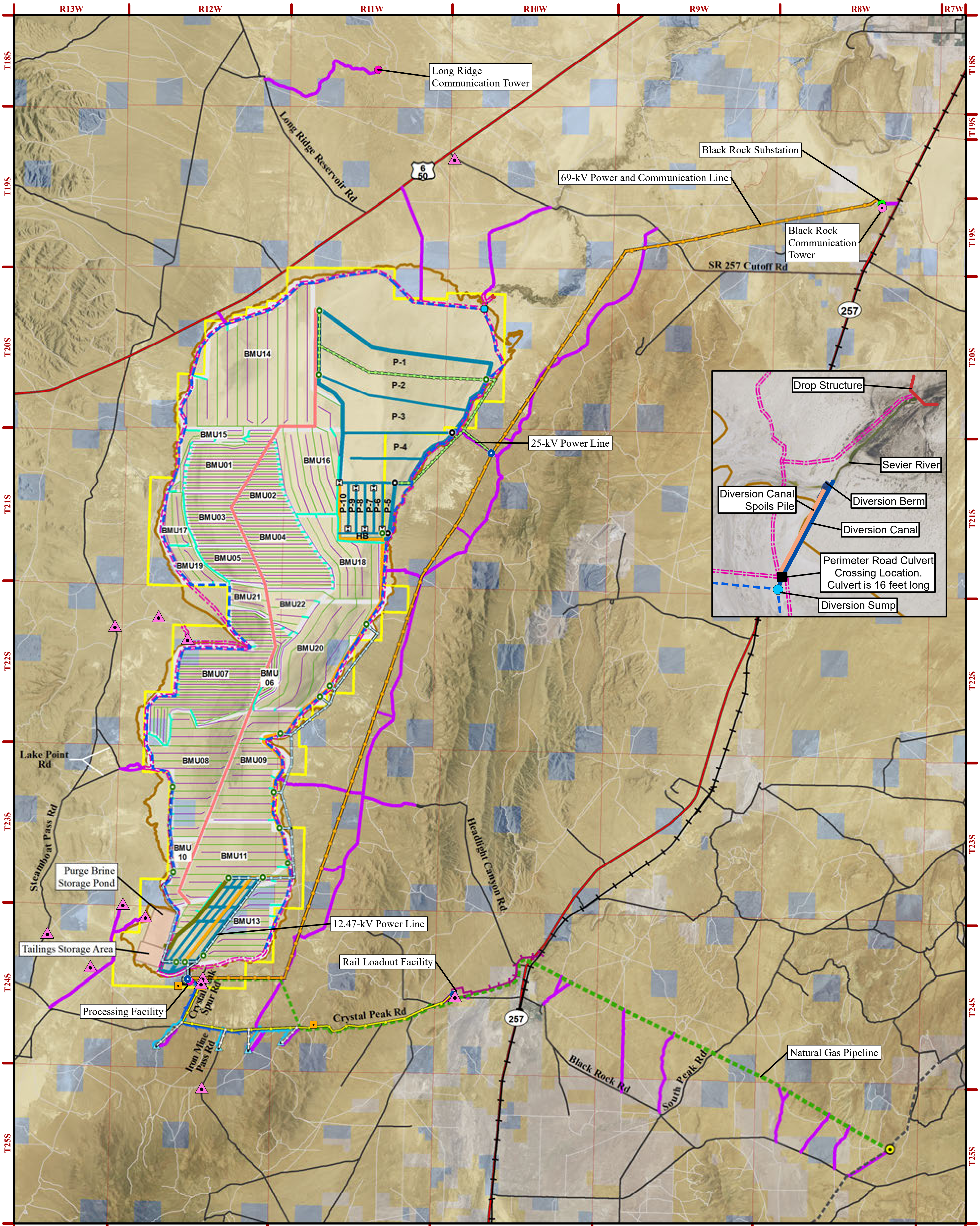
0 20 40 Miles

1 in = 20 miles 1:1,267,200

Sources:
Sevier Playa Boundary, SWCA 2015;
Roads, Utah AGRC 2013;
Terrain Basemap, ESRI 2017

FIGURE 1-1
Regional Vicinity

SEVIER PLAYA POTASH PROJECT



Proposed Project Features

- 69-kV Power and Communication Line
- 25-kV Power Line
- 12.47-kV Power Line
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line Spur
- Access Road - Off-Lease
- Perimeter Road and Spurs - On-Lease
- Rail Spur and Access Corridor
- Recharge Trench
- Extraction Trench
- Recharge Collector
- Recharge Canal
- Extraction Canal
- Brine Transfer Canal / Pipeline
- Purge Brine Pipeline
- Preconcentration and Production Ponds
- Pump Station - Off-Lease
- Pump Station - On-Lease
- Gravel Pit
- Preconcentration Pond Weir
- Water Supply Pipeline
- Water Supply Pipeline Spur
- Water Supply Well
- Communication Tower
- Substation
- Sevier River Diversion
- Brine Mining Unit Boundary
- Natural Gas Pipeline
- Water Monitoring Well

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township/Range Boundary
- Kern River Natural Gas Pipeline
- Kern River Valve Station
- Black Rock Substation
- US Highway, State Highway
- Class B Road
- Dirt Track Road
- Railroad

Land Ownership

- BLM
- State Lands
- Private

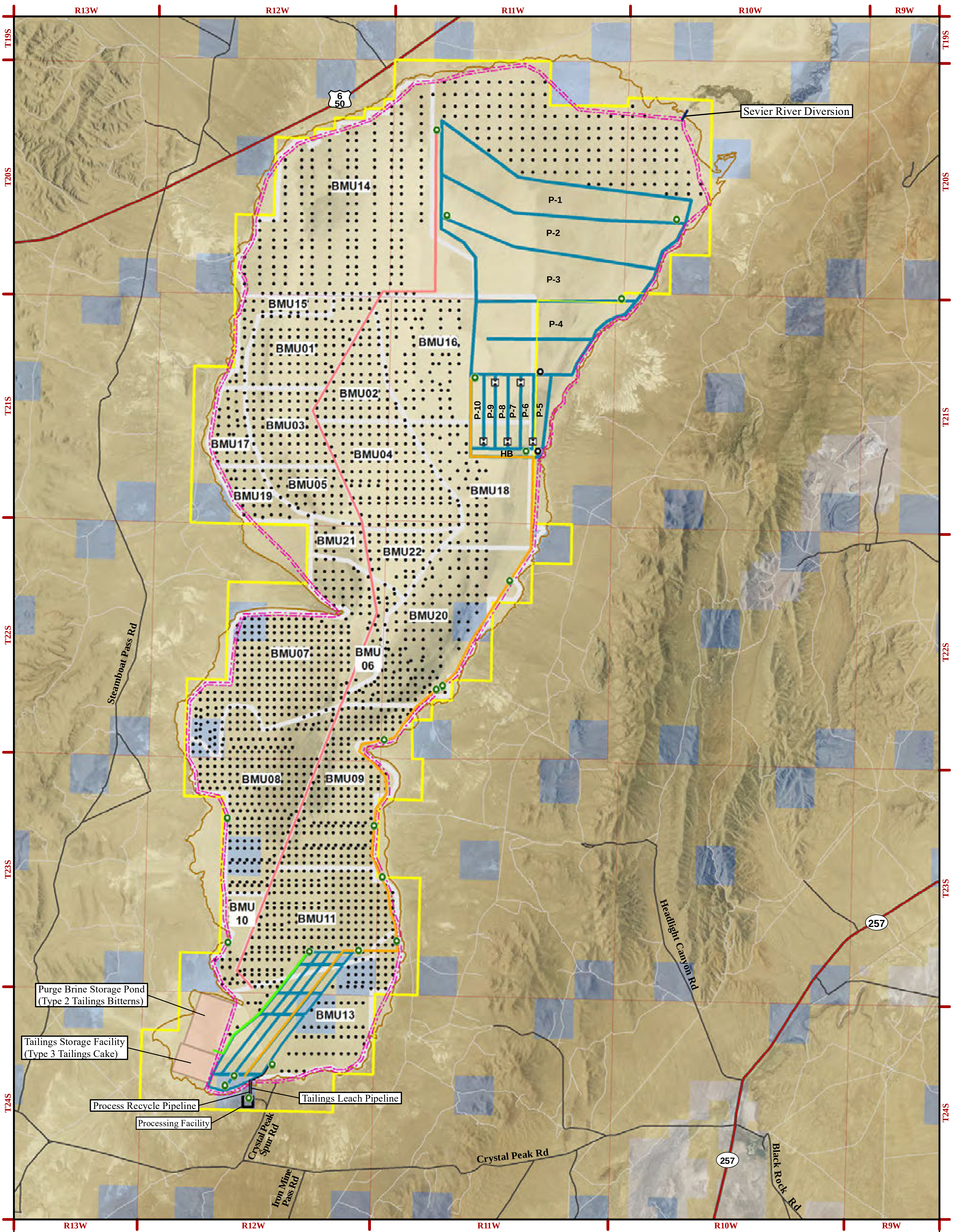
N 0 2 4 Miles
1 in = 4 miles 1:225,000

Sources:
Project features, Crystal Peak Minerals, 2015-2019;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Landownership, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Kern River gas pipeline, BLM 2011;
Aerial Imagery, USDA/APFO 2016

Note:
The rail facility and utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the Project.

FIGURE 1-2
Proposed Layout of Mine Facilities
WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

WMP Fig 1-2 - Project Facilities Overview 190402 4/2/2019 4:38:00 PM



Project Features

- Siliceous Clay Well
- Perimeter Road
- Brine Mining Unit Boundary
- Brine Transfer Canal / Pipeline
- Purge Brine Pipeline
- Main Extraction Canal
- Preconcentration Pond Weir
- Pump Station
- Pump Station - Off Lease
- Sevier River Diversion
- Tailings Area
- Preconcentration and Production Ponds
- Processing Facility

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Township and Range

Land Ownership

- BLM
- State Lands
- Private

N

0 2 4 Miles

1:150,000

Sources:
Project features, Crystal Peak Minerals 2015, 2016, 2017;
Sevier Playa Boundary, SWCA 2015;
Norwest, 2017;
Public land survey system, BLM 2013;
Roads, Millard County, 2013;
Aerial Imagy, NAIP 2016

Notes:
• The project facilities not drawn to exact scale to improve legibility of figure.
• The project facilities shown on this map are draft and may be revised and/or refined throughout the development of the project.
• All production extraction features will terminate at least 500 feet inside lease boundary.

Figure 1-3
Mine Plan Extraction Well Locations
WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT
10/26/2017

WMP Fig 2-3 Extraction Well Locations20171026 10/26/2017 4:17:27 PM

Proposed Project Features

- Water Supply Pipeline
- Water Supply Pipeline Spur
- 12.47-kV Power and Communication Line
- 12.47-kV Power Line Spur
- Water Supply Well
- Access Road - Off-Lease
- Processing Plant Perimeter Security Fence

General Reference

- BLM and SITLA Lease Boundary
- Sevier Playa Boundary
- Class B Road
- Dirt Track Road

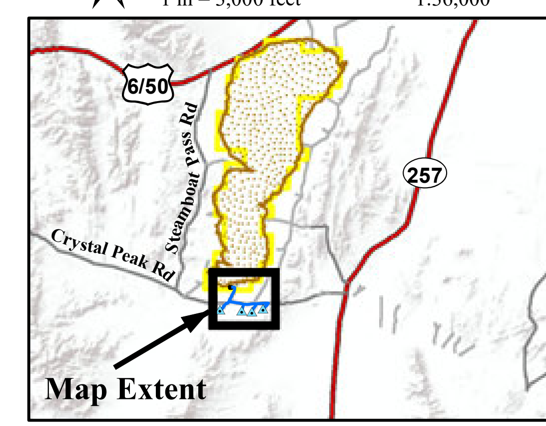
Land Ownership

- BLM
- State Lands

N

0 0.5 1 Miles

1 in = 3,000 feet 1:36,000



Note:
• The Utility siting areas shown on this map are draft and may be revised and/or refined throughout the development of the project.

Sources:
Project features, Crystal Peak Minerals, 2016-2019;
Public land survey system, BLM 2013;
Sevier Playa Boundary, SWCA 2015;
Land jurisdiction, BLM 2013;
Roads, Millard County 2013;
Aerial Imagy, USDA/APFO 2016

Figure 1-4
Water Supply and Distribution Facility Overview
WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

WMP_Fig_1-4 Water Well and Water LIne Overview190403 4/3/2019 11:47:37 AM

Special Stipulation 13 of the federal leases states:

> "Sufficient base line data shall be established prior to conducting any surface disturbing activity which shall be determined necessary by the AO [Authorized Officer]. In order to accomplish this, the lessee shall submit for review and approval by the AO a plan to analyze ground and surface water interactions as part of any operations or exploration on the leases. The plan shall be submitted prior to or concurrent with a Mining or Exploration plan, under 43 CFR 3592.1. The plan shall include, but not be limited to the following items, and shall describe how the lessee proposes to; (1) develop sufficient baseline groundwater information to document existing hydrogeology associated with Sevier Lake basin fill and underlying carbonates, encompassing a reasonable area of potential resources, springs, and the alluvial and bedrock aquifers. This shall include items such as the location, size, and depth of any hole that would encounter water and/or brine as well as any information that would be collected on each hole. (2) Determine the potential impacts to existing water right holders, wells, wetlands, and surface and groundwater throughout their operations. Water chemistry (including stable isotopes as necessary), estimated flow and water quantity (water balance) shall be addressed. (3) Monitor the actual impacts to groundwater resources throughout and surrounding the operation including but not limited to changes in meteoric precipitation and springs, wells (base conditions, water levels, and chemistry conditions prior to construction and monitoring after construction), wetlands, and ditches. Wells, wetlands, and springs (at sites determined to be relevant based upon the groundwater study that would be conducted prior to development) shall be monitored during operations in order to minimize potential impacts to groundwater resources by allowing an early identification. Further, the plan shall contain sufficient detail to allow it to be independently assessed and include such things as the type of groundwater model that would be used (and/or other methods of analysis), phasing of the analysis and proposed iterative studies. The plan shall also contain a list of people and their qualifications to accomplish the work and a list of deliverables with a timing schedule. The lessee shall be responsible for any cost incurred for the plan and the accomplishing of the work."

1.2 Plan Purpose

This Water Monitoring Plan ("Plan") was developed to address the applicable requirements of the above-noted rules and stipulations. Implementation of this Plan would be the responsibility of those individuals listed in Attachment A. The intent of this Plan is to provide a framework for the collection of both baseline and operational hydrologic data in the vicinity of the Sevier Playa to aid in assessing the impacts of the Project, if any, on surface and groundwater. Specifically, in accordance with Special Stipulation 13, this Plan was designed to:

1. Document baseline groundwater conditions associated with the playa sediments as well as the adjacent alluvial/colluvial sediments and the bedrock that underlies the region;
2. Provide sufficient data to evaluate the potential impacts of Project operations on existing water right holders, wells, riparian areas, surface water, and groundwater;
3. Provide a framework for monitoring hydrologic resources in the vicinity of the Sevier Playa to determine whether Project operations impact surface and groundwater resources near the playa, thereby allowing an early identification of impacts and the development of mitigation plans to minimize those impacts; and
4. Define a framework and schedule for evaluation and reporting of Project water-resource data.

With respect to Item 3 above, CPM would implement an adaptive management approach to the collection and evaluation of data under this Plan. This approach is summarized graphically in Figure 1-5. The first two phases of this cycle have been completed. However, under adaptive management, these phases would be re-visited over time. Future data collected under this Plan would determine the extent to which adaptations of the Plan and/or Project operations become necessary. Such adaptations may include the installation of new monitoring wells, changes to the analyte list, modifications to the frequency at which data are collected, alterations to the methods used to handle products, etc. As these adaptations are made, critical threats (e.g., contamination of local groundwater supplies) would be re-evaluated and future monitoring efforts would be modified, if necessary. The cycle would then continue.

The focus of this Plan is the collection of baseline data and documentation of baseline hydrologic conditions within and near the playa (i.e., Item 1 above). Hydrologic data collected prior to 2018 would also be evaluated under this Plan to determine the appropriateness of including these data in the Project baseline database. While this Plan would serve as a framework for monitoring hydrologic conditions during the period of Project operations (Item 3 above), experience gained during the baseline monitoring period may dictate modifications to ensure that the Plan remains appropriately focused during the operational period. Any such modifications would be submitted to UDWQ and BLM for approval before they are implemented.

The baseline and operational data would serve as the basis for evaluating the potential impacts of Project operations on baseline water resources (i.e., Item 2 above). Therefore, this Plan presents a discussion of the statistical evaluations and data-analysis methods that would be used to assess the extent and magnitude of Project impacts, if any, on water resources (see Attachment C). This evaluation would be ongoing during the course of operations and would be discussed in quarterly data submittals and annual water-monitoring reports as further described in this Plan.

For ease of review, this Plan is divided into five sections, including this introduction (Section 1). Section 2 provides information regarding the hydrologic setting of the Sevier Playa. A description of methods proposed for the collection and validation of historic and new baseline data is presented in Section 3, followed in Section 4 by a discussion of planned data-evaluation procedures. References cited in this Plan are presented in Section 5. Appendices follow the text.

Figure 1-5. Adaptive Management Cycle[1]

[1] Source: https://www.miradi.org/open-standards/

2.0 HYDROLOGIC SETTING

The area of interest associated with this Plan is shown in Figure 2-1. This area extends generally 3 to 4 miles beyond the lease area on the west, south, and east sides of the playa, with the western boundary of the area extending into the foothills of the House Range and Black Hills, the eastern boundary extending to the ridge of the Cricket Mountains, and the southern boundary extending to the foothills of the San Francisco Range. On the north, the area of interest extends north of US Highway 6/50 and northeast to Conks Dam.

The area of interest shown on Figure 2-1 is generally smaller than that being evaluated by BLM in their Environmental Impact Statement regarding the Project. However, this boundary was set to extend beyond areas where it could reasonably be expected that water resources may be impacted by Project operations. The monitoring network described in Section 3.0, which includes surface-water monitoring locations as well as several existing and proposed groundwater monitoring wells, is designed to evaluate potential impacts on surface and groundwater quality or on hydrologic conditions resulting from Project operations (including brine extraction, brine processing, and freshwater well pumping). If future data indicate that hydrologic impacts from this Project may extend beyond the area of interest shown on Figure 2-1, the monitoring network would be expanded accordingly to ensure that the extent of those impacts is properly assessed.

2.1 PHYSIOGRAPHIC SETTING

The Sevier Playa is a terminal playa at the downstream end of the Sevier River, the drainage area of which covers approximately 16,200 square miles. The Sevier Playa area is characterized by north-trending, block-faulted ranges and alluvial slopes that encircle the down-dropped sediment-filled Sevier Lake graben, which forms the lowest part of the basin (Wilberg 1991). The Sevier River enters the basin from the northeast, between the Cricket Mountains and Long Ridge. There is no surface drainage out of the Sevier Playa. Based on LIDAR data, the surface of the Sevier Playa is relatively flat, but slopes very gently to a low point in the southern part of the northern half of the playa.

The Sevier Playa is located in western Utah’s Sevier Desert, in a broad valley that is 10 to 15 miles wide and bounded on the east by the Cricket Mountains and on the west by the Black Hills portion of the House Range. South and southwest of Sevier Playa are the San Francisco and Wah Wah Mountains, respectively, which together flank the Wah Wah Valley (Figure 2-1). North of Sevier Playa, a portion of the topography slopes toward the playa as part of the gently south-sloping surface of the Sevier Desert. About 7 miles north of the playa, the topography divides and slopes to the north, away from the playa.

LEGEND

Sevier Playa Potash Project Water Resources Area of Interest

Sources:
Sevier Playa Potash Project Water Resources Analysis Area, Baseline Water Resources Technical Report for the Sevier Playa Potash Project, Whetstone 2017;
Land Jurisdiction, BLM 2013;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO/NAIP 2016

0 5 10 20
Miles

1 inch = 10 miles

N

Figure 2-1
Physiographic Location
WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

DEN D:\GIS\PEAK MINERALS\OPERATIONAL MONITORING PLAN\WMP FIG 2-1 PHYSIOGRAPHIC LOCATION 181023.MXD BRIAN DOUBEK 10/24/2018 1:51:20 PM

2.2 GEOLOGY

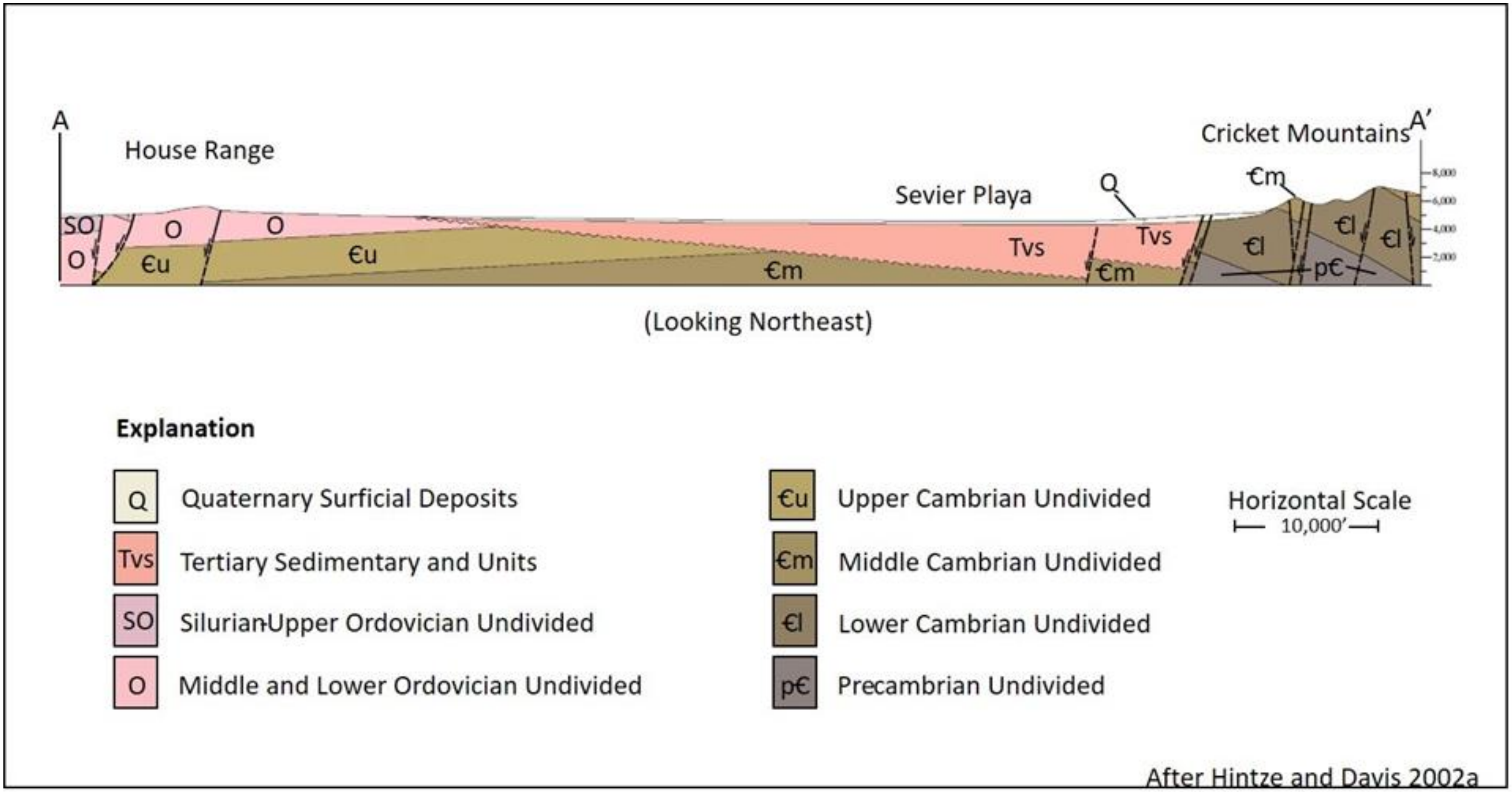
The Sevier Playa Basin lies within the Great Basin, an area of internal drainage within the Basin and Range physiographic province. The playa is a remnant of a succession of pluvial lakes (lakes fed by abundant rainfall during glacial periods) that formed during the Pleistocene epoch and culminated with the final high stand of Lake Bonneville approximately 15,000 years ago. Quaternary surficial materials were deposited in lacustrine and deltaic environments during the pluvial period, with playa and eolian environments developing as Lake Bonneville receded (Wilberg 1991).

The Sevier Playa is within an asymmetrical east-dipping graben between the Cricket Mountains and the House Range. The graben is bound to the east and west by high-angle normal faults. To the east, the faults are collectively referred to as the East Sevier Lake Fault Zone and are down-dropped approximately 4,000 feet to the west. Sedimentary fill near the east margin of the graben is estimated to be 4,600 feet thick (Case and Cook 1979). The West Sevier Lake Fault Zone is more loosely defined by high-angle normal faults near the north and central parts of the playa.

The Sevier Playa is composed of unconsolidated lacustrine, clayey sediments. Along the margins of the playa, these sediments interbed discontinuously with alluvial fan and colluvial deposits that generally consist of poorly sorted silt to cobble-sized material. These unconsolidated lacustrine, alluvial, and colluvial deposits overlie Cambrian to Ordovician-age limestone, dolomite, and quartzite (Hintze and Davis 2002a, 2002b), as indicated in the generalized stratigraphic cross section presented in Figure 2-2.

Tangalos et al. (2016) divided the Sevier Lake Basin into three hydrostratigraphic units (“HSUs”) consisting of the Playa HSU, the Alluvial/Colluvial HSU, and the Regional Bedrock HSU. Heilweil and Brooks (2011) and Wilberg (1991) varied in their terminology from that of Tangalos et al. (2016) but still noted similar geologic conditions consisting of unconsolidated basin-fill and playa sediments as well as regionally-extensive bedrock. The terminology of Tangalos et al. (2016) will be used in this document. The Playa HSU, which represents the localized brine aquifer that is of interest to the Project, is further described in Section 2.4.1 of this Plan.

Figure 2-2 Stratigraphic Cross Section



2.3 SURFACE WATER

2.3.1 Sevier Playa

Surface water flows onto the Sevier Playa from the Sevier River and local ephemeral drainages that flow only in response to snowmelt or high-intensity rainfall. The upstream use of surface water for agricultural purposes and upstream storage in retention facilities greatly limits the volume of Sevier River water that enters the playa. Furthermore, transmission losses due to evaporation and infiltration generally reduce or consume ephemeral runoff before it reaches the edge of the playa.

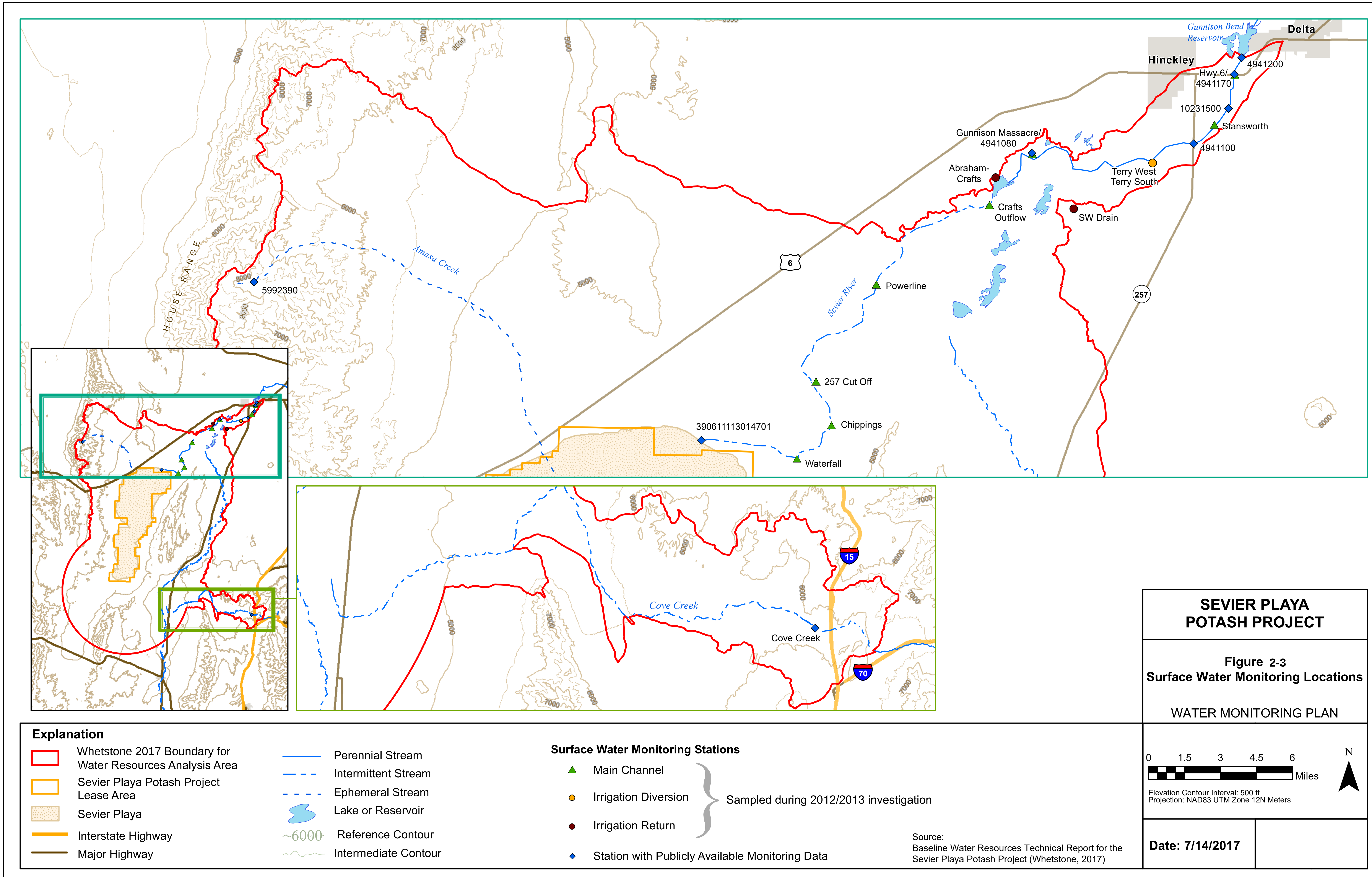
Satellite imagery acquired from August 1999 through August 2002 (Gwynn 2006) indicates that water on the surface of the Sevier Playa occurs typically during November through April, though likely amounting to only several inches in depth due to local atmospheric conditions and substantial flow control placed on the river by upstream irrigation reservoirs (e.g., Gunnison Bend Reservoir and DMAD Reservoir[2]). During the remainder of the year (May through October), the majority of the playa's surface is typically dry. However, periodic wet climatic conditions occasionally create substantial flow onto the Sevier Playa and cover the playa with water. For example, from 1983 to 1987, runoff of about 2.27 million acre-feet (ac-ft) in the Sevier River reestablished Sevier Lake, which reached a maximum lake elevation of 4,527 feet in June 1985. In late 2011 and early 2012, Sevier Lake received an estimated 250,000 ac-ft of water, resulting in widespread inundation of the playa and up to 4.5 feet of standing water in some locations. The historical record of surface water is not complete, but periods of abnormally wet climatic conditions that flood the playa appear to occur with a frequency of about once every two decades.

2.3.2 Sevier River Below Gunnison Bend Reservoir

Regulations promulgated by UDWQ in UAC R317-2-13.6a classify the Sevier River below Gunnison Bend Reservoir as a Category 3 waterbody that is designated as Beneficial Use Class 2B, 3C, and 4 waters (secondary contact recreation, non-game fish and other aquatic life, and agricultural use, respectively). A 6-mile segment (Figure 2-3) of the Sevier River, directly above Crafts Lake, is mapped by the U.S. Geological Survey ("USGS") as a perennial stream (USGS 2014). The remaining segments of the river below Gunnison Bend Reservoir are mapped as intermittent (UDWQ 2014).

Surface water quality is subject to Section 303(d) of the Clean Water Act, which requires States to identify streams and lakes that do not meet water quality standards for their intended beneficial use and to establish total maximum daily loads (TMDLs) for various pollutants. Utah's 303(d) listed streams and established TMDLs are summarized in the 2016 Final Integrated Report (UDWQ 2016). Sevier River is not 303(d) listed below Gunnison Bend Reservoir and does not have a TMDL.

[2] DMAD Reservoir gained its name from the four irrigation companies that cooperated to build the dam in 1959 that created the reservoir (Delta, Melville, Abraham, and Deseret irrigation companies).



Delta
Gunnison Bend Reservoir
Hinckley
4941200
Hwy 6/ 4941170
10231500
Stansworth
Gunnison Massacre/ 4941080
4941100
Abraham-Crafts
Terry West Terry South
Crafts Outflow
SW Drain
Amasa Creek
HOUSE RANGE
5992390
6
257
Sevier River
Powerline
257 Cut Off
Chippings
390611113014701
Waterfall
Cove Creek
Cove Creek
15
70
SEVIER PLAYA POTASH PROJECT
Figure 2-3
Surface Water Monitoring Locations
WATER MONITORING PLAN
Explanation
Whetstone 2017 Boundary for Water Resources Analysis Area
Sevier Playa Potash Project Lease Area
Sevier Playa
Interstate Highway
Major Highway
Perennial Stream
Intermittent Stream
Ephemeral Stream
Lake or Reservoir
6000 Reference Contour
Intermediate Contour
Surface Water Monitoring Stations
Main Channel
Irrigation Diversion
Irrigation Return
Sampled during 2012/2013 investigation
Station with Publicly Available Monitoring Data
Source:
Baseline Water Resources Technical Report for the Sevier Playa Potash Project (Whetstone, 2017)
0 1.5 3 4.5 6 Miles
N
Elevation Contour Interval: 500 ft
Projection: NAD83 UTM Zone 12N Meters
Date: 7/14/2017

Baseline surface water monitoring for the Project was performed for CPM by CH2M in 2012 and 2013 at several points along and near the Sevier River. The purpose of this monitoring was to assess streamflow and/or water quality below Gunnison Bend Reservoir. These baseline data can be supplemented with surface water data that are publicly available from sources maintained by the U.S. Geological Survey and the U.S. Environmental Protection Agency (Whetstone 2017). Locations where surface water data have been collected in the Project vicinity are shown on Figure 2-3. Streamflow data collected during 2012 and 2013 do not indicate a correlation between spring run-off or precipitation and flow in the Sevier River below Gunnison Bend Reservoir. This lack of correlation is not unexpected, given that flow in the river is highly controlled by upstream reservoirs, irrigation return flow, and groundwater seepage from Gunnison Bend Reservoir (CH2M 2015).

The Sevier River between the US Highway 6/50 and Stansworth monitoring locations (a river reach of 3.7 miles) experienced an increased flow up to 95 percent during 2012 and 2013 due to irrigation return water (CH2M 2015). During this period, the Sevier River continued to gain 3 percent water between the Conks Dam and Gunnison Massacre monitoring locations. Below Crafts Lake, the Sevier River transitions to a losing river, with an annual flow decrease of 13 to 18 percent during 2012 and 2013 over a distance of 18.8 miles (CH2M 2013). Although the magnitude of the losses and gains likely varies from year to year, the transition from a gaining river above Crafts Lake to a losing river below that location is probably consistent.

Water quality data for the Sevier River below Gunnison Bend Reservoir are available from four locations monitored by CPM (Table 2-1). Review of the CPM water quality data indicates that Sevier River below Crafts Outflow is well buffered sodium chloride water with variable TDS concentrations ranging from 884 to 4,700 mg/L. The highest concentrations typically occur in late fall and winter (October through March) sometimes with a secondary peak in April or May. This chemistry is consistent with UDWQ water quality monitoring at Deseret, Utah (No. 4941100), just below the Stansworth location (see Figure 2-3) that averaged 2,416 mg/L TDS for 186 samples collected between May 1980 and September 2014 (Whetstone, 2017). TDS concentrations in the Sevier River are typically greater than the agricultural standard (Class 4) of 1,200 mg/L at monitoring points closest to the playa. Review of water quality data collected from the Sevier River at the locations shown on Figure 2-3 indicates that water in the river sporadically exceeds the lowest Class 2B (recreation and aesthetics), Class 3C (non-game fish and other aquatic life), and Class 4 (agriculture) Utah State Class water quality standards for cadmium, lead, mercury, selenium, silver, zinc, and pH.

Table 2-1 Surface Water Samples Collected by CPM from Sevier River, below Gunnison Bend Reservoir

Parameter	Units	Lowest Standard Class 2B, 3C, 4	Crafts Outflow	257 Cutoff		Chippings	Waterfall
			Crafts Outflow SW-06102013 Lab ID # 1306182-005 06/10/2013	Sevier River Baseline Lab ID # 1202158-002 02/09/2012	257 Cutoff SW-06102013 Lab ID # 1306182-002 06/10/2013	Chippings 06102013 Lab ID # 1306182-001 06/10/2013	Waterfall SW-06102013 Lab ID # 1306182-004 06/10/2013
Major Ions and Solution Parameters							
Bicarbonate Alkalinity	mg/L $CaCO_3$	–	438.	240	352.	331	295
Carbonate Alkalinity	mg/L $CaCO_3$	–	<20	<40	<20	<20	52.9
Calcium	mg/L	–	192	55.9	191	199 J	153
Magnesium	mg/L	–	252	56	313	333	294
Potassium	mg/L	–	11.9	5.8	15.3	16.1	16.4
Sodium	mg/L	–	1,090	163	1,360	1,450	1,220
Chloride	mg/L	–	667	218	1,300	2,110	1,200
Fluoride	mg/L	–	0.675	0.365	0.646	0.701	0.622
Silicon	mg/L	–	14	4.98	5.9	<5	<5
Sulfate	mg/L	–	1,330	286	1,550	1,350	1,360
TDS	mg/L	1,200	3,900	884	4,700	4,700	4,100
Nutrients							
Nitrate	mg/L as N	4	<0.01	<0.01	<0.01	<0.01	<0.01
Total Orthophosphate	mg/L as P	–	<0.05	<0.05	<0.05	<0.05	<0.05
Metals (total)							
Aluminum	mg/L	0.087	<1	0.313	<1	<1	<1
Arsenic	mg/L	0.1	0.0297	0.00758	0.0293	0.0204	0.0151

Parameter	Units	Lowest Standard Class 2B, 3C, 4	Crafts Outflow	257 Cutoff		Chippings	Waterfall
			Crafts Outflow SW-06102013 Lab ID # 1306182-005 06/10/2013	Sevier River Baseline Lab ID # 1202158-002 02/09/2012	257 Cutoff SW-06102013 Lab ID # 1306182-002 06/10/2013	Chippings 06102013 Lab ID # 1306182-001 06/10/2013	Waterfall SW-06102013 Lab ID # 1306182-004 06/10/2013
Beryllium	mg/L	–	<0.01	<0.0006	<0.01	<0.01	<0.01
Boron	mg/L	0.75	<5	<0.5	<5	<5	<5
Cadmium	mg/L	0.00025	<0.0025	<0.00018	<0.0025	<0.0025	<0.0025
Chromium	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	0.009	<0.01	<0.00212	<0.01	<0.01	<0.01
Iron	mg/L	1.0	<1	0.227	<1	<1	<1
Lead	mg/L	0.0025	<0.01	<0.0004	<0.01	<0.01	<0.01
Manganese	mg/L	...	<0.0124	0.00842	<0.01	<0.01	<0.01
Mercury	mg/L	0.000012	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Selenium	mg/L	0.0046	<0.01	<0.0008	<0.01	<0.01	<0.01
Silver	mg/L	0.0016	<0.01	<0.0004	<0.01	<0.01	<0.01
Zinc	mg/L	0.12	<0.025	<0.00568	<0.0283	<0.025	<0.025

Note: Bolded values exceed lowest standard for Class 2B, 3C, or 4 water. Non-detect data with minimum detection limit above the standard were not compared to the standard.
The stations are listed in downstream order.

2.4 GROUNDWATER

2.4.1 Playa HSU

The stratigraphy of the brine-saturated sediments of the Playa HSU, in downward order from the surface, is divided into three lithologic horizons consisting of fat (i.e., cohesive, compressible, high plasticity) clay, marl (i.e., calcium carbonate-rich) clay, and siliceous (i.e., high silica, low carbonate content) clay (Figure 2-4). The Fat Clay Zone ("FCZ") has a low hydraulic conductivity. This dense grey clay is capped by a thin salt crust that is typically a few inches thick over most of the Playa but can range up to 18 inches thick in certain areas.

The FCZ extends to a depth of about 12 feet below ground surface ("bgs") and is comprised of two sub-horizons. The upper part of the FCZ consists of approximately 9 to 10 feet of homogenous, dense, plastic clay. This clay zone contains gypsum crystals up to 6-inches in diameter. Underlying this homogenous clay is a plastic clay zone that contains abundant organic material, commonly appearing as grass mats and root structures, likely representing a dry period when the Playa surface was covered by grassy beds. This organic clay zone is an important marker bed that represents the bottom of the FCZ.

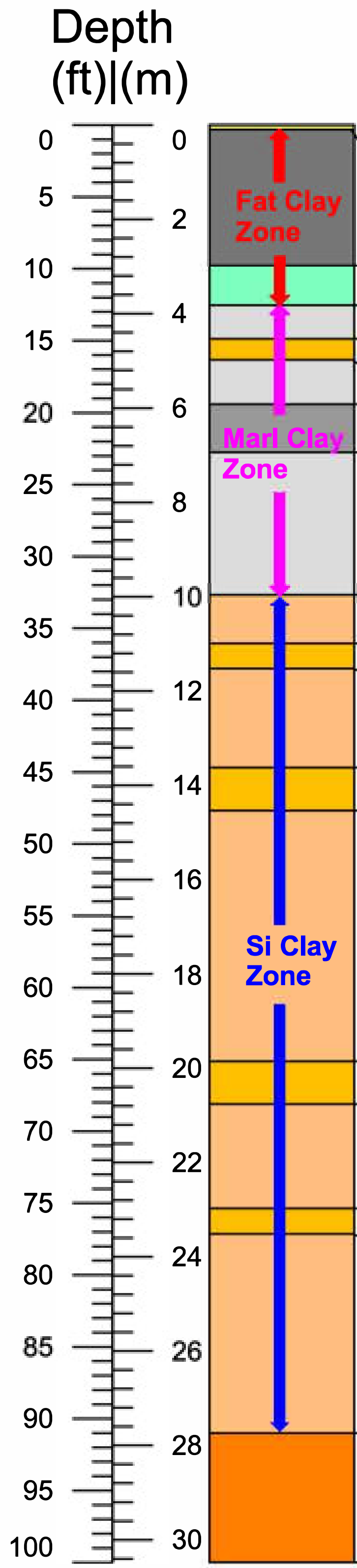
The Marl Clay Zone ("MCZ") has a higher hydraulic conductivity than the FCZ and consists of calcium carbonate-rich grey, bedded, granular clay that extends from about 12 to 40 feet bgs. The MCZ is the primary host of potash brine to be produced by the Project.

Previous geotechnical studies by Intermountain GeoEnvironmental Services (2012) described the MCZ sediments as "fissured clay", probably due to osmotic desiccation. However, more recent field investigations indicate that these sediments have a granular texture that arises from what is observed to be silt-size granules of smaller clay particles loosely bound by a soft calcareous or gypsiferous matrix. This zone also contains numerous gypsum crystals up to 6-inches in diameter. An unconsolidated sand and gravel bed frequently occurs near the top of the MCZ but is not consistent throughout the Playa. Where present, this sandy or gravelly zone has an average thickness of 18 inches.

A dense zone of stiff clay averaging approximately 3 feet thick occurs in the MCZ approximately 3 feet below the sand and gravel bed, where present. Penetrometer readings for the stiff clay zone of the MCZ range from 1.5 to 3.0 tons/square feet (t/ft^2). For comparison, the surrounding MCZ exhibits penetrometer readings between 0 and 1.25 t/ft^2 while the overlying FCZ exhibits penetrometer readings between 0 and 0.5 t/ft^2 (see Figure 2-4).

Below the stiff clay bed of the MCZ is an additional 10± feet of marl clay that transitions rapidly into the predominantly siliceous clay of the underlying Siliceous Clay Zone ("SCZ"). The contact between the marl clay and underlying siliceous clay was identified using sediment mineralogy and carbonate content test results from X-ray Powder Diffraction ("XRD") mineralogy analyses, as illustrated in the stratigraphic column shown in Figure 2-4.

The SCZ is an olive grey, quartz-rich clay with a carbonate content that is noticeably lower than the overlying MCZ. Discontinuous sand and gravel beds have been identified within the SCZ from drill-hole records. These sand and gravel units are generally thicker near the margins of the playa and are often missing toward the center of the playa. Average thicknesses of the sand and gravel beds, where present, vary from about 1.5 to 3 feet.



Thickness (m)(ft)	Carbonate (%)	Penetrometer (t/ft²)
0-0.5m (0-1.5ft)	38.6	0 - 0.25
2.9m (9.5ft)	38.6	0 - 0.5
0.9m (2.8ft)	46.2	0 - 0.5
0.7m (2.4ft)	46.5	0 - 0.5
0.4m (1.5ft)	46.9	0 - 0.5
0.9m (3.1ft)	47.3	0 - 0.5
1.0m (3.4ft)	48.5	1.5-3.0
3.0m (9.9ft)	47.7	0.75-1.25
1.0m (3.4ft)	29.6	0.75-1.25
0.5m (1.8ft)	32.2	0.75-1.25
2.1m (6.9ft)	34.4	0.75-1.25
0.9m (3.0ft)	31.1	0.75-1.25
5.3m (17.5ft)	32.2	1.0-1.5
0.9m (3.0ft)	28	1.0-1.5
2.2m (7.3ft)	33.6	1.0-1.5
0.5m (1.8ft)	34	1.0-1.5
4.2m (13.9ft)	31.1	1.0-1.5
-	-	>5

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LEGEND

- Salt Crust
- Fat Clay with organics
- Fat (plastic) Clay
- Stiff Marl Clay
- Marl Clay
- Sand and Gravel
- Siliceous Clay
- Hard Dry Clay

FIGURE 2-4

Sevier Playa Potash Project
Brine Aquifer
Stratigraphy

DATE: 09/20/2017 | SCALE: NTS | FILE: 89-12 FIG 3

NORWEST CORPORATION

The SCZ is generally between 10 and 40 feet thick in the south end of the playa and between 40 and 80 feet thick in the central and northern regions of the playa. The base of the SCZ is marked by a dull red, relatively dry, hard clay that occurs beneath the entire area. The top of this red, hard, dry clay, which was encountered in all boreholes drilled through the SCZ, lies at a maximum depth of approximately 120 feet bgs.

Extraction wells would produce potash brine from the lower portion of the MCZ and the upper portion of the SCZ. Under current plans, the average depth of extraction wells would be about 77 feet, but well depths may vary from 61 to 110 feet, based on the depth of the brine resource.

Underlying the resource zone, several lean clay horizons have been logged to a depth of 497 feet bgs (the depth to which monitoring well SN2-11-400 was drilled). Occasional sand to sandy silt zones (ranging in thickness from less than 1 inch to 5.5 feet) exist below the resource zone. The field logs describe many of these zones as being moist, while two of the thickest of these zones were saturated and SN2-11-400 was completed across these two separate zones, while the materials above and below these moist zones are described in the field notes as being hard and dry. Data summarized by Whetstone (2017) indicate that measured water levels in wells monitoring these discontinuous sandy zones below the SZC are generally within about 5 feet of the playa surface. Following correction for salinity, the equivalent freshwater levels in the deep playa sediments are near or above the surface elevation of the playa. These head values indicate that these saturated zones are under confined conditions. While some zones of minor saturation exist locally, no laterally continuous zones of saturation have been identified in these lean clay horizons that underlie the red, hard, dry clay at the bottom of the SCZ.

The water table within the Playa HSU is relatively flat, mimicking the playa surface. It appears that groundwater within the playa sediments is mounded relative to that within the adjacent Alluvial/Colluvial groundwater system. This groundwater mound is likely caused by periodic inflows of surface water from the Sevier River and nearby ephemeral washes, high matric forces within the clays that retain water that infiltrates into the playa sediments, and capillary forces created by the evaporative pull of groundwater through the playa sediments.

Aquifer testing indicates that the hydraulic conductivity of the playa sediments ranges from 0.01 to 24.2 feet per day. The higher values were from wells that encountered several silt and sand layers near the inlet of the Sevier River and southeast of Needle Point. The remaining wells were completed predominately in the more-typical silt and clay playa sediments where hydraulic conductivity values ranged from 0.01 to 1.08 feet per day.

2.4.2 Alluvial/Colluvial HSU

As is typical of alluvial/colluvial sediments in the Intermountain West, the sediments that comprise the Alluvial/Colluvial HSU are quite variable in thickness and composition. In some areas, this layer consists of a thin veneer or blanket of in-place sands, silts, and clays draped over hillsides while in others, primarily at the mouths of drainages formed at the base of the mountains, this HSU consists of reworked alluvial fans and stream deposits that are thick and relatively coarse grained. These sediments tend to be interbedded due to the variable nature of the geologic forces of erosion and mass wasting that occurred intermittently over time.

Groundwater in the Alluvial/Colluvial HSU originates from the infiltration of precipitation, snowmelt, and seepage into the underlying alluvial sediments as runoff flows in ephemeral channels. This groundwater flows within the alluvial/colluvial sediments to points that are in contact and interbedded with the playa sediments; discharges as seeps; or percolates vertically or laterally and enters the bedrock where it recharges the underlying Regional Bedrock HSU.

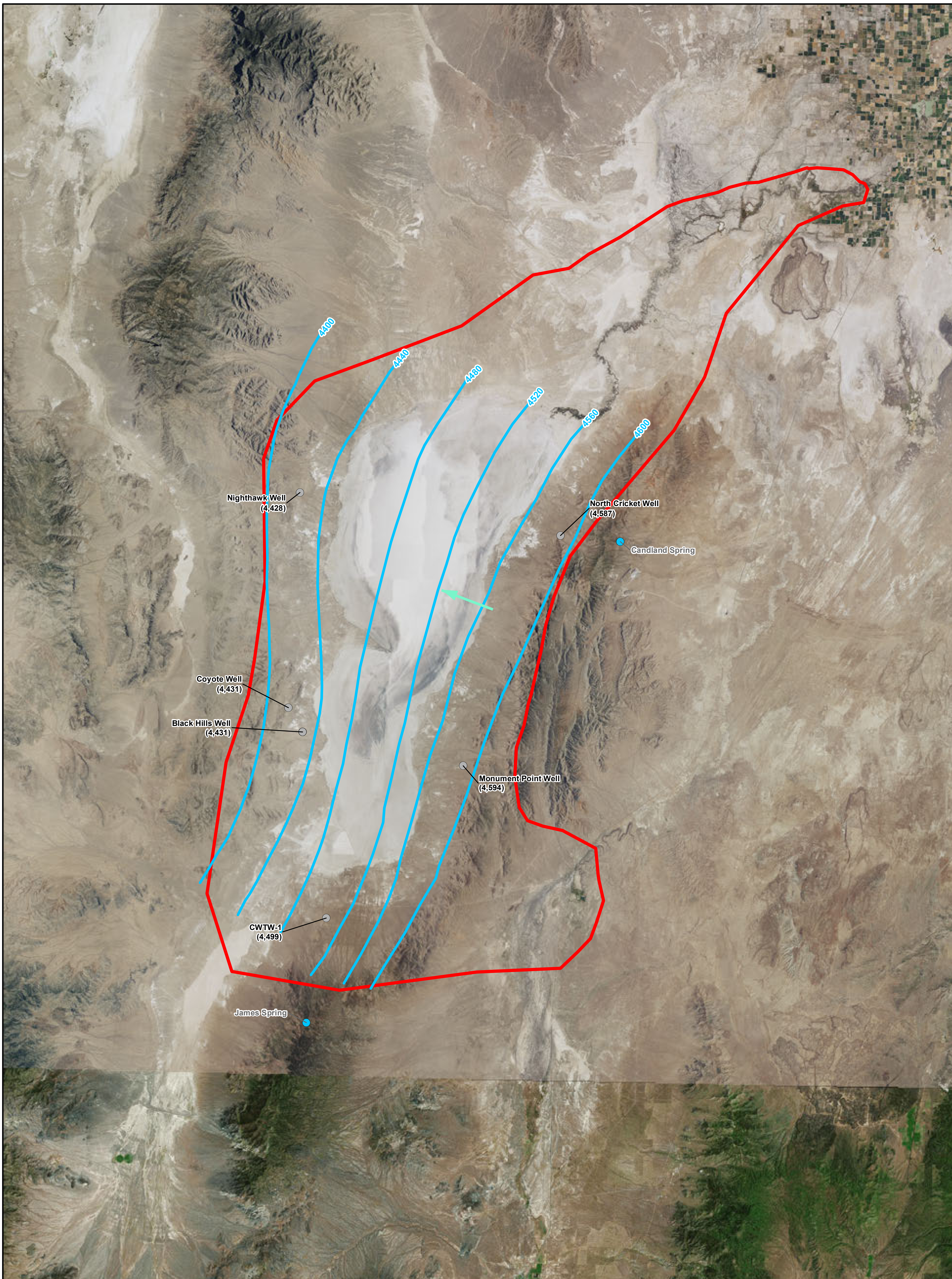
Aquifer tests conducted in the Project area and summarized by Whetstone (2017) show the range of hydraulic conductivity of the Alluvial/Colluvial HSU strata to be from 0.06 to 51 ft/day. The high value was from the Wah Wah Well located 9.5 miles south of the playa. The most reliable test results provided hydraulic conductivity data for the alluvial/colluvial sediments within the range of 0.6 to 0.9 feet per day.

2.4.3 Regional Bedrock HSU

The bedrock formations in the vicinity of the playa consist of the Prospect Mountain Quartzite in the Cricket Mountains east of the playa, the Notch Peak Limestone in the House Range/Black Hills west of the playa, and either the Prospect Mountain Quartzite or Mutual Formation in the San Francisco Mountains south of the playa. Some areas of volcanic flows are also draped over these formations along the southern portion of the area.

Potentiometric data collected from wells completed in bedrock near the playa indicate that groundwater in the Regional Bedrock HSU flows to the west-northwest beneath the playa (Figure 2-5), with a horizontal hydraulic gradient of approximately 0.003 feet per foot through the central portion of the basin. This groundwater flow direction is in general agreement with the south-southeast to north-northwest regional groundwater flow direction described by Heilweil and Brooks (2011).

Aquifer tests conducted by CPM in the Project area and summarized by Whetstone (2017) indicate that the hydraulic conductivity of the Regional Bedrock HSU in the vicinity of the playa ranges from 0.9 to 133 feet per day. This range is typical of those presented by Bedinger et al. (1989), Belcher et al. (2002), and Sweetkind et al. (2011) for fractured carbonate and metamorphic rocks in the Great Basin.



Legend

- Bedrock Well
- Mountain Spring
- Horizontal Direction of Groundwater Flow
- Bedrock HSU Potentiometric Surface Contours
- Sevier Playa Potash Project Water Resources Area of Interest

N

0 2.5 5 Miles

1:330,600

Sources:
Sevier Playa Potash Project Water Resources Analysis Area,
Baseline Water Resources Technical Report for the Sevier Playa
Potash Project, Whetstone 2017;
Bedrock HSU Potentiometric Surface Contours, Tangalos, et al, 2016;
Aerial Imagy, NAIP/USDA/APFO 2016
Notes:
HSU - hydrostratigraphic unit
(750) - Potentionmetric Elevation

Figure 2-5
Potentiometric Contour Map of the Bedrock Hydrostratigraphic Unit

WATER MONITORING PLAN
SEVIER PLAYA POTASH PROJECT

DVR \\MNUSTRICTGFS01\PROJECTS\GIS\DEN\SEVIER_PLAYA_RESOURCE_REPORTS\GIS\MAPFILES_V2\WATER\FIG16_BEDROCK_HYDROSTRATIGRAPHIC_UNIT_POTENTIOMETRIC_MAP_11X17_V2.MXD BRIAN DOUBEK 2/14/2019 4:56:52 PM

2.4.4 Groundwater Quality

CPM collected groundwater samples in 2012 and 2013 from wells completed in the Playa, Alluvial/Colluvial, and Regional Bedrock HSUs throughout the playa region. The existing wells from which these samples were collected are shown in Figure 3-1. The results of analyses of these samples are detailed in Whetstone (2017), discussed below, and summarized in Attachment B.

Groundwater in the Playa HSU is a sodium-chloride brine (TDS concentrations of 13,800–194,000 mg/L) with near-neutral pH (6.19–7.90). The brine is classified by UDWQ as a Class IV groundwater, based on its TDS concentration being greater than 10,000 mg/L. State of Utah groundwater quality standards ("UGWQS") for Class IV groundwater have not been established. Rather, protection levels for Class IV groundwater are established on a case-by-case basis to protect human health and the environment.

Groundwater in the Alluvial/Colluvial HSU is a sodium-chloride to sodium-sulfate type water with near-neutral to alkaline pH (6.68–9.30) and variable TDS concentrations ranging from 472 to 3,410 mg/L. TDS concentrations tend to be higher near the playa where interaction with playa groundwater is probable. The exception to this generality is the 257 Cutoff well, located about 5 miles northeast of the playa. This well is screened shallower than the other wells in the Alluvial/Colluvial HSU and contains a sodium chloride brine composition with TDS concentrations ranging from 80,800 to 82,700 mg/L, likely due to evaporation of near-surface groundwater.

Fluoride, arsenic and pH results were above the UGWQS in some alluvial/colluvial wells. Arsenic was detected once in the Crystal Peak Road, Miller Canyon, and UDOT 2 wells, and twice in the 257 Cutoff well at concentrations ranging from 0.0519 to 0.652 (UGWQS of 0.05 mg/L). Fluoride was detected once in the Bonneville well at 6.36 mg/L (above UGWQS of 0.359 mg/L). The field parameter pH was above the UGWQS of 7.77 in the Bonneville well at 8.82, the UDOT 2 well at 9.14, and the UDOT 3 well at 9.30. The remaining analytical results from the alluvial/colluvial wells were reported at concentrations below the applicable UGWQS.

The Regional Bedrock HSU includes zones of Lower Cambrian and Precambrian quartzite, the Notch Peak Formation, and areas of volcanic bedrock. Analytical results from the Monument Point and North Cricket wells indicate that groundwater in the quartzite east of the playa is a sodium-chloride water with slightly alkaline pH (7.70–8.24) and relatively low TDS concentrations ranging from 400 to 480 mg/L. A groundwater sample collected from the CWTW-1 freshwater supply exploration borehole was characterized as a calcium-bicarbonate to calcium-chloride composition with alkaline pH (8.4–8.5) and TDS concentrations ranging from 352 to 396 mg/L. The analytical results for groundwater collected from wells completed in quartzite bedrock were all reported at concentrations below the UGWQS.

Analytical results from the Black Hills, Coyote, and Nighthawk wells west of the playa indicate the groundwater in the Notch Peak Formation is a sodium-chloride to sodium-sulfate water with near-neutral pH (6.89–7.52) and moderate TDS concentrations (528–744 mg/L). The analytical results from wells completed in the limestone/dolomite bedrock were reported at concentrations below the UGWQS.

An analytical result from the Lakeview well screened in volcanic rock near the south end of the playa indicates the groundwater at this location is a sodium-chloride composition with slightly alkaline pH (7.77) and relatively low TDS concentration (420 mg/L). The analytical results from the volcanic bedrock were reported at concentrations below the UGWQS.

2.5 WATER RIGHTS

Water rights surrounding the Sevier Playa were summarized by Whetstone (2017). Within their area of evaluation, they found 712 perfected water right points of diversion, 533 approved water right points of diversion, and 265 water right points of diversion that were unapproved or had been terminated within their area of analysis, which was somewhat more extensive than the area of interest shown on Figure 2-1. Of the 1,245 point of diversion applications that had been perfected or approved, 760 were for underground water, 253 were for surface water, 204 were point to point diversions, 5 were spring water rights, 7 were re-diversion water rights, and 3 were return water rights. The largest percentages of approved uses are for stock watering (25%), mining (15%) and combined domestic/ irrigation/stock watering (10%).

CPM owns or controls 431 approved water right points of diversion, of which 147 are for surface water and 284 are for underground water. The water right points of diversion owned or controlled by CPM are summarized in Table 2-2.

Table 2-2 Summary of Water Right Points of Diversion Owned or Controlled by CPM

Water Right Number	Quantity (AF/yr)	Water Source
69-106	1,000	Fresh water: Sevier River and underground wells
69-110	20,000	Brine water
69-111	500	Freshwater – groundwater
69-112	222,000	Brine water
69-113	28,000	Brine water
69-117	250,000	Sevier Lake and adjacent ephemeral streams

2.6 RIPARIAN AREAS

In 2016, SWCA Environmental Consultants ("SWCA") prepared a wetland and riparian baseline inventory for the Project Area as well as the Sevier River corridor from the Sevier Playa to Gunnison Bend Reservoir (SWCA 2016). A copy of this report was provided previously to BLM. The inventory began with desktop identification and interpretation of wetlands and riparian areas using high-resolution aerial photographs and other data sources in ArcGIS. A field visit was then conducted to refine the desktop mapping and correlate the results of the desktop study to actual ground conditions.

SWCA's remote sensing specialist identified the centerline of the river between the Sevier Playa and the location where the river consistently aligned with the National Hydrography Dataset (USGS 1999) by interpreting aerial imagery from the National Agriculture Imagery Program (U.S. Department of Agriculture Farm Service Agency 2014). In some areas, the river channel splits, with a bed, a bank, open water, and wetland or riparian vegetation being present along two or more channels. To be conservative, the study area was expanded to include areas where these channels were identified. Human-made diversion structures and ditches also exist along the Sevier River channel; the study area was not expanded to capture channels that appeared human-made (SWCA 2016).

Riparian vegetation, mostly in the form of invasive salt cedar and salt cedar intermixed with wetland floodplain vegetation, are common along the banks and floodplains of the Sevier River upstream from the Sevier Playa. At the inlet of the Sevier River onto the Sevier Playa, the river corridor dissipates into an alluvial fan of shallow, wandering, braided channels. In this area, vegetation is present in some locations between and around the margins of the channels, as well as in depressions and around the margins left by previous channels. The vegetation is primarily herbaceous wetland and wetland floodplain vegetation intermixed with unvegetated playa areas (SWCA 2016).

Based on a review of aerial imagery, the distribution and extent of vegetated and unvegetated areas at the inlet and on the Sevier Playa has substantial annual variation controlled by inundation and shifting soils, which are related to the volume of water flowing onto the Sevier Playa. In wetter years, such as 2011, the area is largely inundated with water, and vegetation is largely absent. In drier years, such as 2014 and 2016, herbaceous and annual vegetation are extensive (SWCA 2016).

3.0 DATA COLLECTION AND VALIDATION

Data will be collected under this Plan from the locations shown on Figure 3-1. Details regarding planned project sampling and data validation procedures are presented in the *Combined Sampling and Analysis Plan and Quality Assurance Project Plan for the Sevier Playa Project* provided in Attachment C.

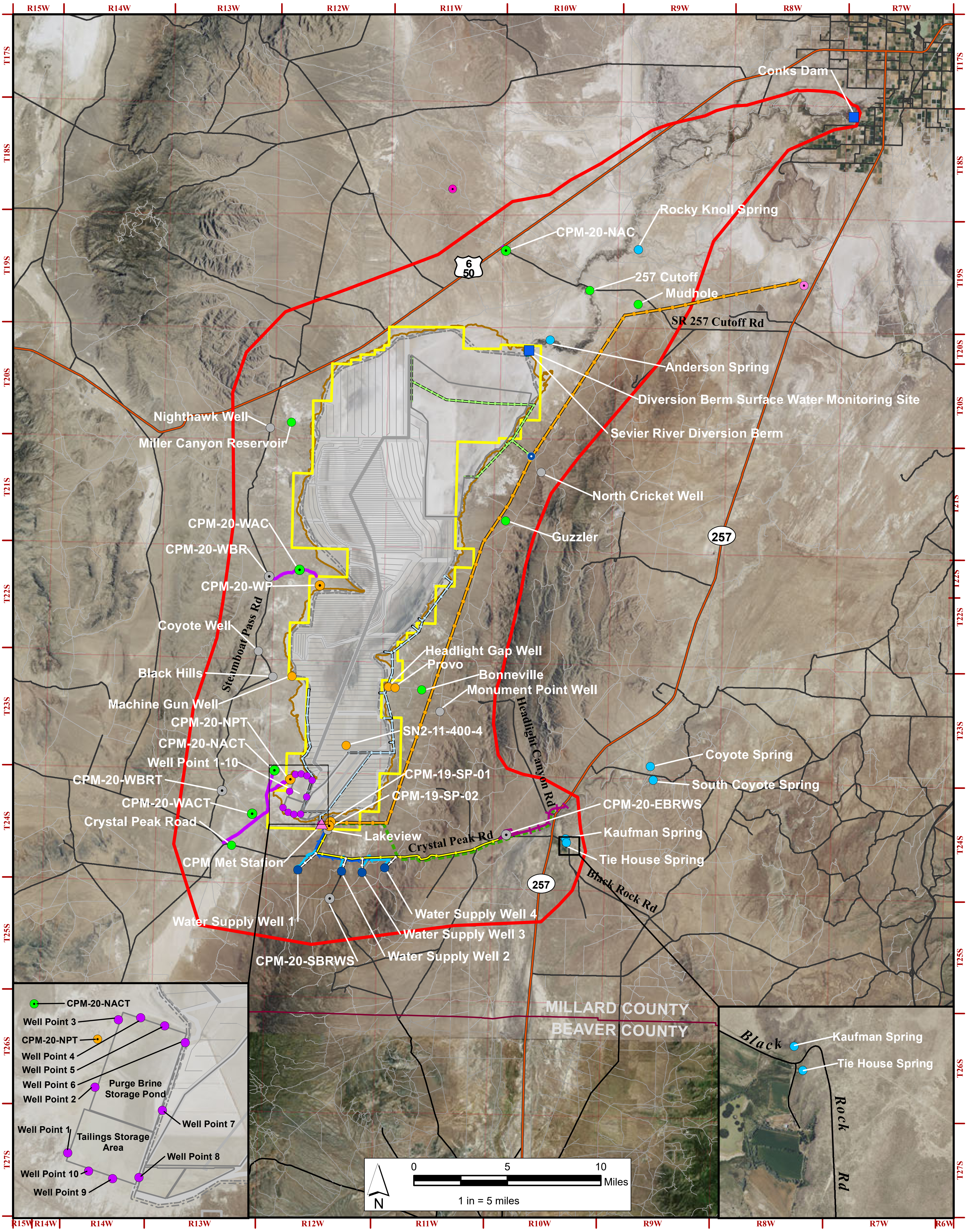
The goal of monitoring during the baseline data-collection period will be to develop a statistically valid database that adequately describes pre-Project hydrologic conditions. To that end, data will be collected quarterly during the baseline period to assess seasonal variations in hydrologic conditions within the area of interest.

It is currently anticipated that Project construction would begin in Fall 2019. Since baseline monitoring under this Plan began in September 2018, this will allow monitoring during five quarterly events prior to the start of construction. The U.S. Environmental Protection Agency (2009) recommends that a minimum of eight to ten independent baseline observations be collected before running most statistical tests. Thus, the period of baseline data collection would likely extend beyond the start of Project construction. This is not considered problematic for the following reasons:

- CPM began collecting hydrologic data from the playa area in 2011. These data would be reviewed for validation and if found valid, would be included in the baseline database.
- Given the typical hydraulic conductivities discussed in Section 2.4, it is estimated that average linear groundwater velocities in the Playa HSU are substantially less than 1 ft/yr. As a result, any impacts to groundwater in the Alluvial/Colluvial and Regional Bedrock HSUs caused by Project construction on the playa would not be observable for a period of several years. Thus, data collected from the Alluvial/Colluvial and Regional Bedrock HSUs during the one or two years following the onset of construction would still be indicative of baseline conditions.
- Only one water supply well would be drilled initially, and this well would be pumped only intermittently during the baseline sampling period as Project facilities are being constructed. This well (and the other three eventual water supply wells) would be drilled approximately 3 miles south of the Processing Facility area and 3.5 miles south of the playa. Because the first fresh water production well would be pumped only intermittently, it is unlikely that the radius of influence due to this well would extend to the playa.
- As a terminal basin, no surface water flows out of the playa. Furthermore, the inflow of Project-related recharge water to the playa would not occur until at least one year after construction begins. Thus, data collected from the Sevier River monitoring locations following the beginning of construction would still be indicative of baseline conditions.

Given these circumstances, it is concluded that sufficient data will be available to assess baseline conditions, even if some of these data are collected following the startup of construction operations.

The goal of monitoring during the period of Project operations would be to determine whether or not the Project has an adverse impact on water resources. Decisions regarding the frequency of monitoring during the Project operational period would be made following the collection and review of the baseline data. These decisions would be presented to UDWQ and BLM for approval and incorporated into this Plan before implementation.



Existing and Proposed Proposed Project Features

- Existing Playa Aquifer Well
- Proposed Playa Aquifer Well
- Existing Alluvial/Colluvial Aquifer Well
- Proposed Alluvial/Colluvial Aquifer Well
- Existing Bedrock Aquifer Well
- Proposed Bedrock Aquifer Well
- Proposed Well Point Location
- Proposed Water Supply Well
- Surface Water Monitoring Site
- Spring
- Proposed Sevier River Diversion Berm
- Sevier Playa Potash Project Water Resources Area of Interest
- BLM/SITLA Lease Boundary
- Access Road - Off-Lease
- Proposed 69-kV Power and Communication Line
- Proposed 25-kV Power Line
- Proposed 12.47-kV Power Line
- Proposed 12.47-kV Power and Communication Line
- Proposed 12.47-kV Power Line Spur
- Proposed Rail Spur and Access Corridor
- Proposed Rail Loadout Facility
- Proposed Natural Gas Pipeline
- Proposed Communication Tower
- Proposed Substation
- Meteorological Station
- Proposed Water Supply Pipeline
- Proposed Water Supply Pipeline Spur

Sources:
Project Features, Crystal Peak Minerals, 2015, 2016, 2017, 2018, 2019;
Sevier Playa Potash Project Water Resources Analysis Area,
Baseline Water Resources Technical Report for the Sevier Playa
Potash Project, Whetstone 2017;
Sevier Playa Boundary, SWCA 2015;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO 2016

NO.	DATE	REVISION	BY	APVD
4	2/15/2019	Revised based on comments		
3	10/15/2018	Revised based on comments		
2	7/18/2018	Revised based on comments		
1	6/19/2018	Revised based on comments		
0	10/25/2017	Initial Submission		

DSGN	DR	CHK	APVD

FIGURE 3-1

Sevier Playa Potash Project Surface and Groundwater Monitoring Network

DATE: 4/11/2019 SCALE: 1:318,859

CRYSTAL PEAK MINERALS INC.

D:\GIS\Peak Minerals\Operational Monitoring Plan\WMP Fig 3-1 - Groundwater_Monitoring_Network_190411.mxd4/11/2019 4:59:17 PM

Two sedimentation ponds (one at the Processing Facility and one at the rail loadout facility) would be constructed to control Project storm-water runoff. These ponds would be permitted and monitored under the UDWQ Utah Pollutant Discharge Elimination System. Since they would be monitored under a State-issued permit, they are not included in this Plan.

3.1 METEOROLOGICAL DATA COLLECTION

Data on file with the Western Regional Climate Center indicate that the National Weather Service maintained a weather monitoring station at the south end of the Sevier Playa from October 1987 through April 1993.[3] Data collected from this station included precipitation (rainfall and snowfall), snow depth, air temperature, evaporation, and wind movement.

CPM has maintained a meteorological station since November 2011 at the location shown on Figure 3-1. Data collected at this station include wind direction and speed, air temperature, solar radiation, relative humidity, precipitation, and barometric pressure. CPM would maintain this station through the Project operational period. Data collected during the Project baseline and operational periods would be compared with the prior National Weather Service data to understand trends in climatic patterns that may influence the hydrologic regime of the Sevier Playa region.

3.2 SURFACE WATER DATA COLLECTION

Surface water flow and quality data will be collected during the baseline period from two locations on the Sevier River, as indicated in Table 3-1 and shown on Figure 3-1. Access to these sampling locations will be via existing routes.

Since the Sevier Playa is a terminal playa at the downstream end of the Sevier River, no surface water discharge locations exist downstream from the proposed Project operations. As a result, no potential downstream surface water monitoring locations exist.

Table 3-1 Proposed Surface Water Monitoring Locations

Site Name	Location (NAD83 degrees)		Monitoring Purpose
	Latitude	Longitude	
Sevier River below Conks Dam	39.278885	-112.683384	Downstream from all irrigation diversions
Sevier River at Diversion Structure	39.092431	-113.002535	Inflow to playa

Note: In all cases, surface water will be monitored in accordance with Section 4.2 of the SAP/QAPP, with samples being analyzed for the parameters contained in Table 3-1 of the SAP/QAPP. Data Quality Objectives and Measurement Quality Objectives for surface water sampling are outlined in Sections 3.2 and 3.3, respectively, of the SAP/QAPP and summarized in Table 3-3 of the SAP/QAPP.

Surface water data will be collected during the baseline period as indicated in Section 6.3 of Attachment C. Following collection of the baseline data, all valid data will be reviewed, and a list of monitoring parameters and schedules will be developed for monitoring during the operational period. Any modifications to this Plan to accommodate surface

[3] https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ut7747

water sampling during the Project operational period would be submitted to UDWQ and BLM for review and approval prior to implementation.

The Conks Dam surface-water sampling location is downstream from all irrigation diversions on the Sevier River. Data collected from the river at this location will be indicative of the quality of surface water used for irrigation and the quantity of water released to the channel at the downstream extent of irrigation diversions.

As indicated in Section 2.3.2, the Sevier River gains flow between Conks Dam and Crafts Lake due to irrigation return flows. Below Crafts Lake, the Sevier River loses flow to channel seepage and evapotranspiration. Therefore, data collected from the river at the Diversion Structure location will be generally indicative of the quality and quantity of water that enters the playa.

Given the high degree to which the Sevier River is regulated at and above Gunnison Bend Reservoir, it is possible that one or both of the Sevier River monitoring locations will be dry when sampling is attempted, particularly during the baseline monitoring period when Project recharge water is not being conveyed by the river. Such conditions will be noted on the field logs. Publicly-available data collected from the applicable locations shown on Figure 2-3 will be evaluated as outlined in Section 3.5 and, where valid, will be incorporated into the surface water baseline database to provide additional understanding on baseline surface-water conditions in the area.

3.3 GROUNDWATER DATA COLLECTION

Groundwater level and quality data will be collected during the baseline period from 16 existing monitoring wells and 16 proposed monitoring wells, when completed, as indicated in Table 3-2 and shown on Figure 3-1. These wells will be divided between the various HSUs as follows:

- Playa HSU: 4 existing and 4 proposed monitoring wells
- Alluvial/Colluvial HSU: 6 existing and 4 proposed monitoring wells
- Regional Bedrock HSU: 6 existing and 8 proposed monitoring/production wells
- Well Points: 10 proposed well points

Access to these sampling locations will be via existing routes, as shown on Figure 3-1.

Four of the proposed new wells in the Regional Bedrock HSU would be freshwater production wells. As noted in Figure 3-1, two of the remaining proposed Regional Bedrock HSU monitoring wells would be installed west of the playa, one would be installed south of the freshwater production wells, and one would be installed east of the freshwater production wells. The proposed monitoring wells south and east of the freshwater well field would be installed concurrent with the installation of the first freshwater production well. The terminal stratigraphy of the proposed Regional Bedrock HSU production and monitoring wells would depend on local subsurface conditions. However, in any case they would be constructed to monitor and/or produce groundwater from the Regional Bedrock HSU.

Table 3-2 Proposed Groundwater Monitoring Locations

Well Name	Location (NAD83 degrees)		Sampling Method	Monitoring Purpose
	Latitude	Longitude		
Playa HSU Wells (Existing)				
Headlight Gap	38.8296586	-113.1341471	Low-Flow	Groundwater flow to/from east edge of playa
Machine Gun	38.8361191	-113.2298862	Low-Flow	Groundwater flow to/from west edge of playa
Provo	38.8291203	-113.1274863	Snap	Groundwater flow to/from east edge of playa
SN2-11-400-4	38.7835250	-113.1744970	Snap	Groundwater in south-central portion of playa. Monitor influence of water supply wells on the Playa HSU.
Playa HSU Wells (Proposed)				
CPM-19-SP-01	38.726343	-113.192944	TBD	Groundwater flow to/from south edge of playa. Monitor influence of water supply wells on the Playa HSU.
CPM-19-SP-02	38.723402	-113.191879	TBD	Groundwater flow to/from south edge of playa. Monitor influence of water supply wells on the Playa HSU.
CPM-20-WP	38.9070000	-113.204567	TBD	Groundwater flow to/from west edge of playa
CPM-20-NPT	38.756441	-113.231382	TBD	Groundwater flow to/from playa near waste product storage area
Alluvial/Colluvial HSU Wells (Existing)				
257 Cutoff	39.1405648	-112.9426389	Snap	Groundwater in Sevier River alluvium north of playa
Bonneville	38.8279350	-113.1010343	Snap	Groundwater flow to/from east side of playa
Crystal Peak Road	38.7040571	-113.2856608	Low-Flow	Groundwater flow to/from south side of playa
Guzzler	38.9605644	-113.0213739	Snap	Groundwater flow to/from east side of playa
Miller Canyon Reservoir	39.0332852	-113.2365813	Snap	Groundwater flow to/from west side of playa
Mudhole	39.1305575	-112.8943545	Low-Flow	Groundwater flow to/from north side of playa
Alluvial/Colluvial Wells (Proposed)				
CPM-20-NACT	38.762242	-113.244973	TBD	Groundwater flow to/from northwest side of waste product storage area
CPM-20-WACT	38.7232486	-113.250747	TBD	Groundwater flow to/from southwest side of waste product storage area
CPM-20-WAC	38.9186167	-113.224933	TBD	Groundwater flow to/from west side of playa
CPM-20-NAC	39.1700167	-113.027133	TBD	Groundwater flow to/from north side of playa
Regional Bedrock HSU Wells (Existing)				
Black Hills	38.8356642	-113.2488075	Low-Flow	Regional groundwater downgradient from the playa
Coyote	38.8550295	-113.2637821	Snap	Regional groundwater downgradient from the playa
Lakeview	38.7175450	-113.1909711	Low-Flow	Regional groundwater cross-gradient from the playa
Monument Point	38.8115229	-113.0825462	Snap	Regional groundwater upgradient from the playa
Nighthawk	39.0284436	-113.2573385	Snap	Regional groundwater downgradient from the playa
North Cricket	38.9987550	-112.9872956	Snap	Regional groundwater upgradient from the playa
Regional Bedrock Wells (Proposed)				
CPM-20-WBRT	38.748624	-113.250783	TBD	Regional groundwater downgradient from the playa
CPM-20-WBR	38.9129333	-113.2550500	TBD	Regional groundwater downgradient from the playa
CPM-20-SBRWS	38.66426	-113.18734	TBD	Regional groundwater upgradient from the water supply wells
CPM-20-EBRWS	38.71673	-113.01396	TBD	Regional groundwater east of the water supply wells
Water Supply 1	38.6861005	-113.2194244	TBD	Potential impacts to regional groundwater from pumping
Water Supply 2	38.6857800	-113.1761975	TBD	Potential impacts to regional groundwater from pumping
Water Supply 3	38.6850996	-113.1557851	TBD	Potential impacts to regional groundwater from pumping
Water Supply 4	38.6895652	-113.1334771	TBD	Potential impacts to regional groundwater from pumping
Waste Product Storage Areas Well Points (Proposed)				
Well Points 1-10	Perimeter of proposed waste product storage area		Water Level	Groundwater flow toward and/or away from the future waste product storage area

Note: In all cases, groundwater will be monitored in accordance with Section 4.1 of the SAP/QAPP, with samples being analyzed for the parameters contained in Table 3-2 of the SAP/QAPP. Data Quality Objectives and Measurement Quality Objectives for groundwater sampling are outlined in Sections 3.2 and 3.3, respectively, of the SAP/QAPP and summarized in Table 3-3 of the SAP/QAPP.

Groundwater level and quality data will be collected during the baseline period as indicated in Sections 6.4 of Attachment C. Following collection of the baseline data, all data will undergo review and validation as indicated in Section 3.4 of Attachment C, and a list of monitoring parameters and schedules will be developed for the operational period. Any modifications to this Plan to accommodate groundwater sampling during the Project operational period would be submitted to UDWQ and BLM for review and approval prior to implementation of sampling.

The rationale for monitoring the selected existing wells and the locations for the proposed wells is discussed further in Section 4.1 of Attachment C. These wells (both existing and proposed) were selected to monitor conditions regionally upgradient (east), downgradient (west) and cross-gradient (north and south) from the playa. Hence, it is anticipated that data obtained from these wells will provide a good indication of spatial variations in baseline groundwater levels and quality near the playa and proposed Project operations.

Assuming weather conditions are conducive to playa access, CPM plans to drill two of the proposed Playa HSU monitoring wells in calendar year 2019. The remaining proposed monitoring wells would be drilled at least two years prior to the construction of facilities in the immediate vicinity. The order in which these new monitoring wells are drilled would be determined by the schedule of Project operations, with the goal of establishing a statistically valid understanding of baseline conditions prior to potential impacts from Project operations.

Ten well points would also be installed around the perimeter of the Waste Product Storage Area (which consists of the Purge Brine Storage Ponds and the Tailings Storage Area) in the southwest corner of the playa (see Section 4.1.2.5 of Attachment C). The well points would be installed into the Marl Clay Zone concurrent with initial construction of the Waste Product Storage Area berms, approximately 20 feet from the outside toe of the ultimate berm footprint. The purpose of these well points would be to determine whether and where leakage is occurring from the Waste Product Storage Area, and to determine the direction of flow for mitigation purposes. The groundwater encountered at these well points would be monitored for water level and specific conductance throughout the Project operational period, as discussed in Section 4.1.2.5 of Attachment C.

If leakage is detected from the Waste Product Storage Area, an evaluation would be made of the appropriateness of the then-existing wells to monitor that leakage. If the monitoring system is deemed to be inadequate, additional monitoring wells would be added and changes would be made to this Plan as needed. All such changes would be presented to UDWQ and BLM for approval before implementation.

3.4 SPRING DATA COLLECTION

Under Federal Lease Special Stipulation 13, regional springs were to be included in the Project water monitoring program. However, the majority of the springs identified in the region by Whetstone (2017) are geographically remote from and at substantially higher elevations than the proposed Project operations. Thus, it is highly unlikely that these springs would be impacted by the Project. Although springs shown on Figure 3-1 that are closer and at similar elevations to the Project may be monitored during the baseline period, the collection of consistent data from these springs would be difficult for the following reasons:

- Anderson Spring – Located about two miles upstream from the playa. This spring discharges into the bottom of the Sevier River channel. Hence, it cannot be monitored during periods when the river is flowing at that location.

- Rocky Knoll Spring – Located about 8 miles northeast of the north end of the playa. This “spring” is actually an area of moist soil occupied by tamarisk and other phreatophytes. No flow has been observed from this location for the past several years.
- Kaufman Seep and Tie House Spring – Both located about 11 miles east-southeast of the south end of the playa. These sources are located on private land and may not be accessible.

Because Kaufman Spring is located on private land, consideration was given to monitoring the nearby Coyote Spring and Coyote South Spring as an alternate method to monitor the potential impacts of project construction (particularly installation of the natural gas pipeline) and pumping the fresh water production wells. However, a recent hydrogeologic assessment of the area of these springs concluded that a hydraulic connection between the springs and the regional aquifer that supplies the proposed freshwater wells does not likely exist (Summers 2018). As a result, there is not a valid hydrologic reason to include Coyote Spring or Coyote South Spring as part of the Project ground water monitoring plan (Summers 2018). This is based on the assessment of possible effects at the springs over the life of the Project (personal communication, Paul Summers, April 2019).

Kaufman Spring is also considered not likely to be at risk for impacts from pumping the fresh water production wells during the life of the Project (personal communication, Paul Summers, April 2019). Further, use of Coyote Spring[s] as an indicator for monitoring possible impacts to Kaufman Spring is not a valid approach because Coyote Springs and the Kaufman Spring are supplied by water from two different aquifers which are not hydraulically connected (Summers 2018).

3.5 DATA VALIDATION

All surface and groundwater data collected under this Plan will be validated as discussed in Section 3.4 of Attachment C. As noted in Section 2.3 of Attachment C, CPM began monitoring groundwater within and near the Sevier Playa in 2011. This effort was expanded in 2012 to include monitoring of discharge and water quality in the Sevier River. These pre-2018 data will also be reviewed using the data validation process presented in Section 3.4 of Attachment C. Any surface and groundwater data collected prior to 2018 that are determined to be valid will be incorporated into the baseline database and used to establish pre-project hydrologic conditions within and near the playa.

3.6 REPORTING

It is anticipated that water quality data from the laboratories will be provided to CPM via electronic file transfer. All monitoring data will be maintained in an electronic database by CPM for documentary and comparative purposes. Selection of the software and preparation of the database will be conducted following the start of data collection.

CPM will incorporate the validated laboratory and field data into a database application where data can be queried by location(s), individual constituent of concern, sample medium, etc. The database may be linked to an electronic site map capable of showing the associated sample locations. These data will be supplied electronically to UDWQ and BLM on a quarterly basis, normally within 45 days of receiving and validating data from that sampling event. This submittal will include tabulated field and laboratory analytical results and data collected from the meteorological station maintained by CPM at the Sevier Playa. This will be accompanied by a validation summary like that provided in Attachment D.

3.6.1 Baseline Reporting

A valid baseline dataset will serve as the basis for evaluating changes to water resources within and near the playa that may be associated with Project operations. Following generation of the valid baseline database, a baseline monitoring summary will be prepared in which all surface water flow and quality, groundwater elevation and quality, and meteorological data will be presented. The data will also be plotted for graphical display (e.g., time series plots, histograms, box-whisker plots, etc.) as needed to support the analyses.

Baseline data will be evaluated for statistical distribution(s), outliers, summary statistics, and handling of non-detect data. This will be accomplished using the latest version of ProUCL[4] or other appropriate statistical evaluation package.

The baseline data report will present an evaluation of spatial and seasonal variations in surface and groundwater quantity and quality. This will be accomplished using time-series plots, trilinear diagrams of chemical data, iso-concentration lines, and other appropriate evaluations of flow, water-level, and water quality data as supported by the data. Additionally, summary statistics will be calculated on the data. The data will be assessed at individual locations and, in the case of groundwater, by grouping wells according to their HSU. This assessment will include comparisons with applicable UDWQ water-quality standards as promulgated in R317-2 (surface water) and R317-6 (groundwater) as well as the requirements of Special Stipulation 8 of the federal leases.

To the extent supported by the data, the baseline data report will include appropriate plots of iso-concentration contours for select chemical constituents, graphs that show concentrations of selected parameters over time, comparison to relevant water quality standards, summary statistics, and a description of data validation. The statistical evaluation will include an establishment of threshold values (e.g., upper tolerance limits or upper prediction limits, as further discussed in Section 4) against which future data may be compared to determine whether or not Project operations have resulted in water-resource impacts. Report appendices will include copies of pertinent field notes, laboratory analytical results, QC data, data validation results, well records, well testing data, water level data, field water quality measurements, and other field data, as applicable.

3.6.2 Operational Reporting

Each post-baseline quarterly data submittal would include a statistical evaluation of the data as outlined in Section 4. This would include a location-by-location comparison to determine if the most recent analytical results are statistically different than the baseline conditions at a reasonable level of significance. If this evaluation indicates that Project operations have potentially adversely impacted water resources, the quarterly data submittal would include recommendations for impact verification and/or mitigation. For example, if it is suspected that leakage from the Waste Product Storage Area on the southwest portion of the playa has adversely affected off-playa groundwater in the Alluvial/Colluvial or Regional Bedrock HSU in that area, these recommendations would, as a minimum, include a meeting with UDWQ and BLM to discuss an appropriate path forward for assessing and mitigating the impacts. Depending on the potential impact, these recommendations may also include re-sampling of existing monitoring wells

[4] ProUCL is a statistical software package developed by the U.S. Environmental Protection Agency for the evaluation of environmental data. Additional information regarding ProUCL can be found at https://www.epa.gov/land-research/proucl-version-5100-documentation-downloads

and/or installation and sampling of new off-playa monitoring wells south, west, and/or northwest of the Waste Product Storage Area within the area of interest shown on Figure 3-1. If additional off-playa monitoring wells are required to properly assess the extent and magnitude of impacts, these would be installed only after required cultural resource, biological, and other clearances were obtained and applicable permits are issued.

CPM would also prepare annual reports detailing the results of meteorological data collected and surface and groundwater monitoring completed during the prior calendar year. Annual monitoring reports would be electronically submitted to the BLM and UDWQ by the end of the first calendar quarter of the following year. The annual reports would include all field and laboratory results, a brief narrative describing any changes and the significance of those changes observed during the year, with updated copies of the above tables and graphs as appropriate. Data would be presented cumulatively as appropriate to allow trends to be assessed.

The annual reports would also include recommended steps for optimization of the monitoring program (when applicable) and a discussion of identified impacts to surface or groundwater resources. If exceedances or changes identified during the year suggest that Project operations are adversely impacting water resources in the area, the results of the adaptive management approach to impact mitigation would be discussed (see Section 1.2), specific actions taken to mitigate those impacts would be summarized, and recommendations for further mitigation would be provided to UDWQ and BLM. Where appropriate, the mitigation measures may include additional sampling, review of sampling protocols, recommend changes to the operational monitoring plan, additional placement of monitoring wells, changes in Project operation, or other recommendations to mitigate observed negative impacts to water resources.

4.0 DATA EVALUATION

An important purpose of the water monitoring program is to detect statistically significant changes to local water resources following the startup of Project operations. This would be accomplished by comparing baseline and operational data using EPA's ProUCL or other appropriate statistical approaches as noted in Section 3.5 of this Plan. Guidance provided by the U.S. Environmental Protection Agency (2009) and other appropriate statistical references would be used to select data analysis methods that are applicable to the data set. Furthermore, since reversals of the flow direction near a well could cause abrupt changes in the water chemistry (Fetter 1980), basic observation of data trends would be employed.

Each data set would be evaluated for potential outliers, potential trends, and underlying statistical distributions. Baseline and operational water quality data would be summarized using measures of central tendency and dispersion including mean, minimum, maximum, and standard deviation complimented by time-series plots, histograms, box plots, etc. to graphically present the data. Baseline data would be evaluated to establish control limits (e.g., upper tolerance limits and/or upper prediction limits) against which data collected during Project operations would be compared. The methods used to develop these limits would depend upon the statistical distributions exhibited by the data. Guidance provided by the U.S. Environmental Protection Agency (2009) would be relied upon when establishing the baseline control limits. Standards and limits as prescribed by UDWQ would be used as regulatory controls.

The statistical distribution of the baseline data would be assessed and an appropriate method would be used to test the significance of differences between baseline and operational data. It is anticipated that these methods would include: the classical normal distribution, the non-parametric Kruskal-Wallis (1952) analysis of variance, the non-parametric Friedman (1939) method, the Wilcoxon-Mann-Whitney test (Bain and Engelhardt 1992), or other appropriate methods. Post-hoc statistical tests would be performed if required by the analytical approach.

Trend analyses would be performed using ordinary least squares regression models, Mann-Kendall analysis, or Theil-Sen analysis, depending on the statistical distribution. The appropriateness of seasonally adjusting the time-trend data using the methods of Hirsch et al. (1982) would also be evaluated.

The U.S. Environmental Protection Agency (2009) recommends that a minimum of 8 to 10 independent baseline observations be collected before running most statistical tests. UDWQ recommends a minimum of 10 data points at individual sites except for metals analysis and in cases where access is limited or analytical protocols are supported by fewer samples (Toole 2010). If less than 10 samples are collected from a location when establishing baseline conditions, the data would be reviewed to determine if sound decisions can be made. Although still a small sample size by statistical standards, these levels may allow for acceptable estimates of variability and evaluation of trends and goodness-of fit. If sound decisions cannot be made with the smaller data set, then additional baseline data would be collected to ensure an adequate baseline data set. Such samples may be collected after the start of construction activities and would only be included in the data set if their use as representative of undisturbed conditions could be justified. Given the low permeability of the playa sediments, the travel time for water and brines in and surrounding the playa would allow a few years before any affect from construction activities could reach the surrounding monitoring points.

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ATTACHMENT A

Water Monitoring Plan Key Responsibilities

SEVIER PLAYA POTASH PROJECT
WATER MONITORING PLAN
KEY RESPONSIBILITIES

The responsibilities of key personnel involved in the generation and review of waster-resource data associated with the Sevier Playa Potash Project (the "Project") are presented below. Contact information for these individuals is presented in Table 1. As significant changes to duties or personnel occur, CPM will document those changes by updating this document within 60 days of the change(s) and notify UDWQ and BLM accordingly. Where changes do not reflect an alteration in the overall scope of the activities or a change of requirements, such changes will be identified in the annual Project report.

UDWQ Lead Engineer – Wynn John P.E.: Mr. John will be the primary UDWQ contact for issues related to compliance of the Project to the UDWQ Groundwater Discharge Permit. He will review the Project Water Monitoring Plan ("WMP") and the Sampling and Analysis Plan/Quality Assurance Project Plan ("SAP/QAPP") and will be responsible for determining compliance of the WMP and SAP/QAPP with state regulatory requirements. He will also review future monitoring data and audit monitoring activities.

BLM Authorized Officer – Mike Gates: Mr. Gates will be the primary BLM contact responsible for ensuring proper implementation of the WMP and SAP/QAPP. He will review the WMP and SAP/QAPP, audit monitoring activities, and assess the adequacy of the resulting data for meeting the requirements of the federal lease Special Stipulations.

Project Manager – LeeAnn Diamond, P.G.: The Project Manager ("PM") will provide overall direction to task managers and monitoring personnel necessary to accomplish the objectives of the WMP and SAP/QAPP, including development and completion of the technical work scope; coordination and execution of the scope, schedule, and budget requirements; reporting on the status of monitoring activities; assuring that staff with appropriate technical qualifications is utilized during implementation of the WMP and SAP/QAPP; and serving as primary liaison between CPM and the affected agencies (UDWQ and BLM). Ms. Diamond has a Bachelor of Science degree in geological engineering, 17 years of environmental project management experience, and 10 years of groundwater and soil monitoring and Phase I environmental investigation experience.

Discipline Manager – Leigh Beem, P.G.: The Discipline Manager ("DM") is responsible for conducting and/or oversight of field activities associated with implementation of the WMP and SAP/QAPP. Specific DM responsibilities include:

- Conduct or oversee installation of monitoring wells, downhole testing, and sample collection activities and ensure that work performed by the analytical laboratories is conducted in accordance with accepted protocols;
- Ensure that all field and data management personnel have reviewed the WMP and SAP/QAPP, are properly trained in procedures discussed in this document, and follow established policies and procedures;

- Review and validate testing and analytical results to ensure that the results fulfill the data quality objectives established in the WMP and SAP/QAPP; and
- Direct or prepare annual reports in which data collection activities are summarized and the resulting data are presented.

Mr. Beem has both a Bachelor of Science degree and a Master of Science degree in geology and 28 years of experience working RCRA-regulated sites, CERCLA-affected sites, leaking underground storage tanks, Phase I and II environmental investigations, groundwater monitoring and remediation, fate and transport modeling, and environmental risk assessments.

Quality Assurance Officer – Betsy Lang: The Quality Assurance Officer (“QAO”) will oversee implementation of the WMP and SAP/QAPP and ensure that all analytical data generated thereby are validated according to appropriate procedures. Specific responsibilities of the QAO include:

- Provide independent QA oversight during implementation of the WMP and SAP/QAPP;
- Review log books, chain-of-custody forms, and laboratory analytical reports to determine if data meet the requirements of the WMP and SAP/QAPP;
- Maintain an accurate and complete database of all analytical and other data generated during implementation of the WMP and SAP/QAPP;
- Assess analytical data to determine if the data meet appropriate measurement quality objectives;
- Report data quality issues, quality control (“QC”) concerns, and data non-conformance to established standards to the PM and DM;
- Periodically review the groundwater and surface water sampling program, analytical results, and data validation procedures for conformance to protocols and standards established in the WMP and SAP/QAPP; and
- Specify corrective actions to be taken in the event of QC failures or non-conformance to protocols and standards specified in the WMP and SAP/QAPP.

Ms. Lang has a Bachelor of Science in Environmental Engineering and 7 years of experience in environmental compliance and reporting, groundwater monitoring, and data management.

Project Reviewer – Thomas J. Suchoski, P.G.: The Project Reviewer will provide oversight of technical and quality assurance efforts during implementation of the WMP and SAP/QAPP. He will also assist in the preparation of future updates to the WMP and SAP/QAPP as needed. Mr. Suchoski has a Bachelor of Science degree in geology and a Master of Science degree in hydrology. He has 38 years of experience working with surface and groundwater baseline studies, water well drilling and development, water monitoring and risk assessments, RCRA, CERCLA, Phase I and II environmental investigations, and environmental permitting.

Laboratory Managers

The laboratories and managers for the laboratories that may work on this Project are: Kyle Gross, American West Analytical Laboratory (Salt Lake City, Utah), and John Hawkins, ESC Lab Sciences (Mt. Juliet, Tennessee). The laboratory managers will be responsible for ensuring that all quality assurance/ quality control procedures are implemented in accordance with in-house plans. They will also serve as the primary point of contact between CPM, its contractors, and the laboratory if questions arise during the data validation process.

Table 1-1 Project Contact Information

Name	Project Position	Agency/Company	Contact Information
Mike Gates	BLM Authorized Officer	BLM	Phone: 435-743-3100 E-mail: **mgates@blm.gov**
Wynn John	Environmental Scientist	UDWQ	Phone: 801-536-4355 E-mail: **wjohn@utah.gov**
LeeAnn Diamond	Project Manager	CPM	Phone: 801-485-0223 email: **ldiamond@crystalpeakminerals.com**
Betsy Lang	Quality Assurance Officer	CPM	Phone: 801-485-0223 email: **betsy@crystalpeakminerals.com**
Leigh Beem	Discipline Manager	Johnston-Leigh	Phone: 801-726-6845 Email: **leigh@johnstonleighinc.com**
Tom Suchoski	Senior Hydrologist	Norwest-Stantec	Phone: 801-539-0044 email: **tsuchoski@norwestcorp.com**
John Hawkins	Lab Manager	ESC Laboratories	Phone: 615-773-9669 email: **JHawkins@esclabsciences.com**
Kyle Gross	Lab Manager	AWAL	Phone: 801-263-8686 email: **awal@awal-labs.com**

ATTACHMENT B

Summary of Historical Groundwater Data

Table B-1. Groundwater Analytical Results 2012–2013: Bedrock

			Bedrock							
			Prospect Mountain Quartzite			Notch Peak Formation				Unidentified Lava Fm
	Station Name		**Monument Point**		**North Cricket**	**Black Hills**		**Coyote**	**Nighthawk**	**Lakeview**
	Sample ID Lab ID		SEV-11-007 1204204-001A, 1204204-001B, 1204204-001C 04/11/2012	Monument Point 1305029-003A, 1305029-003B, 1305029-003C 04/25/2013	N. Cricket-Baseline-001 1304401-001A, 1304401-001B, 1304401-001C 04/11/2013	Black Hills Baseline - 08:05 1202170-004A, 1202170-004B, 1202170-004C 02/10/2012	Black Hills Baseline - 09:50 1202170-001A, 1202170-001B, 1202170-001C 02/10/2012	SEV-11-013 1203367-001A, 1203367-001B, 1203367-001C 03/22/2012	SEV-11-014 1203303-001A, 1203303-001B, 1203303-001C 03/19/2012	Lakeview Baseline 1202149-001A, 1202149-001B, 1202149-001C 02/08/2012
Parameter	**Units**	**Utah Groundwater Standard**								
Major Ions and TDS										
Alkalinity	mg/L $CaCO_3$	–	–	–	–	–	–	–	–	–
Bicarbonate	mg/L $CaCO_3$	–	145.	144.	138.	175.	173.	178. J	233.	113.
Carbonate	mg/L $CaCO_3$	–	<20	<10	<20	<20	<20	<20 J	<40	<20
Hardness, Ca+Mg	mg/L	–	265.9	184.5	246.4	197.3	203.1	190.6	154.4	199.9
Calcium	mg/L	–	37.8	35.6	53.3 J	38.4 J	39.4	37.7	26.5	37.5
Magnesium	mg/L	–	41.8	23.3	27.6	24.7	25.5	23.5	21.5	25.9
Potassium	mg/L	–	17.7	5.54	5.5	11.1	11.0	11.3	11.3	9.08
Sodium	mg/L	–	407.	86.9	91.5	121.	125.	110.	214.	74.4
Chloride	mg/L	–	146.	141.	166.	105.	106.	102. J	159.	148.
Fluoride	mg/L	4	0.281	0.254	0.304	0.907	0.919	0.836 J	1.48	0.359
Silicon	mg/L	–	6.07	6.15	8.32	12.	12.1	11.3	7.48	22.3
Sulfate	mg/L	–	62.2	62.7	50.9	132.	136.	120. J	139.	55.8
Total dissolved solids	mg/L	–	400.	476.	480.	536.	536.	528. J	744.	420.
Nutrients										
Nitrate	mg/L N	10	0.868 J	–	–	0.604	0.590	0.597 J	0.66	2.73
Total Orthophosphate	mg/L P	–	<0.05	–	–	<0.05	<0.05	<0.05 J	<0.05	<0.05
Dissolved metals										
Aluminum	mg/L	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	mg/L	0.05	0.00793	0.00558	0.00266	0.0277	0.0284	0.0206	0.0306	0.0198
Beryllium	mg/L	0.004	<0.0003	<0.002	<0.002	<0.006	<0.006	<0.0006	<0.0006	<0.0006
Boron	mg/L	–	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.587 J	<0.5
Cadmium	mg/L	0.005	<0.00009	<0.0005	<0.0005	<0.0009	<0.0009	<0.00018	<0.00018	<0.00018
Chromium	mg/L	0.1	<0.01	<0.002	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01
Copper	mg/L	1.3	0.0015	<0.00229	<0.002	0.566 J	<0.008	0.00118	0.00149	<0.00105
Iron	mg/L	–	<0.1	<0.1	<0.428	<0.1	<0.1	0.141	0.162	<0.1
Lead	mg/L	0.015	<0.0002	<0.002	<0.002	<0.002	<0.002	<0.0004	<0.0004	0.00135
Manganese	mg/L	–	0.0263	<0.00675	<0.0293	<0.012	<0.012	0.0179	0.0226	<0.0012
Mercury	mg/L	0.002	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015
Selenium	mg/L	0.05	0.00137	<0.002	<0.002	<0.004	<0.004	<0.0008	<0.0008	<0.0008
Silver	mg/L	0.1	<0.0002	<0.002	<0.002	<0.002	<0.002	<0.0004	<0.0004	<0.0004
Zinc	mg/L	5	0.019	<0.164	<0.00828	0.124	0.120	0.0841	0.113	0.0683

			Bedrock							
			Prospect Mountain Quartzite			Notch Peak Formation				Unidentified Lava Fm
	Station Name		Monument Point		North Cricket	Black Hills		Coyote	Nighthawk	Lakeview
	Sample ID Lab ID		SEV-11-007 1204204-001A, 1204204-001B, 1204204-001C 04/11/2012	Monument Point 1305029-003A, 1305029-003B, 1305029-003C 04/25/2013	N. Cricket-Baseline-001 1304401-001A, 1304401-001B, 1304401-001C 04/11/2013	Black Hills Baseline - 08:05 1202170-004A, 1202170-004B, 1202170-004C 02/10/2012	Black Hills Baseline - 09:50 1202170-001A, 1202170-001B, 1202170-001C 02/10/2012	SEV-11-013 1203367-001A, 1203367-001B, 1203367-001C 03/22/2012	SEV-11-014 1203303-001A, 1203303-001B, 1203303-001C 03/19/2012	Lakeview Baseline 1202149-001A, 1202149-001B, 1202149-001C 02/08/2012
Parameter	**Units**	**Utah Groundwater Standard**								
Field parameters										
DTW	feet	–	–	–	499	–	85	391	476	85
Temperature	°C	–	23	–	20	–	24	27	21	23
pH	s.u.	6.5–8.5	8.24	–	7.70	–	7.52	7.50	6.89	7.77
SC	µS/cm	–	952	–	910	–	932	887	1,072	751
Turbidity	NTU	–	140	–	0.0	–	R	–	–	R
DO	mg/L	–	10	–	9	–	4	6	6	3
ORP	mV	–	200	–	25	–	-8	-108	-122	-16

DO = dissolved oxygen
DTW = depth to water
ND = statistic not calculated, all data below the detection limit
%ND = percent of samples reported as below the detection limit
% > WQ Standard = percent of samples reported above the groundwater quality standard
TDS = total dissolved solids
SC = specific conductance
ORP = oxidation-reduction potential
H = sample exceeded holding time
J = data were qualified as an estimated value
R = data rejected as not representative of sample
U = detected in equipment blank
s.u. = standard unit

Table B-2. Groundwater Analytical Results, 2012–2013: Alluvial/Colluvial Deposits

Parameter	Station Name / Sample ID Lab ID / Units	Utah Groundwater Standard	Unconsolidated Deposits: 257 Cutoff Well	257 Cutoff Well	Black Rock	Bonneville	Crystal Peak Road	Guzzler	Miller Canyon Reservoir	Mudhole	UDOT 2	UDOT 3	Wah Wah
			257 Cutoff 1305029-001A, 1305029-001B, 1305029-001C 04/27/2013	257 Cutoff-Well-06102013 1306182-003A, 1306182-003B, 1306182-003C 06/10/2013	Blackrock Baseline 1202158-001A, 1202158-001B, 1202158-001C 02/09/2012	Bonneville 1303067-003A, 1303067-003B, 1303067-003C 03/03/2013	CPR Baseline 1202300-001A, 1202300-001B, 1202300-001C 02/20/2012	Guzzler 1303067-002A, 1303067-002B, 1303067-002C 03/01/2013	Miller Canyon 1304417-001A, 1304417-001B, 1304417-001C 04/12/2013	Mudhole Baseline 1202158-003A, 1202158-003B, 1202158-003C 02/09/2012	UDOT 2 1304402-001A, 1304402-001B, 1304402-001C 04/10/2013	UDOT 3 1304402-002A, 1304402-002B, 1304402-002C 04/11/2013	Wah Wah Baseline 1202149-002A, 1202149-002B, 1202149-002C 02/08/2012
Major Ions and TDS													
Alkalinity	mg/L $CaCO_3$	–	–	–	–	–	–	–	–	–	–	–	–
Bicarbonate	mg/L $CaCO_3$	–	348.	363.	320.	399.	111.	147.	236.	156.	209.	136.	124.
Carbonate	mg/L $CaCO_3$	–	<20	<20	<40	28.6	<20	<10	<20	<20	<20	35.8	<20
Hardness, Ca+Mg	mg/L	–	8,918.5	11,688.	462.	37.9	772.2	240.2	57.1	249.	129.1	202.2	306.5
Calcium	mg/L	–	845.	690.	83.3	<7.6	117.	43.1	<8.28	47.1	<24.9	<23	51.9
Magnesium	mg/L	–	1,660.	2,430.	61.9	4.61	117.	32.3	8.87	32.	16.3	35.3	43.1
Potassium	mg/L	–	397.	373.	37.2	5.8	25.3	6.73	14.	11.4	5.22	19.	16.3
Sodium	mg/L	–	15,500.	23,900.	598.	385.	865.	69.2	430.	149.	791.	1,030.	318.
Chloride	mg/L	–	29,600.	33,000.	1,320.	193.	1,340.	144.	299.	241.	889.	1,140.	546.
Fluoride	mg/L	4	0.5	0.219	1.52	6.36	0.635	0.418	2.29	0.468	1.58	1.6	0.564
Silicon	mg/L	–	33.1	12.5	20.6	6.44	17.9	6.94	7.03	13.7	12.9 J	<0.651	18.2
Sulfate	mg/L	–	16,400.	14,000.	583.	226.	730.	35.5	263.	127.	333.	602.	458. J
Total dissolved solids	mg/L	–	82,700.	80,800.	3,180.	1,060.	3,410.	472.	1,150.	688.	2,000.	2,820.	1,330.
Nutrients													
Nitrate	mg/L N	10	–	<0.01	<0.01	–	0.273	–	–	<0.01	–	–	2.93
Total orthophosphate	mg/L P	–	–	0.104	0.136	–	<0.05	–	–	<0.05	–	–	<0.05
Dissolved Metals													
Aluminum	mg/L	–	<1.44	<1	<0.1	<0.11	0.17	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Arsenic	mg/L	0.05	0.652 J	0.267	0.0421	0.00443	0.0519	<0.002	0.182	0.0365	0.223	<0.002	0.0254
Beryllium	mg/L	0.004	<0.002	<0.01	<0.0006	<0.002	<0.003	<0.002	<0.002	<0.0006	<0.002	<0.002	<0.0006
Boron	mg/L	–	11.	8.18	2.06	2.79	0.832 J	<0.5	0.818	<0.5	2.33	2.87	<0.5
Cadmium	mg/L	0.005	<0.0005	<0.0025	<0.00018	<0.0005	<0.0009	<0.0005	<0.0005	<0.00018	<0.0005	<0.0005	<0.00018
Chromium	mg/L	0.1	<0.00646	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<0.002	<0.01
Copper	mg/L	1.3	<0.00412	<0.01	<0.00218	<0.002	<0.004	<0.00238	<0.002	<0.0008	<0.002	<0.002	<0.000986
Iron	mg/L	–	<0.1	6.01	0.763	<0.1	0.122	<0.1	<0.1	0.28	<0.406	<0.801	<0.1
Lead	mg/L	0.015	0.00249	<0.01	<0.0004	<0.002	<0.002	<0.002	<0.002	<0.0004	0.00513	<0.002	0.000743
Manganese	mg/L	–	0.689	1.54	0.338	<0.0356	0.0166	<0.103	<0.0407	0.0163	<0.0263	<0.0526	<0.0012
Mercury	mg/L	0.002	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015

			Unconsolidated Deposits										
	Station Name		257 Cutoff Well		Black Rock	Bonneville	Crystal Peak Road	Guzzler	Miller Canyon Reservoir	Mudhole	UDOT 2	UDOT 3	Wah Wah
	Sample ID Lab ID		257 Cutoff 1305029-001A, 1305029-001B, 1305029-001C 04/27/2013	257 Cutoff-Well-06102013 1306182-003A, 1306182-003B, 1306182-003C 06/10/2013	Blackrock Baseline 1202158-001A, 1202158-001B, 1202158-001C 02/09/2012	Bonneville 1303067-003A, 1303067-003B, 1303067-003C 03/03/2013	CPR Baseline 1202300-001A, 1202300-001B, 1202300-001C 02/20/2012	Guzzler 1303067-002A, 1303067-002B, 1303067-002C 03/01/2013	Miller Canyon 1304417-001A, 1304417-001B, 1304417-001C 04/12/2013	Mudhole Baseline 1202158-003A, 1202158-003B, 1202158-003C 02/09/2012	UDOT 2 1304402-001A, 1304402-001B, 1304402-001C 04/10/2013	UDOT 3 1304402-002A, 1304402-002B, 1304402-002C 04/11/2013	Wah Wah Baseline 1202149-002A, 1202149-002B, 1202149-002C 02/08/2012
Parameter	**Units**	**Utah Groundwater Standard**											
Selenium	mg/L	0.05	<0.005	<0.01	<0.0008	<0.002	<0.004	<0.002	<0.002	<0.0008	<0.002	<0.002	0.00208
Silver	mg/L	0.1	<0.002	<0.01	<0.0004	<0.002	<0.002	<0.002	<0.002	<0.0004	<0.002	<0.002	<0.0004
Zinc	mg/L	5	<0.128	<0.0719	0.121	0.323	<0.025	<0.0352	<0.0225	<0.0104	<0.005	<0.00879	0.15
Field Parameters													
DTW	feet	–	21	–	12	181	179	376	269	3	187	–	212
Temperature	°C	–	16	–	13	15	12	21	16	20	21	16	16
pH	s.u.	6.5–8.5	7.16	–	7.48	8.82	7.56	7.28	6.68	7.69	9.14	9.30	7.79
SC	µS/cm	–	99,900	–	4,260	1,980	4,135	790	2,100	1,117	3,920	5,230	2,013
Turbidity	NTU	–	571	–	R	515	2,146	203	25	R	116	23	R
DO	mg/L	–	0	–	0	9	3	10	11	0	12	10	1
ORP	mV	–	-175	–	-148	-151	180	14	121	-157	-182	-36	0

= exceeds lowest applicable WQ standard

DO = dissolved oxygen

DTW = depth to water

ND = statistic not calculated, all data below the detection limit

%ND = percent of samples reported as below the detection limit

% > WQ standard = percent of samples reported above the groundwater quality standard

TDS = total dissolved solids

SC = specific conductance

ORP = oxidation-reduction potential

H = sample exceeded holding time

J = data were qualified as an estimated value

R = data rejected as not representative of sample

U = detected in equipment blank

s.u. = standard unit

Table B-3. Groundwater Analytical Results, 2012–2013: Playa Sediments

			Playa Sediments																
	Station Name		Amasa	Dike Access	Glass Ocean	Glitter Gulch	Headlight Gap	Laceration	Machine Gun	Mudflat	Nautilus	Provo	PVC Shoal	Red Boat	RR7-1	RR7-4	S13	SN2-11-400-4	Wishing Well
	Sample ID Lab ID		Amasa Baseline 1202119-001A, 1202119-001B, 1202119-001C 02/07/2012	Dike Access 1303067-001A, 1303067-001B, 1303067-001C 02/27/2013	Glass Ocean Baseline 1202244-002A, 1202244-002B, 1202244-002C 02/15/2012	Glitter Gulch Baseline 1202244-001A, 1202244-001B, 1202244-001C 02/15/2012	Head Light Gap Baseline 1202283-001A, 1202283-001B, 1202283-001C 02/17/2012	Laceration Baseline 1202170-002A, 1202170-002B, 1202170-002C 02/10/2012	Machine Gun Baseline 1202119-003A, 1202119-003B, 1202119-003C 02/07/2012	Mudflat Baseline 1202300-002A, 1202300-002B 02/20/2012	Natilus Baseline 1202283-002A, 1202283-002B, 1202283-002C 02/17/2012	Provo 1305029-002A, 1305029-002B, 1305029-002C 04/29/2013	PVC Shoal Baseline 1202119-002A, 1202119-002B, 1202119-002C 02/07/2012	Red Boat Baseline 1202224-002A, 1202224-002B, 1202224-002C 02/14/2012	RR7-1-100 1203461-003A, 1203461-003B, 1203461-003C 03/28/2012	RR7-4-35 1203461-001A, 1203461-001B, 1203461-001C 03/28/2012	S13-23 1204046-001A, 1204046-001B, 1204046-001C 04/03/2012	SN2-11-400-4" Baseline 1202320-002A, 1202320-002B, 1202320-002C 02/21/2012	Wishing Well Baseline 1202224-001A, 1202224-001B, 1202224-001C 02/14/2012
Parameter	**Units**	**Utah Groundwater Standard**																	
Major Ions and TDS																			
Alkalinity	mg/L $CaCO_3$	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bicarbonate	mg/L $CaCO_3$	–	101.	91.3	88.3	122.	99.2	92.8	122.	175.	215.	104.	706.	111.	348.	262.	308.	65.5	81.9
Carbonate	mg/L $CaCO_3$	–	<10	<10	<10	<20	<10	<10	<10	<20	<20	<10	<10	<10	<20	<20	<20	<10	<10
Hardness, Ca+Mg	mg/L	–	12,259.	1,546.8	6,474.5	4,555.9	9,815.	6,429.5	4,645.2	7,749.	12,715.	4,421.8	1,869.7	4,601.3	7,547.	37,121.	15,570.	10,558.	4,133.
Calcium	mg/L	–	1,640.	253.	835.	717.	974.	817.	633.	820.	576.	665.	146.	704.	1,100.	7,780. J	652.	1,550.	661.
Magnesium	mg/L	–	1,990.	223.	1,070.	674.	1,800.	1,070.	747.	1,390.	2,750.	673.	367.	693.	1,170.	4,310.	3,400.	1,630.	605.
Potassium	mg/L	–	366.	19.3	181.	84.4	285.	92.9	123.	783.	1,000.	39.7	372.	73.	186.	2,550.	2,560.	211.	80.2
Sodium	mg/L	–	11,600.	4,190.	18,800.	12,100.	26,000.	23,600.	17,600.	26,700.	27,600.	9,750.	9,600.	15,100.	24,300.	70,900.	66,900.	30,400.	10,500.
Chloride	mg/L	–	21,300.	5,590.	23,200.	11,800.	39,300.	29,000.	22,700.	39,500.	41,300.	10,300.	17,600.	19,200.	26,800.	116,000.	107,000. J	44,600.	11,200.
Fluoride	mg/L	4	<1	0.797	<0.1	<0.1	<0.1	<0.1	<1	0.122	0.136	0.226	<1	0.337	1.	<0.5	<0.5	0.202	0.833 J
Silicon	mg/L	–	19.9	8.55	6.2	8.57	8.23	7.3	8.49	9.	9.25	8.25	11.3	3.59	6.14	15.3	15.2	7.87	6.7
Sulfate	mg/L	–	5,010.	1,860.	8,580.	10,600.	12,100.	9,810.	8,140.	15,100.	19,600.	7,840.	4,220.	8,440.	5,590.	6,930.	19,900.	6,950.	8,480.
Total dissolved solids	mg/L	–	52,600.	13,800.	103,000.	33,000.	122,000.	117,000.	58,100.	84,200.	109,000.	33,000.	38,200.	76,000.	66,600.	191,000.	194,000.	95,700.	51,500.
Nutrients																			
Nitrate	mg/L N	10	39.8	–	0.271	<0.01	<0.01	<0.02	<0.0556	12.5	8.08	–	1.26	<0.01	<0.01	<0.01	0.0255	<0.01	<0.01
Total Orthophosphate	mg/L P	–	<0.05	–	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.13	–	8.59	<0.05	0.0625	0.222	0.226	<0.1	<0.05
Dissolved Metals																			
Aluminum	mg/L	–	0.227	<0.2	0.181	0.115	0.164 J	0.179	<1	0.345	0.145	<0.2	<0.1	0.129	0.205	0.377 J	0.3 J	0.565	0.105
Arsenic	mg/L	0.05	0.129	<0.002	0.055	0.296	0.0557	0.771	0.264	0.0522	0.124	0.0729	0.0717	0.125	<0.015	0.0184 J	0.264 J	0.111	0.0678
Beryllium	mg/L	0.004	<0.006	<0.002	<0.015	<0.003	<0.006	<0.006	<0.006	<0.006	<0.006	<0.002	<0.006	<0.006	<0.015	<0.015 J	<0.015	<0.006	<0.003
Boron	mg/L	–	9.26	1.55	5.61	5.93	11.3	3.57	4.15	14.7	33.7	3.14	1.76	3.63	3.12	12.	17.8	3.53	4.28
Cadmium	mg/L	0.005	<0.0018	<0.0005	0.00154	0.00234	<0.0018	<0.0018	<0.0018	<0.0018	<0.0018	<0.0005	<0.0018	<0.0009	<0.0018	<0.0018	<0.0045	<0.0018	0.0012
Chromium	mg/L	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	0.0192	<0.01	0.018	0.0305 J	<0.01 J	<0.01	<0.01
Copper	mg/L	1.3	0.0293	<0.0039	0.0343	0.0479	0.202	0.194	0.0429	0.053	0.0897	<0.002	<0.008	0.0354	0.0418	0.0647	0.135	0.0307	0.0295
Iron	mg/L	–	0.246	<0.168	0.116	0.33	<0.1	0.95	0.255	<0.1	0.236	<0.123	<0.1	0.187	21.9	1.55 J	0.269 J	0.678	0.31
Lead	mg/L	0.015	<0.004	<0.002	0.00693	<0.002	0.00925 J	<0.004	0.123	0.00443	0.0161	0.00215	<0.004	0.0138	<0.004	<0.004	<0.01	<0.004	<0.002
Manganese	mg/L	–	0.121	0.795	0.156	0.138	0.0763 J	0.0745	0.352	0.385	0.0562	1.94	0.154	0.106	2.88	0.125	0.312	0.796	0.21
Mercury	mg/L	0.002	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015	<0.00015 J	<0.00015 J	<0.00015	<0.00015

Parameter	Units	Utah Groundwater Standard	Playa Sediments																
	Station Name		**Amasa**	**Dike Access**	**Glass Ocean**	**Glitter Gulch**	**Headlight Gap**	**Laceration**	**Machine Gun**	**Mudflat**	**Nautilus**	**Provo**	**PVC Shoal**	**Red Boat**	**RR7-1**	**RR7-4**	**S13**	**SN2-11-400-4**	**Wishing Well**
	Sample ID Lab ID		Amasa Baseline 1202119-001A, 1202119-001B, 1202119-001C 02/07/2012	Dike Access 1303067-001A, 1303067-001B, 1303067-001C 02/27/2013	Glass Ocean Baseline 1202244-002A, 1202244-002B, 1202244-002C 02/15/2012	Glitter Gulch Baseline 1202244-001A, 1202244-001B, 1202244-001C 02/15/2012	Head Light Gap Baseline 1202283-001A, 1202283-001B, 1202283-001C 02/17/2012	Laceration Baseline 1202170-002A, 1202170-002B, 1202170-002C 02/10/2012	Machine Gun Baseline 1202119-003A, 1202119-003B, 1202119-003C 02/07/2012	Mudflat Baseline 1202300-002A, 1202300-002B 02/20/2012	Natilus Baseline 1202283-002A, 1202283-002B, 1202283-002C 02/17/2012	Provo 1305029-002A, 1305029-002B, 1305029-002C 04/29/2013	PVC Shoal Baseline 1202119-002A, 1202119-002B, 1202119-002C 02/07/2012	Red Boat Baseline 1202224-002A, 1202224-002B, 1202224-002C 02/14/2012	RR7-1-100 1203461-003A, 1203461-003B, 1203461-003C 03/28/2012	RR7-4-35 1203461-001A, 1203461-001B, 1203461-001C 03/28/2012	S13-23 1204046-001A, 1204046-001B, 1204046-001C 04/03/2012	SN2-11-400-4" Baseline 1202320-002A, 1202320-002B, 1202320-002C 02/21/2012	Wishing Well Baseline 1202224-001A, 1202224-001B, 1202224-001C 02/14/2012
Selenium	mg/L	0.05	0.0727	<0.002	0.00701	<0.004	<0.008	<0.004	<0.004	<0.008	<0.008	<0.002	<0.004	<0.004	<0.008	<0.008	<0.02 J	<0.008	<0.004
Silver	mg/L	0.1	<0.004	<0.002	<0.002	<0.002	<0.004	<0.004	<0.004	<0.004	<0.004	<0.002	<0.004	<0.002	<0.004	<0.004	<0.01	<0.004	<0.002
Zinc	mg/L	5	0.122	2.56	3.16	1.49	<3.01	2.13	2.33	0.151	<2.47	0.906	<0.05	7.75	<0.05	<0.05	0.164	0.0568	0.0598
Field Parameters																			
DTW	feet	–	60	34	18	155	109	86	38	129	12	87	10	176	0	5	3	–	98
Temperature	°C	–	1	16	7	13	14	14	14	14	11	20	–	15	–	16	14	12	12
pH	s.u.	6.5–8.5	7.04	7.27	7.55	7.58	7.62	7.38	7.4	6.96	7.52	7.9	–	7.37	–	6.19	6.58	7.41	7.72
SC	µS/cm	–	42,590	59,800	65,390	21,590	76,120	71,330	70,910	103,900	86,030	99,900	–	26,240	–	177,600	174,400	111,600	33,540
Turbidity	NTU	–	R	709	R	245	19	R	R	328	188	179	–	45	–	58	R	1	132
DO	mg/L	–	1	10	1	5	1	0	2	2	2	1	–	4	–	0	0	17	1
ORP	mV	–	42	50	84	119	149	-108	-35	-53	128	-177	–	34	–	10	65	-146	-85

= exceeds lowest applicable WQ standard

DO = dissolved oxygen

DTW = depth to water

ND = statistic not calculated, all data below the detection limit

%ND = percent of samples reported as below the detection limit

% > WQ standard = percent of samples reported above the groundwater quality standard

TDS = total dissolved solids

SC = specific conductance

ORP = oxidation-reduction potential

H = sample exceeded holding time

J = data were qualified as an estimated value

R = data rejected as not representative of sample

U = detected in equipment blank

s.u. = standard unit

1

ATTACHMENT C

Combined Sampling and Analysis Plan and Quality Assurance Project Plan for the Sevier Playa Project

COMBINED SAMPLING AND ANALYSIS PLAN

AND

QUALITY ASSURANCE PROJECT PLAN FOR THE

SEVIER PLAYA PROJECT

CRYSTAL PEAK MINERALS
SEVIER PLAYA POTASH PROJECT

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June 4, 2019

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Revision	Description	Author		Quality Check		Independent Review	
10/25/18	Final Draft	Tom Suchoski/ Rich White	10/25/18	Rich White	10/25/18	Toni Jack	10/25/18
2/11/19	Draft Revision	Tom Suchoski/ Rich White	2/11/19			Toni Jack	2/11/19
2/14/19	Draft Revision	Tom Suchoski	2/13/19			Toni Jack	2/14/19
4/5/19	Draft Revision	Tom Suchoski/ Rich White	4/3/19	Betsy Lang	4/4/19	Toni Jack	4/5/19
6/3/19	Draft Revision	Rich White	6/3/19	Betsy Lang	6/4//19	Toni Jack	6/4/19

Prepared by ____

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Tom Suchoski/Rich White

Reviewed by ____

(signature)

Rich White

Approved by ____

(signature)

Tom Suchoski

Stantec

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ABBREVIATIONS

AMSL	above mean sea level
ASTM	American Society of Testing Materials
BLM	U.S. Bureau of Land Management
BTOC	below top of casing
CCVs	Continuing Calibration Verification Standards
CDFM	Corehole Dynamic Flowmeter
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
CoC	Chain of Custody
CPM	Peak Minerals Inc. (DBA "Crystal Peak Minerals")
DO	dissolved oxygen
DQI	Data Quality Indicators
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
ft	feet
HSU	Hydrostratigraphic unit
ICV	Initial calibration value
ITRC	Interstate Technology and Regulatory Council
K_2SO_4	Potassium sulfate
LCSD	Laboratory Control Sample Duplicates
LCS	laboratory control sample
LMS	Laboratory matrix spike
LMSD	Laboratory Matrix Spike Duplicates
MDL	method (or minimum) detection limit
mg/L	milligrams per liter
ml	milliliter
MQO	Measurement Quality Objectives
MS	matrix spikes
MS/MSD	matrix spike/matrix spike duplicate
MTM	Monitoring Task Manager
NELAP	National Environmental Accreditation Program
NTU	Nephelometric Turbidity Units
Pace	Pace Laboratories, formerly ESC Lab Sciences

PM	Project Manager
PQL	practical quantitation limit
Project	Sevier Playa Potash Project
PSI	pounds per square inch
PVC	polyvinyl chloride
QAO	Quality Assurance Officer
QA/QC	quality assurance and quality control
QC	quality control
QCS	quality control summary
RCRA	Resource Conservation and Recovery Act
RPD	relative percent difference
SAP	Sampling Analysis Plan
SAP/QAPP	Sampling and Analysis Plan/Quality Assurance Project Plan
SC	Specific conductance
SITLA	State of Utah School and Institutional Trust Lands Administration
SOP	Sulfate of potash
SW	southwest
TDS	total dissolved solids
TSS	total suspended solids
UAC	Utah Administrative Code
UDWQ	Utah Division of Water Quality
ug/l	Micrograms per liter
WPSA	Waste Product Storage Area

1 INTRODUCTION

1.1 Background

Crystal Peak Minerals (“CPM”) is proposing to construct and operate the Sevier Playa Potash Project (“Project”) on federal, state, and private lands in Millard County, Utah. The Project would be designed to produce an average of approximately 328,500 tons per year of potash in the form of potassium sulfate (“K_2SO_4”), also known as sulfate of potash (“SOP”), as well as other associated minerals. CPM controls through agreement the right to develop and operate potassium mineral leases on approximately 118,000 acres of land administered by the U.S. Bureau of Land Management (“BLM”), and controls through agreement potash mineral leases on an additional approximately 6,400 acres of state lands administered by the State of Utah School and Institutional Trust Lands Administration (“SITLA”).

In general, the on-lease mining design for the Project would consist of the following three major features: (1) a brine extraction system consisting of canals, trenches, and wells; (2) a recharge system consisting of canals and trenches; and (3) a series of evaporation ponds consisting of preconcentration and production ponds. The brines extracted from below the surface of the Sevier Playa would be concentrated by solar evaporation in a series of preconcentration ponds. The brines would be further evaporated, and the potassium-rich salts precipitated in the production ponds would be harvested and transported to an on-lease processing facility. The salts would be processed at the processing facility to produce saleable SOP, as well as other associated minerals.

Infrastructure to support the Project would include: (1) access roads, (2) communication towers, (3) power and communications lines, (4) a natural gas pipeline, (5) a rail loadout facility and associated rail spur, (6) water supply facilities, 7) groundwater monitoring wells; and 8) gravel pits. These components would all be located on off-lease lands.

The Utah Division of Water Quality (“UDWQ”), as the regulatory agency with jurisdiction over groundwater within the state, requires that a baseline assessment of the groundwater resources in the area be prepared as part of an anticipated Groundwater Discharge Permit application. Further, the federal lease held by CPM contains two Special Stipulations that require monitoring of surface and groundwater in the vicinity of the Project (BLM 2011).

Special Stipulation 8 of the federal leases states:

> “The Lessee at his expense, will be responsible to replace any water resources (that contain in a base line analysis of <10,000 mg/L TDS), that are lost or adversely affected (quality or quantity) by their mining operations. . . .If replacement is required, the lessee shall replace

> the sources with an alternate source in the same quantity and quality to maintain existing uses. . . . The lessee/operator shall obtain sufficient base line data and monitoring in order to establish parameters to show whether water resources are affected."

Special Stipulation 13 of the federal leases states:

> "Sufficient base line data shall be established prior to conducting any surface disturbing activity which shall be determined necessary by the AO [Authorized Officer]. In order to accomplish this, the lessee shall submit for review and approval by the AO a plan to analyze ground and surface water interactions as part of any operations or exploration on the leases. The plan shall be submitted prior to or concurrent with a Mining or Exploration plan, under 43 CFR 3592.1. The plan shall include, but not be limited to the following items, and shall describe how the lessee proposes to: (1) Develop sufficient baseline groundwater information to document existing hydrogeology associated with Sevier Lake basin fill and underlying carbonates, encompassing a reasonable area of potential resources, springs, and the alluvial and bedrock aquifers. This shall include items such as the location, size, and depth of any hole that would encounter water and/or brine as well as any information that would be collected on each hole. (2) Determine the potential impacts to existing water right holders, wells, wetlands, and surface and groundwater throughout their operations. Water chemistry (including stable isotopes as necessary), estimated flow and water quantity (water balance) shall be addressed. (3) Monitor the actual impacts to groundwater resources throughout and surrounding the operation including but not limited to changes in meteoric precipitation and springs, wells (base conditions, water levels, and chemistry conditions prior to construction and monitoring after construction), wetlands, and ditches. Wells, wetlands, and springs (at sites determined to be relevant based upon the groundwater study that would be conducted prior to development) shall be monitored during operations in order to minimize potential impacts to groundwater resources by allowing an early identification. Further, the plan shall contain sufficient detail to allow it to be independently assessed and include such things as the type of groundwater model that would be used (and/or other methods of analysis), phasing of the analysis and proposed iterative studies. The plan shall also contain a list of people and their qualifications to accomplish the work and a list of deliverables with a timing schedule. The lessee shall be responsible for any cost incurred for the plan and the accomplishing of the work."

1.2 Objectives of this SAP/QAPP

The purpose of this Sampling and Analysis Plan/Quality Assurance Project Plan ("SAP/QAPP") is to present methods for collecting and validating the above-required data. This SAP/QAPP provides a description of the procedures for collecting surface and groundwater data to supplement data collected to date; to better assess the seasonal fluctuations within the hydrologic regime; to monitor wells, springs, and streams; and to ensure a valid data set that can be used to evaluate potential future impacts from the proposed Project. The collection of meteorological data at the site is discussed in the associated Water Monitoring Plan (Norwest 2019).

At the request of BLM, this plan was prepared in general accordance with guidance provided by the U.S. Environmental Protection Agency ("EPA") (2002 and 2012) for the preparation of Quality Assurance Project Plans and Sampling and Analysis Plans, respectively. To avoid duplication, the Sampling and Analysis Plan and the Quality Assurance Project Plan have been combined in this document, which was organized using the template prepared by the EPA (2012). The use of this template and guidance should not be construed as implying the Project falls under the umbrella of the Resource Conservation and Recovery Act ("RCRA") or the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA").

1.3 Area of Interest

The area of interest associated with this SAP/QAPP consists of the Sevier Playa and adjacent areas located in Millard County, Utah. Figure 2-2, a map showing the area of interest, together with additional information regarding the playa and adjacent areas, is presented in Section 2.1 of this document.

1.4 Sampling Area Location

The Sevier Playa is a terminal basin located at the downstream end of the Sevier River in west-central Utah. As a salt-encrusted and occasionally-flooded area, the playa is not in current use. Areas adjacent to the playa are currently used as rangeland and wildlife habitat.

1.5 Responsible Agency

Monitoring activities conducted under this SAP/QAPP will be performed by or under contract to CPM. The resulting data will be submitted to UDWQ and BLM for review to ensure that CPM is in compliance with the requirements of the state groundwater discharge permit and the federal lease Special Stipulations, respectively.

1.6 Project Organization

The SAP/QAPP organizational chart is presented in Figure 1-1, with the responsibilities of key Project personnel presented below. Contact information for these individuals is presented in Table 1-1. Some team members may be responsible for more than one position.

As significant changes to duties or personnel occur, CPM will document and append such changes to this SAP/QAPP within 60 days of the change(s) and notify UDWQ and BLM. Where changes do not reflect an alteration in the overall scope of the activities or a change of requirements, such changes will be incorporated into the next required SAP/QAPP revision.

UDWQ Lead Engineer: This individual will be the primary UDWQ contact for issues related to compliance of the Project to the UDWQ Groundwater Discharge Permit. He/she will review this SAP/QAPP and will be responsible for determining compliance of the SAP/QAPP with state regulatory requirements. He/she will also review future monitoring data and audit monitoring activities.

BLM Authorized Officer: The Authorized Officer will be the primary BLM contact responsible for ensuring proper implementation of the SAP/QAPP. They will review this SAP/QAPP, audit monitoring activities, and assess the adequacy of the resulting data for meeting the requirements of the federal lease Special Stipulations.

CPM Project Manager: The CPM Project Manager ("PM") will provide overall direction to task managers and monitoring personnel necessary to accomplish the objectives of the SAP/QAPP, including development and completion of the technical work scope; coordination and execution of the scope, schedule, and budget requirements; reporting on the status of monitoring activities; assuring that staff with appropriate technical qualifications are utilized during implementation of the SAP/QAPP; and serving as primary liaison between CPM and the affected agencies (UDWQ and BLM).

Monitoring Task Manager: The Monitoring Task Manager ("MTM") is responsible for conducting and/or oversight of field activities associated with implementation of the SAP/QAPP. Specific MTM responsibilities include:

- Conduct or oversee installation of monitoring wells, downhole testing, and sample collection activities and ensure that work performed by the analytical laboratories is conducted in accordance with accepted protocols;
- Ensure that all field and data management personnel have reviewed the SAP/QAPP, are properly trained in procedures discussed in this document, and follow established policies and procedures;
- Review and validate testing and analytical results to ensure that the results fulfill the data quality objectives ("DQOs") established in the SAP/QAPP; and
- Direct or prepare annual reports in which data collection activities are summarized and the resulting data are presented.

Figure 1-1 Project Personnel Organization Chart

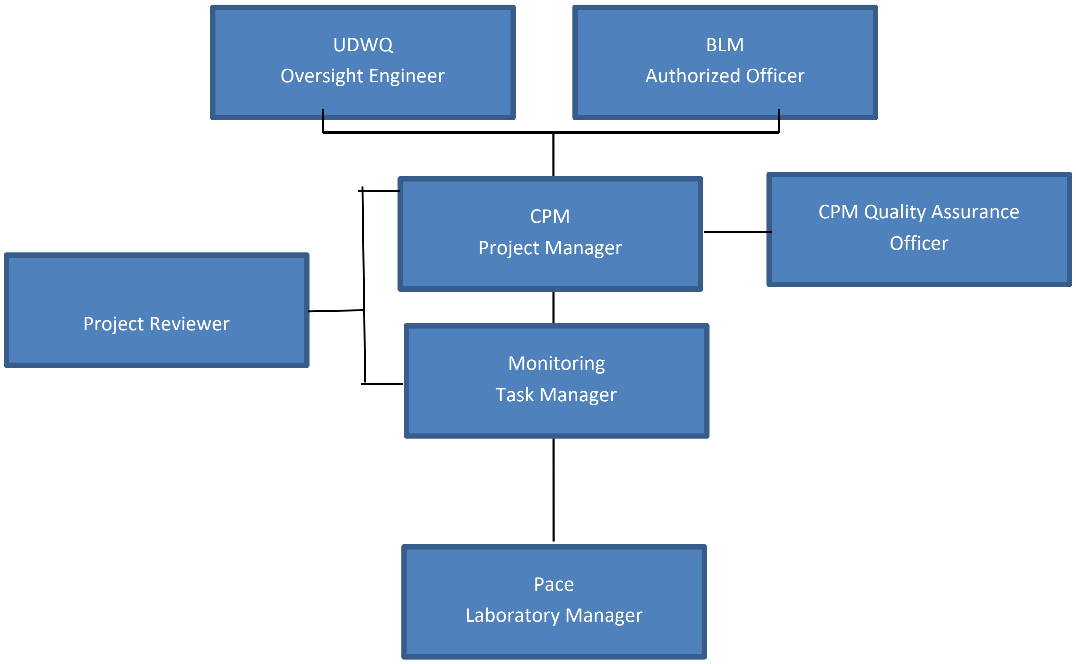


Table 1-1 Distribution List

Position	Agency	Contact Information
BLM Authorized Officer	BLM	Phone: 435-743-3100
UDWQ Lead Engineer	UDWQ	Phone: 801-536-4355
CPM Project Manager	CPM	Phone: 801-485-0223
CPM Quality Assurance Officer	CPM	Phone: 801-485-0223
Monitoring Task Manager	Johnston-Leigh	Phone: 801-726-6845
Project Reviewer	Stantec	Phone: 801-539-0044
Pace Laboratory Manager	Pace Labs	Phone: 615-773-9669

CPM Quality Assurance Officer: The Quality Assurance Officer ("QAO") will oversee implementation of the SAP/QAPP and ensure that all analytical data generated thereby are validated according to appropriate procedures. Specific responsibilities of the QAO include:

- Provide independent QA oversight during implementation of the SAP/QAPP;
- Review log books, chain-of-custody (CoC) forms, and laboratory analytical reports to determine if data meet the requirements of the SAP/QAPP;
- Maintain an accurate and complete database of all analytical and other data generated during implementation of the SAP/QAPP;
- Assess analytical data to determine if the data meet appropriate measurement quality objectives ("MQOs");

- Report data quality issues, quality control ("QC") concerns, and data non-conformance to established standards to the PM and DM;
- Periodically review the groundwater and surface water sampling program, analytical results, and data validation procedures for conformance to protocols and standards established in the SAP/QAPP; and
- Specify corrective actions to be taken in the event of QC failures or non-conformance to protocols and standards specified in the SAP/QAPP.

Project Reviewer: The Project Reviewer will provide oversight of technical and quality assurance efforts during implementation of the SAP/QAPP. They will also assist in the preparation of future updates to the SAP/QAPP as needed.

Laboratory Manager: The laboratory that would work on this Project is Pace Labs, formerly ESC Lab Sciences ("Pace") in Mt. Juliet, Tennessee. The laboratory manager will be responsible for ensuring that all quality assurance/quality control procedures are implemented in accordance with in-house plans and this SAP/QAPP. He/she will also serve as the primary point of contact between CPM, its contractors, and the laboratory if questions arise during the data validation process.

2 BACKGROUND

2.1 Sampling Area Description

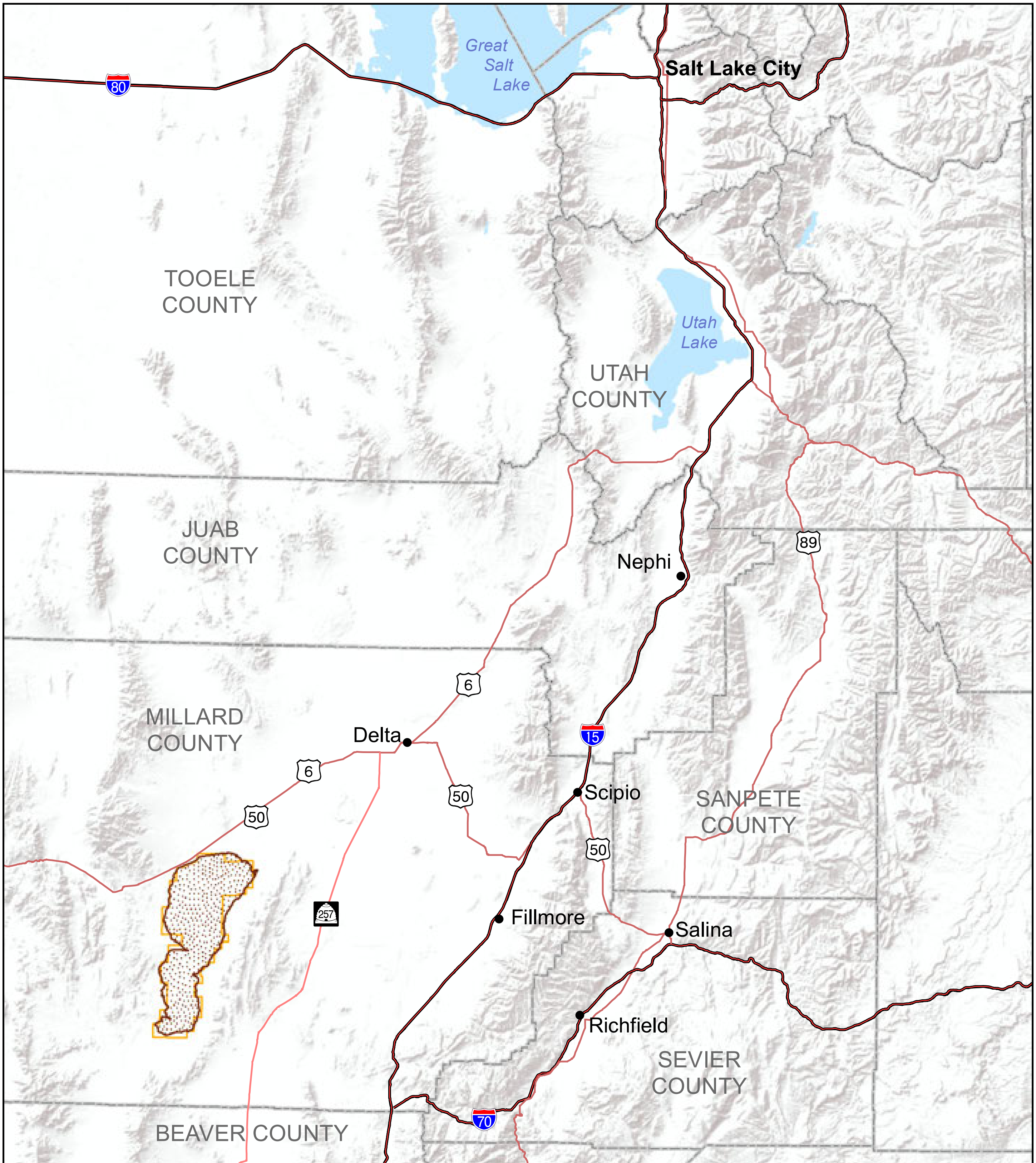
The Sevier Playa is located in west-central Utah approximately 140 miles southwest of Salt Lake City and about midway between the towns of Delta (30 miles to the northeast) and Milford (25 miles to the south-southeast) (Figures 2-1 and 2-2). The playa is approximately 26 miles long by an average of 8 miles wide and covers approximately 130,000 acres at an average elevation of about 4,514 feet above mean sea level ("AMSL"). The center of the playa is located at about latitude 38.921^{o} North, longitude 113.134^{o} West.

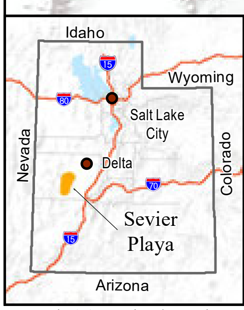
The area of interest associated with this SAP/QAPP is shown in Figures 2-2 and 4-1. This area extends generally 3 to 4 miles beyond the lease area on the west, south, and east sides of the playa. On the north, the area of interest extends north of US Highway 6/50 and northeast to Conks Dam. This area is considered sufficient to monitor the potential hydrologic impacts of the Project, as further explained in the companion Water Monitoring Plan (Stantec 2019).

2.2 Operational History

According to Brebner et al. (2018), a prior developer of the Sevier Playa assembled a lease position in 1978 that encompassed the entire surface of the Sevier Playa, including the current Project area. This company carried out significant site activities through 1990 focused on resource characterization and measurement of climatic conditions. These leases were eventually relinquished back to the resource owners.

CPM was granted potash leases from SITLA in 2008 and installed wells in the southern portion of the playa to monitor and confirm brine chemistry. CPM also controls development rights to federal potassium leases that were granted to others from BLM by competitive bid in 2011. Since then, CPM has focused its efforts on further evaluation of the mineral potential of the playa and obtaining the permits necessary to begin extraction of the playa's resources. This has included drilling of more than 400 boreholes and the installation and testing of over 90 wells. The wells and borings have concentrated on conditions within the upper 100 feet of the playa surface, but several boreholes have also been completed to depths up to about 500 feet below ground surface to evaluate the stratigraphy of the playa.





Sevier Playa Boundary

BLM and SITLA Lease Boundary

N

0 20 40 Miles

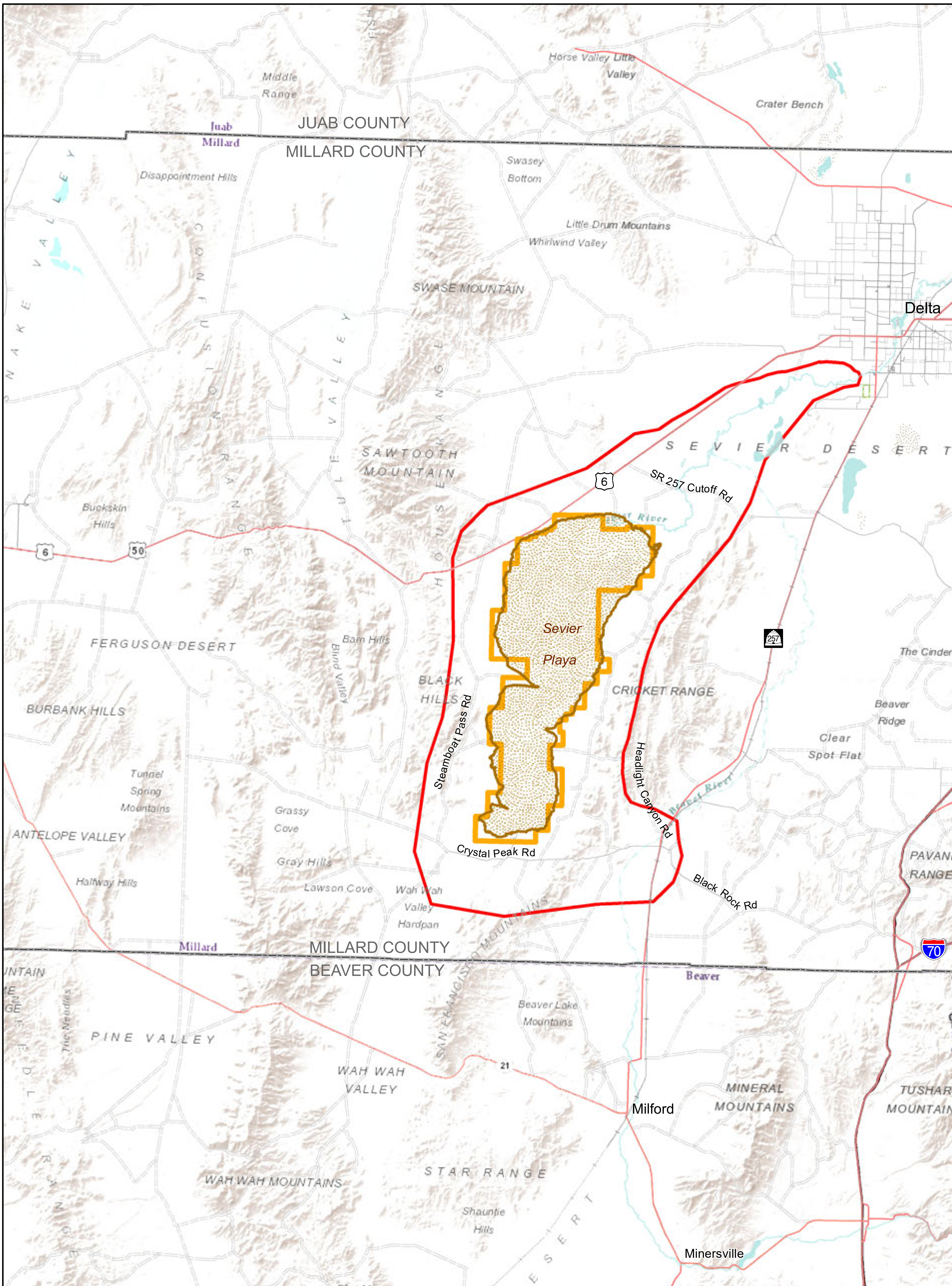
1 in = 20 miles 1:1,267,200

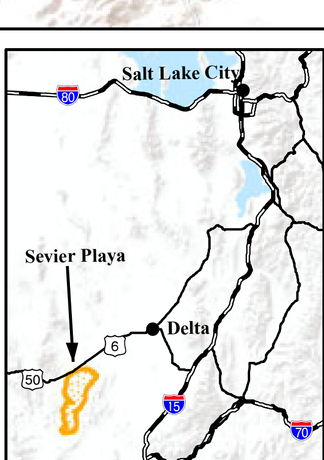
Sources:
Sevier Playa Boundary, SWCA 2015;
Roads, Utah AGRC 2013;
Terrain Basemap, ESRI 2017

FIGURE 2-1
Regional Vicinity

SEVIER PLAYA POTASH PROJECT

WMP Fig 1-1 - Regional Location Map 20171026 10/26/2017 4:33:44 PM





Project Vicinity

- Sevier Playa Boundary
- BLM and SITLA Lease Boundary
- Sevier Playa Potash Project Water Resources Area of Interest

N

0 4.5 9 Miles

1:500,000

Sources:
Sevier Playa Boundary, SWCA 2015;
Roads, Utah AGRC 2013;
Terrain Basemap, ESRI 2017

Figure 2-2
Project Vicinity
SEVIER PLAYA POTASH PROJECT

MXD Name: WMP Fig 2-2 Project Vicinity 190214 | Date Saved: 2/14/2019 12:09:39 PM

2.3 Previous Investigations

CPM began monitoring groundwater beneath and adjacent to the Sevier Playa in 2011 with the installation of a monitoring well network, refurbishment of existing wells, performance of hydrologic testing, and monitoring of groundwater levels and water quality. This effort was expanded in 2012 to include monitoring of discharge and water quality in the Sevier River.

Whetstone (2017) prepared a summary of publicly-available and site-specific data for the playa available through 2013 as well as select data through 2015. Norwest Corporation (Norwest), now Stantec Consulting Services, Inc. (Stantec), subsequently prepared a Technical Memorandum (Norwest 2018) summarizing additional data collected from 2014 through 2016 that were not included in the Whetstone (2017) report. These data provide a good basic understanding of surface and groundwater quality and quantity in the area of the playa.

The State of Utah classifies surface and groundwater in UAC Title R317 based on quality and intended use. As noted in R317-6, groundwater in the state is classified as follows:

- Class I – Includes Class IA (Pristine), Class IB (Irreplaceable), and Class IC (Ecologically Important) groundwater. Groundwater is categorized as Class IA if the Total Dissolved Solids ("TDS") concentration is less than 500 milligrams per liter ("mg/L") and no contaminant concentration exceeds the standards provided in Appendix A of this plan. Class IB and Class IC groundwater are classified based on use rather than quality.
- Class II – Groundwater of a quality sufficient for human consumption. The TDS concentration of this water is between 500 and 3,000 mg/L, and no constituent concentration may exceed the standards provided in Appendix A of this plan.
- Class III – Limited Use groundwater. This classification is reserved for groundwater with a TDS concentration between 3,000 and 10,000 mg/L or where the concentration of one or more of the contaminants listed in Appendix A exceeds the associated standard.
- Class IV – Saline groundwater. The TDS concentration of this class of groundwater is greater than 10,000 mg/L.

UAC Title R317-2 classifies surface water based on location and Beneficial Use. According to R317-2-13.6, the Sevier River from the Sevier Playa upstream to Gunnison Bend Reservoir (located about 27 miles northeast of the northern end of the Sevier Playa) is classified for protection of the following uses:

- Class 2B – Infrequent primary contact for recreation as well as secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water (such as wading, hunting, and fishing);

- Class 3C – Non-game fisheries and aquatic life, including the necessary organisms in their food chain; and
- Class 4 – Agricultural uses including irrigation of crops and stock watering.

Appendix A provides a list of the water-quality standards for these classifications of surface water as contained in UAC Title R317-2-14.

The data from Whetstone (2017) and Norwest (2018) provide an understanding of the quality and quantity of surface and groundwater in and around the playa. From these data, the State classification and condition of waters in and around the playa can be identified. Based on the data collected to date, surface and groundwater resources within and adjacent to the Sevier Playa can be summarized as follows:

2.3.1 Surface Water

- Under current water use conditions, the majority of the Sevier River flow is diverted upstream from the playa for various beneficial uses. As a result, flows in the lower Sevier River toward the playa are infrequent and consist primarily of irrigation return flows. Infrequent flooding occurs, generally resulting from snowmelt during high precipitation years.
- Runoff from the ephemeral watersheds surrounding the playa is typically lost to infiltration and evaporation as it flows downstream toward the playa. Only during high-intensity precipitation or substantial snowmelt events does runoff reach the playa from these ephemeral watersheds.
- During high flow years, the flow in the Sevier River below Conks Dam (located about 22 miles northeast of the northern end of the Sevier Playa) occasionally exceeds channel capacity. During normal years, the Sevier River is typically dry below Conks Dam except for a 6-mile reach above Crafts Lake which, based on mapping by the U.S. Geological Survey, flows perennially.
- During years when surface flow exists within the lower Sevier River, the quality of this surface water is relatively poor, with TDS concentrations often exceeding 3,000 mg/L. This water tends to be a well-buffered sodium-chloride type. The highest TDS concentrations typically occur in late fall and winter (October through March) with occasional secondary peaks in April or May. The TDS concentration of the river water is typically greater than the surface water agricultural standard (Class 4) of 1,200 mg/L at monitoring points closest to the playa.
- Water in the lower Sevier River sporadically exceeds state surface water quality standards listed in UAC Title R317-2 for cadmium, lead, mercury, selenium, silver, zinc, and pH.

2.3.2 Groundwater

- Groundwater within the area of interest occurs in three hydrostratigraphic units: the playa groundwater system, the alluvial/colluvial groundwater system, and the regional bedrock groundwater system.
- The playa groundwater system occurs in playa sediments that consist generally of very fine-grained clays with local, discontinuous interbeds of silts, sands, and gravel that extend laterally into the playa sediments from the mountain ranges on both sides of the playa. The production zone for the Project is generally considered to be the upper 90 to 95 feet of playa sediments. Below this depth, the playa sediments are typically hard and dry.
- The alluvial/colluvial groundwater system occurs in sediments on slopes adjacent to the playa. These sediments consist of interbedded sand, silt, and clay of variable composition and thickness. The alluvial/colluvial sediments often interbed with the playa sediments near the edges of the playa.
- The regional bedrock groundwater system occurs in the Prospect Mountain Quartzite in the Cricket Mountains east of the playa, the Notch Peak Limestone in the House Range/Black Hills west of the playa, and either the Prospect Mountain Quartzite or Mutual Formation on the south. Structurally, the playa formed in a depression created by down-dropped faulting where the sediments collected.
- Groundwater quality in the aquifers within the area of interest ranges from Class I near the ridges of the adjacent mountains to Class IV adjacent to and within the playa groundwater system.
- Within the regional bedrock system, groundwater flows beneath the playa generally from east to west in the area of interest. Within the alluvial/colluvial system, groundwater recharges the regional bedrock system and flows toward to the playa.
- Whetstone (2017) and Norwest (2018) interpreted differently the extent to which alluvial/colluvial groundwater on the west side of the playa flows toward the playa and the degree of interaction between the playa and regional bedrock groundwater systems. It is anticipated that data collected under the SAP/QAPP will assist in better defining these systems.
- Well testing has determined that groundwater flow velocities within the area of interest are relatively high in the regional bedrock system, moderate in the alluvial/ colluvial strata, and very low in the clayey playa deposits.
- The groundwater chemistry of the regional bedrock system varies depending on the formation, ranging from a sodium-chloride water type to a calcium-bicarbonate to calcium-chloride water type. Whetstone (2017) pointed out that groundwater in the

regional bedrock system meets state Class I water quality standards in the area of interest.

- Alluvial/colluvial aquifers in the area of interest have groundwater chemistry of a sodium-chloride to a sodium-sulfate water type. Groundwater samples collected from the unconsolidated deposits typically meet the numerical groundwater standards listed in Appendix A, with the exception of fluoride, arsenic, and pH. These waters are generally categorized as Class III waters.
- Groundwater within the playa sediments is a sodium-chloride water type. Due to TDS concentrations above 10,000 mg/L, these waters are categorized as Class IV under the state standards.

2.4 Scoping Meeting

Multiple meetings have been held between CPM and BLM as well as CPM and UDWQ to discuss the scope and content of this SAP/QAPP. As a result of those discussions, Norwest (2017) submitted a 50% Framework Water Monitoring Plan to BLM on November 10, 2017. That document consisted of a draft Sampling and Analysis Plan as well as a Quality Assurance Project Plan. BLM and its contractors (ENValue and Whetstone Associates) provided comments on that plan on December 6, 2017.

CPM then held a meeting with BLM on April 17, 2018, to further discuss the scope of the document that would be needed to meet the requirements of the federal lease Special Stipulations. Dan Hall, of UDWQ, attended a portion of the meeting to discuss UDWQ's position on the scope that they require. This SAP/QAPP is intended to address that combined scope.

2.5 Geological/Meteorological Information

2.5.1 Geology

A good summary of the geology of the area of interest is provided by Whetstone (2017). As indicated therein, the Sevier Playa is located in an east-dipping structural graben between the House Range and Cricket Mountains. Little is known of the playa sediments below a depth of 975 feet (the greatest depth to which a borehole has been drilled from the playa surface). However, based on data collected from a gravity survey of the area, Case and Cook (1979) estimated that up to 4,600 feet of "alluvium and/or volcanics" may exist beneath the east edge of the playa.

The Sevier Playa is a terminal hydrologic basin, having no exterior drainage. Given this condition, mineral-rich brine exists within the playa sediments. This brine consists of the mineral salts that exist naturally in the playa groundwater. The playa sediments that contain the brine are composed primarily of clay and marl (carbonate-rich clay).

Consistent with borehole logs from Gwynn (2006) and Wilberg (1991), discontinuous stringers of coarse alluvial/colluvial sediments have been found to extend laterally into the playa sediments. These alluvial/colluvial deposits generally grade from coarser grained to finer grained with interbedded distance into the playa.

Cambrian to Ordovician-age limestone, dolomite, and quartzite underlie the area of interest (Hintze and Davis 2003). The shallowest of these bedrock layers consist of the Notch Peak Formation, which crops out in the House Range west of the playa, and the Prospect Mountain Quartzite, which crops out in the Cricket Mountains east of playa.

2.5.2 Meteorology

The climate of the area of interest is semi-arid. Data downloaded from the Western Regional Climate Center indicate that the average annual precipitation at Delta, Utah is 7.89 inches, with an average annual maximum temperature of 65.7°F and an average annual minimum temperature of 34.5°F. At Milford, Utah, the average annual precipitation is reported to be 9.03 inches, with an average annual maximum temperature of 65.5°F and an average annual minimum temperature of 33.3°F. In both cases, March, April, May, and October are typically the wettest months while June and July are typically the driest months.

2.6 Impact on Human Health and/or the Environment

Given the remoteness of the Project area, the lack of anthropological beneficial use of potentially-impacted surface and groundwater in the area of interest (other than for the future production of minerals under the Project), and the innocuous nature of the minerals that would be produced, no impacts to human health are anticipated from operation of the Project. However, impacts to the environment may occur if TDS concentrations in surface or groundwater are elevated by Project operations above levels that are considered safe for wildlife and agricultural (i.e., stock watering) purposes.

3 PROJECT AND DATA QUALITY OBJECTIVES

3.1 Project Task and Problem Definition

The intent of this SAP/QAPP is to collect the necessary data to meet the requirements of a Groundwater Discharge Permit from UDWQ and the requirements of federal lease Special Stipulations 8 and 13. UDWQ rules require an assessment of groundwater quality in the uppermost aquifer that may be impacted by a project. UDWQ personnel have determined that aquifer to be the alluvial/colluvial groundwater system at the edge of the playa. The BLM stipulations require that monitoring be conducted not only in the alluvial/colluvial groundwater system but also in the regional bedrock groundwater system.

CPM understands that, under Special Stipulation 8, it would be responsible to replace any water resources (with baseline TDS concentrations of less than 10,000 mg/L) "that are lost or adversely affected (quality or quantity)" by Project operations (see Section 1.1). The determination of whether a water resource has been "adversely affected" would be made through statistical comparisons of data collected during the baseline period with that collected during the Project operational period, as further described herein. Thus, once the baseline database is established and accepted by BLM, that database would be used to assess the data collected during operational monitoring and to evaluate potential Project-related impacts to surface and groundwater resources within the area of interest.

CPM also understands that the baseline data would be compared to operational monitoring data to determine compliance with state regulations through both direct standards comparison and trend analysis. If Project-caused impacts are determined to have occurred, CPM would work with the UDWQ and BLM to develop acceptable measures to reduce impacts and replace impacted water sources as appropriate.

Based on the above, the purposes of the SAP/QAPP are to:

- Collect baseline surface and groundwater data within the area of interest;
- Develop a valid set of water quality and quantity data under natural, pre-Project conditions;
- Monitor water sources within the area of interest during operational of the Project to document future water quality and quantity conditions; and
- Develop a valid data set that would allow a determination to be made of whether or not operation of the Project results in changes to the quality or quantity of water in surface resources or in the alluvial/colluvial or regional bedrock groundwater systems that require future mitigation actions.

To date, work associated with the Project has focused on resource evaluation and environmental monitoring. No site development or full-scale mineral production has occurred.

As noted in Section 2.3, surface water within the area of interest is categorized under UDWQ regulations as Beneficial Use Class 2B, Class 3C, and Class 4. Therefore, constituents of potential concern in surface water within the area of interest include pH and the metals and inorganic constituents that are regulated under Utah Administrative Code ("UAC") Title R317-2. These analytes are listed in Table 3-1. Hexavalent chromium and biochemical oxygen demand are not included in this table due to holding time restrictions that cannot be met because of site remoteness. Additional parameters that are not regulated under the Utah surface-water regulations have been added to Table 3-1, including total suspended solids ("TSS"), specific conductance, various forms of alkalinity, and major cations and anions. Concentrations of these additional analytes would be used by CPM to assist in data interpretation and validation, as discussed in Sections 3.3 and 3.5. During the baseline monitoring period, surface-water samples will be analyzed for the list of constituents presented in Table 3-1.

As also indicated in Section 2.3, groundwater in the area of interest is categorized as Class IA, II, III, and IV water, depending on its location. Therefore, constituents of potential concern in groundwater within the area of interest include pH as well as the metals and inorganic constituents that are regulated under UAC Title R317-6. These analytes are presented in Table 3-2. As is the case with surface water, additional analytes that are not regulated under the Utah groundwater regulations have been added to Table 3-2 to assist in data interpretation and validation, as discussed in Sections 3.3 and 3.5. During the baseline monitoring period, groundwater samples will be analyzed for the list of constituents presented in Table 3-2.

The focus of this SAP/QAPP is currently the collection of baseline hydrologic data to supplement existing data and gain a better understanding of spatial and temporal variations in surface and groundwater quality and quantity within the area of interest. During the Project operational period, the focus of monitoring would shift to determining whether hydrologic impacts have occurred in the area of interest as a result of Project activities. If experience indicates that future changes to the SAP/QAPP are appropriate for the Project operational period, CPM would recommend modifications to the SAP/QAPP. For instance, if certain parameters have not been detected during the baseline monitoring period and nothing about Project operations suggests that these analytes may be affected by future operations, CPM may request that these parameters be dropped from the analytical lists contained in Tables 3-1 and 3-2. Such recommendations would be submitted to BLM and UDWQ for approval as part of an annual report (see Section 3.5.3) before implementing any changes.

Table 3-1 Surface Water Analytes

Parameter	Basis	Lowest Standard Class 1, 2, 3, or 4	Analysis Method	Method Detection Limit	Practical Quantification Limit	Preservative	Min Sample Volume
Specific Conductance (µmhos/cm)	Dissolved	--	Field	10	10	Field (none)	
pH (s.u.)	--	6.5-8.5	Field	0.1	0.1	Field (none)	
Cation-Anion Balance	Dissolved	--	Manual				
TDS (measured) (mg/L)	Dissolved	--	2540 C-2011	2.82	10	None (4oC)	125 ml
TDS (calculated)	Dissolved	--	Manual				
pH (s.u.)	Dissolved		9040C			None (4oC)	250ml
Alkalinity, total (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, carbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, bicarbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Alkalinity, hydroxide (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4oC)	
Chloride (mg/L)	Dissolved	--	9056A	0.0519	1	None (4oC)	125 ml
Fluoride (mg/L)	Dissolved	4.0	9056A	0.0099	0.1	None (4oC)	
Sulfate (mg/L)	Dissolved	--	9056A	0.0774	5	None (4oC)	
Nitrate+Nitrite as nitrogen (mg/L)	Dissolved	10.0	353.2	0.0197	0.1	H2SO4	250ml
Phosphorous (mg/L)	Dissolved	--	365.4	0.035	0.1	H2SO4	
Aluminum (mg/L)	Dissolved	--	6020A	0.100	0.2	None (4oC)	250 ml
Arsenic (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4oC)	
Barium (mg/L)	Dissolved	2.0	6020A	0.0050	0.005	None (4oC)	
Beryllium (mg/L)	Dissolved	0.004	6020A	0.0020	0.002	None (4oC)	
Boron (mg/L)	Dissolved		6010B	0.200		None (4oC)	
Cadmium (mg/L)	Dissolved	0.005[(a)]	6020A	0.001	0.002	None (4oC)	
Calcium (mg/L)	Dissolved	--	6020A	1.0	1	None (4oC)	
Chromium (mg/L)	Dissolved	0.231[(a)]	6020A	0.0020	0.01	None (4oC)	
Copper (mg/L)	Dissolved	1.3[(a)]	6020A	0.0050	0.01	None (4oC)	
Iron (mg/L)	Dissolved	--	6020A	0.100	0.1	None (4oC)	
Lead (mg/L)	Dissolved	0.015	6020A	0.0020	0.005	None (4oC)	
Magnesium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	
Mercury (mg/L)	Dissolved	0.002	7470A	0.00020	0.0002	None (4oC)	
Potassium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	
Selenium (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4oC)	
Sodium (mg/L)	Dissolved	--	6020A	1.00	1	None (4oC)	

[(a)]Standard is a function of hardness

Note: Parameter units are consistent across rows except where noted.

Stantec

Table 3-2 Groundwater Analytes

Parameter	Basis	Lowest Standard Class 1, 2, 3, or 4	Analysis Method	Method Detection Limit	Practical Quantification Limit	Preservative	Min Sample Volume
Specific Conductance (µmhos/cm)	Dissolved	--	Field	10	10	Field (none)	
pH (s.u.)	--	6.5-8.5	Field	0.1	0.1	Field (none)	
Cation-Anion Balance	Dissolved	--	Manual				
TDS (measured) (mg/L)	Dissolved	--	2540 C-2011	2.82	10	None (4_{o}C)	125 ml
TDS (calculated)	Dissolved	--	Manual				
pH (s.u.)	Dissolved		9040C			None (4_{o}C)	250ml
Alkalinity, total (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4_{o}C)	
Alkalinity, carbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4_{o}C)	
Alkalinity, bicarbonate (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4_{o}C)	
Alkalinity, hydroxide (as mg/L $CaCO_3$)	Dissolved	--	2320 B-2011	2.71	20	None (4_{o}C)	
Chloride (mg/L)	Dissolved	--	9056A	0.0519	1	None (4_{o}C)	125 ml
Fluoride (mg/L)	Dissolved	4.0	9056A	0.0099	0.1	None (4_{o}C)	
Sulfate (mg/L)	Dissolved	--	9056A	0.0774	5	None (4_{o}C)	
Nitrate+Nitrite as nitrogen (mg/L)	Dissolved	10.0	353.2	0.0197	0.1	H2SO4	250ml
Phosphorous (mg/L)	Dissolved	--	365.4	0.035	0.1	H2SO4	
Aluminum (mg/L)	Dissolved	--	6020A	0.100	0.2	None (4_{o}C)	250 ml
Arsenic (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4_{o}C)	
Barium (mg/L)	Dissolved	2.0	6020A	0.0050	0.005	None (4_{o}C)	
Beryllium (mg/L)	Dissolved	0.004	6020A	0.0020	0.002	None (4_{o}C)	
Boron (mg/L)	Dissolved		6010B	0.200		None (4_{o}C)	
Cadmium (mg/L)	Dissolved	0.005	6020A	0.001	0.002	None (4_{o}C)	
Calcium (mg/L)	Dissolved	--	6020A	1.0	1	None (4_{o}C)	
Chromium (mg/L)	Dissolved	0.231	6020A	0.0020	0.01	None (4_{o}C)	
Copper (mg/L)	Dissolved	1.3	6020A	0.0050	0.01	None (4_{o}C)	
Iron (mg/L)	Dissolved	--	6020A	0.100	0.1	None (4_{o}C)	
Lead (mg/L)	Dissolved	0.015	6020A	0.0020	0.005	None (4_{o}C)	
Magnesium (mg/L)	Dissolved	--	6020A	1.00	1	None (4_{o}C)	
Mercury (mg/L)	Dissolved	0.002	7470A	0.00020	0.0002	None (4_{o}C)	
Potassium (mg/L)	Dissolved	--	6020A	1.00	1	None (4_{o}C)	
Selenium (mg/L)	Dissolved	0.05	6020A	0.0020	0.01	None (4_{o}C)	
Sodium (mg/L)	Dissolved	--	6020A	1.00	1	None (4_{o}C)	

Note: Parameter units are consistent across rows except where noted.

Following the collection and validation of baseline data, the purposes of hydrologic monitoring during the operational period would be to:

- Monitor hydrologic resources within the area of interest including, but not limited to, changes in surface water, meteoric precipitation, groundwater, wetlands, and ditches and
- Determine the impacts, if any, to existing water right holders, wetlands, surface water, and groundwater as a result of Project operations.

3.2 Data Quality Objectives

EPA guidance identifies seven elements that should be addressed when developing DQOs for a project (EPA 2006). These elements consist of the following:

1. State the problem
2. Identify the goals of the study
3. Identify information inputs
4. Define the boundaries of the study
5. Develop the analytic approach
6. Specify performance or acceptance criteria
7. Develop the plan for obtaining data.

These elements are described in more detail below.

3.2.1 Problem Statement

In order to comply with the requirements of UDWQ and BLM, CPM will determine baseline surface and groundwater conditions (quantity and quality) within the area of interest. These data will be necessary to determine whether or not operation of the Project is in compliance with a future UDWQ Groundwater Discharge Permit and Special Stipulations 8 and 13 of the federal leases.

The conceptual hydrologic model of the area of interest is described generally in Section 2.3 of this document. In summary, this model consists of the following:

- Surface water within the area of interest is regulated by the State of Utah for infrequent contact recreational use, non-game fisheries and aquatic life, and agricultural use.
- Much of the surface water in the Sevier River upstream from the Sevier Playa is beneficially used before it reaches the playa, except during periods of above-normal precipitation.

- No substantial surface runoff occurs to the playa from adjacent slopes due to the ephemeral nature of those watersheds.
- The beneficial use of groundwater within the area of interest is regulated by the State of Utah as a function of the baseline quality of that groundwater.
- Groundwater within the area of interest occurs in playa sediments, alluvial/colluvial sediments, and bedrock. The classification of this groundwater, under rules promulgated by UDWQ, varies substantially within the area of interest due primarily to a wide range of natural TDS concentrations.
- The degree of interaction between the groundwater systems within the area of interest is not fully defined.

The planning team, decision makers, and data users associated with this effort are presented in Section 1.4. CPM has committed the necessary resources to implement this SAP/QAPP in a manner that satisfies the data needs of the Project as well as the appropriate governmental agencies (primarily UDWQ and BLM). CPM desires to begin data collection under this SAP/QAPP as soon as practical following approval of the SAP/QAPP.

3.2.2 Study Goals

Study questions and alternative actions help establish study goals. The key study questions associated with the SAP/QAPP are:

- What spatial and temporal variability naturally exists in the quality and quantity of surface and ground water within the area of interest?
- What is the degree of interaction between the playa groundwater system, the alluvial/colluvial groundwater system, and the regional bedrock groundwater system within the area of interest?

Two alternative actions exist to address these study questions:

- Monitor the quality and quantity of surface and groundwater within the area of interest to provide data that, when combined with historic information, will result in a better understanding of seasonal variations in and the degree of interaction between hydrologic systems in the vicinity of the proposed Project, or
- Take no action.

The no-action alternative will not address either of the study questions. Therefore, the decision statement and goal of the SAP/QAPP is to develop a valid set of surface and groundwater quality and quantity data under natural, pre-Project conditions. These data will then be evaluated, along with historic CPM and publicly-available data from the area of interest, to define baseline conditions and to provide a better understanding of the degree to which groundwater systems interact within the area of interest. These data would also be used during the operational period to determine whether or not operation of the Project has impacted local water resources to the extent that mitigation actions are needed.

3.2.3 Information Inputs

A substantial amount of hydrologic, geologic, and other environmental and resource data has been collected within the area of interest. These data have been generated from investigations conducted by public entities (most notably the U.S. Geological Survey), by CPM, and by prior investigators of the mineral reserves associated with the Sevier Playa.

This historic database has resulted in the formulation of a conceptual model of surface and groundwater conditions within the area of interest. These historic data will be reviewed to validate their usefulness. Historic data that are determined to be valid will be used in future decision-making. Historic data that are determined to not be valid will be appropriately flagged.

The historic database is not sufficient to fully address the study questions contained in Section 3.2.2. Additional surface and groundwater quality and quantity data will be required to properly address those study questions. Tables 3-1 and 3-2 provide a list of the parameters that will be monitored on a routine basis during the baseline data-collection period. The methods that will be used to collect the routine data and address the study questions are outlined in Sections 4 through 6 of this SAP/QAPP.

As indicated previously in this SAP/QAPP, the baseline data would serve as a point of comparison to determine if operation of the Project has adversely impacted surface and groundwater resources within the area of interest. The action levels against which the baseline data would be compared are detailed in federal lease Special Stipulations 8 and 13 and in the Groundwater Quality Discharge Permit that would be issued by UDWQ.

3.2.4 Study Boundaries

The spatial boundary in which the SAP/QAPP will be implemented is defined as the area of interest shown in Figure 4-1. A description of the extent of these boundaries is provided in Section 2.1.

The goal of monitoring during the baseline data-collection period will be to develop a statistically-valid database that adequately describes pre-Project hydrologic conditions. To that end, data will be collected quarterly during the baseline period to assess seasonal variations in hydrologic conditions within the area of interest.

It is currently anticipated that Project construction would begin in the autumn of 2019. Since baseline monitoring under this Plan began in September 2018, this will allow monitoring during at least five quarterly events prior to the start of construction. The U.S. Environmental Protection Agency (2009) recommends that a minimum of eight to ten independent baseline observations be collected before running most statistical tests. Thus, the period of baseline data collection will likely extend beyond the start of Project construction. This is not considered problematic for the following reasons:

1. CPM began collecting hydrologic data from the playa area in 2011. These data, which must still be validated, will likely contribute to the baseline database.
2. Given the typical hydraulic conductivities discussed in Section 2.4, it is estimated that average linear groundwater velocities in the Playa hydrostratigraphic unit ("HSU") are substantially less than 1 ft/yr. As a result, any impacts to groundwater in the Alluvial/Colluvial and Regional Bedrock HSUs caused by Project construction on the playa would not be observable for a period of several years. Thus, data collected during the one or two years following the onset of construction from monitoring wells in the Alluvial/Colluvial and Regional Bedrock HSUs would still be indicative of baseline conditions.
3. Only one water supply well would be drilled initially, and this well would be pumped only intermittently during the baseline sampling period as Project facilities are being constructed. This well (and the other three eventual water supply wells) would be drilled approximately 3 miles south of the processing facility area and 3.5 miles south of the playa. As a result, it is unlikely that the radius of influence associated with intermittent pumping of the one initial well would extend to the playa.
4. As a terminal basin, no surface water flows out of the playa. Furthermore, the inflow of Project-related recharge water to the playa would not occur until at least one year after construction begins. Thus, data collected from the Sevier River monitoring locations following the beginning of construction would still be indicative of baseline conditions.

Given these circumstances, it is concluded that enough data will be available to assess baseline conditions, even if some of these data are collected following the startup of some construction operations. Monitoring of water resources within the area of interest during the operation period of the Project would be defined following a review of the baseline data.

Locations within the area of interest that will be monitored are discussed in Section 4. Sampling units from which data will be collected consist of the Sevier River and monitoring wells completed in the playa, alluvial/colluvial and regional bedrock groundwater systems. A limited number of samples have also been collected from springs in the general vicinity of the playa and may be collected from those sources in the future. Future decisions regarding the need for impact mitigation, if any, would be made based on data collected from the location(s) of impact.

Three practical constraints exist with respect to implementation of the SAP/QAPP: (1) weather conditions (e.g., freezing temperatures, difficult or unsafe site access, etc.), (2) access permission from private landowners in the case of certain springs that may be monitored, and (3) vandalism of monitoring locations. If conditions are such that collection of data from a specific location during a particular sampling event is not feasible, these conditions would be documented and provided to UDWQ and BLM.

3.2.5 Approach to Data Analytics

Analyses of environmental data often assume that the data follow a normal distribution. While this may be the case for water quality and quantity data collected from the area of interest during the baseline period, it is inappropriate to make that assumption prior to the generation of additional data.

Following the collection of baseline data, all data will be subject to the data validation process discussed in Section 3.4. All valid data that are collected under this SAP/QAPP will be evaluated to provide a set of statistics that are appropriate to the data distribution. For this evaluation, the data will be grouped by individual monitoring point as well as within sampling units (e.g., all wells completed in the alluvial/colluvial groundwater system, all samples collected from the Sevier River, etc.).

It is currently anticipated that the data will be evaluated using ProUCL[1], a statistical data-evaluation software package developed by the EPA, or another appropriate data evaluation package. ProUCL calculates basic statistics (e.g., means, median, standard deviation, etc.) as well as statistical intervals, single and two sample hypothesis tests, analysis of variance, regression, trend evaluation, outlier, and goodness-of-fit tests. It also provides graphical analyses, including probability plots, histograms, box plots, and line/trend plots.

[1] https://www.epa.gov/land-research/proucl-software

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Data collected during the operational period would be compared with the baseline data to determine if Project operations have impacted water resources within the area of interest. It is currently anticipated that these comparisons would be made using ProUCL and an approach that is applicable to the data statistical distribution. Comparisons would be made against the applicable UDWQ surface and groundwater quality standards and the federal lease TDS concentration limitation of <10,000 mg/L. If impacts are determined to have occurred, then CPM would take appropriate action in consultation with UDWQ or BLM, depending on the standard or limitation against which the impact has been determined.

3.2.6 Performance or Acceptance Criteria

All data collected during the baseline and operational periods would undergo review and validation, as indicated in Section 3.4. All valid data collected during the baseline and operational periods would be accepted. Data that are not considered valid would be appropriately flagged.

3.2.7 Selected Sampling Design

Sampling under this SAP/QAPP would be performed as indicated in Sections 4 through 6. The sampling design was selected to provide additional baseline data as well as data to determine whether future impacts, if any, occur to water resources within the area of interest due to operation of the Project.

3.3 Measurement Quality Objectives

MQOs are used to determine the viability and usability of field and laboratory data. MQOs are defined by the criteria established for the following data quality indicators ("DQIs"):

1. Accuracy
2. Precision
3. Sensitivity
4. Comparability
5. Completeness
6. Representativeness

MQOs represent the "acceptance criteria" for the DQI attributes and are set based on the equipment used in field sampling and laboratory analyses. These DQIs and their associated acceptance goals are summarized in Table 3-3 and discussed below.

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Table 3-3 Data Quality Indicators Measurement Performance Criteria

Parameter	Method Quality Indicator Goal	Quality Control Sample and/or Activity
Accuracy/Bias	Laboratory Control Sample ("LCS") spiked result is >80% and <120% of spiked amount. Laboratory Matrix Spike ("LMS") result is >75% and <125% of spiked amount.	Paired limit trend charts documenting LCS and LMS sample results included in Quality Control Summary ("QCS") of each Pace Laboratory report. QC data outside the paired line limits require consultation with laboratory. Summary report on data usability provided with each data validation summary.
Precision	Field Duplicate Relative Percent Difference ("RPD") of 25% for samples with a TDS concentration of ≤3,000 mg/L and 35% for samples with a TDS concentration of >3,000 mg/L. Laboratory RPD of 20% or less for Laboratory Control Sample Duplicates ("LCSD") and RPD of 30% or less for Laboratory Matrix Spike Duplicates ("LMSD") 20%.	Trend Charts documenting LCSD and LMSD sample results included in QCS of each Pace laboratory report. QC data outside the paired line limits require consultation with laboratory. Summary report on data usability provided with each data validation summary
Sensitivity	1) Laboratory ability to detect a compound above zero with 99% confidence and provide method (or minimum) detection limit ("MDL") above the documented cleanup level, if applicable. 2) Continuing Calibration Verification Standards ("CCVs") are analyzed at a frequency determined by the analytical method.	1) Determine the matrix specific MDL using EPA Revision 2, December 2016. 2) Evaluate Initial Calibration Value ("ICV") and CCV % recovery values outside calibration actions based on Method applicable guidelines. Provide trend charts if applicable.
Comparability	Pace Laboratory National Environmental Laboratory Accreditation Program ("NELAP") certification # 6157585858 which requires them to routinely participate in performance tests to ensure the comparability of their data to results from other laboratories.	Use only NELAP accredited analytical laboratories for sample analysis.
Completeness	95% or higher completeness	% Completeness = Number of Valid Data Points/Number of Expected Data Points)*100.
Representativeness	Sampling procedure is consistent between sampling events.	Sampling Analysis Plan ("SAP") techniques and procedures are adhered to and performed using the same techniques and equipment and performed in the same sequence each sampling event.

Notes
The closer the spiked results are to the true value coupled with high precision means higher accuracy and lower bias.
The smaller the RPD the better. High precision and high accuracy means low bias.
The RPD acceptance cutoff limit of 3,000 mg/L was selected to be inclusive of groundwater categorized by UDWQ as Class I and Class II groundwater.

3.3.1 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference value. Accuracy measures how close QC results are to the "true "value. To measure accuracy, the laboratory introduces a known concentration of Compound X into the QC sample. The QC sample is then analyzed to determine the concentration of Compound X. The QC result (amount recovered) is then compared against the "true" value to determine how close the laboratory recovery is to "true". The assessment of accuracy is usually expressed as percent recovery as shown by the following equation:

$$\text{Percent Recovery} = \frac{(C2 - C1)x\ 100\%}{CO}$$

Where:

C0 = amount of analyte added to the sample matrix;
C1 = amount of analyte present in the un-spiked sample matrix (equal to zero for the standard matrix); and
C2 = amount of spiked material recovered in the analysis.

The amount of an analyte spiked into a field sample matrix is specified by the laboratory QC program. For data evaluation purposes, the accuracy MQO of this SAP/QAPP is to obtain the following percent recovery:

- Laboratory Control Sample (LCS) spiked result is >80% and <120% of spiked amount. Laboratory Matrix Spike (LMS) result is >75% and <125% of spiked amount.

Results outside of these limits may be qualified as "estimated."

Trend Charts documenting LCS and LMS sample results are included in QCS of each Pace report. The closer the spiked results are to the true value coupled with high precision means higher accuracy and lower bias.

3.3.2 Precision

Precision is a measure of the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform internally. This indicator is used to evaluate the variability related to sample collection and handling as well as laboratory sample handling and analysis procedures.

Precision will be determined by analyzing field, laboratory, and matrix spike/matrix spike duplicate ("MS/MSD") samples. A field (or "blind") duplicate is a sample collected in the field from the same location and matrix at the same time as the original using the same sample collection and handling procedures but labeled with a different sample number.

Blind duplicates will be collected in the field at a rate of 10 percent of the total number of samples collected (or portion thereof) from each matrix (i.e., surface water or groundwater).

A laboratory duplicate is a laboratory split of a submitted field sample. A MS/MSD sample is a field-collected and -designated sample used by the laboratory to spike with a known concentration of a compound and then split and analyzed for the original compound. These samples will be collected in the field at a rate of one MS/MSD sample for every 20 field samples (i.e., at a 5% collection rate), thus allowing the laboratory to run MS/MSD analyses at a rate of 5% of their analyses. Field-collected MS/MSD samples are labeled as such. Thus, the laboratory will be notified which field MS/MSD samples are available for laboratory MS/MSD batch QAQC analysis.

The precision of the field and analytical data will be determined by calculating the relative percent difference between the value reported for the original sample and the value reported for the duplicate sample as follows:

$$RPD = \frac{|(C2-C1)\ x\ 100\%|}{((C2+C1)/2)}$$

Where:

RPD = relative percent difference
C1 = analyte concentration in the original sample; and
C2 = analyte concentration in the sample duplicate.

The precision MQO goal for the SAP/QAPP is to obtain duplicate data that demonstrate a Relative Percent Difference (“RPD”) of 20% or less for LCSDs and an RPD of 30% or less for LMSDs. The MQO goal for field duplicate data is an RPD of less than 25% for samples with a TDS concentration of less than or equal to 3,000 mg/L and an RPD of less than 35% for samples with a TDS concentration of greater than 3,000 mg/L. This TDS limit was selected to be equivalent to the UDWQ Class I/Class II standard.

The smaller the RPD between the original and duplicate samples the higher precision and accuracy and lower the bias. Trend charts documenting the LCSD and LMSD sample results included in Quality Control Summary of each Pace report will be used to identify results over time that are outside the precision MQO goals outlined above. Results outside these limits may be qualified as "estimated."

It should be noted that RPDs outside of the above ranges often occur when dealing with low concentrations that are near the method detection limit, particularly when the TDS concentration is high (as will often be the case for this project). Thus, professional judgment will be exercised when designating a result as "estimated" based on the precision MQO.

3.3.3 Sensitivity

Sensitivity is the capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. Sensitivity is addressed through the selection of appropriate analytical methods and instrumentation as well as through the use of matrix spike, laboratory control, and continued calibration verification samples.

Sensitivity is initially addressed using standards, prepared at specified concentrations, to calibrate and define the quantitative response relationship of the instrument to the analytes of interest. Instrument calibration is also performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method. Continued CCV is an approach used to verify the initial calibration of an instrument during its use in an analytical method. CCVs are implemented in the laboratory at a frequency determined by the analytical method.

The sensitivity of laboratory analyses is a function of the MDL and the practical quantitation limit ("PQL"). The MDL represents the minimum concentration of an analyte that can be measured above the instrument background noise. Thus, when MDLs are used as reporting limits, the laboratory is indicating that the analyte is not present at or above the value given. It may be present at a lower concentration but cannot be "seen" by the instrument.

The PQL is the minimum concentration of an analyte that can be measured within specified limits of precision and accuracy. This limit is determined by the laboratory based on interference that is naturally present in the sample (e.g., high salinity may require dilution of the sample which may affect the ability of the laboratory to accurately determine the magnitude of analytes that are present in low concentration).

The sensitivity MQO goals for the SAP/QAPP are as follows (except as affected by high salinity which may constrain laboratory procedures):

- Laboratory ability to detect a compound above zero with 99% confidence and provide MDLs above the documented regulatory standard, if applicable.
- CCV Standards analyzed at a frequency determined by the analytical method.
- PQLs less than or equal to 10 times the associated MDL for analytes without a regulatory standard.

The laboratory will provide CCV data for each laboratory report and these data will be compared to MOQ goals and, if necessary, trend charts will be evaluated to document the degree of adherence to the MQO.

3.3.4 Comparability

Comparability is a qualitative measure of the confidence with which one data set can be compared to another. It is currently anticipated that samples for the same analytes will be analyzed by the same laboratory throughout implementation of this SAP/QAPP. The field methods to collect the samples during baseline evaluation will be same as those used for long-term operational monitoring. The field personnel will use and follow prescribed standard operating procedures. Each of these factors will increase the comparability of the resulting data.

Pace is accredited through the NELAP. This program requires Pace to routinely participate in performance tests to ensure the comparability of their data to results from other laboratories. The Pace NELAP certification number is 6157585858.

As indicated in Section 5.1, Pace is also certified by the State of Utah. Compliance with the standards established by the State of Utah and NELAP provides the primary comparability check on the laboratory data.

3.3.5 Completeness

Completeness is a measure of the amount of valid data obtained from a sampling event, expressed as a percentage of the number of valid measurements that were planned to be collected during that sampling event. Analytical completeness will be assessed by comparing the total number of valid analytical results to the number of planned analyses.

Completeness is determined by:

$$C = \frac{P1\ x\ 100\%}{PO}$$

Where:

C = completeness (%)
P0 = total number of valid data points planned, and
P1 = number of actual valid data points.

The completeness MQO for the SAP/QAPP is 95 percent or higher.

The completeness of the analyses will also be checked by calculating the total dissolved solids content as a sum of the individual constituents (after mathematically converting alkalinity [as $CaCO_3$] to carbonate and bicarbonate) and comparing this value to the laboratory-measured TDS concentration. The ionic charge balance error will also be calculated by comparing the molar-equivalent concentrations of the major cations (primarily calcium, magnesium, potassium, and sodium) with the molar-equivalent concentrations of the major anions (primarily alkalinity, chloride, and sulfate). These calculations will be performed using dissolved constituents only. The MOQ goals for these calculated values are:

- Calculated TDS concentration within $\pm$20% of the measured TDS concentration.
- Total cation molar-equivalent concentration within $\pm$10% of the total anion molar-equivalent concentration.

Hem (1985) notes that the accuracy of the above comparisons can be problematic in water with high dissolved solids contents (such as will likely occur with many of the samples that will be collected under this SAP/QAPP). However, Hem (1985) also indicates that these comparisons tend to be relatively consistent at individual locations, even if they fall outside of typical ranges.

3.3.6 Representativeness

Representativeness is the degree to which data accurately and precisely represent the population. Representativeness is usually considered a qualitative term that does not lend itself to direct measurement. However, including it in the MQO is meant to re-enforce the goal of confirming that measurements are made and physical samples are collected in a manner that appropriately reflects actual conditions. This is addressed primarily in the sample design through the selection of sampling sites and procedures that reflect the SAP/QAPP goals and environment being sampled. For instance, under the low-flow well sampling method, the intake for each low-flow pump will be located within the screen interval determined by field testing to be the dominant inflow zone (see Section 6.4.2.1). Furthermore, the procedure of purging until the field parameters stabilize presumably ensures that fluid samples are representative of the aquifer waters. Similarly, for the no-purge (in-situ equipment) groundwater sampling method, the sample bottles will be located within a zone that has been evaluated by down-well flow measurements to indicate that the waters within the casing interval occupied by the in-situ sampling equipment are representative of the waters within the aquifer (see Section 6.4.2.2).

Representativeness is ensured in the laboratory through: (1) the proper handling and storage of samples, and (2) analysis within the specified holding times so that the material analyzed reflects the material collected as accurately as possible. Sample integrity can then be documented with the following procedures:

- Laboratory preparation of field preservation vials;
- Proper sample handling (i.e.., CoC); and
- Evaluating holding times and condition of samples on arrival at the laboratory.

Proper procedures will minimize the potential for alterations of the samples and ensure that samples received by the laboratory are representative of those at the site.

3.4 Data Review and Validation

The analytical laboratory will be responsible to review each data package prior to release for validation. CPM will independently review the laboratory data package as part of the data validation process outlined in Appendix D of the Water Monitoring Plan (Stantec, 2019), of which this SAP/QAPP is a part. At a minimum, the following reviews must be performed by the laboratory:

- Peer review of the data by a qualified analyst;
- Review of the reported data and deviations by a technical supervisor or data coordinator; and,
- QA officer review of 10% of the data.

Field teams will note any field-related quality problems in the logbook. QA reports will be provided to the MTM whenever field quality problems are encountered. In addition, a third-party entity under contract to CPM will review all field and laboratory data and validate those data. This review will involve the following:

- Sample holding times to ensure that they meet applicable requirements;
- Initial and continuing calibration of field instrumentation;
- Results of field blank analyses;
- Results of duplicate analyses;
- Sample handling and storage procedures; and
- Completeness of field documentation.

Data validation is performed to assess the degree to which sampling and analytical methods have generated consistent, reliable, and accurate data. Section 3.3 and Table 3-3 present the criteria for deciding the degree to which the data have met predetermined measurement quality objectives. Data that do not meet MQOs will be flagged. Results that are less than the reporting limits but exceed the method detection limits will be qualified as estimates and used in calculations as a detected value. All corrections, notions, and flagged comments will be added to the Project database.

Data validation reports will be provided to the MTM by the QAO. These reports will include a discussion of any significant quality problems that were observed and their effect on the use of the data. Quality issues identified by the field team, laboratory, and data validation specialist will be incorporated into the data evaluation report(s) submitted to the PM, UDWQ, and BLM. If significant problems are encountered, the MTM will report these issues along with the results of the necessary response actions to the PM, UDWQ, and BLM.

3.4.1 Response Actions

Response actions will be implemented on a case-by-case basis to correct quality problems. All personnel involved in the implementation of the SAP/QAPP are responsible for discovering QA problems or deficiencies in their areas of responsibility. Any such deficiencies will be reported to the Quality Assurance Officer as soon as possible after discovery. The QAO will report the issue to the PM and will have authority to stop sampling work until the issue is corrected. The PM, in consultation with the CPM Quality Assurance Officer, will prepare QA response actions in cooperation with personnel in the area where the deficiency was found.

The corrective action process has two components that must be addressed: (1) resolve the immediate problem, and (2) prevent future occurrences of the problem. It is the responsibility of the PM to ensure that both components are addressed, and to finalize the action necessary to achieve resolution.

Results of the following QA activities may also initiate corrective actions:

- Performance audits;
- Systems audits; and
- Failure to adhere to the approved SAP/QAPP.

3.4.2 Reconciliation with User Requirements

The DQIs listed in Section 3.3 will be evaluated at the end of each sampling event. The potential need for adjustments or corrective action to keep measurement systems in control will be evaluated and discussed with the BLM and UDWQ, as necessary.

Data validation reports prepared by CPM will include an evaluation of the usability of the data. Precision, accuracy, representativeness, completeness, and comparability will be evaluated and compared with the Project DQOs by the MTM, in consultation with the QAO and PM, as each data set is received. At the completion of each year, an annual assessment of data usability and compliance with the DQOs will be conducted and documented in the annual report.

3.5 Data Management

Data from both the surface water and groundwater monitoring efforts will be used to describe the water resources in the area of interest. Using ProUCL or other appropriate statistical evaluation packages, the data will be evaluated for confidence intervals, the presence of outliers, determination of appropriate distributions for statistical analysis, and preparation of summary statistics and evaluation of non-detect data. The data may also be plotted graphically (e.g., time series plots, histograms, box-whisker plots, etc.) and using tri-linear diagrams of water quality as needed to support data interpretation. These values and graphs will then be used as a comparison with future data to determine if impacts have occurred.

3.5.1 Statistical Data Analysis

Groundwater chemistry can vary with time under non-equilibrium groundwater conditions if the flow field is altered. Reversals of the flow direction near a well could cause abrupt changes in the water chemistry (Fetter 1980). Therefore, a primary purpose of the groundwater sampling program is to detect statistically significant changes in groundwater chemistry from baseline conditions following construction and start-up of Project operations.

Statistical evaluations of baseline vs. operational datasets would be performed as outlined in Section 3.2.5. The precise methods that would be used in these comparative analyses would be determined once the baseline data have been collected, reviewed, and validated and their statistical distribution(s) has been determined.

3.5.2 Data Management Process

CPM will incorporate the collected laboratory and field data into a relational database. Laboratory data will be transferred to CPM electronically, thereby minimizing the potential for data entry errors. Data Reporting

Following receipt of analytical reports from the laboratories for each sampling round, a third-party entity under contract to CPM will validate the data as outlined in Section 3.4. Copies of the validated data will be provided electronically to BLM and UDWQ within 45 days of receiving all data associated with a sampling event. Each data submittal will include a statistical evaluation of the data as outlined above. If this evaluation indicates that Project operations have adversely impacted water resources, the quarterly data submittal would include recommendations for impact verification and/or mitigation.

CPM will prepare annual reports detailing the results of the surface and groundwater monitoring completed for the prior year. Copies of these reports will be provided electronically to UDWQ and BLM before the end of the first quarter of the following year. The annual reports will include tabulated field and laboratory results. These annual data and all previous monitoring data will be included in the database for documentary and comparative purposes and can be supplied to UDWQ or BLM, if required.

Data interpretation may include appropriate plots of iso-concentration contours for selected constituents, graphs that show concentrations of selected parameters over time, comparisons to relevant water quality standards, updated surface and groundwater analytical tables, summary statistics, and a description of data validation. Report appendices will include copies of pertinent field notes, laboratory analytical results, QC data, data validation, summary statistics, well records, well testing data, water level data, field water quality measurements, and other field measurements such as transducer data and rating curves, as applicable. Given the probable voluminous nature of the laboratory analytical reports, these will be provided only in electronic format.

Also, the reports will include recommended steps for optimization of sampling and analysis efforts (when applicable) and a discussion on any identified impacts to surface or groundwater resources. If exceedances of standards or significant changes in conditions identified during the year suggest that Project operations are affecting local water resources, specific actions taken or anticipated following such exceedances would be summarized and recommendations for further activities would be provided. These may include additional sampling, review of sampling protocols, changes to the operational monitoring plan, or other recommendations to mitigate observed negative impacts to water resources.

3.6 Assessment Oversight

The CPM Quality Assurance Officer will oversee implementation of the SAP/QAPP and ensure that all analytical data generated thereby are validated according to appropriate procedures. Specific responsibilities of the Quality Assurance Officer include:

- Provide independent QA oversight during implementation of the SAP/QAPP;
- Review log books, CoC forms, and laboratory analytical reports to determine if data meet the requirements of the SAP/QAPP;
- Maintain an accurate and complete database of all analytical and other data generated during implementation of the SAP/QAPP;
- Assess analytical data to determine if the data meet appropriate MQOs;
- Report data quality issues, quality control concerns, and data non-conformance to established standards to the CPM project manager;

- Periodically review the sampling program, analytical results, and data validation procedures for conformance to protocols and standards established in the SAP/QAPP; and
  Specify corrective actions to be taken in the event of QC failures or non-conformance to protocols and standards specified in the SAP/QAPP and follow up to ensure that those corrective actions are implemented.

4 SAMPLING DESIGN AND RATIONALE

As noted in Section 3.1, one of the primary purposes of the SAP/QAPP is to collect sufficient, validated baseline surface and groundwater data to define natural, pre-Project conditions and to allow future determinations to be made of whether or not operation of the Project results in changes to the quality or quantity of surface or groundwater within the area of interest. To accomplish this, selected surface water locations together with existing and new wells will be monitored.

4.1 Groundwater

In developing the proposed SAP/QAPP groundwater monitoring network, existing wells in the area were evaluated for their adequacy to provide acceptable data. An assessment was also made of the need to drill and complete new monitoring wells to provide additional information. Based on this evaluation, it is proposed that 32 wells (16 existing and 16 proposed) be used to assess baseline groundwater conditions under this SAP/QAPP. The selected existing and new wells to be included in the monitoring network represent the regional bedrock, alluvial/colluvial, and playa groundwater systems within the area of interest.

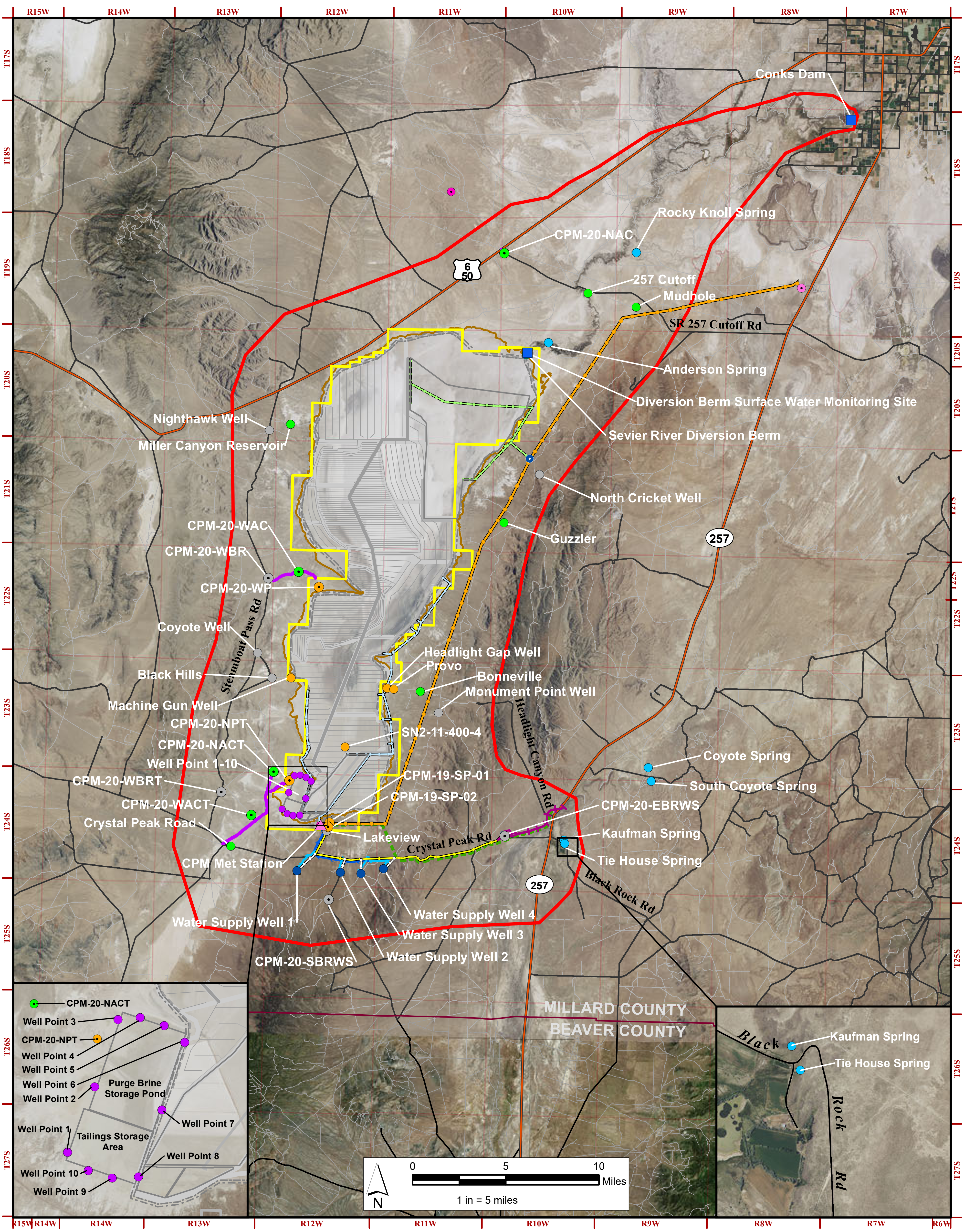
Groundwater monitoring efforts will consist of measuring groundwater levels and collecting groundwater quality samples at each of the wells listed in Table 4-1 and shown on Figure 4-1. Sampling of groundwater issuing from springs is discussed in Section 4.1.3 of this document. Sample collection dates will be selected to represent seasonal variations in groundwater conditions. The wells to be monitored are described below.

Table 4-1 Baseline Groundwater Monitoring Sites

Well ID	Ownership	Latitude (NAD83) Decimal degree	Longitude (NAD83) Decimal degree	Casing Elevation (ft AMSL)	Total Depth (ft BTOC)	Diameter (inch)	Screen (ft BTOC)	Screen Length (ft)	Depth to Sample Intake (ft BTOC)	Measuring Point Stick Up (ft)	Boring Construction Log	Single Well Drawdown Test	Max Flow and Drawdown (SW)	Suitable for Low Purge		Suitable for No Purge
														Yes/No	Why	
Playa Wells (Existing)																
SN2-11-400-4	Crystal Peak Minerals	38.7835250	-113.174497	4527.38	497	4	497-347	150	406-411		Yes	No	NA	Yes	Previous Field Data	Yes
Machine Gun	USGS	38.8361191	-113.2298862	4531.54	102	2	100-95	5	101-104		Yes	No	NA	Yes	Yes, purge record	Yes
Headlight Gap	USGS	38.8296586	-113.1341471	4549.94	207	2	210-207	3	207-210		Yes	No	NA	Yes	Purge Record	Yes
Provo	Crystal Peak Minerals	38.8291203	-113.1274863	4575.75	460	4	460-260	200	270-276		Yes	Yes	1 GPM 67'	Yes	Drawdown Test	Yes
Playa Wells (Proposed)																
CPM-20-WP	Crystal Peak Minerals	38.9070000	-113.204567	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-NPT	Crystal Peak Minerals	38.756441	-113.231382	-	-	4	-	-	-		-	-	-	-	-	-
CPM-19-SP-01	Crystal Peak Minerals	38.726343	-113.192944	-	-	4	-	-	-		-	-	-	-	-	-
CPM-19-SP-02	Crystal Peak Minerals	38.723402	-113.191879	-	-	4	-	-	-		-	-	-	-	-	-
Alluvial Colluvial Wells (Existing)																
257 Cutoff	Crystal Peak Minerals	39.1405648	-112.9426389	4552.84	60	4	60-45	15	50-56		Yes	Yes	1.75 GPM 22.80'	Yes	Drawdown Test	Yes
Bonneville	Crystal Peak Minerals	38.8279350	-113.1010343	4772.15	315	4	310-210	100	215-221		Yes	Yes	0.53 GPM 97.77'	**Questionable**	Drawdown Test	Yes
Crystal Peak Road	USGS	38.7040571	-113.2856608	4623.94	195	2	195-177	18	185-188		Yes	No	NA	Yes	High Turbidity	Yes
Guzzler	Crystal Peak Minerals	38.9605644	-113.0213739	4966.81	425	4	425-325	100	385-389		Yes	Yes	4 GPM 18'	Yes	Drawdown Test	Yes
Miller Canyon Reservoir	Crystal Peak Minerals	39.0332852	-113.2365813	4699.22	315	4	315-245	70	272-278		Yes	Yes	10 GPM 7'	Yes	Drawdown Test	Yes
Mudhole	BLM	39.1305575	-112.8943545	4559.56	503	8	338-365	27	370-373		No	Yes	37 GPM 7.8'	Yes	Drawdown Test	Yes
Alluvial/Colluvial Wells (Proposed)																
CPM-20-NAC	Crystal Peak Minerals	39.1700167	-113.0271333	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-WAC	Crystal Peak Minerals	38.9186167	-113.224933	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-WACT	Crystal Peak Minerals	38.7232486	-113.250747	-	-	4	-	-	-		-	-	-	-	-	-
CPM-20-NACT	Crystal Peak Minerals	38.762242	-113.244973	-	-	4	-	-	-		-	-	-	-	-	-

Well ID	Ownership	Latitude (NAD83) Decimal degree	Longitude (NAD83) Decimal degree	Casing Elevation (ft AMSL)	Total Depth (ft BTOC)	Diameter (inch)	Screen (ft BTOC)	Screen Length (ft)	Depth to Sample Intake (ft BTOC)	Boring Construction Log	Single Well Drawdown Test	Max Flow and Drawdown (SW)	Suitable for Low Purge		Suitable for No Purge
													Yes/No	Why	
Bedrock Wells (Existing)															
Black Hills	BLM	38.8356642	-113.2488075	4638.12	560	6	?	?	540-543	No	Yes	18 GPM 19'	Yes	Drawdown Test	Yes
Coyote	Crystal Peak Minerals	38.8550295	-113.2637821	4784.27	765	5	760-560	200	705-711	Yes	Yes	55 GPM 40'	Yes	Drawdown Test	Yes
Lakeview	BLM	38.7175450	-113.1909711	4590.11	532	6	125-70 and 500-420	80	94-100	Yes	Yes	26 GPM 2'	Yes	Drawdown Test	Yes
Monument Point	Crystal Peak Minerals	38.8115229	-113.0825462	4891.3	1215	5	1210-1030	180	1155-1161	Yes	Yes	54 GPM 96'	Yes	Drawdown Test	Yes
Nighthawk	Crystal Peak Minerals	39.0284436	-113.2573385	4804.36	780	5	780-580	200	608-614	Yes	Yes	45 GPM 74'	Yes	Drawdown Test	Yes
North Cricket	Crystal Peak Minerals	38.9987550	-112.9872956	5083.78	780	5	780-580	200	661-667	Yes	Yes	36 GPM 3'	Yes	Drawdown Test	Yes
Bedrock Wells (Proposed)															
CPM-20-WBR	Crystal Peak Minerals	38.9129333	-113.255050	-	-	4	-	-	-	-	-	-	-	-	-
CPM-20-WBRT	Crystal Peak Minerals	38.748624	-113.250783	-	-	4	-	-	-	-	-	-	-	-	-
CPM-20-SBRWS	Crystal Peak Minerals	38.66426	-113.18734	-	-	4	-	-	-	-	-	-	-	-	-
CPM-20-EBRWS	Crystal Peak Minerals	38.71673	-113.01396	-	-	4	-	-	-	-	-	-	-	-	-
Water Supply 1	Crystal Peak Minerals	38.6861005	-113.2194244	-	-	8	-	-	-	-	-	-	-	-	-
Water Supply 2	Crystal Peak Minerals	38.6857800	-113.1761975	-	-	8	-	-	-	-	-	-	-	-	-
Water Supply 3	Crystal Peak Minerals	38.6850996	-113.1557851	-	-	8	-	-	-	-	-	-	-	-	-
Water Supply 4	Crystal Peak Minerals	38.6895652	-113.1334771	-	-	8	-	-	-	-	-	-	-	-	-
Springs from Which Samples Were Previously Collected															
Anderson Spring	BLM	39.101146	-112.982398	-	-	-	-	-	-	-	-	-	-	-	-
Rocky Knoll Spring	BLM	39.172633	-112.896757	-	-	-	-	-	-	-	-	-	-	-	-
Coyote Spring	Rasmuson	38.683521	-112.877867	-	-	-	-	-	-	-	-	-	-	-	-
South Coyote Spring	BLM	38.674192	-112.871611	-	-	-	-	-	-	-	-	-	-	-	-
Springs from Which Samples May be Collected															
Tie Fork Spring	Kaufman	38.7110271	-112.9541065	-	-	-	-	-	-	-	-	-	-	-	-
Kaufman Spring	Kaufman	38.7129352	-112.9560873	-	-	-	-	-	-	-	-	-	-	-	-
Sevier River															
Below Conks Dam	N/A	39.278949	-112.683078	-	-	-	-	-	-	-	-	-	-	-	-
At Diversion Structure	N/A	39.092431	-113.002535	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1. AMSL = Above mean sea level
2. BOTC = Below top of casing



Existing and Proposed Proposed Project Features

- Existing Playa Aquifer Well
- Proposed Playa Aquifer Well
- Existing Alluvial/Colluvial Aquifer Well
- Proposed Alluvial/Colluvial Aquifer Well
- Existing Bedrock Aquifer Well
- Proposed Bedrock Aquifer Well
- Proposed Well Point Location
- Proposed Water Supply Well
- Surface Water Monitoring Site
- Spring
- Proposed Sevier River Diversion Berm
- Sevier Playa Potash Project Water Resources Area of Interest
- BLM/SITLA Lease Boundary
- Access Road - Off-Lease
- Proposed 69-kV Power and Communication Line
- Proposed 25-kV Power Line
- Proposed 12.47-kV Power Line
- Proposed 12.47-kV Power and Communication Line
- Proposed 12.47-kV Power Line Spur
- Proposed Rail Spur and Access Corridor
- Proposed Rail Loadout Facility
- Proposed Natural Gas Pipeline
- Proposed Communication Tower
- Proposed Substation
- Meteorological Station
- Proposed Water Supply Pipeline
- Proposed Water Supply Pipeline Spur

Sources:
Project Features, Crystal Peak Minerals, 2015, 2016, 2017, 2018, 2019;
Sevier Playa Potash Project Water Resources Analysis Area,
Baseline Water Resources Technical Report for the Sevier Playa
Potash Project, Whetstone 2017;
Sevier Playa Boundary, SWCA 2015;
Roads, Millard County 2013;
Railroads, ESRI 2000;
Aerial Imagy, USDA/APFO 2016

NO.	DATE	REVISION	BY	APVD
4	2/15/2019	Revised based on comments		
3	10/15/2018	Revised based on comments		
2	7/18/2018	Revised based on comments		
1	6/19/2018	Revised based on comments		
0	10/25/2017	Initial Submission		

DSGN | DR | CHK | APVD

FIGURE 4-1

Sevier Playa Potash Project
Surface and Groundwater
Monitoring Network
SAP-QAPP

DATE: 4/11/2019 SCALE: 1:318,859

CRYSTAL PEAK MINERALS INC.

D:\GIS\Peak Minerals\Operational Monitoring Plan\WMP Fig 4-1 - SAP_QAPP_190411.mxd4/11/2019 5:01:07 PM

4.1.1 Existing Wells

In selecting the existing wells to be included in the monitoring network, prior sampling data were reviewed. In reviewing field logs associated with prior well sampling in the general area of the Project, it was apparent that some of the wells may have yielded unreliable data (e.g., field water-quality measurements that did not stabilize during well purging and/or the well being pumped dry during purging). Therefore, it was decided that existing wells used for baseline and operational groundwater monitoring should meet the following criteria where feasible:

- The well construction details are known, including screen intervals;
- The well can be purged using EPA (2017) low-flow purging methods, resulting in: (1) no more than 0.3 foot of drawdown during purging (or stabilized drawdown if greater than 0.3 foot), and (2) static water levels that are above the screen interval at the time of sampling; and
- The well diameter can accommodate sampling system equipment and provide a sufficient volume of water to allow for the analysis of original and duplicate samples.

Based on these criteria, 16 existing wells were chosen for the SAP/QAPP groundwater well monitoring network (see Table 4-1 and Figure 4-1). Four of the existing wells to be monitored under the SAP/QAPP are located within or at the perimeter of the Sevier Playa (Playa Wells). These consist of:

- SN2-11-400-4;
- Provo Well;
- Headlight Gap Well; and
- Machine Gun Well.

These wells were selected as representative of the elevation and quality of groundwater in the playa groundwater system both at depth and along the edge of the playa.

The following six existing wells were selected to monitor the alluvial/colluvial groundwater system:

- 257 Cutoff Well as an indicator of groundwater near the point at which the Sevier River flows into the playa;
- Guzzler Well, Mudhole Well, and Bonneville Well as indicators of groundwater upgradient from the playa; and

- Crystal Peak Road Well and Miller Canyon Reservoir Well as being potentially downgradient from the playa.

These wells were selected as representative of the elevation and quality of the alluvial/colluvial groundwater system adjacent to the playa.

The following six existing wells completed in the regional bedrock groundwater system are included in the SAP/QAPP:

- Coyote Well, Nighthawk Well, and Black Hills Well on the west (downgradient) side of the playa;
- Monument Point Well and North Cricket Well on the east (upgradient) side of the playa; and
- Lakeview Well on the south (upgradient) side of playa.

These wells were selected as representative of the elevation and quality of the regional bedrock groundwater system near the playa.

The data from these wells will aid in developing a representative baseline dataset and provide means to evaluate potential changes to these zones, if any, following the onset of Project operations.

Concerns have been raised that several of the wells proposed for monitoring are older wells completed with steel casing that may influence the quality of groundwater obtained from those wells. Specifically, the Black Hills, Lakeview, and Mudhole wells were completed with steel casing. CPM acknowledges this concern. Summarizing the work of others, Llopis (1991) stated that groundwater samples collected from steel-cased wells tend to contain elevated concentrations of cadmium, chromium, copper, iron, manganese, and zinc. Of these constituents, cadmium, chromium, and copper are included on the groundwater analytical list provided in Table 3-2. However, proper well purging and sampling should minimize those influences. Furthermore, under passive sampling, the samplers are to be located within well sections that, in theory, are representative of the aquifer groundwater. Salinity is of greater concern at this time than individual metallic ions and the effect of the slightly elevated metal concentrations will be minimal relative to the concentrations of TDS and the primary parameters that comprise TDS. Therefore, given the concern, care will be taken during evaluations of baseline metals data collected from wells that are cased with steel to determine if such data should be flagged due to potential interaction with the casing.

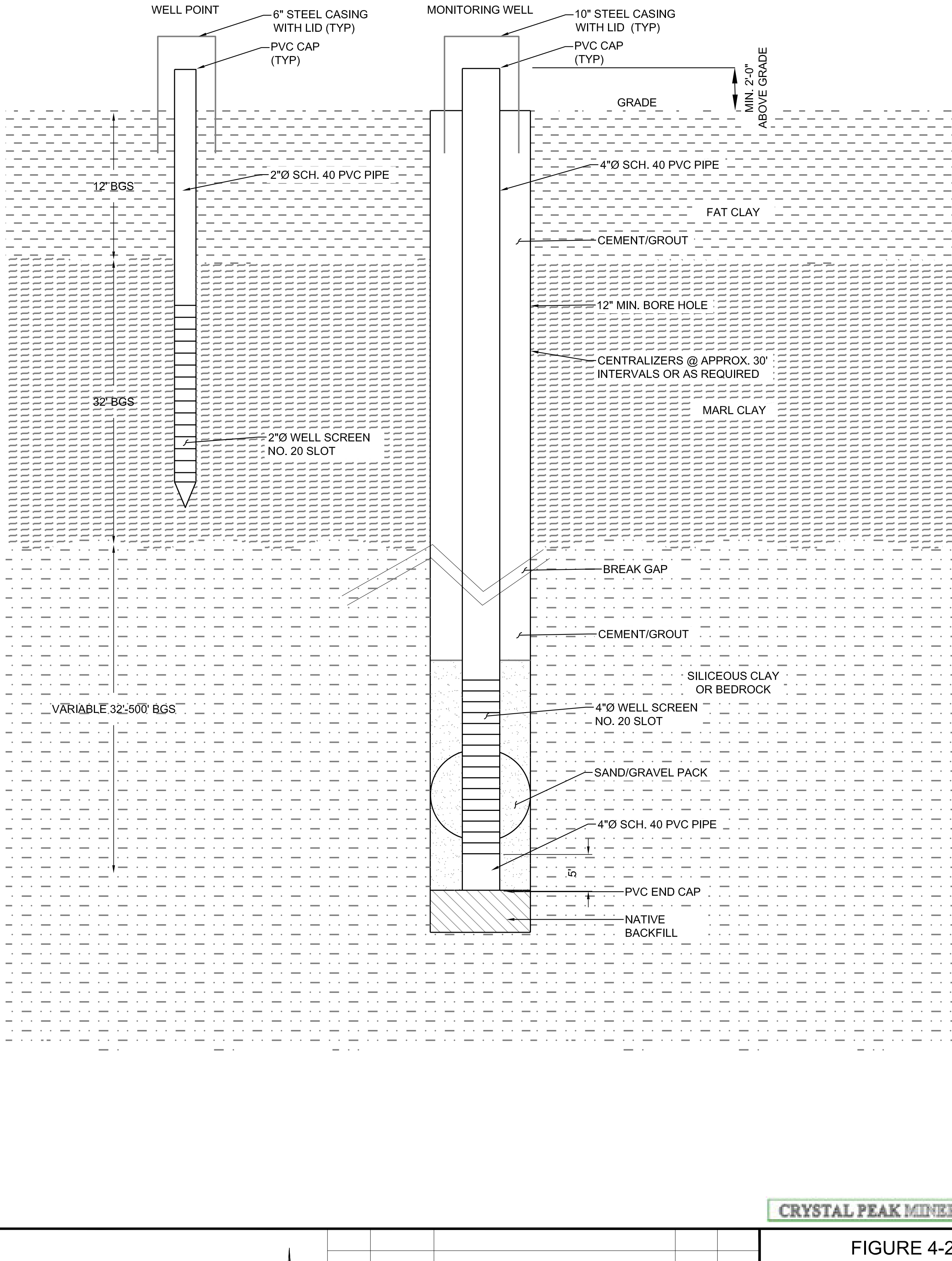
4.1.2 Proposed Wells

In addition to the existing wells, 16 wells (including the Project water supply wells) would be drilled and completed by CPM to add to the monitoring well network (see Table 4-1 and Figure 4-1). Figure 4-2 presents the typical completion detail for these wells. These wells would be drilled using reverse rotary and/or sonic drilling methods. Efforts would be made to drill these holes with air; however, if borehole stability becomes an issue, a combination of air and foam would be used to maintain the hole. Final depths of these wells would be determined based on field geology at the time of drilling.

One new replacement well is proposed on the north end of the playa to replace the UDOT-2 well. Three new wells are proposed to provide additional information along the west side of the playa between Coyote well to the south and Nighthawk well to the north. Four new wells are proposed to monitor potential changes to groundwater levels and chemistry, if any, due to activities in the Waste Product Storage Area (“WPSA”). Four new wells would be drilled to supply water to the Processing Facility. Two wells are proposed to monitor the upgradient effects of the water supply wells. The remaining two new wells are proposed along the south end of the playa to monitor potential water level and quality changes resulting from water supply pumping (see Figure 4-1).

The monitoring wells are proposed to be single well completions and would consist of an 8-inch diameter borehole completed with 4-inch diameter threaded polyvinyl chloride (“PVC”) casing. For wells shallower than 300 feet, the casings would be Schedule 40 PVC. For wells deeper than 300 feet, casings would consist of Schedule 80 PVC. Centralizers would be used to center the casings within the borehole.

Monitoring well construction (shown in Figure 4-2) would consist of a 4-inch diameter casing with an end cap on a section of blank casing that extends at least 5 feet below the screen, a section of well screen, and a section of blank casing extending to a point at least 1 foot above the ground surface with a slip-on cap. Graded sand would be installed as a filter pack in the completion zone surrounding the lower solid casing and well screen to a level at least 5 feet above the top of the screen. Bentonite grout would be tremied into the annular space from the top of the filter pack to 5 feet below the ground surface and cement grout would be placed from the top of the bentonite to the ground surface. A steel protective casing with a locking lid would be installed over the PVC casing, extending at least 3 feet into the cement grout and 2 feet above ground surface. The PVC casing and cap would be adjusted/cut to fit below the top of the steel protective casing before the steel casing is set.



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NO.	DATE	REVISION	BY	APVD
0	10-2-18	INITIAL SUBMITTAL	TJS	GG

DSGN	DR	CHK	APVD
TJS	TJS	RR	GG

FIGURE 4-2

Sevier Playa Potash Project
Monitoring Well Completions
Typical Detail

DATE: 10/2/2018
FILE: Figure 4-2 Typical Monitoring Well Detail
SCALE: NTS

NORWEST CORPORATION

In addition, CPM would install 10 well points around the perimeter of the WPSA as noted on Figure 4-1. These well points would be installed using direct-push methods to depths that extend at least 10 feet into the marl clay zone that serves as the uppermost aquifer in the playa sediments. The purpose of these well points would be to monitor the elevation and quality of groundwater immediately adjacent to the WPSA.

Using 3.25-inch diameter hollow push rods, each well point would be completed with 2-inch diameter threaded PVC casing, with 5 feet of PVC screen at the bottom of the casing string. Graded sand would be installed as a filter pack in the annular space between the borehole wall and the casing string, with the remainder of this space completed as indicated above.

Following drilling and completion, each new monitoring well and well point would be developed by surging, bailing, and/or pumping to ensure that water sampled from the wells in the future is representative of the adjacent natural groundwater. Development of the wells and well points would be conducted for 6 hours or until the water retrieved is visually clear and has stabilized with respect to pH, temperature, and specific conductance.

4.1.2.1 PROPOSED WEST WELLS

Three proposed wells would be installed on the west side of the area of interest near Needle Point as shown on Figure 4-1. These wells would be completed in the three groundwater systems of interest: CPM-20-WBR in the regional bedrock groundwater system, CPM-20-WAC in the alluvial/colluvial groundwater system, and CPM-20-WP in the playa groundwater system. These wells would consist of single-level completions and would be used for water level monitoring and groundwater quality sampling.

4.1.2.2 PROPOSED WASTE PRODUCT STORAGE FACILITY WELLS

The future location of the WPSA, which consists of the Purge Brine Storage Ponds and the Tailings Storage Area, is shown on Figure 4-1. Several investigators with the U.S. Geological Survey, of which Gardner et al. (2011) is just one example, have shown that groundwater in the regional bedrock aquifer flows to the west-northwest beneath the Sevier Playa. Assuming similar flow directions in the alluvial/colluvial groundwater system at the future WPSA, wells would be installed to monitor areas downgradient from that area. CPM-20-NACT and CPM-20-WACT would be completed in alluvial/colluvial sediments, CPM-20-NPT would be completed in the Marl Clay Zone of the playa sediments, and CPM-20-WBRT would be completed in the regional bedrock groundwater system. These new monitoring wells would be used to assess groundwater conditions in the vicinity of the WPSA.

These wells would be monitored to detect potential water levels changes, potential movement of the high concentration brines, and potential changes to the groundwater chemistry of the area, if any, in response to tailings and purge brine storage. These wells would be completed in the same manner as the single-level completion wells discussed above.

4.1.2.3 PROPOSED WATER SUPPLY WELLS

CPM plans to drill and install four water supply wells into the regional bedrock aquifer on BLM and SITLA land, approximately 5.5 miles south of the proposed processing facility area (see Figure 4-1). Information regarding the geology at the site of the proposed water supply wells is available from a 750-foot deep test hole (CWTW-1) that was completed by CPM to assess potential water quality and sustainable discharge rates (CH2M Hill, 2012). It is currently anticipated that these wells would not be drilled until after the start of facility construction. The drilling program is planned to be phased, with one well being drilled in year 1 and the other wells drilled at later dates as water demand increases. Six months prior to the anticipated start date, the final work plan for well drilling and installation, including planned construction details, would be prepared and submitted to BLM and UDWQ under separate cover.

These four wells, when completed, would also be used to monitor the groundwater quality of the bedrock aquifer. Since the wells will be producing on a regular basis, the water produced would be representative of the water within the aquifer. Therefore, a sampling port/tap would be installed on the water line from the well(s) to the processing facility to collect samples from the wells during operation. Additionally, the water levels would be monitored in each production well to assess the impact of pumping from each of the wells.

Additionally, two monitoring wells would be installed south and east of the water supply wells to monitoring the upgradient affects. Well CPM-20-SBRWS would be located south of the water supply wells to assess the drawdown toward the south. Well CPM-20-EBRWS would be installed near the rail loadout to assess the drawdown from the water supply wells to the east.

4.1.2.4 PROPOSED SOUTH-END WELLS

CPM plans to drill and install two single-level water monitoring wells (CPM-19-SP-01 and CPM-19-SP-02) to supplement data obtained from the playa groundwater system via the Dike Access Well. The two new wells will be installed along a line perpendicular to the edge of the playa toward the proposed water supply wells to assess the influence of long-term pumping of the water supply wells on the playa groundwater system, if any, and potential movement of brines toward the water supply wells. These wells will consist of 4-inch diameter screen and casing.

4.1.2.5 PROPOSED WELL POINTS

CPM plans to install ten single-level well points around the perimeter of the WPSA to supplement data obtained from the remainder of the groundwater monitoring network in that area. The well points would be monitored primarily for water levels and specific conductance to determine whether leakage is occurring from the WPSA. As 2-inch dimeter well points, these wells can also be sampled for a broader suite of analytes if deemed necessary.

4.1.2.5 PROPOSED UDOT WELL REPLACEMENT

An existing well, known as UDOT 2 and located north of the playa northeast of the intersection of US Highway 6/50 and the 257 Cutoff Road, has partially filled with sediment, making sampling difficult and data interpretation problematic. A replacement well (CPM-20-NAC) would be installed at the intersection of US Highway 6/50 and the 257 Cutoff Road to monitor groundwater conditions in the alluvial/colluvial sediments upgradient from the playa. This well would be a single-level completion consisting of 4-inch diameter screen and casing.

4.1.3 Springs

Four springs shown on Figure 4-1 may be monitored during the baseline and Project operational periods. These springs consist of Rocky Knoll and Anderson Springs to the north as well as Kaufman Spring and Tie House Spring to the south.

Anderson Spring is a groundwater seep that exists in the bottom of the Sevier River channel near the river’s terminus into the playa. There was no discernable flow at this location during a prior attempt to sample Anderson Spring. During periods when the Sevier River flows at that location, Anderson Spring would not be accessible for sampling.

Phreatophytes have invaded the area of Rocky Knoll Spring, which currently exists as a slight seep with no observable flow. This spring may be sampled if sufficient water is available.

Kaufman Spring and Tie House Spring exist in an adjacent basin southeast of the playa. Although a hydrogeologic connection between these springs and the playa is unlikely (Summers 2018), they may be monitored during the baseline and/or operational periods to provide a general indication of near-surface groundwater in that area if access permission from the private landowner can be obtained. Additional information regarding these springs is provided in the companion Water Monitoring Plan (Norwest 2019a).

A fence has been installed around Rocky Knoll Spring, generally precluding its use by wildlife or livestock. The remaining springs are currently used by wildlife and for stock watering. If monitored, indications of recent wildlife or livestock usage of the springs at the time of sampling would be noted in the field logbook. Since flow measurements may mobilize sediments and cause disturbances in the water, any water quality samples collected from the springs will be done before measuring the flow. If monitored, flow data and water quality samples would be collected from the springs following procedures outlined in Section 4.2.

4.2 Surface Water

The purpose of surface water monitoring would be to document the quality and quantity of surface inflows to the playa. This would be accomplished using the surface water sampling points on the Sevier River shown on Figure 4-1. The samples will be collected below Conks Dam and at the Diversion Structure. Data collected from below Conks Dam will provide information concerning the quality and quantity of water that is released to the lower Sevier River. Data collected from the Diversion Structure site will allow an assessment of the quantity and quality of water that flows onto the playa.

Flow data and water quality samples will be collected from the surface water sampling locations during the baseline sampling period. Sample collection dates will be selected to represent seasonal variations in flow and water quality. Discharge measurements will be collected using methods outlined in Section 6.3.2. Surface water quality samples will be collected as indicated in Section 6.3.1.

It is likely that the depth of surface flow at the time of each monitoring event will be variable, ranging from dry channels to fast moving water. Safety will be a primary concern when conducting monitoring activities at surface water stations. Any safety-driven deviations from the standard monitoring methods outlined in Section 6 (e.g., swift water that may preclude access to the center of the channel for flow measurements and sample collection) will be noted in the field log books.

5 REQUESTS FOR ANALYSES

5.1 Analysis Narrative

Field samples collected during the implementation of this SAP/QAPP will be analyzed for the constituents listed in Tables 3-1 and 3-2. These tables also indicate the analytical methods that will be used by the laboratory. Clean sample containers of appropriate volumes will be obtained from the analytical laboratory. If preservatives other than ice are required, these preservatives will be supplied by the laboratory.

Analyses for the constituents listed in Tables 3-1 and 3-2 will be performed by Pace in Mt. Juliet, Tennessee. Pace is accredited through the NELAP and is certified in Utah (No. 6157585858) to analyze samples for wastewater, drinking water, RCRA, USTs, and air quality. Pace is also certified by the Utah Public Health Laboratory for environmental analyses.

Samples for laboratory analyses will be collected in laboratory-supplied containers immediately following field analyses and filtering. Laboratory analyses are detailed on Tables 3-1 and 3-2. Analytical methods were selected to achieve method detection limits that are no greater than the applicable standard. All analyses will be performed using EPA- and/or UDWQ-approved analytical methods. It is currently anticipated that standard turn-around times will be requested for all analytical results. The collection of field QC samples (i.e., blanks and duplicates) is discussed in Section 10. These samples will be analyzed in the same manner as all other field samples.

UDWQ rules indicate that the standards for the class of water need to be adjusted based on hardness of the waters (R317-2-14, Utah DEQ May 1, 2018). The majority of the waters occurring in the lower Sevier drainage have a hardness of 400 mg/L or more, based on both the data in the Whetstone (2017) report and the 2016 water quality data collected by UDWQ in the general region surrounding the Project. After adjusting for the hardness, the metals standards increase from the values shown in the Utah Groundwater Protection Standards to the following:

- Cadmium – >400mg/L hardness, 1-hour acute value 0.008 mg/L.
- Chromium III- >400 mg/L hardness, 1-hour acute value 1.773 mg/L.
- Copper - >400 mg/L hardness, 1-hour acute value 0.050 mg/L.
- Lead - >400 mg/L hardness, 1-hour acute value 0.281 mg/L.
- Silver - >400 mg/L hardness, 1-hour acute value 0.035 mg/L.

The laboratory MDL for these metals meet the adjusted values based on water hardness. The aluminum standard, footnote 6 of Table 2.14.2 in R317-2-14, Utah DEQ May 1, 2018, indicates that, for sites with pH over 7 and hardness over 50, the standard to be used is 0.75 mg/L. Thus, the 0.1

mg/L reporting limit is also sufficient for aluminum. Additionally, antimony will be analyzed by Pace to meet the 0.006 mg/L standard for Utah groundwater.

Mercury analyses for surface waters are scheduled to be analyzed by Pace to meet the UDWQ standard of 1.2E-5 mg/L. It is anticipated that the naturally high salinity of many of the water samples collected under this SAP/QAPP will cause analytical interference. In those cases, it is typical for the laboratory to dilute the sample, thereby resulting in a higher practical quantitation limit. Pending sample interference due to high salinity, the reporting limit will be 0.5 nanograms per liter or 5.0E-7 mg/L. If sample interference occurs, the reporting limit will be raised.

5.2 Analytical Laboratory

As noted in Section 5.1, analyses for the constituents listed in Tables 3-1 and 3-2 will be performed by Pace. Pace has an internal QA program that has been approved by the National Environmental Laboratory Accredited Program and the State of Utah. A copy of this QA program is provided in Appendix B. CPM understands and agrees to the MQOs that are presented in the Pace QA program and that will be used by Pace for this Project.

6 FIELD METHODS AND PROCEDURES

The purposes of the SAP/QAPP, outlined in Section 3.1, will be accomplished through the collection of surface and groundwater samples from the locations shown on Figure 4-1. This chapter presents a discussion of the field sampling methods and procedures that will be used to accomplish the goals of the SAP/QAPP. Information regarding sample tracking and shipping is provided in Section 7.

Sampling methods used during implementation of the SAP/QAPP will adhere to the sampling, analytical, and data QA/QC procedures outlined herein. These procedures accord with the UDWQ Water Quality Assessment Guidance (UDWQ, 2010) and UDWQ's field procedures described in the DWQ Monitoring Plan Manual (UDWQ, 2006). All samples will be collected and properly preserved so that they are delivered to the laboratory and tested within the holding times required by the applicable EPA analytical method. Personnel involved in sampling will wear clean, disposable gloves that are donned prior to the collection of each sample, thereby minimizing the potential for cross-contamination between samples.

Sampling and field data collection will occur as detailed in the SOPs provided in Appendix C. Summaries of those procedures are presented below. The following summaries are presented to be consistent with EPA guidance for the preparation of the SAP/QAPP documents. Where conflicts exist between the following summaries and the SOPs, the SOPs will govern.

6.1 Monitoring Frequency

Monitoring of surface and groundwater under this SAP/QAPP will be conducted quarterly to assess seasonal variations in hydrologic conditions within the area of interest. Once the initial baseline validity assessment is complete, a report will be prepared and submitted to UDWQ and BLM to present a summary of data collected and justify the valid baseline data set. On-going monitoring throughout the life of the Project would then be used to evaluate potential impacts, if any, from Project operations and to assess conditions for reclamation and closure of the site. Based on the data collected, the report may include recommendations on adjustments to the SAP/QAPP regarding the sampling points and analyte list to better monitor the potential impacts from future Project operations.

6.2 Field Equipment

6.2.1 List of Equipment

Equipment that will be used in the field during the collection of surface and groundwater samples is listed in Table 6-1. Some of the field instrumentation may be combined into a single piece of equipment (e.g., through the use of multi-parameter instruments).

Stantec

Manufacturer's information on the recommended equipment described in Table 6-1 is included in Appendix D. Portions of field equipment that will contact the water to be sampled will be rinsed in distilled water prior to use at the next sample location, thereby minimizing the potential for cross contamination.

Table 6-1 Equipment List

Field Equipment	Manufacture Specification
Water Level Monitoring	
Solinst 101 P7 Laser marked 1/100-foot increments PVDF tape	https://www.solinst.com/products/level-measurement-devices/water-level-meters.php
Solinst Levelogger Edge 3001 conductivity, water level and temperature	https://www.solinst.com/products/dataloggers-and-telemetry/3001-levelogger-series/levelogger-edge/datasheet/
Solinst Barologger Edge absolute pressure, W Data Wizard	https://www.solinst.com/products/data/3001.pdf
Surface Water Flow	
USGS Top Setting Wading Rod, 0.2, 0.6 and 0.8 depth settings	http://rickly.com/usgs-topset-wading-rod-1-2m/
USGS Type AA Current Meter, Price-type	http://rickly.com/usgs-type-aa-current-meter/
Groundwater Sampling	
Snap Sampler, QED Environmental Systems, Inc.	https://www.snapsampler.com/
Geotech 1.66x36 inch Bladder Pumps	http://www.geotechenv.com/pdf/ground_water_sampling_equipment/geotech_bladder_pumps.pdf
Geotech BP Controller 300/500 pounds per square inch ("PSI")	http://www.geotechenv.com/pdf/ground_water_sampling_equipment/bp_controller.pdf
Groundwater/Surface Water Field Meter	
YSI EXO Multimeter Platform	https://www.ysi.com/EXO-HH
YSI EXO1 Multiparameter Sonde, SC/Temp, pH, DO, Turbidity	https://www.ysi.com/EXO1?EXO1-Water-Quality-Sonde-89
YSI EXO1 Flow Cell	https://www.ysi.com/Accessory/id-599080/EXO1-and-ProDSS-Flow-Cell
Geotech Portable Turbidity Meter (Option 2)	http://www.geotechenv.com/pdf/water_quality/geotech_turbidity_meter.pdf

6.2.2 Calibration of Field Equipment

All instruments and equipment used during sampling and analysis will be operated, calibrated, and maintained in accordance with the manufacturers' recommendations, as well as criteria set forth in the applicable analytical methodology references. Documentation of all routine and special maintenance and calibration information will be maintained in a logbook and will be available for review by authorized agency representatives upon request.

Most field equipment used during site monitoring is factory calibrated. Equipment that is not factory calibrated will be calibrated each day prior to collecting field data. Calibration and operation of all equipment used for collection of samples and field parameters will conform to the respective manufacturer's specifications. Instrument calibrations and calibration checks will be recorded daily in a log book and on Forms B and C of Appendix E.

The YSI meter listed in Table 6-1 measures several different water parameters. The calibration of this instrument will be performed as follows:

- Calibration of the pH meter will be performed to pH standards (4, 7, or 10 standard units) bracketing the actual field measured value with a post-calibration check using an alternate pH standard to ensure that the meter is reading within 5% of the standard.
- The specific conductance meter will be calibrated to one of four standards (1,413, 4,000, 6,000, or 10,000 microSiemens per centimeter [µS/cm]) with a post-calibration check using an alternate salinity standard to ensure that the meter is reading within 5% of the standard.
- Dissolved oxygen will be calibrated using the barometric pressure method outlined by the manufacturer.
- The turbidity meter will be calibrated to 0.02, 20, 100, and 800 NTU. Turbidity measurements will be made using a separate turbidimeter and not the flow-through cell used for groundwater sampling.

6.3 Surface Water Sampling

The collection of samples from the Sevier River will start at the downstream-most location and progress upstream. The river conditions and field parameters will be logged on the Surface Water Sample Form C in Appendix E. Flow measurements within the channel will likely mobilize sediments and cause disturbances in the water; therefore, river water quality samples will be collected before flow measurements.

6.3.1 Surface Water Quality Sample Collection

Surface-water samples will be collected from the locations shown in Figure 4-1. The samples will be taken from flowing, not stagnant water. Sample collection bottles will be labeled and transported to the river edge in a sample caddy and remain sealed until the water sample is collected. Depending on site conditions, samples will be collected by use of a sampling pole or by wading into the river. The samples will be collected upstream of the sampling pole location or wading personnel to avoid disturbance of the sampled water. Samples will be collected directly into sample bottles to which no preservatives have been added. In this case, the sample collection bottle will be rinsed a minimum of three times with river water before collecting the sample.

Sample bottles that contain an added preservative will be filled from a rinsed bottle that does not contain a preservative, thereby avoiding the loss of the preservative. These bottles will be filled at least to the neck of the bottle, but not overflowing, before capping.

All surface-water samples will be considered grab samples. Sample collection bottles will be immersed mouth down below the water surface to approximately one-third the depth of the stream flow if the flow depth is sufficient. With the lid removed, the bottle will be pulled up through the water column at a rate that would fill the bottle from a vertical section of the stream, the purpose being be to collect water from different depths in the stream. If the flow depth is insufficient to submerge the bottle, care will be taken to avoid the introduction of bottom sediment into the sample during collection. The sample cap will then be replaced, and the sample bottle placed in the sample caddy.

Samples requiring analyses of dissolved constituents (as noted in Table 3-1) will be field filtered using a 0.45-micron filter to remove larger particles that have been entrained in the water sample. A clean, unused filter will be used for each filtered sample collected. The filtered water samples will be transferred from the filter directly into the appropriate sample containers with a preservative (if required) and processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the filter to the sample container.

Field parameters for temperature, pH, specific conductance, turbidity, and dissolved oxygen will be collected in the flowing water and recorded. Surface water samples will be chilled and processed for shipment to the laboratory. Sample management and custody will be performed following procedures in Section 7.

6.3.2 Surface Water Flow Measurement

Streamflow measurements will be collected using a current meter or other appropriate method approved by the U.S. Geological Survey (Buchanan and Somers, 1969). Once sufficient data are available, rating curves will be developed for each channel location, thereby allowing stage-gauge readings to provide future estimates of flow based on the rating curve. Flow and cross-section data will be collected to represent those periods when flow stage varies between high and low to aid in developing a more accurate rating curve for each stream station.

Absolute pressure transducers will be installed at each surface-water sample location shown on Figure 4-1 to determine the stage at these stations during periods when samplers are not in the field. In both cases, a pressure transducer will be placed inside a section of vertical

PVC casing secured to a vertical T-post and staff gage. These transducers will be programmed to collect water levels at a minimum of once per hour.

During each sampling event, the river stage will be recorded from the staff gauge at each station and data from the pressure transducers will be downloaded. Flow measurements will be recorded on the Surface Water Sample Form C in Appendix E. The transducer level readings will be adjusted for barometric pressure changes and compared with the manual stage readings to ensure appropriate correlation.

The pressure transducer readings and staff gauge heights described above will be used to develop rating curves. These curves will be used to estimate the river flow without having to physically measure the channel area and flow velocity at the time of each stage reading. The rating curves will be developed from a log-log plot of stage and discharge data (Kennedy, 1984), which generates a straight-line equation in the following form:

$$Q=P(G-e)b$$

Where: Q = discharge (cfs)

P = the intercept equal to Q when (G-e) is equal to 1.0
G = the river stage (feet)
e = a constant that, when subtracted from G, would result in a straight line on a log-log plot of Q vs. (G-e); the default value of "e" is zero and is adjusted if initial log-log plot shows curvature
b = the slope of linear trend line on log-log plot

The rating curve will be considered accurate over the range of manually-measured flows if the correlation coefficients (R^2) of the rating curve is greater than 0.8. The rating curves will allow the generation of daily flow records at both gauging stations for duration of the Project.

6.4 Groundwater Sampling

6.4.1 Groundwater Level Measurement

The wells identified in Table 4-1 will be used to monitor groundwater levels in the bedrock, alluvial/colluvial, and playa groundwater systems. These data will consist of manual water level measurements during sampling events to monitor trends in groundwater levels during baseline and operational periods.

Manual water level measurements will be collected using electronic water-level indicators, with the probe tape marked in 0.01-foot increments. All wells will be sounded for depth to water from the top of casing prior to purging. Field water-level indicators will be calibrated according to manufacturer's recommendations before each field sampling event. Field meter probes will be decontaminated before and after use at each well by rinsing with distilled water.

In addition to manual water-level measurements, pressure transducers will be installed in bedrock wells Black Hills, Coyote, Monument Point, Nighthawk and North Cricket and alluvial/colluvial wells Mudhole to the north of the playa and Lakeview on the south end of the playa. Data will be collected from these pressure transducers at a minimum rate of twice each day. The purpose of the pressure transducer measurements is to identify regional daily trends in water levels over time.

When analyzing barometric data, it is important to keep in mind that storm events commonly reduce total atmospheric pressure by about 1.7% from pre-existing high-pressure conditions (1.7% converts to approximately 0.6 feet or 0.2 meters of water level equivalent barometric fluctuation).

The Solinst Levelogger (20 PSI) series of water level dataloggers that will be used measure absolute pressure. Thus, when in water, they measure the total head of water plus the barometric pressure. The general rule is to use one Barologger for an area that has a radius of 20 miles. One Barologger will be placed near Amasa well and used to correct data collected from the pressure transducers installed on the north half of the playa. A second Barologger will be installed at Monument Point well and used to correct data collected from pressure transducers installed on the south half of the playa.

The algorithms programmed into the Barologger are strictly for use in air, making this instrument extremely accurate. The barometric data are then used, along with software Data Wizard, to compensate the Levelogger data and provide true water level readings. To increase the accuracy of barometric compensation data, the Barologgers and pressure transducers will be programmed with the same recording times.

Each transducer will be checked annually to verify its accuracy. This procedure will include raising the transducer to the top of the water surface while monitoring the pressure/head reading. When it measures zero, the cable will be marked. The transducer will then be lowered to depths of 5, 25, and 100 feet below the water surface and the pressure/head readings will be recorded. If these match the actual values, within the accuracy of the transducer, the transducer will be deemed acceptable and will continue in service. If not, the transducer will be replaced and returned for calibration and service.

Data from the transducers will be downloaded during each field sampling event. These data will be stored on a USB flash drive and then transferred to the central database for review, data verification, and analysis.

6.4.2 Groundwater Quality Sampling

It is currently anticipated that samples will be collected from the monitoring wells using low-flow purge and sampling methods or passive sampling methods as discussed further below. In either case, down-well flow testing will be conducted prior to the initial sampling round in order to select a representative depth from which samples will be collected from the wells.

6.4.2.1 Down-Well Flow Testing

Low flow and passive groundwater sampling methods are not recommended for wells with long screens unless the Project team has a good understanding of the zones of inflow to the screen segments. Therefore, prior to use of these proposed sampling protocols, down-well flow tests were conducted, thereby determining the flow zones within the monitoring wells. The testing also assisted in understanding the relationship of groundwater flow between zones within the same groundwater system and provided information regarding interaction between groundwater systems within the area of interest.

Down-well flow testing was conducted in selected wells by Colog of Lakewood Colorado between the dates of June 4-22, 2018. The following wells were tested:

- Playa well SN2-11-400-4.
- Alluvial/colluvial wells 257 Cutoff, Bonneville, Crystal Peak Road, Guzzler, Lakeview, Headlight Gap, Machine Gun, Miller Canyon Reservoir, Mudhole and Provo.
- Bedrock wells Black Hills, Coyote, Monument Point, Nighthawk and North Cricket.

These 16 wells were logged to evaluate the vertical distribution of flow into and out of the wells for the purpose of locating sampling equipment in the wells. The screen interval showing the highest inflow of water will be the zone from which samples will be collected during each sampling event.

Each well was video logged first to determine the location of the well screen. In a few cases, the well screen interval determined by video logging did not match the well driller’s log. Table 3-1 will be updated for accurate screen intervals in the first annual report after this evaluation is complete. This updated information will also be presented in the baseline report.

The down-well flow testing method involves fluid-column conductivity logging over time after the in-situ fluid column has been replaced with environmentally safe deionized water. Finite difference modeling routines are used to determine zones where formation water is entering the well and to calculate aquifer permeability. Zones of in-flow, no-flow or very low flows are calculated throughout the well screen interval. Table 4-1 will be updated in the first annual report after completion of the down-well flow testing with the sampling depth selected for each well. This updated information will also be presented in the baseline report. Published field studies demonstrate that the technique has achieved better low-flow resolution than that reported with other flow measurement techniques (Vernon et al., 1993, reported in EPA CLU-IN, accessed 2018).

Well SN2-11-400-4, located within the playa, was flow tested using a Corehole Dynamic Flowmeter ("CDFM") because the equipment used to test the other wells could not be deployed to the playa surface. Data collection with a CDFM is based on Faraday's Law of Induction: voltage induced by a conductor moving at right angles through a magnetic field is directly proportional to the velocity of the moving conductor. Although the CDFM results are not as detailed and specific as the method used by Colog, interval(s) of higher flow into the well were still identified and will be used to set the sampling equipment depth and update Table 4-1.

At this time, CPM does not anticipate re-testing the wells unless there are noted obstructions in the wells within the sampling intervals that are suspected to potentially change the in-flow depth interval.

6.4.2.2 IN-SITU SAMPLING METHOD

CPM plans to use the ISS method for collecting groundwater quality samples in wells greater than 2-inch diameter, excluding wells equipped with dedicated submersible pumps (Black Hills, Lakeview, and Mudhole wells). Because the ISS sample volume in a 2-inch diameter well is insufficient to collect a duplicate of the full analytical suite shown on Table 3-2, low-flow sampling will be used in 2-inch diameter wells and is described in the subsequent section.

The wells that comprise the SAP/QAPP groundwater monitoring network vary in depth, diameter, and lithology surrounding the screen intervals. Review of previous sampling purge logs shows inconsistencies in purge procedures, apparently in response to individual well characteristics. Most notable are the numbers of wells that go dry when attempting a standard three-well volume purge.

Studies conducted in the 1990s demonstrated that purging of multiple well volumes of groundwater was not necessary to collect representative samples of the groundwater (Powell and Puls 1993; Barcelona et al. 1994; Puls and Barcelona 1996). These studies and others ushered in the low-flow purging method as a replacement to the multiple volumes purging. Robin and Gillham (1987) and Powell and Puls (1993) continued their investigations into low-flow purging and demonstrated that no purging was required as long as the sample device was set in the well screen at a depth where adequate well water exchange was occurring naturally (determined for this Project through down-well flow testing). Puls and Barcelona (1996) indicate that passive sample collection may be more appropriate for obtaining a representative sample in low-permeability and fractured flow formations than standard sampling protocols.

Recent testing and verification of ISS devices can be found in numerous documents including Britt (2006), Interstate Technology and Regulatory Council (“ITRC”) (2007), Parsons (2005), Parker and Mulherin (2007), and the current American Society of Testing Materials (“ASTM”) Standard Guide for Selection of Passive Techniques for Sampling Groundwater Monitoring Wells [ASTM D7929-14] (ASTM, 2014). The benefit of an ISS device is that the sampler is left in the well to equilibrate with the flow through the well screen, which minimizes the alteration of the groundwater sample through purging. This removes some of the sources of variability in water quality data due to differences in sampling personnel, sampling procedures, and equipment (EPA, 2005; Britt et al. 2010).

ASTM D7929-14 states that ISS sampling methods should consider sampler design, ability of the sampler to collect the target contaminants, well construction (including well diameter, screen and filter pack length), vertical and horizontal flow patterns within the well, and the constituents of concern. Passive ISS samplers are particularly well suited for conditions where active sampling methods can be problematic, such as those demonstrated in the purge logs from prior well sampling activities in the area of interest (CH2M, 2013). These conditions can include low-yield formations, where excessive drawdown is unavoidable even at low flow rates or where low-turbidity samples are needed but cannot be obtained using other sampling methods, such as with a bailer or a pump (ASTM D7929-14).

ITRC (2007) encourage the appropriate use of passive sampler technologies in new groundwater monitoring programs and as a replacement for existing high-volume purge sampling systems. The benefits stated by the ITRC (2007) include the following:

- Relatively easy to use;
- Reduces field-sampling variability, resulting in more reproducible data;
- Decreases field labor and project management costs for long-term monitoring;
- Allows rapid field sample collection;
- Allows sampling of the same interval in the well;
- Practical for use where access is difficult or where discretion is desirable;
- Can be deployed in series to provide a vertical chemical profile;
- Can be deployed in most wells; and
- Has no depth limit.

ISS sampling imparts the least degree of differential influence of any of these factors from one sampling event to the next through elimination of variations in sampling procedures and sample handling. Using an ISS system, the focus shifts from the sampling process to interpretation of time-series data. The ISS system will be a dedicated system to reduce field sampling variability but can be removed temporarily to allow use of the well for other purposes. If, for any reason, the ISS system is not functioning correctly in any of the wells, the backup sampling method would be low-flow purge (EPA, 2017).

For the ISS method, CPM proposes to use the Snap Sampler® ISS sampling method. With this system, sample bottles are suspended on a cable at an appropriate depth within the well screen (determined from the down-well flow testing described in Section 6.4.2.1) and allowed to set for a minimum of one week prior to sampling. A minimum of 460 ml of groundwater is required for the analyte list shown on Table 3-2. In 4-inch diameter wells and larger, 2,100 ml of groundwater can be collected using a total of six Snap Sampler bottles. Therefore, sufficient water will be available to allow the collection of the original sample as well as a duplicate or MS/MSD sample from any 4-inch diameter well or larger.

At the time of sampling, the lids on the bottles are triggered closed, thereby sealing the sample. The cable is then withdrawn, and the sample bottles are brought to the ground surface. An appropriate volume of unfiltered groundwater will be transferred into a separate container for field testing of pH and specific conductance. Aliquots of groundwater will be field filtered through a 0.45-micron disposable filter into appropriate laboratory supplied containers. Laboratory supplied preservative will be added to the appropriate sample containers.

Following sample collection, the Snap Sampler bottles will be cleaned using a bristle brush and Liquinox™ or an equivalent non-phosphate detergent, then rinsed with tap water and distilled water. The bottles will be drip-dried (under a paper towel or other cover to preclude dust impacts), after which they will be placed back onto the cable and lowered back into the well. The bottles will be dedicated to an individual well. A standard operating procedure is included in Attachment C.

The sample ID, sample date and time, field parameters, required analyses and sample volume will be recorded on the Groundwater Sample Log Form B (Appendix E). Sample management and shipping will occur in accordance with the procedures in Section 7.

6.4.2.3 Low-Flow Sampling Method

Low flow purge methods will be used in 2-inch diameter wells including Machine Gun, Crystal Peak Road and Headlight Gap and BLM wells with previously-installed submersible pumps (i.e., Black Hills, Lakeview, and Mudhole). Low-flow sampling methods will generally follow procedures recommended by the EPA (2017).

The low-flow wells identified above were down-well flow tested and sample depths are presented on Table 4-1. CPM acknowledges that EPA (2017) recommends that the low flow procedure is preferentially applicable to wells with a well screen length no more than 10 feet and a static water level above the well screen. However, the EPA recommendation assumed that the dominant groundwater inflow interval to a well was not known. Furthermore, Kaminski (2010) recommends that the purge location should relate to the saturated thickness of the monitored zone and preferential pathways rather than an arbitrary screen length (Kaminski 2010).

Low flow purging will be performed using Geotech bladder pumps capable of installation in 2-inch diameter casing and larger. These bladder pumps can operate at depths up to 1,000 feet with true low flow capability for less agitation. Bladder pumps will be installed in accordance with the manufacturer’s instructions and are planned to be a dedicated installation for each well. The pumps will be controlled by the Geotech 300 PSI Controller with accurate microprocessor-controlled fill/discharge timers to sustain low flow sampling techniques. The 300 PSI controller can operate the pumps to sampling depths of 690 feet. The depth at which the pumps are installed are identified on Table 4-1 (determined by the down-well testing described in Section 6.4.2.1), with samples collected from the primary zone of groundwater flow through the well screen.

Tubing from the pump will be connected to a flow-through cell in which dissolved oxygen, specific conductance, temperature, and pH will be monitored until these parameters stabilize for three consecutive readings taken at 5-minute intervals. Turbidity measurements will be collected from water diverted at a bypass valve installed before the flow through cell. The water samples for turbidity will be collected in separate sample cells and analyzed using a turbidimeter. Stable water quality parameter measurements indicate representative sampling is obtainable. Stabilization will be considered complete when the following is achieved (EPA 2017):

- Dissolved Oxygen ("DO"): ±10 percent for values > 0.5 mg/L; if three values are < 0.5 mg/L the water is considered stabilized.
- pH: ± 0.1 unit.
- Specific Conductance ("SC"): ±3 percent.
- Temperature: ±3 percent.
- Turbidity: ±10% for values greater than 5 Nephelometric Turbidity Units ("NTU"); if three turbidity values are less than 5 NTUs, consider the values as stabilized.

There is some concern over the stabilization of field parameters based on previous sampling logs. If field parameters do not stabilize even with adjustments to purge rates, and/or the drawdown in the well is surpassing the preferred quantity of 0.3 foot, field personnel will document the lack of stabilization and stop the purge process. Further, once the required purge volume is obtained (as discussed below), the purge process will not extend past one-half hour. If such steps are taken, they will be noted in the field log and the data will be appropriately qualified.

The discharge from the flow-through cell will be directed to a five-gallon bucket to determine the total volume purged (including that which is collected for turbidity measurements). During pumping, the flow rate will be monitored using a 250-ml graduated cylinder while drawdown in the well is measured. The goal is to purge the well at a rate that produces less than 0.3 foot of drawdown. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume.

Once the field parameters stabilize and the minimum total volume of purge water has been verified by the amount of water collected in the bucket, the water will be sampled. The tubing will be disconnected from the flow-through cell and each bottle will be filled from that tubing.

Samples intended to provide concentrations of dissolved constituents (Table 3-2) will be field filtered using a 0.45-micron filter to remove larger particles that have been entrained in the water sample. A clean, unused filter will be used for each filtered sample collected. Groundwater samples will be transferred from the filter directly into the appropriate sample containers with a preservative and stored on ice until they are processed for shipment to the laboratory. When transferring samples, care will be taken not to touch the filter to the sample container.

Sample containers will be supplied by the analytical laboratory. Commercially available, pre-cleaned jars will be used. The laboratory will be responsible for maintaining a record of certification from the suppliers. Preservatives (if needed) would be added to the sample bottles before filling to reduce the time the sample is handled and open to the atmosphere.

The sample ID, sample date and time, field parameters, required analyses and sample volume will be recorded on the Groundwater Sample Log Form B (Appendix E). The sample management and shipping will occur in accordance with the procedures in Section 7.

At wells where a duplicate sample is to be collected, all bottles designated for a particular analysis for both sample designations will be filled sequentially before bottles for another analysis are filled. In the filling sequence for duplicate samples, bottles with the two different sample designations will alternate. Groundwater samples will be transferred directly into the appropriate sample containers with preservative, if required, chilled if appropriate, and processed for shipment to the laboratory.

6.4.3 Spring Sampling

If springs are monitored in the future, flow measurements will be collected if feasible and the spring water will be sampled if present. Given the intermittent nature of the springs as well as land owner accessibility issues, spring monitoring locations may change as more information becomes available.

If the flow is too low to allow the use of a current meter to measure the discharge rate, the flow velocity will be estimated using the float method or other approach recommended by Buchanan and Somers (1969).

In order to avoid potential disturbances caused by flow measurement, water quality samples will be collected from the springs before measuring the flow. Field measurements of temperature, pH, SC, turbidity, and DO will be collected and recorded during each sampling event. The spring samples and field measurements will be logged on the Surface Water Sample Form C (Appendix E). Sample management and shipping would follow procedures in Section 7. The samples will be analyzed for the constituents listed in Table 3-1.

6.5 Decontamination Procedures

Sampling equipment that comes into contact with water at another source will be decontaminated in accordance with SOP 2 in Appendix C. Disposable equipment intended for one-time use will not be decontaminated but will be packaged for appropriate disposal.

7 SAMPLE CONTAINERS, PRESERVATION, PACKAGING, AND SHIPPING

7.1 Water Sample Containers

The number and type of sample containers are listed in Tables 3-1 and 3-2. The containers will be pre-cleaned and preservatives, if required, will be added to the containers in the field. All samples will be chilled to 4°C $\pm$ 2°C immediately upon collection and labeling. Additional information regarding sample preservation and analysis is provided in Sections 5.1.1 (surface water) and 5.1.2 (groundwater).

7.2 Packaging and Shipping

Glass sample bottles will be individually placed inside a protective bubble wrap container to minimize the potential for breakage during shipment. All sample containers will be placed inside a sealable plastic bag that is placed inside a strong-outside shipping container (e.g., a cooler). Ice will be added to the cooler and empty space in the cooler will be filled with bubble wrap if necessary, to prevent movement and breakage of the sample containers during shipment.

A properly completed CoC form for the samples in the cooler will be placed inside a separate plastic bag, sealed, and taped to the inside lid of the cooler. Security seals will be signed and placed over the lip of the cooler lid. This seal with be secured to the lid with packing tape. The cooler will be shipped directly to Pace via an overnight service.

8 DISPOSAL OF RESIDUAL MATERIALS

In the process of collecting environmental samples, the sampling team will generate different types of waste that may include the following:

- Used sampling gloves,
- Disposable sampling equipment,
- Decontamination fluids,
- Purged groundwater and excess groundwater collected for sample container filling.

Used sampling gloves and disposable equipment will be placed in a municipal refuse dumpster. These wastes are not considered hazardous and can be sent to a municipal landfill.

Decontamination fluids that will be generated in the sampling event will consist of tap water containing a non-phosphate detergent, distilled or deionized water, and residual (innocuous) contaminants. The volume and concentration of the decontamination fluid will be sufficiently low to allow disposal at the site or sampling area and will, therefore, be poured onto the ground.

Purged groundwater will be disposed by pouring onto the ground adjacent to the sampled well.

9 SAMPLE DOCUMENTATION

9.1 Field Documentation

Field documentation serves as the primary foundation for all field data that will be used to evaluate conditions within the area of interest. Care will be taken to ensure that all field documentation is accurate, legible, and written in indelible black or blue ink. No pencils or erasures will be used. Incorrect entries in field books, logs, or on forms that need to be corrected will be crossed out with one line, initialed, and dated. Skipped pages or blank sections at the end of a page will be crossed out with an "X" covering the entire page or blank section. "No Further Entries," initials, and date will be written by the person crossing out the section or page. The responsible field team member will write his/her signature, date, and time after the day's last entry.

9.1.1 Field Logbooks

The field logbook will be a bound, weatherproof book with numbered pages and will serve primarily as a summary of the activities carried out during the fieldwork. The logbook will be signed by the field personnel at the end of the daily entry. All entries will be made in indelible black or blue ink. The field forms (Appendix E, Forms A through C), will contain the documentation for sampling activities and will be referenced in the logbook each day, including an indication of which form(s) were used.

Field logbooks will document the following:

- Date;
- Time of important events;
- Purpose and objective of field work;
- Health and safety issues;
- Personnel and subcontractors on job site and time spent on the site;
- Summary of what was completed/performed;
- Type of sampling equipment used;
- Field instrument readings and calibration;
- Field observations and details related to analysis or integrity of samples (e.g., weather conditions, noticeable odors, colors, etc.);
- Preliminary sample descriptions (e.g., clear or turbid water);
- Sample preservation;
- Lot numbers of the sample containers, sample identification numbers and any explanatory codes, and CoC form numbers;
- Shipping arrangements (overnight air bill number);

- Name(s) of recipient laboratory(ies);
- Problems encountered and corrective action taken;
- Deviations from the sampling plan and reason for the deviations; and
- List of forms completed (i.e., Forms A through C).

Electronic field logs (i.e., using a tablet or laptop computer) may also be used to capture the above information.

9.1.2 Photographs

Photographs will be taken of the sample locations and at other areas of interest to document conditions during each sampling event. Documentation of a photograph is crucial to verify that it represents an existing situation. The following information concerning photographs will be noted in the logbook:

- Date, time, and location photograph was taken - in format mm/dd/yyyy – hh:mm;
- Weather conditions;
- Description of photograph;
- Reasons photograph was taken;
- Sequential number of the photograph; and
- Orientation direction when the photograph was taken.

After the photos are downloaded, the information recorded in the field logbook will be summarized in captions in the digital photo log.

9.2 Sample Labeling

All sample containers will be labeled (pre-printed by laboratory or sampling team) using waterproof labels and ink with the following information written on the labels:

- Client or project name;
- Sample identification number;
- Date and time of collection - in format mm/dd/yyyy – hh:mm;
- Requested analysis; and
- Container type and type of preservation used (chemicals added).

Field information concerning water samples will be listed on the appropriate forms contained in Appendix E.

9.3 Sample Chain-Of-Custody Forms

Chain-of-custody (“CoC”) is used to ensure that samples shipped from the field and data resulting from laboratory analysis are credible and defensible. CoC begins at the time and point of sample collection. Documentation of sample possession and CoC is provided using sample labels and CoC forms.

All sample shipments for analyses will be accompanied by a CoC form. A copy of the form is found in Appendix F. Form(s) will be completed and sent with the samples in each cooler.

Information listed on the CoC includes:

- Sample ID;
- Project name, location, and number;
- Sampling dates and times;
- Name of sampling technician(s);
- Media being tested for each sample;
- Number of containers per sample;
- Signature of person relinquishing and receiving custody;
- Requested analyses for each sample; and
- Special requirements/comments for project or analysis.

The CoC form will identify the contents of each shipment and maintain the custodial integrity of the samples. Generally, a sample is considered to be in someone's custody if it is either in someone’s physical possession, in someone's view, locked up, or kept in a secured area that is restricted to authorized personnel. Until the samples are shipped, the custody of the samples will be the responsibility of the sampling team leader. The sampling team leader or designee will sign the CoC form in the “relinquished by” box and note the date, time, and air bill number.

The field person relinquishing the samples will keep one copy of each CoC form and send the remaining copies with the samples. As noted in Section 7.2, the CoC form will be sealed in a waterproof plastic bag and taped to the inside lid of the shipping container (cooler).

10 QUALITY CONTROL

Quality assurance and quality control ("QA/QC") are critical components of every monitoring program. QA/QC requirements for CPM's monitoring activities are intended to ensure that data collected meet the Project and data quality objectives discussed in Section 3. Quality assurance planning helps ensure that the Project DQOs are met. Quality control samples ensure that procedures and actions are conducted correctly.

10.1 Field Quality Control

QC samples to be collected in the field are briefly described below.

10.1.1 Blind Duplicates

A blind duplicate sample is a duplicate of an original sample collected at the same time and location as the original sample. Blind duplicate water samples are collected in immediate succession, using identical sampling techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned a unique identification number in the field such that they cannot be identified as duplicates by laboratory personnel (i.e., the samples are submitted "blind").

When collecting blind duplicate water samples, bottles representing the original sample and the blind duplicate, with the two different sample identification numbers, will alternate in the filling sequence. Bottles for one type of analysis will be filled before bottles for the next analysis are filled. Duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix.

Blind duplicate sample results are used to assess precision of the overall sample collection and analysis process, as noted in Section 3.3.1. Blind duplicate surface and groundwater samples will be collected at a minimum frequency of one duplicate for every 10 regular samples, or portion thereof, with at least one duplicate for each matrix (i.e., surface water and groundwater).

10.1.2 Field Blanks

Field blanks will be collected to evaluate whether contaminants have been introduced into the samples during sampling due to contamination from sample containers or from environmental conditions (e.g., dust). Field blank samples will be obtained by pouring deionized water into a sampling container at the sampling point, leaving the lid off during sampling at that location. The field blanks that are collected will be analyzed for metals.

One field blank will be collected each time a blind duplicate sample is collected. The field blanks will be preserved, packaged, and sealed in the manner described for the environmental samples. A separate sample number will be assigned to each field blank sample, and it will be submitted blind to the laboratory.

10.1.3 Temperature Blanks

For each sample container that is shipped or transported on ice to an analytical laboratory, a 40-ml or larger glass or polyethylene container will be included that is marked "temperature blank." This blank will contain deionized or distilled water and will be used by the laboratory to check the temperature of samples upon receipt.

10.2 Laboratory Quality Control Samples

QC data are necessary to determine precision and accuracy and to demonstrate the absence of interferences and/or contamination of laboratory glassware and reagents. Each type of laboratory-based QC sample will be analyzed at a rate of 5% or one per batch (a batch is a group of up to 20 samples analyzed together), whichever is more frequent.

10.2.1 Method Blank

A method blank is a sample generated in the laboratory consisting of reagent-grade water that is taken through the entire sample preparation and analysis with the field samples. It is used to monitor for contamination that may be introduced into the samples during processing within the laboratory. Evaluation criteria are provided in the source methods and in the laboratory QA manuals provided in Appendix B.

10.2.2 Laboratory Duplicate

A laboratory duplicate consists of an aliquot of a field sample that is taken from the same container as the initial field sample and prepared and analyzed with the field sample. Laboratory duplicates are used to monitor the precision (in terms of RPD) of the analytical process. In conjunction with blind duplicates, the sampling precision can then be inferred. Criteria for laboratory duplicates are provided in the source methods and in the laboratory QA manuals provided in Appendix B.

10.2.3 Laboratory Control Sample

A LCS consists of a laboratory-generated sample that contains the analytes of interest at known concentrations. It may be prepared by the laboratory or purchased from an outside source. The LCS is taken through the same preparation and analytical procedures as the field samples. Analyte recoveries indicate the accuracy of the analytical system. LCSs and matrix spikes ("MS") together allow the overall accuracy of the sampling and analytical process to be determined. Criteria for LCS evaluation are provided in the source methods and in the laboratory QA manuals provided in Appendix B.

10.2.4 MS/MS Duplicates

MS/MSDs are used to assess the effect of the sample matrix on analyte recovery. Both the MS and the MSD consist of an aliquot of a field sample to which the laboratory adds a known concentration of the analyte(s) of interest. An unspiked aliquot is also analyzed, and the percent recovery for the spiked sample is calculated.

The sample(s) chosen for MS/MSDs should be representative of the sample matrix but should not contain excessive concentrations of analytes or interfering substances. MS/MSDs will be analyzed at a frequency of one MS/MSD per 20 or fewer samples for each matrix and each sampling event.

Analysis of MS/MSDs requires collection of a sufficient volume of sample to accommodate the number of aliquots to be analyzed. The laboratory will be informed of the number of MS/MSD samples to be collected to ensure that a sufficient number of samples contained are filled for the analyses. The laboratory will also be alerted as to which sample is to be used for MS/MSD analysis by a notation on the sample container label and the CoC record or packing list.

When collecting water samples that will be the subject of MS/MSD analyses, bottles for each type of analysis will alternate in the filling sequence. Bottles for one type of analysis will be filled before bottles for the next analysis are filled. Control limits for MS/MSDs are provided in the source methods and in the laboratory quality assurance manuals provided in Appendix B.

11 FIELD VARIANCES

As conditions in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. When possible, the QA Officer will be notified and a verbal approval will be obtained before implementing the changes. Modifications to the approved plan will be documented in the sampling project report.

12 FIELD HEALTH AND SAFETY PROCEDURES

All field activities associated with the SAP/QAPP will be performed in accordance with the most recent edition of the CPM Site Safety Plan.

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APPENDIX A

WATER QUALITY CRITERIA

(Included as Attachments to the PDF Document)

SURFACE WATER STANDARDS

Standards for the quality of surface waters of the State are contained in UAC R317-2. The water quality standards are intended to protect Utah's waters and improve the quality for beneficial uses, including drinking water, fish and aquatic life, wildlife, agricultural, industrial, and recreational uses. The recognized classes of surface waters of the State are as follows:

Class 1 -- Protected for use as a raw water source for domestic water systems.

Class 1C -- Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water

Class 2 -- Protected for recreational use and aesthetics.

Class 2A -- Protected for frequent primary contact recreation where there is a high likelihood of ingestion of water or a high degree of bodily contact with the water. Examples include, but are not limited to, swimming, rafting, kayaking, diving, and water skiing.

Class 2B -- Protected for infrequent primary contact recreation. Also protected for secondary contact recreation where there is a low likelihood of ingestion of water or a low degree of bodily contact with the water. Examples include, but are not limited to, wading, hunting, and fishing.

Class 3 -- Protected for use by aquatic wildlife.

Class 3A -- Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

Class 3B -- Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.

Class 3C -- Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.

Class 3D -- Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.

Class 3E -- Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.

Class 4 -- Protected for agricultural uses including irrigation of crops and stock watering.

Class 5 waters represent a special class reserved for the Great Salt Lake. Individual bodies of water and reaches of flowing water are classified in R317-13 using the above categories.

GROUNDWATER CLASSES

Numerical groundwater quality standards for Utah are defined in UAC R317-6. Protection levels for groundwater are assigned in UAC R317-6-3, using a six-tier classification system based on existing use and background concentrations of TDS and other regulated constituents. The recognized classes of groundwater are as follows:

Class IA: Pristine Groundwater – Class IA groundwaters have less than 500 mg/L TDS. Concentrations of other constituents are less than the standards listed in Tables 2-1a, 2-1b, and 2-1c.

Class IB: Irreplaceable Groundwater – Class IB groundwaters are sources for community public drinking water systems for which no reliable supply of comparable quality and quantity is available because of economic or institutional constraints.

Class IC: Ecologically Important Groundwater – Class IC groundwaters are sources of groundwater discharge that are important to the continued existence of wildlife habitat.

Class II: Drinking Water Quality Groundwater – Class II groundwaters have TDS concentrations between 500 and 3,000 mg/L. Concentrations of other constituents that are less than the standards listed in Tables 2-1a, 2-1b, and 2-1c.

Class III: Limited Use Groundwater – Class III groundwaters have TDS concentrations between 3,000 and 10,000 mg/L. Concentrations of other constituents that exceed the standards listed in Tables 2-1a, 2-1b, and 2-1c.

Class IV: Saline Groundwater – Class IV groundwaters have TDS concentrations greater than 10,000 mg/L.

APPENDIX B

LABORATORY QA/QC PROGRAM

(Included as Attachments to the PDF Document)

Data Packages at a Glance

	Client Report Style	Cover Page	Narrative	Basic QC	Surrogates	Internal Standards	Calibration Summaries	Raw Data	TRRP R Report	TRRP S Report
QC2 (LIMS)	ESC			■	■					
QC2MOD	ESC			■	■	■				
QC2MODCN	ESC		■	■	■	■				
QC2MODCN-AZ *	ESC	■	■	■	■	■				
QC2VAP	ESC		■	■	■	■				
QCAZ *	DPP	■	■	■	■	■				
QCTX	ESC			■					■	
QCTX-S	ESC			■					■	■
QC3	ESC	■	■	■	■	■	■			
QC4	ESC	■	■	■	■	■	■	■		

Basic QC includes:

Blanks
Duplicates
LCS/D
MS/D

*** Includes AZ state qualifiers on QC pages**

Level 2 “LIMS” Data Package (also “Auto-QC2”)

1. Analytical Results
2. Method Blanks
3. Duplicates
4. Laboratory Control Samples
5. Matrix / Matrix Spike Duplicates

Surrogates are included where applicable

Level 2 "MOD" Data Package

1. Analytical Results
2. Wet – Chemical Data
    - 2.1. Quality Control Data
        - 2.1.1. Method Blanks
        - 2.1.2. Laboratory Control Samples
        - 2.1.3. Duplicates
        - 2.1.4. Matrix / Matrix Spike Duplicates
3. Inorganic Data
    - 3.1. Quality Control Data
        - 3.1.1. Method Blanks
        - 3.1.2. Laboratory Control Samples
        - 3.1.3. Duplicates
        - 3.1.4. Matrix Spike / Matrix Spike Duplicates
4. GC Volatiles Data
    - 4.1. Quality Control Data
        - 4.1.1. Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Surrogate Summaries
        - 4.1.4. Matrix Spike / Matrix Spike Duplicates
5. GC/MS Volatiles Data
    - 5.1. Quality Control Data
        - 5.1.1. Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Surrogate Summaries
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
        - 5.1.5. Internal Standard Response and Retention Time Summaries
6. GC Semi-volatiles Data
    - 6.1. Quality Control Data
        - 6.1.1. Blanks
        - 6.1.2. Laboratory Control Samples
        - 6.1.3. Surrogate Summaries
        - 6.1.4. Matrix Spike / Matrix Spike Duplicates

Level 2 “MODCN” Data Package

1. SDG Narrative
2. Analytical Results
3. Wet – Chemical Data
    3.1. Quality Control Data
        3.1.1. Method Blanks
        3.1.2. Laboratory Control Samples
        3.1.3. Duplicates
        3.1.4. Matrix / Matrix Spike Duplicates
4. Inorganic Data
    4.1. Quality Control Data
        4.1.1. Method Blanks
        4.1.2. Laboratory Control Samples
        4.1.3. Duplicates
        4.1.4. Matrix Spike / Matrix Spike Duplicates
5. GC Volatiles Data
    5.1. Quality Control Data
        5.1.1. Blanks
        5.1.2. Laboratory Control Samples
        5.1.3. Surrogate Summaries
        5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC/MS Volatiles Data
    6.1. Quality Control Data
        6.1.1. Blanks
        6.1.2. Laboratory Control Samples
        6.1.3. Surrogate Summaries
        6.1.4. Matrix Spike / Matrix Spike Duplicates
        6.1.5. Internal Standard Response and Retention Time Summaries
7. GC Semi-volatiles Data
    7.1. Quality Control Data
        7.1.1. Blanks
        7.1.2. Laboratory Control Samples
        7.1.3. Surrogate Summaries
        7.1.4. Matrix Spike / Matrix Spike Duplicates

Level 2 “VAP” Data Package

1. SDG Narrative
2. Analytical Results
3. Wet – Chemical Data
    - 3.1. Quality Control Data
        - 3.1.1. Method Blanks
        - 3.1.2. Laboratory Control Samples
        - 3.1.3. Duplicates
        - 3.1.4. Matrix / Matrix Spike Duplicates
4. Inorganic Data
    - 4.1. Quality Control Data
        - 4.1.1. Method Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Duplicates
        - 4.1.4. Matrix Spike / Matrix Spike Duplicates
5. GC Volatiles Data
    - 5.1. Quality Control Data
        - 5.1.1. Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Surrogate Summaries
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC/MS Volatiles Data
    - 6.1. Quality Control Data
        - 6.1.1. Blanks
        - 6.1.2. Laboratory Control Samples
        - 6.1.3. Surrogate Summaries
        - 6.1.4. Matrix Spike / Matrix Spike Duplicates
        - 6.1.5. Internal Standard Response and Retention Time Summaries
7. GC Semi-volatiles Data
    - 7.1. Quality Control Data
        - 7.1.1. Blanks
        - 7.1.2. Laboratory Control Samples
        - 7.1.3. Surrogate Summaries
        - 7.1.4. Matrix Spike / Matrix Spike Duplicates

8. GC/MS Semi-volatiles Data
    8.1. Quality Control Data
        8.1.1. Blanks
        8.1.2. Laboratory Control Samples
        8.1.3. Surrogate Summaries
        8.1.4. Matrix Spike / Matrix Spike Duplicates
        8.1.5. Internal Standard Response and Retention Time Summaries
9. HPLC Data
    9.1. Quality Control Data
        9.1.1. Blanks
        9.1.2. Laboratory Control Samples
        9.1.3. Surrogate Summaries
        9.1.4. Matrix Spike / Matrix Spike Duplicates
10. GC/ECD Pesticide / Aroclor Data
    10.1. Quality Control Data
        10.1.1. Blanks
        10.1.2. Laboratory Control Samples
        10.1.3. Surrogate Summaries
        10.1.4. Matrix Spike / Matrix Spike Duplicates
11. Chain of Custody

Level 2 “AZ” Data Package

1. Cover Page
2. SDG Narrative
3. Analytical Results with AZ qualifiers
4. Wet – Chemical Data
    - 4.1. Quality Control Data
        - 4.1.1. Method Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Duplicates
        - 4.1.4. Matrix / Matrix Spike Duplicates
5. Inorganic Data
    - 5.1. Quality Control Data
        - 5.1.1. Method Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Duplicates
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC Volatiles Data
    - 6.1. Quality Control Data
        - 6.1.1. Blanks
        - 6.1.2. Laboratory Control Samples
        - 6.1.3. Surrogate Summaries
        - 6.1.4. Matrix Spike / Matrix Spike Duplicates
7. GC/MS Volatiles Data
    - 7.1. Quality Control Data
        - 7.1.1. Blanks
        - 7.1.2. Laboratory Control Samples
        - 7.1.3. Surrogate Summaries
        - 7.1.4. Matrix Spike / Matrix Spike Duplicates
        - 7.1.5. Internal Standard Response and Retention Time Summaries
8. GC Semi-volatiles Data
    - 8.1. Quality Control Data
        - 8.1.1. Blanks
        - 8.1.2. Laboratory Control Samples
        - 8.1.3. Surrogate Summaries
        - 8.1.4. Matrix Spike / Matrix Spike Duplicates

Level 2 “TX” Data Package

1. Cover Page
2. TRRP Reports
3. Analytical Results (MDL Format)
4. Wet – Chemical Data
    4.1. Quality Control Data
        4.1.1. Method Blanks
        4.1.2. Laboratory Control Samples
        4.1.3. Duplicates
        4.1.4. Matrix / Matrix Spike Duplicates
5. Inorganic Data
    5.1. Quality Control Data
        5.1.1. Method Blanks
        5.1.2. Laboratory Control Samples
        5.1.3. Duplicates
        5.1.4. Matrix Spike / Matrix Spike Duplicates
6. GC Volatiles Data
    6.1. Quality Control Data
        6.1.1. Blanks
        6.1.2. Laboratory Control Samples
        6.1.3. Matrix Spike / Matrix Spike Duplicates
7. GC/MS Volatiles Data
    7.1. Quality Control Data
        7.1.1. Blanks
        7.1.2. Laboratory Control Samples
        7.1.3. Matrix Spike / Matrix Spike Duplicates
8. GC Semi-volatiles Data
    8.1. Quality Control Data
        8.1.1. Blanks
        8.1.2. Laboratory Control Samples
        8.1.3. Matrix Spike / Matrix Spike Duplicates
9. GC/MS Semi-volatiles Data
    9.1. Quality Control Data
        9.1.1. Blanks
        9.1.2. Laboratory Control Samples
        9.1.3. Matrix Spike / Matrix Spike Duplicates

10. HPLC Data
    10.1. Quality Control Data
        10.1.1. Blanks
        10.1.2. Laboratory Control Samples
        10.1.3. Matrix Spike / Matrix Spike Duplicates
11. GC/ECD Pesticide / Aroclor Data
    11.1. Quality Control Data
        11.1.1. Blanks
        11.1.2. Laboratory Control Samples
        11.1.3. Matrix Spike / Matrix Spike Duplicates
12. Chain of Custody

Level 3 Data Package

1. Cover Page
2. SDG Narrative
3. Analytical Results
4. Wet – Chemical Data
    - 4.1. Quality Control Data
        - 4.1.1. Method Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Duplicates
        - 4.1.4. Matrix / Matrix Spike Duplicates
5. Inorganic Data
    - 5.1. Quality Control Data
        - 5.1.1. Method Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Duplicates
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
        - 5.1.5. Initial and Continuing Calibration Verifications
        - 5.1.6. Initial and Continuing Calibration Blanks
        - 5.1.7. ICP Runlog
6. GC Volatiles Data
    - 6.1. Quality Control Data
        - 6.1.1. Blanks
        - 6.1.2. Laboratory Control Samples
        - 6.1.3. Surrogate Summaries
        - 6.1.4. Matrix Spike / Matrix Spike Duplicates
        - 6.1.5. Calibration Verification Summaries
7. GC/MS Volatiles Data
    - 7.1. Quality Control Data
        - 7.1.1. Blanks
        - 7.1.2. Laboratory Control Samples
        - 7.1.3. Surrogate Summaries
        - 7.1.4. Matrix Spike / Matrix Spike Duplicates
        - 7.1.5. Initial and Continuing Calibration Verifications
        - 7.1.6. Internal Standard Response and Retention Time Summaries

Level 4 Data Package

1. Cover Page
2. SDG Narrative
3. Analytical Results
4. Wet – Chemical Data
    - 4.1. Quality Control Data
        - 4.1.1. Method Blanks
        - 4.1.2. Laboratory Control Samples
        - 4.1.3. Duplicates
        - 4.1.4. Matrix / Matrix Spike Duplicates
        - 4.1.5. Method Blank Summaries
    - 4.2. Raw Data
        - 4.2.1. Instrument Run Data with Bookmarks
            - 4.2.1.1. Continuing Calibration Reports
            - 4.2.1.2. Samples
            - 4.2.1.3. Blanks
            - 4.2.1.4. Laboratory Control Samples
            - 4.2.1.5. Duplicates
            - 4.2.1.6. Matrix Spikes
5. Inorganic Data
    - 5.1. Quality Control Data
        - 5.1.1. Method Blanks
        - 5.1.2. Laboratory Control Samples
        - 5.1.3. Duplicates
        - 5.1.4. Matrix Spike / Matrix Spike Duplicates
        - 5.1.5. Method Blank Summaries
        - 5.1.6. Initial and Continuing Calibration Verifications
        - 5.1.7. Initial and Continuing Calibration Blanks
        - 5.1.8. ICP Interference Check Samples
        - 5.1.9. ICP Runlog
    - 5.2. Raw Data
        - 5.2.1. Digestion Logs
        - 5.2.2. Instrument Run Data with Bookmarks
            - 5.2.2.1. Samples
            - 5.2.2.2. Blanks
            - 5.2.2.3. Laboratory Control Samples
            - 5.2.2.4. Duplicates
            - 5.2.2.5. Matrix Spikes

6. GC Volatiles Data
    - 6.1. Quality Control Data
        - 6.1.1. Blanks
        - 6.1.2. Laboratory Control Samples
        - 6.1.3. Surrogate Summaries
        - 6.1.4. Matrix Spike / Matrix Spike Duplicates
        - 6.1.5. Method Blank Summaries
        - 6.1.6. Calibration Verification Summaries
    - 6.2. Raw Data
        - 6.2.1. Pages from Instrument Run Data with Bookmarks
            - 6.2.1.1. Injection Logs (not bookmarked)
            - 6.2.1.2. Calibration Verification Data
            - 6.2.1.3. Sample Data
            - 6.2.1.4. Blank Data
            - 6.2.1.5. Laboratory Control Sample Data
            - 6.2.1.6. Matrix Spike Data
            - 6.2.1.7. Calibration Curve Data

7. GC/MS Volatiles Data
    - 7.1. Quality Control Data
        - 7.1.1. Blanks
        - 7.1.2. Laboratory Control Samples
        - 7.1.3. Surrogate Summaries
        - 7.1.4. Matrix Spike / Matrix Spike Duplicates
        - 7.1.5. Method Blank Summaries
        - 7.1.6. Instrument Performance Summaries
        - 7.1.7. Relative Response Factor Summaries
        - 7.1.8. Initial and Continuing Calibration Verifications
        - 7.1.9. Internal Standard Response and Retention Time Summaries
    - 7.2. Raw Data
        - 7.2.1. Pages from Instrument Run Data with Bookmarks
            - 7.2.1.1. Injection Logs (not bookmarked)
            - 7.2.1.2. Initial and Continuing Calibration Data
            - 7.2.1.3. Sample Data
            - 7.2.1.4. Blank Data
            - 7.2.1.5. Laboratory Control Sample Data
            - 7.2.1.6. Matrix Spike Data
            - 7.2.1.7. BFB Tune Data
            - 7.2.1.8. Calibration Curve Data

8. GC Semi-volatiles Data

    8.1. Quality Control Data

        8.1.1. Blanks

        8.1.2. Laboratory Control Samples

        8.1.3. Surrogate Summaries

        8.1.4. Matrix Spike / Matrix Spike Duplicates

        8.1.5. Method Blank Summaries

        8.1.6. Calibration Verification Summaries

    8.2. Raw Data

        8.2.1. Pages from Instrument Run Data with Bookmarks

            8.2.1.1. Extraction Logs

            8.2.1.2. Injection Logs (not bookmarked)

            8.2.1.3. Calibration Verification Data

            8.2.1.4. Sample Data

            8.2.1.5. Blank Data

            8.2.1.6. Laboratory Control Sample Data

            8.2.1.7. Matrix Spike Data

            8.2.1.8. Calibration Curve Data

9. GC/MS Semi-volatiles Data

    9.1. Quality Control Data

        9.1.1. Blanks

        9.1.2. Laboratory Control Samples

        9.1.3. Surrogate Summaries

        9.1.4. Matrix Spike / Matrix Spike Duplicates

        9.1.5. Method Blank Summaries

        9.1.6. Instrument Performance Summaries

        9.1.7. Relative Response Factor Summaries

        9.1.8. Initial and Continuing Calibration Verifications

        9.1.9. Internal Standard Response and Retention Time Summaries

- 9.2. Raw Data
  - 9.2.1. Pages from Instrument Run Data with Bookmarks
    - 9.2.1.1. Extraction Logs
    - 9.2.1.2. Injection Logs (not bookmarked)
    - 9.2.1.3. Initial and Continuing Calibration Data
    - 9.2.1.4. Sample Data
    - 9.2.1.5. Blank Data
    - 9.2.1.6. Laboratory Control Sample Data
    - 9.2.1.7. Matrix Spike Data
    - 9.2.1.8. DFTPP Tune Data
    - 9.2.1.9. Calibration Curve Data

10. HPLC Data
  - 10.1. Quality Control Data
    - 10.1.1. Blanks
    - 10.1.2. Laboratory Control Samples
    - 10.1.3. Surrogate Summaries
    - 10.1.4. Matrix Spike / Matrix Spike Duplicates
    - 10.1.5. Method Blank Summaries
    - 10.1.6. Initial and Continuing Calibration Summaries
  - 10.2. Raw Data
    - 10.2.1. Pages from Instrument Run Data with Bookmarks
      - 10.2.1.1. Extraction Logs
      - 10.2.1.2. Initial and Continuing Calibration Data
      - 10.2.1.3. Sample Data
      - 10.2.1.4. Blank Data
      - 10.2.1.5. Laboratory Control Sample Data
      - 10.2.1.6. Matrix Spike Data
      - 10.2.1.7. Calibration Curve Data

11. GC/ECD Pesticide / Aroclor Data
    11.1. Quality Control Data
        11.1.1. Blanks
        11.1.2. Laboratory Control Samples
        11.1.3. Surrogate Summaries
        11.1.4. Matrix Spike / Matrix Spike Duplicates
        11.1.5. Method Blank Summaries
        11.1.6. Retention Time Summaries
        11.1.7. Calibration Verification Summaries
    11.2. Raw Data
        11.2.1. Pages from Instrument Run Data with Bookmarks
            11.2.1.1. Extraction Logs
            11.2.1.2. Injection Logs (not bookmarked)
            11.2.1.3. Calibration Verification Data
            11.2.1.4. Sample Data
            11.2.1.5. Blank Data
            11.2.1.6. Laboratory Control Sample Data
            11.2.1.7. Matrix Spike Data
            11.2.1.8. Calibration Curve Data
12. Chain of Custody
13. Login Confirmation

APPENDIX C

STANDARD OPERATING PROCEDURES

(Included as Attachments to the PDF Document)

SOP 1
Well Gauging

Groundwater Well Gauging

One person should measure the fluid levels in every well during each sampling event to avoid potential errors caused by different people reading depth off the fluid level tape. Verify that all the wells are vented to the atmosphere prior to measurement to maintain water equilibration.

Manual Well Gauging Procedure

Measurements of water levels in the wells using an electronic sounder will be performed as follows:

1) Open the well and determine where the top-of-casing elevation survey point is located. This is usually a “v” notch in the casing or a mark on the casing.
2) Know the previous water level measurement and control the rate of decent at least 30 feet above the last known depth to water so the meter encounters the water gently.
3) The sounder is lowered down the well gently until the lead probe contacts water and sounds with a “beep”. The sounder should not enter the water abruptly since this may cause hydrologic disturbance prior to sampling.
4) The depth to water is read off the graduated tape with reference to the surveyed point on the top-of-casing.
5) Record the measurement on the Well Gauging Form A.
6) Remove the sounder from the well.
7) Decontaminate the sounder following procedures in SOP 3.

Pressure Transducer

A dedicated pressure transducer (PT) will record water levels in the bedrock wells and select alluvial/colluvial wells twice a day. The purpose of the pressure transducer measurements is to identify regional daily trends in water levels over time. The transducer data will be downloaded once a quarter during the groundwater gauging events.

Pressure Transducer Set up and Operation

A 1-inch diameter PT pipe will be installed in each well from top-of-casing to 30 feet below the average depth-to-water. The purpose for the pipe is keep the PT cable away from the Insitu Sampling System (ISS) cable which will suspend the ISS sample bottles at a specified depth in the well screen. The PT pipe will be securely docked at the well head.

A 20 PSI absolute pressure PT will be installed approximately 20 feet below the average depth-to-water of each well. The correction for atmospheric changes on the ground surface will be accomplished using a Barologger. The general rule is to use one Barologger for an area that has a radius of 20 miles. One Barologger will be placed near Amasa well and used for the PTs installed in wells on the north half of the playa. A second Barologger will installed at Monument Point well and used for PTs installed on the south half of the playa. The PT installed in wells will be set at a depth of approximately 20 feet below top-of-casing. The depth of the pressure transducer will be manually checked twice per year by attaching the Solinst water level meter electronic probe at the same level as the PT measurement reference. The pressure transducer reference depth will be recorded each time it is checked in the log book.

SOP 2
In-situ Sampling System (Snap Sampler)
Low Flow Purge Method (Bladder Pump)

In-situ Sampling System

The goal of this groundwater sampling program is to minimize changes in groundwater chemistry during the sample collection and handling procedures that can distort the physical sample in a manner that may not provide representative samples each time. Under the In-Situ Sampling System (ISS) method, the sample bottles are dedicated inside the well at the screen interval determined by Hydrophysical logging to be the dominate flow area into the well. Once the trigger has closed, the sample is sealed from potential atmosphere changes to the integrity of the sample.

1. Deployment

The procedure for deployment of the Snap Samplers is presented below:

1) Measure the depth-to-water following SOP 1.
2) The Snap Samplers will be installed at a depth well below the groundwater surface so measuring depth-to-water will not influence sample integrity.
3) Turn the translucent (PFA) vial cap on each end of the bottle slightly to release the O-ring.
4) Insert the bottle into the upper end of the sampler as shown in Figure 1.

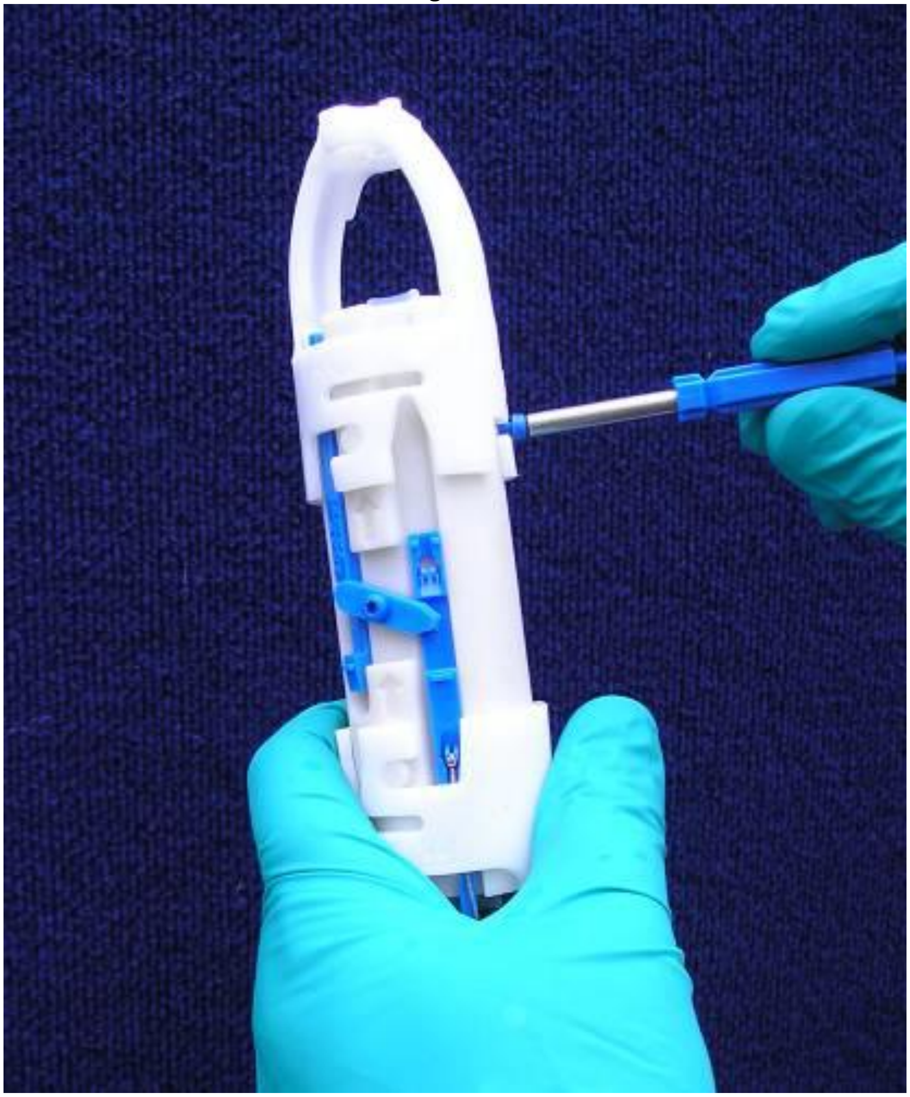
Figure 1

5) Place the sampler connector onto each end of the sampler; turn clockwise to align the set pins/screw shown in Figure 2.

Figure 2

6) Gently tighten the set screw with the Snap Driver Tool (Figure 3).

Figure 3

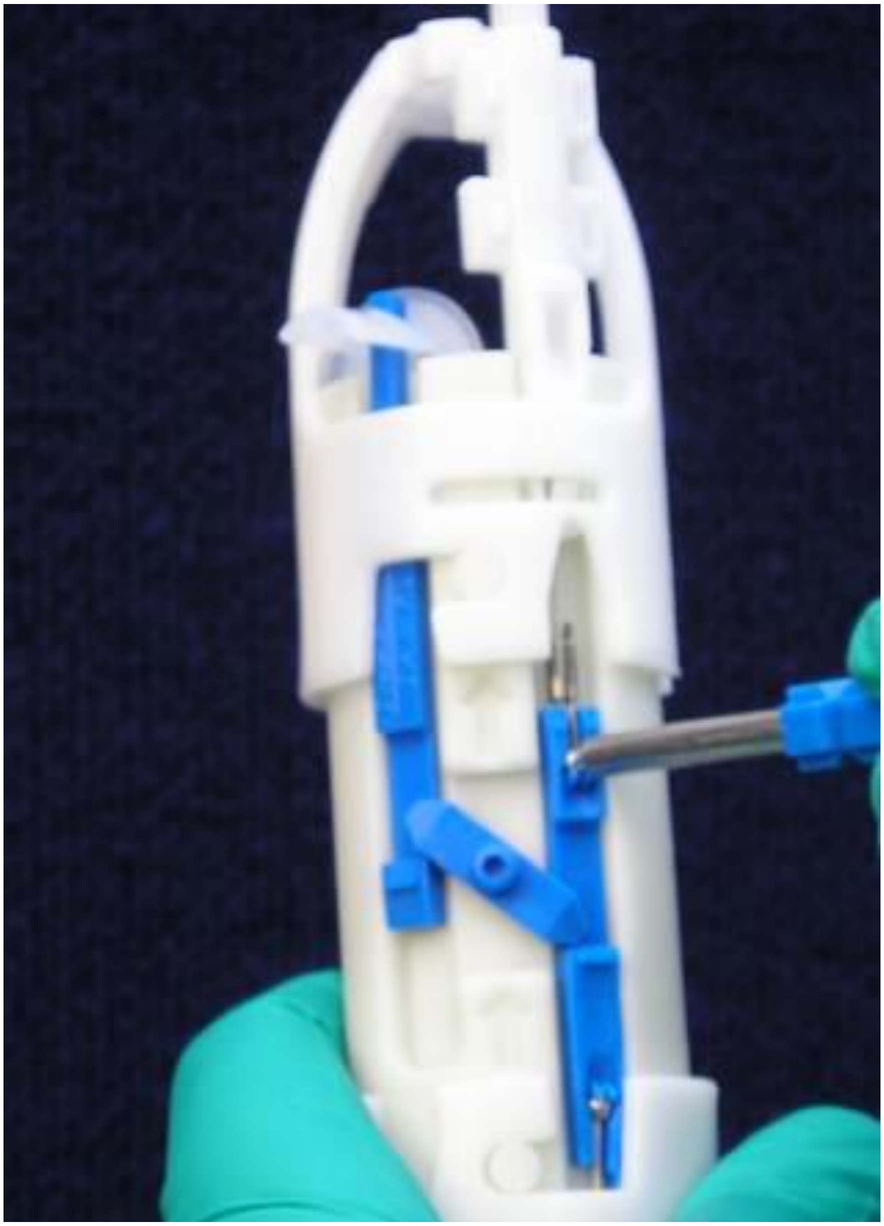


7) Pivot the vial cap (Snap Cap) into its seat with the Snap driver. Push the retainer pin up through the lower hole in the vial cap. Repeat for all Snap Caps (Figure 4). If an O-ring should dislodge from its seat during setting, remove the sample bottle and carefully replace it in the O-ring groove; repeat setting procedure.

Figure 4

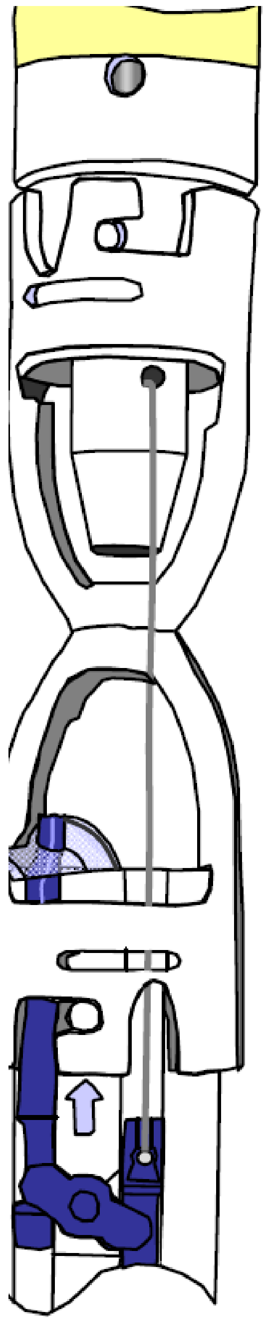
8) For the manual trigger, feed ball-fitting end of trigger cable through lower release pin groove; click tube fitting into connector and press in the ball fitting to attach lower release pin (Figure 5).

Figure 5



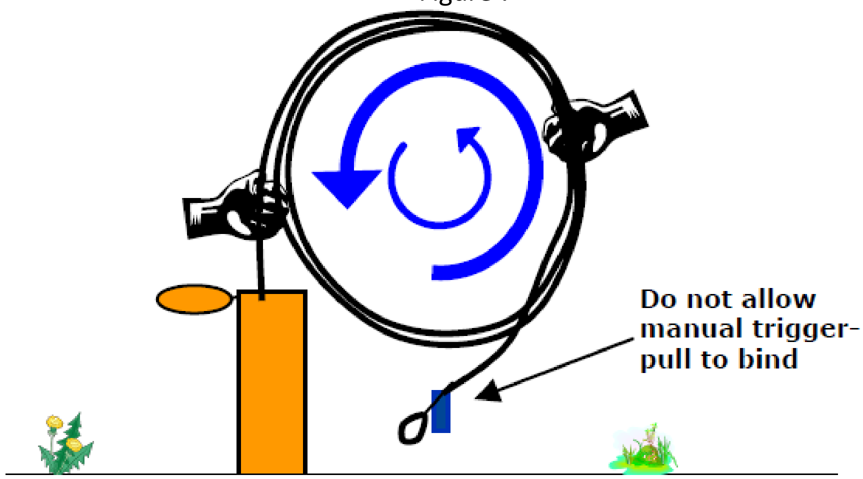
9) For pneumatic trigger, attach the wireline from the plunger (Figure 6).

Figure 6



10) Deploy the samplers to the depth with the trigger cable/tubing and attach to the well head docking station (Figure 7).

Figure 7



11) Additional Snap Samplers can be deployed in series with the single trigger.
12) The Snap Samplers can be deployed for extended periods. No upper bound for sampler deployment has been found.

2. Sample Collection

When deployment is completed, the Snap Sampler bottles will set in the well for a minimum of 2-weeks to equilibrate with the groundwater flow into the well. To collect the sample, the manual or pneumatic trigger at the wellhead is activated. The sample bottles are then retrieved to the surface. Loosen the retainer screw and turn the connector piece to free the sample bottles. The bottom connector piece does not need to be disassembled to remove the bottles.

The water in the Snap Samplers will be field filter as necessary to fill the laboratory prepared sample bottles. The water samples will be filtered through an in-line 0.45 micron filter that is connected to a peristaltic pump with ¼-inch diameter polyethylene tubing. The required filtered sample bottles will be filled at the wellhead. Water from one of the Snap Sample bottles will remain unfiltered and used to measure field parameters Dissolved Oxygen (DO), specific conductance (SC), pH, temperature and turbidity.

The sample ID, sample date and time, required analyses and sample volume are all recorded on the Groundwater Sample Log Form B. Fill out the removable adhesive label according to SOP 4 and attach to the laboratory supplied sample bottles. Fill out the chain-of-custody according to SOP 4, place each bottle in a pre-labeled zip-lock baggie, place the bottles in the shipping cooler and place the chain-of-custody form in a waterproof plastic bag taped to the inside lid of the shipping cooler.

Any water from the Snap Samplers not used for laboratory analyses can be discharged to the ground surface. Clean the Snap Sampler bottles according to SOP 3 and reattach the Snap Sampler bottles to the wireline and redeployed back into the well for the next quarterly sampling event. This procedure significantly reduces the labor and equipment required to collect quarterly groundwater samples.

Low Flow Purge

This SOP provides a description of field procedures related to collection of groundwater samples using the low flow purge method (USEPA, 2017) with two exceptions. The well screen is not limited to 10 feet and field measurements of DO, specific conductance and pH are the primary parameters to stabilize.

1. Calibrate the field multi meter.
2. Calibration of pH meters shall be performed to pH standards (4, 7, or 10 standard units) bracketing the actual field measured value.
3. The specific conductivity meter shall be calibrated to one of three standards, 2,000, 6,000, or 10,000 micro Siemens per centimeter (mS/cm), whichever is closer to the field measured value.
4. Dissolved oxygen is calibrated using the barometric pressure method outlined by the manufacturer.
5. Turbidity calibration is performed using 2-point values of 3 and 7 NTUs.
6. Record the field calibration on the Groundwater Sample Form B.
7. The dedicated bladder pump is set at the pre-determined screen interval where inflow the well was determined using the Hydrophysical logging method.
8. Measurements of DO, SC, temperature, pH, will occur by way of probes that are installed in a clear flow through cell.
9. Turbidity measurements are collected from water diverted at a bypass valve installed before the flow through cell. The water samples for turbidity are collected in separate 25 mm x 60 mm round sample cells and analyzed using the HACH 2100Q turbidimeter.
10. The pumps flow rate will be set to an approximate flow rate of between 100-200 milliliters per minute (mL/min).
11. The flow rate will be adjusted for long pulses of water, so one pump cycle will deliver a minimum of 40 mL of water as recommended by USEPA (USEPA, 2017).
12. Purge groundwater from the monitoring well into a bucket to observe water color and clarity
13. Record the drawdown in the well, adjust the pump to maintain less than 0.3 feet of drawdown.
14. If the drawdown goes below 0.3 feet but then stabilizes, continue to purge the well until field parameters stabilize.
15. The final purge volume must be greater than the stabilized drawdown volume plus the pumps tubing volume. If the drawdown exceeds 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level and add the volume of water in the pump tubing. This combined total volume of water must be purged before sample collection.
16. Record DO, SC, pH, temperature and turbidity at a frequency of 5 minute intervals. Stabilization is considered to be achieved when three consecutive readings are within the following limits:
    - DO - 10% for values greater than 0.5 mg/L; if three DO values are less than 0.5 mg/L, consider the values stable;
    - Specific conductance 3%;
    - pH +- 0.2 unit;
    - Temperature +- 3%; and
    - Turbidity 10% for values greater than 5 NTU, if three turbidity values are less than 5 NTU consider the values stable.
17. There is some concern over the stabilization of turbidity based on previous sampling logs. If DO, pH and SC have stabilized but turbidity has not, and the drawdown in the well is surpassing the preferred distance of 0.3 feet, field personnel have the option to document the lack of stabilization of turbidity and stop the purge process based on the stabilization of DO, pH and SC.
18. Remove the tubing from the flow through cell and attach the discharge tubing to an in-line 0.45 micron filter. DO NOT SAMPLE FROM THE FLOW THROUGH CELL.
19. Collect all filtered samples directly into laboratory supplied sample container and add the

laboratory color coded preservative to the appropriate sample containers.

20. Collect all non-filtered samples directly into laboratory supplied sample container.
21. Record the sample information on the Groundwater Sample Form B and chain-of-custody.
22. Purge water in the bucket can be discharged to the ground surface.
23. Decontaminate the flow through cell according to procedures in SOP 3.

SOP 3
Decontamination

Decontamination of Sampling Equipment

Sampling equipment that comes in contact with surface water and groundwater will be decontaminated between each sample location by using a three bucket wash and rinse system. The procedure is as follows:

- Wash the equipment in bucket one using low-phosphate detergent and tap water,
- Triple rinse the equipment with tap water into bucket two, and
- Rinse the equipment with deionized/distilled water into bucket three.
- Allow the sampling equipment to air dry and then place equipment inside a clean, disposable protective case or bag before proceeding to the next sampling point.

The Snap Sampler bottles will be cleaned after each sampling event using a three bucket wash and rinse system. The procedure is as follows:

- Wash the bottles in bucket one that is only used for Snap Sampler bottles using low-phosphate detergent and tap water,
- Triple rinse the Snap Sampler bottles with tap water into bucket two, and
- Rinse the Snap Sampler bottles with deionized water into bucket three.

Immediately replace the Snap Samplers in the well by attaching to the wire line and lowering back down the well to the sampling interval. Do not let the Snap Samplers air dry.

Drilling Equipment

All down hole drilling equipment and associated tools will be pressure-washed between boreholes. Pipe racks or similar will be used to elevate the drilling equipment (e.g., rods and augers) during pressure washing. Wash water can be dispensed to the ground surface.

SOP 4
Sample Management and Chain-of-Custody

Introduction

This section describes sample handling and shipping documentation requirements to ensure the integrity of the samples collected and submitted to the laboratory for analysis, and to provide the laboratory with instructions for the analytical services required. The following general procedures are summarized in this section:

- Sample labeling,
- Sample packaging and shipping, and
- Chain-of-custody.

Sample Labeling

All sample containers will be labeled using waterproof ink with the following information on labels:
Client or project name,

- Sample identification number,
- Date and time of collection,
- Requested analysis, and
- Container type and type of preservation used.

All groundwater samples collected each day are to be documented in the Log Book, and on the Groundwater Sample Form A. Duplicate samples will be labeled with a "D" after the fictitious well ID, and recorded in the Log Book with the correct well ID from which it was collected.

Sample Packaging and Shipping

The following procedures apply to all groundwater samples packed for transport to the laboratory:

1. Place each glass sample bottle into an individual laboratory supplied bubble wrap bag. Plastic bottles do not need to be placed inside protective bubble wrap.
2. The bottles are then placed into a 1-liter sealable baggie and labeled on the outside of the baggie with the sample name, date, and sample time. This is performed to verify the sample during preparation of the chain of custody, and to assist the laboratory personnel at the log in procedure at the laboratory.
3. Place bubble wraps on the inside bottom of the cooler.
4. Line the cooler with a laboratory supplied 6-millimeter thick clear plastic bag (plastic bag) that extends above the cooler at least 18-inches so the bag can be sealed with a zip-tie strap.
5. Place the samples inside the plastic bag and pack the plastic bag with the contents of one bag of crushed ice. Spread the ice evenly over the entire contents of the plastic bag. Zip tie the plastic bag shut.
6. Place the completed chain of custody inside a 1-liter sealable baggie and tape the baggie to the inside lid of the cooler.
7. Remove any expired shipping label for the cooler. Place the laboratory supplied overnight priority shipping label on the cooler. Remove the copy receipt of the shipping label and attach it to the copy of the chain-of-custody that is inside the cooler.
8. Attach two signed custody seals over the cooler lid where it seals to the body of the cooler. Tape the cooler shut by wrapping shipping tape around the cooler lid and base and over the custody seals at least two layers thick.
9. Ship the coolers using Federal Express or United Parcel Service only from a distribution location

that is staffed by company personnel. No shipping cooler is ever to be left unattended at a drop location.

Chain-of-Custody

Chain-of-custody is a mechanism employed to ensure that data resulting from laboratory analysis are credible and defensible. Chain-of-custody begins at the time and point of sample collection. Documentation of sample possession and chain-of-custody is provided by the use of sample labels and chain-of-custody forms.

The chain-of-custody record will be initiated in the field and will accompany samples during shipment to the laboratory. The chain-of-custody record allows transfer of custody of a sample or group of samples in the field to any laboratory. Information listed on the chain-of-custody includes:

1. Sample Identification;
2. Project name, location, and number;
3. Sampling dates and times;
4. Name of sampling technician(s);
5. Media being tested for each sample;
6. Number of containers per sample;
7. Signature of person relinquishing and receiving custody;
8. Requested analyses for each sample; and
9. Special requirements/comments for project or analysis.

The sampler relinquishing the samples will keep one copy of the chain-of-custody forms and send the original and remaining copies with the samples. The chain-of-custody form shall be sealed in a waterproof plastic bag and placed inside the shipping container.

SOP 5
Surface Water Flow and Sampling Procedures

Introduction

The collection of samples from the Sevier River will start at the downstream-most location and progress upstream. The river conditions and field parameters will be logged on the Surface Water Sample Form C in Attachment E. Flow measurements within the channel will likely mobilize sediments and cause disturbances in the water; therefore, river water quality samples will be collected before flow measurements.

Surface Water Sampling

Sample bottles will be transported to the river edge in a sample caddy and remain sealed until the water sample is collected. Depending on site conditions, samples will be collected by use of a sampling pole or by wading into the river. The samples will be collected upstream of the sampling pole location or wading personnel to avoid disturbance of the sampled water. Samples will be collected directly into sample bottles to which no preservatives have been added. In this case, the sample collection bottle will be rinsed a minimum of three times with river water before collecting the sample.

Sample bottles that contain an added preservative will be filled from a rinsed bottle that does not contain a preservative, thereby avoiding the loss of the preservative. These bottles will be filled at least to the neck of the bottle, but not overflowing, before capping.

1. Sample collection bottles will be immersed mouth down below the water surface to approximately one-third the depth of the stream flow if the flow depth is sufficient.
2. With the lid removed, the bottle will be pulled up through the water column at a rate that would fill the bottle from a vertical section of the stream, the purpose being be to collect water from different depths in the stream. If the flow depth is insufficient to submerge the bottle, care will be taken to avoid the introduction of bottom sediment into the sample during near surface water collection.
3. The sample cap will then be replaced and the sample bottle placed in the sample caddy. The sample caddy will be carried away from the river for sample preparation and labeling.
4. Samples requiring analyses of dissolved constituents (as noted in Table 3-1) will be field filtered by transferring the sample to the laboratory supplied containers using a peristaltic pump. The field collected sample will be pumped through ¼-inch diameter polyethylene tubing through an in-line 0.45-micron filter into the laboratory supplied sample containers. When transferring samples, care will be taken not to touch the filter to the sample container.
5. Laboratory supplied color coded preservative (color on preservative matches color label on sample container) will be added to the appropriate containers.
6. Field parameters for dissolved oxygen (DO), specific conductance (SC), pH, temperature and turbidity will be measured in the field. Rinse a 100 ml wide mouth sample bottle at least three times from the water being sampled. Fill a 100 ml sample bottle approximately ½ full and place the DO, SC, temperature and pH probes in the sample bottle.
7. Collect a second 100 ml aliquot of the surface water using the same procedure as described in #6 above to measure turbidity. Transfer the aliquot into the 25 mm x 60 mm round turbidity sample bottle and place in the turbidity meter for measurement.
8. Label the surface water samples, complete the chain-of-custody form, and pack the samples for shipment to the laboratory following the procedures in SOP 4.

Surface Water Flow

Streamflow measurements will be collected using a current meter or other appropriate method approved by the U.S. Geological Survey (Buchanan and Somers, 1969). Once sufficient data are available, rating curves will be developed for each channel location, thereby allowing stage-gauge readings to provide future estimates of flow based on the rating curve. Flow and cross-section data will be collected at least quarterly and more frequently (i.e., monthly) if possible during those periods when flow stage varies between high and low to aid in developing a more accurate rating curve for each stream station. the general procedures are as follows:

1. Install a 10 PSI absolute pressure PT at each surface-water sample location shown on Figure 4-1.
2. Install a vertical T- post in the center of the river channel during a time when the river is dry.
3. Secure a staff gauge with visible one-tenth foot markers and at least five feet total markings on the T- post. The 0-foot depth corresponds to the bottom of the river bed.
4. Place the PT inside a section of vertical PVC casing secured to the T-post and staff gage.
5. The transducers will be programmed to collect water levels at a minimum of twice per day.
6. The correction for atmospheric changes on the ground surface will be accomplished using a Barologger. The general rule is to use one Barologger for an area that has a radius of 20 miles. One Barologger will be placed near Amasa well and used for the PTs installed on the north half of the playa. A second Barologger will be installed at Monument Point well and used for PTs installed on the south half of the playa.
7. During quarterly monitoring, recorded the river depth from the staff gauge at each station and download the data from the PT installed inside the 2-inch pipe attached to the T-post.
8. Record the data on the Surface Water Sample Form C in Attachment E.
9. Download the barometric pressure data from the Barologger stations quarterly when collecting surface water and groundwater samples.
10. Correct the PT level readings for barometric pressure changes and compare with the manual stage readings to ensure appropriate correlation.

The pressure transducer readings and staff gauge heights described above will be used to develop rating curves. These curves will be used to estimate the river flow without having to physically measure the channel area and flow velocity at the time of each stage reading. The rating curves will be developed from a log-log plot of stage and discharge data (Kennedy, 1984), which generates a straight-line equation in the following form:

$$Q=P(G-e)^{b}$$

Where: Q is discharge (cfs) from
P is the intercept equal to Q when (G-e) is equal to 1.0
G is the river stage (feet)
e is a constant that when subtracted from G, will result in a straight line on log-log plot of Q vs. (G-e); the default value is zero and is adjusted if initial log-log plot shows curvature
b is the slope of linear trend line on log-log plot

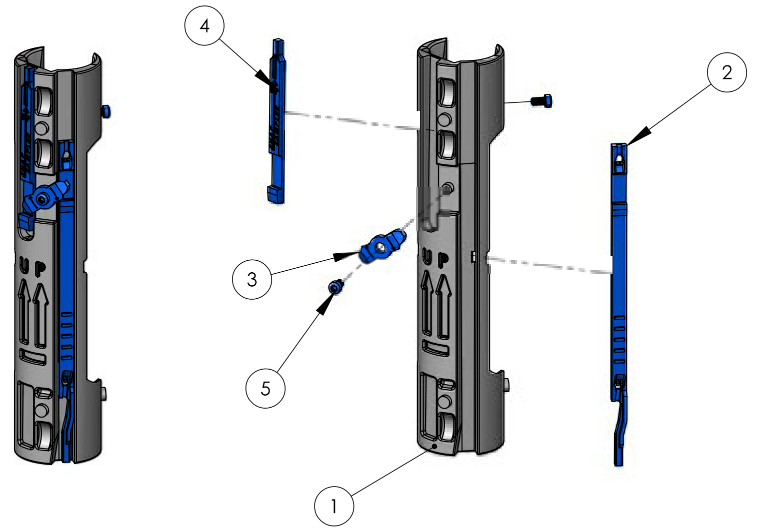
The pressure transducer data will be used with the rating curves to produce a relatively daily flow record at both gauging stations for duration of the Project.

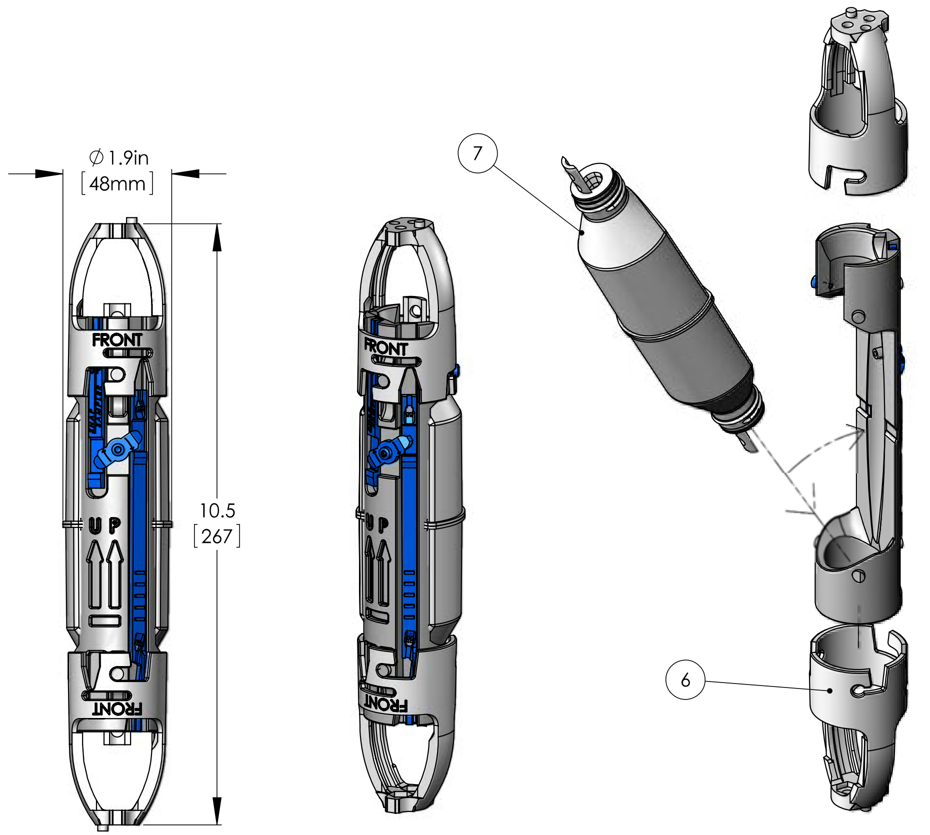
APPENDIX D

FIELD EQUIPMENT SPECIFICATIONS

(Included as Attachments to the PDF Document)

ITEM NO.	DESCRIPTION	STACKED/QTY.
1	125mL/350mL SAMPLER BODY	1
2	LOWER RELEASE PIN (LONG)	1
3	RELEASE PIN LEVER	1
4	UPPER RELEASE PIN	1
5	4-40 SCREW (PLASTIC)	2
6	TWIST-ON CONNECTOR	2
7	125mL BOTTLE	1





UNLESS OTHERWISE SPECIFIED:		NAME	DATE
DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 1/16 ANGULAR: 1° TWO PLACE DECIMAL ± 0.01 THREE PLACE DECIMAL ± 0.005	DRAWN	MAB	01/02/13
	CHECKED		
	ENG APPR.		
INTERPRET GEOMETRIC TOLERANCING PER: ASME Y14.5-2009	MFG APPR.		
	Q.A.		
MATERIAL	COMMENTS: 1in [25.4mm]		
FINISH			
DO NOT SCALE DRAWING			

ProHydro, Inc.

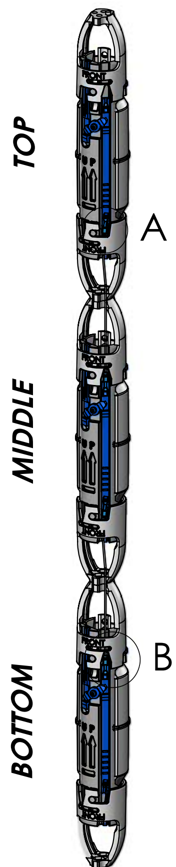
MADE IN THE USA | 585-385-0023 | www.prohydro.com

TITLE: 125mL SNAP SAMPLER

SIZE: B | PART NO.: | REV:

SCALE: 1:2 | WEIGHT: | SHEET 1 OF 2

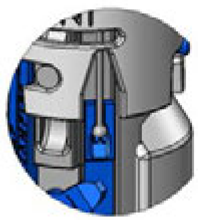
ITEM NO.	DESCRIPTION	QTY.
1	BALL END CONNECTOR (PLASTIC)	2
2	BALL END CONNECTOR (S.S.)	2
3	125mL SNAP SAMPLER	3
4	SCREW (PLASTIC)	4
5	HEX NUT (PLASTIC)	4



DETAIL A
PLASTIC CONNECTOR
CABLE INSERTION

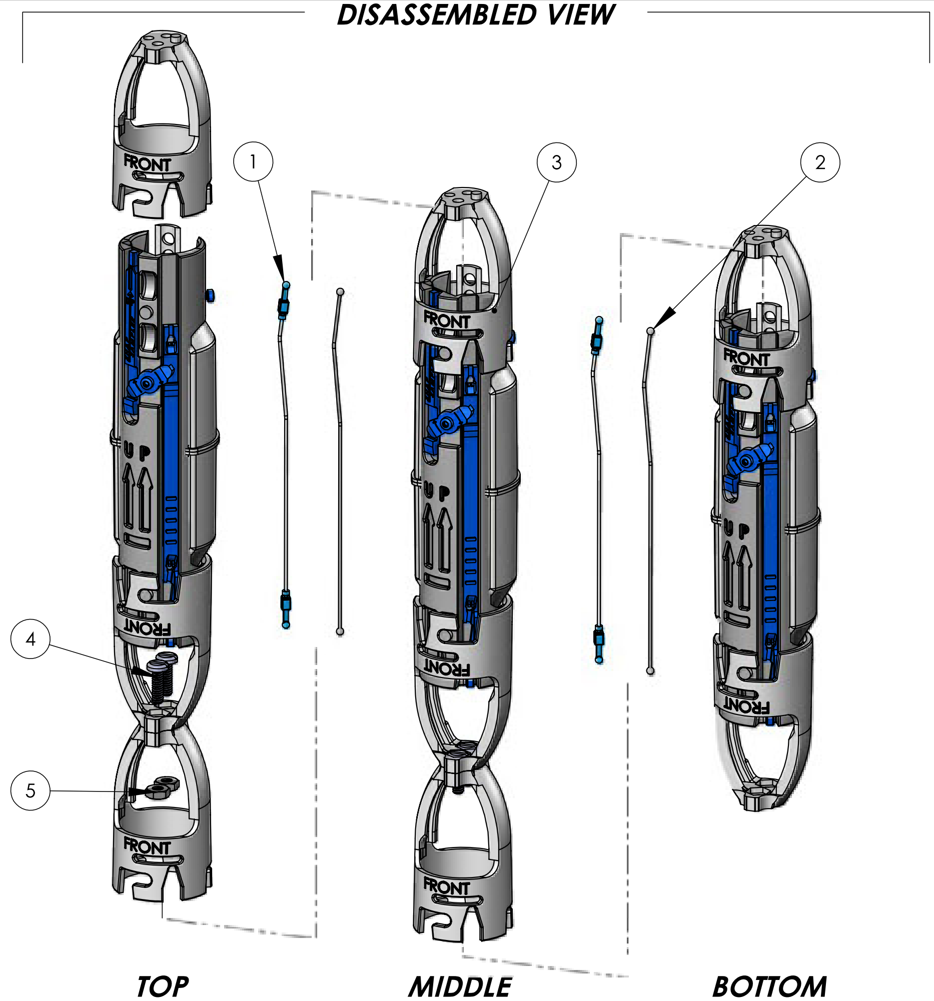
DETAIL A'
S.S. CONNECTOR
CABLE INSERTION

DETAIL B
PLASTIC CONNECTOR
CABLE INSERTION



DETAIL B'
S.S. CONNECTOR
CABLE INSERTION

DISASSEMBLED VIEW



NOTE:
- 40mL AND 125mL SNAP SAMPLERS ARE INTERCHANGEABLE AND CAN BE ASSEMBLED IN ANY COMBINATION UP TO 6 IN SERIES.
- EITHER CABLE CONNECTOR(S) (PLASTIC OR STAINLESS STEEL) CAN BE USED

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/16
ANGULAR: 1°
TWO PLACE DECIMAL ± 0.01
THREE PLACE DECIMAL ± 0.005
INTERPRET GEOMETRIC TOLERANCING PER:
ASME Y14.5-2009
MATERIAL
FINISH
DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	MAB	01/02/13
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
1in
[25.4mm]

ProHydro, Inc.
MADE IN THE USA | 585-385-0023 | www.prohydro.com

TITLE: 125mL SNAP SAMPLER

SIZE B | PART NO. | REV

SCALE: 1:2 | WEIGHT: | SHEET 2 OF 2

GO TO GEOTEC

geotech

Bladder Pump Controller

Geotech BP Controller 300/500 PSI

The simple-to-use Bladder Pump (BP) Controller (300 or 500 PSI) utilizes accurate microprocessor-controlled fill/discharge timers to sustain true low-flow sampling techniques. Both Controllers are equipped with high-pressure valves and fine resolution regulators that can perform in deep-well applications.

The Geotech BP Controller universally connects to any bladder pump system using simple quick-connect adapters.

FEATURES

- **Designed for durable, trouble-free operation**
- **High pressure operation for greater depths**
- **Multiple power input options**
- **Microprocessor controlled timers for accuracy**
- **Internal over-pressure protection**
- **Battery over-draw protection**
- **Water Level Meter compatibility for well draw-down**
- **Intuitive user controls and status indicator**
- **Accessories cavity for easy portability**
- **Included:** Air-In and Air-Out Hoses, AC Power Supply, DC Power Cord and Clip Adapter, Geotech Drawstring Bag, Carry Case

BP Controller 300 PSI with optional draw-down control for low-flow sampling

Geotech BP Controller 500 PSI

Geotech BP Controller 300 PSI

SPECIFICATIONS

	300 PSI	500 PSI
Performance		
Operating Depth	0-690 feet (210 m)	0 -1000 feet (0-305 m)
Input Air Pressure	Up to 300 psi (20.5 bar)	100 to 500 psi (34 bar)
FILL Timer Range	5 - 120 seconds	5 - 180 seconds
DISCHARGE Timer Range	5 - 120 seconds	5 - 180 seconds
Timer Resolution	2 seconds	2 seconds
Timer Accuracy	±2 seconds	±3 seconds
12V 8Ah Battery Life	1,300 cycles @ 30 sec. timers	50,000 cycles
Internal Battery/Life	External only	(2x) 9V/30,000 cycles
Environmental		
Operating Temperature	32°-158°F (0°-70°C)	32°-158°F (0°-70°C)
Storage Temperature	-40°-185°F (-20°-85°C)	-40°-185°F (-20°-85°C)
Physical		
Enclosure	7" x 16" x 12" (18 x 41 x 30.5 cm)	7" x 19" x 14" (18 x 48 x 35 cm)
Weight	15 lbs. (6.8 kg)	25 lbs. (11.4 kg)
Enclosure Material	Structural resin	Structural resin
Input Power		
External Battery	10.5-13.8V DC	10.5-26V DC
AC	90-240V AC*	90-240V AC*
Line Frequency	45-65 Hz	45-65 Hz
Maximum Power	15 Watts	15 Watts pulse for 50mS

*International AC Power Plug Adapters available (UK, AUS, EURO)

CE

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Levelogger® Edge

Model 3001

The Levelogger Edge records highly accurate groundwater and surface water level and temperature measurements. It combines a pressure sensor, temperature detector, 10-year lithium battery, and datalogger, sealed within a 7/8" x 6.25" (22 mm x 159 mm) stainless steel housing with Titanium based PVD coating.

The Levelogger Edge measures absolute pressure using a Hastelloy pressure sensor, offering excellent durability and reliability. Combined with the Titanium based PVD coating, both elements have high corrosion resistance in harsh environments, allowing stable readings in extreme pressure and temperature conditions. The Hastelloy sensor can withstand 2 times over-pressure without permanent damage.

The Levelogger Edge features a wide temperature compensated pressure range (0 to 50°C, -10 to 50°C for Barologger Edge), and rapid thermal response time. The Levelogger Edge has high resolution and an accuracy of 0.05% FS. The convenient Barologger Edge provides the easiest and most accurate method of barometric compensation.

Get Quote | More Info

Applications

- Aquifer characterization: pumping tests, slug tests, etc.
- Watershed, drainage basin and recharge monitoring
- Stream gauging, lake and reservoir management
- Harbour and tidal fluctuation measurement
- Wetlands and stormwater run-off monitoring
- Water supply and tank level measurement
- Mine water and landfill leachate management
- Long-term water level monitoring in wells, surface water bodies and seawater environments

Fast communication and downloading speeds with a high speed Optical Reader

Features

- 0.05% FS Accuracy
- Corrosion resistant Titanium based PVD coating
- Robust Hastelloy pressure sensor
- Accurate temperature compensation
- Memory for up to 120,000 readings
- Basic and advanced data compensation options

The Levelogger Edge has a battery life of 10 years based on a 1-minute sampling rate. It has FRAM memory for 40,000 sets of data points – or up to 120,000 using the compressed linear sampling option.

The Levelogger Edge uses a Faraday cage design, which protects against power surges or electrical spikes caused by lightning. Its durable maintenance-free design, high accuracy and stability, make the Levelogger Edge the most reliable instrument for long-term, continuous water level recording.

Flexible Communication

Levelogger PC Software is streamlined, making it easy to program dataloggers, and to view and compensate data, in the office or in the field. The software has useful programming options, including compressed and repeat sampling, and future start/stop. Data compensation has been simplified, and allows multiple data files to be barometrically compensated at once.

The extremely intuitive Solinst Levelogger App, and Levelogger App Interface on your in-field Leveloggers, creates a Bluetooth® connection between your Leveloggers and smart device. Also an option, the DataGrabber is a field-ready, USB data transfer unit designed specifically for the Levelogger Series.

Remote monitoring options include the LevelSender, a simple and compact device that fits right in a 2" well, STS Telemetry Systems, and RRL Remote Radio Link. In addition, Levelogger Series dataloggers are SDI-12 compatible.

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® Hastelloy is a registered trademark of Haynes International Inc.

Levelogger Setup

Programming Leveloggers is extremely intuitive. Simply connect to a PC using an Optical Reader or PC Interface Cable. All in one screen fill in your project information and sampling regime. Templates of settings can be saved for easy re-use.

The Levelogger time may be synchronized to the computer clock. There are options for immediate start or future start and stop times. The percentage battery life remaining and the amount of free memory are indicated on the settings screen.

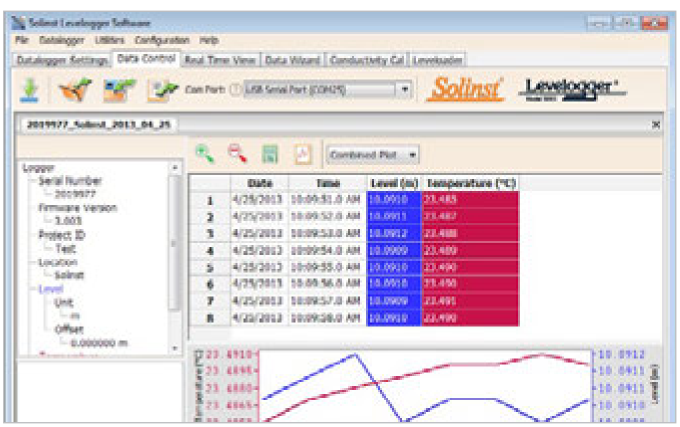
Leveloggers can also be programmed with a sampling regime and start/stop times using the Solinst Levelogger App on your smart device.

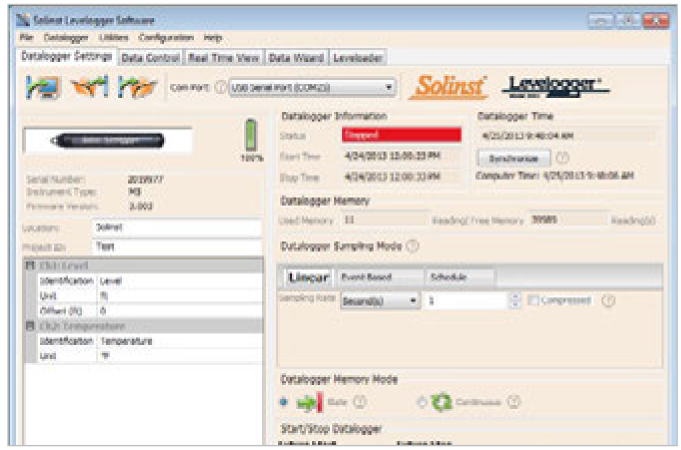
Convenient Sampling Options

Leveloggers can be programmed with linear, event-based, or a user-selectable sampling schedule. Linear sampling can be set from 1/8 second to 99 hours. The Levelogger Edge can be programmed with compressed linear sampling, which increases memory from 40,000 to up to 120,000 readings.

Event-based sampling can be set to record when the level changes by a selected threshold. Readings are checked at the selected time interval, but only recorded in memory if the condition has been met. A default reading is taken every 24 hours if no "event" occurs.

The Schedule option allows up to 30 schedule items, each with its own sampling rate and duration. For convenience, there is an option to automatically repeat the schedule.





Levelogger Edge Settings Software Windows

Data Download, Viewing and Export

Data is downloaded to a PC with the click of a screen icon. There are multiple options for downloading data, including 'Append Data' and 'All Data'. The software also allows immediate viewing of the data in graph or table format using the 'Real Time View' tab.

The level data is automatically compensated for temperature, and the temperature data is also downloaded. Barometric compensation of Levelogger data is performed using the Data Wizard, which can also be used to input manual data adjustments, elevation, offsets, density, and adjust for Barometric efficiency.

The software allows easy export of the data into a spreadsheet or database for further processing.

The Solinst Levelogger App also allows you to view and save real-time, or logged data right on your smart device.

Helpful Utilities

The 'Self-Test Diagnostic Utility' can be used in case of an unexpected problem. It checks the functioning of the program, calibration, backup and logging memories, the pressure transducer, temperature sensor and battery voltage, as well as enabling a complete Memory Dump, if required.

A firmware upgrade will be available from time to time, to allow upgrading of the Levelogger Edge, as new features are added.

Solinst Levelogger App & Levelogger App Interface

The Levelogger App Interface uses Bluetooth® technology to connect your Levelogger to your smart device. With the Solinst Levelogger App, you can download data, view real-time data, and program your Leveloggers. Data can be e-mailed from your smart device directly to your office (see Model 3001 Levelogger App & Interface data sheets).

Download on the App Store

GET IT ON Google play

Standard Cable Deployment

Leveloggers may be suspended on a stainless steel wireline or Kevlar® cord. This is a very inexpensive method of deployment, and if in a well, allows the Levelogger to be easily locked out of sight and inaccessible. Solinst offers stainless steel wireline assemblies and Kevlar cord assemblies in a variety of lengths.

Solinst 3001 Well Cap Assembly

The 2" Locking Well Caps are designed for both standard and Direct Read Cable deployment options.

The well cap has a convenient eyelet for suspending Leveloggers using wireline or Kevlar cord. The Well Cap insert has two openings to accommodate Direct Read Cables for both a Levelogger and Barologger. Adaptors are available to fit 4" wells.

The cap is vented to equalize atmospheric pressure in the well. It slips over the casing, and the cap can be secured using a lock with a 3/8" (9.5 mm) shackle diameter.

Levelogger 2" Locking Well Cap Installations (see Well Caps data sheet for more details)

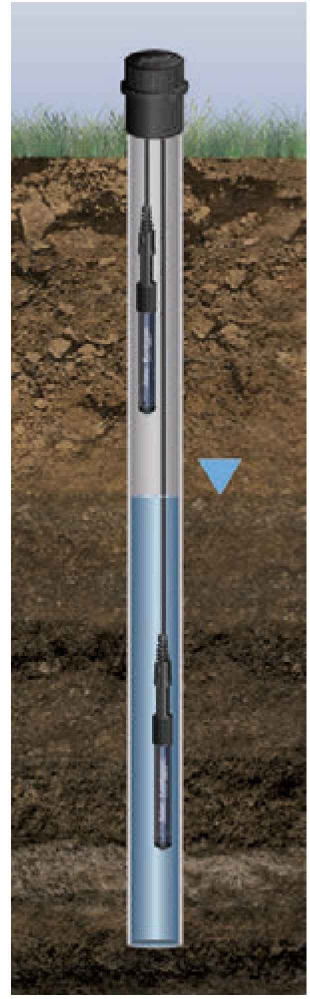
Direct Read Cables

When it is desired to get real-time data and communicate with Leveloggers without removal from the water, they can be deployed using Direct Read Cables. This allows viewing of the data, downloading and/or programming in the field using a portable computer, DataGrabber, or the Solinst Levelogger App and Interface.

Leveloggers can also be connected to an SDI-12 datalogger using the Solinst SDI-12 Interface Cable attached to a Direct Read Cable.

Cable Specifications

Direct Read Cables are available for attachment to any Levelogger in lengths up to 1500 ft. The 1/8" dia. (3.175 mm) coaxial cable has an outer polyethylene (MDPE) jacket for strength and durability. The stranded stainless steel conductor gives non-stretch accuracy.



Barologger and Levelogger installed in Well Using Direct Read Cables

Accurate Barometric Compensation

The Levelogger Edge measures absolute pressure (water pressure + atmospheric pressure) expressed in feet, meters, centimeters, psi, kPa, or bar.

The most accurate method of obtaining changes in water level is to compensate for atmospheric pressure fluctuations using a Barologger Edge, avoiding time lag in the compensation.

The Barologger is set above high water level in one location on site. One Barologger can be used to compensate all Leveloggers in a 20 mile (30 km) radius and/or with every 1000 ft. (300 m) change in elevation.

The Levelogger Software Data Compensation Wizard automatically produces compensated data files using the synchronized data files from the Barologger and Leveloggers on site.

The Barologger Edge uses pressure algorithms based on air rather than water pressure, giving superior accuracy.

The recorded barometric information can also be very useful to help determine barometric lag and/or barometric efficiency of the monitored aquifer.

The Barologger Edge records atmospheric pressure in psi, kPa, or mbar. When compensating submerged Levelogger Edge, Gold or Junior data, Levelogger Software Version 4 can recognize the type of Levelogger and compensate using the same units found in the submerged data file (Levelogger Gold and Junior measure in feet, meters, or centimeters). This makes the Barologger Edge backwards compatible.

Synchronize & Streamline Your Barometric Compensation Efforts, Across Your Entire Site

® Kevlar is a registered trademark of DuPont Corp.

Levelogger Edge Specifications

Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Accuracy:	± 0.05% FS (Barologger Edge: ± 0.05 kPa)
Stability of Readings:	Superior, low noise
Units of Measure:	m, cm, ft., psi, kPa, bar, ºC. ºF (Barologger Edge: psi, kPa, mbar, ºC, ºF)
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	0º to 50ºC (Barologger Edge: -10 to +50ºC)
Temperature Sensor:	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05ºC
Temp. Sensor Resolution:	0.003°C
Battery Life:	10 Years - based on 1 reading/minute
Clock Accuracy:	± 1 minute/year (-20ºC to 80ºC)
Operating Temperature:	-20ºC to 80ºC
Maximum # Readings:	40,000 readings FRAM memory, or up to 120,000 using linear data compression
Memory Mode:	Slate and Continuous
Communication:	Optical Infrared Interface. Conversion to RS-232, USB, SDI-12. Serial at 9600 bps, 38,400 bps with USB
Size:	7/8" x 6.25" (22 mm x 159 mm)
Weight:	4.6 oz. (129 grams)
Corrosion Resistance:	Titanium based PVD coating
Other Wetted Materials:	Delrin®, Viton®, 316L stainless steel, Hastelloy, Titanium based PVD coating
Sampling Modes:	Linear, Event & User-Selectable with Repeat Mode, Future Start, Future Stop, Real-Time View
Measurement Rates:	1/8 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km radius)

Models	Full Scale (FS)	Accuracy
Barologger	Air only	± 0.05 kPa
M5	5 m (16.4 ft.)	± 0.3 cm (0.010 ft.)
M10	10 m (32.8 ft.)	± 0.5 cm (0.016 ft.)
M20	20 m (65.6 ft.)	± 1 cm (0.032 ft.)
M30	30 m (98.4 ft.)	± 1.5 cm (0.064 ft.)
M100	100 m (328.1 ft.)	± 5 cm (0.164 ft.)
M200	200 m (656.2 ft.)	± 10 cm (0.328 ft.)

Low Cost Datalogging: See Levelogger Junior Edge Data Sheet.
Vented Dataloggers: See LevelVent and AquaVent Data Sheets.
Conductivity Datalogging: See LTC Levelogger Edge Data Sheet

DataGrabber™

The DataGrabber is a field-ready data transfer device that allows you to copy data from a Levelogger, onto a USB flash drive key.

The DataGrabber is compact and very easy to transport. It connects to the top end of a Levelogger's Direct Read Cable, or an Adaptor is available to allow direct connection to a Levelogger.

One push-button is used to download all of the data in a Levelogger's memory to a USB device plugged into the DataGrabber. A convenient LED light indicates the operation of the DataGrabber. The data in the Levelogger memory is not erased, and logging is not interrupted if the Levelogger is still running. The DataGrabber uses its own replaceable 9V battery.

LevelSender Telemetry

The LevelSender is a simple, low cost telemetry system designed to send data from Leveloggers in the field, to your smart device and PC database via cellular communication.

Initial set up is done through a user-friendly software wizard at the Home Station. There is two-way communication between the LevelSender and Home Station, allowing remote updates.

Each LevelSender device has a single port to connect one Levelogger with an optional splitter that allows the connection of a Barologger.

LevelSender stations are compact in design, which allows them to be discreetly installed inside a 2" (50 mm) well (see Model 9500 data sheet).

STS Telemetry

The STS Telemetry System provides an efficient method to send Levelogger data from the field to your desktop. Cellular communication options give the flexibility to suit any project. STS Systems are designed to save costs by enabling the self-management of data. Alarm notification, remote firmware upgrades and diagnostic reporting make system maintenance simple (see Model 9100/9200 data sheet).

RRL Telemetry

The RRL Remote Radio Link is ideal for short range applications up to 20 miles or 30 km; distances can be increased by using radios as relay stations. Ideal for creating closed-loop monitoring networks using Leveloggers (see Model 9100/9200 data sheet).

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™DataGrabber is a trademark of Solinst Canada Ltd.

For further information contact: Solinst Canada Ltd.
Fax: +1 (905) 873-1992; (800) 516-9081 Tel: +1 (905) 873-2255; (800) 661-2023
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Overview

Includes flowcell, 3/8 inch and 1/4 inch fittings, lubricant and instructions.

Specifications

Video

Application Notes

Brochures and Catalogs

Manuals

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geotech

Bladder Pumps, Groundwater Sampling

Geotech Bladder Pumps

Together with the USGS, Geotech designed the original bladder pump for groundwater quality and pollution monitoring. Geotech Bladder Pumps can pump from as deep as 1000 feet (305 meters) with minimal agitation for the best representative samples.

FEATURES

- **True low flow capability for less agitation**
- **Proprietary resin grade virgin PTFE bladder for long life**
- **Constructed of #316 SS for durability**
- **Dedicated or portable turnkey systems**
- **Robust screened intake extends bladder life**
- **Optional Drop-Tube assembly available for sampling from greater depths**
- **Limited lifetime warranty on dedicated stainless steel systems**
- **Compatible with the Geocontrol PRO and BP Controller units**

BLADDER PUMP MODELS

A. 1.66, 36" (4 cm, 91 cm)
Made from SS for maximum durability. Highest volume rate for a low flow pump. For 2" (5 cm) wells or larger. Available in High Pressure and Low Pressure models to meet site specic requirements.

B. 1.66, 18" (4 cm, 46 cm)
The same as above but for lower pump volume requirements.

C. .850, 18" (2.2 cm, 46 cm)
Made from high-grade SS for maximum durability.
Extra slim design provides excellent performance for its size.

D. .675, 18" (1.7 cm, 46 cm)
Our smallest bladder pump, fits in any well .75" (1.9 cm) or larger. Made with the same polished stainless steel as our other top-of-the-line pumps.

SPECIFICATIONS

	1.66, 36"	1.66, 18"	.850, 18"	.675, 18"
Pump Housing	316 SS	316 SS	316 SS	316 SS
Bladder Material	Virgin PTFE	Virgin PTFE	Virgin PTFE	Virgin PTFE
O.D.	1.66" (4.2 cm)	1.66" (4.2 cm)	.850" (2.2 cm)	.675" (1.7 cm)
Length w/Screen	38" (96.5 cm)	20" (51 cm)	18 5/8" (47.3 cm)	18 3/4" (47.6 cm)
Weight	5.5 lbs. (2.5 kg)	3.5 lbs. (1.6 kg)	1.1 lbs. (.5 kg)	.83 lbs. (.4 kg)
Volume / Cycle	22 oz. (650 ml)	11 oz. (325 ml)	.9 oz. (29 ml)	.5 oz. (15 ml)
Min. Well I.D.	2" (50 mm)	2" (50 mm)	1.00" (2.5 mm)	.75" (1.9 mm)
Operating Pressure				
Low Pressure BP:	10-125 psi (.7-8.6 bar)	10-125 psi (.7-8.6 bar)	100 psi (6.9 bar)	100 psi (6.9 bar)
High Pressure BP:	10-500 psi (.7-34 bar)	10-500 psi (.7-34 bar)	N/A	N/A
Min. Operating Pressure	5 psi (.34 bar) ash*	5 psi (.34 bar) ash*	5 psi (.3 bar) ash*	5 psi (.3 bar) ash*
Maximum Depth				
Low Pressure BP:	290' (88 m)	290' (88 m)	200' (61 m)	200' (61 m)
High Pressure BP:	1000' (305 m)	1000' (305 m)	N/A	N/A
Air Line (ID x OD)				
Low Pressure BP:	.17" x .25" (4 mm x 6 mm)	.17" x .25" (4 mm x 6 mm)	.17" x .25" (4 mm x 6 mm)	.17" x .25" (4 mm x 6 mm)
High Pressure BP:	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)	N/A	N/A
Discharge Line (ID x OD)	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)	.25" x .375" (6 mm x 10 mm)

*ash = above static head

A. B. C. D.

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BP Controller 300 PSI

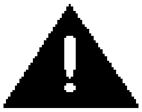
Installation and Operation Manual

Rev 1/21/2017 Part # 11150362

Table of Contents

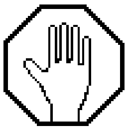
DOCUMENTATION CONVENTIONS

This document uses the following conventions to present information:



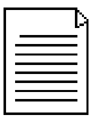
WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.



CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.

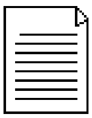


NOTE

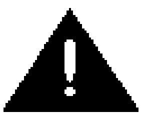
A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

In order to ensure that your Controller has a long service life and operates properly, adhere to the cautions below and read this manual before use.

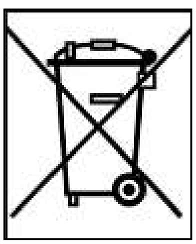
- Disconnect from power source when not in use.
- Controller power input source must not exceed maximum ratings.
- Controller must be wired to a negative ground system.
- Controller may not operate properly with excess wiring not supplied by manufacturer.
- Avoid spraying fluid directly at controller.
- Never submerge controller.
- Avoid pulling on wires to unplug controller wiring.
- Avoid using controller with obvious physical damage.
- To prevent controller damage, avoid dropping controller.



The BP Controller 300PSI cannot be made dangerous or unsafe because of failure due to EMC interference.



Do not operate this equipment if it has visible signs of significant physical damage other than normal wear and tear.



Notice for consumers in Europe:
This symbol indicates that this product is to be collected separately.

The following apply only to users in European countries:

- This product is designated for separate collection at an appropriate collection point. Do not dispose of as household waste.

For more information, contact the seller or the local authorities in charge of waste management.

Section 1: System Description

Function and Theory

The Bladder Pump (BP) Controller 300 PSI is a high-pressure pump controller that uses advanced electronic logic to control gentle low-flow sampling. Equipped with a high-pressure solenoid activated valve and self-relieving regulator, the BP Controller can purge depths down to 690’ (210m).

This controller connects to any Bladder Pump (BP) system with the use of simple push-to-connect hose adapters. The two timers are adjusted to set the amount of time that the pump pressurizes (discharge cycle) and depressurizes (fill cycle). During the discharge cycle, the pump pressurizes squeezes the bladder, forcing the sample through the center discharge line. During the fill cycle, the compressed pump now exhausts through the controller vent allowing the pump to fill again, hydrostatically.

A user-friendly interface visually communicates operating status of the controller, as well as informing the user of low battery conditions. The BP Controller is compatible with Water Level Meter equipment by connecting a drawdown cable.

System Components

The control panel is mounted inside a heavy-duty case for ease of mobility and long-term durability. Accessories for the BP Controller consist of high-pressure AIR IN (from supply) and AIR OUT (to pump) hoses, and an AC and DC Power Cord.

<u>Air Connections</u>

The couplings on the AIR IN and AIR OUT Hose Assembilies are Push-to-Connect fittings; press the socket onto the plug until a ‘click’ is heard. It should be a secure fit which can not be pulled off when tugged. To remove the coupling, push down on the socket’s jacket and the connection will ‘pop’ out (see Figure 1-1).

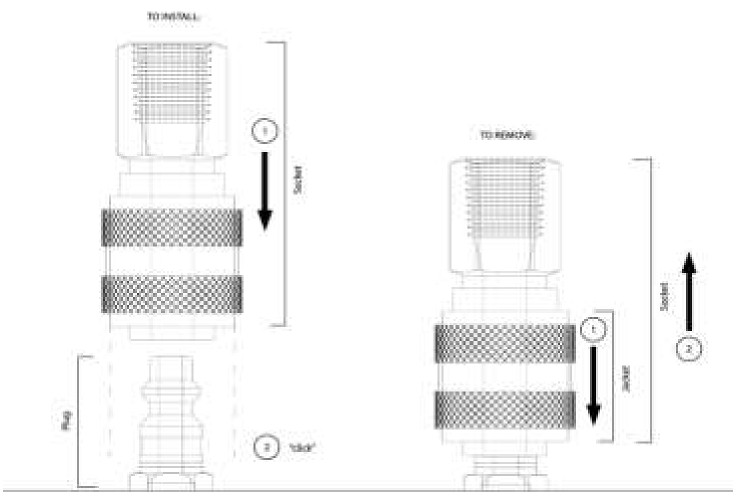
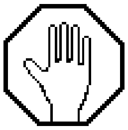


Figure 1-1: Push-to-Connect fitting

Section 2: System Installation



The BP Controller requires dry, moisture free air.
Disregarding this caution can increase the likelihood of unnecessary maintenance.

Power Source

Determine your power source, either 115 VAC or 12 VDC. Power connects are on the side of the control panel.

If using Water Level Meter Equipment, connect a drawdown cable to the ‘AUX INPUT’.

Selecting an Air Source

Air consumption depends on the volume of tubing and the size of deployed Bladder Pump. Follow the general guidelines and examples below to calculate the air consumption for specific sampling configurations.

Volume of Tubing

	TUBING LENGTH				
TUBE I.D.	1 ft./ 0.3 m	10 ft./ 3 m	50 ft./ 15 m	100 ft./ 30 m	690 ft./ 210 m
0.17 in/ 0.43 cm	0.3 in^3/ 5 cm^3	3 in^3/ 50 cm^3	15 in^3/ 246 cm^3	30 in^3/ 492 cm^3	207 in^3/ 3392 cm^3
0.25 in/ 0.64 cm	0.6 in^3/ 10 cm^3	6 in^3/ 100 cm ^{3}	30 in^3/ 492 cm^3	60 in^3/ 984 cm^3	414 in^3/ 6784 cm^3
0.5 in/ 1.2 cm	2.4 in^3/ 39 cm^3	24 in^3/ 393 cm^3	120 in^3/ 1967 cm^3	240 in^3/ 3933 cm^3	1656 in^3/ 27137 cm^3

Volume of Bladder Pumps

1.66 BP LENGTH	VOLUME
18 in/ 46 cm	39 in^3/ 640 cm^3
36 in/ 91 cm	78 in^3/ 1278 cm^3

Calculation guideline:

Volume of Tubing (in^3/cm)
+ Volume of Bladder Pump (in^3/cm^3)
= Air Consumption per cycle (in^3/cm^3)

Example (use metric units when applicable):

When using an 18” bladder pump and 0.17” I.D. tubing, what size compressor is recommended to purge a sample 200’ deep?

Step 1: Determine air consumption per cycle.
In this case the 1.66 BP 18” pump is used with 200’ of 0.17” I.D. tubing.

Volume of tubing = 30 in^3 * 2 = **60 in^3**
Volume of pump = **39 in^3**
Total air consumption per cycle = 60 in^3 + 39 in^3 = **99 in^3**

Step 2: Determine air consumption per hour.
Assuming the pump cycles no more than 6 times per minute, we can estimate maximum air consumption per hour.

99 in^3/cycle * 6 cycles/min * 60min/hour = **35,640 in^3/hour** or 21 ft^3/hour

When using an air compressor use one reserve tank to ensure proper air supply to the pump. When using a Nitrogen Tank, see Figure 2-1 for Nitrogen Tank Volume vs. Bladder Pump consumption.

Determining PSI

Determine the air pressure needed to operate the Bladder Pump based on the length of the air supply line to the pump (well depth).
Use this simplified formula:

0.5 PSI (per foot) + 10 PSI (to account for tubing friction) = required PSI
0.12 bar (per meter) + 0.7 bar (to account for tubing friction) = required bar

Example (use metric units when applicable:

For a pump 400’ away from the air source
(400’ * 0.5 PSI) + 10 = **210 PSI**

As mentioned above, the additional 10 PSI (0.7 bar) is to account for the pump itself and friction loss along the airline tubing. When the length of the airline is 50’ (15m) or less, there is no need for the additional pressure.

To determine minimum operating pressures for the specific Bladder Pump model you are using, consult the pump’s specifications. Typically, the minimum operating pressure will be 5 PSI (0.4 bar) above static head.

The formulas stated above are not absolute, and are meant to provide baseline information.

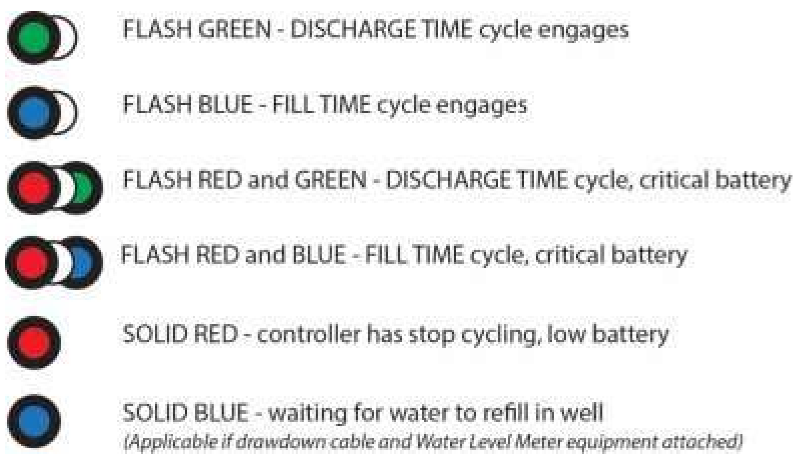
General Operating Definitions

The BP Controller interface utilizes ‘FILL TIME’ and ‘DISCHARGE TIME’ to identify the alternating timed air cycles. The ‘STATUS’ light will indicate the current cycle or error code.

<u>FILL TIME</u> – During this cycle, the controller is exhausting compressed air from the BP system (tubing and pump) to allow hydrostatic fill of liquid within the pump.

<u>DISCHARGE TIME</u> – During this cycle, the controller is routing compressed air into the BP and squeezing the flexible bladder, which then displaces liquid up the discharge line.

<u>STATUS</u> – The LED on the control panel will visually communicate the status of the sampling system:



Battery Overdraw Protection

The controller is designed to stop cycling if there is a potential for battery overdraw, as an overdrawn battery cannot be recharged and reused.

- A flashing red LED will indicate that your power source is in a critically low condition.
- A solid red LED will indicate that the controller has stop cycling to help protect against battery overdraw.

Operating Battery Voltage	11.7V to 14V
Critically Low Battery Voltage	11V to 11.6V
Low Battery Voltage	below 11V
*Recharge Voltage required to re-engage	12.8V

*If the controller’s power source is connected to a solar panel for battery recharge, the *battery will have to be recharged to 12.8V or above before the controller will continue cycling.*

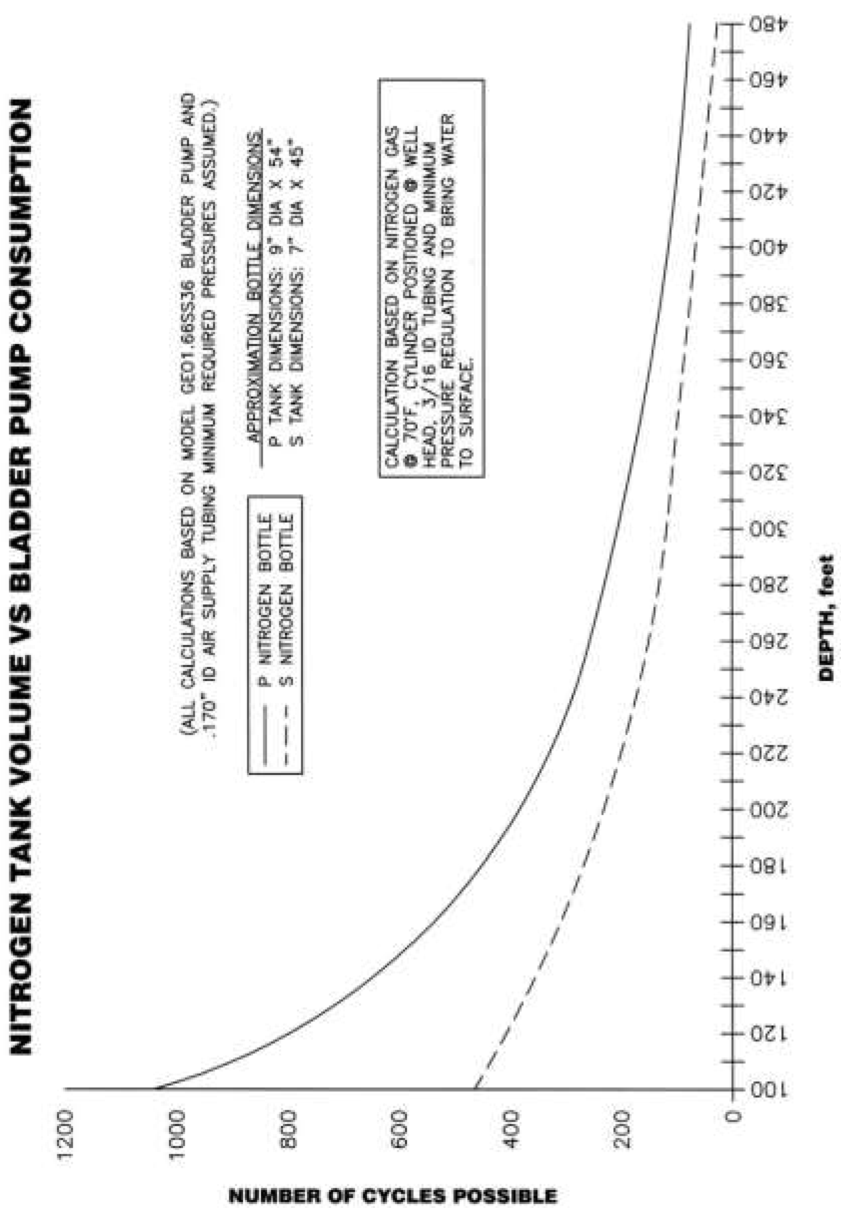


Figure 2-1: Nitrogen tank volume vs. Bladder Pump consumption

Section 3: System Operation

The BP Controller 300 PSI has a *Normally Closed* valve. Therefore, if power is disconnected from the unit, the controller will automatically stop the flow of air. This helps to protect the integrity of the bladder and protects against draining the air source.

Quick Start Guide

1. Connect Power Supply to side of controller (see *Section 2* 'Power Source').

2. Connect drawdown cable to Water Level Meter equipment (if applicable).

3. Set FILL TIME and DISCHARGE TIME knobs to approximately 30 seconds.
   - *A low cycle time limits the amount of initial pressurized air entering the pump, so as not to collapse the bladder.*

4. Flip BP Controller power switch to the ON position.
   - *After about 30 seconds, there should be* a distinct 'click' when the solenoid *valve shifts.*
   - *If the controller only cycles once and then displays a red light, there is not sufficient power from the battery. See* Section 5: System Troubleshooting *for more information.*

5. Connect 'AIR OUT' hose socket to the 'AIR OUT' plug on the control panel (1/4" coupling size). Connect the other end of the 'AIR OUT' hose to the pump airline on the wellhead (1/4" quick-connect fitting).
   See Section 1 'System Components' *for details on the air connection couplings.*

6. Connect the unpressurized 'AIR IN' hose socket to the 'AIR IN' plus on the control panel (3/8" coupling size). Connect the other end of the 'AIR IN' hose to the regulated air supply (compressor, bottle, tank, etc.)

The controller has an imbedded safety relief valve, which will exhaust compressed air that enters the system in excess of 350PSI (24 bar). To reset the relief valve and allow air through the controller, incoming air must be regulated to 300PSI (20.7 bar) or below.

7. Adjust the air source to the appropriate PSI (MAXIMUM: 300PSI/20.7 bar). See 'Determining PSI' in *Section 2*).

8. Adjust the FILL TIME and DISCHARGE TIME based on pump and well specifications (see 'Adjusting Cycle Timers' in *Section 3* for guidelines).
   a. Let controller cycle until fluid starts pumping from discharge tubing.
   b. Adjust DISCHARGE TIME so that the air supply turns off when fluid stops flowing from tubing.
   c. Adjust FILL TIME to desired setting that allows pump to hydrostatically fill.

9. When pumping is complete, turn off air supply (exhaust excess air if applicable) and flip BP Controller power switch to the OFF position.

10. Use caution when disconnecting hoses, as the system may be slightly pressurized. Hoses and power adapters are stored in the accessory bag.

Water Level Meter Compatibility

A connected Water Level Meter is used to control drawdown in the well, and when installed correctly will cause the BP Controller to cycle only when the Water Level Meter probe is submerged. The probe should be positioned at or above the pump's head.

The Water Level Meter with drawdown feature connects to the BP Controller through the "AUX INPUT" terminal.

Once connected, the probe of the Water Level Meter must be submerged in water to initiate the drawdown logic. If the Water Level Meter is accidently disconnected, the BP Controller will enter a "Waiting for Water" status.

The BP Controller must be power cycled to exit Water Level Meter mode.

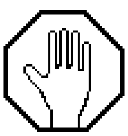
Follow the Water Level Meter's Installation and Operation Manual for additional information.

Adjusting Cycle Timers

The FILL TIME and DISCHARGE TIME knobs have a large diameter for maximum resolution. The timers have a range from 5-120 seconds.

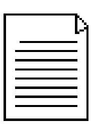
Adjust DISCHARGE TIME knob to approximately 10 seconds, and adjust FILL TIME knob to approximately 30 seconds. A 30 second exhaust cycle (FILL TIME) will be enough time to hydrostatically fill a bladder at approximately 100' (30.5m) deep.

The DISCHARGE TIME cycle can be adjusted by watching the sample line. When a steady stream of water stops during the cycle (STATUS light = green), set the DISCHARGE TIME back about five seconds.



DO NOT OVER PRESSURIZE (EXCESS DISCHARGE TIME) as this will cause excessive bladder wear.

Once the DISCHARGE TIME is adjusted, measure the volume of the sample and adjust the FILL TIME back about one second. Let the pump cycle a few times after each modification before adjusting again. Measure the volume of sample to make sure it is not decreasing. Continue to reduce the FILL TIME until the sample volume decreases. A decrease in sample volume indicates that the exhaust cycle (FILL TIME) is not long enough for the pump bladder to fill to its maximum capacity. Add one second to the FILL TIME at this point to make sure the maximum volume in the bladder is achieved.



Discharge and Fill times will vary depending on the depth of well and size of airline tubing. It may take a few cycles to see fluid as the pump fills the discharge tubing incrementally.

The following Fill cycle time guidelines are based on a 0.5” (1.3 cm) I.D. airline tube:

TYPE	DEPTH	DISCHARGE TIME
Standard Sampling	up to 172’ / 52m	0-30 seconds
Deep Well Sampling	up to 345’/ 105m	0-60 seconds
Max. Depth Sampling	up to 690’/ 210m	0-120 seconds

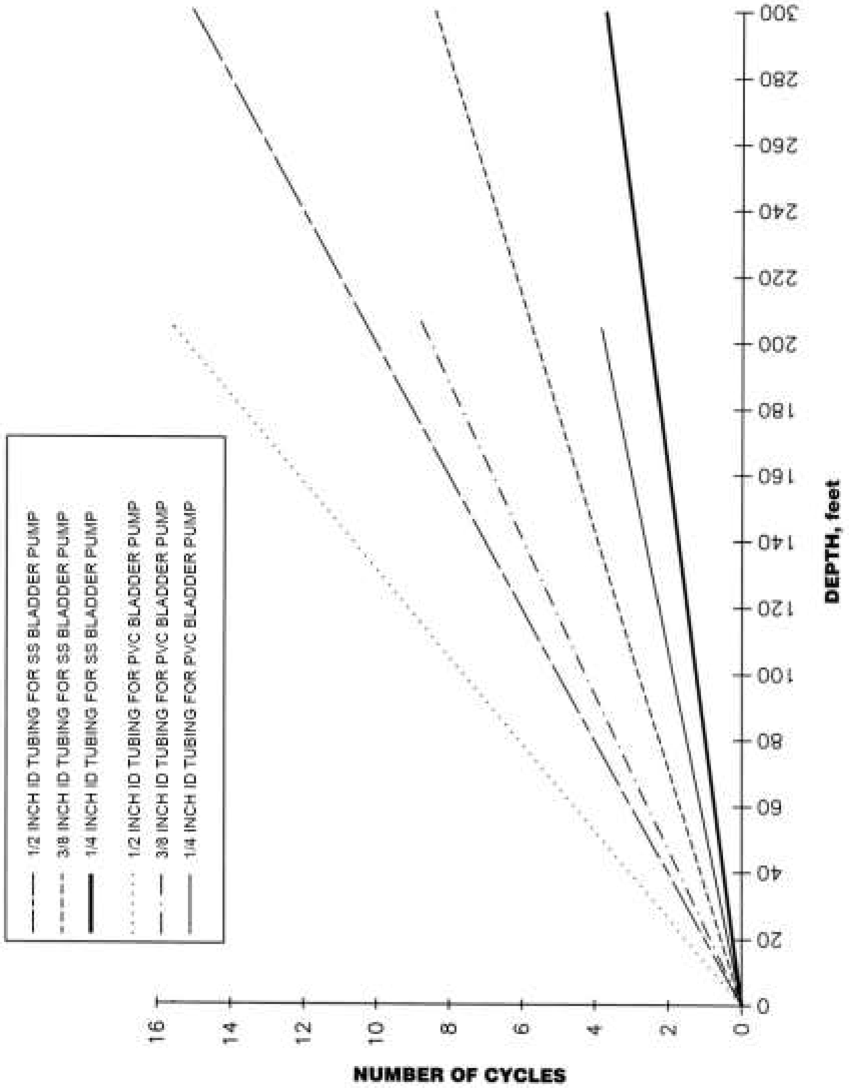


Figure 3-2: Cycles vs. Depth

Section 4: System Maintenance

The BP Controller does not require a regular maintenance program; however, proper care will ensure reliability.

As stated in installation and operation, this unit requires dry, moisture-free air. To disregard will increase the likelihood of unnecessary maintenance or hardware replacement.

To keep your BP Controller reliable, follow these simple guidelines:

- Do not drop your BP Controller.
- Do not immerse your BP Controller.
- Do not subject your BP Controller to poor power supplies.
- Do not subject your BP Controller to extreme heat or cold when in use.

Controller

Keep your BP Controller clean and dry. In the event that the controller is subjected to significant splashing or immersion, discontinue use and wipe the unit down immediately with a clean dry cloth.

Let the controller dry out in between uses by opening the heavy-duty case. When closed the heavy-duty case has a waterproof seal and will trap in unattended water.

Power Cords

Always replace a kinked or damaged power cord.

Air Connections

When build up is present, clean the AIR IN and AIR OUT coupling connections using a phosphate-free cleaning detergent and water solution.

Solenoid

Qualified personnel may clean the solenoid. The following procedure outlines how to disassemble and clean a stuck solenoid piston:

1) Remove power source and all air connections.
2) Remove the four (4) scews holding the control panel faceplate to the heavy-duty case.
3) Lift the control panel faceplate from the heavy-duty case and turn it over to expose controller components.

4) Locate the solenoid. See Figure 4-1.

Figure 4-1: Solenoid

5) Using a 3/32 Alan Wrench, remove the two retaining screws on the solenoid faceplate.

6) Remove the spring, bushing, and piston.

Figure 4-2: Removing Solenoid Parts

Figure 4-3: Solenoid Parts

7) Clean the piston and piston cavity with a lint-free cloth.

8) Lubricate the piston using a silicon based or aerosol lubricant.
 Do not over lubricate.

9) Using the end of a cotton swab, (or a thin, solid object) push the pin on the inside of the piston cavity to ensure the pin functions.

10) On the coil side of the solenoid, verify that the piston will easily move by depressing the silver button on the end of the solenoid.
    Repeat 2-3 times to ensure the button functions.

Figure 4-4: Silver button on solenoid

11) Reassemble the solenoid by inserting the piston, bushing, and spring.

12) Compress the spring with the solenoid faceplate and refasten the two retaining screws.

13) Reattach the control panel faceplate to the heavy-duty case.

14) Reconnect the power and airlines. Resume operation.

Section 5: System Troubleshooting

Problem: Unit will not turn on.

Solution:

- Check power source and cables for damage.
- If using a battery, see Section 2, 'Battery Overdraw Protection'.
- If using DC, verify that you have a 12 VDC power source. If on AC, verify that you are getting a consistent 115 VAC current.

Problem: Unit turns on but cycles rapidly, no pumping.

Solution:

- Discharge and Fill times not set correctly.
- Check and adjust Discharge and Fill cycle times (i.e., if discharge time too long and fill time too short, or discharge time too short). Review *Section 3*: *System Operation* for correct cycle times.

Problem: Turns on, cycles correctly but does not pump water.

Solutions:

- Check for tubing kinks.
- Pressure may be too low, check the gauge. Calculate based on 0.5 PSI per foot (.1 bar per meter) of head and add 10 PSI (.7 bar) for friction.
- Increase FILL TIME. The pump needs to depressurize to allow pump to fill.
- Solenoid may have moisture or debris build-up. See *Section 4: System Maintenance.*

Problem: Unit was working, but stopped cycling.

Solutions:

- Check power source.
- If using a battery, see *Section 2,* 'Battery Overdraw Protection'.
- If power source is good, check air source.
- Ensure the air source is using clean, dry air.

For further assistance contact Geotech at 1-800-833-7958.

Section 6: System Specifications

Model: BP Controller, 300 PSI

Maximum Ratings

Input DC Power Source	0.5-13.8 VDC
DC Current Draw	0.5 Amps
DC Input Surge Current	<50 Amps
Input AC Power Source	105-130 VAC
AC Current Draw	0.1 Amps
AC Input Surge Current	<15 Amps
Input AC Line Frequency	45-65 Hz
Maximum Power	15 Watts

Performance

Operating Air Pressure	10 - 300 PSI (20.5 bar)
Max. Air Input	350 PSI (24 bar)
Operating Depth	0-690' (0-210m)
DISCHARGE Timer Range	10 to 120 seconds
FILL Timer Range	10 to 120 seconds
Minimum Timer Value	*5 seconds (Discharge & Fill)
Timer Resolution	1 second, between 10 – 120 seconds
Timer Accuracy	± 2 seconds

*5 second minimum timer value with timer dial set between 0 and 10 seconds.

Battery Performance

12V 8AH Battery Life	1300 cycles, 20 Hours @ 30 sec FILL & DISCHARGE timers (70°F)

Environmental

Operating Temperature Range	32° – 158°F (0-70º C)
Storage Temperature Range	-4° – 185°F (-20° to 85º C)
Position Effect	0.10% change at any angle
Vibration	No change after 10G RMS 20 to 2000 Hz
Shock	No change after 50Gs for 11minutes
EMI Emissions	Class A

Physical

Enclosure	7" x 16" x 12" (18cm x 41cm x 30.5cm)
Enclosure Material	Structural resin
Weight	15 lbs (6.8 kg)

Section 7: System Schematics

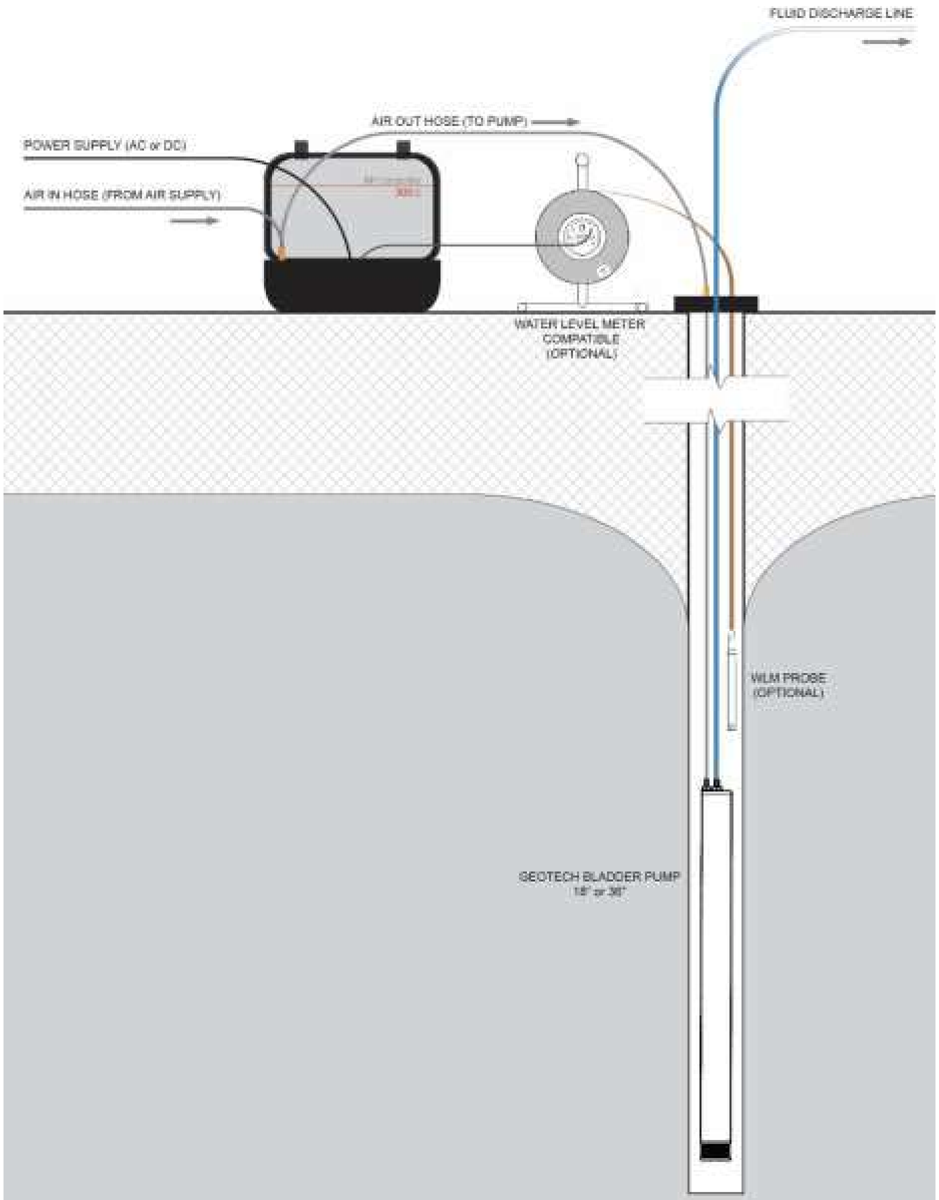


Figure 7-1: Site Schematic

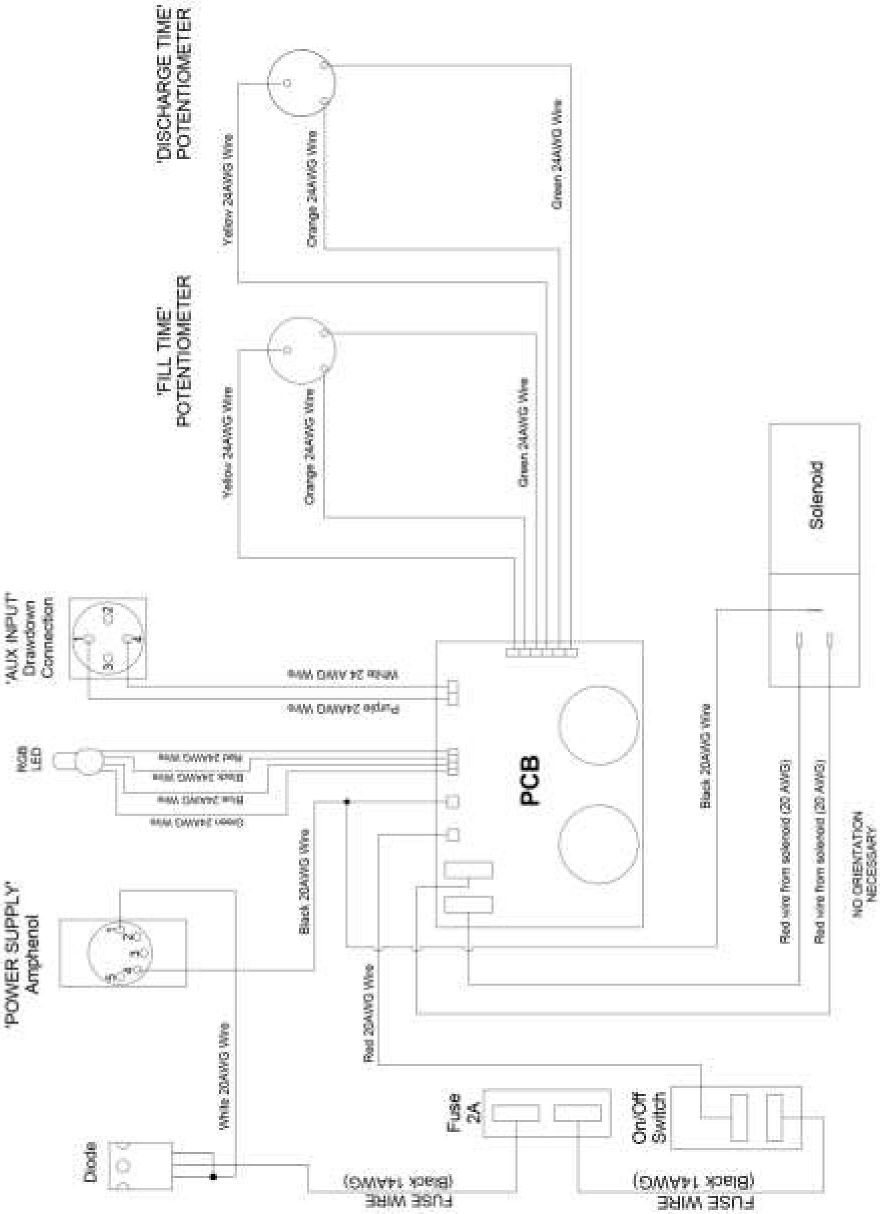


Figure 7-2: Wiring Diagram

Section 8: Parts and Accessories

Part Number	**Part Description**
Main Components	
81150042	BP, CONTROLLER, 300PSI, CE
51150064	ASSY, POWER SUPPLY, BP CONTR, CE BP CONTROLLER 300PSI
57500008	ASSY, POWER CORD, DC W/ AMP
51150074	ASSY, HOSE, AIR IN, BP CONTROLLER 300PSI
51150075	ASSY, HOSE, AIR OUT, BP CONTROLLER 300PSI
11150362	MANUAL, BP CONTROLLER, 300PSI, CE
11150360	FUSE, 2A/32V, BLADE
51150076	ASSY, PCB, BP CONTROLLER 300PSI, POTTED
51150134	BAG, ACCESSORY, BPC
Power Cord Adapters	
11150367	AC ADAPTER, PLUG-IN, US, 15W/30W
11150368	AC ADAPTER, PLUG-IN, EURO, 15W/30W
11150369	AC ADAPTER, PLUG-IN, UK, 15W/30W
11150370	AC ADAPTER, PLUG-IN, AUS, 15W/30W

DOCUMENT REVISIONS		
EDCF#	DESCRIPTION	REV/DATE
-	Initial Release	9/12/13
-	Updated Wiring Diagram – SP	10/9/13
-	Added to Section 6: Battery Life Information - SP	10/30/13
-	Updated Section 8: Parts & Accessories descriptions to match sales database – SP	11/18/13
-	Updated wiring diagram, add header to EC Declaration of Conformity – SP	1/22/14
Project 1392	Added metric where missing, added NC information, edited timer specifications, updated wiring diagram – SP	4/2/14
-	Updated back page info & EC Declaration of Conformity, SP	1/13/14
2005	Instruction steps for maintaining solenoid, minor style edits, SR	11/21/16

NOTES

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geotech

EC Declaration of Conformity

Manufacturer:

Geotech Environmental Equipment, Inc.
2650 E 40th Avenue
Denver, CO 80205

Declares that the following products,

Product Name: BP (Bladder Pump) Controller 300PSI

Model(s): 81150042

Year of manufacture: 2013

Conform to the principle safety objectives of 2006/95/EC Low Voltage Directive (LVD) by application of the following standards:

EN 61010-1: 2010

Year of affixation of the CE Marking: 2013

Conform to the protection requirements of 2004/108/EC Electromagnetic Compatibility (EMC) by application of the following standards:

EN 61000-6-1: 2007
EN 61000-6-3: 2012
EN 61326-1: 2013, emissions Class A

EMC conformity established 09/01/2013.

Production control follows the ISO 9001:2008 regulations and includes required safety routine tests.

This declaration issued under the sole responsibility of Geotech Environmental Equipment, Inc.

Joseph Leonard

Joe Leonard
Product Development

Serial number ________________

The Warranty

For a period of one (1) year from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call our 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958.

Model Number: ________________

Serial Number: ________________

Date of Purchase: ________________

Equipment Decontamination

Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used. Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate the equipment for a fee, which will be applied to the repair order invoice.

Geotech Environmental Equipment, Inc.
2650 East 40th Avenue Denver, Colorado 80205
(303) 320-4764 ● (800) 833-7958 ● FAX (303) 322-7242
email: sales@geotechenv.com
website: www.geotechenv.com
In the EU
Geotech Equipos Ambientales
Calle Francesc I Ferrer, Guardia Local 19, Mollet del Valles, Barcelona 08100, España
Tlf: (34)93 5445937
email: ventas@geotechenv.com
website: http://spanish.geotechenv.com

Printed in the United States of America

Portable Turbidity Meter

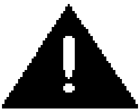
Installation and Operation Manual

Rev 06/15/2017 Part # 22100045

Table of Contents

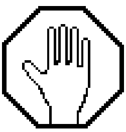
DOCUMENTATION CONVENTIONS

This uses the following conventions to present information:



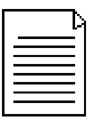
WARNING

An exclamation point icon indicates a **WARNING** of a situation or condition that could lead to personal injury or death. You should not proceed until you read and thoroughly understand the **WARNING** message.



CAUTION

A raised hand icon indicates **CAUTION** information that relates to a situation or condition that could lead to equipment malfunction or damage. You should not proceed until you read and thoroughly understand the **CAUTION** message.

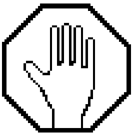


NOTE

A note icon indicates **NOTE** information. Notes provide additional or supplementary information about an activity or concept.

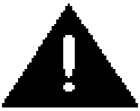
General Information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.



In order to ensure your Turbidity Meter has a long service life and operates properly, adhere to the following cautions and read this manual before use.

- **Disconnect from power source when not in use.**
- **Power input source must not exceed maximum ratings.**
- **Equipment must be wired to a negative ground system.**
- **Equipment may not operate properly with excess wiring not supplied by manufacturer.**
- **Avoid spraying fluid directly at equipment.**
- **Never submerge equipment.**
- **Avoid pulling on wires to unplug equipment wiring.**
- **Avoid using equipment with obvious physical damage.**
- **To prevent equipment damage, avoid dropping it.**



WARNING

Do not operate this equipment if it has visible signs of significant physical damage other than normal wear and tear.

Notice for consumers in Europe:

This symbol indicates that this product is to be collected separately.

The following applies only to users in European countries:

- This product is designated for separate collection at an appropriate collection point. Do not dispose of as household waste.
- For more information, contact the seller or the local authorities in charge of waste management.

Section 1: System Description

Function and Theory

Geotech's Portable Turbidity Meter offers great precision, repeatability and ease of use in a low cost extremely robust portable/laboratory instrument. Data points from field sample events can be stored to memory and transferred to computer or other storage device.

Turbidity Meters provide fluid clarity insight by shining light onto a sample and measuring the amount of light scattered by suspended particles in the fluid.

The Geotech Portable Turbidity Meter has two light source models to fulfill specific customer and site requirements:

Model GTW: White Light source, compliant to US EPA method 180.1
Model GTI: Infrared light source, compliant to ISO 7027 standards

Instrument Features

- Sample chamber with lid
- Data port/ power supply (serial output, USB to Mini-B cable not included)
- Sealed battery compartment (4x AA batteries)
- IP67 Seal for extension into hazardous environments
- Digital display and navigation keypad

System Components

- Economy carry case included, optional custom foam cut case available
- Lint-free cleaning cloth
- 2 sample vials
- Primary Calibration Standards: 0.10, 20, 100, 800 NTU

Figure 1-1: Instrument Features

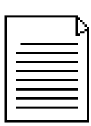
Section 2: System Installation & Navigation

Install the battery

1. With a small Phillips screwdriver, remove the battery cover (located on the backside of the instrument).
   - Take care to keep the small screws and washers safe when removing the battery cover.
2. Install four (4) AA alkaline or nickel metal hydride (NiMH) batteries.
   - Make sure that batteries are installed in the correct orientation.
3. Replace the battery cover.
   - For optimal seal, we recommend using a torque screwdriver set to 4N-m.

Figure 2-1: Replacing the batteries

Sample Vial Handling



Handle calibration and sample vials by caps only. Any scratches on the vials will compromise accurate turbidity readings.

Figure 2-2: Sample chamber

When placing the vials into the instrument, ensure that the white line on the sample vial is aligned with the black arrow on the bottom edge of the instrument's sample chamber.

The sample vials must be very clean while calibrating or doing field readings; no debris or fingerprints should be visible on the glass. Use a soft cleaning cloth to ensure clarity before each measurement. Do no store samples and vial in extreme temperatures or direct sunlight.

User Interface

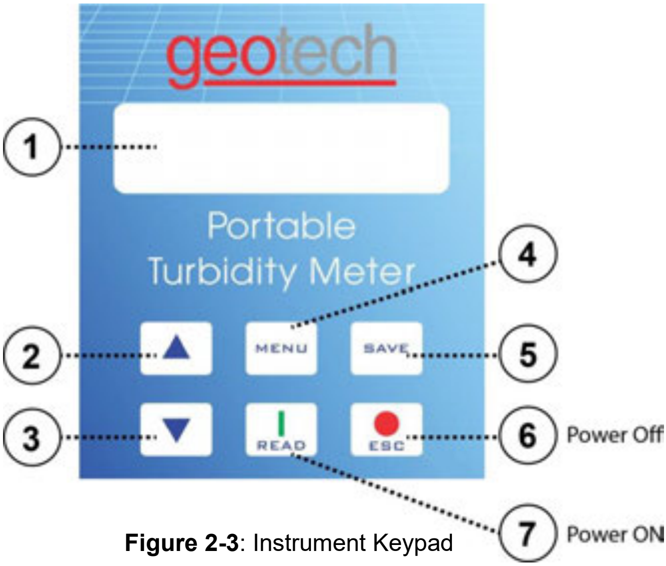


Figure 2-3: Instrument Keypad

1. **DISPLAY**

   Displays readings, diagnostics, and operational data.

2. **UP ARROW (▲)**
   Scroll through menus, enter numbers and letters

3. **DOWN ARROW (▼)**
   Scroll through menus, enter numbers and letters

4. **MENU**
   Enters into main menu function, selects options to configure the instrument, select analysis, and moves cursor to the right.

5. **SAVE**
   Store Selections and data, saves the result to be USB transferred and selects the parameters.

6. **ESC/OFF**
   Powers off the instrument (hold for 3 seconds), aborts operations, return to the previous screen.

7. **READ/ON**
   Powers on the instrument (hold for 3 seconds), confirms options, initiates sample reading, moves cursor to the left.

Section 3: System Operation

3.1 Quick Start Guide

To turn ON unit: press and hold the **READ** button for 3 seconds.

To turn OFF unit: press and hold the **ESC** button for 3 seconds.

Figure 3-1: Read (ON/Enter) ESC (OFF/Back)

Basic Operation

1. Turn instrument on by pressing **READ** for 3 seconds.
    a. Once through the welcome screens, the unit will automatically begin reading a sample.
    b. See *Section 3.2.2: Calibrate* if Calibration is required.

2. Rinse the inside of each sample vial three times with the sample to be tested.

3. Completely fill sample vial with sample, then dry and clean the outside of vial.
    - Handle vial by the cap.

4. Align white mark on vial with arrow on bottom of sample chamber.
    - See “Sample Vial Handling” in *Section 2: System Installation & Navigation* for details.

5. Close the sample chamber cap.

6. Press **READ** button again to take sample, NTU reading will appear after status bar is complete.

7. Press **SAVE** button to mark reading, “M” will flash for 3 seconds in upper left corner of display.

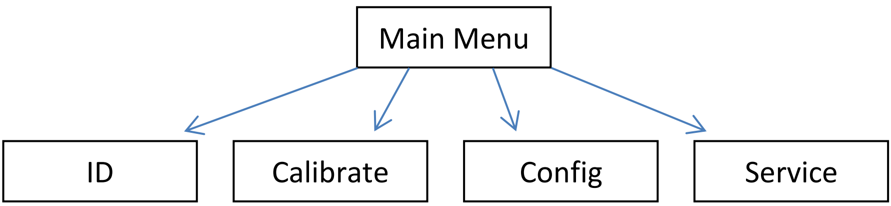
Figure 3-1: Basic Operation

3.2 Menu Navigation

The Geotech Portable Turbidity Meter has several configuration capabilities. The menu structure is easy and simple to operate, please follow the steps below to configure the unit according to your needs.

To Enter Main Menu: With instrument turned on, press **MENU** key for 3 seconds to enter the Menu Function. You will see the following screen:

Using ▲ or ▼ the user can navigate between the main menu functions. When you reach the desired menu or function press **READ** to enter, or **ESC** to go back to the previous screen.



The four main sub menus are listed below:

- ID - Access the user identification function
- Calibrate - Access the calibration functions
- Config - Access the configuration functions
- Service - Access the service functions (only for certified technicians)

The fifth menu item is “Back” – when selected will navigate to the ready-to-sample screen.

Please reference the following pages for an explanation of instrument configuration and menu navigation. See section *3.4: Menu Structure* for an overview of the complete menu structure.

3.2.1 ID (Identification)

From the main menu, use the ▲ or ▼ keys select the ID function, then press **READ** to enter that submenu.

Sample

Use the ▲ or ▼ keys to set sample number from 0-99. Use the **READ** or **SAVE** button to set the sample number and exit to the ID menu.

User

Use the ▲ or ▼ keys to set user number from 0-99. Use the **READ** or **SAVE** button to set the user number and exit to the ID menu.

3.2.2 Calibrate

From the main menu, use the ▲ or ▼ keys select the Calibrate function, then press **READ** to enter that submenu.

The Standard vials must be thoroughly cleaned before each measurement, using a lint-free cloth.

Guided Cal.

The complete calibration procedure, as outlined below, should be performed by the user according to required quality and maintenance programs.

1. Gather the four (4) calibration sample vials with formula standards of <0.10 (i.e. 0.02), 20.0, 100, 800 NTU (or stabilized primary standards in the same concentrations).
   - Ensure each vial is cleaned with a soft cloth.

2. Hold **MENU** button for 3 seconds until the main menu is displayed.

3. Scroll through the menu using the ▲ or ▼ keys until “Calibrate” is displayed.

4. Press the **READ** button to enter into the calibration menu.

5. Select “Guided Cal” and follow the scrolling prompts on the screen.
   - Before placing each vial into the sample chamber, gently invert the vial to ensure a homogeneous mix.

6. Once done calibrating to the four standards, the instrument will return to the calibration menu.

7. Press the **ESC** key twice to navigate to the ready-to-sample screen.

Free Cal.

Free Calibration allows for a single calibration point. For many users, this single point calibration will be sufficient for routine work.

1. Follow steps 1-3 from “Guided Cal” above.

2. Select “Free Cal”

3. On the “Cal. Auto” screen, there will be a value displayed from the previous calibration. Place one of the calibration standards into the sample chamber.

4. Press READ button and wait for result.

5. If necessary use ▲ or ▼ keys to change the displayed value for this standard to match its label, press and hold **SAVE** for 3 seconds.
   - "Saving" will be displayed.

6. After the value is saved, the display returns to the "Calibrate" menu.

7. Recalibrate against the same standard for better accuracy, or perform the “Guided Cal” routine.

NOTE 1: If an error message displays, check the standards and repeat the previous steps.

NOTE 2: After the calibration, perform standard readings for verification, and if needed repeat the calibration procedure.

3.2.3 Config (Configuration)

From the main menu, use the ▲ or ▼ keys select the Config function, then press **READ** to enter that submenu.

Time/Date

When inside this configuration you can change ***Time*** and ***Date***.

Use **MENU/READ** to move the cursor right/left and ▲ or ▼ keys to adjust the numbers as desired. Press and hold **SAVE** for 3 seconds to store the data, or **ESC** to return to the previous menu without saving any changes.

Display

When inside this configuration you can set and change Contrast, Backlight Time and Backlight Brightness (Time and Contrast only on instruments with Backlight optional installed), use ▲ or ▼ to select between the options and **READ** to enter it or **ESC** to go back to the previous menu.

Contrast

Using ▲ or ▼, you can change the contrast to the desired level: 00-30. When done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Backlight Time

From 0 up to 60 minutes of backlight on.

Using ▲ or ▼ change the time to the desired backlight time, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Backlight Level

From 0 up to 100 (intensity level).

Using ▲ or ▼ change the level to the desired, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Partial Res.

Using ▲ or ▼ to choose Yes or No.

Big Number

Using ▲ or ▼ to choose Yes or No to show the large number displayed on the Auto screen.

Instrument

When inside this configuration you can set Auto off, Readings, Color compensation, curves, fast settling, Sampling, ID, Calibration interval, personalization, patrimony, use ▲

or ▼ to select between the options and **READ** to enter it or **ESC** to go back to the previous menu.

Auto off

The Auto off function shall be activated to save the batteries; it can be configured to turn the unit off after 0 to 60 minutes of inactivity.

Using ▲ or ▼ change the time to the desired level, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

NOTE: When the time is in 0 minutes the auto off will not be operational.

Auto Reading

The Auto reading function can be activated from 1 to 250 seconds; this will set the time between readings.

NOTE: If you configure the Auto reading for 5 seconds the unit will make readings every 5 seconds until it is turned off.

Using ▲ or ▼ change the desired time between readings, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Color Compensation

The instrument can compensate for the color of the sample for a more accurate reading.

A password is required to access this feature. Default password is **9999.** Input password and hold **SAVE** for 3 seconds to proceed.

Using ▲ or ▼ select Yes or No, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

NOTE: When activated (Yes selected) "C" will appear in the upper right corner of the display in the reading mode screen.

Test Curves

You can define which curves will appear in the curve selection menu (when you press and release the Menu key).

Press **ESC** to remove the * icon from the curves you don´t want and **READ** to put the * icon in the ones you want.

Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Measure Mode/ Fast Settling

When selected, instrument will take a snapshot of the sample and display the immediate reading before particles settle in the vial (for high solids samples).

Using ▲ or ▼ select yes or no, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Sample

This function can be used to set the number of readings the unit will take to calculate the average and present it as a measurement in the display. Number of samples ranges from 8-100.

1. User ID

Here you can set up user names/passwords and when they shall be requested by the unit.

Edit

To create users and its passwords:

- Choose the user number between 00 and 50 , press **READ**
- Choose a name for this user using ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data. Name can be a maximum of thirteen (13) characters.
- You will see "PIN:" on the Display, use ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data. Pin must be four (4) characters.
- Press and Hold **ESC for 3 seconds** to return to the previous menu.

Request

To define when the user ID and password will be required:

- Choose between the following options using ▲ or ▼, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Always	– ID and password will be request at every measurement.
On Start	– ID and password will be request at Instrument Start Up.
MEMO	– ID and password will be request when **SAVE** is pressed.
Previous	**–** ID and password will not be requested, the previous user informed will be assigned for all operations.
No	– ID and password will not be requested.

2. Sample ID

Here you can set up sample names /passwords and when they shall be requested by the unit.

Edit

To create sample names and their passwords:

- Choose the user number between 00 and 50, press **READ**
- Choose a name for this sample using ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.
- Press and Hold **ESC for 3 seconds** to return to the previous menu.

Request

To define when the sample name will be required:

- Choose between the following options using ▲ or ▼, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Always –Sample name will be request at every measurement.
On Start –Sample name will be request at Instrument Start Up.
MEMO –Sample name will be request when **SAVE** is pressed.
Previous –Sample name will not be requested, the previous user informed will be assigned for all operations.
No –Sample name will not be request.

Schedule Cal.

Access this function to set up the time (Days/hours) before calibration is requested.

A password is required to access this feature. Default password is **9999.** Input password and hold **SAVE** for 3 seconds to proceed.

F.Scale

- Choose the number of days and hours before the calibration warning graph will appear on the display using ▲ or ▼ and **MENU/READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

NOTE: When the calibration schedule is programmed, a graph will be displayed in the upper right corner during measurements, when the calibration date arrives, a bar will appear in the graph and a Calibration warning will be displayed.

Customize

Use ▲ or ▼ and **MENU/READ** (send the cursor to the right/left) to set an ID for the unit, press and hold **SAVE** for 3 seconds to store the data. ID must be four (4) characters.

Tag Number

Use ▲ or ▼ and **MENU/READ** (send the cursor to the right/left) to set an ID number for the unit, press and hold **SAVE** for 3 seconds to store the data. ID must be four (4) characters.

Language

Use ▲ or ▼ to select the desired language from the list below, press and hold **SAVE** for 3 seconds to store the data.

- US – English
- ES – Spanish
- BR – Portuguese

Communication

Use ▲ or ▼ to select between Eco Result or Log Transmit and **READ** to enter it or **ESC** to go back to the previous menu.

Eco Result

In this mode, the measurement displayed is sent to the USB port. You can select to send all measurements only part of them.

Using ▲ or ▼ select Auto, Manual and Off, when done, press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

- Auto – Sends all measurements to the USB (when they are performed)
- Manual – Sends measurements that are selected (**SAVE** pressed during on measurement mode)
- Off – No measurement will be sent to the USB

Log Transmit

Here you can select 4 ways to send the instrument measurement log

Using ▲ or ▼ select between, New Mark, All Mark, New, All, Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Auto - Sends all measurements to the USB (when they are performed)

Manual - Sends measurements that are selected (**SAVE** pressed during on measurement mode)

Off - No measurement will be sent to the USB

NOTE: When the time is in 0 minutes the instrument will not be shut off.

Serial Baud

Sets the data rate in bits for data transmission.

Options include: 57600, 38400, 19200, and 9600. Default/suggested configuration is 19200bits/sec. Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

Header

Select Yes or No to display header. Press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

CSV Separator

Determines character to be placed in between spaces. Select a symbol then press and hold **SAVE** for 3 seconds to store the data and **ESC** to return to the previous menu.

User Test

The instrument allows users to calibrate a user curve.

NOTE: When user curve is calibrated, the instrument performance might change due to standard and procedures adopted, factory calibrated curve is made with 100% traceable standards and reference materials in controlled environment, use it in order to have full confidence in instrument performance.

Security/Password

Here you can set up the security level and password for the Calibration, configuration and service functions.

The Factory pre-saved password is 9999, if this is required during configuration or operation use ▲ to scroll faster to letters , ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

ID

Here you will assign a security level and password to access all the ID functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level

Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

Password

Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data. Password must be four (4) characters.

Calibration
Here you will assign a security level and password to access all the calibration functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level
Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

Password
Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

Config.
Here you will assign a security level and password to access all the Configurable functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level
Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

Password
Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

Service
Here you will assign a security level and password to access all the service functions.

Using ▲ or ▼ select the desired security level, when done, press and hold **SAVE** for 3 seconds to store the data.

Sec. Level
Choose the user number between 0 and 5, press and hold **SAVE** for 3 seconds to store the data.

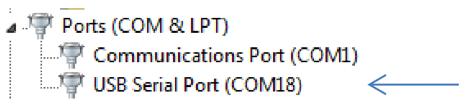
Password
Using ▲ to scroll faster to letters, ▼ to scroll faster to numbers (both can be used to go up or down) and **MENU**/**READ** (send the cursor to the right/left), press and hold **SAVE** for 3 seconds to store the data.

3.3 USB Connection

1. Plug the unit into the computer; wait for device driver to download. Device connection is successful if an additional COM port is recognized in the Device Manager.

2. Identify a communication port for the connection, look in the computer's Device Manager (example: COM2, COM18).

If unsure of which communication port, disconnect and then reconnect the Turbidity Meter while Device Manager is open and notice which new communication/USB serial port opens, look under "Ports (COM & LPT)".



3. Open a serial terminal connection to access the saved data.

   Serial terminal programs are available to download from the internet.
   For example, "PuTTY" or "TeraTerm" are two serial terminal programs which are quick and free to download, and simple to use.

4. Configure the serial terminal interface as follows:

Parameter	Value
Speed	19200 bits/sec (baud rate)
Data bits	8
Parity	None
Stop Bits	1
Flow Control	None

5. To transmit the Data use the menu structure diagram (*see Section 3.4*) to navigate to Service > Datalog > Log Transmit.

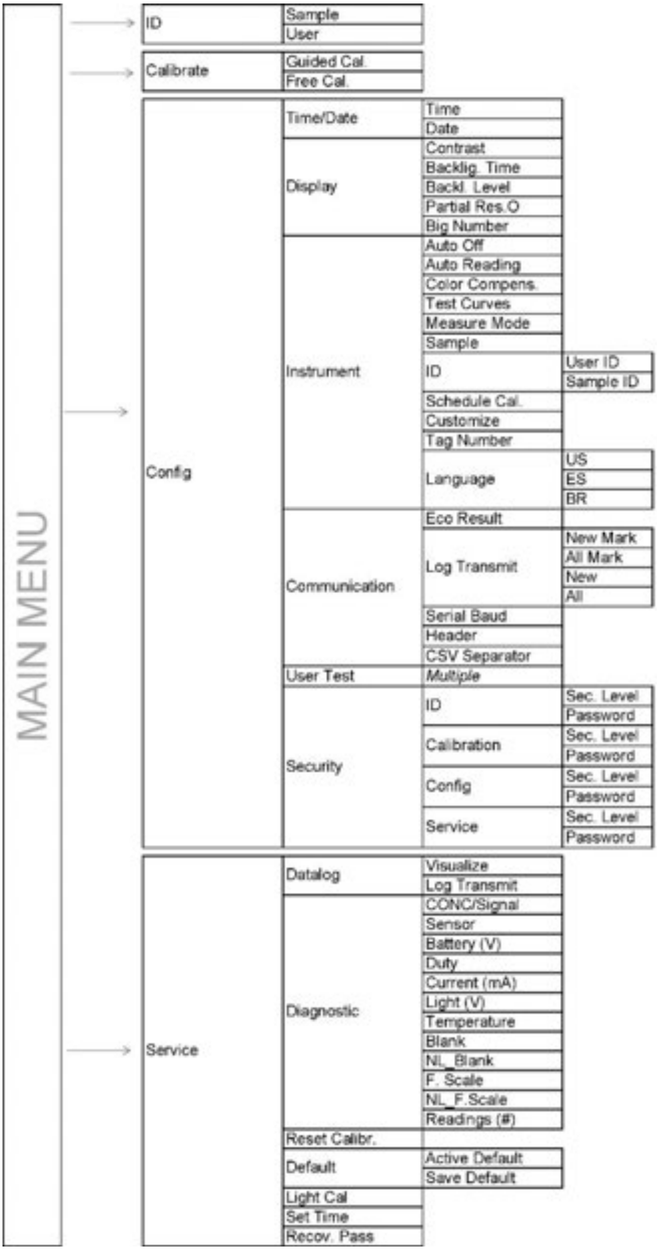
The display will read, "Wait…" and the serial terminal on the computer will begin the data log transfer. The data output could be copied and pasted into a data processing program, such as MS Excel or Word (comma delineated import).

Note: Some variables will appear in the data collected,

"M": Marked
"D": Point where the data has already being transmitted
"E": Clock not adjusted in last transmission

3.4 Menu Structure

Use the “**READ**” button to enter into a sub menu, use the “**ESC**” button to exit a sub menu.



Section 4: System Maintenance

The Geotech Portable Turbidity Meter is designed to be a low-maintenance lab instrument that can be used in the field.

General cleaning guidelines:

- Use a soft cloth with mild soap and warm water to clean the unit.
- Clean and dry the sample chamber to ensure no water droplets accumulate on the lens, as this can affect the accuracy of turbidity readings.

Per each use:

- Keep unit clean and free of debris when traveling - build up on sample chamber lenses could permanently damage the instrument
- Calibrate before each use to ensure good data

Seasonal use:

- Keep unit clean and free of debris when storing - build up on lenses could permanently damage the instrument
- Remove batteries when storing long term
- Ensure a complete calibration is conducted when bringing unit out of storage

Calibration Solutions:

- Avoid exposing calibration standards to extreme temperatures. Do not store below the freezing point, or above 122 °F (55°C)

Section 5: System Troubleshooting

Problem: Unit will not turn on.

Solution:
- No power to unit:
  - Check that batteries are installed and in the correct orientation (+/- polarity)

Problem: Cannot get accurate readings on control samples.

Solution:
- Recalibrate unit
- Clean lenses inside sample chamber to ensure a clear read
- Clean outside of bottles
- Check the expiration date on the calibration standards. Expired standards will result in an inaccurate reading.

If these troubleshooting guidelines have not resolved the problem, contact Geotech Environmental Equipment at 1-800-833-7958.

Section 6: System Specifications

Measurement Method	Nephelometric
Regulatory	EPA method 180.1 (GTW)
	ISO method 7027 (GTI)
Light Source	EPA - White light Tungsten (GTW)
	ISO - 860nm LED (GTI)
Range	0 to 1000 NTU (FNU)
Accuracy	±2% of reading plus stray light
Repeatability	±1% of reading, or 0.01 NTU (FNU), whichever is greater
Resolution	0.01 NTU on lowest range
Stray Light	<0.02 NTU (FNU)
Signal Averaging	Selectable On/Off (programmable from 8 to 100 readings/ 4 to 27 seconds)
Detector	Silicon photocell
Reading Modes	Fast Settling, automatic, manual reading, EBC
Data Logger	1000 Data Sets
Download	Standard USB, no special software required
Languages	English, Spanish, Portuguese
Power	4 AA Alkaline batteries
	USB 5VDC/500mA
Operating Temperature	32 to 122°F (0 to 50°C)
Storage Conditions	-40 to 140°F (-40 to 60°C), instrument only
Instrument Enclosure Rating	IP67 with lid open or closed
Sample Required	0.473 oz. (14 ml)
Sample Vials	2.55 x 0.94 in. (65 x 24 mm)
Dimensions	4.48 x 7.79 x 3.26 in. (114 x 198 x 83 mm)
Weight	1.09 lb. (496 g) without batteries
	1.28 lb. (585 g) with 4 AA alkaline batteries
Warranty	2 year

Section 7: Parts and Accessories

Part Number	Qty	Part Description
82100003	1	TURBIDITY METER,0-1000NTU,GEOTECH,CALKIT,FIELD CASE
82100005	1	TURBIDITY METER,0-1000NTU,GEOTECH,CALKIT, ECO CASE
52100003	1	CASE,FIELD,TURBIDITY
52100000	1	CAL KIT,TURBIDITY,GEOTECH(.1, 20, 100, 800 NTU)
22100046	.5	VIAL,TURBIDITY,4PK
22100048	1	CLOTH,LINT FREE,TURBIDITY
PPE041006	4	BATTERY, 1.5V, SIZE AA, EACH
22100045	1	MANUAL, PORTABLE TURBIDITY METER,GEOTECH
*22100049	1	CASE,ECONOMY,TURBIDITY
*52100004	1	COMM CABLE,USB,TURBIDITY

**Indicates optional accessories.*

For additional information, please call Geotech Environmental Equipment at:
1-800-833-7958

Document Revisions		
EDCF #	**Description**	**Rev/Date**
-	Release, SP	07/07/2016
Project #1496	Updated graphics, additional user instructions, StellaR, SP	06/08/2017

NOTES

NOTES

geotech

EC Declaration of Conformity

Manufacturer:

Geotech Environmental Equipment, Inc.
2650 E 40th Avenue
Denver, CO 80205

Declares that the following products,

Product Name: Geotech Portable Turbidity Meter

Model(s): Portable Turbidity Meter, White Light (GTW)
Portable Turbidity Meter, Infrared Light (GTI)

Year of manufacture: 2017

Conform to the principle safety objectives of 2006/95/EC Low Voltage Directive by application of the following standards:

EN 61010-1: 2010

Year of affixation of the CE Marking: 2017

Conform to the protection requirements of 2004/108/EC Electromagnetic Compatibility (EMC) by application of the following standards:

EN 61000-6-1: 2007
EN 61000-6-3: 2012
EN 61326-1: 2013

EMC conformity established 5/24/2017

Production control follows the ISO 9001:2008 regulations and includes required safety routine tests.

This declaration issued under the sole responsibility of Geotech Environmental Equipment, Inc.

Joseph Leonard

Joe Leonard
Product Development

Serial number ________________

CE

DOCUMENT REVISIONS		
EDCF#	DESCRIPTION	REV/DATE
-	Release, SP	07/07/2016
Project #1496	Added Declaration of Conformity, general updates to images and menu descriptions, SB	05/26/2017
Project#1496	Updated parts list, updated menu navigation, StellaR	6/15/2017

The Warranty

For a period of two (2) years from date of first sale, product is warranted to be free from defects in materials and workmanship. Geotech agrees to repair or replace, at Geotech's option, the portion proving defective, or at our option to refund the purchase price thereof. Geotech will have no warranty obligation if the product is subjected to abnormal operating conditions, accident, abuse, misuse, unauthorized modification, alteration, repair, or replacement of wear parts. User assumes all other risk, if any, including the risk of injury, loss, or damage, direct or consequential, arising out of the use, misuse, or inability to use this product. User agrees to use, maintain and install product in accordance with recommendations and instructions. User is responsible for transportation charges connected to the repair or replacement of product under this warranty.

Equipment Return Policy

A Return Material Authorization number (RMA #) is required prior to return of any equipment to our facilities, please call our 800 number for appropriate location. An RMA # will be issued upon receipt of your request to return equipment, which should include reasons for the return. Your return shipment to us must have this RMA # clearly marked on the outside of the package. Proof of date of purchase is required for processing of all warranty requests.

This policy applies to both equipment sales and repair orders.

FOR A RETURN MATERIAL AUTHORIZATION, PLEASE CALL OUR SERVICE DEPARTMENT AT 1-800-833-7958.

Model Number: ________________

Serial Number: ________________

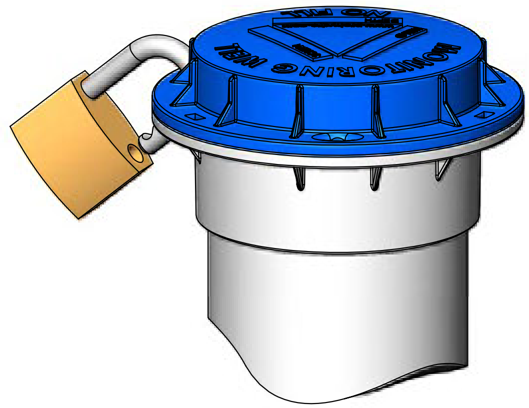
Date of Purchase: ________________

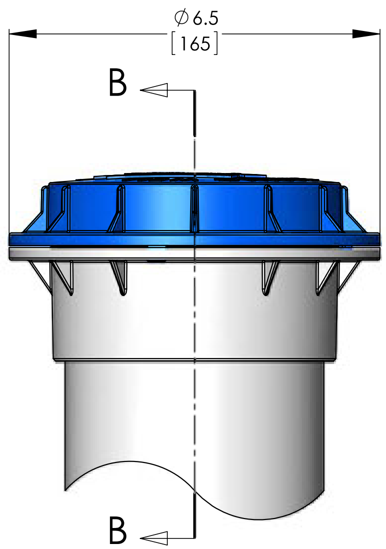
Equipment Decontamination

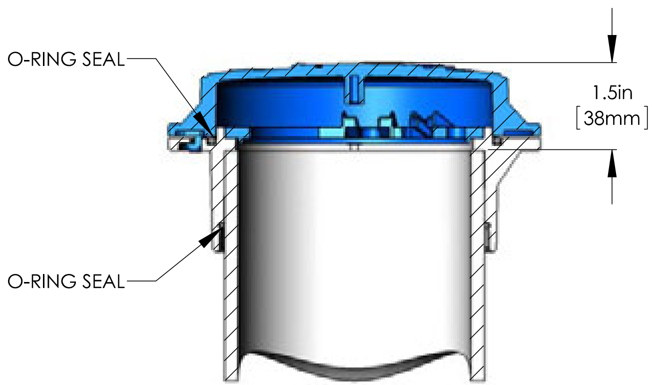
Prior to return, all equipment must be thoroughly cleaned and decontaminated. Please make note on RMA form, the use of equipment, contaminants equipment was exposed to, and decontamination solutions/methods used. Geotech reserves the right to refuse any equipment not properly decontaminated. Geotech may also choose to decontaminate the equipment for a fee, which will be applied to the repair order invoice.

Geotech Environmental Equipment, Inc.
2650 East 40th Avenue Denver, Colorado 80205
(303) 320-4764 ● **(800) 833-7958** ● FAX (303) 322-7242
email: sales@geotechenv.com website: www.geotechenv.com

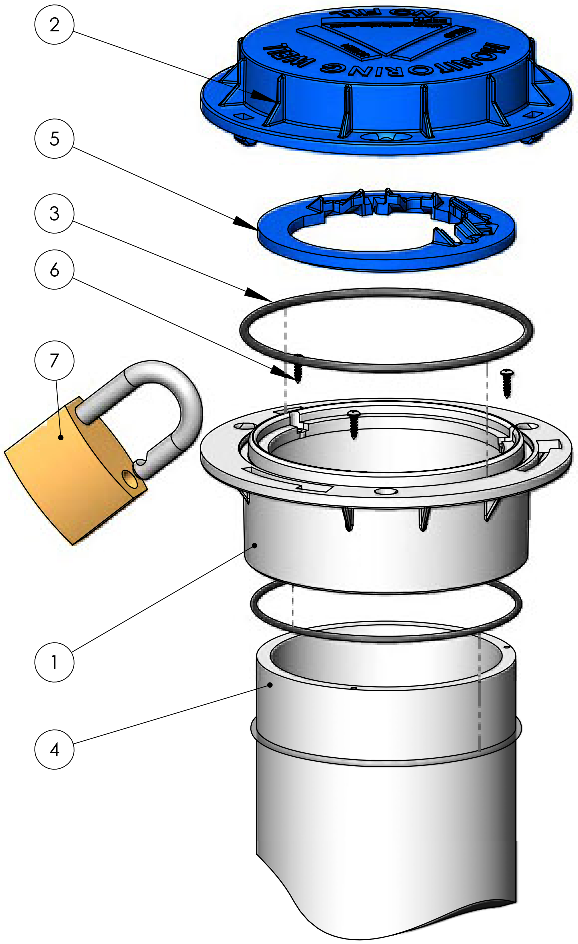
ITEM NO.	DESCRIPTION	QTY.
1	4" WELL DOCK BASE	1
2	4" WELL DOCK CAP	1
3	VITON O-RING	2
4	4" WELL RISER PIPE	1
5	4" WELL DOCK EQUIPMENT SUPPORT RING	1
6	410 SS SCREW (MAGNETIC)	3
7	PADLOCK (EXAMPLE; NOT INCLUDED)	1







SECTION B-B



UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ± 1/16
ANGULAR: 1°
TWO PLACE DECIMAL ± 0.01
THREE PLACE DECIMAL ± 0.005
INTERPRET GEOMETRIC TOLERANCING PER:
ASME Y14.5-2009

MATERIAL

FINISH

DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	MAB	01/02/13
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		

COMMENTS:
1in
[25.4mm]

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TITLE:
4" WELL CAP ASSEMBLY

SIZE B | PART NO. | REV

SCALE: 1:2 | WEIGHT: | SHEET 2 OF 2

Levelogger® Edge

Model 3001

The Levelogger Edge records highly accurate groundwater and surface water level and temperature measurements. It combines a pressure sensor, temperature detector, 10-year lithium battery, and datalogger, sealed within a 7/8" x 6.25" (22 mm x 159 mm) stainless steel housing with Titanium based PVD coating.

The Levelogger Edge measures absolute pressure using a Hastelloy pressure sensor, offering excellent durability and reliability. Combined with the Titanium based PVD coating, both elements have high corrosion resistance in harsh environments, allowing stable readings in extreme pressure and temperature conditions. The Hastelloy sensor can withstand 2 times over-pressure without permanent damage.

The Levelogger Edge features a wide temperature compensated pressure range (0 to 50°C, -10 to 50°C for Barologger Edge), and rapid thermal response time. The Levelogger Edge has high resolution and an accuracy of 0.05% FS. The convenient Barologger Edge provides the easiest and most accurate method of barometric compensation.

Applications

- Aquifer characterization: pumping tests, slug tests, etc.
- Watershed, drainage basin and recharge monitoring
- Stream gauging, lake and reservoir management
- Harbour and tidal fluctuation measurement
- Wetlands and stormwater run-off monitoring
- Water supply and tank level measurement
- Mine water and landfill leachate management
- Long-term water level monitoring in wells, surface water bodies and seawater environments

Fast communication and downloading speeds with a high speed Optical Reader

Features

- 0.05% FS Accuracy
- Corrosion resistant Titanium based PVD coating
- Robust Hastelloy pressure sensor
- Accurate temperature compensation
- Memory for up to 120,000 readings
- Basic and advanced data compensation options

The Levelogger Edge has a battery life of 10 years based on a 1-minute sampling rate. It has FRAM memory for 40,000 sets of data points – or up to 120,000 using the compressed linear sampling option.

The Levelogger Edge uses a Faraday cage design, which protects against power surges or electrical spikes caused by lightning. Its durable maintenance-free design, high accuracy and stability, make the Levelogger Edge the most reliable instrument for long-term, continuous water level recording.

Flexible Communication

Levelogger PC Software is streamlined, making it easy to program dataloggers, and to view and compensate data, in the office or in the field. The software has useful programming options, including compressed and repeat sampling, and future start/stop. Data compensation has been simplified, and allows multiple data files to be barometrically compensated at once.

The extremely intuitive Solinst Levelogger App, and Levelogger App Interface on your in-field Leveloggers, creates a Bluetooth® connection between your Leveloggers and smart device. Also an option, the DataGrabber is a field-ready, USB data transfer unit designed specifically for the Levelogger Series.

Remote monitoring options include the LevelSender, a simple and compact device that fits right in a 2" well, STS Telemetry Systems, and RRL Remote Radio Link. In addition, Levelogger Series dataloggers are SDI-12 compatible.

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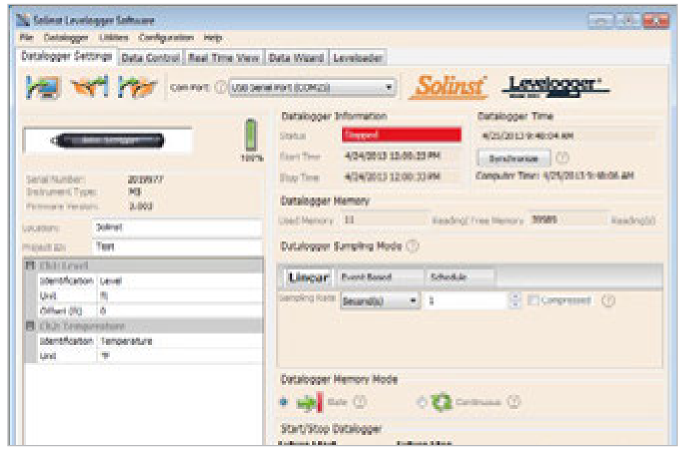
® Hastelloy is a registered trademark of Haynes International Inc.

Levelogger Setup

Programming Leveloggers is extremely intuitive. Simply connect to a PC using an Optical Reader or PC Interface Cable. All in one screen fill in your project information and sampling regime. Templates of settings can be saved for easy re-use.

The Levelogger time may be synchronized to the computer clock. There are options for immediate start or future start and stop times. The percentage battery life remaining and the amount of free memory are indicated on the settings screen.

Leveloggers can also be programmed with a sampling regime and start/stop times using the Solinst Levelogger App on your smart device.



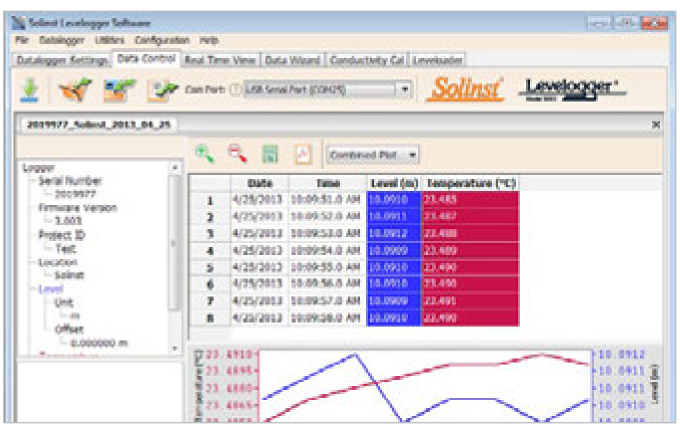
Levelogger Edge Settings Software Windows

Convenient Sampling Options

Leveloggers can be programmed with linear, event-based, or a user-selectable sampling schedule. Linear sampling can be set from 1/8 second to 99 hours. The Levelogger Edge can be programmed with compressed linear sampling, which increases memory from 40,000 to up to 120,000 readings.

Event-based sampling can be set to record when the level changes by a selected threshold. Readings are checked at the selected time interval, but only recorded in memory if the condition has been met. A default reading is taken every 24 hours if no "event" occurs.

The Schedule option allows up to 30 schedule items, each with its own sampling rate and duration. For convenience, there is an option to automatically repeat the schedule.



Data Download, Viewing and Export

Data is downloaded to a PC with the click of a screen icon. There are multiple options for downloading data, including 'Append Data' and 'All Data'. The software also allows immediate viewing of the data in graph or table format using the 'Real Time View' tab.

The level data is automatically compensated for temperature, and the temperature data is also downloaded. Barometric compensation of Levelogger data is performed using the Data Wizard, which can also be used to input manual data adjustments, elevation, offsets, density, and adjust for Barometric efficiency.

The software allows easy export of the data into a spreadsheet or database for further processing.

The Solinst Levelogger App also allows you to view and save real-time, or logged data right on your smart device.

Helpful Utilities

The 'Self-Test Diagnostic Utility' can be used in case of an unexpected problem. It checks the functioning of the program, calibration, backup and logging memories, the pressure transducer, temperature sensor and battery voltage, as well as enabling a complete Memory Dump, if required.

A firmware upgrade will be available from time to time, to allow upgrading of the Levelogger Edge, as new features are added.

Solinst Levelogger App & Levelogger App Interface

The Levelogger App Interface uses Bluetooth® technology to connect your Levelogger to your smart device. With the Solinst Levelogger App, you can download data, view real-time data, and program your Leveloggers. Data can be e-mailed from your smart device directly to your office (see Model 3001 Levelogger App & Interface data sheets).

Download on the App Store

GET IT ON Google play

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Standard Cable Deployment

Leveloggers may be suspended on a stainless steel wireline or Kevlar® cord. This is a very inexpensive method of deployment, and if in a well, allows the Levelogger to be easily locked out of sight and inaccessible. Solinst offers stainless steel wireline assemblies and Kevlar cord assemblies in a variety of lengths.

Solinst 3001 Well Cap Assembly

The 2" Locking Well Caps are designed for both standard and Direct Read Cable deployment options.

The well cap has a convenient eyelet for suspending Leveloggers using wireline or Kevlar cord. The Well Cap insert has two openings to accommodate Direct Read Cables for both a Levelogger and Barologger. Adaptors are available to fit 4" wells.

The cap is vented to equalize atmospheric pressure in the well. It slips over the casing, and the cap can be secured using a lock with a 3/8" (9.5 mm) shackle diameter.

Levelogger 2" Locking Well Cap Installations (see Well Caps data sheet for more details)

Direct Read Cables

When it is desired to get real-time data and communicate with Leveloggers without removal from the water, they can be deployed using Direct Read Cables. This allows viewing of the data, downloading and/or programming in the field using a portable computer, DataGrabber, or the Solinst Levelogger App and Interface.

Leveloggers can also be connected to an SDI-12 datalogger using the Solinst SDI-12 Interface Cable attached to a Direct Read Cable.

Cable Specifications

Direct Read Cables are available for attachment to any Levelogger in lengths up to 1500 ft. The 1/8" dia. (3.175 mm) coaxial cable has an outer polyethylene (MDPE) jacket for strength and durability. The stranded stainless steel conductor gives non-stretch accuracy.

Barologger and Levelogger installed in Well Using Direct Read Cables

Accurate Barometric Compensation

The Levelogger Edge measures absolute pressure (water pressure + atmospheric pressure) expressed in feet, meters, centimeters, psi, kPa, or bar.

The most accurate method of obtaining changes in water level is to compensate for atmospheric pressure fluctuations using a Barologger Edge, avoiding time lag in the compensation.

The Barologger is set above high water level in one location on site. One Barologger can be used to compensate all Leveloggers in a 20 mile (30 km) radius and/or with every 1000 ft. (300 m) change in elevation.

The Levelogger Software Data Compensation Wizard automatically produces compensated data files using the synchronized data files from the Barologger and Leveloggers on site.

The Barologger Edge uses pressure algorithms based on air rather than water pressure, giving superior accuracy.

The recorded barometric information can also be very useful to help determine barometric lag and/or barometric efficiency of the monitored aquifer.

The Barologger Edge records atmospheric pressure in psi, kPa, or mbar. When compensating submerged Levelogger Edge, Gold or Junior data, Levelogger Software Version 4 can recognize the type of Levelogger and compensate using the same units found in the submerged data file (Levelogger Gold and Junior measure in feet, meters, or centimeters). This makes the Barologger Edge backwards compatible.

Synchronize & Streamline Your Barometric Compensation Efforts, Across Your Entire Site

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Levelogger Edge Specifications

Level Sensor:	Piezoresistive Silicon with Hastelloy Sensor
Accuracy:	± 0.05% FS (Barologger Edge: ± 0.05 kPa)
Stability of Readings:	Superior, low noise
Units of Measure:	m, cm, ft., psi, kPa, bar, ºC. ºF (Barologger Edge: psi, kPa, mbar, ºC, ºF)
Normalization:	Automatic Temperature Compensation
Temp. Comp. Range:	0º to 50ºC (Barologger Edge: -10 to +50ºC)
Temperature Sensor:	Platinum Resistance Temperature Detector (RTD)
Temp. Sensor Accuracy:	± 0.05ºC
Temp. Sensor Resolution:	0.003°C
Battery Life:	10 Years - based on 1 reading/minute
Clock Accuracy:	± 1 minute/year (-20ºC to 80ºC)
Operating Temperature:	-20ºC to 80ºC
Maximum # Readings:	40,000 readings FRAM memory, or up to 120,000 using linear data compression
Memory Mode:	Slate and Continuous
Communication:	Optical Infrared Interface. Conversion to RS-232, USB, SDI-12. Serial at 9600 bps, 38,400 bps with USB
Size:	7/8" x 6.25" (22 mm x 159 mm)
Weight:	4.6 oz. (129 grams)
Corrosion Resistance:	Titanium based PVD coating
Other Wetted Materials:	Delrin®, Viton®, 316L stainless steel, Hastelloy, Titanium based PVD coating
Sampling Modes:	Linear, Event & User-Selectable with Repeat Mode, Future Start, Future Stop, Real-Time View
Measurement Rates:	1/8 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km radius)

Models	Full Scale (FS)	Accuracy
Barologger	Air only	± 0.05 kPa
M5	5 m (16.4 ft.)	± 0.3 cm (0.010 ft.)
M10	10 m (32.8 ft.)	± 0.5 cm (0.016 ft.)
M20	20 m (65.6 ft.)	± 1 cm (0.032 ft.)
M30	30 m (98.4 ft.)	± 1.5 cm (0.064 ft.)
M100	100 m (328.1 ft.)	± 5 cm (0.164 ft.)
M200	200 m (656.2 ft.)	± 10 cm (0.328 ft.)

Low Cost Datalogging: See Levelogger Junior Edge Data Sheet.
Vented Dataloggers: See LevelVent and AquaVent Data Sheets.
Conductivity Datalogging: See LTC Levelogger Edge Data Sheet

DataGrabber™

The DataGrabber is a field-ready data transfer device that allows you to copy data from a Levelogger, onto a USB flash drive key.

The DataGrabber is compact and very easy to transport. It connects to the top end of a Levelogger's Direct Read Cable, or an Adaptor is available to allow direct connection to a Levelogger.

One push-button is used to download all of the data in a Levelogger's memory to a USB device plugged into the DataGrabber. A convenient LED light indicates the operation of the DataGrabber. The data in the Levelogger memory is not erased, and logging is not interrupted if the Levelogger is still running. The DataGrabber uses its own replaceable 9V battery.

LevelSender Telemetry

The LevelSender is a simple, low cost telemetry system designed to send data from Leveloggers in the field, to your smart device and PC database via cellular communication.

Initial set up is done through a user-friendly software wizard at the Home Station. There is two-way communication between the LevelSender and Home Station, allowing remote updates.

Each LevelSender device has a single port to connect one Levelogger with an optional splitter that allows the connection of a Barologger.

LevelSender stations are compact in design, which allows them to be discreetly installed inside a 2" (50 mm) well (see Model 9500 data sheet).

STS Telemetry

The STS Telemetry System provides an efficient method to send Levelogger data from the field to your desktop. Cellular communication options give the flexibility to suit any project. STS Systems are designed to save costs by enabling the self-management of data. Alarm notification, remote firmware upgrades and diagnostic reporting make system maintenance simple (see Model 9100/9200 data sheet).

RRL Telemetry

The RRL Remote Radio Link is ideal for short range applications up to 20 miles or 30 km; distances can be increased by using radios as relay stations. Ideal for creating closed-loop monitoring networks using Leveloggers (see Model 9100/9200 data sheet).

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For further information contact: Solinst Canada Ltd.
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35 Todd Road, Georgetown, Ontario Canada L7G 4R8
Web Site: www.solinst.com E-mail: instruments@solinst.com

USGS TopSet Wading Rod, 1.2m

Price:	Item No.:	Weight:
$400.00	105-008	6.00 LBS

Quantity: 1 ADD TO CART

Add to Wish List

Click the button below to add the USGS TopSet Wading Rod, 1.2m to your wish list.

ADD TO WISH LIST

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Product Overview

The standard USGS Top Setting Wading Rod is intended for use with the Type AA and pygmy current meters. It is designed for measuring shallow streams, with the standard English rod marked in feet and tenths and comes in 4, 6 and 8-foot long models. The standard metric rod marked in centimeter increments with a length of 1.2 meters. These wading rods also are available in lengths (up to 10 feet or 3 meters long) as desired by the customer. The anodized aluminum handle has an integral scale to indicate the correct setting of the current meter at the 0.2, 0.6 and 0.8- depth settings, which corresponds to the conventional two- position method. This unit permits convenient setting of the current meter at the proper depth. It allows the hydrologist to quickly set the meter at the correct depth without bringing the meter out of the water. The depth of the water is read on the graduated hex main rod. When the round setting rod is adjusted to the depth of the water, the current meter is automatically positioned for the 0.6-depth method (0.4-depth position up from the streambed). Setting the unit to half the water depth will place the meter at the 0.2-depth up from the streambed. Conversely, setting the unit to twice the water depth will place the meter at the 0.8-depth position up from the streambed. The latter two positions correspond to the conventional two-position method. The electrical lead to the current meter is supplied, and a standard plug is fitted into the handle to accept the leads from a headphone, counter or AquaCalc 5000. The commonly used two prong connector can also be supplied as required. All parts are made of stainless steel, anodized aluminum and brass.

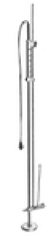
Vernier Setting	Actual Current Meter Position
Exact Water Depth	0.4 up from the streambed
Twice Water Depth	0.2 up from the streambed
1/2 Water Depth	0.8 up from the streambed

Wading Rod, TopSet, 1.2m

Accessories

Rickly IMAGE COMING SOON

Rickly IMAGE COMING SOON



USGS TopSet Wading Rod, 8ft
$470.00

Electronic TopSet Wading Rod, 1.2m
$430.00

USGS TopSet Wading Rod, 2.4m
$490.00

AquaRod TopSet Wading Rod, 1.2m
$470.00

Breakdown TopSet Wading Rod, 1.2m
$455.00

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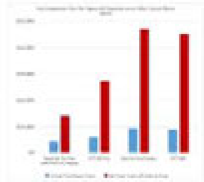
Cost and Accuracy Comparisons



Mechanical Current Meter System with AquaCalc Versus Other Point Velocity Discharge Systems
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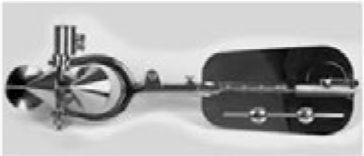
Home | Stream Gaging Equipment | Current Meters | USGS Type AA Current Meters | USGS Type AA Current Meter



USGS Type AA Current Meter

Price: $795.00 | Item No.: 101-001 | Weight: 8.00 LBS

Quantity: 1 ADD TO CART

Add to Wish List

Click the button below to add the USGS Type AA Current Meter to your wish list.

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Product Overview | Product Videos

The USGS Type AA current meter is commonly known as the Price-type current meter. This current meter is suspended in the water using a cable with sounding weight or wading rod (taking the tail section off) and will accurately measure streamflow velocities from 0.1 to 25 feet per second (0.025 to 7.6 meters per second). The main features of this meter are the uniquely designed bucket wheel shaft bearings and the two post contact chamber. The bucket wheel has six conical shaped cups, is five inches (12.7 cm) in diameter and rotates on a vertical axis inside the yoke. The tungsten carbide bearings for the bucket wheel shaft are located in deeply recessed inverted cups. When the meter is in use, these cups become air chambers and the entrapped air effectively excludes water and silt from the bearing surfaces giving extremely low starting velocities and minimal friction in the bearings.

The contact chamber houses a penta gear and two binding posts, each having a fine platinum alloy contact wire. One wire makes contact with the bucket wheel shaft once during every revolution; the other is used when fast velocities are encountered, and makes contact with the penta gear once during every five revolutions of the bucket wheel.

Each current meter is provided with a U.S. Geological Survey approved standard rating table to convert bucket revolutions to stream velocity in either English units (feet per second) or metric units (meters per second), spare parts, instrument oil, cleaning cloth, screwdriver and an instrument case with a water tight o-ring seal that floats if dropped in the water and provides proper protection of the meter during transportation and storage.

The meter is made from brass and stainless steel and all exposed surfaces are chrome plated for corrosion-free service. The standard Type AA was designed for use with all of the counters as well as the AquaCalc 5000 Digital Flow Computer. No conversion kits or replacement contact chambers are necessary to use the latest digital technology with this meter.

Accessories

USGS TopSet Wading Rod, 4ft
$380.00

AquaCalc 5000 Computer
$2,000.00

Headphone, Two Ear
$70.00

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3

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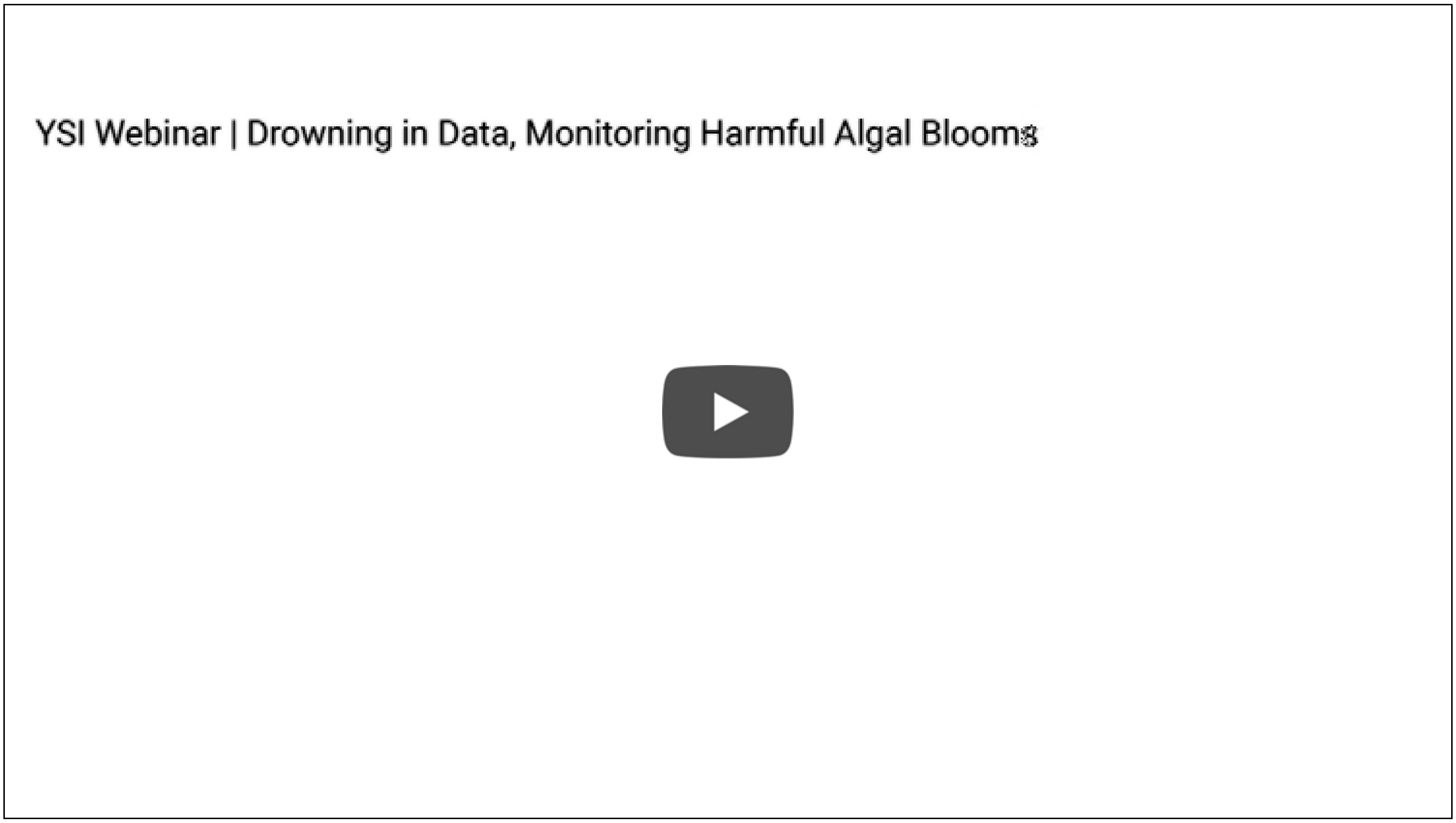
EXO Multiparameter Sondes



EXO advanced water quality monitoring platform for continuous field water quality measurements in challenging conditions.

Price: Request Pricing

SKU: 599960

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Enhanced interface for the EXO platform

In water quality monitoring, instruments must hold up to harsh conditions. Rain or shine, sleet or snow, your equipment needs to keep up with you.

Download the EXO Handheld Operation Mini-Manual (https://www.ysi.com/File%20Library/Documents/Manuals/E117-EXO-Handheld-Operation-Mini-Manual.pdf)

Overview

Specifications

Autostable:	Yes
Cable Options:	Any EXO field cable

Certifications:	CEC, CE; RoHS; IP-67; WEEE; FCC; UN Part III, Section 38.3, Test methods for lithium-ion batteries (Class 9)
Connector:	Wet-mate connectors
Desktop Software Compatible:	KOR software for the EXO platform
Equipment used with:	Any EXO Sonde
GPS:	Yes
Graphic Display:	Graphic display with detailed help menus and auto-sized dashboard text based on number of sensors
Keypad:	Yes
Languages:	German, English, Spanish, Italian, Norwegian, Traditional Chinese, French, Simplified Chinese, Japanese, Portuguese
Logging Capabilities:	> 100,000 data sets with single point or continuous logging with autostability option
Operating Temperature:	0 to 50 °C (32 to 122 °F)
Power:	Rechargeable lithium-ion battery pack provides ~48 hours if powering the handheld only and ~20 hours if powering the handheld, sonde and four sensors; battery recharge time is ~9 hours with the AC power adapter. The instrument can also be powered via AC or external power pack though the USB port.
Sampling:	Yes
Size:	Instrument: 8.3 cm width x 21.6 cm length x 5.6 cm depth (3.27 in x 8.5 in x 2.21 in)
Storage Temperature:	0 to 45 °C (32 to 113 °F) with battery installed; 0 to 60 °C (32 to 140 °F) without battery installed. Note: Storing Li-Ion batteries in cool environments will help extend their lifespan.
User Calibratable:	Yes, 400 detailed calibration records can be stored and are available to view, download and print for traceability.
Warranty:	3-year handheld; 1-year Li-ion battery pack
Waterproof:	Floats, IP-67
Weight:	Weight with Battery, 567 grams (1.25 lbs)

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EXO - State-of-the-art Water Quality Monitoring Platform

Live Chat

EXO, a state-of-the-art water quality monitoring platform, is designed to address the many challenges of collecting accurate field data in the natural environment. In this video you will learn about the EXO sondes and EXO's innovative features, including: Universal smart sensors; Expansive and high-performance sensor suite; and Extremely rugged design for deeper depths and longer deployments.

Price: Request Pricing

Option: EXO1 Sonde, No Depth, 4 Sensor Ports

SKU: 599501-00

Request a Quote (/request-a-quote)

4-Port Multiparameter Water Quality Sonde

Instrument Only. Cables, probes/sensors, and accessories sold separately.

Overview

Specifications

Depth / Pressure Rating / Limit:	0 to 250 m (0 to 820 ft)
Desktop Software Compatible:	KOR for EXO
Flow Cell:	Yes

Languages:	Chinese, German, Japanese, French, Spanish, English
Logging Capabilities:	Yes
Medium:	Fresh, sea or polluted water
Memory:	>1,000,000 logged readings, 512 MB total memory
Multiparameter:	Yes
Operating Temperature:	-5 to +50°C
Power:	2 Alkaline Batteries
Sampling:	Yes
Smart Sensors / Ports:	Yes
Storage Temperature:	-20 to +80°C
Unit of Measure:	Parameter Dependent
User Calibratable:	Yes
Waterproof:	Yes

EXO1 Specifications	
Battery Life	90 days*
Communications	Computer Interface: Bluetooth wireless technology (between sonde and handheld or computer with KOR software), USB Output Options: USB with signal output adapter (SOA); RS-232 & SDI-12 with DCP-SOA.
Diameter	4.70 cm (1.85 in)
Length	64.77 cm (25.50 in)
Peripheral Ports	1 power communication port
Sample Rate	Up to 4 Hz
Sensor Ports	4
Warranty: 3 mos	Replaceable reagent modules for ammonium, chloride, and nitrate
Warranty: 1 yr	Optical DO membranes and replaceable reagent modules for pH and pH/ORP
Warranty: 2 yrs	Cables; sonde bulkheads; handheld; conductivity, temperature, depth, and optical sensors; electronics base for pH, pH/ORP, ammonium, chloride, and nitrate sensors; and accessories
Weight	1.42 kg (3.15 lbs)

*Typically 90 days at 20°C at 15-minute logging interval; temperature/conducti turbidity sensors installed on EXO1. Battery life is heavily dependent on sensor configuration.

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
Ammonium *(freshwater only)*	Ammonium Sensor *Ammonia with pH sensor* SKU: 599710 (/Product/id-599710/EXO-Ammonium-Smart-Sensor)	0 to 200 mg/L (0 to 30°C)	±10% of reading or 2 mg/L-N, w.i.g.	T63<30 sec	0.01 mg/L
Barometric Pressure	Integral Barometer	375 to 825 mmHg	±1.5 mmHg from 0 to 50°C	-	0.1 mmHg
Blue-green Algae, Phycocyanin	Total Algae Sensor SKU: 599102-01 (/Product/id-599102-01/EXO-Total-Algae-PC-Smart-Sensor)	0 to 100 µg/L; 0 to 100 RFU;	Linearity: R^2 >0.999 for serial dilution of Rhodamine WT solution from 0 to 100 µg/mL BGA-PC equivalents	T63<2 sec	0.01 µg/L; 0.01 RFU
Blue-green Algae, Phycoerythrin	Total Algae Sensor SKU: 599103-01 (/Product/id-599103-01/EXO-Total-Algae-PE-Smart-Sensor)	0 to 280 µg/L; 0 to 100 RFU;	Linearity: R^2 >0.999 for serial dilution of Rhodamine WT solution from 0 to 280 µg/mL BGA-PE equivalents	T63<2 sec	0.01 µg/L; 0.01 RFU
Chloride *(freshwater only)*	Chloride Sensor SKU: 599711 (/Product/id-599711/EXO-Chloride-Smart-Sensor)	0 to 18000 mg/L-Cl (0 to 30°C)	±15% of reading or 5 mg/L-Cl, w.i.g.	T63<30 sec	0.01 mg/L
Chlorophyll	Total Algae Sensor SKU: 599102-01 (/Product/id-599102-01/EXO-Total-Algae-PC-Smart-Sensor), 599103-01 (/Product/id-599103-01/EXO-Total-Algae-PE-Smart-Sensor)	0 to 400 µg/L Chl; 0 to 100 RFU	Linearity: R^2 >0.999 for serial dilution of Rhodamine WT solution from 0 to 400 µg/L Chl *a* equivalents	T63<2 sec	0.01 µg/L Chl; 0.01 RFU
Conductivity[1]	Conductivity / Temperature Sensor SKU: 599870 (https://www.ysi.com/Product/id-599870/EXO-Conductivity--Temperature-Smart-Sensor)	0 to 200 mS/cm	0 to 100: ±0.5% of reading or 0.001 mS/cm, w.i.g.; 100 to 200: ±1% of reading	T63<2 sec	0.0001 to 0.01 mS/cm (range dependent)

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
Depth - 10 m	Integral, Non-vented Depth Sensor[3]	0 to 10 m (0 to 33 ft)	±0.04% FS (±0.004 m or ±0.013 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
Depth - 100 m	Integral, Non-vented Depth Sensor[3]	0 to 100 m (0 to 328 ft)	±0.04% FS (±0.04 m or ±0.13 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
Depth - 250 m	Integral, Non-vented Depth Sensor[3]	0 to 250 m (0 to 820 ft)	±0.04% FS (±0.10 m or ±0.33 ft)	T63<2 sec	0.001 m (0.001 ft) (auto-ranging)
Dissolved Oxygen, % air saturation	Optical Dissolved Oxygen Sensor SKU: 599100-01 (/Product/id-599100-01/EXO-Optical-Dissolved-Oxygen-Smart-Sensor)	0 to 500% air saturation	0 to 200%: ±1% of reading or 1% saturation, w.i.g.; 200 to 500%: ±5% of reading [4]	T63<5 sec[5]	0.1% air saturation
Dissolved Oxygen, mg/L	Optical Dissolved Oxygen Sensor SKU: 599100-01 (/Product/id-599100-01/EXO-Optical-Dissolved-Oxygen-Smart-Sensor)	0 to 50 mg/L	0 to 20 mg/L: ±0.1 mg/L or 1% of reading, w.i.g.; 20 to 50 mg/L: ±5% of reading [4]	T63<5 sec[5]	0.01 mg/L
fDOM *(CDOM)*	fDOM Sensor SKU: 599104-01 (/Product/id-599104-01/EXO-fDOM-Smart-Sensor)	0 to 300 ppb Quinine Sulfate equivalents (QSU)	Linearity: R2 > 0.999 for serial dilution of 300 ppb QS solution Detection Limit: 0.07 ppb QSU	T63<2 sec	0.01 ppb QSU
Level, Vented - 10 m	Integral Vented Level Sensor	0 to 10 m (0 to 33 ft)	±0.03% FS (±0.003 m or ±0.010 ft)	T63<2 sec	0.001 m (0.001 ft)
Nitrate *(freshwater only)*	Nitrate Sensor SKU: 599709 (/Product/id-599709/EXO-Nitrate-Smart-Sensor)	0 to 200 mg/L-N (0 to 30°C)	±10% of reading or 2 mg/L-N, w.i.g.	T63<30 sec	0.01 mg/L

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
pH	pH Sensor SKU:599701 guarded (/Product/id-599701/EXO-pH-Smart-Sensor), 599702 unguarded (/Product/id-599702/EXO-pH-Smart-Sensor) pH/ORP Sensor SKU:599705 guarded (/Product/id-599705/EXO-pH--ORP-Smart-Sensor), 599706 unguarded (https://www.ysi.com/Product/id-599706/EXO-pH--ORP-Smart-Sensor)	0 to 14 units	±0.1 pH units within ±10°C of calibration temp; ±0.2 pH units for entire temp range[7]	T63<3 sec[8]	0.01 units
ORP	pH/ORP Sensor SKU:599705 guarded (/Product/id-599705/EXO-pH--ORP-Smart-Sensor), 599706 unguarded (https://www.ysi.com/Product/id-599706/EXO-pH--ORP-Smart-Sensor)	-999 to 999 mV	±20 mV in Redox standard solution	T63<5 sec[6]	0.1 mV
Temperature	Conductivity / Temperature Sensor SKU: 599870 (https://www.ysi.com/Product/id-599870/EXO-Conductivity--Temperature-Smart-Sensor)	-5 to 35°C 35 to 50°C	±0.01°C[2] ±0.05°C[2]	T63<1 sec	0.001 °C
Turbidity[9]	Turbidity Sensor SKU: 599101-01 (/Product/id-599101-01/EXO_Turbidity_Smart_Sensor)	0 to 4000 FNU	0 to 999 FNU: 0.3 FNU or ±2% of reading, w.i.g.; 1000 to 4000 FNU: ±5% of reading[10]	T63<2 sec	0 to 999 FNU = 0.01 FNU; 1000 to 4000 FNU = 0.1 FNU
Salinity	Calculated from Conductivity and Temperature[11]	0 to 70 ppt	±1.0% of reading or 0.1 ppt, w.i.g.	T63<2 sec	0.01 ppt
Specific Conductance	Calculated from Conductivity and Temperature[11]	0 to 200 mS/cm	±0.5% of reading or .001 mS/cm, w.i.g.	-	0.001, 0.01, 0.1 mS/cm (auto-scaling)

EXO Parameter Measured	Sensor**	Range	Accuracy	Response	Resolution
Total Dissolved Solids (TDS)	Calculated from Conductivity and Temperature[11]	0 to 100,000 mg/L Cal constant range 0.30 to 1.00 (0.64 default)	Not Specified	-	Variable
Total Suspended Solids (TSS)	Calculated from Turbidity and user reference samples	0 to 1500 mg/L	Not specified	T63<2 sec	Variable

**Specifications indicate typical performance and are subject to change. All sensors have a depth rating to 250 m (820 ft), except shallow and medium depth sensors, ammonium, chloride, and nitrate. Accuracy specification is attained immediately following calibration under controlled and stable environmental conditions. Performance in the natural environment may vary from quoted specification.
w.i.g. = whichever is greater

EXO sensors are not compatible with YSI 6-Series sondes, sensors, or handheld.

[1]Outputs of specific conductance (conductivity corrected to 25°C) and total dissolved solids are also provided. See Calculated Parameters and footnote 11.
[2] Temperature accuracy traceable to NIST standards
[3]Accuracy specifications apply to conductivity levels of 0 to 100,000 µS/cm.
[4] Relative to calibration gases
[5] When transferred from air-saturated water to stirred deaerated water
[6] When transferred from water-saturated air to Zobell solution
[7]Within the environmental pH range of pH 4 to pH 10.
[8]On transfer from water-saturated air to rapidly stirred air-saturated water at a specific conductance of 800 µS/cm at 20°C; T63<5 seconds on transfer from water-saturated air to slowly-stirred air-saturated water.
[9] Calibration: 1-, 2-, or 3-point, user-selectable
[10] Performance based on 3-point calibration done with YSI AMCO-AEPA standards of 0, 124, and 1010 FNU. The same type of standard must be used for all calibration points.
[11] Values are automatically calculated from conductivity according to algorithms found in *Standard Methods for the Examination of Water and Wastewater* (Ed. 1989).

Xenoy is a trademark of SABIC Innovative Plastics IP BV.

EXO Bluetooth modules comply with Part 15C of FCC Rules and have FCC, CE Mark and C-tick approval. Bluetooth-type approvals and regulations can be country specific. Check local laws and regulations to insure that the use of wireless products purchased from Xylem are in full compliance.

Accessories

Video

Reviews

Application Notes

Brochures and Catalogs

Guides

Infographics

Manuals

News Briefs

Technical Notes

Tips

You may also need

(/Accessory/id-599680/EXO1-Replacement-O-Ring-Kit)

EXO1 Replacement O-Ring Kit (/Accessory/id-599680/EXO1-Replacement-O-Ring-Kit)

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details (/Accessory/id-599680/EXO1-Replacement-O-Ring-Kit)

(/Accessory/id-599020-01/EXO1-Hard-Sided-Wheeled-Carrying-Case)

EXO1 Hard Sided Wheeled Carrying Case (/Accessory/id-599020-01/EXO1-Hard-Sided-Wheeled-Carrying-Case)

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(/EXO-HH)

EXO Handheld Displ (/EXO-HH)

Enhanced interface for the E platform.

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Live Chat

Carrying-Case)

APPENDIX E

FIELD FORMS

(Included as Attachments to the PDF Document)

Johnston Leigh Inc.

Page ______ of ______

Date: __________ Project No. __________ Field Geo/Eng __________

Client: __________ Project __________ Location __________

Personnel On Site:

Name	Employer	PPE Level	Time On	Time Off

Weather Conditions: __________

Temperature __________ Wind Direction: __________ Wind Speed: __________

Tasks to be completed: __________

____

Personal Protective Equipment

Initial to document PPE used:

Fire Retardant Coverall __________ Hearing Protection __________

Gloves (type) __________ Hard hat __________

Boots __________ Eye Protection __________

Respirator __________ Cartridge Type __________

Monitoring Equipment

Indicate Manufacture and Model:

Water Level Meter __________ Barologger __________

Peristaltic Pump __________ Pressure Transducer __________

PID __________ Water Meter __________

Calibration

Indicate Standards Used and Meter Calibration Response

pH Standards __________

Conductivity Standards __________

Turbidity Standards __________

Time/Duration/Description of Daily Activities/Events

Johnston Leigh Inc.

Continue on Reverse Side if Needed

Time/Duration/Description of Daily Activities/Events

Well Gauging Form A
Freshwater Baseline Monitoring

Date:

Weather conditions:

	Well	Well Acronym	Time	Date	Depth to Groundwater	Constructed Well Depth	Screen Interval	Depth Snap Sampler	Depth Low Flow Pump	Pressure Transducer Depth
					(ft)	(ft)	(ft)	(ft)	(ft)	(ft)
	Playa Perimeter Wells									
1	Headlight Gap (HLG)	HLG							207-210	
2	Provo (PRO)	PRO				460.00	260-460	270-276		
3	SN2-11-400-4 (SN2)	SN2				497	347-497	406-411		
4	Machine Gun (MCG)	MCG				102	98-102		101-104	
	Playa Perimeter Well									
	Alluvial/Colluvium Wells									
5	257 Cutoff	257				60	45-60	50-56		
6	Mudhole	MUD				503.00	338-365		370-370	30
7	Guzzler	GUZ				425.00	325-425	385-389		
8	Bonneville	BON				315.00	210-310	215-221		
9	Black Rock	BKR				250.00	50-84			
10	Miller Canyon Reservoir	MCR				315.00	245-315	272-278		
11	Crystal Peak Road	CPR				195.00	177-195		185-188	
12	Lakeview	LKV				532.00	420-500	94-100		130
	Tailings West									
	Tailings North									
	Bedrock Wells									
13	North Cricket	NCT				780.00	580-780	661-667		550
14	Monument Point	MNP				1215.00	1030-1210	1155-1161		350
15	Nighthawk	NTH				780.00	580-780	608-614		410
16	Coyote	CYT				765.00	560-760	705-711		400
17	Black Hills	BKH				560.00			540-543	230
	Bedrock 1 West									
	Water Supply 1									
	Water Supply 1									
	Water Supply 1									
	Water Supply 1									

Well ______ Date: ______ Sampler: ______
Weather: ______ Purge Method: Circle One ISS Low Flow
DTW: ______ Boring Dia: ______ Well Dia: ______ Well Depth: ______ Screen Interval: ______
Snap Sampler Depth: ______ Low Flow Pump Depth: ______

ISS Method

Sample Depth Interval: ______ # Snap Bottles: ______ Snap Bottles Volume: ______
Snap Trigger Pressure: Snap Trigger Time:

Temperature (F of C)	pH	Conductivity (ms/cm)	DO (mg/l)	Turbidity (NTU)	Appearance	Sample Time:
						Sample ID:
						Blind Dup:

No. Laboratory Containers: ______
125 ml Anions - No Preservative: ______
250 ml Dissolved Metals - No Preservative: ______
250 ml N02, N03, Phosphorus - H2SO4 preservative: ______
250 ml TDS, Mercury, SC - No Preservative: ______
pH, Alkalinity - No Preservative: ______

Low Flow Method

Purge Calculator ______ X ______ + ______ = ______
Tubing Length (ft) Tubing DF Stable SW Volume (ml) Purge Volume (ml)

Tubing Diameter Factors (DF)	3/8" =	9.84 ml/ft	1/2" =	38 ml/ft	5/8" =	60ml/ft		
Stable SW Volume ml:	2" well =	617.46 ml/ft	4" well=	2467.80 ml/ft	5" well=	3859.15 ml/ft	6" well=	5557.18 ml/ft

Time	Purge Rate	Temperature (F of C)	pH	Conductivity (ms/cm)	DO (mg/l)	Turbidity (NTU)	Fill - Discharge time: Fill	Discharge	Drawdown (SW) (ft)

No. Laboratory Containers: ______
125 ml Anions - No Preservative: ______
250 ml Dissolved Metals - No Preservative: ______
250 ml N02, N03, Phosphorus - H2SO4 preservative: ______
250 ml TDS, Mercury, SC - No Preservative: ______
pH, Alkalinity - No Preservative: ______

Sample Time:
Sample ID:
Blind Dup:

Ship Date: ______
Ship to: Pace Laboratory
12065 LeBanon Pike
Mount Juliet, TN 37122
(615) 758-5858

If field parameters do not stabilize within 30 minutes after purge volume has been removed, record the final measurement and collect groundwater sample.

Sampler Signature: ______

Johnston Leigh Inc.

Form C
Surface Water Sample Log
Sevier Playa Potash Project

Location: ____________________ Date: __________ Sampler: ____________________

Weather: ____

Wading Stick Used: ____________________ Flow Meter Used: ____________________

Sketch Cross Section Area of Measurment Area

Flow 0.2

Flow 0.6

Flow 0.8

Ave Flow

Average Flow Cross Section Area: ____________________

Bucket Flow Rate: 1st __________ 2nd __________ 3rd __________ Average: __________

Field Measurments:

Temperature (F of C)	pH	Conductivity (ms/cm)	DO (mg/l)	Turbidity (NTU)	Appearance	Notes

Ship Date: ____________________

Ship To: Pace Laboratory
12065 LeBanon Pike
Mount Juliet, TN 37122
(615) 758-5858

Sample Time
Sample ID:

Sampler Signature: ____________________

APPENDIX F

CHAIN-OF-CUSTODY FORMS

(Included as Attachments to the PDF Document)

Billing Information:

Pres Chk

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES

a subsidiary of Pace Analytical

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to:

Email To:

Project Description:

City/State Collected:

Phone:
Fax:

Client Project #

Lab Project #

L #

Table #

Collected by (print):

Site/Facility ID #

P.O. #

Acctnum:

Template:

Prelogin:

TSR:

PB:

Shipped Via:

Collected by (signature):

Immediately Packed on Ice N ____ Y ____

Rush? (Lab MUST Be Notified)

___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs											Remarks	Sample # (lab only)

* Matrix:
SS - Soil **AIR** - Air **F** - Filter
GW - Groundwater **B** - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other_________

Remarks:

pH _______ Temp _______

Flow _______ Other _______

Samples returned via:
__ UPS __ FedEx __ Courier __ ______

Tracking #

Sample Receipt Checklist
COC Seal Present/Intact: __NP __Y __N
COC Signed/Accurate: __Y __N
Bottles arrive intact: __Y __N
Correct bottles used: __Y __N
Sufficient volume sent: __Y __N
If Applicable
VOA Zero Headspace: __Y __N
Preservation Correct/Checked: __Y __N

Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Trip Blank Received: Yes / No HCL / MeoH TBR	
Relinquished by : (Signature)	Date:	Time:	Received by: (Signature)	Temp: °C Bottles Received:	If preservation required by Login: Date/Time
Relinquished by : (Signature)	Date:	Time:	Received for lab by: (Signature)	Date: Time:	Hold: Condition: NCF / OK

ATTACHMENT D

Example Data Validation Summary

To: ***
From: ***
Date: ***
Subject: Data Validation Summary for *** Sampling Event

Stations Not Sampled

- The pump in well MW-A was pulled for repair.

Receiving Temperatures

- Receiving temperatures for all samples were between 0 °C and 6 °C, with none frozen. Given that all receiving temperatures were within the desired range, no Extended Qualifiers were assigned by XYZ Laboratory.

Cooler ID	Receiving Temperature (ºC)	Laboratory Batch	Sample ID
1234	4.0	ABC1-01	MW-B
		ABC1-02	MW-C
5678	4.6	ABC3-01	MW-D
9101	2.5	ABC4-01	MW-E
		ABC4-02	MW-F
1213	0.6	ABC6-01	MW-G
		ABC6-02	MW-H
1415	4.2	ABC7-01	MW-I

Holding Times

- All samples were analyzed past holding time for lab pH. Samples flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.
- Sample from MW-B, lab turbidity, was analyzed past holding time. Sample flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.
- Sample from MW-C, lab turbidity, was analyzed past holding time. Sample flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.
- Sample from MW-D, lab turbidity, was analyzed past holding time. Sample flagged by XYZ Laboratory with 'H'. Validation Flag 'J' assigned.

Sample ID	Parameter	Received	Analyzed	Lab Extended Qualifier
MW-H	pH, Lab	1 Day 21 Hrs	2 Day 15 Hrs	
MW-B	pH, Lab	1 Day 19 Hrs	4 Day 0 Hrs	
MW-C	pH, Lab	2 Day 0 Hrs	2 Day 17 Hrs	
MW-D	pH, Lab	1 Day 23 Hrs	3 Day 13 Hrs	
MW-E	pH, Lab	1 Day 22 Hrs	3 Day 13 Hrs	
MW-F	pH, Lab	1 Day 18 Hrs	3 Day 8 Hrs	
MW-G	pH, Lab	1 Day 2 Hrs	2 Day 16 Hrs	
MW-B	Turbidity, Lab	1 Day 19 Hrs	2 Day 21 Hrs	HE
MW-C	Turbidity, Lab	2 Day 0 Hrs	2 Day 2 Hrs	H3
MW-D	Turbidity, Lab	1 Day 23 Hrs	2 Day 0 Hrs	HE

Original and Duplicate Sample

- **Radiologic**
  - All original and duplicate pairs had intersecting error bands.

Station	Parameter	Original	Duplicate
MW-G	Gross alpha, total	4.8±3.2	5.4±3.5
	Gross beta, total	10±3.6	12±4
	Radium 226, total	0.19±0.1	0.28±0.09
	Radium 228, total	0.63±0.65	2.1±1.2

- **RPDs**
  - Total iron had an RPD of 40.0%; however, both results were detected below the PQL, therefore no Validation Flag assigned for total iron.
  - Dissolved iron had an RPD of 40.0%; however, both results were detected below the PQL, therefore no Validation Flag assigned for dissolved iron.
  - Dissolved zinc had an RPD of 40.0%. One result was non-detect and the other result was detected below the PQL. A qualifier cutoff value (QCV) was calculated at 5 times the detected value. All results in the batch detected below the QCV (MW-C, MW-D, MW-H) were flagged as estimated ('J').
  - All other parameters were non-detect for original and duplicate samples or had an RPD less than 25%.

TDS Ratio

- Sample collected from well MW-E had a TDS ratio of 1.31.
- All other TDS ratios were within range of >0.80 and <1.20.

Sample ID	Sample	Parameter	Value	Result
MW-I	Original	TDS ratio, measured/calculated	1.09	Normal
MW-B	Original	TDS ratio, measured/calculated	1.03	Normal
MW-C	Original	TDS ratio, measured/calculated	0.99	Normal
MW-D	Original	TDS ratio, measured/calculated	1.04	Normal
MW-E	Original	TDS ratio, measured/calculated	1.31	High
MW-F	Duplicate	TDS ratio, measured/calculated	1.04	Normal
MW-G	Original	TDS ratio, measured/calculated	1.02	Normal
MW-H	Original	TDS ratio, measured/calculated	0.97	Normal

Cation-Anion Balance

- All samples had a cation-anion balance of less than five percent.

Sample ID	Sample	Parameter	Value (%)	Result
MW-I	Original	Cation-Anion Balance	0.00	Normal
MW-B	Original	Cation-Anion Balance	2.90	Normal
MW-C	Original	Cation-Anion Balance	2.90	Normal
MW-D	Original	Cation-Anion Balance	1.30	Normal
MW-E	Original	Cation-Anion Balance	3.00	Normal
MW-F	Duplicate	Cation-Anion Balance	0.00	Normal
MW-G	Original	Cation-Anion Balance	1.60	Normal
MW-H	Original	Cation-Anion Balance	1.10	Normal

	Original (MW-G)			Duplicate (MW-I)			
	Result	MDL	PQL	Result	MDL	PQL	RPD
Major Ions and Solution Parameters							
pH, lab	8.5	0.1	0.1	8.5	0.1	0.1	0.0%
Total alkalinity	400	2	20	400	2	20	0.0%
Bicarbonate alkalinity	375	2	20	372	2	20	0.8%
Carbonate alkalinity	24.2	2	20	28.2	2	20	15.3%
Hydroxide alkalinity	<2	2	20	<2	2	20	0.0%
Hardness	70	0.2	5	69	0.2	5	1.4%
Calcium, dissolved	15.5	0.1	0.5	15.3	0.1	0.5	1.3%
Magnesium, dissolved	7.6	0.2	1	7.4	0.2	1	2.7%
Sodium, dissolved	182	0.2	1	179	0.2	1	1.7%
Potassium, dissolved	7	0.2	1	6.9	0.2	1	1.4%
Chloride	13.0	0.5	2.5	13.0	0.5	2.5	0.0%
Fluoride	3.01	0.05	0.25	3.01	0.05	0.25	0.0%
Bromide	<0.05	0.05	0.25	<0.05	0.05	0.25	0.0%
Sulfate	44.0	0.5	2.5	44.1	0.5	2.5	0.2%
TDS, filterable @ 180C	526	10	20	532	10	20	1.1%
Nutrients							
Nitrate/nitrite	0.27	0.02	0.1	0.27	0.02	0.1	0.0%
Ammonia	0.74	0.05	0.2	0.75	0.05	0.2	1.3%
Phosphorus, dissolved	<0.02	0.02	0.05	<0.02	0.02	0.05	0.0%
Phosphorus, total	<0.02	0.02	0.05	<0.02	0.02	0.05	0.0%
Dissolved Metals							
Aluminum	<0.03	0.03	0.2	<0.03	0.03	0.2	0.0%
Antimony	<0.0004	0.0004	0.002	<0.0004	0.0004	0.002	0.0%
Arsenic	0.0388	0.0002	0.001	0.0393	0.0002	0.001	1.3%
Barium	0.124	0.003	0.02	0.123	0.003	0.02	0.8%
Beryllium	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Boron	2.35	0.01	0.05	2.30	0.01	0.05	2.2%
Cadmium	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Chromium	<0.0005	0.0005	0.002	<0.0005	0.0005	0.002	0.0%
Copper	<0.0005	0.0005	0.003	<0.0005	0.0005	0.003	0.0%
Iron	0.03	0.02	0.05	0.02	0.02	0.05	**40.0%**
Lead	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Manganese	0.0988	0.0005	0.003	0.0994	0.0005	0.003	0.6%
Mercury	<0.0002	0.0002	0.001	<0.0002	0.0002	0.001	0.0%
Molybdenum	<0.02	0.02	0.1	0.02	0.02	0.1	0.0%
Nickel	<0.008	0.008	0.04	<0.008	0.008	0.04	0.0%
Selenium	<0.0001	0.0001	0.0003	<0.0001	0.0001	0.0003	0.0%
Silver	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Thallium	0.0001	0.0001	0.0005	0.0001	0.0001	0.0005	0.0%
Uranium	0.0006	0.0001	0.0005	0.0006	0.0001	0.0005	0.0%
Vanadium	0.0110	0.0002	0.001	0.0111	0.0002	0.001	0.9%
Zinc	0.003	0.002	0.005	<0.002	0.002	0.005	**40.0%**
Total Metals							
Aluminum	<0.03	0.03	0.2	<0.03	0.03	0.2	0.0%
Antimony	<0.0004	0.0004	0.002	<0.0004	0.0004	0.002	0.0%
Arsenic	0.0397	0.0002	0.001	0.0426	0.0002	0.001	7.0%
Barium	0.124	0.003	0.02	0.124	0.003	0.02	0.0%
Beryllium	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Boron	2.30	0.01	0.05	2.31	0.01	0.05	0.4%
Cadmium	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Chromium	<0.0005	0.0005	0.002	<0.0005	0.0005	0.002	0.0%
Copper	<0.0005	0.0005	0.003	<0.0005	0.0005	0.003	0.0%
Iron	0.02	0.02	0.05	0.03	0.02	0.05	**40.0%**
Lead	<0.0001	0.0001	0.0005	<0.0001	0.0001	0.0005	0.0%
Manganese	0.0998	0.0005	0.003	0.1004	0.0005	0.003	0.6%
Mercury	<0.0002	0.0002	0.001	<0.0002	0.0002	0.001	0.0%
Molybdenum	<0.02	0.02	0.1	<0.02	0.02	0.1	0.0%
Nickel	<0.008	0.008	0.04	<0.008	0.008	0.04	0.0%
Selenium	<0.0001	0.0001	0.0003	<0.0001	0.0001	0.0003	0.0%
Silver	<0.00005	0.00005	0.0003	<0.00005	0.00005	0.0003	0.0%
Thallium	0.0001	0.0001	0.0005	0.0001	0.0001	0.0005	0.0%
Uranium	0.0006	0.0001	0.0005	0.0006	0.0001	0.0005	0.0%
Vanadium	0.0125	0.0002	0.001	0.0137	0.0002	0.001	9.2%
Zinc	<0.002	0.002	0.005	<0.002	0.002	0.005	0.0%

Extended Qualifiers with Validation Flags

- No extended qualifiers required validation.

Results Exceeding Standards

- MW-D
  - Dissolved aluminum exceeded Federal SMCL Groundwater Standards.
  - Total aluminum exceeded State Groundwater Secondary Standards.
  - Total iron exceeded State Groundwater Secondary Standards.
- MW-F
  - Lab pH exceeded State Groundwater Secondary Standards.
  - Total dissolved solids exceeded State Groundwater Secondary Standards.
  - Dissolved arsenic exceeded Federal MCL Standards.
  - Dissolved manganese exceeded State Groundwater Secondary Standards.
  - Total arsenic exceeded Federal MCL Standards.
  - Total manganese exceeded State Groundwater Secondary Standards.
- MW-H
  - Lab pH exceeded State Groundwater Secondary Standards.
  - Dissolved arsenic exceeded Federal MCL Standards.
  - Total arsenic exceeded Federal MCL Standards.

Station Name	Units	Federal MCL Groundwater Standards	Federal SMCL Groundwater Standards	State Groundwater Secondary Standards	MW-D	MW-F	MW-H
Major Ions and Solution Parameters							
pH, lab	s.u.		6.5-8.5	6.5-8.5		**8.5**	**8.5**
TDS, filterable @ 180C	mg/l		500	500		**526**	
Dissolved Metals							
Aluminum	mg/l		0.05	0.2	**0.05**		
Arsenic	mg/l	0.01				**0.0388**	**0.0186**
Manganese	mg/l		0.05	0.05		**0.0988**	
Total Metals							
Aluminum	mg/l		0.05	0.2	**0.33**		
Arsenic	mg/l	0.01				**0.0397**	**0.0188**
Iron	mg/l		0.3	0.3	**0.36**		
Manganese	mg/l		0.05	0.05		**0.0998**	