# Corrective Measures Assessment

# CCR Landfill - Huntington Power Plant
# Huntington, Utah

May 2019

**Prepared For:**
Huntington Power Plant
6 mi. W of Huntington, Hwy. 31
Huntington, UT 84528

PacifiCorp
1407 West North Temple, Ste 280
Salt Lake City, Utah 84116

**Prepared By:**
Water & Environmental Technologies
480 East Park Street
Butte, Montana 59701
406.782.5220

## TABLE OF CONTENTS


**1.0 PURPOSE & SCOPE ..... 1**

1.1 Organization ..... 1

**2.0 SITE BACKGROUND & HISTORY ..... 1**

2.1 Site Conceptual Model ..... 2

2.2 Physiography ..... 2

2.3 Surface Water ..... 3

2.4 Geology ..... 4

2.5 Hydrogeology ..... 4

2.6 Aquifer Resource Value ..... 6

2.7 Previous Investigations ..... 6

2.7.1 Background Water Quality Site Investigations ..... 7

2.7.2 Groundwater Discharge Permits ..... 7

2.7.3 CCR Monitoring ..... 8

**3.0 NATURE & EXTENT OF RELEASE ..... 9**

3.1 Nature of Release ..... 9

3.2 Extent of Release ..... 10

3.3 History of Corrective Measures ..... 12

3.4 Potential Risks to Human Health & Environment ..... 13

3.5 Clean Up Levels / Attainment Criteria ..... 16

3.6 Point(s) of Compliance ..... 16

**4.0 ASSESSMENT OF CORRECTIVE MEASURES ..... 17**

4.1 Maintain Current Corrective Actions ..... 18

4.2 Pump and Treat ..... 20

4.3 Impermeable Barrier / Pumpback System ..... 21

4.4 Reactive Permeable Barrier ..... 23

4.5 In Situ Injection of Reactive Compound ..... 24

4.6 Phyto-Technologies ..... 25

4.7 Electro-Kinetics ..... 26

4.8 Beneficial Reuse ..... 27

4.9 In Place Capping and Closure ..... 27
4.10 Closure by Removal ..... 28
4.11 Corrective Measures Alternatives ..... 31
**5.0 SELECTION OF THE REMEDY ..... 31**
**6.0 REFERENCES ..... 32**

## LIST OF FIGURES

Figure 1. CCR Sample Locations
Figure 2. Geologic Map
Figure 3. Groundwater Elevation Map - CCR Landfill
Figure 4. Groundwater Elevation Map - Huntington Creek Alluvium
Figure 5. Points of Diversion
Figure 6. Facility Monitoring Wells
Figure 7. CCR Appendix IV Isoconcentration Map
Figure 8. Water Collection System

## LIST OF TABLES

Table 1. Huntington Power Plant - Slug Test Results
Table 2. Summary of Groundwater Quality Comparisons – Assessment Monitoring
Table 3. Huntington CCR Landfill Source Results
Table 4. Results from Farm Well Sampling
Table 5. Mean versus Background Concentrations
Table 6. Huntington CCR Landfill Groundwater Protection Standards
Table 7. Alternative Comparison

## ACRONYMS

| | |
|---|---|
| bgs | Below Ground Surface |
| BLM | Bureau of Land Management |
| CCR | Coal Combustion Residuals |
| cfs | Cubic Feet per Second |
| COPC | Constituent of Potential Concern |
| CVSSD | Castle Valley Special Service District |
| DEQ | Utah Department of Environmental Quality |
| EPA | U.S. Environmental Protection Agency |
| ET | Evapotranspiration |
| FGD | Flue-Gas Desulfurization |
| gpm | Gallons per minute |
| HDPE | High Density Polyethylene |
| HPP | Huntington Power Plant |
| MCL | National Public Water Supply - Maximum Concentration Limit |
| MNA | Monitored Natural Attenuation |
| O&M | Operations & Maintenance |
| OSHA | Occupational Safety & Health Administration |
| RPB | Reactive Permeable Barrier |
| RCRA | Resource Conservation and Recovery Act |
| SAP | Sampling and Analysis Plan |
| TDS | Total Dissolved Solids |
| USDA-FS | U.S. Department of Agriculture - Forest Service |
| WDEQ-DWQ | Wyoming Department of Environmental Quality – Division of Water Quality |
| WET | Water & Environmental Technologies |

## 1.0 PURPOSE & SCOPE

This report provides the findings of an investigation to determine the nature and extent of the release and an assessment of corrective measures for the Coal Combustion Residual (CCR) Landfill, at the Huntington Power Plant in Huntington, Utah. It was prepared for PacifiCorp by Water and Environmental Technologies (WET) to comply with the requirements detailed in *Code of Federal Regulations* (CFR) § 257.95(g)(1) and 257.96 (*Final Rule*).

Detection monitoring was conducted between September 2015 and October 2017. The results of detection monitoring revealed statistically significant levels above background for the following Appendix III constituents: boron, calcium, fluoride, pH, and sulfate.

As a result, the CCR Landfill monitoring program was transitioned to assessment monitoring in 2018. The results of two rounds of sampling completed between February and May of 2018, revealed Appendix IV constituents - chromium, cobalt, lithium, and selenium were at statistically significant levels above the groundwater protection standards established for the CCR Landfill.

CFR § 257.95(g)(1) requires the owner of a CCR unit in which one or more constituents in Appendix IV are detected at statistically significant levels above the site-specific groundwater protection standards, to characterize the nature and extent of the release and any relevant site conditions that may affect the remedy ultimately selected. CFR § 257.95(g)(3)(i) requires the owner of the CCR unit, to assess corrective measures as required by 257.96. In compliance with these requirements, PacifiCorp conducted, in parallel, an investigation to assess the nature and extent of the release and an assessment of potential corrective measures for the CCR Landfill.

### 1.1 Organization

This report is organized to address the requirements of CFR § 257.95 and CFR § 257.96 under the *Final Rule* as follows:

- Site Background & History
- Nature & Extent of Release
- Assessment of Corrective Measures
- Reporting

## 2.0 SITE BACKGROUND & HISTORY

The Huntington Power Plant (HPP) is located on Highway #31 in Emery County, approximately nine miles west of Huntington, Utah (Figure 1). The physical location of the power plant is in the northeast corner of Section 1, Township 17 South, Range 7 East in Emery County. The HPP is a two-unit coal-fired electrical generation plant owned by PacifiCorp. After dewatering and treatment, Flue-Gas Desulfurization (FGD) waste, fly ash and bottom ash are disposed of in the CCR Landfill. As a result, it is considered a CCR unit.

The Huntington CCR Landfill became operational in January 2002. It is located southeast of the former combustion waste landfill (Old Landfill). It is a valley fill type landfill which was constructed on a relatively flat plateau in a small valley. The subsurface under the landfill consists of shale. Stormwater run-on from the area surrounding the landfill is routed around the landfill via diversion ditches and run-off from the landfill itself is collected and retained in a sediment basin north of the landfill. This basin has no discharges.

## 2.1 Site Conceptual Model

The site conceptual model for the Huntington Power Plant was developed to summarize site information that is currently available and provide the background information needed to assess corrective measures for the site. As defined in Section 2 of this report considerable historic information and environmental data are available to characterize site conditions. These data have been collected, evaluated and organized into the conceptual site model described below.

## 2.2 Physiography

The Huntington Power Plant is located along Highway #31 in Emery County, Utah a few miles east of the Manti-Sal National Forest. It is situated in the Huntington Creek Valley in the easternmost portion of the Wasatch Range, at a mean elevation of 6,450 feet above sea level. The community of Huntington, with a 2010 population of 2,129, is located approximately nine miles east of the plant, along Highway #31. Huntington is the largest city in Emery County. Other nearby cities include the communities of Castle Dale (pop. 1,630), Wellington (pop. 1,676) and Price (pop. 8,371).

The region is rich in coal, oil and natural gas, and mineral deposits which have undergone exploration and extraction since the 1890s. Non-industrial private lands in the area, as well as large units of Bureau of Land Management (BLM) and U.S. Department of Agriculture - Forest Service (USDA - FS) lands distributed throughout the regional landscape support cattle grazing, agriculture, recreational uses, oil and gas development, and mining. Most of the land at the HPP is zoned for mining and grazing. In addition, land adjacent to Huntington Creek in the eastern portion of the plant site is used for agriculture. This agricultural use continues eastward along Huntington Creek to the community of Huntington and beyond. Land north, west and south of the plant is zoned for mountain use.

The climate can be classified as semi-arid (steppe). Utah steppe lands occur between desert and high mountain regions in areas where the average annual precipitation is less than the potential evapotranspiration. The climate in the area is dry due to the effective barrier to moisture from the Pacific Ocean offered by the Cascade and Sierra Nevada ranges. The climate at the plant site is likely also be influenced by its location on the east slope of the Wasatch Plateau. Average precipitation is between 6 and 10 inches per year, with the highest precipitation occurring in late July through October. The area is prone to short duration, high intensity storm events. Ten to 20 inches of snow can be expected in the winter, representing between one and two inches of the annual precipitation. Temperature range is normally from a low of 10° (F) in January to the high

80's in July. Skies are clear about 150 days per year. Winds are generally light to moderate in all seasons. The strongest winds normally blow from the south during the spring.

The surface soils in the valley bottom in vicinity of the Huntington Power Plant are generally alluvial fans of well drained calcareous soils that are loamy textured mixed clay, silt, sand, and cobbles; mostly derived locally from the upgradient Mancos Shale (Figure 2). Soils along Huntington Creek are generally coarser grained with a lower clay content than the upgradient soils that occur along the valley slopes. Formations of limestone, sandstone, siltstone, shale, conglomerate and coal are encountered at depths no greater than 50 feet below ground surface.

Native vegetation in the area is sparse, as both precipitation and surface soil are poor for supporting vegetative growth. Vegetation at the plant site is dominated by Utah juniper, pinyon pine and sagebrush. In the wooded mountainous areas north, west and southwest of the plant site, dominant plant species are aspen, Douglas fir and alpine fir, blue spruce, ponderosa pine, sagebrush and bromes. Progressing downstream from the power plant the land along Huntington Creek, as well as the land surrounding the city of Huntington is cultivated.

The Manti-Sal National Forest surrounding the plant site to the north, west and southwest provides habitat for a variety of wildlife species including Rocky Mountain elk, black bear and mountain lion, several different raptors (including golden eagles and northern goshawks), small mammals and cavity nesting birds (BLM and USDA-FS, 2012).

## 2.3 Surface Water

Huntington Creek flows from northwest to southeast along the HPP northern boundary. Spring and fall 2015 groundwater elevation contours (WET, 2016) indicate that groundwater discharges to Huntington Creek via seeps along the south escarpment at the contact of the alluvium and the shale, making this stream generally a gaining stream as it flows through the plant site. Deer Creek flows into Huntington Creek north of the plant. The USGS topographic map indicates that both Huntington Creek and Deer Creek are ephemeral streams. Deer Creek has remained dry within the plant footprint, since the Deer Creek Mine initiated closure, except during heavy precipitation events. An unnamed incised valley downgradient of the landfill contains water during storm events that flows into a storm water pond and then evaporates, infiltrates into the alluvium, or is captured and used in plant processes.

Huntington Creek is a tributary of the San Rafael River, which in turn flows into the Green River, a chief tributary of the Colorado River. Huntington Creek serves as a water supply to the HPP. Between the power plant and the City of Huntington, water from Huntington Creek is diverted via pipelines, ditches and canals, most of which are managed by the Huntington Cleveland Irrigation Company. Proceeding downstream from the HPP along Huntington Creek, Harrison Ditch is the first diversion encountered. It is about 0.6 miles northeast of the CCR Landfill. Further downstream, about 0.8-miles north / northeast of the CCR Landfill is Rowley Ditch. Both ditches divert water for stock watering and irrigation. One mile east of the landfill is the Castle Valley Special Service District (CVSSD) domestic water treatment plant, and the Seeley Collard Diversion that supplies local stock and irrigation water. The water treatment plant

was built in 2005 to serve as a back-up in the event the CVSSD springs were unable to supply sufficient domestic water. To date the plant has not been needed for this purpose. In addition to industrial and agricultural use, Huntington Creek provides recreational opportunities. A search of Utah water rights revealed no active groundwater users within several miles downgradient of the landfill.

## 2.4 Geology

The HPP is located in the northwestern portion of the Colorado Plateau physiographic province and within the Mancos Shale Lowlands (Stokes, 1986). The Mancos Shale Lowlands are characterized by sloping, gravel-covered sediments, rugged badlands and narrow, flat-bottomed alluvial valleys (Figure 2). The CCR Landfill is located on the Masuk Member of Mancos Shale elevated above the Huntington Creek valley, which is incised into the Wasatch Plateau, draining east into the Castle Valley.

The Mancos Shale was deposited in offshore and open-marine environments of the Cretaceous Interior Seaway. It is 3450 to 4150 feet thick where exposed in the southern part of the Piceance and Uinta Basins (Fisher and others, 1960) and geophysical logs indicate it is approximately 5400 feet thick in the central part of the Uinta Basin (Hettinger and Kirschbaum, 2002). The upper portion of the Mancos grades into and interfingers with the Mesaverde Group and the shale tongues typically have sharp basal contacts and gradational upper contacts.

Lithologic logs from onsite monitoring wells completed in the shale, note a light gray to dark gray or gray-black shale in various stages of weathering from very weathered to consolidated and un-weathered or competent shale.

The Huntington alluvial valley aquifer is typically composed of gravel to boulder sized material mixed with varying amounts of sand, silt and clay. It was deposited by Huntington Creek on an erosional contact with the Mancos Shale. In this environment, the alluvium is generally deposited during high energy storm events that wash eroded sediments from the uplands into the valley. These sediments are reworked by meandering stream channels and exhibit a fining upward depositional sequence. Alluvial well descriptions describe a tan, orange-brown, and red mixture of fine to medium grained sand and sandstone boulders.

## 2.5 Hydrogeology

Groundwater beneath the CCR Landfill is present in the Masuk Member of the Mancos Shale. The low permeability of the Mancos Shale and the arid high desert climate result in a discontinuous aquifer with multiple perched layers that may be locally de-watered seasonally and/or by sampling activities. Further downgradient of the CCR Landfill, water is present at the colluvial/shale contact along the drainages. Groundwater flows along the contact following the topography of the shale and, in some areas, infiltrates into the fractured Mancos shale. Given the generally dry desert climate, infiltration is relatively minimal and groundwater flow from the uplands is a small component of the total flow into the Huntington Creek alluvial valley aquifer.

Because of its geochemical composition and erodibility, the Mancos Shale, a dark gray to black ridge forming marine shale deposit, provides a natural source of soluble salts. It was deposited in a transgressive/regressive coastal-marine environment and is a known source of sodium chloride, calcium and sodium-sulfate minerals (Waddell et al.1979). These minerals are highly soluble and dissolve readily when in contact with groundwater.

The upper aquifer near the CCR Landfill is predominantly a water table aquifer. However, groundwater at HLF-1N, a monitoring well east of the landfill, is found under confined conditions (Figure 3). Depths to water in the shale near the CCR Landfill, vary from 90 ft to nearly 200 ft bgs. The alluvial aquifer is up to 20 ft thick with depths to water varying from 8 ft to 20 ft bgs. From boring log descriptions and well development procedures, aquifer permeability is relatively low in the shale and moderate in the alluvium. Typical hydraulic conductivities for shale aquifers range from $10^{-3}$ to $10^{-7}$ gpd/ft$^2$ (Freeze and Cherry, 1979). Coarse-grained material at the alluvium-shale contact account for a majority of the subsurface flow. Recent slug testing indicates that hydraulic conductivity of the uppermost aquifer varies from approximately 0.04 ft/day to 0.70 ft/day (Table 1) with a geometric mean of 0.3 ft/day. Per Morris and Johnson, 1967, site-specific aquifer porosity and effective porosity are 35% and 12%, respectively.

In general, groundwater flows from the plateau into the incised creek valleys and then along the valley bottoms. Thus, higher elevation areas along the Duck Pond Drainage, in which the both the CCR Landfill and old landfill are located, flow to the alluvium in the incised valley bottom which then discharges into the Huntington Creek Valley alluvium. The groundwater flow direction beneath the CCR Landfill is from the south to the north with a hydraulic gradient varying from approximately 3.10 x 10-2 ft/ft to 3.26 x 10-2 ft/ft. The corresponding groundwater flow velocity varies from 0.070 ft/day to 0.074 ft/day. Groundwater moving from the Duck Pond drainage alluvium into the Huntington Creek alluvium changes flow direction from northward flow in the Duck Pond drainage to flow to the southeast in the Huntington Creek alluvium (Figure 4). The Huntington Creek Valley alluvium drains the site from the northwest until it exits the facility to the southeast.

**Table 1.** Huntington Power Plant – Slug Test Results

| | HDP-2 | HLF-3ND | HLF-4N | HLF-8N |
|---|---|---|---|---|
| **Calculated Hydraulic Conductivity** | 2.65E-04 | 2.38E-05 | 1.26E-04 | 1.34E-04 |
| | 2.86E-04 | | 1.04E-04 | 2.48E-04 |
| | 1.93E-04 | 5.92E-06 | 1.40E-04 | 1.76E-04 |
| **# of Measurements:** | 3 | 2 | 3 | 3 |
| **Mean Conductivity (cm/sec):** | 2.48E-04 | 1.48E-05 | 1.23E-04 | 1.86E-04 |
| **Mean Conductivity (ft/day):** | 0.70 | 0.04 | 0.35 | 0.53 |
| Slug testing was conducted on a facility-wide subset of wells to characterize site-wide hydrogeologic characteristics. Not all of the slug test wells appear on every site-specific map. | | | | |

## 2.6 Aquifer Resource Value

The landfill at the Huntington Power plant is underlain by the Mancos shale, which is a natural source of salts, boron, selenium and trace metals (ESL 2011). As a result of its natural degradation, groundwater quality is generally poor with many monitoring wells exhibiting TDS values in excess of 10,000 mg/l characteristic of Class IV Groundwater also referred to as Saline Groundwater. Water quality degrades in the downgradient direction due to dissolution of shale constituents and varies widely from monitoring well to monitoring well due to varying consolidation of the shale (UDEQ 2017).

The Mancos has a relatively low permeability as indicated by the aquifer testing results shown in Table 1. Hydraulic conductivities in the shale vary from 0.04 ft/day to 0.53 ft/day and most wells provide limited, low quality water. Many monitoring wells at this site do not provide enough water to allow for purging before environmental sampling.

Because of the limited quantity and poor quality of the groundwater in the Mancos shale, current and future use of the water is very limited without treatment. Groundwater quality in the alluvial aquifer along Huntington Creek is comparatively higher quality than the Mancos Shale water and is classified as Class III-Limited Use Water. "Groundwater under the Research Farm is of limited extent and generally poor quality at least partly due to natural conditions, except in wells adjacent to Huntington Creek" (UDWQ 2017).

At this arid, high desert site, alternate water supplies are scarce as evidenced by Figure 5. This map shows all points of diversion within 5 miles of the plant on a geologic map. The map indicates very few points of diversion within the Mancos Shale, because of its limited quantity and poor quality. Most points of diversions are located within the Quaternary alluvium along Huntington Creek or in the North Horn Formation. Many of the purple "Underground" diversions near the facility boundary, are monitoring wells for the plant site.

## 2.7 Previous Investigations

The HPP is undergoing groundwater monitoring under two separate programs, one mandated by the Division of Water Quality of the Utah Department of Environmental Quality (DEQ) as a condition for a Groundwater Discharge Permit (UGW150002) and the second to address the requirements detailed in the CCR *Final Rule*.

HPP began voluntary groundwater monitoring in 2003 to assess site conditions as part of the groundwater discharge permit application. Initial monitoring was performed quarterly, and then transitioned to a semi-annual rotation. CCR monitoring was initiated in 2015 and continues to the present. In addition, several site-specific environmental investigations have been completed, with an emphasis on hydrogeologic and environmental conditions.

### 2.7.1 Background Water Quality Site Investigations

In 2003, the HPP began a voluntary investigation into potential groundwater discharges with the submittal and approval of a Site-Wide Sampling and Analysis Plan (SAP) to the DWQ. The initial groundwater well network was designed to determine background water quality and to monitor potential impacts to groundwater from various plant operations including the CCR Landfill. Twenty-eight monitoring wells at the site were installed and sampled quarterly from the fourth quarter of 2003 through the third quarter of 2004 and semiannually starting in the spring of 2005 through the spring of 2006 for water quality parameters both up and downgradient of potential areas of concern including the landfill. The results from the groundwater monitoring and other investigations was submitted to DEQ and was then used in the development of a Groundwater Discharge Permit.

### 2.7.2 Groundwater Discharge Permits

A Groundwater Discharge Permit (UGW150002) was issued by DEQ to HPP in June 2006 and renewed in June 2011 and April 2018. The 2006 permit required PacifiCorp to prepare a Corrective Action Plan for the closed and existing landfills which remedied the groundwater impacts and surface impacts in the drainage below the landfills. In addition, the corrective action plan was required to propose a groundwater monitoring program and best management practices for the landfill. As part of the preparation of the Corrective Action Plan, corrective measures were evaluated under UAC R317-6-6.45 which utilizes screening criteria that mirrors the criteria found in § 257.95(g)(1) and 257.96. The plan was submitted to and approved by UDEQ.

The corrective action plan and best management plan was prepared and submitted to and approved by DEQ. The corrective action plan addressed: 1) eliminating the source of the liquid in the landfill; 2) collecting leachate at the landfill and the leachate that had exited the landfill footprint to prevent any further impacts to the groundwater, and 3) monitoring the groundwater downgradient of the landfill to ensure there were no impacts to Huntington Creek.

The corrective measures selected and implemented were: 1) installation of a groundwater monitoring network with semiannual groundwater sampling; 2) upgrades to the FGD waste treatment practices in 2006 and 2010 to eliminate all free liquids in the landfill; 3) the 2008 installation of a collection system to collect leachate under the landfill and also intercept leachate as it entered the drainage below the landfills.

All water potentially impacted was collected and utilized within the plant. 4) Implementation of best management practices including storm water run-on/run-off controls, landfill inspections, and fugitive dust controls. The 2011 permit renewal established groundwater protection standards based on background data collected prior to 2011. The 2016 permit required PacifiCorp to place an environmental covenant on the property that restricts use of groundwater for any purpose to address the potential risk associated with use of impacted groundwater.

### 2.7.3 CCR Monitoring

Between 2015 and 2017, initial detection monitoring was conducted at the CCR Landfill to comply with the CCR *Final Rule*. This monitoring effort included monitoring of new and existing wells, to obtain a sufficient number of measurements to determine if any CCR-specified Appendix III constituents exceed site-specific background concentrations. The results of detection monitoring revealed background exceedances for the following Appendix III constituents: boron, calcium, fluoride, pH, and sulfate. These exceedances were observed in one or more of the following five wells: HDP-1, HDP-2, HLF-3ND, HLF-4N, HLF-8N.

In accordance with the *Final Rule*, assessment monitoring was initiated at the CCR Landfill in February of 2018. This effort revealed that chromium, cobalt, lithium and selenium concentrations exceeded the groundwater protection standards established for the CCR Landfill in well HDP-1, HDP-2 and HLF-8N (Table 2). These results indicate a release has taken place from the CCR Landfill which has impacted groundwater.

**Table 2.** Summary of Groundwater Quality Comparisons – Assessment Monitoring

| Analyte | Upper Tolerance Limit (mg/L) | Maximum Contaminant Level (mg/L) | Groundwater Protection Standard (mg/L) | Downgradient Wells Exceeding the Groundwater Protection Standard |
|---|---|---|---|---|
| Antimony | 0.002 | 0.006 | 0.006 | None Exceed |
| Arsenic | 0.00787 | 0.01 | 0.01 | None Exceed |
| Barium | 1.34 | 2 | 2 | None Exceed |
| Beryllium | 0.002 | 0.004 | 0.004 | None Exceed |
| Cadmium | 0.00 | 0.005 | 0.005 | None Exceed |
| Chromium | 0.02 | 0.10 | 0.10 | HDP-2 |
| Cobalt | 0.0085 | 0.006 | 0.0085 | HDP-1 |
| Fluoride | 2.2 | 4 | 4 | None Exceed |
| Lead | 0.0379 | 0.015 | 0.0379 | None Exceed |
| Lithium | 1.23 | 0.040 | 1.23 | HDP-2, HLF-8N |
| Mercury | 0.0 | 0.002 | 0.002 | None Exceed |
| Molybdenum | 0.0267 | 0.100 | 0.100 | None Exceed |
| Radium | 23.68 | 5 | 23.68 | None Exceed |
| Selenium | 0.002 | 0.05 | 0.05 | HDP-2 |
| Thallium | 0.002 | 0.002 | 0.002 | None Exceed |

## 3.0 NATURE & EXTENT OF RELEASE

The following sections describe the nature of the release at the Huntington Power Plant and define its extent.

### 3.1 Nature of Release

Groundwater in the vicinity of the CCR Landfill is monitored by a groundwater well network that was voluntarily developed in 2003 and expanded in 2016 under the Utah DEQ Groundwater Permit. This network was designed to provide early detection of possible releases to groundwater.

Examination of groundwater elevations and water quality near the CCR Landfill showed a reduction of water levels and constituent concentrations in shallow monitoring wells, following the implementation of the measures outlined in the Corrective Action Plan which included: updated FGD waste handling procedures that eliminated free liquids in FGD waste being placed in the landfill and the installation of a leachate collection system, consisting of a drain system capturing leachate under the existing landfill and impacted water in the Duck Pond Drainage downgradient from both the CCR landfill and the historic landfills.

Site-specific shale and alluvial well lithologic logs provide information on the natural sources of minerals in groundwater at the HPP plant site. They specifically identify the presence of gypsum in both shale and alluvium at the site. This indicates that minerals and salts are readily available for dissolution. As a result, groundwater in the shale shows natural degradation (increased concentrations of minerals) along flow paths because of the high concentration of soluble minerals in the shale and the relatively long residence time of water due to low permeability of the shale.

An investigation to assess the nature and extent of groundwater impacts was completed in 2018 per § 257.95 (g)(1) of the *Final Rule*. The scope of the investigation included the collection of data from source materials disposed in the landfill and sampling of Research Farm wells downgradient of the Duck Pond Drainage, including a well on the facility boundary (Figure 6). Sampling of source material was completed in the fall of 2018 to support this examination, and to provide a profile of likely sources contributing to releases. Sampling of Research Farm wells was also completed in the fall of 2018. Table 3 provides a profile of the composition of source material disposed in the CCR Landfill. The results reflect a sodium sulfate solution, enriched with chloride and magnesium. Based on the results from source sampling, and detection and assessment monitoring, the composition of the release at HPP consists of those Appendix IV constituents exceeding their groundwater protection standards:

- Chromium
- Cobalt
- Lithium
- Selenium

**Table 3.** Huntington CCR Landfill Source Results

| Sample Id: | Analyte | Result | Units |
|---|---|---|---|
| **Huntington Source Material** | Antimony | ND | mg/L |
| | Arsenic | ND | mg/L |
| | Barium | 0.02 | mg/L |
| | Beryllium | ND | mg/L |
| | Boron | 4.32 | mg/L |
| | Cadmium | ND | mg/L |
| | Chloride | 3,260 | mg/L |
| | *Chromium | ND | mg/L |
| | *Cobalt | ND | mg/L |
| | Fluoride | 0.28 | mg/L |
| | Lead | ND | mg/L |
| | *Lithium | 4.47 | mg/L |
| | Mercury | ND | mg/L |
| | Molybdenum | 0.01 | mg/L |
| | pH | 7.62 | s.u. |
| | *Selenium | 0.10 | mg/L |
| | Sulfate | 5,440 | mg/L |
| | Thallium | ND | mg/L |
| | Total Dissolved Solids | 13,300 | mg/L |

* Appendix IV constituents that exceed groundwater protection standards

## 3.2 Extent of Release

At the HPP, groundwater flows from the plateau into the incised creek valleys and then along the shallow alluvium in valley bottoms. Groundwater originating at higher elevations follows topography and flows into the alluvium in the incised valley bottoms. The valleys then discharge into the Huntington Creek Valley alluvium, which drains the site from northwest the southeast.

The groundwater flow direction beneath the CCR Landfill is from the southwest to the northeast (Figure 3). Releases from the landfill generally migrate along this flow path, with constituents released at the landfill migrating to the northeast along the more permeable alluvial contact. To assess if the release was bounded within the facility, low flow pumps were installed and samples were collected from Research Farm wells downgradient of the Duck Pond Drainage, including: NH-1W, NH-2W, NH-4W, NH-5W, and NH-10W. These wells provide spatial coverage of the alluvial aquifer from the bottom of the Duck Pond Drainage, to the southeastern facility boundary. Table 4 provides a summary of results acquired from the Research Farm wells. Appendix IV constituents that exceeded groundwater protection standards in 2018 from CCR monitoring wells, are presented in bold.

The results of the Research Farm well sampling effort reveals selenium in well NH-4W exceeds the groundwater protection standard. Of the remaining Research Farm wells, NH-4W is the

nearest downgradient well to HDP-2 along the flow path north to south across the Huntington Creek Valley alluvium. NH-5W and NH-10W are located cross-gradient and east of NH-4W; NH-2W and NH-1W are downgradient of NH-4W. NH-1W is located at the southern facility boundary. None of the wells cross or downgradient of NH-4W exceed groundwater protection standards for any constituents. These results indicate the release has not migrated offsite and is bounded between wells NH-4W and NH-2W (Figure 7). As a result, offsite sampling is not required to bound the nature or extent of release.

CCR assessment groundwater monitoring at the Huntington Plant will continue to incorporate the Research Farm wells moving forward, to ensure FGD-related constituents do not migrate beyond the plant boundary, and to monitor the effectiveness of corrective measures currently in place and any additional measures that may be implemented as part of the selected remedy developed in 2019.

When indications of contamination were first discovered during the voluntary investigations that were initiated in 2003, it was evident that, leachate/impacted groundwater was flowing on the surface and down the drainage. A collection system was installed to collect the leachate plus impacted groundwater and significant quantities were collected from 2003 until mid-2009. Once free liquids were eliminated from the ash disposal process, leachate surface flows disappeared, and seepage began to reduce. Currently, there is no liquid entering the collection system under the CCR landfill and very little/intermittent capture within the seeps in the Duck Pond drainage. Current disposal practices have eliminated seepage and the remaining leachate has drained and left residual constituents behind in the aquifer matrix. The flushing of these residual constituents will continue for years but will decrease in concentration over time. There is no additional seepage from the CCR landfill to groundwater. The evaluation of corrective measures presented in Section 4 address the residual impacts to groundwater presented.

**Table 4.** Results from Farm Well Sampling

| Analyte | Groundwater Protection Standard (mg/L) | NH-1W | NH-2W | NH-4W | NH-5W | NH-10W |
|---|---|---|---|---|---|---|
| | | mg/L | | | | |
| Antimony | 0.006 | ND | ND | ND | ND | ND |
| Arsenic | 0.01 | ND | ND | ND | ND | 0.003 |
| Barium | 2 | 0.022 | 0.015 | 0.023 | 0.080 | 0.386 |
| Beryllium | 0.004 | ND | ND | ND | ND | ND |
| Cadmium | 0.005 | ND | ND | ND | ND | ND |
| **Chromium** | **0.1** | ND | ND | 0.018 | 0.003 | 0.005 |
| **Cobalt** | **0.0085** | ND | ND | ND | ND | 0.004 |
| Fluoride | 4 | 0.29 | 0.29 | 0.18 | 0.19 | 0.15 |
| Lead | 0.0379 | ND | ND | ND | ND | 0.005 |
| **Lithium** | **1.23** | 0.19 | 0.21 | 0.90 | ND | ND |
| Mercury | 0.002 | ND | ND | ND | ND | ND |

| Analyte | Groundwater Protection Standard (mg/L) | NH-1W | NH-2W | NH-4W | NH-5W | NH-10W |
|---|---|---|---|---|---|---|
| | | mg/L | | | | |
| Molybdenum | 0.0267 | ND | ND | ND | ND | ND |
| Radium | 23.68 | ND | ND | ND | ND | ND |
| **Selenium** | **0.05** | 0.016 | 0.019 | **0.083** | 0.024 | 0.003 |
| Thallium | 0.002 | ND | ND | ND | ND | ND |

Providing an estimate of the quantity of material released from the CCR unit is required under §257.95(g)(1)(ii). The best available data to estimate the quantity of Appendix IV constituents released from the unit, to the groundwater, is to utilize concentrations found in the groundwater as depicted in the iso-contour map (Figure 5) and an estimated volume of the aquifer. The volume of the aquifer was calculated by estimating the depth of the aquifer from site wells logs and estimating the aerial extent of the impacted groundwater from the monitoring data. The effective porosity of the aquifer determined during aquifer testing was then used to calculate the volume of water within the pore space of the aquifer material.

The concentrations were estimated as a gradient across the aquifer. The background concentration for each constituent was subtracted from the concentration detected in the downgradient wells. The volume was then multiplied by the concentration and converted to pounds to estimate the quantities of Appendix IV constituents released to the environment as dissolved compounds. The estimated quantities are only approximations due to the different geochemical characteristics of each analyte: absorption, dispersion and attenuation (i.e. some metals readily react, degrade or adsorb to the aquifer matrix, while other compounds are conservative and remain in solution).

Parameters that exceed groundwater protection standards at the Huntington Power Plant are chromium, cobalt, lithium and selenium. The mass detectable in the aquifer, based on current data for each of these constituents is: chromium – 6.5 lbs.; cobalt – 1.1 lbs.; Lithium 162 lbs.; and selenium – 7.7 lbs.

## 3.3 History of Corrective Measures

All corrective action at the site has been conducted under the Groundwater Discharge Permit (UGW150002) by DEQ as discussed in Section 2.7.2. The corrective action plan addressed: 1) eliminating the source of the liquid in the landfill; 2) collecting leachate at the landfill and the leachate that had exited the landfill footprint to prevent any further impacts to the groundwater, and 3) monitoring the groundwater downgradient of the landfill to ensure there were no impacts to Huntington Creek.

The corrective measure selected and implemented were: 1) installation of a groundwater monitoring network with semiannual groundwater sampling; 2) upgrades to the FGD waste treatment practices in 2006 and 2010 to eliminate all free liquids in the landfill; 3) the 2007 - 2008 installation of a collection system to collect leachate under the landfill and also intercept

leachate as it entered the drainage below the landfills. All water potentially impacted was collected and utilized within the plant. 4) Implementation of best management practices including storm water run-on/run-off controls, landfill inspections, and fugitive dust controls. The 2011 permit renewal established groundwater protection standards based on background data collected prior to 2011. The 2016 permit required PacifiCorp to place an environmental covenant on the property that restricts use of groundwater for any purpose to address the potential risk associated with use of impacted groundwater.

The collection system installed in 2007 – 2008 in the landfill has been collecting the leachate since installation. The drain system within the landfill has prevented leachate from exiting the landfill footprint and also collected and removed the leachate from within the landfill. As a result, there is no leachate exiting the landfill. The collection system in the drainage below the landfill captured leachate emanating from the landfill for a short period and now collects impacted groundwater. The leachate that was collected and the impacted water collected in the collection system water is pumped to the plant mist eliminators when the system is operating, where it is consumed. When not operating, collected water is mixed with cleaner water within the collection system and sent to the Evaporation Pond (Figure 8). The system has undergone optimization since it first became operational in 2008. Using semi-annual groundwater monitoring data, system performance has been evaluated and system modifications have been implemented to enhance groundwater capture.

## 3.4 Potential Risks to Human Health & Environment

Constituents of potential concern (COPCs) found in groundwater at the HPP, include those Appendix IV constituents that exceed health-based guidelines (MCLs) established under the *National Primary Drinking Water Regulations* and/or updates to the *Final* Rule issued in July 2018. These constituents include - chromium, cobalt, lithium, and selenium. Human health effects associated with these constituents are as follows (ATSDR 2019):

- Chromium: lung irritation and cancer, intestinal tract irritation and cancer
- Cobalt: lung irritation, birth defects, cancer
- Lithium: none
- Selenium: skin irritation, impedes central nervous system

In order for COPCs to pose a risk to human health or the environment, complete exposure pathways must be present, whereby receptors regularly come into contact with elevated concentrations of the COPCs.
Potential exposure routes include:

1. Dermal exposure or ingestion of collection system water as it is routed back to the plant.
2. Dermal exposure or ingestion of impacted water in the Evaporation Pond.
3. Ingestion of irrigated crops that may uptake COPCs.
4. Ingestion of impacted groundwater through wells.
5. Release of impacted waters to Huntington Creek.

**Collection System Water.** Impacted water downgradient and east / northeast of the landfill is captured in a subdrain, piped to the pumphouse and pumped back to the plant for reuse in the mist eliminators for Unit 2, where it is consumed (Figure 8). When Unit 2 is not operating, captured water is pumped to cement basins north of the plant for storage, before being transferred to the Evaporation Pond north of Huntington Creek, southeast of the plant. This process results in substantial dilution of the impacted waters, prior to their use as a supplement for crop irrigation – primarily alfalfa – during the summer growing season. Per the 2017 Ground Water Discharge Permit (UGW150002), the use of waste water for irrigation will be discontinued after 2022. Since, captured water is hard piped and pumped back to the plant and consumed it eliminates any exposure risk to human health and the environment.

**Evaporation Pond Water.** Human exposure to water stored in the Evaporation Pond is limited and likely does not represent a complete exposure route or at a minimum, does not represent regular exposure for plant personnel. The use of waste water for irrigation will be discontinued after 2022 when all waste water will be treated by reverse osmosis and re-used in the plant, effectively eliminating this exposure pathway.
Little or no impact on wildlife is expected from captured waters at the plant, as the only complete exposure pathways for wildlife would include ingestion of water from the Evaporation Pond. Concentrations of chromium in the Evaporation Pond are not available. However, other indicator chemicals that have been measured in Evaporation Pond water (e.g. sulfate) show as much as a four times dilution from concentrations found in landfill leachate. Based on this, chromium concentrations are expected to be a fraction of the concentrations measured in groundwater at the landfill boundary. In addition, exposure timeframes are limited in time and likely not regular.

**Irrigated Crops.** Recycled waters are used to irrigate fields that primarily raise alfalfa. Processed alfalfa is used to enhance the soil stockpiled to be used to cover the landfill. Alfalfa grown on the research farm is not utilized for stock feeding but is periodically consumed by wildlife. While some plant uptake is expected as part of plant growth, partitioning of metals in alfalfa likely would result in minimal risks to wildlife.

**Ingestion of Groundwater.** There are no potable water wells within the Duck Pond Drainage or in areas within the plant footprint downgradient of the drainage. As a result, ingestion of impacted groundwater is not a complete exposure route for receptors. A prohibition on current or future use of groundwater has been instituted at the facility through a restrictive covenant put into place in 2018.

**Huntington Creek.** Impacted groundwater is not used for drinking water and is confined to PacifiCorp property, within the Duck Pond Drainage and on the western edge of the valley alluvium. The potential for exposure to impacted groundwater water is limited due to the active collection system. The majority of impacted water originating in the drainage, is captured in the current water collection system, pumped to the plant, and used in the mist eliminators where it is consumed. If the units are offline, the collected water is mixed with cleaner water and sent to the Evaporation Pond.

CCR monitoring completed between 2015 and 2018, coupled with an evaluation of the nature and extent of releases from the CCR Landfill in 2018, indicate the magnitude of impact to shallow groundwater is limited to slightly elevated metals concentrations downgradient of the CCR Landfill. The results also indicate impacted groundwater is contained within the plant boundary, between Research Farm wells NH-4W and NH-2W. Based on these findings, current site use, and facility water management practices, risks to human health and Huntington Creek at the HPP are negligible and are fully manageable with current interim remedies, until a more comprehensive remedy can be implemented that will meet all of the attainment objectives in the *Final Rule*.

The mean concentrations for wells exhibiting the highest concentrations are provided in Table 5. Their corresponding background concentrations are also included. The results illustrate that contributions from HPP operations represent, in most cases, incremental increases in groundwater concentrations, when compared with naturally occurring levels in facility groundwater.

**Table 5.** Mean versus Background Concentrations

| Analyte | Well Id# | Mean Concentration (mg/L) | Background Concentration (mg/L) |
|---|---|---|---|
| [1]Fluoride | HLF-3N | 2.78 | 2.2 |
| Chromium | HDP-2 | 0.16 | 0.02 |
| Cobalt | HDP-1 | 0.012 | 0.0085 |
| Lithium | HLF-8N | 3.67 | 1.23 |
| Selenium | HDP-2 | 0.14 | 0.02 |

The *Final Rule* also mandates an examination of potential damage to physical structures should the implementation of remedies take substantial time. No impacts to facility structures have been observed due to the trace levels of chromium or chloride found in captured surface and groundwater at the plant or their use in the plant. Based on this, no long-term damage to plant operations or structures are expected to occur in the future.

Overall, the only complete exposure pathway for human receptors is potential dermal contact or ingestion of impacted groundwater. The extent of impacted groundwater has been defined and is being managed with the current corrective actions under the Groundwater Permit. Impacted groundwater is contained within the plant boundaries, and current waste management practices and controls show no leachate formation and decreases in impacted groundwater. Current irrigation practices will be discontinued in 2022. Based on these factors, the long-term risk

[1] Fluoride is included in both the Appendix III and Appendix IV constituent lists. While it exceeded the site-specific background concentration, it did not exceed the groundwater protection standard.

management objectives for the CCR Landfill is to address risks associated with residual impacts to the groundwater that have the potential to migrate to Huntington Creek.

All the corrective actions implemented under the UDEQ Groundwater Discharge Permit at the site will continue and be maintained. Additional remedial action may be implemented based on the evaluation of corrective measures and selection of remedy under the CCR Final Rule to address the residual groundwater impacts that have the potential to migrate to Huntington Creek.

## 3.5 Clean Up Levels / Attainment Criteria

The *Final Rule* prescribes what clean-up levels will be implemented and what will constitute attainment at all CCR units as follows:

> *Compliance with the groundwater protection standards established under § 257.95(h) has [have] been achieved by demonstrating that concentrations of constituents listed in appendix IV to this part have not exceeded the groundwater protection standard(s) for a period of three consecutive years using the statistical procedures and performance standards in § 257.93(f) and (g).*

The *Final Rule* dictates the clean-up levels for the selected remedy at the CCR Landfill as the groundwater protection standards established in 2018 and as updated using semi-annual groundwater data. Table 6 lists the groundwater protection standards developed based on 2018 monitoring data, coupled with guidance provided in the July 2018 modification to the *Final Rule* (EPA 2018).

## 3.6 Point(s) of Compliance

The *Final Rule* prescribes points of compliance for CCR units where groundwater protection standards have been exceeded, as follows:

> *The owner or operator of the CCR unit demonstrates compliance with the groundwater protection standards established under § 257.95(h) has been achieved at all points within the plume of contamination that lie beyond the groundwater monitoring well system established under § 257.91.*

The *Final Rule* also mandates that groundwater monitoring must be conducted at the waste unit boundary under *§ 257.91*. This means, all groundwater impacted by a release beyond the waste unit boundary must be addressed as part of the selected remedy. The selected remedy will be considered complete when concentrations of Appendix IV constituents in all CCR landfill groundwater monitoring wells are below the groundwater protection standards for three years. Site-specific groundwater protection standards were established as part of assessment monitoring completed in 2018 and are provided in Table 6.

**Table 6.** Huntington CCR Landfill Groundwater Protection Standards

| Analyte | Groundwater Protection Standard (mg/L) |
|---|---|
| Antimony | 0.006 |
| Arsenic | 0.01 |
| Barium | 2 |
| Beryllium | 0.004 |
| Cadmium | 0.005 |
| Chromium | 0.1 |
| Cobalt | 0.009 |
| Fluoride | 4 |
| Lead | 0.038 |
| Lithium | 1.23 |
| Mercury | 0.002 |
| Molybdenum | 0.100 |
| Radium | 23.68 |
| Selenium | 0.05 |
| Thallium | 0.002 |

## 4.0 ASSESSMENT OF CORRECTIVE MEASURES

As noted, risks to human health and the environment are considered low. The current corrective measures implemented at the site under the Groundwater Permit are providing protectiveness by capturing the majority of impacted groundwater along the flow path from the Old Landfill and the CCR Landfill. However, the current measures do not currently meet attainment criteria in the *Final Rule*. Additional corrective measures may be needed to satisfy these criteria.

As required by CCR regulations, various potential corrective measures for the Huntington CCR Landfill were evaluated. They were screened based on several factors including the specific elements defined in § 257.96 and § 257.97 and their ability to reduce residual risks associated with migration of impacted groundwater from the Old Landfill and the CCR Landfill reaching Huntington Creek. Specific criteria include the following:

- Performance
- Reliability
- Ease of Implementation
- Potential Safety Impacts
- Cross-Media Impacts
- Exposure Control to Residual Contamination

**Source Control and Treatment of Impacted Groundwater.** Corrective measures to address residual groundwater impacts will likely include; extracting groundwater and using and/or treating the extracted water and treating the impacted water in-situ. Two pump and treat and five in-situ treatment options were evaluated. Table 7 provides a summary of the evaluation. As

discussed in Section 3.3, corrective actions undertaken under the Utah DEQ Groundwater Permit have addressed and substantially eliminated the release of leachate from the landfill which resulted in the ground water impacts. Three corrective measures that further address the potential for future leachate are evaluated with in place closure, re-use of ash and removing/lining the landfill. The corrective measures evaluated are listed below and discussed in the following sections.

1. Maintain Current Corrective Actions with Groundwater Monitoring
2. Pump and Treat
3. Impermeable Barrier with Pumpback
4. Permeable Reactive Barrier
5. In Situ Injection of Reactive Compound
6. Phyto-Technologies
7. Electro-Kinetics
8. Beneficial Use of Ash
9. In-Place Closure
10. Closure by Removal

## 4.1 Maintain Current Corrective Actions

Normally the no action alternative is included as a baseline to compare the benefits of more active remedial measures. However, for HPP the no action alternative includes existing interim measures already implemented to address impacted groundwater and future actions required under the Utah DEQ Groundwater Permit. These include:

- Waste pre-treatment before landfill placement, that removes free liquids,
- Run-on/Run-off controls that prevent surface water infiltration into both landfills,
- Groundwater capture downgradient of both landfills and re-use in plant operations,
- Discontinued use of waste water for irrigation (2022), and
- Ongoing groundwater monitoring.

The current interim remedy combines the noted dewatering techniques implemented at the plant, to eliminate liquid being placed in the CCR Landfill with a groundwater collection system implemented in 2008. A collection system was installed to intercept FGD impacted water at both the CCR and Old Landfill areas (Figure 8).

The collection system was constructed below the toe of the northwest corner of the CCR Landfill. Water was flowing from the landfill along the contact between the bottom of the ash and the native ground, following natural drainage paths. The collection system was designed to intercept and direct the water and into a collection ditch. The ditch was lined with a high-density polyethylene (HDPE) channel lining system called SmartDitch©. A perforated 4-inch HDPE pipe was placed in the bottom of the ditch liner conveying water to the flanged bulkhead connection at the lowest end of the collection ditch. Using a flanged connection, the perforated pipe was joined to 4-inch, solid HDPE pipe and routed from the collection system, to the pump house. Water captured by the collection system is mixed with cleaner water collected from other

areas and is then directed to the mist eliminators in the plant where it is consumed. If the plant is off line, the collected water is directed to the Evaporation Pond.

The current system also has ongoing groundwater monitoring under the Utah DEQ Groundwater Permit. The groundwater is monitored to ensure that the impacted groundwater plume is stable and/or decreasing. Any increases or anomalies are investigated, and appropriate corrective measures are implemented. The ongoing monitoring relies on natural processes to decrease or attenuate concentrations of contaminants in soil or groundwater. This approach has been effective since the source of contaminants is controlled and leachate is no longer being released from the landfill. Natural processes such as soil adsorption and dispersion are likely to facilitate attenuation of contaminants or reduce their mobility in the environment.

**Performance.** The current measures have been successful in preventing trace metals defined in Appendix IV of the Final Rule, from migrating offsite. Current CCR monitoring indicates metals are bounded between farm wells NH-2W and NH-4W. The current and future measures have addressed all potential exposure routes and address the residual impacts to groundwater by monitoring and reduction through natural processes. Since these corrective measures are the baseline, performance has been rated as neutral in Table 7.

**Reliability.** Waste dewatering and run-on/run-off controls have significantly reduced the quantity of leachate formation in the CCR Landfill. These surface water controls require little to no maintenance, and waste dewatering has become part of routine plant operations. The existing groundwater capture system is removing metals loading in groundwater preventing offsite migration. The system consists of a slotted pipe that acts as a sump along the groundwater flow path downgradient of the landfills. It requires periodic maintenance in order to remove sediment and debris that accumulates in the pipe, particularly following storm events. The system is a passive collection system that requires active pumping to route captured water to the plant mist eliminators. Pumps require periodic maintenance. The current measures have been successful in preventing trace metals defined in Appendix IV of the Final Rule, from migrating offsite and the plume appears to be stable. Additional monitoring will determine if conditions are present within the landfill drainage and the alluvial aquifer that will facilitate attenuation of metals over time. Overall, the current interim remedy is reliable.

**Implementability.** The current interim remedy has been in place since 2008 and has undergone optimization steps through 2010. The removal of free liquids from the waste has been very effective with limited operations and maintenance (O&M) issues. The capture system has experienced periods of ineffectiveness following large storm events. During these episodes, sedimentation and debris have entered the systems, causing them to clog reducing the quantity of water they can accept. Because rain events, although rare, are large, interruptions to full-effectiveness limit their ability to sustain short-term effectiveness. As a secondary measure, water from large storm events have been contained in the Duck Pond storm water basin and pumped into the reuse system. The current system has been implemented and will continue to operate.

**Potential Environmental / Safety Impacts / Exposure Control.** Because the current interim remedy has already been implemented, no adverse impacts to the environment are expected or are expected due to its continued operation. No heightened safety concerns of plant personnel or the public are expected, since no additional work would be completed that would create potential exposures to the environment, plant personnel, or the members of the public. As discussed in Section 3.4 above, exposure to impacted media is minimal and is being addressed under the current corrective measures.

**Time to Implement / Complete.** No time is required to implement the current interim remedy, as it is in place and operating. The current remedy will require time to reach attainment criteria and relies on dispersion and groundwater mixing over time. This option is currently being employed under the Utah DEQ Groundwater Permit. Time to complete estimates range from 10-20 years as residual impacts are slowly washed through the system by precipitation events.

**Permits & Public Health Requirements.** The current remedy is already permitted through State and local agencies, as required by State and Local rules. No additional permitting is required to maintain the existing interim remedy. No special measures would be required with respect to public health requirements.

**Summary.** Maintaining the existing interim remedy is fully implementable, reliable, and poses no risks to public health and safety by its continued operation. This alternative has demonstrated effectiveness in reducing the quantity of water migrating downgradient of the two landfills and removing metals from impacted water. Alone this alternative will likely reach attainment requirements under the *Final Rule*, by meeting groundwater protection standards at the waste unit boundary but it will require many years to reach the standards. To shorten the duration of time in meeting the groundwater protection standards at the boundary, additional corrective measures would be required.

## 4.2 Pump and Treat

Pump and Treat involves the physical extraction of impacted groundwater to either remove contaminant mass from the subsurface and/or to hydraulically control plume migration. The extracted water is then used in a process or treated through a variety of methods, depending on the contaminant characteristics and volume of material recovered to reduce contaminant loading in the groundwater, while containing / remediating recovered groundwater in a controlled setting.

**Performance.** The pumping aspect of this alternative is included in several other proposed corrective measures. It is a proven technology in use for a variety of similar applications as the CCR Landfill, and with performance monitoring and optimization, can be successfully applied at HPP. Pending volumes, treatment of captured groundwater would be routed through the planned reverse osmosis (RO) unit for polishing, and then either used in the plant mist eliminators or discharged to the facility Evaporation Pond. This alternative actively addresses the impacted groundwater and would reduce the time required to the attainment of the groundwater criteria at the waste unit boundary, by removing impacted groundwater in recovery wells.

**Reliability.** Pump and treat technologies are widely used in the industry to capture / collect contaminated groundwater and contain or treat it to meet discharge standards. Recovery wells, pumps and piping would make up the recovery network, which in general, are low maintenance items. Periodic maintenance of each will be required to remove scaling that will eventually build up due to contact with shale water. These activities can be built into a regular schedule at low costs and without disruption to plant operations.

**Implementation.** Installation of the pumping system is not complex. Based on an understanding of site hydrogeology and informed by pilot testing, a series of wells could be installed to capture groundwater as it passes the Old Landfill and CCR Landfill boundaries. System optimization requires frequent performance monitoring early-on, to ensure effective groundwater recovery. Pump and treat is fully implementable at the HPP.

**Potential Environmental / Safety Impacts / Exposure Control.** Captured groundwater would be contained in piping and sent to either the plant mist eliminators where it will be consumed or be routed through the planned reverse osmosis (RO) unit for polishing, and then either used in the plant mist eliminators or discharged to the facility Evaporation Pond. Worker exposures are possible during active O&M activities. The remainder of the time captured water would be contained before treatment.

**Time to Implement / Complete.** The pump and treat alternative could likely be designed and installed in one year. Optimization would be ongoing through performance monitoring, with frequent monitoring during the first year and reduced monitoring once the system has been optimized. Pump and treat will result in faster removal of ground water from the system, potentially speeding up ground water cleanup. By incorporating Pump & Treat into the current remedial measure, the site could meet attainment standards in 7-12 years.

**Permits & Public Health Requirements.** This remedial technology would require permitting and design through the State agencies, which may require significant time in the review and design process. Both DEQ permitting and water rights issues would need to be resolved prior to implementation, which could require up to one year. Public health impacts would be minor since site access is controlled.

**Summary.** The pump and treat technology is fully implementable and reliable and would offer the capability to reach attainment at the waste unit boundary. A pilot study would be required to determine the quantity of water that will be recovered, and if current plant infrastructure can accommodate captured water for treatment.

## 4.3 Impermeable Barrier / Pumpback System

An impermeable barrier is a cement/bentonite mix placed in the subsurface as a wall designed to stop groundwater flow and contaminant migration. By itself, an impermeable wall is unlikely to achieve attainment in areas of continuous, groundwater flow and therefore this option includes a groundwater pumpback system. The groundwater would be directed to an area where a pumpback system would be optimized.

**Performance.** An impermeable barrier and pumpback system would offer a long-term containment measure for impacted groundwater. The barrier would direct / contain groundwater in a localized area, allowing for the pumpback system to capture water. Captured water would require long-term management, until a period after landfill closure and capping is complete. This alternative actively addresses the impacted groundwater and would reduce the time required to the attainment of the groundwater criteria at the waste unit boundary. Performance of the system is similar to the pump and treat system utilizing wells for extraction discussed in Section 4.2.

**Reliability.** While the impermeable barrier technology has been utilized successfully for a number of environmental applications, site-specific considerations will determine whether or not the barrier can effectively serve as an underground dam, directing water to the pumpback system. Significant geotechnical evaluation of drainage downgradient of the landfill would be needed, to determine if the barrier can be constructed and perform its function. The reliability of the impermeable barrier is unknown. If properly designed, the pumpback technology is reliable and effective in capturing impacted groundwater and providing hydraulic control in the aquifer. However, the geological formation within the drainage and the depth of the containment would be difficult to ensure proper capture. Therefore, the reliability is rated as negative. Given the steep terrain downgradient of the CCR landfill, the likelihood of successfully installing the barrier is questionable.

**Implementation.** Implementing this alternative is very invasive. Large excavations are required to accommodate placement of the barrier. Groundwater flow would require evaluation following the barrier installation, to optimize the placement and construction of pumpback wells.

**Potential Environmental / Safety Impacts / Exposure Control.** Of the available alternatives, impermeable barriers offer some of the highest risks to exposure from workers. Excavations will expose the aquifer and dewatering is required during installation. Workers may be exposed to contaminated groundwater throughout this process. The risk to release of impacted groundwater is very high as well, because the aquifer material is exposed, and groundwater inflow is being actively managed. While dewatering can be done safely and controlled, exposure control will take significant effort to mitigate.

**Time to Implement / Complete.** The design element of this alternative is likely to be time intensive, for engineering design and installation. Once installed, aquifer evaluation will be required to determine the proper placement and construction of pumpback wells. Performance monitoring will be required to determine effectiveness over the short-term. Installation will likely require one construction season to prepare the site and install the barrier. The barrier and pump & treat would perform similar to Pump & Treat alone, with an expected timeframe to achieve attainment in the 7-12 year range. The barrier system, if properly placed, may slightly increase the capture efficiency and reduce the timeframe to 6-11 years.

**Permits & Public Health Requirements.** State permits would be required to design and install an impermeable boundary and a pump and treat system. Both DEQ permitting and water rights issues would need to be resolved prior to implementation, which could require up to one year.

With respect to public safety, site access control would need to be maintained to limit public exposure to the pumped water.

**Summary.** An impermeable barrier and pumpback system will allow for active capture and treatment of impacted water. Water management may require the construction of additional storage ponds, unless current infrastructure is sufficient to store captured water. Installation of the barrier will be very invasive and will require special planning. Given the steep terrain downgradient of the CCR landfill, the likelihood of successfully installing the barrier is questionable. In order to capture groundwater from both landfills, the barrier will need to be placed downgradient of both. As a result, achieving attainment at the waste unit boundary is unlikely.

## 4.4 Reactive Permeable Barrier

A reactive permeable barrier (RPB) is a placed to intercept contaminants along the groundwater flow path within a contaminant plume. The RPB is designed to react with and/or reduce the toxicity or mobility of a contaminant as it passes through the barrier. When properly designed, the contaminant is immobilized in the wall or degraded by compounds used in construction of the wall.

**Performance.** A reactive permeable barrier can be very effective in treating groundwater where the flow path is well understood or contained, and the quantities of groundwater undergoing treatment are well understood. Treatability testing would be required to determine the optimal composition of an RPB to address impacted groundwater at HPP. It is unlikely an RPB could be installed such that attainment could be reached at the waste unit boundary.

**Reliability.** RPBs would offer low to moderate reliability. Because they are designed to react with groundwater, several factors affect their ability to function over the long-term, including breakthrough in areas of higher than expected groundwater flow, burnout due to localized flow, and the need to remove and/or replenish the reactive compound due to interactions with contaminants. As a result, RPBs can include long-term O&M and periods of down-time for the system, while maintenance or replacement takes place.

**Implementation.** Implementing this alternative is very invasive. Large excavations are required to accommodate placement of the barrier, and similar invasive activities are needed during maintain them. Treatability testing would be required to determine if an RPB will effectively support removal of metals from impacted groundwater at the facility.

**Potential Environmental / Safety Impacts / Exposure Control.** Of the available alternatives, RPBs offer some of the highest risks to exposure from workers. Excavations will expose the aquifer and dewatering is required during installation. Workers may be exposed to contaminated groundwater throughout this process. The risk to release of impacted groundwater is very high as well, because the aquifer material is exposed, and groundwater inflow is being actively managed. While dewatering can be done safely and controlled, exposure control will take significant effort to mitigate.

**Time to Implement / Complete.** RPBs will require relatively intensive testing in order to design a barrier that will be effective in treating the metals found in groundwater at HPP. The design element of this alternative is likely to be time intensive, both from a RPB composition perspective, and for engineering design and installation. Once installed, the RPB will begin treating impacted groundwater. Performance monitoring will be required to determine its effectiveness. Installation will likely require one construction season to prepare the site and install the RPB. The RPB would reduce the concentration downgradient of the system and allow clean water to flow through the downgradient portion of the plume but would do little to remove residual concentrations between the landfill and the RPB. As a result, if the RPB could be placed and constructed correctly, it would reduce the time to necessary to achieve attainment, which is estimated at 9-14 years.

**Permits & Public Health Requirements.** Additional permits would be required through State agencies to design and construct an RPB. Since the material is reactive, public safety would need to be considered during implementation. Site controls will be required during implementation and operation of the system.

**Summary.** An RPB offers some very favorable properties, specifically passive treatment of impacted groundwater throughout the year. Implementing this alternative will take 2 to 3 years, and long-term O&M will be required, until landfill closure and capping are complete, and groundwater impacts curtail to levels below groundwater protection standards. Treatability testing will be required in order to determine the feasibility of this alternative. Based on this, the likelihood of success for an RPB is unknown.

## 4.5 In Situ Injection of Reactive Compound

In-situ injection involves introducing a chemical agent into the subsurface that physically reacts with the contaminants to degrade, stabilize or immobilize the contaminant in the aquifer. Knowledge of all contaminants, the geochemistry of the aquifer matrix, and the impacted water to undergo treatment is required to successfully implement this technology.

**Performance.** Injection of chemicals to treat impacted groundwater is unlikely to be successful as a stand-alone alternative. While in situ treatment could result in decreased mobility of metals in the aquifer over the short-term, the homogeneity of the impacted aquifer and depth profile it occupies, is unlikely to result in the successful placement of chemicals to treat all impacted groundwater.

**Reliability.** The reliability of chemical treatment of landfill wastes will require a pilot study, to determine if chemicals can be effectively applied within the waste profile, and if chemical applications immobilize FGD-related constituents sufficiently to support long-term attainment objectives. Presently, the reliability of this alternative is unknown.

**Implementation.** A pilot study would be required to determine if chemical(s) could be applied in the waste across the entire depth profile to effectively immobilize contaminants of concern. The study would also seek to identify which chemical applications have the greatest chance of

success to support the cleanup objectives. Because these factors are unknown at this time, the ability to implement this alternative is also unknown.

**Potential Environmental / Safety Impacts / Exposure Control.** In situ application of chemicals to the landfill waste would be relatively non-invasive. Likely chemicals would be injected through temporary wells, placed in the landfill based on the pilot study. Manageable amounts of waste (drill cuttings) would be generated during this process, but safe work practices can mitigate risks to workers. Cuttings can be placed in the landfill along with other plant waste to mitigate the potential for releases to the environment during active treatment. Exposure to the treatment chemicals while handling and injecting would pose a risk to workers but can be reduced by a Health & Safety Plan and proper engineering controls.

**Time to Implement / Complete.** The pilot study could require up to a year to complete. Vertical profiles of the impacted areas would have to be acquired as core samples, followed by batch testing to determine the efficacy of potential chemical amendments. If the pilot test concludes this alternative is viable, chemical injections could begin after the injection well network is developed and installed. Performance monitoring would be frequent during the first year to ensure the effectiveness of the treatment. The in situ injection would reduce the concentration downgradient of the injection area and allow clean water to flow through the downgradient portion of the plume but would do little to remove residual concentrations between the landfill and the injection site. As a result, if the in situ injection could be placed and constructed correctly, it would reduce the time to necessary to achieve attainment, most likely in the 9-14 year timeframe.

**Permits & Public Health Requirements.** Remedial activity would require permitting and design documents to be approved by the State Agencies. Public health impacts are not expected since site access is controlled, and the majority of the work will be completed in the subsurface.

**Summary.** If successful, in situ injection of reactive chemicals would immobilize FGD-related constituents in the groundwater, reducing or eliminating their mobility in the groundwater. Treatability testing is required in order to determine if this alternative can be implemented in the heterogenous waste profile in the impacted area of the aquifer. This alternative does not address the volume of the impacts, just the mobility.

## 4.6 Phyto-Technologies

Phyto-remediation is the use of plants or vegetation to uptake contaminants in soil or water and immobilize the contaminant in the cell structures. Specific to groundwater remediation, the selected plant(s) must be in contact with groundwater and thrive while processing the contaminants. Groundwater elevations at the HPP are much deeper than the normal root zones of plants that can survive the arid climate of Utah. Bringing groundwater to the surface (pumping) to facilitate Phyto-remediation will be prohibited at the plant after 2022, when the current groundwater discharge permit expires. Based on these factors, this alternative is not viable to achieve groundwater attainment.

## 4.7 Electro-Kinetics

Electro-kinetic methods induce a low intensity direct current through the soil or groundwater using a cathode and anode array. The current causes positively charged ions to move toward the cathode and negatively charged ions to move toward the anode where they can be captured or immobilized.

**Performance.** Electro-kinetic methods can be effective in treating localized or contained contamination, and in relatively homogeneous aquifer settings. It is not clear this alternative can treat groundwater over the spatial area impacted by discharge from the Old Landfill and the CCR Landfill. A pilot study would be required to determine the viability of this alternative under site-specific conditions.

**Reliability.** This alternative has been demonstrated as an effective treatment under the right conditions. During active treatment, poles in the system foul over time, due to electro-plating of desired constituents. This results in periods of decreasing efficacy and down time to eliminate the effects of fouling. The reliability of the system would be considered moderate.

**Implementation.** Electro-Kinetic remediation requires a specific contaminant that is attracted to a cathode or anode in an array or a contaminant that can be destroyed by heat. In addition, these methods consume electricity at a very high rate and can only be operated for short periods of time due to the cost. They can be effective if the contaminant is in high concentrations or very limited in extent. As is the case at CCR units, the contaminants are typically dispersed over a large area and in low concentrations once in groundwater. As a result, the ability to implement this alternative at the HPP is questionable.

**Potential Environmental / Safety Impacts / Exposure Control.** Potential exposures to workers could occur during installation of the system, and during periods of maintenance. Because the system treats groundwater in situ, additional exposure to workers or releases to the environment are not anticipated during active operations. The use of electricity does pose a risk to workers.

**Time to Implement / Complete.** A pilot study would be required to determine if electro-kinetics will serve as a viable alternative to treating impacted groundwater. The pilot study and system design will require a year. Installation could be completed in three months, with system optimization to follow.

**Permits & Public Health Requirements.** Remediation would require a very specific design and a complicated permitting effort, since the technology is not used extensively. A detailed pilot study would be required to collect the data needed to complete the permitting process. As a result, significant time would be required to obtain the necessary permits. Public health issues are not expected since site access is controlled.

**Summary.** A pilot study would be required to determine if site-specific conditions would lend themselves to effective treatment using electro-kinetics. Based on these findings, an array would

be designed and installed to treat impacted groundwater. At present, the viability of electro-kinetics to achieve attainment criteria at the waste unit boundary are unknown.

## 4.8 Beneficial Reuse

If waste reuse can eliminate environmental concerns while benefitting the end user in a manner that is both economical and protective of the environment, it is generally the preferred alternative.

**Performance.** Currently the viability of harvesting and use of CCR material (bottom ash, fly ash and FGD waste) is mixed. Mapping of waste disposal practices can make certain parts amenable to beneficial use. However, the manner of placement of the FGD waste in the Huntington landfill has made harvesting usable product not feasible. End users cannot economically utilize the mixed waste in their processes so there is no market/use for mixed waste. Since beneficial use is currently not feasible, the other elements were not evaluated for this option.

## 4.9 In Place Capping and Closure

This alternative would include implementing a phased capping program rather than constructing a final cover system at the time of landfill closure. The phased capping approach would reduce the amount of precipitation infiltration into the wastes, thereby reducing the quantity of potential leachate that could develop in the landfill. The site is located in an arid region, hence infiltration of precipitation is minimal. This alternative addresses potential future leachate formation but does not address the residual impacted groundwater.

**Performance.** The phased capping corrective measure provides progressively increasing protection of human health and the environment as the evapotranspiration (ET) cap reduces infiltration of precipitation, contact with the landfill waste and possible contaminant migration until the landfill is closed and fully capped. Once the phased capping alternative is fully implemented, the cap would satisfy landfill closure requirements, and minimize the infiltration of precipitation through the waste.

**Reliability.** The area of the phased capping and the final cap will require periodic inspection and maintenance during the post-closure period, to ensure it remains intact and effective. Overall, given the arid climate, caps are highly effective at minimizing infiltration.

**Implementation.** The phased capping alternative is not readily implementable as current landfill operations are well established and the changes needed to implement this alternative would require major modifications to the operation of the landfill. CCR landfills are regularly capped in accordance with regulations and permits, which are based on approved operations plans. Contractors with the experience and equipment are readily available. This alternative would need to conform with applicable Utah DEQ landfill regulations as modifications to the current landfill permit would be required.

**Potential Environmental / Safety Impacts / Exposure Control.** The alternative would occur at the power plant which is an access-controlled site, remote from communities. Conducting the phased capping measure would introduce manageable short-term risks to worker health and safety during construction activities. Worker exposures and safety concerns would be addressed through implementation of a site safety plan, adherence to Occupational Safety & Health Administration (OSHA) construction practices. Storm water management control measures are a key component of the measure. No environmental impact from construction activities is expected to occur.

**Time to Implement / Complete.** The time to install the cap will occur over several years, coinciding with the CCR Landfill reaching capacity and undergoing closure. Because this alternative will not actively capture or treat groundwater, it is not expected to meet near-term attainment standards. The capping is not expected to be complete until the site is fully closed. Given the low amount of precipitation at the site, phased capping would only provide incremental decreases in liquid potentially entering the landfill. As a result, this method is not expected to decrease the time to complete corrective measures beyond what can be achieved through natural attenuation.

**Permits & Public Health Requirements.** Capping requires a permit from the State for construction of the cap and ancillary permits such as construction storm water. While these permits are common, it often requires more than one year to complete the requirements. Public health issues are not expected since the site access is controlled, and the action would serve to contain wastes in place with an engineered cover.

**Summary.** Phased capping would reduce the potential for precipitation to enter the landfill and thus reduce the potential for the formation of leachate. However, it does not address impacted groundwater and is unlikely to achieve attainment at any point where water has been impacted by releases.

The phased capping alternative would occur over an extended timeframe as the landfill accumulates wastes. This alternative will not be fully implemented until the landfill reaches capacity and the closure plan is implemented. Capping the landfill at closure will serve as a long-term solution to leachate formation and potential releases to shallow groundwater.

## 4.10 Closure by Removal

This option would involve siting, designing, permitting and constructing a new lined repository, removing all waste from the existing CCR Landfill, and transporting and placing it in the new repository for final disposal. Once removal and compaction are complete, a cap meeting all CCR requirements would be placed on the repository.

**Performance.** The removal and placement in a lined repository would prevent release of leachate. The new site would be a new CCR Unit and would require long term care and monitoring. The removal would not address impacted groundwater. Over the long-term, natural attenuation would eventually result in attainment of standards, but this period is unknown.

**Reliability.** A new landfill that meets all of the CCR requirements for liner installation, leachate detection / collection, and an engineered cover would reduce or prevent release of future leachate. This alternative would not address current conditions in groundwater.

**Implementation.** Siting a new repository at the HPP would be difficult, as available space suitable to construct a new landfill is very limited. The upper reaches of the plant where the Old and CCR Landfills reside, takes up the majority of available land. If a suitable location can be identified, the design and construction of a new landfill is fully implementable.

**Potential Environmental / Safety Impacts / Exposure Control.** Increased chances of worker exposure would require mitigation during excavation of existing CCR material, and transport and placement in the new repository. Heightened potential for releases to the environment would also require mitigation, to ensure CCR material is not released as fugitive dust or as a result of spills or accidental dumping. Exposures to workers and released to the environment can be mitigated through safe work practices and stormwater management.

**Time to Implement / Complete.** The siting, design, and construction of a new landfill will likely take up to two years to complete. Removal and placement of existing waste to the new repository would also likely require two years as well. This alternative would not address near-term impacts to facility groundwater. Long-term attainment of standards is possible through MNA. Given the volume of waste that would have to be moved and the fact that the remaining contamination is residual or adsorbed to the soil, this alternative is not expected to result in a faster cleanup than could be achieved through natural attenuation.

**Permits & Public Health Requirements.** A significant permitting effort is expected to site, design and permit a new repository in this location for a large mass of waste. Given the site topography, limited areas are available that are large enough to encapsulate this volume of material. In addition, permits to transport the waste to a new repository may be required depending on the distance from the current landfill and the new repository location. If public haul routes are used, potential public health issues associated with large haul traffic and fugitive dust will need to be mitigated.

**Summary.** Excavation and placement of existing CCR material in a new onsite repository / landfill, is implementable if a suitable location can be identified and permitted. This alternative will not provide any appreciable benefits to impacted groundwater and would only address the potential for future formation of leachate in the landfill.

**Table 7.** Alternatives Screening

| Regulatory Reference | 257.96 (c) (1) | | | | | | 257.96 (c) (2) | | 257.96 (c) (3) |
|---|---|---|---|---|---|---|---|---|---|
| **Corrective Measure – Alternative:** | **Performance** | **Reliability** | **Implementation** | **Potential Impacts of Remedy** | **Safety Impacts** | **Control of Exposure** | **Time Required to Begin** | **Time Required to Complete** | **State & Local Permits, Public Health Requirements** |
| Maintain Current Corrective Actions | = | = | = | = | = | = | = | = | = |
| Pump & Treat | + | + | + | + | - | - | + | + | - |
| Impermeable Barrier / Pumpback System | = | - | - | - | - | - | - | + | - |
| Reactive Permeable Barrier | = | - | - | - | - | - | - | + | - |
| In Situ Injection of Reactive Compound | - | - | - | - | - | + | - | - | - |
| Phyto-Technologies | NV | | | | | | | | |
| Electro-Kinetics | = | - | - | - | - | + | - | = | - |
| Beneficial Reuse | NV | | | | | | | | |
| In-Place Closure | - | + | = | - | - | - | + | - | = |
| Closure by Removal | + | + | - | - | - | - | - | + | - |

+ Positive
- Negative
= Neutral
NV: Not Viable

## 4.11 Corrective Measures Alternatives

Sections 4.1 through 4.10 present the evaluation of the ten prospective corrective measures. The evaluation indicates the current corrective measures implemented under the Groundwater Discharge Permit address all concerns at the site. Active treatment of the impacted groundwater would reduce the time by approximately 10 years for the impacted groundwater to meet groundwater protection standards under the *Final Rule*. From the evaluation, a pump and treatment system is the preferred option to actively treat the impacted groundwater. Removal of the landfill would not have an appreciable effect on impacted groundwater. Based on this, two alternatives appear to be the most applicable to address groundwater impacts associated with the Huntington CCR Landfill:

1. Alternative 1: Maintain existing Corrective Measures

2. Alternative 2: Maintain Existing Corrective Measures with a Pump and Treat Groundwater Treatment System

# 5.0 SELECTION OF THE REMEDY

The remedy at the CCR Landfill will be selected following public meetings / public comment. The remedy selected will be determined by utilizing the requirements § 257.96 in the *Final Rule.*

## 6.0 REFERENCES


ATSDR, 2019. Agency for Toxic Substances and Disease Registry, Public Health Statements, Chromium, Cobalt, Lithium, and Selenium. https://www.atsdr.cdc.gov/phs/index.asp

BLM and USDA-FS, 2012. Environmental Assessment: Deer Creek – Upper Cottonwood Two Lease Modifications to Federal Coal Leases UTU-06039 and UTU-88554, Emery County, Utah. DOI-BLM-UT-G023-2012-0018-EA. November 2012.

EPA, 2018. Federal Register Notice, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; Amendments to the National Minimum Criteria (Phase One, Part One), 40 CFR Part 257 [EPA–HQ–OLEM–2017–0286; FRL–9981– 18–OLEM] RIN 2050–AG88, July 30, 2018.

Fisher and others, 1960. Freeze R.A. and Cherry, J.A. 1979. Groundwater. Prentice Hall. Englewood Cliffs, New Jersey. 604p.

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, NJ, Prentice-Hall

Hettinger, R.D. and Kirschbaum, M.A.2002. Stratigraphy of the Upper Cretaceous Mancos Shale (upper part) and Mesaverde Group in the southern part of the Uinta and Piceance Basins, Utah and Colorado. USGS. Geologic Investigations Series I-2764.

Morris, D.A. and Johnson, A.I. (1967). Summary of Hydrologic and Physical Properties of Rock and Soil Materials, as Analyzed by the Hydrologic Laboratory of the U.S. Geological Survey, 1948-1960. USGS Water Supply Paper: 1839-D. In Kresic N. 2007. Hydrogeology and Groundwater Modeling, p 111. CRC Press.

Oliveria, 2012. Chromium as an Environmental Pollutant: Insights on Induced Plant Toxicity, Journal of Botany, Volume 2012, Article ID 375843.

Stokes, W.L. 1986. Geology of Utah. Utah Museum of Natural History and Utah Geological and Minerals Survey.

Utah Department of Environmental Quality, 2017. Groundwater Quality Discharge Permit UGW15002 – Statement of Basis, PacifiCorp Huntington Power Plant, Huntington Utah, June 2017.

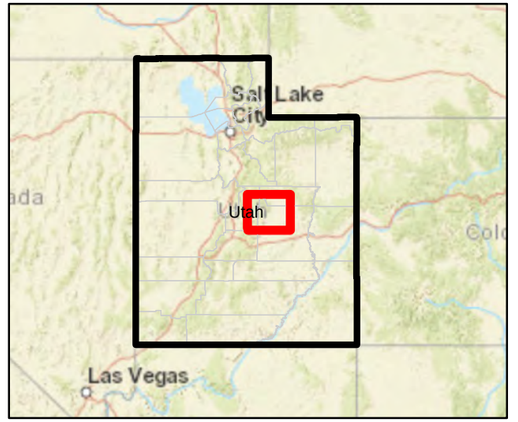
UDWR, 2000. Utah Division of Water Resources, Utah State Water Plan – West Colorado River Basin, October 2000.

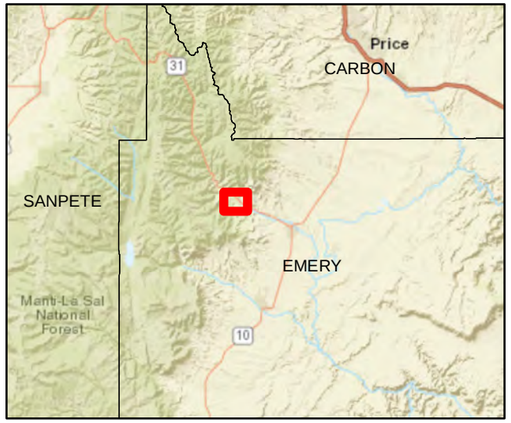
Waddell, K.M. Contratto, P.K. Sumison, C.T. and Butler, J.R. 1979. Hydrologic Reconnaissance of the Wasatch Plateau-Book Cliffs Coal-Fields Area, Utah. USGS Geological Survey – Water Supply Paper 2068.

Water & Environmental Technologies, 2016. Huntington Power Plant CCR Landfill Run-On and Run-Off Control Plan, September 2016.

Water & Environmental Technologies, 2016. Huntington Power Plant Site Wide Monitoring Program, 2004 Annual Monitoring Report, December 2005..

# FIGURES




**Legend**

- CCR Wells
- Dry/Abandoned Wells
- CCR Units

*Note background image is 2016 1 ft. resolution ESRI Aerial

Feet
0 500 1,000 2,000

N W E S

PACIFICORP

Water & Environmental TECHNOLOGIES

# HUNTINGTON POWER PLANT

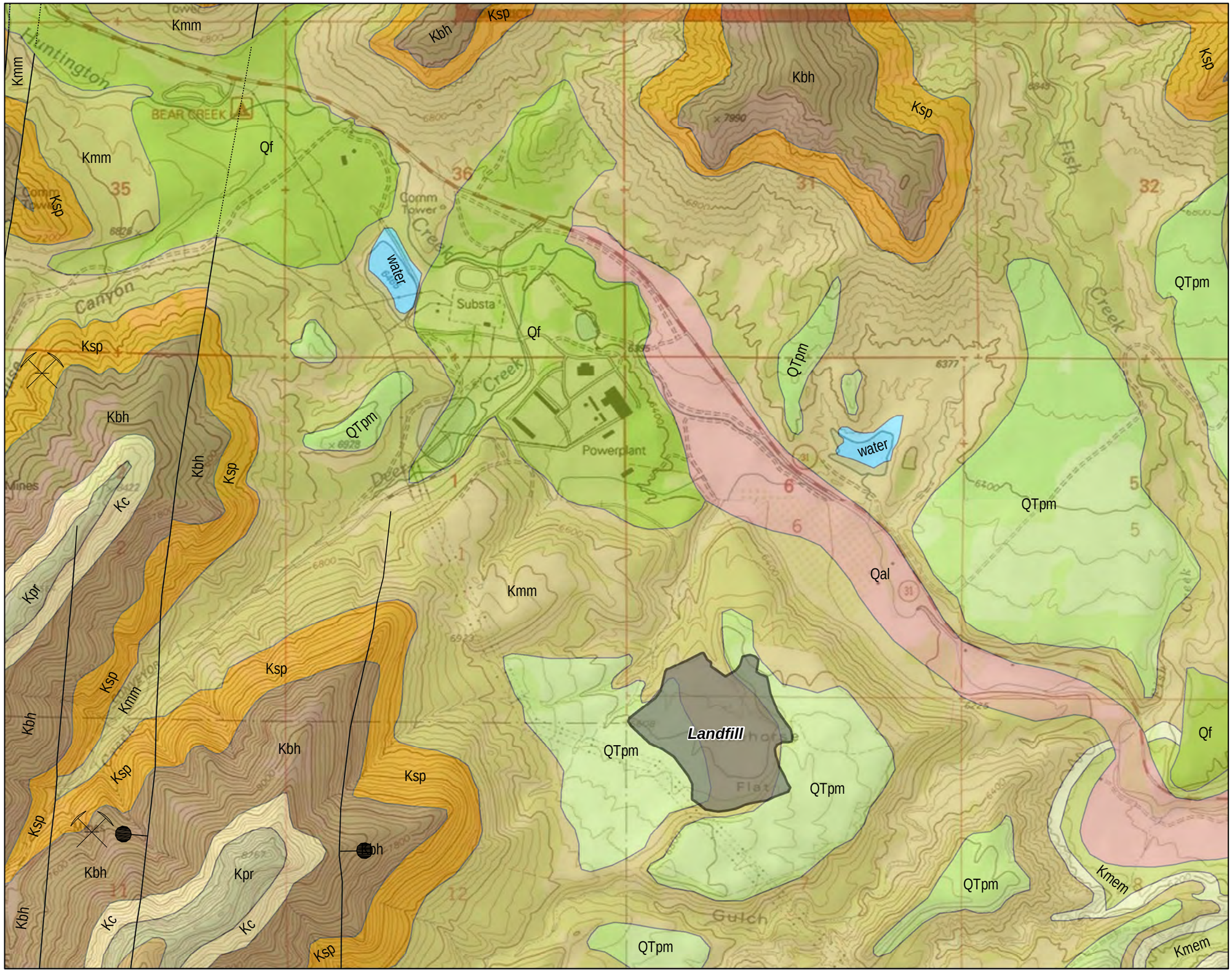
***CCR Sampling Locations***

Job#: PERCM53

Date: 1/18/2018

**FIGURE 1**

Path: M:\PERC_CCR\Huntington\Huntington_Fig1_CCR.mxd, Author: brutherford




## Legend

- fault, normal, well located
- fault, normal, concealed

### Geologic Unit

- Kbh, Blackhawk Formation
- Kc, Castlegate Sandstone
- Kmem, Middle unit of the Emery Sandstone Member of the Mancos Shale
- Kmeu, Upper unit of the Emery Sandstone Member of the Mancos Shale
- Kmm, Masuk Member of the Mancos Shale
- Kpr, Price River Formation
- Ksp, Star Point Sandstone
- QTpm, Pediment Mantle
- Qal, Alluvium
- Qf, Alluvial fan
- TKn, North Horn Formation
- water, water

N
W E
S

Feet
0 1,500 3,000

PACIFICORP

Water & Environmental TECHNOLOGIES

# HUNTINGTON POWER PLANT

***Geologic Map***

Job#: PERCM53

Date: 12/20/2017

**FIGURE 2**

Path: M:\PERC_CCR\Huntington\Huntington_Figure 2_Geology.mxd, Author: Stefanie

## Legend

HLF-3ND - Well ID
6,471.30 - Water Level Elevation (ft.)
NM = Not Measured

- CCR Well
- CCR Well - Dry & Abandoned
- Groundwater Elevation Contour (Contour Interval = 20 ft.)

HDP-3 NM
HDP-2 6,304.43
6320
6340
HLF-7NN 6,138.99
HLF-8N 6,359.49
6360
HDP-1 6,368.94
6380
6400
6420
HLF-6N
6440
HLF-5N
HLF-4N 6,463.88
6460
HLF-3ND 6,471.30
6480
HLF-1O 6,582.61
CCR Landfill
6500
6520
6540
HLF-1N 6,555.57
HLF-7N

**Measurement Date: 05/31/2018**

N
W E
S

Feet

0 300 600 1,200 1,800 2,400

PACIFICORP

Water & Environmental TECHNOLOGIES

**HUNTINGTON POWER PLANT**

***Groundwater Elevation Map***
***CCR Landfill***

Job#: PERCM052

Date: 8/13/2018

**Figure 3**

Path: M:\PERC_CCR\2018_May_Sampling\2018_May_All Sites_DDPs.mxd, Author: brutherford

## Legend

- Ground Water Elevation Contour
- Inferred Ground Water Elevation Contour
- Abandoned Well
- Existing Monitoring Well
- Monitoring Network Well
- Surface Water Sample Point (CFS)

N
W E
S

Feet
0 500 1,000 2,000

PACIFICORP

WET Water & Environmental Technologies

# HUNTINGTON POWER PLANT

***Huntington Creek Alluvium GW Elevation Map (Fall 2013)***

Job#: PERCM02

Date: 4/11/2019

**FIGURE 4**

Path: M:\Huntington\2019\Figure4_GWElev.mxd, Author: jleprowse

## Legend

- Plant Boundary
- Site Buffer (5 mi.)
- Normal Fault
- Inferred Normal Fault

**Points of Diversion (PODs)**

- Abandonded Well - [Count = 2]
- Rediversion - [Count = 140]
- Spring - [Count = 4]
- Surface - [Count = 202]
- Underground - [Count = 86]

**Simplified Geologic Units**

- Water
- Q - Alluvium, Pediment Mantle, Alluvial Fan Deposits, Slope Wash
- Tf - Flagstaff Limestone
- TKn - North Horn Formation
- Kpr - Price River Formation
- Kc - Castlegate Sandstone
- Kbh - Blackhawk Formation
- Ksp - Star Point Sandstone
- Km - Mancos Shale

CARBON CO
EMERY CO

N
W E
S

Feet

0 3,000 6,000 12,000 18,000 24,000

PACIFICORP

Water & Environmental TECHNOLOGIES

| | |
|---|---|
| Huntington Power Plant | |
| Points of Diversion (PODs) Map | |
| Job#: PERCM053 | Figure 5 |
| Date: 2/22/2019 | |
| Path: M:\Huntington\2018\Points of Diversion_Geo.mxd, Author: jleprowse | |

**Legend**

- Monitoring Well
- CCR
- Surface Water

N
W E
S

Feet

0 500 1,000 2,000 3,000 4,000

Water & Environmental TECHNOLOGIES

# Facility Monitoring Wells

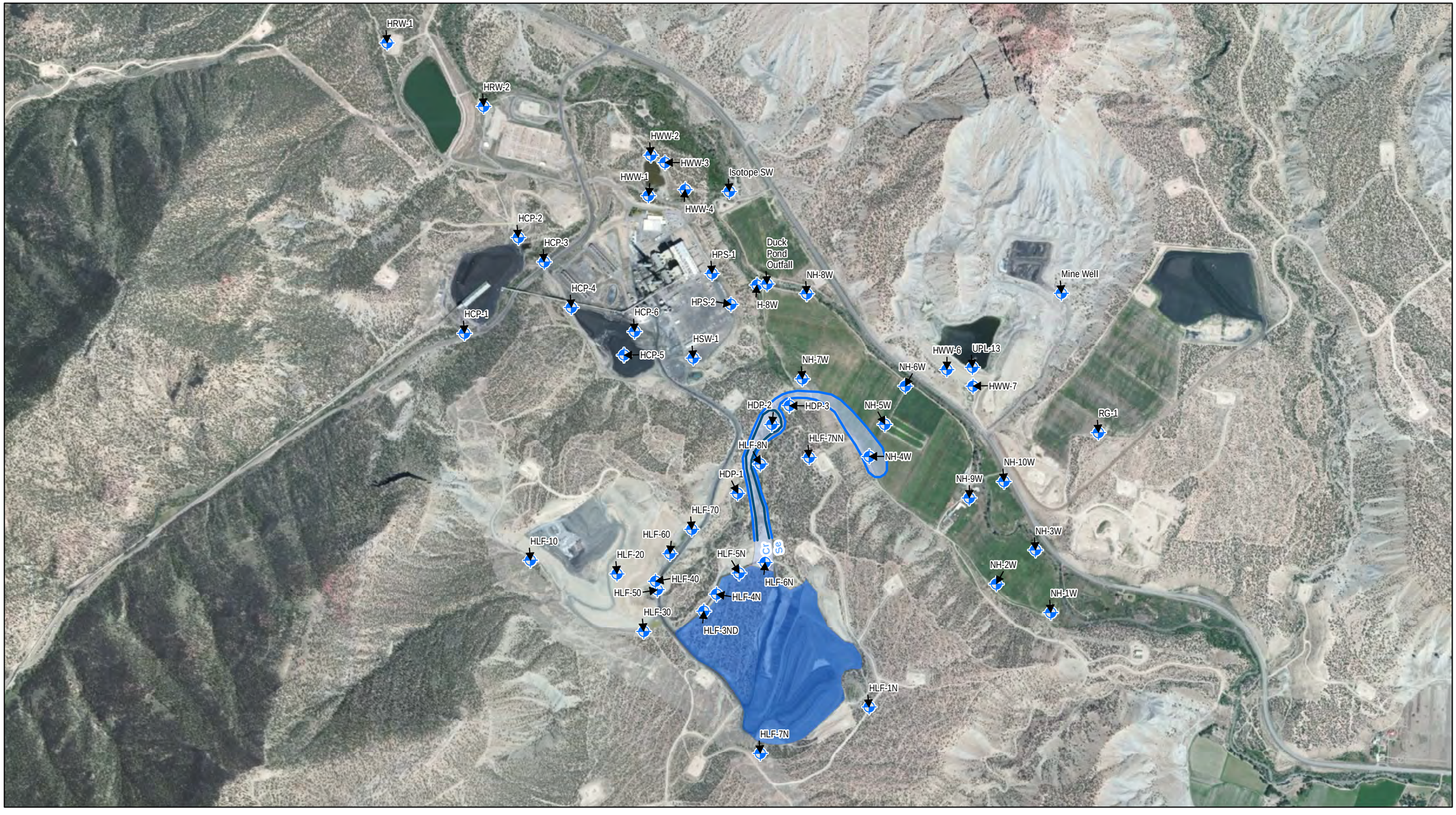
## *Huntington Power Plant*

Job#: PERCM73

Date: 1/16/2019

**FIGURE 6**

Path: M:\Huntington\All_Wells.mxd, Author: jleprowse




**Legend**

- Monitoring Well
- Cr - Chromium
- Se - Selenium
- Groundwater Plume
- Landfill

N
W E
S

Miles

0 0.25 0.5 0.75 1

PACIFICORP

Water & Environmental TECHNOLOGIES

# HUNTINGTON POWER PLANT

***Appendix VI - Isoconcentration Map***

Job#: PERCM53

Date: 3/8/2019

**Figure 7**

Path: M:\PERC_CCR\Huntington\2019\App_IV_Fig_2_Huntington.mxd, Author: jslocum

**Legend**

- Existing Monitoring Well
- Monitoring Well
- Surface Water Sample Point
- Proposed HDPE Pipeline from old Landfill & New Landfill
- Proposed HDPE Pipeline from Duck Pond Drain

N
W E
S

Feet
0 200 400 800

PACIFICORP

WET Water & Environmental TECHNOLOGIES

# HUNTINGTON POWER PLANT

***Water Collection System***

Job#: PERCM016

Date: 3/19/2019

**FIGURE 8**

Path: M:\Huntington\Collection_System.mxd, Author: jleprowse