

F

Level II Antidegradation Review

Great Salt Lake Phase 1 Lithium Extraction Project

In support of UPDES Permit and Great Salt Lake Mineral Extraction Facility Operator Certification

Waterleaf Phase 1 LLC

Box Elder County, Utah

July 23, 2026 R1



Contents

1	Background	1
1.1	Purpose	2
1.2	Contents of Submittal	2
2	Proposed Project	3
2.1	Project Description	5
2.2	Influent and Discharge Characteristics	8
2.2.1	Flow-weighted, Optimal Period Analysis	10
2.2.2	Facility Mass Balance Analysis	11
2.2.3	External Influences on Commercial Plant Concentrations	13
2.3	Facility Scale-up and Changes from the Demonstration Plant	13
2.3.1	Upsizing of the Manganese Treatment System	13
2.3.2	Replacement of the Carbon Steel Tanks	14
2.3.3	Upsizing of the Groundwater RO Treatment Process	14
2.3.4	Recycling and Recirculation	15
2.3.5	Other Changes	15
3	Standards for Receiving Waters	16
3.1	Beneficial Uses	16
3.2	Water Quality Standards	16
3.3	Impaired Waters	17
3.4	Antidegradation Category of Receiving Water	17
4	Social, Environmental, and Economic Importance	17
4.1	Social, Economic, and Environmental Benefits	18
4.2	Social, Economic, and Environmental Losses	19
4.3	Supporting Information from Affected Communities on Preserving Assimilative Capacity	20
4.4	Structures or Equipment That Would Be Placed in or adjacent to the Receiving Water	20
5	Parameters of Concern	21
5.1	Potential Parameters of Concern – Water Quality Parameters	21
5.2	Ranking and Weighting of Parameters of Concern	22
6	Alternatives Analysis	22
7	Additional Alternative Analysis	22
8	Optional Public Notice	23
9	Optional Information	23
10	Summary and Conclusion	23
11	References	24

Tables

Table 1. Commercial Plant Influent and Discharge Characteristics.....	9
Table 2. Beneficial-use Classes for Gunnison Bay.....	16

Figures

Figure 1. GSL and the Proposed Project Site.....	4
Figure 2. Commercial Plant Facility Plan	5
Figure 3. Commercial Plant Process Schematic.....	6

Appendices

- A Final Monitoring Report, Waterleaf Resources Demonstration Project
- B Waterleaf Phase 1 Groundwater Well Quality Memorandum
- C Microbialite Survey

Abbreviations

303(d)	Section 303(d) of the Clean Water Act
ADR	Antidegradation Review
af/yr	acre-feet per year
DLE	direct lithium extraction
FFSL	Utah Division of Forestry, Fire and State Lands
gpm	gallons per minute
GSL	Great Salt Lake
IX	ion exchange
IXM	ion exchange media
mgd	million gallons per day
MMF	multimedia filter
MSL	mean sea level
NGVD 1929	National Geodetic Vertical Datum of 1929
No.	number
POC	parameter of concern
RO	reverse osmosis
TDS	total dissolved solids
UAC	Utah Administrative Code
UDWQ	Utah Division of Water Quality
UPDES	Utah Pollutant Discharge Elimination System
Waterleaf Resources	Waterleaf Phase 1 LLC
WSE	water surface elevation

1 Background

Waterleaf Phase 1 LLC (Waterleaf Resources) is proposing to extract lithium from the Great Salt Lake (GSL) by constructing and operating the Phase 1 Lithium Project (Commercial Plant). The Commercial Plant is a processing facility that will extract lithium using a proprietary ion-exchange (IX) direct lithium extraction (DLE) process. This proprietary IX technology is a nonconsumptive, nonevaporative process. This means that all GSL brine withdrawn will be discharged back into the GSL, and the open waters of the lake will not be depleted.

In September 2023, Waterleaf Resources submitted a Clean Water Act Section 402 Utah Pollutant Discharge Elimination System (UPDES) application (Waterleaf Resources 2023) to the Utah Division of Water Quality (UDWQ) for authorization to discharge effluent from the Demonstration Plant. In addition, the GSL Mineral Extraction Facility Operator Application was submitted to authorize operation of the Demonstration Plant by rule (Waterleaf Resources 2024). The UPDES permit was issued for the Demonstration Project on February 4, 2025 (UPDES Minor Industrial Permit No. UT0026280), which included the GSL Mineral Extraction Facility Operator Certification Approval by Rule.

Waterleaf Resources operated the Demonstration Plant for 28 weeks in 2025 to validate the IX DLE technology. In accordance with the UPDES permit and the GSL Mineral Extraction Facility Operator Application Approval by Rule, weekly influent and discharge flows were sampled, analyzed, and reported. In addition to compliance monitoring, Waterleaf Resources conducted a Demonstration Plant Biota Study (Baxter 2025) to examine the presence and abundance of North Arm biota (archaea, algae, bacteria, and fungi) in the influent and discharge flows. The data and information gathered during operation of the Demonstration Plant provide scientific evidence to support Commercial Plant discharge and operation permitting applications. Chemistry and biota monitoring are summarized in the *Waterleaf Resources GSL Demonstration Plant Final Monitoring Report* (see Appendix A).

This revised Level II Antidegradation Review (ADR) is submitted to provide additional data; the initial Commercial Plant ADR was submitted in October 2025 and revised in April 2026. This ADR is submitted to support a Commercial Plant UPDES Permit; an application modification was submitted in October 2025. The application was determined to be complete in November 2025. In addition to the UPDES Permit modification application, a GSL Mineral Extraction Facility Operator Certification Application (Operator Certification) for the Commercial Plant was submitted to UDWQ on November 3, 2025, and revised to provide requested information in February and April 2026. UDWQ determined the application to be complete in May 2026.

1.1 Purpose

Waterleaf Resources is submitting this revised Level II ADR to provide additional information to support the Section 402 UPDES Permit and Operator Certification applications.

ADRs are required as part of the discharge permitting process for any action that has the potential to degrade water quality. The Level I ADR is completed as part of the UPDES application modification and requires a Level II analysis to document that the proposed operation of the Commercial Plant will maintain the recreation and wildlife beneficial uses of Gunnison Bay of the GSL and is consistent with the State of Utah's antidegradation policies.

What are beneficial uses?

Lakes, rivers, and other water bodies have uses to humans and other life. These uses are called beneficial uses.

1.2 Contents of Submittal

Waterleaf Resources has prepared this Level II ADR resubmittal to be consistent with the UPDES application for the Commercial Plant to demonstrate consistency with the State of Utah's antidegradation policy. The following topics are discussed in this submittal:

- Proposed project
- Standards for receiving waters
- Social, environmental, and economic importance
- Parameters of concern
- Alternatives analysis
- Public notice
- Certification

This submittal contains the following additional information:

- The data and information gathered during operation of the Demonstration Plant provide scientific evidence to support Commercial Plant discharge and operation permitting applications. Chemistry and biota monitoring data are detailed in the *Final Monitoring Report* (see Appendix A).
- Groundwater will be treated to remove salts and added to the IX process. The results of groundwater water quality testing are provided in Appendix B.
- The results of a microbialite survey for the lakebed where project infrastructure is located are provided in Appendix C.

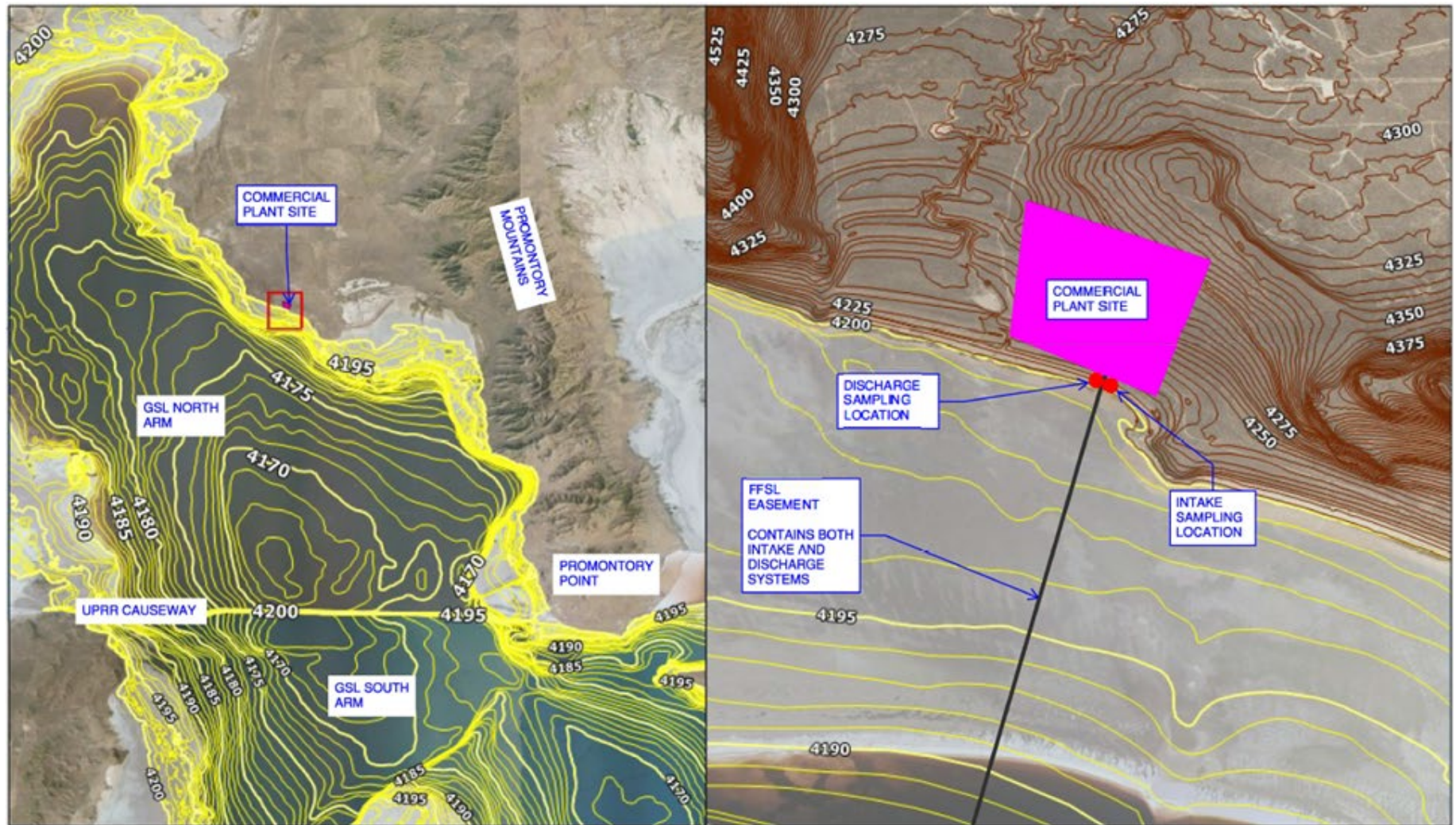
2 Proposed Project

Waterleaf Phase 1 LLC (Waterleaf Resources) is proposing to extract lithium from the North Arm brine waters of the Great Salt Lake (GSL) by constructing and operating the Phase 1 Lithium Extraction Project (Commercial Plant), which uses a proprietary ion-exchange (IX) direct lithium extraction (DLE) process to produce lithium carbonate for commercial sale. This proprietary technology is a nonconsumptive and nonevaporative process. The GSL brine that is withdrawn will be discharged back into the GSL with no brine depletion.

The Commercial Plant will be located adjacent to Gunnison Bay (North Arm) of the GSL on the western slopes of the Promontory Mountains in Box Elder County, Utah (Figure 1). The Commercial Plant IX process was validated by the operation of the Demonstration Plant from February through August 2025. No changes in the Commercial Plant's proprietary DLE IX process have been made due to the results of the chemical and biota testing during the Demonstration Plant's operation (see Appendix A). Ancillary facilities and systems will be added to the Commercial Plant due to higher process flow (scale-up) and the preparation of the final commercial product, lithium carbonate.

Commercial Plant process steps, influent and discharge characteristics, and facility scale-up information is provided below.

Figure 1. GSL and the Proposed Project Site



2.1 Project Description

The Commercial Plant will have an annual production capacity of up to 5,000 tons per annum of lithium carbonate, the final saleable lithium product. To meet this production goal, a maximum design flow of about 11,300 gallons per minute (gpm) or 16.27 million gallons per day (mgd) of brine will be withdrawn from Gunnison Bay. In addition, a maximum groundwater flow of about 124 gpm will be withdrawn and added to the process operation and subsequently discharged to Gunnison Bay with the lithium-depleted brine. In total, Waterleaf Resources assumes a designed discharge rate of 16.49 mgd. The UPDES modification will permit a maximum discharge rate of 20 mgd. The Commercial Plant will be designed to operate 24 hours a day, 7 days a week, and 52 weeks a year for 20 years. A facility plan and schematic of the process design are provided in Figure 2 and Figure 3.

Figure 2. Commercial Plant Facility Plan

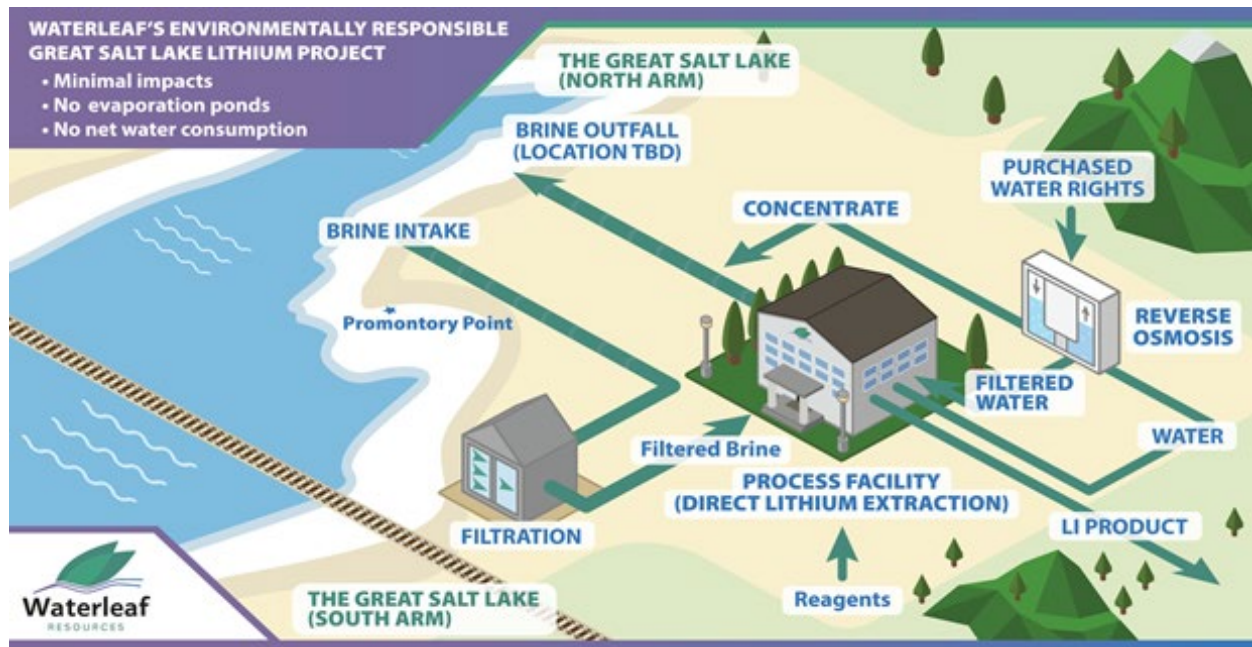
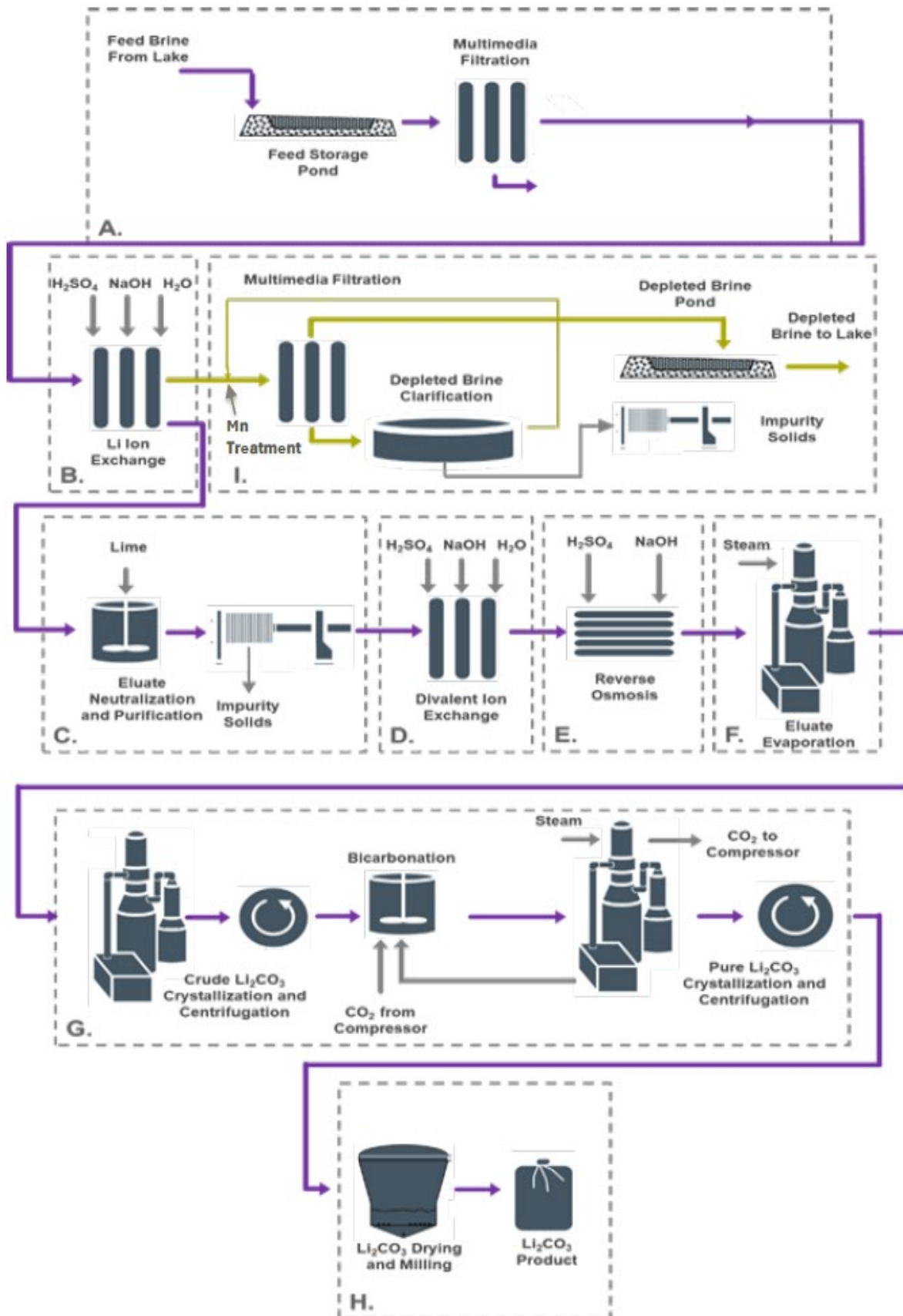


Figure 3. Commercial Plant Process Schematic



The Commercial Plant's footprint will be about 5 acres and will consist of the following general process steps and infrastructure:

- **Intake.** GSL North Arm brine will be pumped from the GSL to a lined influent (feed) brine surge pond. The intake pipeline will extend from the Commercial Plant to the GSL meander line and then be located on the lakebed to a lakebed elevation of about 4,185 feet mean sea level (MSL) (NGVD 1929) within the Utah Division of Forestry, Fire and State Lands (FFSL) easement. The intake system will be driven by a skid-mounted suction pump station, which will have a design flow rate of 11,300 gpm and will be located near the open water shoreline. Influent flow and water quality monitoring will occur prior to the influent brine surge pond.
- **Filtration.** Influent brine will be piped from the feed brine surge pond and filtered through a multimedia filter (MMF) to remove suspended solids.
- **Ion Exchange.** After filtration, the brine will be sent to the IX DLE equipment, where lithium will be selectively exchanged with a hydrogen ion in the IX media (IXM), resulting in lithium-depleted brine. Groundwater (externally sourced groundwater treated by reverse osmosis [RO]) will be used as a washing agent in the extraction process. The IXM will be regenerated, producing eluate (lithium-rich water), which will be further purified and concentrated to produce lithium carbonate, the final commercial product. The eluate flow will not be discharged to the North Arm of the GSL.
- **Filtration.** The depleted brine will be treated to reduce manganese levels to be comparable to North Arm background levels, and pH will be adjusted prior to filtration. The depleted brine, including the groundwater, RO concentrate, and recirculated wash water, will be conveyed to the MMF and then into a depleted brine pond. Residual solids will be managed and disposed of off site. Depleted brine will be pumped from the depleted brine pond to the outfall infrastructure.
- **Discharge.** The outfall pipeline will extend from the Commercial Plant to the North Arm open water to the GSL lakebed to an elevation of about 4,190 feet MSL within the FFSL easement. Waterleaf Resources anticipates a design discharge rate of 11,450 gpm (when accounting for depleted brine plus the addition of groundwater). Discharge flow and water quality monitoring will occur at the outfall pipeline.

2.2 Influent and Discharge Characteristics

The Commercial Plant will intake brine from and discharge effluent to Gunnison Bay (North Arm) of the GSL. Gunnison Bay is classified as 5B waters of the state and is protected for beneficial uses of infrequent primary and secondary contact recreation, waterfowl, shore birds, and other water-oriented wildlife including their necessary food chain (Utah Administrative Code [UAC] R317-2-6.5). No numeric water quality standards have been developed for Gunnison Bay; state narrative standards apply.

The North Arm (Gunnison Bay) is a hypersaline bay of the GSL, with salinity over 25% (as compared to the other bays of the GSL with salinity ranges of 5% to 15%) (FFSL 2013). Inflows to the North Arm are currently being managed by FFSL through modifications of the GSL management berm to meet overall GSL management objectives. Due to management actions and the naturally occurring variation in the hydrologic cycles, the physical, chemical, and biological characteristics of the North Arm fluctuate. The Commercial Plant will withdraw North Arm brine over seasonal, annual, and decadal variations, resulting in comparable variations in the discharges back to the North Arm.

This section describes the average influent and discharge chemical characteristics of the anticipated constituents based on results compiled during the operation of the Demonstration Plant and from Waterleaf Resources mass balance analyses using Commercial Plant design targets.

Waterleaf Resources anticipates that the chemical characteristics of the Commercial Plant's influent and discharge will be comparable to the concentrations listed in Table 1. The basis for the concentrations shown in Table 1 is dual: (1) the flow-weighted average concentrations during the Demonstration Plant's optimal period of operation and (2) anticipated average discharge concentrations based on facility mass balance analysis.

Influent and discharge concentrations, shown in Table 1, are based on the flow-weighted optimal period analysis of the Demonstration Plant for most constituents [designated with footnote (a)]. For a limited subset of constituents, concentrations, shown in Table 1, are based on anticipated concentrations from the commercial facility mass balance analysis [designated with footnote (b)].

Table 1. Commercial Plant Influent and Discharge Characteristics

Constituent	Influent		Discharge	
	Average Concentration ^a (mg/L)	Min/Max	Average Concentration ^a (mg/L)	Min/Max
Alkalinity	572.6	526.0/599.0	294.6	119.0/492.0
Aluminum	1.65	ND (<1.20)/5.20	1.49	1.60/5.10
Arsenic	0.51	0.36/0.61	0.36	0.26/0.48
Barium	0.20	0.14/0.34	0.18	0.13/0.29
Bicarbonate	572.6	526.0/599.0	294.6	119.0/492.0
BOD	5.13	ND (<2.0)/12.0	7.42	ND (<2.0)/13.0
Boron	61.97	56.9/64.1	59.50	55.6/60.2
Bromide	177.9	140.0/201.0	166.2	139.0/186.0
Cadmium	ND (<0.0012)	NA	ND (<0.0012)	NA
Calcium	308.64	277.0/327.0	300.2 ^b	NA
Carbonate	ND (<0.2)	NA	ND (<0.2)	NA
COD	1,516.89	ND (<617)/2,800	1,096.63	ND (<617)/2,800
Chloride	183,942 ^b	NA	182,006 ^b	NA
Chromium	0.10	ND (<0.1)/0.25	0.10 ^b	NA
Copper	0.035	ND (<0.02)/0.080	0.035 ^b	0.030/0.060
Cyanide	ND (<0.022)	NA	ND (<0.022)	NA
Hardness	60,996.14	55,900/64,900	58,874.2	54,700/59,900
Hydroxide	ND (<0.2)	NA	ND (<0.2)	NA
Iron	ND (<0.57)	NA	0.567 ^b	NA
Lead	ND (<0.0087)	NA	ND (<0.0087)	NA
Lithium	68.0	61.9/70.9	14.2 ^b	NA
Magnesium	14,633	13,400/15,600	14,462 ^b	NA
Manganese	0.036	0.030/0.040	0.036 ^b	NA
Mercury	39.35 ng/L	21.8/211.0 ng/L	30.48 ng/L	24.9/51.0 ng/L
Molybdenum	0.14	0.11/0.22	0.13	0.050/0.31
Nickel	0.035	ND (<0.01)/0.110	0.035 ^b	NA
Nitrate	ND (<6.64)	NA	ND (<6.64)	NA
Nitrite	ND (<0.01)	NA	ND (<0.01)	NA
Oil and grease	ND (<5.0)	NA	ND (<5.0)	NA
Potassium	8,720.58	8,050/9,650	8,626 ^b	NA
Selenium	0.54	0.10/0.91	0.53	0.10/0.93
Silica	6.06	ND (<4.2)/7.70	7.01	ND (<4.2)/9.20

Table 1. Commercial Plant Influent and Discharge Characteristics

Constituent	Influent		Discharge	
	Average Concentration ^a (mg/L)	Min/Max	Average Concentration ^a (mg/L)	Min/Max
Silicon	2.69	ND (<2.0)/3.60	3.15	ND (<2.0)/4.30
Silver	ND (<0.008)	NA	ND (<0.008)	NA
Sodium	98,464.32	93,200/112,000	97,742 ^b	NA
Sulfate	26,975.6	24,300/28,100	27,202 ^b	NA
TDS	333,938.22 ^b	NA	330,782 ^b	NA
TSS	38.19	ND (<3.0)/395	35.3	6.00/175.0
Zinc	ND (<0.5)	NA	ND (<0.5)	NA

Definitions: BOD = biological oxygen demand; COD = chemical oxygen demand; kafy = thousand acre-feet per year; lb = pounds; MDL = minimum detection limit; mg/L = milligrams per liter; NA = not analyzed (influent and discharge concentrations are nondetect); ND = nondetect (not detected above MDL); TDS = total dissolved solids; TSS = total suspended solids

^a Average influent and discharge concentration based on flow-weighted concentrations during the Demonstration Plant's optimal period, weeks 16–28.

^b Anticipated average concentrations based on facility mass balance analysis.

These two analytical methods, used to determine Commercial Plant influent and discharge concentrations and annual mass loadings, are further described below.

2.2.1 Flow-weighted, Optimal Period Analysis

Commercial Plant influent and discharge concentrations, as shown above in Table 1, are derived from a flow-weighted, optimal period analysis of the Demonstration Plant data. Waterleaf Resources has determined that the Demonstration Plant's operation during weeks 16 through 28 is the period when the plant's activities (operation and production) were most consistent (Waterleaf Resources 2026, Section 10). Waterleaf Resources selected flow-weighted average concentrations during the optimal period of the Demonstration Plant's operation as the primary analytical basis for estimating Commercial Plant discharge concentrations (Table 1). This method most accurately represents the true mass of constituents discharged from the Demonstration Plant to the receiving waters over time under optimal operating conditions.

The following calculation was used to determine flow-weighted, optimal period concentrations:

$$C_{\text{flow-weighted}} = \frac{([C_{16} * V_{16}] + [C_{17} * V_{17}] + \dots + [C_{28} * V_{28}])}{V_{16} + V_{17} + \dots + V_{28}}$$

Where: C_n = Concentration of constituent from weekly monitoring
 V_n = Weekly brine volume

Waterleaf Resources determined that weeks 16 through 28 of the Demonstration Plant's operation represented the "optimal period," during which process optimization, testing

conditions, and equipment were the most consistent. Flow-weighted averaging, over the optimal period, captures the most consistent influent and discharge concentrations with the corresponding flow rate, thereby directly linking concentration data to actual mass loading (Waterleaf Resources 2026, Section 4.1.2).

For the Commercial Plant application, flow-weighted concentrations derived from the Demonstration Plant's optimized performance period were selected as the most representative dataset because they reflect stable operations under conditions most like anticipated commercial performance.

In summary, the use of flow-weighted averages, over the optimal period, provides a technically robust, transparent, and environmentally protective basis for estimating discharge concentrations and allows Waterleaf Resources and UDWQ to more effectively evaluate potential impacts.

2.2.2 Facility Mass Balance Analysis

For several constituents (chromium, copper, iron, lithium, manganese, nickel, and salt constituents), the Commercial Plant's concentrations will vary from the Demonstration Plant's flow-weighted average discharge concentrations during the optimal period due to process changes, equipment scale-up, and manganese treatment (Waterleaf Resources 2026, Section 8).

These constituents' average Commercial Plant concentrations, shown in Table 1 [designated by footnote (b)], are based on the Waterleaf Resources facility mass balance analysis, which consider all process interactions (Waterleaf Resources 2026, Section 4 and Appendix J).

The Commercial Plant will include several processes to optimize performance that were not practical to incorporate at the Demonstration Plant's scale. Due to these processes, the performance of most unit operations in the plant will affect all other unit operations. The commercial facility mass balance is the tool used to predict how each of these changes will affect each other and the expected discharge composition while still adhering to the setpoints and collected data from the Demonstration Plant.

Below are descriptions of the predicted Commercial Plant discharge concentrations and the basis for that concentration.

1. The Commercial Plant's average discharge concentrations for manganese will be lower than the Demonstration Plant's flow-weighted average discharge concentrations. The depleted brine will be treated to reduce manganese concentrations in the depleted brine after passing through the IX process and prior to filtration. As a result, the Commercial Plant's average discharge concentrations will be comparable to its influent concentrations. The discharge concentration for manganese was determined based on testing and facility mass balance analysis and is shown in Table 1.
2. Discharge metal concentrations (chromium, copper, iron, and nickel), associated with carbon steel corrosion, were reported during the Demonstration Plant's operation to spike due to the use of carbon steel surge tanks and filter media tanks. These carbon steel tanks and filter media tanks will be replaced with high-density polyethylene (HDPE)-lined ponds and concrete basins, respectively, for the Commercial Plant's

operation to accommodate higher process flows and higher capacity requirements. As a result of eliminating the carbon steel tanks, the Commercial Plant's average discharge concentrations of chromium, copper, iron, and nickel will decrease when compared to Demonstration Plant data. The discharge concentrations are based on commercial-scale testing and facility mass balance analysis and are shown in Table 1.

3. The Commercial Plant's average discharge concentrations of salt constituents (calcium, chloride, magnesium, potassium, sodium, and sulfate) and total dissolved solids (TDS) will vary from the Demonstration Plant's flow-weighted average discharge concentrations due to three factors: (1) the upsizing of the groundwater RO treatment system, (2) the addition of recycle and recirculation systems, and (3) treatment for manganese reduction. The concentrate from the RO system will be added to the depleted brine discharge flow, filtered, and then discharged to the North Arm (see Figure 1 above). The recycle and recirculation systems will also alter the discharge concentrations of salt constituents and TDS when compared to the Demonstration Plant data. The manganese treatment will occur prior to filtrations (see Figure 2 above) and will affect the discharge concentrations of salt constituents and TDS. Waterleaf Resources anticipates that these three processes will alter the Commercial Plant's discharge concentrations of salt constituents (calcium, chloride, magnesium, potassium, sodium, and sulfate) and TDS compared to the Demonstration Plant's optimal period flow-weighted average salt discharge concentrations. The discharge concentrations for these constituents are based on commercial facility mass balance analyses and are shown in Table 1.
4. The Commercial Plant's average discharge concentrations for lithium will be lower than the Demonstration Plant's flow-weighted average discharge concentrations due to facility scale-up and additional processes that will be added to the Commercial Plant. These process changes include recirculation and recycle systems that will result in lower average concentrations of lithium in the discharge. The Commercial Plant's average lithium discharge concentrations are based on commercial-scale testing and facility mass balance analyses and are shown in Table 1.

In summary, based on compliance monitoring during the Demonstration Plant's optimal period of operation and the anticipated Commercial Plant operation, Waterleaf Resources expects that the Commercial Plant's influent and discharge flow characteristics will be comparable to the average flow-weighted concentrations shown in Table 1 for most constituents. For a subset of constituents, flow chemical characteristics will be comparable to concentrations based on facility mass balance analysis, due to changes in ancillary systems and facilities as shown in Table 1.

2.2.3 External Influences on Commercial Plant Concentrations

Waterleaf Resources does acknowledge that there are outside independent influences which may affect the Commercial Plant's influent and discharge concentrations. These independent influences include the following:

- Influent characteristics will fluctuate as the North Arm water surface elevation (WSE), volume, and salinity vary in response to natural hydrologic conditions and state management actions. This variation of North Arm characteristics is expected seasonally and annually, and surface flow to the GSL and North Arm will fluctuate.
- Laboratory analysis of the North Arm brine will have the same challenges as were experienced during the Demonstration Plant's compliance monitoring analyses. Waterleaf Resources anticipates that the same error and uncertainty considerations will apply to compliance monitoring of the Commercial Plant's influent and discharge flows (see Appendix A).
- Error and uncertainty (lab interference) need to be considered when reviewing the data. The heavy brine requires that samples are diluted to be analyzed effectively by equipment that normally processes fresh water samples. The dilution rates for analyses ranged from undiluted (rate of 1) to 6, 20, and 50 up to a high of 100. Also, all samples were analyzed independently, so the influent and discharge samples for the same day might be diluted differently. Laboratory method accuracy is measured by percent recovery, and these percent recoveries vary for the different methods used for this project. For example, salts generally have a $\pm 20\%$ recovery, while metals have a $\pm 15\%$ recovery. The Utah Geological Survey has estimated that, for most GSL data, a minimum error of about 10% could be attributed to the challenges of processing the brine, based on conversations with the analytical laboratory (see Appendix A).

2.3 Facility Scale-up and Changes from the Demonstration Plant

As discussed above, the Commercial Plant's IX process is the same process that was validated by operation of the Demonstration Plant during 2025. Ancillary facilities and systems will be added to the Commercial Plant to support higher process flows and capacities to produce the final commercial product, lithium carbonate.

This section provides additional information about the upsizing of the manganese treatment system, replacement of carbon steel tanks with lined ponds, upsizing of the groundwater RO treatment process, recycling and recirculation, and other changes.

2.3.1 Upsizing of the Manganese Treatment System

Operation of the Demonstration Plant intermittently tested a manganese treatment process to reduce concentrations of manganese in the discharge. On further discussion with UDWQ, it was determined that manganese discharged to the North Arm should not exceed background concentrations. Waterleaf Resources conducted additional testing and data analyses to determine that manganese discharge concentrations could be further reduced, lower than Demonstration Plant discharge levels, so that discharge

concentrations from the Commercial Plant would be comparable to influent concentrations (background North Arm concentrations).

The Commercial Plant will include an upsized treatment process to reduce manganese in the depleted lithium brine to influent concentration (background) levels prior to filtration and discharge (see Figure 2) when compared to the Intermittent Demonstration Plant's manganese treatment process. The manganese treatment process will precipitate soluble manganese by adding sodium hypochlorite prior to the MMF. The solids will be captured in the depleted brine waste solids and taken off site for disposal. Residual chlorines will be neutralized with sodium sulfite prior to conveying the depleted brine to the storage pond and discharging it to the North Arm. Continuous residual chlorine monitoring will be conducted on the Commercial Plant's discharge to verify no impact to North Arm biota and chemistry.

The annual amount of chemicals anticipated to be used in the manganese treatment process are detailed in the facility mass balance analysis (Waterleaf Resources 2026, Appendix J).

Monitoring during the intermittent manganese treatment process operation indicated residual hypochlorite was nondetect in discharge flow due to complete reaction of the chlorine by sulfite addition. The same outcome from the Commercial Plant's process is anticipated because the oxidant dosing and sulfite treatment steps will follow the same reaction pathways.

2.3.2 Replacement of the Carbon Steel Tanks

The Commercial Plant will be constructed and operated to process higher annual volumes of North Arm brine than the Demonstration Plant (18,230 acre-feet per year [af/yr] vs. 3.35 af/yr, respectively), and the physical infrastructure elements and process facilities of the Commercial Plant will be scaled up accordingly. The Commercial Plant's facilities are discussed in Section 2.1.

The temporary carbon steel surge and mix tanks used during the Demonstration Plant's operation will be replaced with lined brine storage ponds and concrete basins. Therefore, Waterleaf Resources does not anticipate that the spikes of metal (chromium, copper, iron, and nickel) concentrations that were observed during the Demonstration Plant's operation will occur during operation of the Commercial Plant (see Appendix A). As a result, the anticipated discharge concentrations of chromium, copper, iron, and nickel from the Commercial Plant, as shown in Table 1, are different from the Demonstration Plant's flow-weighted average discharge concentrations and are determined based on the facility mass balance analysis (Waterleaf Resources 2026, Section 8).

2.3.3 Upsizing of the Groundwater RO Treatment Process

The Commercial Plant will include an upsized RO groundwater treatment system as compared to the Demonstration Plant's RO groundwater treatment system due to increased groundwater flows. The concentrate from the RO system will be added to the depleted brine discharge flow, filtered, and then discharged to the North Arm (see Figure 2). In addition to the RO concentrate influence, discharge salt concentrations will be further influenced by the addition of recycling and recirculation systems and the

manganese treatment process. These three process changes in the Commercial Plant's operations will vary the discharge of salt constituents (calcium, chloride, magnesium, potassium, sodium, and sulfate) and TDS compared to the Demonstration Plant's average salt discharge concentrations and TDS concentration (see Appendix A). The anticipated salt concentrations are calculated from the facility mass balance which accounts for all process interactions (Waterleaf Resources 2026, Section 4.1.2 and Appendix J).

2.3.4 Recycling and Recirculation

The Commercial Plant's lithium discharge concentration will decrease compared to the Demonstration Plant's flow-weighted concentration over the optimal period. Recirculation and recycling processes will be incorporated into the Commercial Plant, and these systems did not exist during operation of the Demonstration Plant. These systems will be piped to recycle flow to the influent (feed) brine system. Due to these systems, the Commercial Plant's anticipated lithium discharge concentration is 14.2 milligrams per liter (mg/L) (see Table 1), as calculated from the facility mass balance, which accounts for all process interactions (Waterleaf Resources 2026, Section 4.1.2 and Appendix J).

2.3.5 Other Changes

Other system changes anticipated due to sizing up supporting facilities and processes at the Commercial Plant include the following:

- Due to its temporary nature, the Demonstration Plant produced a liquid product that was transported for further processing off site. This processing resulted in about 4% total water loss during the plant's operation. The Commercial Plant will produce a solid lithium carbonate product, and this process will result in nonconsumptive use of brine water.
- Solids management will be required for the filtration systems. All solids generated will be managed and transported off site. In addition, salts may precipitate in the raw brine and depleted brine ponds; routine maintenance will remove the accumulated salts to maintain capacity. Salts removed will be managed and transported off site.
- The operation of the Demonstration Plant provided valuable data regarding the seasonal changes of the North Arm brine in relation to pH balancing. As a result, Waterleaf Resources has determined that continuously adjusting the pH of the influent brine may not be necessary, and pH will instead be adjusted as necessary based on influent characteristics.

These changes, as discussed above, will be made to the Commercial Plant to accommodate the higher volume of brine processed and product manufactured compared to the Demonstration Plant.

3 Standards for Receiving Waters

The Commercial Plant will discharge waters into Gunnison Bay of the GSL. The following beneficial use and water quality standards information is provided for the receiving waters.

3.1 Beneficial Uses

UDWQ has designated beneficial uses for the different named bays of the GSL. The Commercial Plant will be constructed and operated adjacent to Gunnison Bay (the North Arm of the GSL). Due to the location of the Commercial Plant and the nominal amount of North Arm flow to the South Arm of the GSL, the Commercial Plant will have *de minimis* impacts to Gilbert, Farmington, and Bear River Bays (located in the South Arm of the GSL). Therefore, Waterleaf Resources focused this analysis on the open waters of Gunnison Bay (Table 2).

Table 2. Beneficial-use Classes for Gunnison Bay

Class	Location	Beneficial Uses
5B	Gunnison Bay (the North Arm of the GSL excluding evaporation ponds)	Gunnison Bay is protected for infrequent primary and secondary contact recreation, waterfowl, shore birds, and other water-oriented wildlife, including their necessary food chain.
5E	Transitional waters along the shoreline of the GSL geographical boundary	Transitional waters along the shoreline of the GSL geographical boundary are protected for infrequent primary and secondary contact recreation, waterfowl, shore birds, and other water-oriented wildlife, including their necessary food chain.

Source: UAC R317-2, Standards of Water Quality for the State, as in effect September 22, 2025

3.2 Water Quality Standards

UDWQ applies numeric and narrative standards to waters of the state to protect designated beneficial uses. State water quality numeric standards refer to specific water quality criteria that are applied to each class of water to protect its beneficial uses. Gunnison Bay and transitional waters (Classes 5B and 5E) have no established numeric water quality standards (UAC R317-14, Numeric Criteria, as in effect September 22, 2025).

State water quality narrative standards apply to the GSL. Narrative standards prohibit the discharge of waste or other substances that result in unacceptable water quality conditions, such as visible pollution or undesirable aquatic life. If a water body does not meet numeric or narrative water quality standards, the beneficial uses of that water body are adversely affected.



3.3 Impaired Waters

In UDWQ's *2024 Integrated Report on Water Quality* (UDWQ 2024), which includes the list of impaired waters in the state, Gunnison Bay is listed as Category 3—having insufficient data to support a determination of impairment.

The list of impaired waters is referred to as the 303(d) list because the listing process follows the regulatory requirements of Section 303(d) of the Clean Water Act. Impaired waters are defined as those water bodies that do not meet their beneficial uses.

Typically, these waters exceed the specific numeric water quality standards associated with a specific class or beneficial use.

What is a Section 303(d) list?

When a lake, river, or stream fails to meet the water quality standards for its designated beneficial use, Section 303(d) of the Clean Water Act requires that the State place the water body on a list of "impaired" waters, which is also known as a Section 303(d) list.

Gunnison Bay's water surface level has varied over the years. The water surface level has decadal, annual, and seasonal variations based on watershed hydrology and diversions, direct diversions from the GSL, and management of openings in the Union Pacific Railroad causeway that spans the GSL from Weber County to Box Elder County. This variation in water surface level results in corresponding changes in salinity, which also have decadal, annual, and seasonal variations. The State has not found any evidence of impairment of Gunnison Bay's beneficial use during past water surface level and salinity changes. The Commercial Plant will allow Gunnison Bay's water surface level to continue to vary and meet its beneficial uses because the plant will not deplete Gunnison Bay's brine or lower its WSE.

3.4 Antidegradation Category of Receiving Water

UDWQ has a statewide antidegradation policy that protects water bodies from proposed project activities that could lower or degrade water quality. The policy requirements include reviews and analyses to protect the existing beneficial uses of the water bodies. The ADR provides a process to identify options if degrading a water's quality is necessary for social and economic development. To facilitate this policy, all waters in Utah are designated as Category 1, 2, or 3 waters. The GSL is considered a Category 3 water subject to ADRs (UAC R317-2-12, Category 1 and 2 Waters, as in effect September 22, 2025).

4 Social, Environmental, and Economic Importance

As provided in UDWQ's guidelines, this section provides details to facilitate UDWQ's concurrence that benefits associated with the Commercial Plant are socially and economically important. It describes the social, environmental, and economic benefits that will be realized by the proposed Commercial Plant to extract lithium from GSL brine using a nonevaporative and nonconsumptive proprietary DLE technology. This section also discusses the social, economic, and environmental losses associated with the Commercial Plant.

Section 4.1 discusses the social, economic, and environmental benefits associated with Commercial Plant, and Section 4.2 discusses the social, economic, and environmental losses. Section 4.3 discusses the supporting information from affected communities regarding preserving assimilative capacity, and Section 4.4 discusses the structures or equipment that will be placed in or adjacent to the receiving water.

4.1 Social, Economic, and Environmental Benefits

Social Benefits. Waterleaf Resources' Commercial Plant will maintain the recreational beneficial use of Gunnison Bay, a social benefit. This assertion is based on the technology being nonconsumptive, meaning that withdrawn brine will be discharged back into the GSL with no water depletion. The North Arm's WSE will not be lowered due to the Commercial Plant's operation. Commercial Plant discharge allows Gunnison Bay to maintain its naturally occurring variation in water surface levels and salinity. The State of Utah's legislative and executive offices increase management oversight for mineral leases, salinity, and water surface levels, and the Commercial Plant is consistent with measures to use innovative technologies to extract minerals while minimizing direct depletions of lake water. This goal, to minimize lake water depletion, is further supported by the continuous flow-monitoring data that were collected during operation of the Demonstration Plant, as discussed in the *Final Monitoring Report* (see Appendix A). Flow monitoring proved that the Demonstration Plant's influent volume was less than the discharge volume.

Economic Benefits. The Commercial Plant will operate DLE technology that can viably and economically extract lithium from GSL brine and produce battery-grade lithium products without depleting water from the GSL. Using a nonevaporative process will maintain beneficial uses and protect the GSL ecosystem. Waterleaf Resources plans to use the DLE technology to produce battery-grade lithium, which is a designated critical mineral necessary for economic and energy security.

The Commercial Plant is projected to provide substantial economic benefits to both the local community and the state of Utah. Excluding construction and auxiliary support positions, the plant will generate 61 new operational jobs with a median annual salary of \$86,110. Resulting increases in income and state sales tax revenues are expected to raise state tax receipts by about \$7.2 million per year. Additionally, commercial operations will enable Waterleaf Resources to establish a royalty agreement with FFSL for lithium extraction from the GSL, potentially contributing up to \$2 million in annual royalty payments to the State. Property tax revenues are also anticipated to increase significantly; Box Elder County currently collects about \$107 per year in property taxes on the parcel where the Commercial Plant will be located, and this assessment is estimated to rise to nearly \$2 million annually once the plant is completed and operational.

Environmental Benefits. The environmental benefits of the Commercial Plant include sustaining the North Arm's WSE, protecting the North Arm's beneficial uses, causing no impact to North Arm habitat, and maintaining the abundance and diversity of the biological community.

The Commercial Plant is consistent with state efforts to reverse historic declines in the GSL's volume by managing new mineral-extraction activities through encouraging using

innovative and nonconsuming technologies. The nondepletive DLE process that the Commercial Plant will implement will return all withdrawn brine to the GSL. Through use of this technology, North Arm WSE and volume will not be lowered.

The physical, biological, and chemical data obtained during operation of the Demonstration Plant provide evidence that the Demonstration Plant met UPDES permit requirements and therefore was protective of the North Arm's beneficial uses. Waterleaf Resources expects that the Commercial Plant will maintain these beneficial uses by meeting water quality standards similarly to the Demonstration Plant.

During the Demonstration Plant's operation, influent and discharge water samples were collected in three separate monitoring events and analyzed for the presence of biota (fungi, archaea, bacteria, and algae) by Dr. Bonnie Baxter of Westminster University (Baxter 2025). This biota study was designed to examine and characterize the microbial biomass and community in the influent and discharge of the Demonstration Plant during its operation. In addition, the study inoculated the discharge flows to examine whether biota would survive. In summary, the biota study found North Arm biological communities present and abundant in the influent and discharge flows of the Demonstration Plant. This scientific evidence supports Waterleaf Resources' assertion that the Demonstration Plant did not harm North Arm biota, which Waterleaf Resources anticipates will be the same for operation of the Commercial Plant. The biota study report is included in the *Final Monitoring Report* (see Appendix A).

The GSL area where the Commercial Plant infrastructure will be constructed and operated can be described as exposed GSL lakebed and North Arm hypersaline open waters. Mapping has identified the western, eastern, and southeastern shoreline areas in the North Arm that might contain microbialites (Wilcock and others 2021). Microbialite structures provide a food source for brine shrimp and brine flies (Baxter and Butler 2020). However, research has documented that, due to limited availability of nutrients, the North Arm microbialite structures have lower mass, productivity, and/or diversity compared to microbialites in the South Arm (Baxter and Butler 2020).

Waterleaf Resources conducted a microbialite survey of the lakebed intake and outfall construction area (FFSL easement area) to identify the existence of these important habitat structures in the project area. Microbialite structures were not found in the surveyed project area (see Appendix C).

Summary. The Commercial Plant will provide social, economic, and environmental benefits using innovative, nonconsumptive technology to withdraw GSL brine and discharge the same amount of brine back to the GSL. This technology also meets state policy objectives to protect the GSL's volume and to produce critical lithium products, which are a focus of national and global concerns.

4.2 Social, Economic, and Environmental Losses

Waterleaf Resources maintains that there will be no social, economic, or environmental losses from operation of the Commercial Plant. Operation of the Commercial Plant will use nondepletive proprietary extraction technology, recreational beneficial uses will be maintained, jobs and economic outputs will be realized, and North Arm habitat, biota, and water chemistry will be sustained.

The Commercial Plant will convey brine to the processing facilities and then discharge it back to the GSL. This nonevaporative process will not directly deplete GSL brine from Gunnison Bay; as a result, Gunnison Bay could respond to the annual variations in water surface level and in salinity based on hydrologic conditions and state management actions. The infrequent recreational and ecological uses of Gunnison Bay will continue to be provided within the range of water surface level fluctuation.

Beneficial uses will be maintained during the operation of the Commercial Plant, based on the physical, biological, and chemical monitoring and reporting conducted during the Demonstration Plant's operation. The protection of beneficial uses will not result in environmental losses.

The Commercial Plant will not interfere with nor affect the State's ability to manage Gunnison Bay's water surface level and salinity via the railway causeway management berm.

4.3 Supporting Information from Affected Communities on Preserving Assimilative Capacity

The Commercial Plant will discharge depleted brine into Gunnison Bay within the requirements of a UPDES permit and GSL Mineral Extraction Facility Operator Certification rules. Waterleaf Resources notes that operating the nonconsumptive Commercial Plant, withdrawing brine from the GSL, and returning the removed brine to the GSL will maintain existing water surface and chemistry conditions and preserve assimilative capacity.

4.4 Structures or Equipment That Would Be Placed in or adjacent to the Receiving Water

The Commercial Plant will include constructing intake and outfall infrastructure within the GSL boundaries (below the meander line). Waterleaf Resources has submitted a request for an easement from FFSL for constructing and operating the intake and outfall structures that lie on state lands, below the meander line. The FFSL easement is in the same location as the Demonstration Plant's easement. The intake and outfall pipelines are described in Section 2.

The Commercial Plant will be placed upland on leased private land adjacent to the GSL above the GSL meander line. The intake and outfall infrastructure and associated maintenance activities will allow navigation and open-water inundation consistent with the fluctuating water levels of Gunnison Bay.

5 Parameters of Concern

Parameters of concern (POCs) are normally defined as water quality pollutants that are present in the applicant's discharge at concentrations greater than ambient concentrations in the receiving water or that exceed water quality standards. As mentioned in Section 3.2, there are no numeric water quality standards for Gunnison Bay. Narrative standards apply to all water bodies in the state. Waterleaf Resources intends to operate the Commercial Plant and monitor both influent and discharge water quality to show that UPDES permit compliance and GSL Mineral Extraction Facility Operator Certification rule requirements are met.

5.1 Potential Parameters of Concern – Water Quality Parameters

The Commercial Plant will withdraw brine, extract lithium from the brine, and discharge the lithium-depleted brine back to Gunnison Bay of the GSL.

In accordance with Section 4.0 of the *Utah Antidegradation Review Implementation Guidance* document (UDWQ 2019), the following considerations are provided to determine the POCs associated with the Commercial Plant:

- The Demonstration Plant's UPDES permit will authorize discharge from the Commercial Plant. The GSL Mineral Extraction Facility Operator Certification will approve operation of the Commercial Plant. The UPDES permit and Operator Certification applications identify water quality constituents for influent and discharge monitoring, specifically alkalinity, aluminum, arsenic, barium, bicarbonate, biological oxygen demand, boron, bromide, cadmium, calcium, carbonate, chemical oxygen demand, chloride, chromium, copper, cyanide, density, dissolved oxygen, flow, hardness, hydroxide, iron, lead, lithium, magnesium, manganese, mercury, molybdenum, nickel, nitrate, nitrite, oil and grease, pH, potassium, selenium, silver, silica, silicon, sodium, sulfate, temperature, total dissolved solids, total suspended solids, and zinc.
- Manganese was identified in the Demonstration Plant's UPDES permit because manganese has potential to be discharged by the DLE process above background concentrations. Waterleaf Resources will treat and reduce manganese during the Commercial Plant's operation, as discussed in Section 2. The manganese treatment—addition of sodium hypochlorite to the depleted brine stream prior to filtration—will reduce manganese in the depleted brine discharge to a similar concentration as what is present in the influent brine (background). Residual chlorines will be neutralized with sodium sulfite prior to discharge into the depleted brine pond (see Figure 3). Continuous residual chlorine monitoring will be conducted on the depleted brine discharge to verify no impact to North Arm chemistry and biota. This intermittent treatment process and testing for residual chlorine (not detected) was conducted during the Demonstration Plant's operation, and similar results are expected to be achieved during the Commercial Plant's operation (Waterleaf Resources 2026, Section 8).

- Groundwater will be added to the IX process, as discussed in Section 2. Groundwater quality of the source has been analyzed and determined to contain no POCs (see Appendix B).
- Effluent from the Commercial Plant will not be discharged into a Class 1C drinking water source receiving water.
- There are no numeric standards or existing impairment determination for Gunnison Bay. There is no ongoing or approved total maximum daily load (TMDL) analysis for Gunnison Bay or the GSL.

In summary, Waterleaf Resources determined that the POCs for the Commercial Plant are manganese and residual chlorine.

5.2 Ranking and Weighting of Parameters of Concern

Manganese and residual chlorine are equally ranked, because the two constituents are fundamental in the manganese treatment process.

As mentioned above, continuous discharge monitoring for residual chlorine will be conducted, as required by the UPDES permit, to verify no impact to North Arm biota and chemistry. Manganese influent and discharge monitoring will be conducted weekly, as required by the UPDES permit.

Other constituents monitoring during the Commercial Plant's operation are not considered POCs because they are present in both the influent and discharge at similar concentrations.

6 Alternatives Analysis

A Level II ADR requires an analysis of whether there are feasible, less-degrading alternatives to a proposed project. The Commercial Plant will require an amended UPDES permit to discharge water to the GSL from the proposed lithium extraction DLE Commercial Plant.

The Commercial Plant will use the innovative technology proven by the Demonstration Plant to withdraw brine from the GSL, extract lithium from the brine, and return all withdrawn brine back to the GSL. The Commercial Plant is designed with a specific proprietary IX process; no alternative to this IX process is analyzed.

Conventional discharge alternatives, such as pollutant trading, reuse, land application, and containment, are not appropriate or feasible.

7 Additional Alternative Analysis

No additional alternative analysis has been performed due to the unique and proprietary nature of the DLE process.

8 Optional Public Notice

Because the proposed project will go through a public comment period associated with the amended UPDES permit, Waterleaf Resources requests that the optional public review is not held.

9 Optional Information

The following information is provided to support the determination that the Commercial Plant will be consistent with antidegradation policy and will not impair or degrade water quality.

The Commercial Plant will operate consistent with state antidegradation policy and will protect the beneficial uses of the North Arm of the GSL. This assertion is supported by the water quality, flow, and biota monitoring that was conducted during the operation of the Demonstration Plant, and this monitoring validated the proprietary, nonconsumptive IX DLE technology. The Commercial Plant will operate in a similar manner as the Demonstration Plant with the same processes and with comparable discharge flow characteristics.

The Demonstration Plant's monitoring included influent and discharge water chemistry, continuous flow, and biota presence and abundance. The results of these monitoring efforts are summarized in the *Final Monitoring Report* (see Appendix A).

10 Summary and Conclusion

This Level II ADR is submitted to demonstrate compliance with the State of Utah's antidegradation policy in fulfillment of information requests by UDWQ to support the modified UDDES permit application for the proposed GSL Phase 1 Lithium Extraction Project (Commercial Plant).

Waterleaf Resources anticipates that the Commercial Plant will operate similarly to the Demonstration Plant, with similar discharge characteristics as compared to influent characteristics. As shown in Table 1, influent and discharge concentrations are based on Demonstration Plant compliance monitoring results and Waterleaf Resources facility mass balance. The POCs are manganese and residual chlorine, because they are fundamental in the reduction of manganese in the depleted brine flows. Monitoring of these constituents will be conducted to meet UPDES requirements.

The Demonstration Plant operated for 7 months, from February through August 2025; its discharges to the GSL were authorized by UPDES Permit No. UT0026280 and GSL Mineral Extraction Facility Operator Certification Approval by Rule. The compliance monitoring conducted during the operation of the Demonstration Plant included influent and discharge water quality and continuous flow. In addition, the Demonstration Plant's influent and discharge flows were sampled and tested to examine the presence and abundance of biota (archaea, algae, bacteria, and fungi). This monitoring provided quantitative data and scientific data that showed compliance with the UPDES permit and GSL Mineral Extraction Facility Operator Certification Approval by Rule. The *Final*

Monitoring Report (see Appendix A) details compliance monitoring results and biota monitoring report.

Waterleaf Resources notes that influent characteristics (North Arm chemistry) will fluctuate over the operation of the Commercial Plant in response to varying WSEs due to hydrologic conditions and state management actions. Therefore, the discharge characteristics will fluctuate accordingly. The comparative analysis (discharge concentrations to influent concentrations) will provide data to support compliance with permit and certification requirements and consistent with antidegradation policy. For these reasons, operating the Commercial Plant using the proprietary nonconsumptive technology that was validated by operation of the Demonstration Plant is consistent with the State's antidegradation policy and will not exceed the GSL's water quality standards nor impair the GSL's beneficial uses.

11 References

Baxter, Bonnie

2025 Demonstration Plant Biota Study. July 28.

Baxter, Bonnie, and Jaimi Butler, eds.

2020 Great Salt Lake Biology. Switzerland: Springer Nature.

[FFSL] Utah Division of Forestry, Fire and State Lands

2013 Final Great Salt Lake Comprehensive Management Plan and Record of Decision. March.

[UDWQ] Utah Division of Water Quality

2019 Utah Antidegradation Review Implementation Guidance. Version 2.1. January 29.

2024 2024 Integrated Report on Water Quality. <https://lf-public.deq.utah.gov/WebLink/ElectronicFile.aspx?docid=87957&eqdocs=DWQ-2024-003593&dbid=0&repo=Public>.

Waterleaf Resources

2023 Waterleaf Demonstration Plant UPDES Permit Application. September 6.

2024 Waterleaf Resources Demonstration Plant GSL Mineral Extraction Facility Operator Application. October 16.

2026 Waterleaf Resources Phase 1 Lithium Extraction Project GSL Mineral Extraction Facility Operator Application. Revised April 2, 2026.

Wilcock, Laura, Carie M. Frantz, and Michael D. Vanden Berg

2021 Use of Remote Imagery to Map Microbialite Distribution at Great Salt Lake, Utah: Implications for Microbialite Exposure. *Geosites* 51 (January), 1–26.

APPENDIX A

Final Monitoring Report, Waterleaf Resources Demonstration Project



Final Monitoring Report

Waterleaf Resources Great Salt Lake
Lithium Extraction Demonstration
Plant

Prepared for
Waterleaf Resources

Prepared by
HDR, Inc.
2825 E. Cottonwood Parkway, Suite 200
Salt Lake City, UT 84121

October 25, 2025

Contents

1	Introduction.....	1
1.1	Purpose	1
1.2	Background	2
2	Summary of Monitoring Means and Methods	3
2.1	Water Quality Monitoring.....	3
2.1.1	Field and Laboratory Parameters and Methods.....	3
2.1.2	Quality Assurance	5
2.2	Flow Monitoring	6
2.3	Biota Monitoring	6
3	Water Quality Results.....	8
3.1	Visual Observation Results	9
3.2	Chemistry Monitoring Results	9
3.3	Chemistry Monitoring Results Discussion and Graphs.....	14
3.3.1	Minimum Detection Limits and Uncertainty.....	15
3.3.2	Outlier Analyses	16
3.3.3	Metals Discussion	18
3.3.4	Salts Discussion.....	25
3.3.5	Manganese.....	28
3.3.6	Lithium.....	30
3.4	Field Chemistry Results	31
3.4.1	Density	31
3.4.2	Dissolved Oxygen	32
3.4.3	pH.....	33
3.4.4	Temperature.....	34
3.4.5	Influent and Discharge Water Salinity.....	34
4	Flow Monitoring Results	37
4.1	Monthly Volume Results.....	37
4.2	Total Water Balance.....	38
5	Biota Monitoring Results	39
5.1	Presence of Biota	39
5.2	Biota Diversity	40
5.3	Biota Growth in Discharge.....	43
6	Evaluation of No Negative Impact on the GSL from Demonstration Plant Operation.....	45
6.1	Impacts on North Arm Salinity or Water Quality Chemistry	45
6.2	Impacts on North Arm Volume, Flows, or Water Levels	46
6.3	Impacts on North Arm Habitat.....	46
6.4	Impacts on North Arm Biota	47
7	References	48

Tables

Table 1. Water Quality Monitoring Laboratory Methods	4
Table 2. Dates of Water Quality Compliance Monitoring Events.....	8
Table 3. Summary of All Laboratory Analytical Results (Weeks 1–28)	11
Table 4. Summary of Performance Run Laboratory Analytical Results (Weeks 16–18).....	13
Table 5. Summary of Outlier Analyses	17
Table 6. Metal Concentration Data Comparison of Start-up and Regular Operations	23
Table 7. Metals Load Comparison of Demonstration Plant Operations and North Arm.....	24
Table 8. Salt Load Comparison of Demonstration Plant Operations and North Arm	28
Table 9. Manganese Load Comparison of Demonstration Plant Operations and North Arm.....	29
Table 10. Lithium Load Comparison of Demonstration Plant Operations and North Arm	31
Table 11. Summary of Field Measurements	31
Table 12. Influent and Discharge Density Results	36
Table 13. Demonstration Plant Influent and Discharge Flow Volume	37
Table 14. Biota Cell Counts and Dry Weight	39

Figures

Figure 1. Graphs of Metal Constituents with Lower Average Discharge Concentrations.....	19
Figure 2. Graphs of Metal Constituents with Higher Average Discharge Concentrations.....	22
Figure 3. Graphs of Salt Constituents.....	26
Figure 4. Graph of Manganese Influent and Discharge Data	29
Figure 5. Graph of Lithium Influent and Discharge Data	30
Figure 6. Density Graph	32
Figure 7. Dissolved Oxygen Graph.....	32
Figure 8. pH Graph	33
Figure 9. Temperature Graph	34
Figure 10. North Arm Volume	35
Figure 11. April 2025 Biota Abundance Graphs	41
Figure 12. June 2025 Biota Abundance Graphs.....	42
Figure 13. April and June 2025 Biota Growth Results.....	44

Appendices

- A. UPDES Permit
- B. Laboratory Data Results
- C. Biota Monitoring Report

Abbreviations

°C	degrees Celsius
af	acre-feet
Demonstration Plant	Great Salt Lake Lithium Extraction Demonstration Plant
DLE	direct lithium extraction
DMR	discharge monitoring report
DNA	deoxyribonucleic acid
DO	dissolved oxygen
EPA	U.S. Environmental Protection Agency
g/cm ³	grams per cubic centimeter
g/L	grams per liter
g/mL	grams per milliliter
g/mol	grams per mole
GSL	Great Salt Lake
IQR	interquartile range
ITS	internal transcribed spacer
IX	ion exchange
lb	pounds
maf	million acre-feet
MDL	minimum detection limit
mg/L	milligrams per liter
mL	milliliter
NA	not applicable
NetDMR	Network Discharge Monitoring Report
NVGD 1929	National Geodetic Vertical Datum of 1929
No.	number
rRNA	ribosomal ribonucleic acid
Si	silicon
SiO ₂	silica (silicon dioxide)
UAC	Utah Administrative Code
UDFFSL	Utah Division of Forestry, Fire and State Lands
UDWQ	Utah Division of Water Quality
UGS	Utah Geological Survey
UPDES	Utah Pollutant Discharge Elimination System
USGS	U.S. Geological Survey
Waterleaf	Waterleaf Resources
WSE	water surface elevation

1 Introduction

Waterleaf Resources (Waterleaf) prepared this final monitoring report to present data and data analysis related to chemistry, flow, and biota data obtained during the operation of the Great Salt Lake (GSL) Lithium Extraction Demonstration Plant (Demonstration Plant).

The chemistry and flow data were collected, analyzed, and reported pursuant to Utah Pollutant Discharge Elimination System (UPDES) Permit No. UT0026280, which was issued to Waterleaf by the Utah Division of Water Quality (UDWQ) on February 4, 2025 (UDWQ 2025a). The Demonstration Plant's discharge of effluent to the GSL was authorized by the UPDES permit, which is provided in Appendix A, *UPDES Permit*. The UPDES permit also authorized the operation of the GSL lithium extraction facility, by certification by rule, under Utah Administrative Code (UAC) R317-16.

Summaries of the laboratory chemistry results and continuous flow monitoring data are provided in Appendix B, *Laboratory Test Results*.

The microbial diversity (biota) report (Baxter 2025; Appendix C, *Biota Monitoring Report*) is summarized in this final monitoring report. The biota report provides additional data that characterize the biota in the North Arm of the GSL and in the discharge flow of the Demonstration Plant. The UPDES permit did not require an assessment of the North Arm biota data.

1.1 Purpose

This report is being provided to support the applications for authorizations required to operate Waterleaf's GSL Phase 1 Lithium Extraction Commercial Plant. These applications are the UDWQ UPDES Permit UT0026280 modification, the UDWQ GSL Mineral Extraction Facility Operator Certification (Operator Certification) (UAC R317-16-5(4)), and Utah Division of Forestry, Fire and State Lands (UDFFSL) agreements.

The information in this report and appendices includes summaries of UPDES compliance monitoring data, continuous flow data, North Arm habitat identification, and additional data collected to characterize North Arm biota.

Demonstration Plant discharges are evaluated to determine that there would be no negative impacts to the GSL, as defined by UDWQ R317-16-16 and as supported by chemical monitoring results review and analysis, flow monitoring results, North Arm habitat inventory, and a North Arm biota monitoring study.

1.2 Background

The Waterleaf Resources Demonstration Plant operated from February 2025 through August 2025. The Demonstration Plant, a temporary facility, was operated to validate Waterleaf's proprietary ion-exchange (IX) direct lithium extraction (DLE) process. This proprietary technology is a nonconsumptive and nonevaporative process to extract lithium from GSL North Arm brine. GSL North Arm brine was conveyed to the plant, processed through the IX DLE equipment, and discharged back into the GSL with no brine depletion. Intake and outfall (influent and discharge) infrastructure was located in the open water of the North Arm of the GSL, and the Demonstration Plant's equipment and offices were located on the western slope of the Promontory Mountains in Box Elder County, Utah.

The North Arm (Gunnison Bay) of the GSL is classified as a Class 5B water of the state. It is protected by UDWQ for infrequent primary and secondary contact recreation, waterfowl, and shorebirds and other water-oriented wildlife including their necessary food chain (UAC R317-2-6.5). Numeric water quality standards for the North Arm are not established but narrative standards apply.

Influent brine and discharge water chemistry data, flow data, and biota data were collected during operation of the Demonstration Plant. Operation activities spanned 28 weeks during the winter, spring, and summer. The data collected reflect seasonal changes in GSL North Arm water surface levels, brine temperature, brine chemistry, salinity, and biota growth.

The influent and discharge chemistry weekly monitoring events summarized in this report were conducted and reported in accordance with the UPDES permit and UAC R317-16. The UPDES compliance monitoring data results, which were submitted electronically, can be accessed through the U.S. Environmental Protection Agency's (EPA) ECHO website for facility UT0026280.¹

¹ U.S. Environmental Protection Agency, Enforcement and Compliance History Online (ECHO) website, National Pollutant Discharge Elimination System (NPDES) Monitoring Data Download page, <https://echo.epa.gov/trends/loading-tool/get-data/monitoring-data-download>.

2 Summary of Monitoring Means and Methods

This section summarizes the monitoring methods and means that were used to collect data during the Demonstration Plant's operation.

- **Water quality monitoring.** HDR conducted weekly composite water quality sampling and analysis on influent and discharge flows on behalf of Waterleaf.
- **Flow monitoring.** Waterleaf conducted continuous flow monitoring at the intake and outfall systems.
- **Biota monitoring.** Dr. Bonnie Baxter of Westminster University conducted biota monitoring on behalf of Waterleaf. Three biota monitoring events were conducted in 2025.

2.1 Water Quality Monitoring

HDR conducted the required water quality monitoring on behalf of Waterleaf. Required water quality monitoring occurred during the Demonstration Plant's operation in accordance with the UPDES permit (UDWQ 2025a). The data results were reported electronically via EPA's Network Discharge Monitoring Report (NetDMR) system. This section summarizes the means and methods that were used to collect water quality samples and perform the laboratory analyses.

2.1.1 Field and Laboratory Parameters and Methods

HDR collected weekly water quality samples, which were composited for laboratory analysis. Discrete samples were collected every 2 hours over a 6-hour duration. Instantaneous flow rates were measured and used to prepare the flow-weighted composites for chemical analysis by a state-certified analytical laboratory. Chemtech-Ford Laboratory in Salt Lake City, Utah, conducted all water chemistry laboratory analyses.

Silicon (Si) concentrations were calculated by using the UDWQ equation (UDWQ 2025b), using silica concentrations and a molar mass conversion equation:

$$\begin{aligned}
 [\text{Si}] &= [\text{SiO}_2] \times (\text{Si molar mass} / \text{SiO}_2 \text{ molar mass}) \\
 [\text{Si}] &= [\text{SiO}_2] \times (28.09 \text{ g/mol} / 60.08 \text{ g/mol}) \\
 [\text{Si}] &= [\text{SiO}_2] / 2.139
 \end{aligned}$$

Where: Si = Silicon concentration, mg/L
SiO₂ = Silica concentration, mg/L

In addition to the laboratory chemical analyses, field measurements were taken and reported for pH, dissolved oxygen, and temperature using a Horiba U-53-2 handheld multimeter. Field measurements for density were made using an Anton-Paar density meter. Table 1 lists the constituents and methods that were used for the water quality analysis.

Table 1. Water Quality Monitoring Laboratory Methods

Analysis Method	Constituents
Metals (Total)	
EPA 200.7, Metals in Water by ICP-AES	Boron, calcium, lithium, potassium, silica ¹ , sodium
EPA 200.8, Metals in Water by ICP/MS	Aluminum, arsenic, barium, cadmium, chromium, copper, iron, lead, magnesium, manganese, molybdenum, nickel, selenium, silver, zinc
EPA 1631, Mercury in Water by CVAFS	Mercury
Inorganic Nonmetals	
EPA 300.0, Determination of Inorganic Anions by Ion Chromatography	Bromide, chloride, nitrate, sulfate
EPA 335.4, Determination of Total Cyanide by Semi-automated Colorimetry	Cyanide
SM 2320 B, Alkalinity by Titration	Alkalinity, bicarbonate, carbonate, hardness, hydroxide
SM 4500 NO ₂ B, Nitrite by Colorimetry	Nitrite
SM 5210 B, 5-Day BOD Test	Biochemical oxygen demand (BOD)
Hach 8000, EPA Reactor Digestion Method	Chemical oxygen demand (COD)
APHA Standard Method 2540 C, Total Dissolved Solids Dried at 180°C	Total dissolved solids (TDS)
APHA Standard Method 2540 D, Total Suspended Solids Dried at 103–105°C	Total suspended solids (TSS)
Other Methods	
Field Measurement – Instantaneous	Dissolved oxygen, pH, water temperature, density, flow
Visual Observations	Unnatural deposits, floating debris, oil, scum, or other nuisances such as color or odor
Grab Sample	Oil and grease
Continuous Monitoring	Influent and discharge flows

Definitions: °C = degrees Celsius; AES = atomic emission spectroscopy; APHA = American Public Health Association; BOD = biochemical oxygen demand; CVAFS = cold vapor atomic fluorescence spectroscopy; EPA = U.S. Environmental Protection Agency; ICP = inductively coupled plasma; MS = mass spectrometry; NO₂ = nitrogen dioxide; SM = Standard Method

1. Silica data have been used to calculate silicon values.

2.1.2 Quality Assurance

Water quality data were analyzed in accordance with the UPDES permit requirements; these requirements include constituents analyzed, frequency, and laboratory minimum detection limits (MDLs). Additional UDWQ Director's requirements were included in the UPDES permit, including providing laboratory Level IV data quality packages. Level IV data quality packages were submitted electronically with the discharge monitoring reports (DMRs).

As a result of this process, Waterleaf observed the following:

- **Precision**
 - Field duplicate samples were collected by UDWQ staff during February and March 2025 as required by UPDES permit UT0026280 and were analyzed to validate Waterleaf's sample results.
 - The precision of the water quality results is documented in the Level IV data quality packages, which include equipment calibration and validation.
- **Accuracy and Bias**
 - Field instrument calibration met manufacturers' requirements.
 - Laboratory quality assurance/quality control (QA/QC) met each laboratory's internal method requirements.
 - Trace-level mercury was not detected in field blank samples when analyzed during the May 1, 2025, monitoring event.
- **Representativeness**
 - All field measurements and samples were collected from locations and on a frequency as required by UPDES permit UT0026280.
 - Weekly compliance monitoring events were conducted when the Demonstration Plant discharged to the GSL (February through August 2025). During the Demonstration Plant's operation, discharges to the GSL were suspended for three 1-week periods, so compliance monitoring was not conducted during those three 1-week periods.
- **Completeness**
 - Field and laboratory completeness requirements were met.
- **Comparability**
 - Field conditions were within the range of the selected in-situ meter and probe capabilities.
 - Laboratory method detection limits were sufficient to meet UPDES requirements and data quality objectives (Waterleaf 2025a).

Detailed Level IV laboratory quality control and quality assurance documentation was submitted electronically via EPA's NetDMR system. This documentation can be accessed through EPA's ECHO website, as discussed in Section 1.2, *Background*.

2.2 Flow Monitoring

Waterleaf conducted continuous and instantaneous flow monitoring on influent and discharge flows during the Demonstration Plant's operation.

Continuous flow monitoring was conducted using Krohne Optiflux 4300 and Rosemount Magnetic flow meters installed in the Demonstration Plant's intake and outfall infrastructure, respectively. Influent flow monitoring occurred before GSL brine entered the intake holding tank; discharge flow monitoring occurred after brine was discharged from the outfall holding tank. Inline flow meters were installed to continuously monitor the influent flows from the GSL and discharges to the GSL.

Instantaneous flow monitoring was conducted by HDR during water chemistry monitoring events. For each discrete water quality sample, an instantaneous flow measurement was recorded. These instantaneous flow measurements were used to prepare the flow-weighted composite sample for laboratory analysis. Instantaneous flows were recorded from the Waterleaf continuous flow meters.

2.3 Biota Monitoring

Waterleaf contracted with Dr. Bonnie Baxter of Westminster University to study the microbial biomass and community (bacteria, archaea, algae, and fungi) in the influent to and discharge from the Demonstration Plant, which was located on the eastern shore of the North Arm of the GSL (Baxter 2025). The goals of the study were to characterize the biota community in the influent flow and evaluate whether the discharge from the Demonstration Plant affected the biota community of the North Arm.

The following data collection and analysis were conducted to evaluate the influent and discharge characteristics during the Demonstration Plant's operation:

- Identify the biota cells present to estimate cell density and measure biomass.
- Extract and sequence DNA associated with bacteria, archaea, algae, and fungi to determine their abundance and presence.
- Inoculate samples to determine cell growth rate for three conditions: influent, discharge, and a mix (50:50) of influent and discharge.

To identify the presence or absence of biota cells, Dr. Baxter collected water samples from the raw brine intake tank and the Demonstration Plant's discharge tank and pumped the samples through a sterile polyvinylidene fluoride (PVDF) membrane pressure filter unit with a pore size of 0.22 micrometer (μm) to analyze the accumulated biomass. The filter media were frozen on site with liquid nitrogen to preserve the samples and were transported to the lab frozen on dry ice. In the lab, the samples were run through a centrifuge and dried to create a pellet of the cells, and the dry weight of the cell pellet was measured. Using a hemacytometer (which provides a grid and special cover glass to control the distributed volume), the cell density in each of the samples was estimated. The presence of cells in the influent and discharge flows was then verified and further analyzed through biosignatures (DNA sequencing).

To identify microbial diversity, the filter samples were sent to an external laboratory to conduct the DNA sequencing, which establishes the species of life present. The lab

extracted the biota DNA from filters and then amplified the specific genes associated with bacteria, archaea, algae, and fungi. Evaluations were conducted on the DNA sequencing results to determine the presence and relative abundance of microbial taxa present in the influent and discharge water samples. The genetic data were examined and assembled by relative abundance, meaning that the abundance of species can be compared within a specific sample but not to other sample results.

Water samples were inoculated by Dr. Baxter, and biota and observations were logged over 24 days to document growth rates. Four water samples were inoculated: sterile, influent (raw brine), discharge brine, and a 50:50 mix of influent and discharge. The 50:50 mix represents North Arm brine mixed with discharge brine to determine whether the biota would grow that environment.

3 Water Quality Results

The results of each water quality compliance monitoring event were submitted electronically to EPA's NetDMR website in accordance with the UPDES permit requirements. Analytical laboratory data quality Level IV packages were submitted electronically. Laboratory results are provided in Appendix B, *Laboratory Data Results*. A summary of those results is provided below.

Influent and discharge samples were collected and analyzed weekly during the Demonstration Plant's operation. Table 2 lists the dates of the water quality compliance monitoring events annotated with a description of Demonstration Plant operation phases.

Table 2. Dates of Water Quality Compliance Monitoring Events

Week	Sampling Date	Influent Sampling	Discharge Sampling	Notes
1	2/6/25	✓	✓	Start-up operations
2	2/13/25	✓	✓	Start-up operations
3	2/20/25	—	—	No discharge
4	2/26/25	✓	✓	Start-up operations
5	3/4/25	✓	✓	Start-up operations
6	3/13/25	✓	✓	Equipment validation
7	3/18/25	✓	✓	Equipment validation
8	3/25/25	✓	✓	Equipment validation
9	4/2/25	✓	✓	Equipment validation
10	4/8/25	✓	✓	Equipment validation
11	4/15/25	✓	✓	Equipment validation
12	4/22/25	✓	✓	Equipment validation
13	5/1/25	✓	✓	Equipment validation
14	5/6/25	✓	✓	Equipment validation
15	5/12/25	—	—	No discharge
16	5/20/25	✓	✓	Performance run
17	5/29/25	✓	✓	Performance run
18	6/03/25	✓	✓	Performance run
19	6/12/25	✓	✓	Equipment validation
20	6/17/25	✓	✓	Equipment validation
21	6/24/25	✓	✓	Equipment validation
22	7/1/25	✓	✓	Equipment validation
23	7/10/25	✓	✓	Equipment validation
24	7/15/25	✓	✓	Equipment validation
25	7/22/25	—	—	No discharge
26	7/29/25	✓	✓	Equipment validation
27	8/7/25	✓	✓	Equipment validation
28	8/12/25	✓	✓	Equipment validation

3.1 Visual Observation Results

Observations of water quality covered by state narrative water quality standards were made and documented during compliance monitoring. These observations targeted unnatural deposits, floating debris, oil, scum, or other nuisances such as color or odor, that are specifically identified in the narrative standards. No floating debris, oil, scum, or odor were observed in the influent and discharge samples that were evaluated.

The color of the influent and discharge varied throughout the Demonstration Plant's operation; no color was observed early in the plant's operation (February and March), and color was increasingly observed in the influent for the remainder of the plant's operation (April through August). The color of the influent increasingly became pinker as the North Arm's brine temperatures rose and the presence of biota increased. This observation is normal and is supported by the biota monitoring that was conducted (see Appendix C, *Biota Monitoring Report*).

During the first several weeks of the Demonstration Plant's operation, steel rust flakes were observed in the discharge samples. The source of the rust flakes was determined to be corrosion from the intake and outfall steel holding tanks and other carbon steel equipment throughout the Demonstration Plant. Waterleaf observed that the steel holding tanks were corroding and that rust was flaking off the tank interiors as the brine levels fluctuated in the holding tanks and the exposed steel discolored and began to disintegrate.

After the observations were made, Waterleaf modified operation of the Demonstration Plant to minimize the change in water level in the tanks, thereby reducing the exposure of the steel tanks' interiors. The rust flakes were observed and recorded during the February biota monitoring event along with the presence of biota. The biota monitoring report concluded that the corrosion of the holding tanks was not adversely affecting the microorganisms in the discharge (Appendix C, *Biota Monitoring Report*). Rust flakes were not observed after week 5 of the Demonstration Plant's operation.

3.2 Chemistry Monitoring Results

The influent and discharge flows were sampled and analyzed in compliance with the UPDES permit and the Operator Certification. In all, 25 monitoring events were conducted at the Demonstration Plant during its 28-week operation (there was no discharge during 3 of the 28 weeks). A summary of all laboratory analytical results and laboratory MDLs is provided in Table 3 for each constituent in alphabetical order. Field measurements (density, dissolved oxygen, pH, and temperature) are discussed in Section 3.4, *Field Chemistry Results* including a discussion on salinity characteristics of the influent and discharge.

Additionally, as required by UDFFSL rules, a performance run period occurred during weeks 16 through 18 of operation (May 20 through June 10, 2025). During the performance run of the Demonstration Plant, equipment operations were optimized and maintained to measure certain performance metrics (Waterleaf 2025b). Table 4 summarizes average influent and discharge concentrations for this period.

In this section, Waterleaf examines the influent and discharge chemical data in context with laboratory MDLs and uncertainty or error. Also, the chemical data were evaluated for outliers based on interquartile range (IQR) outlier analysis.

During the 28-week operation of the Demonstration Plant, the plant operated in three phases: start-up operations, equipment validation, and performance run (see Table 2 for the duration of each phase). During start-up operations, spikes in some metal constituents and rust flakes were observed, as discussed above in Section 3.1. Data results during start-up are discussed in Section 3.3.3 and summarized in Table 6 for the specific metal constituents that had data spikes during start-up.

To assess whether Demonstration Plant mass loads changed North Arm background mass, loads for metals, salt, and manganese are compared in Table 7, Table 8, and Table 9.

Lithium concentrations and mass loading are provided in Table 10.

In addition to the chemical laboratory analyzes reported in this section, UPDES required the reporting of silicon. Waterleaf used the UDWQ molar mass equation, using silica laboratory results, including the MDL value for nondetect values. Using the UDWQ molar mass equation and the silica data results, the silicon data are:

- Influent characteristics:
 - Average concentration: 2.5 mg/L
 - Minimum concentration: 2.0 mg/L
 - Maximum concentration: 3.6 mg/L
- Discharge characteristics:
 - Average concentration: 2.7 mg/L
 - Minimum concentration: 2.0 mg/L
 - Maximum concentration: 4.3 mg/L

Table 3. Summary of All Laboratory Analytical Results (Weeks 1–28)

Constituent	Influent Average (min/max)	Discharge Average (min/max)	Minimum Detection Limit (mg/L)	UPDES Specified Minimum Detection Limit (mg/L)
Alkalinity	569 (526/599)	360 (119/504)	0.2	NA
Aluminum, total	1.7 (ND/5.2)	1.6 (ND/5.1)	1.2	NA
Arsenic, total	0.477 (0.361/0.620)	0.322 (0.054/0.483)	0.0044	0.180 ¹
Barium, total	0.190 (ND/0.342)	0.169 (ND/0.322)	0.057	NA
Bicarbonate	569 (526/599)	360 (119/504)	0.2	NA
Biological oxygen demand	7.4 (ND/16)	6.7 (ND/13)	2.0	NA
Boron, total	60.3 (50.6/65.5)	56.7 (46.7/62.8)	0.61 ²	NA
Bromide	174 (140/201)	160 (132/186)	0.5 ³	NA
Cadmium, total	ND	ND	0.0012 ⁴	0.0052
Calcium, dissolved	302 (277/327)	288 (258/318)	0.7 ⁵	NA
Carbonate	ND	ND	0.2	NA
Chemical oxygen demand (COD)	2,420 (ND/7,020)	1,617 (ND/4,300)	617.0 ⁶	NA
Chloride	181,400 (159,000/194,00)	168,360 (144,000/181,000)	180.0	NA
Chromium, total	0.072 (0.014/0.250)	0.069 (ND/0.236)	0.0062 ⁷	0.0166
Copper, total	0.0391 (0.0182/0.0759)	0.0470 (0.0052/0.1360)	0.0182 ⁸	0.067
Cyanide, total	ND	ND	0.022 ⁹	0.0093
Hardness	59,692 (55,400/67,100)	56,256 (48,600/62,700)	11.7 ¹⁰	NA
Hydroxide	ND	ND	0.2	NA
Iron, total	0.58 (ND/0.80)	1.57 (ND/16.4)	0.57	NA
Lead, total	ND	ND ¹¹	0.0087 ¹¹	0.0465
Lithium, total	67.7 (55.1/81.6)	30.8 (9.33/54.8)	0.403 ¹²	NA
Magnesium, total	14,312 (13,300/16,100)	13,480 (11,600/15,000)	2.4 ¹³	NA
Manganese, total	0.0411 (0.0264/0.0794)	0.2385 (0.0554/0.91)	0.0159 ¹⁴	NA
Mercury, total	33.2 ng/L (ND/211 ng/L)	39.9 ng/L (ND/109 ng/L)	9 ng/L ¹⁵	0.000022
Molybdenum, total	0.136 (0.111/0.218)	0.111 (0.0169/0.312)	0.038 ¹⁶	NA
Nickel, total	0.049 (0.011/0.29)	0.052 (0.009/0.279)	0.0112 ¹⁷	0.376
Nitrate	ND	ND	6.64 ¹⁸	NA
Nitrite	ND	ND	0.01	NA
Oil and grease	ND	ND	5	NA
Potassium, total	8,662 (8,050/9,650)	8,138 (6,860/9,000)	8.6 ¹⁹	NA
Selenium, total	0.308 (0.074/0.908)	0.301 (0.012/0.933)	0.0141 ²⁰	0.0079

Table 3. Summary of All Laboratory Analytical Results (Weeks 1–28)

Constituent	Influent Average (min/max)	Discharge Average (min/max)	Minimum Detection Limit (mg/L)	UPDES Specified Minimum Detection Limit (mg/L)
Silica, total	5.3 (ND/7.7)	5.7 (ND/9.2)	4.2	NA
Silver, total	ND	ND	0.008 ²¹	0.0899
Sodium, dissolved	92,920 (79,000/112,000)	86,568 (61,400/110,000)	343 ²²	NA
Sulfate, dissolved	24,220 (10,200/28,100)	22,400 (12,600/28,200)	49.4 ²³	NA
Total dissolved solids (TDS)	340,040 (311,000/363,000)	312,640 (259,000/362,000)	1,000 ²⁴	NA
Total suspended solids (TSS)	111 (ND/530)	106 (6/454)	3 ²⁵	NA
Zinc, total	ND	ND	0.05 ²⁶	0.675

Definitions: max = maximum; MDL = minimum detection limit; mg/L = milligrams per liter; min = minimum; NA = not applicable; ND=nondetect (not detected above MDL); ng/L = nanograms per liter

- MDL for arsenic was reported as 0.0088 mg/L for week 1 and 0.022 mg/L for week 24.
- MDL for boron was reported as 12.1 mg/L for week 9.
- MDL for bromide varied between 0.5 and 4.7 mg/L.
- MDL for cadmium was reported as 0.0061 mg/L for week 24.
- MDL for calcium was reported as 14.6 mg/L for week 24.
- MDL for COD was reported as 154 mg/L for weeks 1 through 11, 308 mg/L for week 12, and 617 mg/L for weeks 13 through 28.
- MDL for chromium varied between 0.0062 and 0.0618 mg/L.
- MDL for copper was reported as 0.0364 mg/L for week 1 and 0.0036 mg/L for week 5.
- MDL for cyanide varied between 0.004 and 0.132 mg/L.
- MDL for hardness varied between 11.7 and 234 mg/L.
- MDL for lead was reported as 0.0174 mg/L for week 1 and 0.0435 mg/L for week 24; discharge value was reported at 0.015 mg/L for week 20.
- MDL for lithium was reported as 8.07 mg/L for week 8.
- MDL for magnesium was reported as 48 mg/L for weeks 8, 14, 15, 18, and 24, and 4.8 mg/L for week 4.
- MDL for manganese was reported as 0.0318 mg/L for week 1.
- MDL for mercury was reported as 44.9 ng/L for week 1 and 70 ng/L for week 27.
- MDL for molybdenum was reported as 0.0075 mg/L for week 1 and 0.0188 mg/L for week 24.
- MDL for nickel was reported as 0.0223 mg/L for week 1 and 0.112 mg/L for week 17.
- MDL for nitrate was reported as 33.2 mg/L for week 10.
- MDL for potassium was reported as 171 mg/L for weeks 8, 16, 18, and 24.
- MDL for selenium was reported as 0.0283 mg/L for week 1 and 0.0707 mg/L for week 24.
- MDL for silver was reported as 0.017 mg/L for week 1 and 0.042 mg/L for week 24.
- MDL for sodium was reported as 172 mg/L for week 6.
- MDL for sulfate was reported as 247 mg/L for weeks 1, 7, 9, 10, 12, 17–20, 23, and 26–28.
- MDL for TDS was reported as 20 mg/L for week 4.
- MDL for TSS varied between 0.8 and 8 mg/L.
- MDL for zinc was reported as 0.09 mg/L for week 1.

Table 4. Summary of Performance Run Laboratory Analytical Results (Weeks 16–18)

Constituent	Influent Average (Min/Max) (mg/L)	Discharge Average (Min/Max) (mg/L)
Alkalinity	560 (552/569)	373 (312/414)
Aluminum, total	2.7 (1.2/5.2)	2.5 (1.2/5.1)
Arsenic, total	0.43 (0.39/0.48)	0.31 (0.31/0.32)
Barium, total	0.19 (0.18/0.20)	0.16 (0.15/0.18)
Bicarbonate	560 (552/569)	373 (312/414)
Biological oxygen demand	10 (9/11)	9 (7/10)
Boron, total	60.2 (59.3/61.0)	58.0 (57.4/58.6)
Bromide	173 (140/201)	156 (139/170)
Cadmium, total	ND (ND/ND)	ND (ND/ND)
Calcium, dissolved	291 (277/300)	284 (270/293)
Calculated silicon ¹	2.5 (2.3/2.7)	3.1 (2.9/3.4)
Carbonate	ND (ND/ND)	ND (ND/ND)
Chemical oxygen demand (COD)	1,006 (617/1200)	845 (617/1,300)
Chloride	182,333 (177,000/187,000)	173,333 (166,000/181,000)
Chromium, total	0.048 (0.021/0.062)	0.051 (0.030/0.062)
Copper, total	0.039 (0.030/0.052)	0.040 (0.032/0.054)
Cyanide, total	ND (ND/ND)	ND (ND/ND)
Hardness	58,800 (58,100/59,600)	56,833 (55,500/57,900)
Hydroxide	ND (ND/ND)	ND (ND/ND)
Iron, total	ND (ND/ND)	1.72 (1.30/2.40)
Lead, total	ND (ND/ND)	ND (ND/ND)
Lithium, total	67.4 (66.1/69.6)	16.0 (14.4/18.8)
Magnesium, total	14,100 (13,900/14,300)	13,633 (13,300/13,900)
Manganese, total	0.038 (0.030/0.043)	0.163 (0.141/0.182)
Mercury, total	25.3 (23.3/27.2)	28.6 (24.9/31.4)
Molybdenum, total	0.126 (0.122/0.132)	0.081 (0.055/0.122)
Nickel, total	0.052 (0.015/ND)	.0512 (ND/ND)
Nitrate	ND (ND/ND)	ND (ND/ND)
Nitrite	ND (ND/ND)	ND (ND/ND)
Oil and grease	ND (ND/ND)	ND (ND/ND)
Potassium, total	8,423 (8,280/8,600)	8,137 (7,880/8,480)
Selenium, total	0.185 (0.101/0.238)	0.242 (0.121/0.342)
Silica, total	5.4 (5.0/5.8)	6.7 (6.3/7.3)
Silver, total	ND (ND/ND)	ND (ND/ND)
Sodium, dissolved	95,100 (94,200/96,700)	92,500 (90,300/93,600)
Sulfate, dissolved	25,400 (24,300/26,700)	25,167 (25,000/25,300)
Total dissolved solids (TDS)	341,667 (335,000/349,000)	328,667 (326,000/332,000)
Total suspended solids (TSS)	127 (62/228)	112 (64/175)
Zinc, total	ND (ND/ND)	ND (ND/ND)

Definitions: max = maximum; MDL = minimum detection limit; mg/L = milligrams per liter; min = minimum; NA = not applicable; ND=nondetect (not detected above MDL); ng/L = nanograms per liter

1. This is a calculated value based on silica data.

3.3 Chemistry Monitoring Results Discussion and Graphs

This section reviews the results Demonstration Plant weekly laboratory analyses and summarizes the monitoring results for metals, salts, manganese, and lithium. The metal constituents reviewed are aluminum, arsenic, barium, boron, cadmium, chromium, copper, iron, lead, mercury, molybdenum, nickel, selenium, silver, and zinc, and the salts constituents reviewed are calcium, chloride, magnesium, potassium, sodium, and sulfate. Metals and salts, as well as other constituents (manganese and lithium), are required to be analyzed and reported by the UPDES permit and GSL Mineral Extraction Facility Operator Certification rules.

Data results for all constituents are summarized in Table 3 above, and laboratory results spreadsheets are attached in Appendix B, *Laboratory Data Results*.

To evaluate whether changes in metals, salts, and minerals (manganese and lithium) discharge concentrations (as compared to intake concentrations) result in a change in chemistry in the North Arm of the GSL. Waterleaf uses various lines of evidence, which consist of the following,

- MDLs and uncertainty of data
- Lack of comparable historic North Arm chemistry data and numeric water quality standards
- Relative increase or decrease in average concentrations (Table 3 above) as compared to MDLs and uncertainty
- Relative increase or decrease in average concentrations during the performance run (Table 4 above)
- Outlier analysis (Table 5 below)
- Relative increase or decrease in normal operations average concentrations (removing the first 5 weeks of start-up operations; see Table 6 below)
- Total change in mass loadings (discharge load subtracted from influent load) based on average concentrations, as compared to North Arm mass, at current water surface elevations (WSE) (Table 7, Table 8, and Table 9 below)
- Biota study results

3.3.1 Minimum Detection Limits and Uncertainty

Chemical analyses on the GSL brine samples and specifically North Arm brine samples are difficult to perform because of the high density, high salinity, and other unique characteristics of GSL brine. These characteristics interfere with laboratory means and methods. Due to these interferences, data results can often have various MDLs, various dilution rates, and large spike recovery ranges, all of which create a level of error and uncertainty. Although this error and uncertainty exists, the individual laboratory test results met data quality criteria and equipment precision ranges.

Overall, the MDLs for the analyzed constituents were consistent and met UPDES requirements. The laboratory data quality packages reported a few cases in which the MDL for selenium was not met. Level IV laboratory data quality results also documented dilution rates and spike recovery rates to meet quality control and assurance requirements.

Waterleaf also uses context when reviewing the data. Some constituents were analyzed at MDLs that were less than designated by the UPDES, as shown in Table 3 above. For example, copper was analyzed with an MDL of 0.0182 mg/L, which is below the UPDES stated MDL of 0.067 mg/L. So, when the influent and discharge average values are calculated at 0.0391 mg/L and 0.0470mg/L, respectively, they are below the UPDES stated MDL and might be considered comparable. Very low MDLs can bias the review of the data by detecting increases and decreases in concentration that are insignificant compared to other data sets.

Error and uncertainty (lab interference) need to be considered when reviewing the data. The heavy brine requires that samples are diluted to effectively be analyzed by equipment that is normally processing fresh water samples. The dilution rates for analyses ranged from undiluted (rate of 1) to 6, 20, and 50 up to a high of 100. Also, all samples were analyzed independently, so the intake and discharge samples for the same day might be diluted differently. Laboratory method accuracy is measured by percent recovery, and these percent recoveries vary for the different methods used for this project. For example, salts generally have a $\pm 20\%$ recovery, while metals have a $\pm 15\%$ recovery. The Utah Geological Survey has estimated that, for most GSL data, a minimum error of about 10% could be attributed to the challenges of processing the brine, based on conversations with the analytical laboratory (UGS 2025).

Waterleaf did report all data to UDWQ consistent with UPDES compliance monitoring requirements. That being said, the laboratory chemical analyses and results provided are adequate to meet the data quality objectives of the monitoring, which are to characterize the chemistry of the North Arm raw brine that is used as influent water to the lithium extraction process and to characterize the discharge of the lithium-depleted brine back to the North Arm.

3.3.2 Outlier Analyses

As with any data set, results often include concentrations that are unusually high or low—or in other words, outside the normal or expected range. To evaluate the impact of outliers on the Demonstration Plant data set, an outlier analysis was performed to identify whether outliers occurred extensively throughout the data set. Waterleaf determined that they did not. Therefore, Waterleaf included all data in the calculation of average, minimum, and maximum. Below is a summary of the outlier analyses and the results.

An IQR outlier analysis was conducted on the laboratory data results for each constituent's influent and discharge data. This analysis requires calculating the upper-quartile boundaries and then comparing the data to this threshold. Data points above this threshold are considered outliers.

In all, of the 1,900 data points analyzed for 38 constituents, 18 constituents were determined to have 59 data exceedances; that is, 59 data points were above the upper-quartile boundary. Of these 59 data points, 34 were influent outlier points and 25 were discharge outlier points. The results of the outlier analyses for those constituents with data exceedances are shown in Table 5 below.

Of note, outlier analyses were not conducted on the 10 constituents with nondetected concentrations. Also, the lower-quartile boundary analyses were not completed due to the presence of nondetection concentrations.

This analysis provides further evidence that the significant variations in data results are limited—using the IQR analytical methodology, about 3.1% of the data reported are considered outliers (outside the upper-quartile boundary).

Based on the IQR outlier analyses for all constituents analyzed, Waterleaf determined that the outliers did not occur extensively. Therefore, all data are included in the calculation of average, minimum, and maximum concentrations.

Table 5. Summary of Outlier Analyses

Constituent	Influent Outliers			Discharge Outliers		
	Influent Average (mg/L)	Upper Boundary (mg/L)	Number of Exceedances	Discharge Average (mg/L)	Upper Boundary (mg/L)	Number of Exceedances
Aluminum, total	1.7	3.0	1	1.6	2.5	2
Barium, total	0.190	0.238	3	0.169	0.248	2
Bromide	0.173	200.5	1	160.1	192.5	0
COD	2,420	4,450	4	1,1617	4,650	0
Chromium, total	0.072	0.196	2	0.069	0.176	2
Copper, total	0.0391	0.0661	2	0.0470	0.0753	2
Hardness	59,692	64,100	2	56,256	65,200	0
Iron, total	0.58	0.57	1	1.57	2.4	2
Lead, total	0.0104	0.0087	0	0.0107	0.0087	1
Lithium, total	67.7	73.0	2	30.6	91.7	0
Magnesium, total	14,312	15,400	2	13,480	15,600	0
Manganese, total	0.0411	0.0550	2	0.239	0.511	1
Mercury, total	33.2	33.7	2	39.9	52.8	3
Molybdenum, total	0.136	0.163	1	0.111	0.178	4
Nickel, total	0.049	0.091	4	0.052	0.087	3
Potassium, total	8,662.4	9,535	1	8,138	9,455	0
Sodium, dissolved	92,920	108,100	1	86,568	114,300	0
TSS	110.9	278.5	3	105.6	264.0	3

Definitions: COD = chemical oxygen demand; mg/L = milligrams per liter; TSS = total suspended solids

3.3.3 Metals Discussion

In this section, Waterleaf reviews the laboratory data results for metal constituents. Metals are often the focus of review due to their potential toxicity and their regulation by the Clean Water Act. Metal MDLs and loads were specific components of the UPDES permit. As stated in Section 1.2, *Background*, the North Arm is protected for recreation and wildlife use; however, numeric water quality standards have not been established.

The metal constituents discussed below are aluminum, arsenic, barium, boron, cadmium, chromium, copper, iron, lead, mercury, molybdenum, nickel, selenium, silver, and zinc.

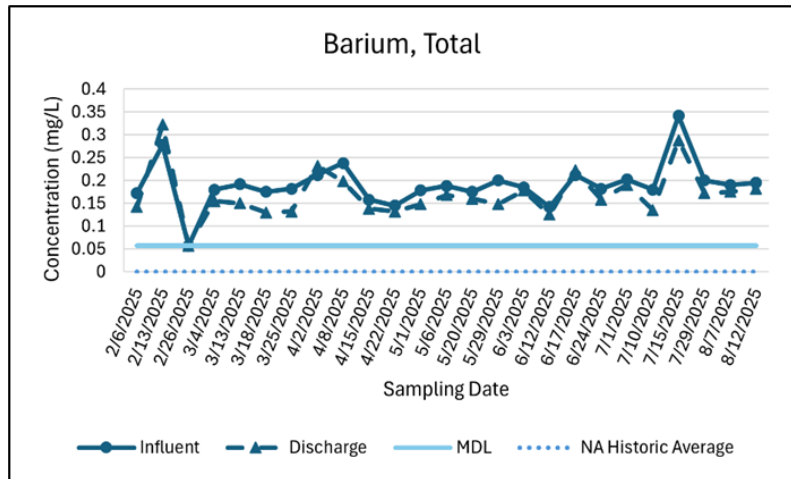
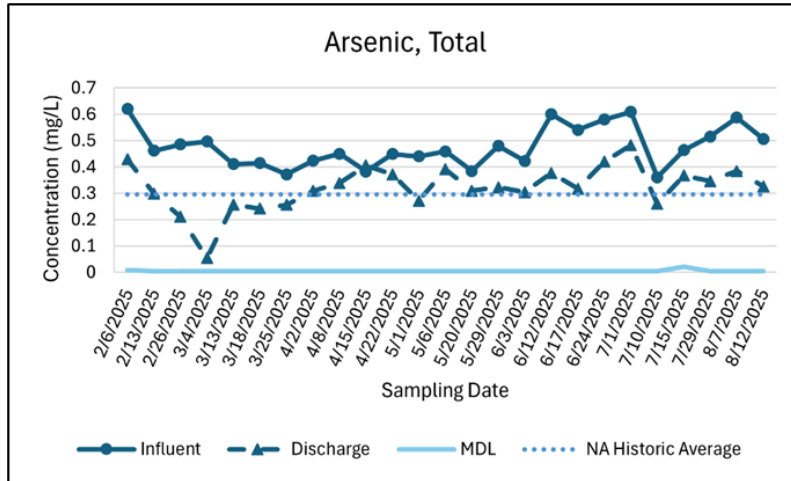
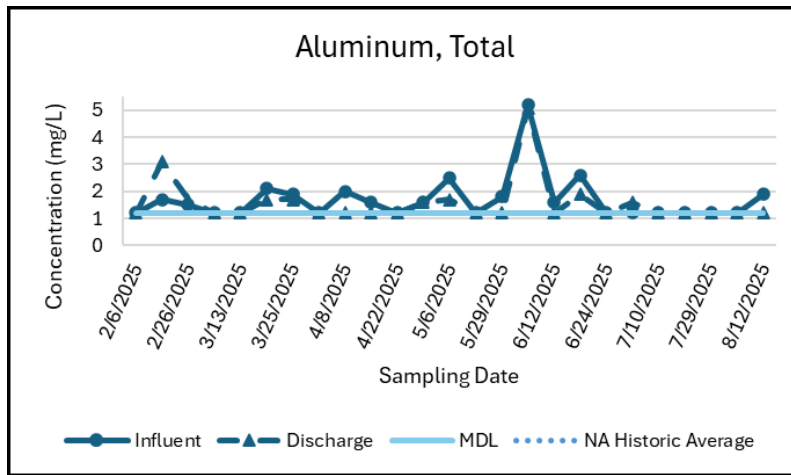
Metals That Were Not Detected. The data results reported four metal constituents (cadmium, lead, silver, and zinc) as nondetected for both influent and discharge concentrations for the entire 28-week operation of the Demonstration Plant, including the start-up and performance run periods (Table 3 above).

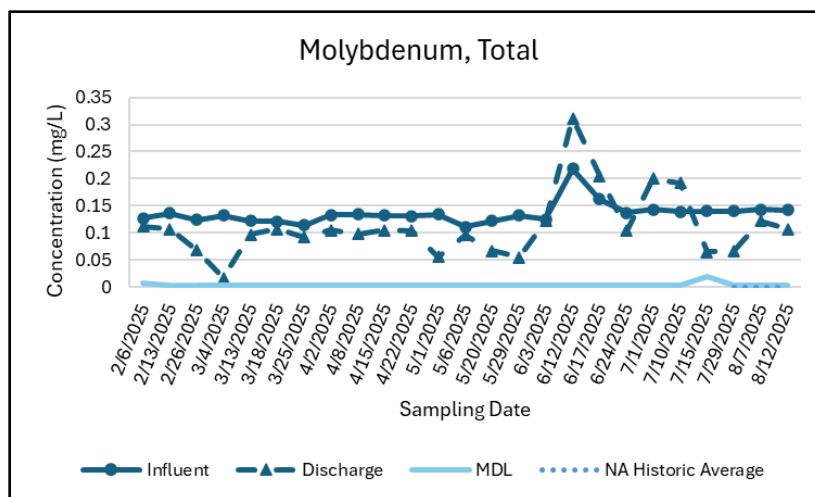
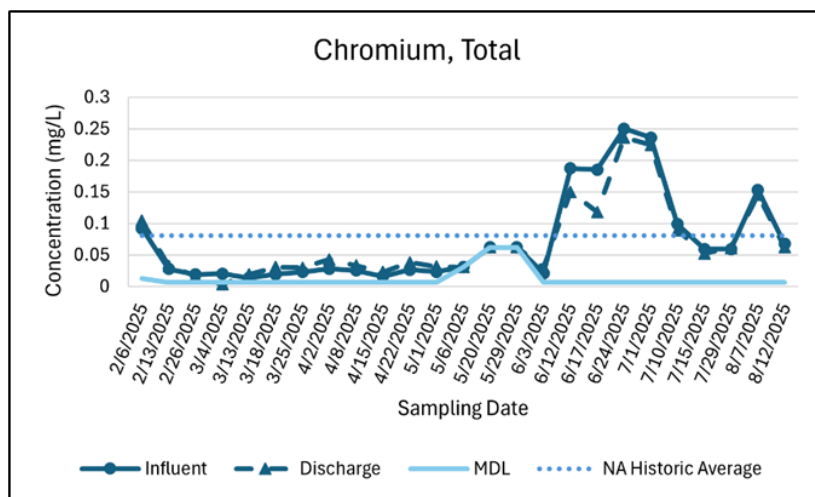
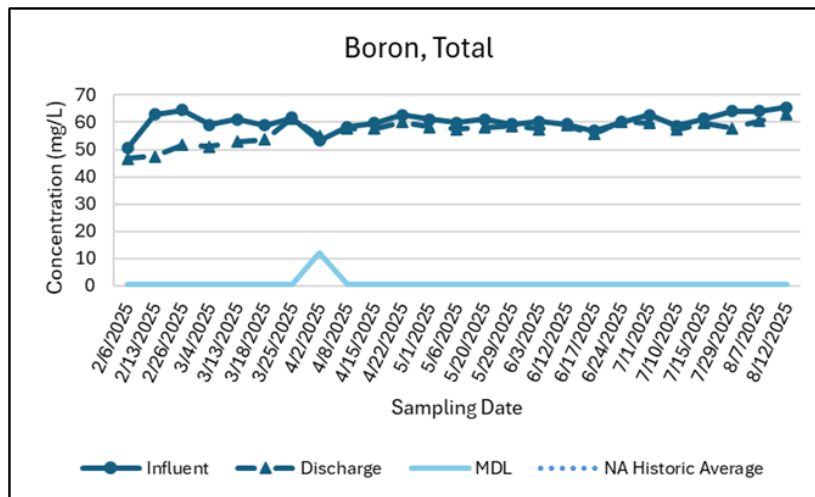
Metals with Lower Discharge Concentrations. Seven metal constituents (aluminum, arsenic, barium, boron, chromium, molybdenum, and selenium) were reported with lower average discharge concentrations than average influent concentrations during the Demonstration Plant's operation. Weekly laboratory data for influent and discharge concentrations are graphically shown below in Figure 1 for these seven constituents along with laboratory MDLs and North Arm historical averages. North Arm historical averages were determined by analyzing the UDWQ water quality database, North Arm monitoring locations, and reported values (HDR 2023). For some constituents, historical data were not available.

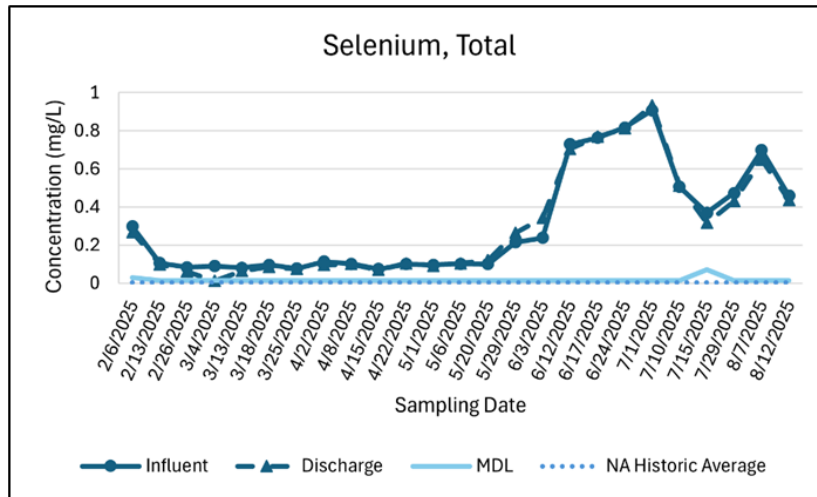
The data for the entire 28-week operation indicate the following decreases in average discharge concentrations compared to average influent concentrations: aluminum (decrease of 7%), arsenic (decrease of 32%), barium (decrease of 11%), boron (decrease of 6%), chromium (decrease of 4%), molybdenum (decrease of 18%), and selenium (decrease of 2%).

These constituents also showed average decreased concentrations compared to intake concentrations during the performance run (weeks 16–18) (Table 4 above), with the exception of chromium and selenium, for which average discharge concentrations increased above average intake concentrations. If the uncertainty estimate of 10% is taken into perspective, the decreases for aluminum, boron, chromium, and selenium are within this error range.

Figure 1. Graphs of Metal Constituents with Lower Average Discharge Concentrations



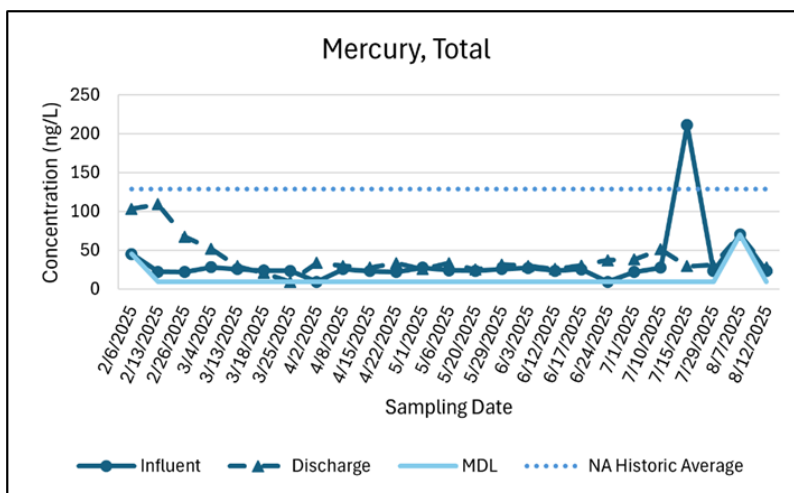
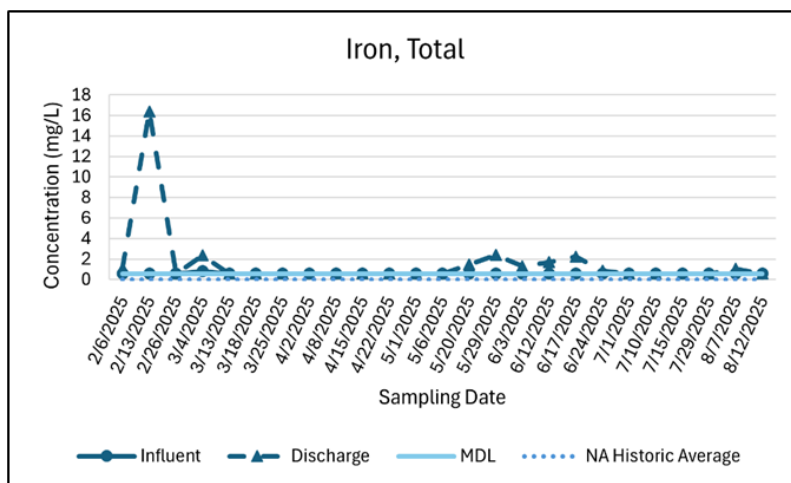
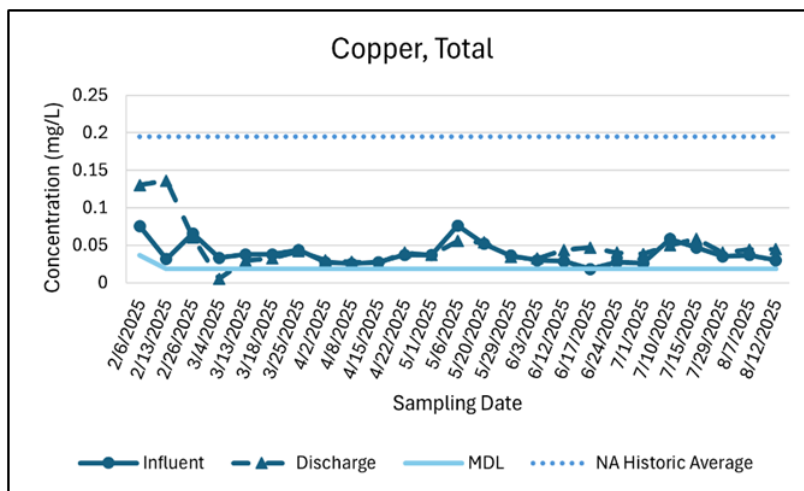


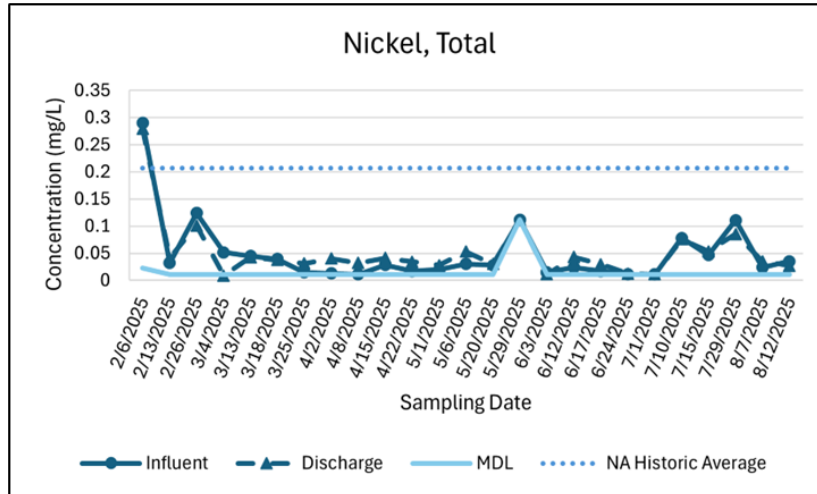


Metals with Higher Discharge Concentrations. Four metal constituents (copper, iron, mercury, and nickel) were reported with higher average discharge concentrations than average influent concentrations during the Demonstration Plant's operation. Weekly laboratory data for influent and discharge concentrations are graphically shown below in Figure 2 for these four constituents along with laboratory MDLs and North Arm historical averages. North Arm historical averages were determined by analyzing the UDWQ water quality database, North Arm monitoring locations, and reported values (HDR 2023).

The increases in average discharge concentrations compared to the average influent concentrations are: copper (increase of 20%), iron (increase of 272%), mercury (increase of 20%), and nickel (increase of 6%). Based on a review of the graphs and the data, it is apparent that, during the Demonstration Plant's start-up period, discharge concentrations for these metals were higher than during the following weeks. Waterleaf conducted further review of the data and operations during this start-up period to determine the cause of the data spikes. Waterleaf determined that, during start-up operations (weeks 1–5), processes and equipment were the cause of the data spikes for certain metal constituents, because these four constituents are not a component of the DLE process.

Figure 2. Graphs of Metal Constituents with Higher Average Discharge Concentrations





The increases in discharge concentrations (compared to influent concentrations) for copper, iron, mercury, and nickel during the start-up period can be partially attributed to the Demonstration Plant's equipment being made from carbon steel, stainless steel, and other corrodible materials. Equipment becomes corroded from exposure to the high-saline North Arm brine and exposure to oxygen. Evidence of corrosion consisted of higher concentrations of four metals (copper and iron, plus mercury and nickel) during the first 5 weeks, which was the Demonstration Plant's start-up period of operation, as well as visual observations of rust flakes in the discharge. During investigations to identify the source of the rust flakes in the discharge, observations were made confirming that the carbon steel frac tanks being used to store raw brine and depleted brine were in fact showing signs of corrosion.

After the initial start-up period of 5 weeks, rust flakes were not observed, and the discharge concentrations became more consistent. Table 6 compares the average influent and discharge results for the start-up period (weeks 1–5) and regular operations (weeks 6–28). As the data indicate, average discharge concentrations drastically reduced after the initial plant start-up process. After start-up, mercury and nickel average discharge concentrations decreased compared to average influent concentrations. Copper and iron results reported an increase in average discharge concentrations compared to average influent concentrations.

Table 6. Metal Concentration Data Comparison of Start-up and Regular Operations

Constituent	Start-up (Weeks 1–5)		Operation (Weeks 6–28)	
	Influent Average (mg/L)	Discharge Average (mg/L)	Influent Average (mg/L)	Discharge Average (mg/L)
Copper, total	0.0513	0.0829	0.0368	0.0401
Iron, total	0.628	5.10	ND (<0.57)	0.902
Mercury, total	29.2 ng/L	82.8 ng/L	34.0 ng/L	31.7 ng/L
Nickel, total	0.124	0.108	0.0348	0.0412

Definitions: mg/L = milligrams per liter; ND = nondetect; ng/L = nanograms per liter

These four constituents, along with chromium and selenium, had increased discharge concentrations compared to influent concentrations during the performance run period.

Waterleaf noticed that iron discharge concentrations increased during a 6-week period during regular operations and conducted further analyses. Most of the iron intake and discharge concentration results were reported nondetect, except during start-up operations and during a 6-week period (weeks 16–22). The increased discharge concentrations during start-up were discussed above. The increased discharge concentrations for weeks 16–22 followed a period of no discharge (week 15). During week 15, the plant experienced equipment failures and did not operate. When the plant was brought back online with replacement equipment operating, increases in iron discharges occurred until the process recovered (week 22). Iron discharge concentrations were reported nondetect during the remainder of operation (weeks 22–28).

Metal Load Analyses. To help determine impacts to North Arm chemistry due to operation of the Demonstration Plant, mass loads for the metal constituents were reviewed. Demonstration Plant mass loads were determined using all the laboratory data during operations (28 weeks), including outliers, compared to North Arm mass. Demonstration Plant loads were calculated by subtracting average influent concentration and influent volume from average discharge concentrations and discharge volume. North Arm mass was calculated using the average influent concentration and the North Arm volume at a WSE of 4,192 feet. The resulting mass load due to Demonstration Plant operation is shown in Table 7.

Table 7. Metals Load Comparison of Demonstration Plant Operations and North Arm

Constituent	Influent Average (mg/L)	Influent Load ¹ (lb)	Discharge Average (mg/L)	Discharge Load ² (lb)	Load to North Arm (lb)	North Arm Mass ³ (lb)
Aluminum, total	1.7	15.49	1.6	15.13	–0.36	14,978,200
Arsenic, total	0.477	4.35	0.322	3.04	–1.3	4,202,700
Barium, total	0.190	1.73	0.169	1.60	–0.13	1,674,000
Boron, total	60.3	549.3	56.7	536.1	–13.2	531,286,700
Chromium, total	0.072	0.66	0.069	0.65	–0.01	634,400
Copper, total	0.0391	0.36	0.0470	0.44	0.09	344,500
Iron, total	0.58	5.28	1.57	14.84	9.56	5,110,200
Mercury, total	0.0000332	1.65	0.0000399	2.0	0.35	290
Molybdenum, total	0.136	1.24	0.111	1.05	–0.19	1,198,300
Nickel, total	0.049	0.45	0.052	0.49	0.04	431,700
Selenium, total	0.308	2.81	0.301	2.85	0.04	2,713,700

Definitions: af = acre-feet; lb = pounds; mg/L = milligrams per liter; WSE = water surface elevation

1. Based on a Demonstration Plant total intake volume of 3.35 af
2. Based on a Demonstration Plant total discharge volume of 3.47 af
3. North Arm Mass based on WSE of 4,192 feet and volume of 3,240,000 af and average influent concentrations

In considering the mass decreases in the North Arm for aluminum, arsenic, barium, boron, chromium, and molybdenum discharges (Table 7 above), mass decreases due to

Demonstration Plant operations are in the range of 0.000002% to 0.00003% compared to North Arm total mass and are considered by Waterleaf to be *de minimis*.

In considering the mass load increases to the North Arm from the Demonstration Plant (Table 7 above), increases for copper (0.00002%), nickel (0.000009%) and selenium (0.0000015%) are considered by Waterleaf to be *de minimis*. The mass increase of iron to the North Arm is estimated at 9.6 pounds (lb), compared to 5.11 million pounds, or an increase of 0.0002%, which is also considered by Waterleaf to be *de minimis*.

The mercury data indicate that the mass load to the North Arm resulted in a 0.35-lb increase, compared to a North Arm mass of 290 lb, or an increase of 0.12%, which is considered by Waterleaf to be not significant. The bulk of this mass load occurred during the start-up period (Figure 2 and Table 6 above). Although mercury concentrations in the discharge during start-up operations were higher than in the influent, subsequently, during the remainder of the Demonstration Plant's operation, average discharge concentrations were less than average influent concentrations.

A review of the start-up comparison (Table 6 above) and investigation into the source of the corrosion revealed conditions specific to the Demonstration Plant's equipment. Comparing the data collected during remainder of the operations and performance run data run (Table 4 above), the temporary discharge of mercury mass load to the North Arm, due to start-up operations, is considered by Waterleaf to be not significant.

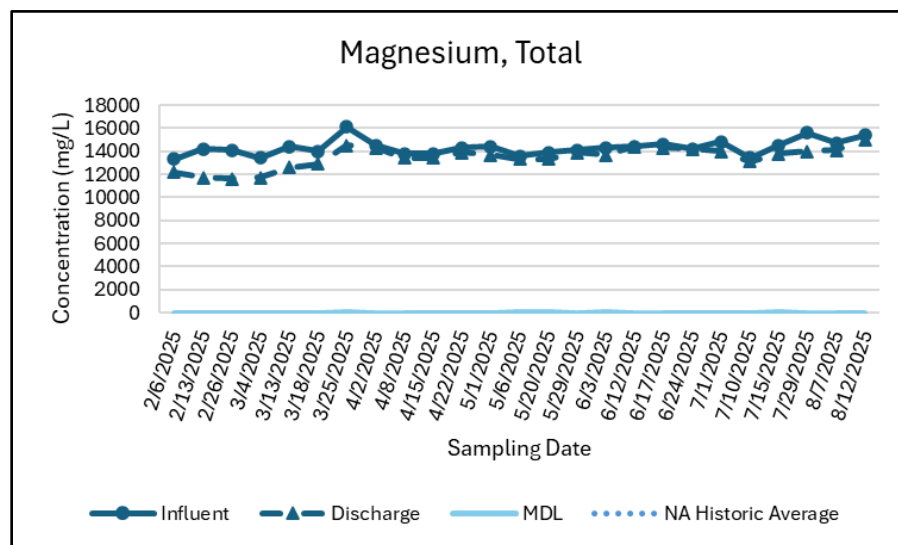
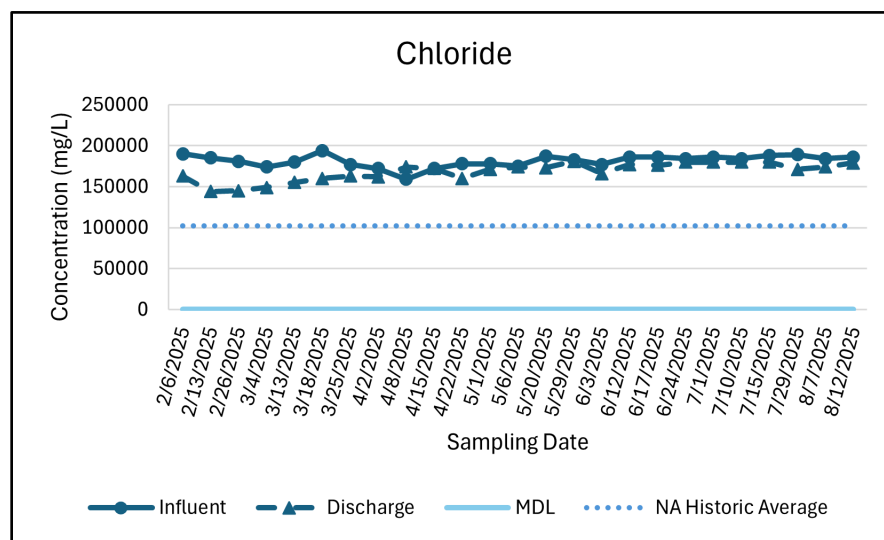
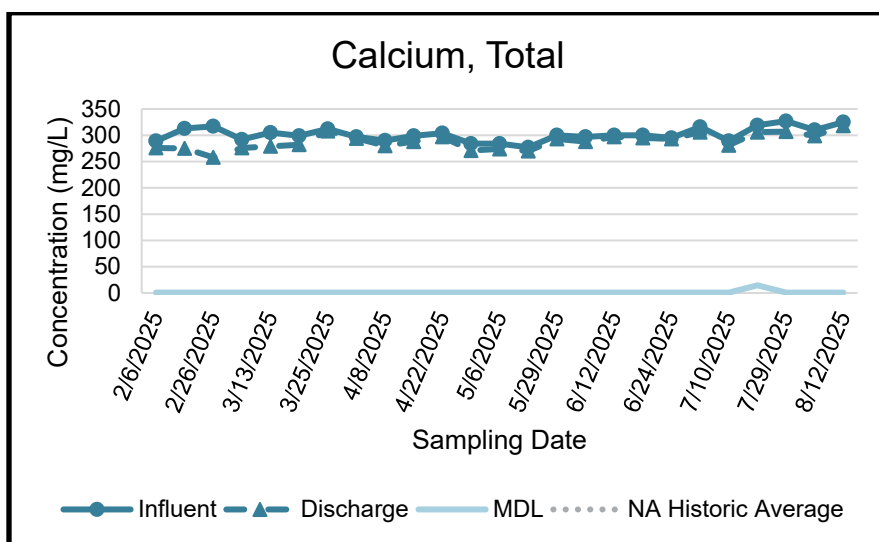
3.3.4 Salts Discussion

In this section, Waterleaf reviews the laboratory data results for salt constituents. GSL salts are important because they support the mineral extraction industry.

All salt cations and anions were reported with lower discharge concentrations than influent concentrations. These salt constituents are calcium, chloride, magnesium, potassium, sodium, and sulfate. The monitoring data for these constituents are graphed in Figure 3 below. Salt constituents' average discharge concentrations decreased in the range of 4.6% to 7.5% compared to average influent concentrations. This range is comparable to the average discharge concentration decrease in TDS of 8% compared to the average influent concentration.

To help determine impacts to North Arm chemistry due to operation of the Demonstration Plant, mass loads for the salt constituents were reviewed. Demonstration Plant mass loads were determined using all the laboratory data during operations (28 weeks). Demonstration Plant mass loads were calculated by subtracting average influent concentration and influent volume from average discharge concentrations and discharge volume. North Arm mass was calculated using the average influent concentration and the North Arm volume at a WSE of 4,192 feet. The result indicates that the Demonstration Plant reduced the salt constituents mass in the North Arm. The mass load comparison is shown in Table 8 below.

Figure 3. Graphs of Salt Constituents



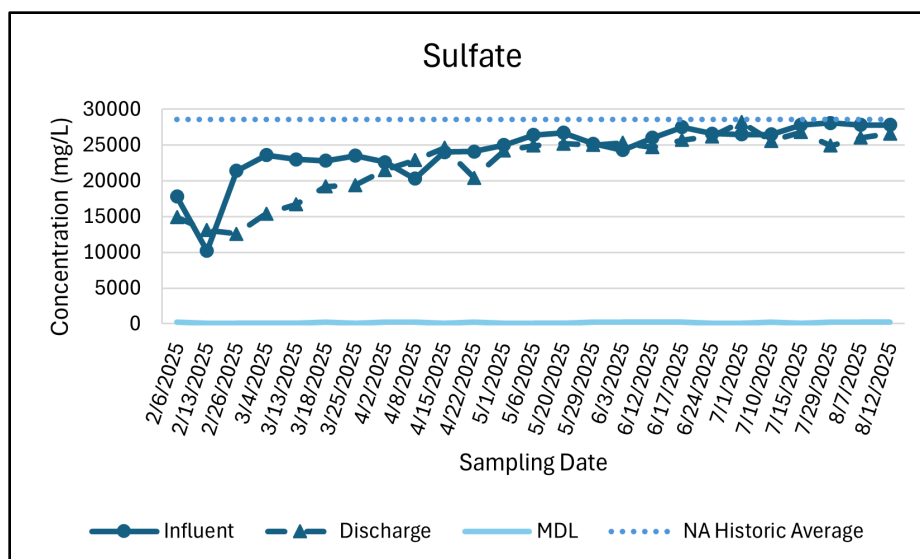
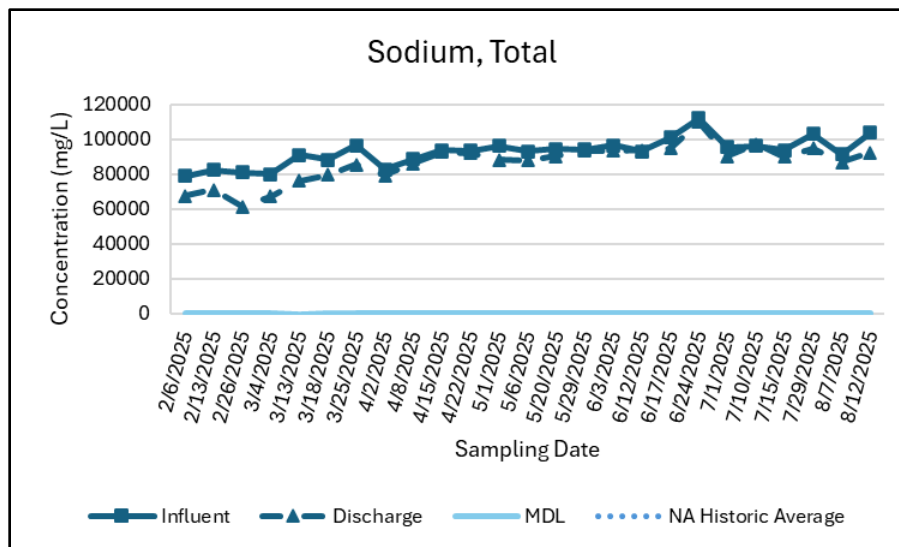
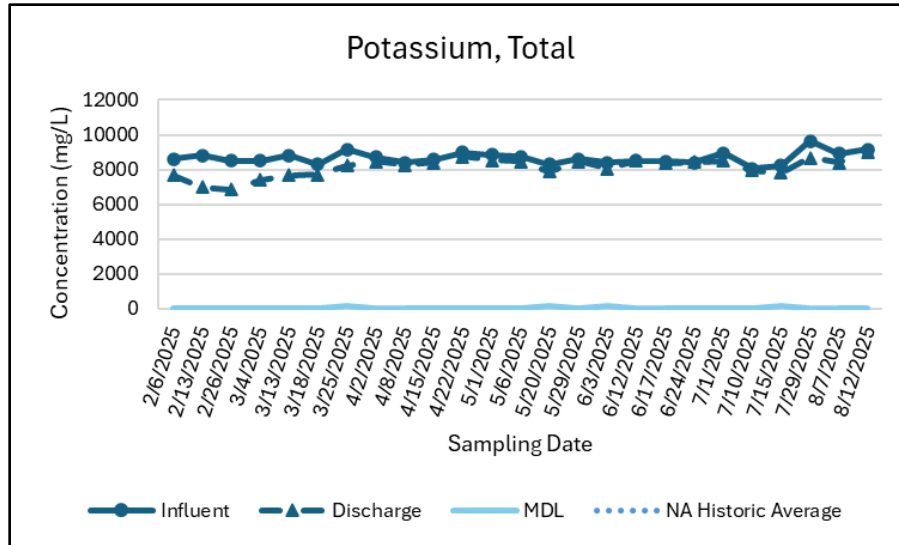


Table 8. Salt Load Comparison of Demonstration Plant Operations and North Arm

Constituent	Influent Average (mg/L)	Influent Load ¹ (lb)	Discharge Average (mg/L)	Discharge Load ² (lb)	Load to North Arm (lb)	North Arm Mass ³ (lb)
Calcium	302	2,750	288	2,720	-30	2,657,315,000
Chloride	181,400	1,652,500	168,400	1,591,900	-60,600	1,598,265,596,000
Magnesium	14,312	130,400	13,480	127,500	-2,900	126,099,103,000
Potassium	8,662	78,900	8,138	76,900	-2,000	76,322,028,000
Sodium	92,920	846,500	86,568	818,500	-28,000	818,692,609,000
Sulfate	24,220	220,600	22,400	211,800	-8,800	213,395,770,000

Definitions: af = acre-feet; lb = pounds; mg/L = milligrams per liter; WSE = water surface elevation

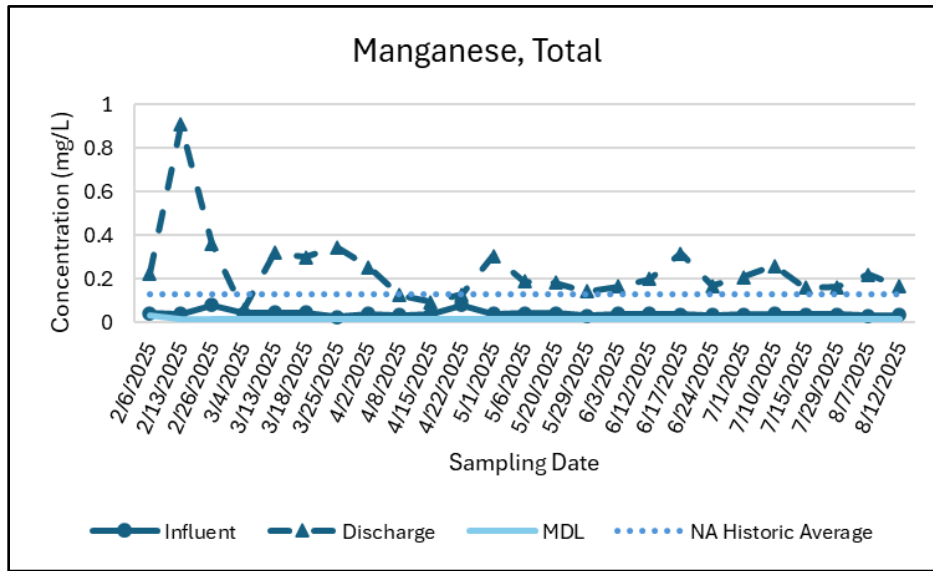
1. Based on a Demonstration Plant total intake volume of 3.35 af
2. Based on a Demonstration Plant total discharge volume of 3.47 af
3. North Arm Mass based on WSE of 4,192 feet and volume of 3,240,000 af with average influent concentrations

In assessing the mass decreases in the North Arm for salt constituents due to the Demonstration Plant's operation, mass decreases are considered by Waterleaf to be *de minimis*.

3.3.5 Manganese

Manganese is identified as a component of the DLE process and is discharged from the Demonstration Plant. This is the only constituent that resulted in higher concentrations in the discharge compared to the influent concentrations because of the DLE process. Figure 4 below shows the results of the weekly influent and discharge compliance sampling for manganese.

Figure 4. Graph of Manganese Influent and Discharge Data



Average discharge concentrations are reported higher than average influent concentrations over the entire duration of the Demonstration Plant's operation, including the start-up and performance run periods.

To help determine impacts to North Arm chemistry due to operation of the Demonstration Plant, the increase of the North Arm manganese mass was reviewed. Demonstration Plant manganese mass load was determined using all the laboratory data during operations (28 weeks). Demonstration Plant mass load was calculated by subtracting average influent concentration and influent volume from average discharge concentrations and discharge volume. North Arm mass was calculated using the average influent concentration and the North Arm volume at a WSE of 4,192 feet. The result indicates that the Demonstration Plant added about 1.88 lb of manganese to the mass in the North Arm, or, in other words, the mass of the North Arm increased by about 0.00052%. This increase in North Arm manganese mass due to the operation of the Demonstration Plant is considered by Waterleaf to be *de minimis*. The mass load comparison for manganese is shown in Table 9.

Table 9. Manganese Load Comparison of Demonstration Plant Operations and North Arm

Constituent	Influent Average (mg/L)	Influent Load ¹ (lb)	Discharge Average (mg/L)	Discharge Load ² (lb)	Load to North Arm (lb)	North Arm Mass ³ (lb)
Manganese	0.0411	0.37	0.2385	2.26	1.88	362,100

Definitions: af = acre-feet; lb = pounds; mg/L = milligrams per liter; WSE = water surface elevation

1. Based on a Demonstration Plant total intake volume of 3.35 af
2. Based on a Demonstration Plant total discharge volume of 3.47 af
3. North Arm Mass based on WSE of 4,192 feet and volume of 3,240,000 af with average influent concentrations

Waterleaf conducted additional data review related to the discharge of manganese. There are no federal or state water quality standards for manganese levels for

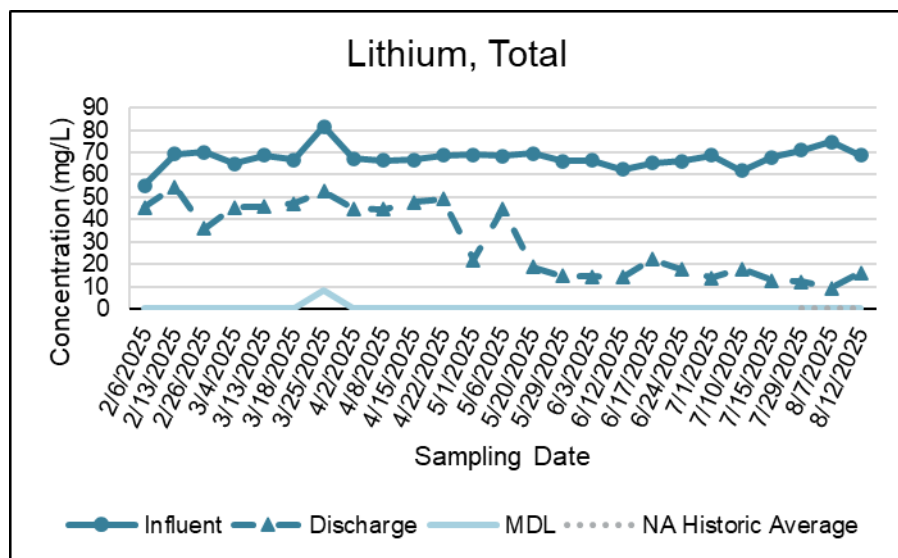
recreational exposures. Manganese is a mineral that exists naturally in the GSL and other freshwater bodies. Federal guidelines are published for dermal exposure to manganese during showering with tap water (drinking water) (HDR 2025). Waterleaf asserts that the manganese in the North Arm and in the depleted brine discharge is in solution and will not precipitate. This review determined that the increase in manganese discharged to the GSL due to the Demonstration Plant was not significant compared to existing standards and guidelines, existing North Arm loads, and protection of existing beneficial uses.

3.3.6 Lithium

Lithium is the targeted mineral for extraction by the Demonstration Plant. As a result, average discharge concentrations are less than average influent concentrations over the entire duration of the Demonstration Plant's operation, including the start-up and performance run periods. The extraction of lithium from the GSL is overseen by UDFSL, and royalties are paid by Waterleaf in accordance with GSL mineral extraction facility rules.

Figure 5 shows the results of the weekly influent and discharge compliance sampling for lithium.

Figure 5. Graph of Lithium Influent and Discharge Data



To help determine impacts to North Arm chemistry due to operation of the Demonstration Plant, the decrease of the North Arm lithium mass was reviewed. Demonstration Plant lithium mass load was determined using all the laboratory data during operations (28 weeks). Demonstration Plant mass load was calculated by subtracting average influent concentration and influent volume from average discharge concentrations and discharge volume. North Arm mass was calculated using the average influent concentration and the North Arm volume at a WSE of 4,192 feet. The result indicates that the Demonstration Plant reduced the North Arm lithium mass by about 326 lb, or, in other words, the mass of the North Arm decreased by about 0.000055%. This decrease in North Arm lithium mass due to the operation of the Demonstration Plant is

considered by Waterleaf to be *de minimis*. The mass load comparison for lithium is shown in Table 10.

Table 10. Lithium Load Comparison of Demonstration Plant Operations and North Arm

Constituent	Influent Average (mg/L)	Influent Load ¹ (lb)	Discharge Average (mg/L)	Discharge Load ² (lb)	Load to North Arm (lb)	North Arm Mass ³ (lb)
Lithium	67.7	617	30.8	291	-326	594,724,000

Definitions: af = acre=feet; lb = pounds; mg/L = milligrams per liter; WSE = water surface elevation

1. Based on a Demonstration Plant total intake volume of 3.35 af
2. Based on a Demonstration Plant total discharge volume of 3.47 af
3. North Arm Mass based on WSE of 4,192 feet and volume of 3,240,000 af with average influent concentrations

3.4 Field Chemistry Results

As identified in Table 1 above, field measurements were taken during the compliance monitoring events for influent and discharge flows. These field measurements are density, dissolved oxygen, pH, and temperature.

Table 11 summarizes the field measurements. Parameter-specific discussions follow the table.

Table 11. Summary of Field Measurements

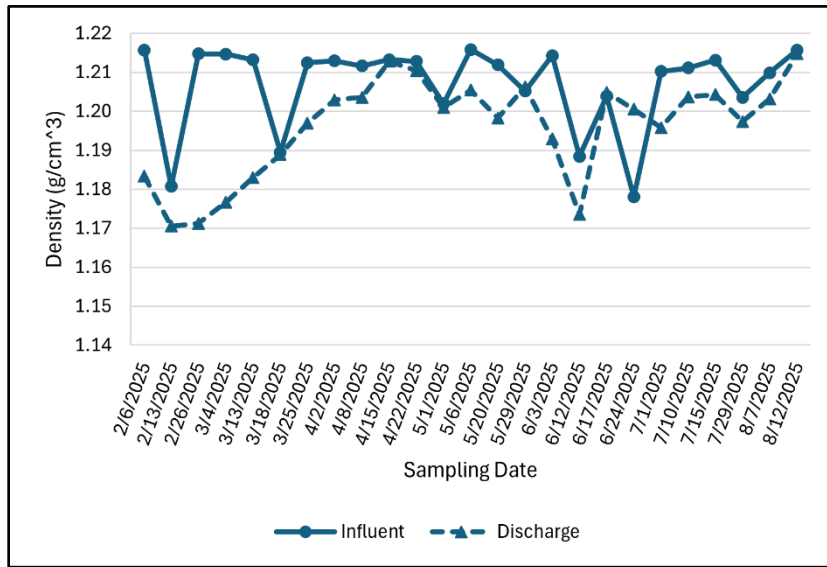
Field Parameter	Influent Average	Discharge Average	UPDES Limit
Density, g/cm ³	1.21	1.20	NA
Dissolved oxygen, mg/L	7.12	6.44	NA
pH	7.52	7.40	6.5–9
Temperature, °C	NA	NA	NA

Definitions: °C = degrees Celsius; g/cm³ = grams per cubic centimeter; mg/L = milligrams per liter; NA = not applicable; UPDES = Utah Pollutant Discharge Elimination System

3.4.1 Density

Influent density was relatively consistent, ranging between 1.21 and 1.22 grams per cubic centimeter (g/cm³). The influent density dipped on several occasions, and these dips were reasoned to be due to environmental conditions, specifically recent rainfall and the shallowness of the intake infrastructure (Figure 6 below).

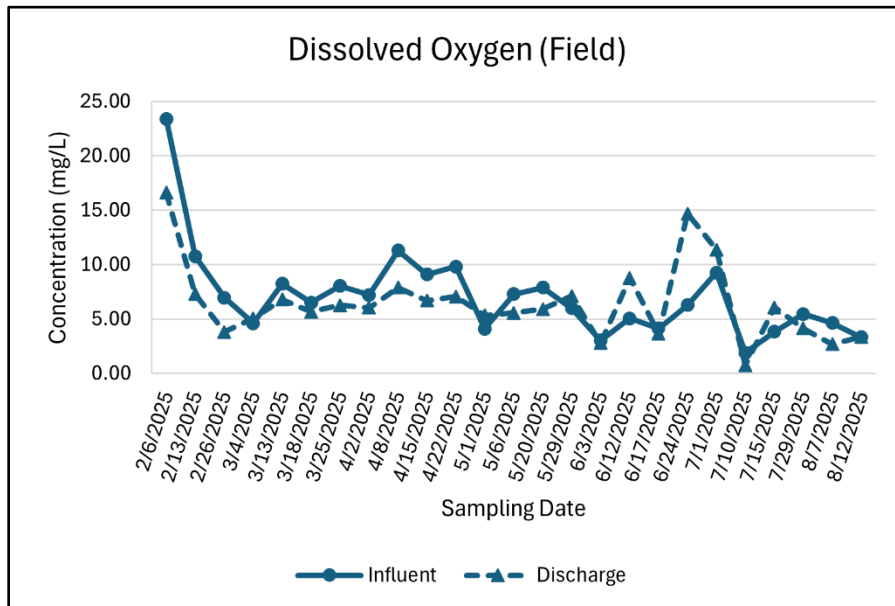
Figure 6. Density Graph



3.4.2 Dissolved Oxygen

Generally, the discharge dissolved oxygen (DO) measurements were less than the influent DO measurements. At the start of the Demonstration Plant's operation, more groundwater than North Arm brine was processed, resulting in higher DO levels (Figure 7).

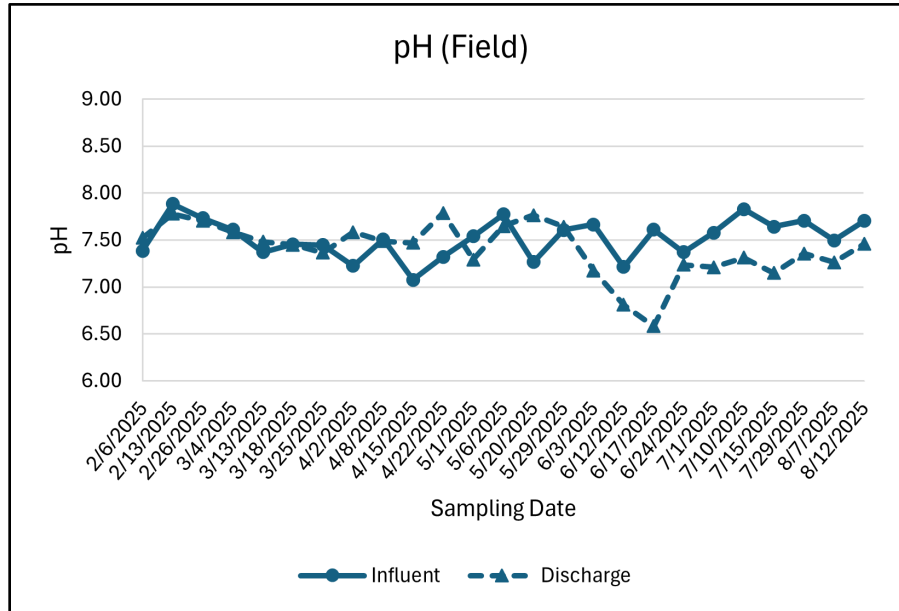
Figure 7. Dissolved Oxygen Graph



3.4.3 pH

Field measurements of pH for both the influent and discharge flows met the UPDES permit limit range of 6.5–9 (Figure 8).

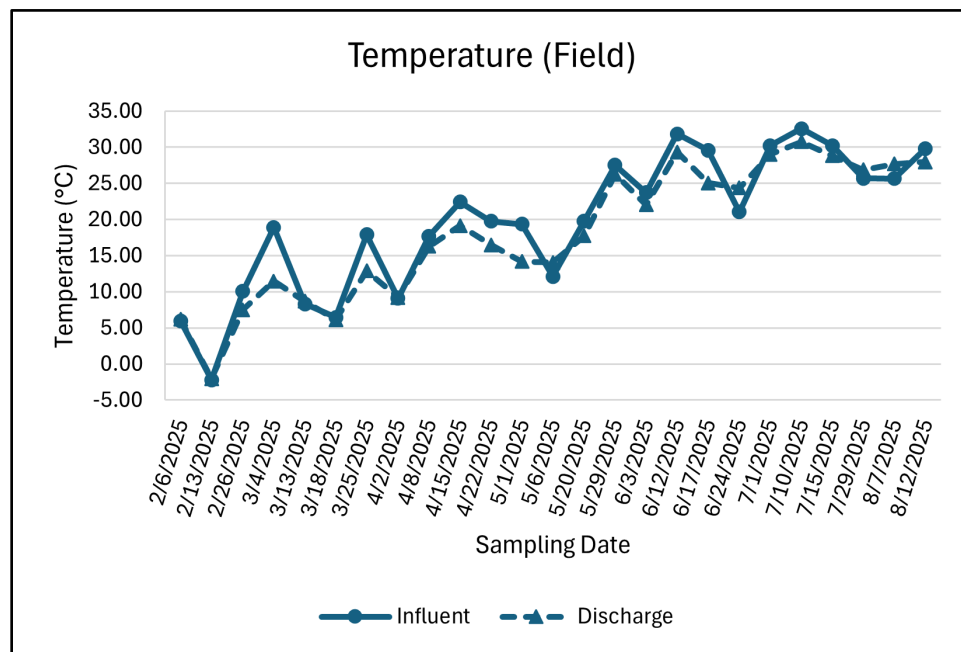
Figure 8. pH Graph



3.4.4 Temperature

Influent and discharge flow temperature measurements rose over the operation of the Demonstration Plant, following the expected seasonal warming of North Arm brine between February and August (Figure 9).

Figure 9. Temperature Graph



3.4.5 Influent and Discharge Water Salinity

HDR collected and reported the density at the intake and outfall locations during the Demonstration Plant's operation. These measurements were taken using an Anton Paar density meter. Per UDWQ rules, the Demonstration Plant cannot negatively alter the salinity of the North Arm of the GSL (UAC R317-16-2(16)(a)).

The GSL's salinity values were calculated using the formula below and documented in Open-File Report 0728, *Standard Operating Procedure – Great Salt Lake Water Density Measurement and Salinity Calculation* (UGS 2020).

$$S = \frac{\left(\sqrt{((1.04708 - (0.00112 * T))^2) - (4 * 0.000314721 * (-(\rho * 1000) + (\rho^0 * 1000) + (0.00199 * T^2) - (1.21061 * T) + 184.01602)))} \right)}{(2 * 0.000314721)}$$

ρ = density of GSL water (g/cm^3) ρ^0 = density of pure water (g/cm^3)
 S = salinity (g/L) T = water temperature ($^\circ\text{K}$)

However, as described in Open-File Report 0728, this salinity calculation is specific to typical South Arm densities, or salinity values up to about 18‰. For salinity values above 18‰, the result “shall be noted as outside the salinity range used to develop the GSL Equation of State” (UGS 2020). In 2023, the U.S. Geological Survey (USGS) published a data release that increased the upper boundary of the GSL salinity equation to 1.214.



Because the North Arm densities exceed this upper boundary, the equation is not validated to calculate North Arm salinity values (USGS 2023). Therefore, the salinity values were not calculated for this report, and Waterleaf compared density values as a surrogate value for salinity. This analysis is provided to support the determination that the Demonstration Project did not negatively alter the salinity (density) of the GSL.

Density profile data are shown in Figure 6 above for the influent and discharge flows for each monitoring event. Table 12 on the following page shows the influent and discharge density values as measured. Waterleaf asserts that the discharge from the Demonstration Plant did not affect the overall density of the North Arm. This is based on (1) the density measurements made and (2) a comparison of the total volume of discharge (3.48 acre-feet [af]) to the total volume of the North Arm of about 3.25 million acre-feet (maf), at an average WSE of 4,192 feet mean sea level during the Demonstration Plant's operation (USGS 2006), as shown in Figure 10 below.

Figure 10. North Arm Volume

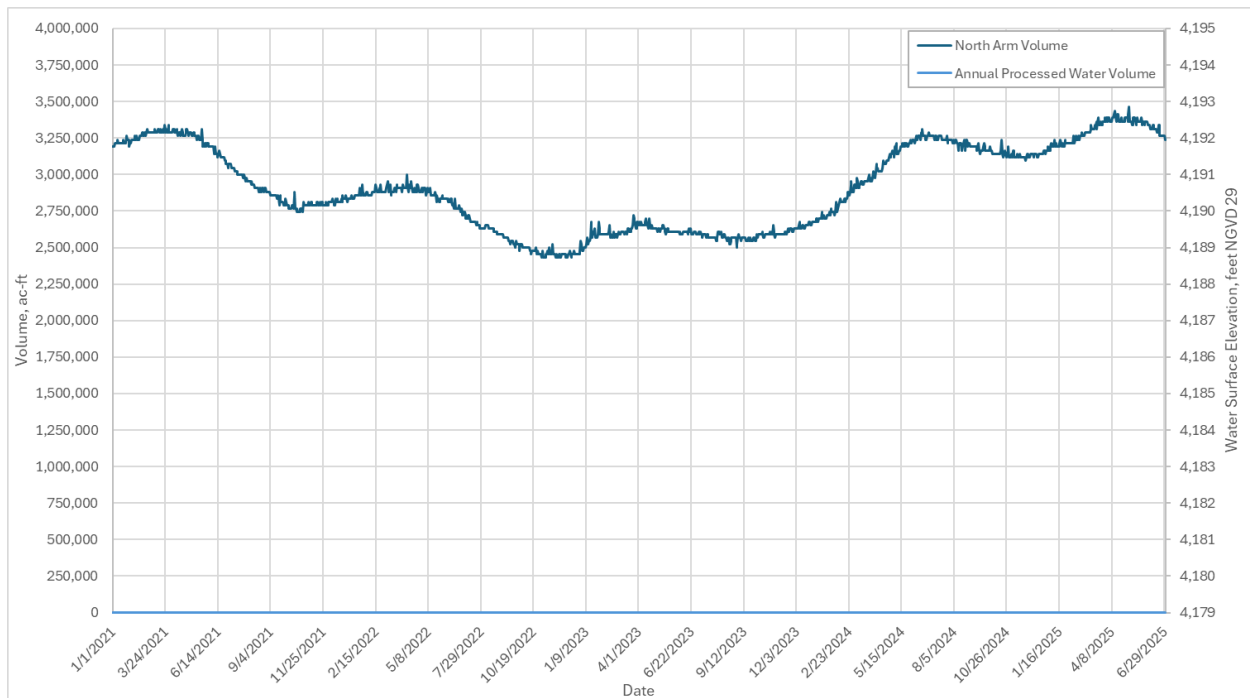


Table 12. Influent and Discharge
Density Results

Date	Influent Density	Discharge Density
2/6/25	1.216	1.183
2/13/25	1.181	1.171
2/20/25	No discharge	
2/26/25	1.215	1.171
3/4/25	1.215	1.177
3/13/25	1.213	1.183
3/18/25	1.190	1.189
3/25/25	1.213	1.197
4/2/25	1.213	1.203
4/8/25	1.212	1.204
4/15/25	1.213	1.213
4/22/25	1.213	1.210
5/1/25	1.202	1.201
5/6/25	1.213	1.205
5/12/25	No discharge	
5/20/25	1.212	1.198
5/29/25	1.205	1.206
6/03/25	1.214	1.193
6/12/25	1.188	1.174
6/17/25	1.204	1.205
6/24/25	1.178	1.201
7/1/25	1.210	1.196
7/10/25	1.211	1.204
7/15/25	1.213	1.204
7/22/25	No discharge	
7/29/25	1.204	1.197
8/7/25	1.210	1.203
8/12/25	1.216	1.215

4 Flow Monitoring Results

In accordance with the UPDES permit requirements, continuous influent and discharge flow monitoring results were used to determine average weekly and monthly maximum and average flows. These data were used to calculate average weekly and annual loads. These flow values were used to calculate monthly volumes for the influent and discharge.

Instantaneous flow monitoring results are documented on weekly field data sheets and were used to determine flow-weighted composite sampling.

In addition, groundwater added to the process was recorded.

4.1 Monthly Volume Results

Continuous flow monitoring during the Demonstration Plant's operation recorded a final influent volume of 3.35 af and a final discharge volume of 3.48 af. Monthly average flows and volumes are shown in Table 13.

Table 13. Demonstration Plant Influent and Discharge Flow Volume

Month	Total Volume (af)	
	Influent	Discharge
February 2025	0.306	0.238
March 2025	0.201	0.237
April 2025	0.662	0.694
May 2025	0.427	0.431
June 2025	0.644	0.627
July 2025	0.730	0.781
August 2025	0.385	0.470
Total	3.355	3.477

Definitions: af = acre-feet

4.2 Total Water Balance

Total water is defined as sum of the brine and externally sourced water (UAC R317-16-2(21)). The Demonstration Plant's total water balance is provided below based on data from the intake and outfall continuous flow meters. The discharge volume includes the flow from the externally sourced groundwater.

- North Arm brine influent volume: 3.355 af
- Externally sourced groundwater: 0.265 af
- Discharge volume to North Arm: 3.477 af

The water balance shows that about 4% of the brine and groundwater flow is not discharged. This residual water was retained in the lithium sulfate product, which is a liquid. The lithium sulfate was shipped off site for further processing into the lithium carbonate equivalent product, which is a powder.

Based on USGS bathymetric and topographic data, the North Arm's volumes at WSEs of 4,190 and 4,198 feet (NVGD 1929) are 2.7 maf and 4.9 maf, respectively (USGS 2006). As of June 25, 2025, the North Arm's WSE was about 4,192.1 feet, and the North Arm had a volume of 3,241,855 af (USGS 2025).

5 Biota Monitoring Results

Three monitoring events were conducted by Dr. Bonnie Baxter of Westminster University during the Demonstration Plant's operation (Baxter 2025). By design, the first monitoring event occurred during the first month of operation, and the second monitoring event occurred 2 months later. The third monitoring event was added during the summer as the algae community began to grow as a result of the warmer brine temperatures. The first monitoring event occurred on February 28, 2025, during week 4 of operation; the second on April 24, 2025, during week 12 of operation; and the third on June 23, 2025, during week 21 of operation. The study design captured seasonal biota presence in the North Arm and the plant's discharge during its operation. This section summarizes the biota monitoring report, which is provided as Appendix C, *Biota Monitoring Report*.

In summary, North Arm biota were present in both the influent and discharge flows collected during all monitoring events, and the abundance and diversity of biota in the samples varied seasonally, as anticipated. The growth rates of biota in the influent, discharge, and mixed samples were similar. The study provides evidence that the Demonstration Plant's DLE process does not harm North Arm biota.

5.1 Presence of Biota

A hemacytometer (which provides a grid and special cover glass to control the distributed volume) was used to estimate the cell density in each of the influent and discharge samples. The results are shown in Table 14. The first samples, from February, demonstrated a robust cell density in the influent sample, but the discharge sample (with observed rust flakes) had few if any visible cells. The April samples had comparable numbers of cells in the discharge as in the influent, and the cells-per-milliliter counts were in the billions. The June samples had more cells in the influent than in the discharge. This decrease is mostly due to the presence of algae (which was not present in February and April) in the influent and reduced numbers in the discharge due to filtration. By comparing influent and discharge samples, this analysis provides evidence that the Demonstration Plant's DLE process does not reduce biota cell count for archaea, bacteria, or fungi; algae reductions, when they occurred, were due to filtration.

Table 14. Biota Cell Counts and Dry Weight

Month	Number of Cells Observed via Hemacytometer (cells per mL)		Dry Weight of Biota (g/L)	
	Influent	Discharge	Influent	Discharge
February 2025	2.8×10^8	None observed ¹	Not analyzed	
April 2025	3.6×10^9	4.6×10^9	3.7	4.5
June 2025	8.1×10^9	5.3×10^9	5.2	4.2

Definitions: g/L = grams per liter; mL = milliliters

- Although no cells were observed using the hemacytometer, DNA sequencing revealed the presence and abundance of archaea, bacteria, and fungi in the discharge sample.

5.2 Biota Diversity

To document the species of biota that are present in both the influent and discharge flows, a consulting laboratory was contracted for DNA sequencing. The laboratory amplified DNA genes (16S rRNA, 18S rRNA, or ITS) associated with bacteria, archaea, algae, or fungi. The DNA is very specific to communities that might be present in North Arm brine. For the February and April monitoring events, archaea, bacteria, and fungi were present and abundant, but algae was not present. This is to be expected because the colder temperatures of North Arm brine in February and April do not support algae communities. Algae communities were observed in samples from the June monitoring event.

This analysis provides the relative abundance of the specific biota. It is important to note that the abundance is relative to other species in the influent or discharge samples, but no comparison of the influent to the discharge is valid. The abundance of archaea, bacteria, and fungi for the April monitoring event is shown in Figure 11. The abundance of archaea and bacteria (prokaryotes) and algae (eukaryotes) for the June monitoring event is shown in Figure 12.

By comparing influent and discharge (effluent) flow samples, this analysis provides evidence that the Demonstration Plant's DLE process does not reduce biota cell diversity in the North Arm of the GSL for archaea, bacteria, and fungi species. These biota are not affected by the DLE processes, including filtration, due to the small size (1–2 microns) of the individual organisms. When algae species are present during the warm summer months, the number of species is reduced by the filtration process due to the larger size (10–20 microns) of the individual organisms.

Figure 11. April 2025 Biota Abundance Graphs

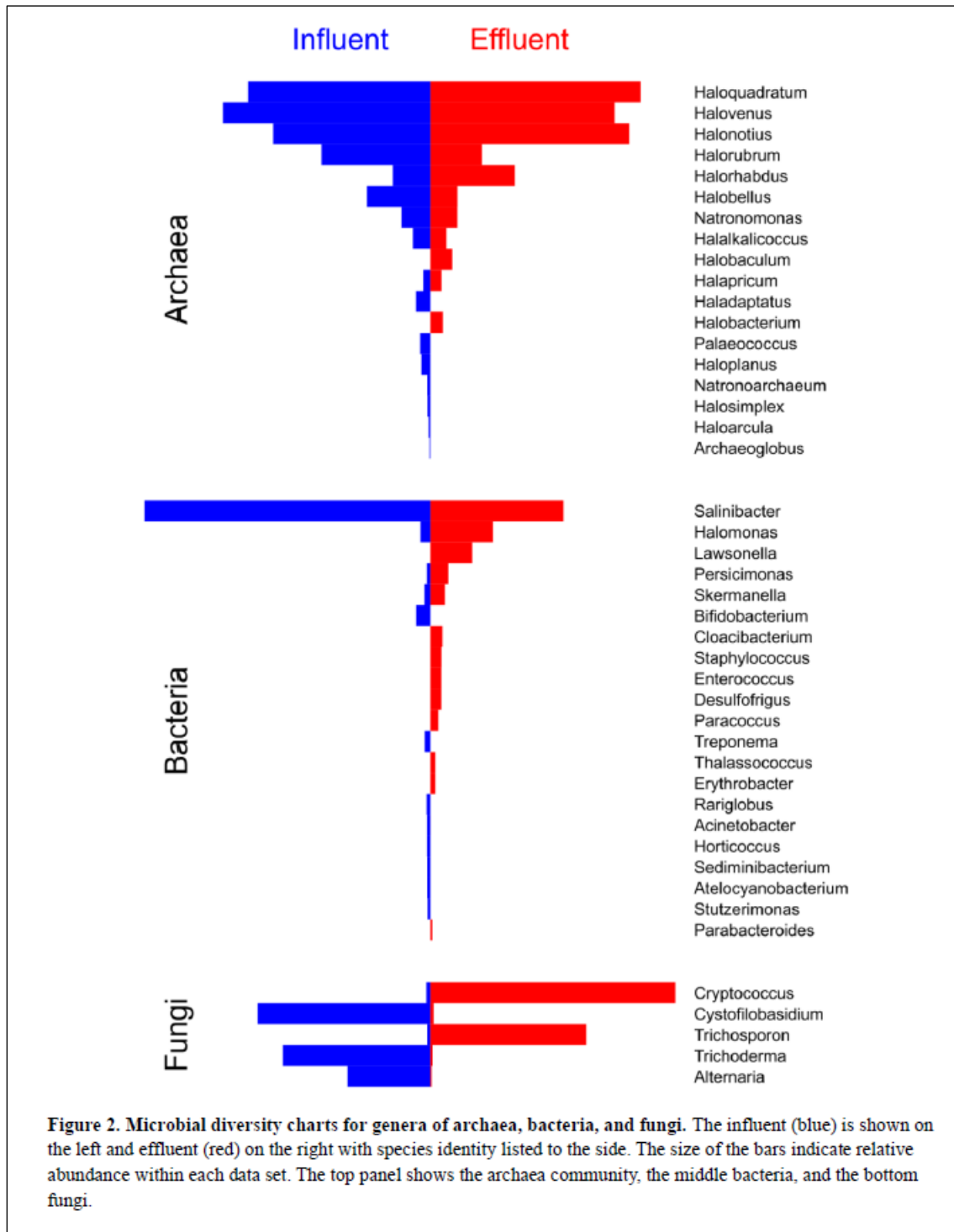
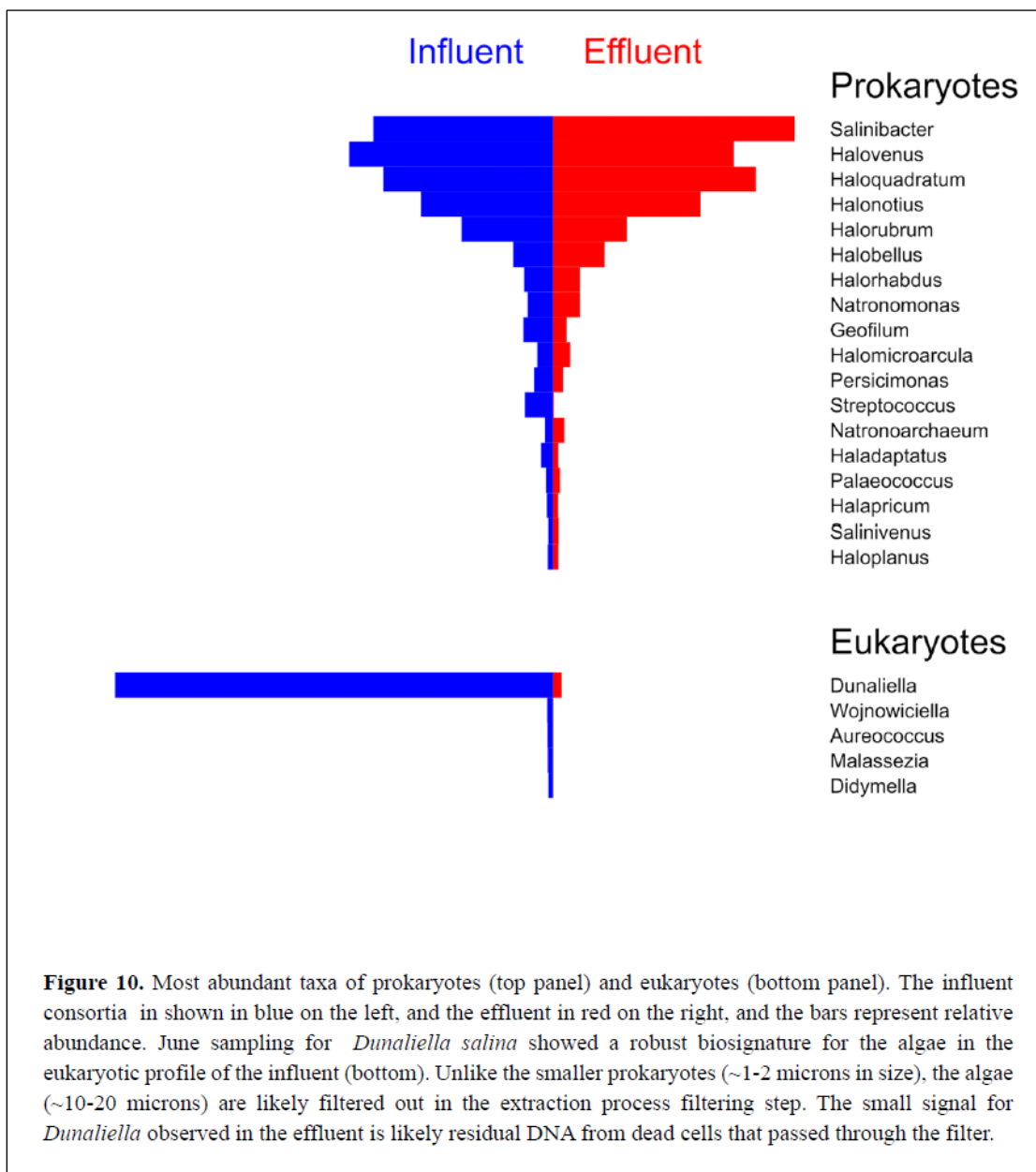


Figure 12. June 2025 Biota Abundance Graphs

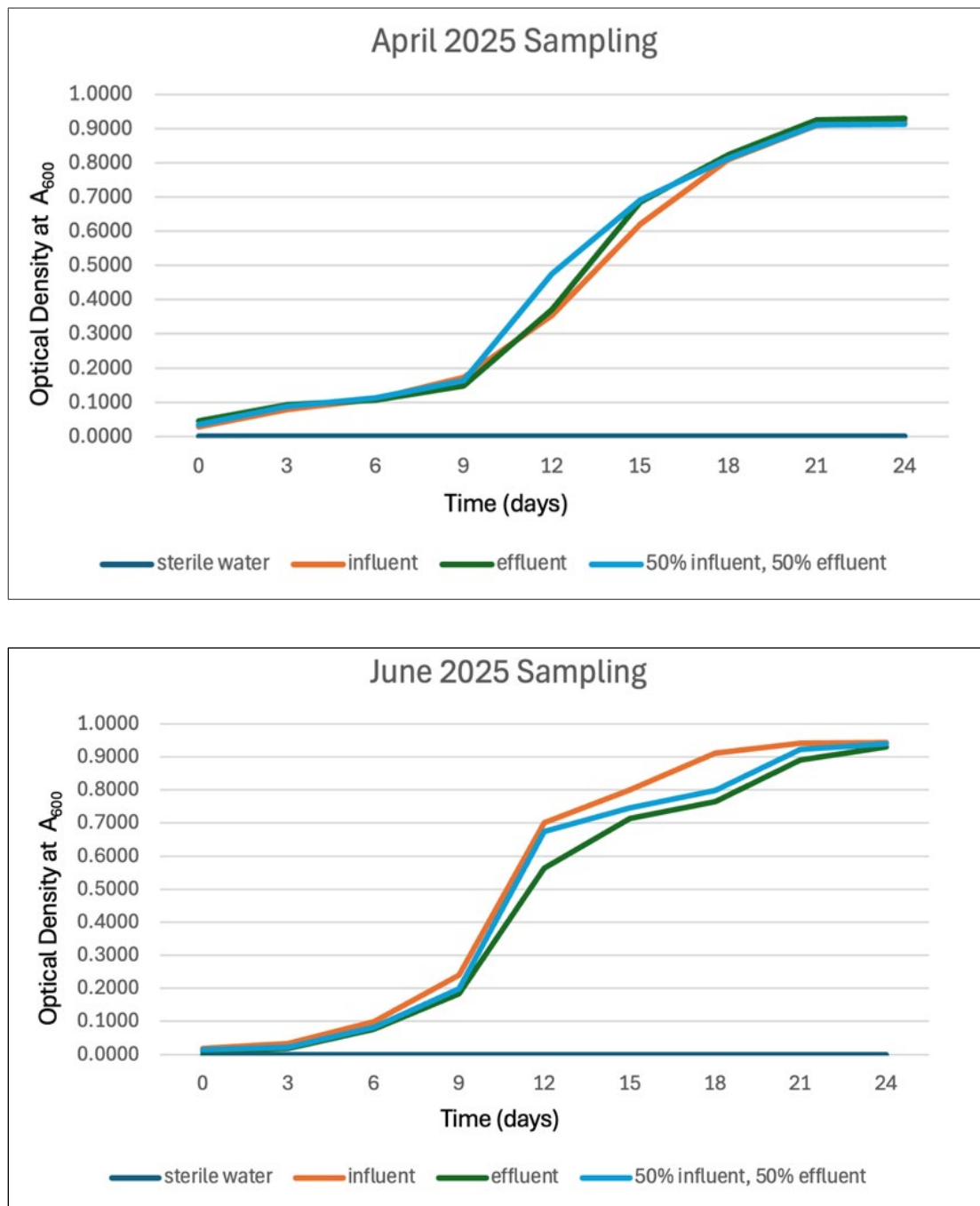


5.3 Biota Growth in Discharge

To understand the effects of discharges into the North Arm on biota growth, a time course growth experiment was conducted on influent, discharge, or a mix of the influent and discharge (representing North Arm brine after discharge). The protocol that was used consisted of inoculating 9 milliliters (mL) of 23% salt modified growth media (Dyall-Smith 2009) with 1 mL of sample. The inoculated samples consisted of (1) sterile deionized water serving as a control, (2) influent flow, (3) discharge (effluent) flow, and (4) a 50:50 mix of influent and discharge, which represents the in-lake mixture of discharge and brine.

Figure 13 shows the growth curves of the samples collected during the April and June monitoring events. All samples follow a standard growth curve. The microbial communities appear to have reached a stationary growth phase over this period of study. This is expected of healthy cultures. Also note that the sample representing the North Arm brine mixed with the discharge flow did not visibly affect growth of the biota. By comparing influent, discharge, and mixture sample results, this analysis provides evidence that the Demonstration Plant's DLE process does not prevent biota cell growth in the North Arm of the GSL.

Figure 13. April and June 2025 Biota Growth Results



6 Evaluation of No Negative Impact on the GSL from Demonstration Plant Operation

Waterleaf evaluated the results of the chemistry and biota analyses to determine whether negative impacts on the North Arm's chemistry and biota occurred during the operation of the Demonstration Plant.

Negative impact is defined by UDWQ R317-16-16 to include the following evaluation criteria:

Negative impact includes any activity or action that:

- Causes pollution, or negatively alters the salinity or other aspects of water chemistry in Great Salt Lake;
- Negatively alters the volume or timing of water flows to Great Salt Lake, or water levels in Great Salt Lake or Great Salt Lake wetlands;
- Reduces, degrades, or otherwise negatively alters habitat in and around Great Salt Lake; or
- Results in harmful physiological impacts to Great Salt Lake biota, including disruptions to survival, reproduction, or growth.

Waterleaf asserts no negative impacts on the North Arm of the GSL based on the above criteria. These evaluation criteria are discussed below.

6.1 Impacts on North Arm Salinity or Water Quality Chemistry

Waterleaf asserts that there were no negative impacts on North Arm salinity or water quality chemistry from operation of the Demonstration Plant, based on the results, analysis and review provided in Section 3.3, *Chemistry Monitoring Results Discussion and Graphs*. This assertion is based on the following:

- Compliance monitoring met the requirements of the UPDES permit for protecting the beneficial uses of the North Arm of the GSL. No water quality standards were exceeded.
- The incremental decrease in volume discharged (0.142 af; influent and groundwater volume subtracted from discharge volume) compared to the total volume of the North Arm of the GSL (3.24 maf) indicates that the Demonstration Plant's retained volume is *de minimis* and would not impact North Arm salinity or water quality.
- The Demonstration Plant's operation was temporary (7 months).
- The results of the compliance monitoring analysis, comparing average discharge concentrations to average influent concentrations and MDLs, uncertainty and error consideration, association of specific monitoring results due to operational phases, comparison of the mass load to the North Arm from Demonstration Plant operations to existing North Arm mass loads, and results of the biota monitoring study provide evidence that the Demonstration Plant did not harm North Arm water quality.

- Manganese, a component of the DLE process, had higher average discharge concentrations compared to the average influent concentrations. Examination of federal and state standards for lake recreational contact revealed that no standards or guidelines exist. Discharge concentrations are well below federal guidelines for dermal exposure due to showering in drinking water.
- The density of the North Arm discharge did not vary significantly from the density of the influent. This data shows that the density (salinity) of the North Arm was not changed due to the operation of the Demonstration Plant.

6.2 Impacts on North Arm Volume, Flows, or Water Levels

Waterleaf asserts that there were no negative impacts on North Arm volume, flows, or water levels from operation of the Demonstration Plant. This assertion is based on continuous flow monitoring data collected during operation of the Demonstration Plant. The flow monitoring data documented that the influent and discharge flows were comparable during operation. The Demonstration Plant diverted raw brine directly from the open waters of the GSL and discharged depleted brine back to the open waters of the GSL. The processing time from when the raw brine was diverted to when the depleted brine was discharged was less than 8 hours. The Demonstration Plant did not divert any surface water flows for its operation.

The results of the flow monitoring events are summarized in Section 4, *Flow Monitoring Results*.

Based on the Demonstration Plant's flow monitoring and the final water balance, the volume of North Arm raw brine diverted and groundwater added was documented to be discharged back to the North Arm, less water lost to processing the product. The amount of water (about 0.142 af) used to produce the liquid product is considered by Waterleaf to be *de minimis* compared to the 3.24 maf in the North Arm (at a WSE of 4,192 feet). Because no surface waters were diverted, the Demonstration Plant did not alter the timing of water flows to the North Arm of the GSL.

Waterleaf asserts that the Demonstration Plant did not alter the volume or timing of water flows to the GSL or the water levels in the GSL or GSL wetlands.

6.3 Impacts on North Arm Habitat

Waterleaf asserts that there were no negative impacts on North Arm habitat. This assertion is based on evaluating the presence of microbialites that could be present or could grow in and along the open waters of the GSL. Based on the survey conducted on the intake and outfall pipe easements before construction of the Demonstration Plant, no microbialite structures were identified (HDR 2024).

Therefore, Waterleaf asserts that the Demonstration Plant did not reduce, degrade, or otherwise negatively alter habitat in and around the North Arm of the GSL.

6.4 Impacts on North Arm Biota

To evaluate impacts on North Arm biota, Waterleaf contracted with Dr. Bonnie Baxter of Westminster University to conduct biota monitoring during operation of the Demonstration Plant (Baxter 2025). The biota monitoring documented the presence and abundance of biota (archaea, bacteria, algae, and fungi) in the influent to and the discharge from the Demonstration Plant during its operation. The study also investigated whether biota could reproduce and grow in the discharge water from the Demonstration Plant.

The results of the biota analyses are summarized in Section 5, *Biota Monitoring Results*, and the complete report is provided as Appendix C, *Biota Monitoring Report*.

Based on the biota monitoring study and results, North Arm biota were documented to be present and abundant in the raw brine influent and Demonstration Plant discharge water during its operation. Biota were also documented to grow and reproduce in the discharge water from the Demonstration Plant. Therefore, Waterleaf asserts that the Demonstration Plant did not disrupt survival, reproduction, or growth of North Arm biota (archaea, algae, bacteria, and fungi) and did not have a negative impact on the biota of the North Arm of the GSL.

7 References

Baxter, Dr. Bonnie

2025 Waterleaf GSL Demonstration Plant Biota Monitoring Report. June 23, 2025.

Dyall-Smith, Mike

2009 The Halohandbook: Protocols for Haloarchaeal Genetics. https://haloarchaea.com/wp-content/uploads/2025/02/Halohandbook_2009_REV_v2.pdf. Version 7.2. March.

HDR, Inc.

2023 Characterization of North Arm, Great Salt Lake. August 9.

2024 Microbialite Preconstruction Survey. July.

2025 Manganese Risk Evaluation Memo.

[UDWQ] Utah Division of Water Quality

2025a Utah Pollutant Discharge Elimination System Permit No. UT0026280. February 4.

2025b Email from L. Shull, UDWQ, to N. Nichols, HDR. September 24.

[UGS] Utah Geological Survey

2020 Standard Operating Procedure – Great Salt Lake Water Density Measurement and Salinity Calculation. Open-File Report 0728. June.

2025 Estimates of Lithium, Magnesium and Potassium Resources in Great Salt Lake Brine. Open-File Report 769.

[USGS] U.S. Geological Survey

2006 Calculation of Area and Volume for the North Part of Great Salt Lake, Utah. December.

2023 Density and Salinity Data to Validate an Equation of State for Hypersaline Water in Great Salt Lake, Utah, 2021–2022. November 13.

2025 Great Salt Lake Hydro Mapper [website]. <https://webapps.usgs.gov/gsl/data.html>. Accessed June 25, 2025.

[Waterleaf] Waterleaf Resources

2025a Data Quality Objectives Memo. May 9.

2025b Great Salt Lake Lithium Feasibility Project – Final Report. **October**

APPENDIX A

UPDES Permit

STATE OF UTAH
DIVISION OF WATER QUALITY
DEPARTMENT OF ENVIRONMENTAL QUALITY
SALT LAKE CITY, UTAH

UTAH POLLUTANT DISCHARGE ELIMINATION SYSTEM (UPDES) PERMITS

Minor Industrial Permit No. **UT0026280**

In compliance with provisions of the Utah *Water Quality Act, Title 19, Chapter 5, Utah Code* (the “Act”),

WATERLEAF RESOURCES, LLC (Permittee),

is hereby authorized to discharge from

GREAT SALT LAKE LITHIUM PROJECT (Facility),

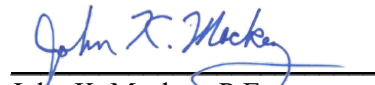
to receiving waters named **GUNNISON BAY, THE GREAT SALT LAKE,**

in accordance with specific limitations, outfalls, and other conditions set forth herein.

This permit shall become effective on **February 4th, 2025.**

This permit expires at midnight on **February 4th, 2028.**

Signed this **fourth day of February 2025.**



John K. Mackey, P.E.
Director

DWQ-2024-000479

Table of Contents

<u>Outline</u>	<u>Page Number</u>
I. DISCHARGE LIMITATIONS AND REPORTING REQUIREMENTS.....	1
A. Description of Discharge Points.....	1
B. Narrative Standard.....	1
C. Specific Limitations and Self-Monitoring Requirements	1
D. Reporting of Monitoring Results.....	4
II. PRETREATMENT REQUIREMENTS.....	5
III. BIOSOLIDS REQUIREMENTS	8
A. Biosolids Treatment and Disposal.....	8
IV. STORM WATER REQUIREMENTS.....	9
V. MONITORING, RECORDING & GENERAL REPORTING REQUIREMENTS.....	10
A. Representative Sampling	10
B. Monitoring Procedures.....	10
C. Penalties for Tampering.....	10
D. Compliance Schedules.....	10
E. Additional Monitoring by the Permittee.....	10
F. Records Contents	10
G. Retention of Records	10
H. Twenty-four Hour Notice of Noncompliance Reporting.....	10
I. Other Noncompliance Reporting	11
J. Inspection and Entry	12
VI. COMPLIANCE RESPONSIBILITIES	13
A. Duty to Comply	13
B. Penalties for Violations of Permit Conditions.....	13
C. Need to Halt or Reduce Activity not a Defense	13
D. Duty to Mitigate	13
E. Proper Operation and Maintenance.....	13
F. Removed Substances.....	13
G. Bypass of Treatment Facilities.....	13
H. Upset Conditions	15
I. Toxic Pollutants	15
J. Changes in Discharge of Toxic Substances.....	15
VII. GENERAL REQUIREMENTS	17
A. Planned Changes	17
B. Anticipated Noncompliance	17
C. Permit Actions.....	17
D. Duty to Reapply.....	17
E. Duty to Provide Information.....	17
F. Other Information	17
G. Signatory Requirements.....	17
H. Penalties for Falsification of Reports.....	19
I. Availability of Reports	19
J. Oil and Hazardous Substance Liability.....	19
K. Property Rights.....	19
L. Severability.....	19
M. Transfers.....	19
N. State or Federal Laws	19
O. Water Quality - Reopener Provision.....	20
P. Biosolids – Reopener Provision.....	Error! Bookmark not defined.
Q. Toxicity Limitation - Reopener Provision	20

VIII. DEFINITIONS	21
A. Wastewater.....	21

PART I
DISCHARGE PERMIT NO. UT0026280
WASTEWATER

I. DISCHARGE LIMITATIONS AND REPORTING REQUIREMENTS

- A. Description of Discharge Points. The authorization to discharge wastewater provided under this part is limited to those outfalls specifically designated below as discharge locations. Discharges at any location not authorized under a UPDES permit are violations of the *Act* and may be subject to penalties under the *Act*. Knowingly discharging from an unauthorized location or failing to report an unauthorized discharge may be subject to criminal penalties as provided under the *Act*.

Outfall Number
001

Location of Discharge Outfall
Discharge to Gunnison Bay, Great Salt Lake.
Located at latitude 41° 26' 44.16" and longitude
112° 41' 36.04".

- B. Narrative Standard. It shall be a violation of this permit, for Permittee to discharge effluent or place any waste, pollutant, or other substance into Waters of the State in such a way as will be or may become offensive such as unnatural deposits, floating debris, oil, scum, or other nuisances such as color, odor or taste, or cause conditions which produce undesirable aquatic life, objectionable tastes in edible aquatic organisms; or result in concentrations or combinations of substances which produce undesirable physiological responses in desirable resident fish, or other desirable aquatic life, or undesirable human health effects, as determined by a bioassay or other tests performed in accordance with standard procedures.

C. Specific Limitations and Self-Monitoring Requirements.

1. Effective immediately, and lasting through the life of this permit, there shall be no acute or chronic toxicity in Outfall 001 as defined in *Part VIII*.
2. Discharge Limitations and Reporting Requirements:
 - a. The limitations specified in this section shall be applied on a net basis, unless otherwise noted, if the source of the applicant's water supply is the same body of water into which the discharge is made. With the exception of calcium, there shall be no discharge of process wastewater pollutants into navigable waters. See Fact Sheet Statement of Basis for more information.
 - b. Permittee must notify the Division of Water Quality (DWQ) fourteen (14) days prior to discharge. From the date the Permittee begins discharge, Permittee will be authorized to discharge from Outfall 001 for twelve (12) consecutive months only.
 - c. Such discharges shall be limited and monitored by the Permittee as specified below:

Parameter	Effluent Limitations *a				
	Maximum Weekly Avg	Annual Load	Weekly Load	Daily Minimum	Daily Maximum
Total Flow *b, *c, *d Demonstration Plant	0.06	--	--	--	0.12
Temperature *d	Report	--	--	--	Report
pH, Standard Units	--	--	--	6.5	9
Oil & Grease	--	--	--	--	10.0
Total Alkalinity, *d	Report	--	--	--	Report
Total Dissolved Solids *d	Report	--	--	--	Report
Total Suspended Solids *d	Report	--	--	--	Report

PART I
DISCHARGE PERMIT NO. UT0026280
WASTEWATER

Sulfate *d	Report	--	--	--	Report
Nitrate *d	Report	--	--	--	Report
Nitrite *d	Report	--	--	--	Report
Carbonate *d	Report	--	--	--	Report
Hydroxide *d	Report	--	--	--	Report
Chemical Oxygen Demand *d	Report	--	--	--	Report
Biological Oxygen Demand *d	Report	--	--	--	Report
Silica *d	Report	--	--	--	Report
Sodium *d	Report	--	--	--	Report
Calcium *d *e	Report	--	--	--	Report
Potassium *d	Report	--	--	--	Report
Boron *d	Report	--	--	--	Report
Bromine *d	Report	--	--	--	Report
Silicon *d	Report	--	--	--	Report
Total Lithium *d	Report	--	--	--	Report
Total Arsenic *d, *f	--	*g	*h	--	--
Total Cadmium *d, *f	--	*g	*h	--	--
Total Chromium *d, *f	--	*g	*h	--	--
Total Copper *d, *f	--	*g	*h	--	--
Total Lead *d, *f	--	*g	*h	--	--
Total Molybdenum *d, *f	--	*g	*h	--	--
Total Nickel *d, *f	--	*g	*h	--	--
Total Selenium *d, *f	--	*g	*h	--	--
Total Silver *d, *f	--	*g	*h	--	--
Total Zinc *d, *f	--	*g	*h	--	--
Total Cyanide *d, *f	--	*g	*h	--	--
Total Mercury *d, *f	--	*g	*h	--	--

Self-Monitoring and Reporting Requirements *a			
Parameter	Frequency	Sample Type	Units
Total Flow *b, *c, *d	Continuous	Recorder	MGD
pH	Weekly	Instantaneous	SU
DO	Weekly	Instantaneous	mg/L
Temperature *d	Weekly	Instantaneous	mg/L
Oil & Grease *i	Weekly	Grab	mg/L
Total Alkalinity, *d	Weekly	Composite	mg/L
Total Dissolved Solids *d	Weekly	Composite	mg/L
Total Suspended Solids *d	Weekly	Composite	mg/L
Sulfate *d	Weekly	Composite	mg/L
Nitrate *d	Weekly	Composite	mg/L
Nitrite *d	Weekly	Composite	mg/L
Carbonate *d	Weekly	Composite	mg/L
Hydroxide *d	Weekly	Composite	mg/L
Chemical Oxygen Demand *d	Weekly	Composite	mg/L
Biological Oxygen Demand *d	Weekly	Composite	mg/L
Silica *d	Weekly	Composite	mg/L
Sodium *d	Weekly	Composite	mg/L
Calcium *d, *e	Weekly	Composite	mg/L
Potassium *d	Weekly	Composite	mg/L
Boron *d	Weekly	Composite	mg/L

PART I
DISCHARGE PERMIT NO. UT0026280
WASTEWATER

Bromine *d	Weekly	Composite	mg/L
Silicon *d	Weekly	Composite	mg/L
Total Lithium *d	Weekly	Composite	mg/L
Total Arsenic	Weekly	Composite	mg/L, kg/day
Total Cadmium	Weekly	Composite	mg/L, kg/day
Total Chromium	Weekly	Composite	mg/L, kg/day
Total Copper	Weekly	Composite	mg/L, kg/day
Total Lead	Weekly	Composite	mg/L, kg/day
Total Molybdenum	Weekly	Composite	mg/L, kg/day
Total Nickel	Weekly	Composite	mg/L, kg/day
Total Selenium	Weekly	Composite	mg/L, kg/day
Total Silver	Weekly	Composite	mg/L, kg/day
Total Zinc	Weekly	Composite	mg/L, kg/day
Total Cyanide	Weekly	Composite	mg/L, kg/day
Total Arsenic	Yearly	Composite	kg/year
Total Cadmium	Yearly	Composite	kg/year
Total Chromium	Yearly	Composite	kg/year
Total Copper	Yearly	Composite	kg/year
Total Lead	Yearly	Composite	kg/year
Total Molybdenum	Yearly	Composite	kg/year
Total Nickel	Yearly	Composite	kg/year
Total Selenium	Yearly	Composite	kg/year
Total Silver	Yearly	Composite	kg/year
Total Zinc	Yearly	Composite	kg/year
Total Cyanide	Yearly	Composite	kg/year

*a See Definitions, *Part VIII*, for definition of terms.

*b Flow measurements of influent/effluent volume shall be made in such a manner that Permittee can affirmatively demonstrate that representative values are being obtained.

*c If the rate of discharge is controlled, the rate and duration of discharge shall be reported.

*d In addition to monitoring the final discharge, influent samples shall be taken and analyzed for this constituent at the same frequency as required for this constituent in the discharge.

*e Discharge of calcium is allowed as a process wastewater pollutant. See Fact Sheet Statement of Basis for more information.

*f The minimum detection limit (MDL) of the test method used for analysis must be below this limit in mg/L. If a test method is not available, Permittee must submit documentation to the Director regarding the method that will be used. Total Arsenic 0.180 mg/L, Total Cadmium 0.0052 mg/L, Total Chromium 0.0166 mg/L, Total Copper 0.067 mg/L, Total Lead 0.0465 mg/L, Total Molybdenum NA, Total Nickel 0.376 mg/L, Total Selenium 0.0079 mg/L, Total Silver 0.0899 mg/L, Total Zinc 0.675 mg/L, Total Cyanide 0.0093 mg/L, Total Mercury 0.000022 mg/L.

*g The average annual load for this parameter in the final discharge shall not exceed +10% of the load in the intake water as reported in kg/year.

*h The average weekly load for this parameter in the final discharge shall not exceed +10% of the load in the intake water as reported in kg/day.

*i Oil & Grease sampled when sheen is present or visible. If no sheen is present or visible, report NA.

d. As authorized in Part VII.E.:

(1) Permittee shall establish laboratory quality performance for the Great Salt Lake North Arm matrix as soon as possible, and present and review the laboratory quality performance with the Director.

(a) Based on the laboratory quality performance, Permittee shall work with the Director to define suitable data quality objectives for the Demonstration Plant, that evidence protection of Great Salt Lake

PART I
DISCHARGE PERMIT NO. UT0026280
WASTEWATER

chemistry and biota. Following the work with the Director, Permittee shall formalize the recommended data quality objectives, in writing, and submit to the Director prior to completion of testing at the Demonstration Plant.

- (2) Permittee shall submit a Level IV data quality package with each compliance sample.
- (3) Permittee shall coordinate with DWQ on the collection and delivery of a split sample for each compliance sample taken. Permittee shall handle and deliver split samples using proper chain of custody procedures as described in 40 C.F.R. § 136.

D. Reporting of Monitoring Results.

- 1. Reporting of Wastewater Monitoring Results Monitoring results obtained by the Permittee during the previous month shall be summarized for each month and reported to DWQ on a Discharge Monitoring Report Form (EPA No. 3320-1) * or by NetDMR, post-marked or entered into NetDMR no later than 28 days after the last day of the reporting period. The first report is due on **March 28, 2025**. If no discharge occurs during the reporting period, “no discharge” shall be reported. Legible copies of these, and all other reports including whole effluent toxicity (WET) test reports required herein, shall be signed and certified in accordance with the requirements of *Signatory Requirements (see Part VII.G)*, and submitted by NetDMR, or to the Division of Water Quality at the following address:

Department of Environmental Quality
Division of Water Quality
PO Box 144870
Salt Lake City, Utah 84114-4870

* Starting January 1, 2017 monitoring results must be submitted using NetDMR unless Permittee has successfully petitioned for an exception.

PART II
DISCHARGE PERMIT NO. UT0026280
PRETREATMENT

II. PRETREATMENT REQUIREMENTS

A. Definitions. For this section, the following definitions shall apply:

1. *Indirect Discharge* means the introduction of pollutants into a publicly-owned treatment works (POTW) from any non-domestic source regulated under section 307 (b), (c) or (d) of the CWA.
2. *Interference* means a discharge which, alone or in conjunction with a discharge or discharges from other sources, both:
 - a. Inhibits or disrupts the POTW, its treatment processes or operations, or its sludge processes, use or disposal; and
 - b. Therefore is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation) or of the prevention of sewage sludge use or disposal in compliance with the following statutory provisions and regulations or permits issued thereunder (or more stringent State or local regulations): Section 405 of the Clean Water Act, the Solid Waste Disposal Act (SWDA) (including title II, more commonly referred to as the Resource Conservation and Recovery Act (RCRA), and including State regulations contained in any State sludge management plan prepared pursuant to subtitle D of the SWDA), the Clean Air Act, the Toxic Substances Control Act, and the Marine Protection, Research and Sanctuaries Act.
3. *Pass Through means* a Discharge which exits the POTW into waters of the United States in quantities or concentrations which, alone or in conjunction with a discharge or discharges from other sources, is a cause of a violation of any requirement of the POTW's NPDES permit (including an increase in the magnitude or duration of a violation).
4. *Publicly Owned Treatment Works or POTW* means a treatment works, as defined by section 212 of the CWA, which is owned by a State or municipality (as defined by section 502(4) of the CWA). This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes sewers, pipes and other conveyances only if they convey wastewater to a POTW Treatment Plant. The term also means the municipality, as defined in section 502(4) of the CWA, which has jurisdiction over the Indirect Discharges to and the discharges from such a treatment works.
5. *Significant Industrial User (SIU)* is defined as an Industrial User discharging to a POTW that satisfies any of the following:
 - a. Has a process wastewater flow of 25,000 gallons or more per average work day;
 - b. Has a flow greater than five percent of the flow carried by the municipal system receiving the waste;
 - c. Is subject to Categorical Pretreatment Standards, or
 - d. Has a reasonable potential for adversely affecting the operation of the POTW or violating any pretreatment standard or requirement.
6. *User or Industrial User (IU)* means a source of Indirect Discharge.

PART II
DISCHARGE PERMIT NO. UT0026280
PRETREATMENT

- B. Discharge to POTW. Any wastewaters discharged to a Publicly Owned Treatment Works (POTW), either as an Indirect Discharge or as a hauled waste, are subject to Federal, State and local pretreatment regulations. Pursuant to Section 307 of The Water Quality Act of 1987, Permittee shall comply with all applicable federal General Pretreatment Regulations promulgated at 40 CFR 403, the State Pretreatment Requirements at Utah Administrative Code (UAC) R317-8-8, and any specific local discharge limitations developed by the POTW accepting the wastewaters. At a minimum, the discharge into a POTW must meet the requirements of Part II. C., D. and E. of the permit.
- C. Hazardous Waste Notification. Permittee must notify the POTW, the EPA Regional Waste Management Director, the Director and the State hazardous waste authorities in writing if they discharge any substance into a POTW that, if otherwise disposed of, would be considered a hazardous waste under 40 CFR 261. This notification must include the name of the hazardous waste, the EPA hazardous waste number, and the type of discharge (continuous or batch).
- D. General and Specific Prohibitions.
1. General Prohibitions. Permittee may not introduce into a POTW any pollutant(s) which cause Pass Through or Interference. These general prohibitions and the specific prohibitions in II. D. 2. of this section apply to the introducing pollutants into a POTW whether or not Permittee is subject to other National Pretreatment Standards or any national, State, or local Pretreatment Requirements.
 2. Specific Prohibitions. The following pollutants shall not be introduced into a POTW:
 - a. Pollutants which create a fire or explosion hazard in the publicly owned treatment works (POTW), including, but not limited to, wastestreams with a closed cup flashpoint of less than 140°F (60°C);
 - b. Pollutants, which will cause corrosive structural damage to the POTW, but in no case, discharges with a pH lower than 5.0;
 - c. Solid or viscous pollutants in amounts which will cause obstruction to the flow in the POTW resulting in Interference;
 - d. Any pollutant, including oxygen demanding pollutants (BOD, etc.), released in a discharge at such volume or strength as to cause Interference in the POTW;
 - e. Heat in amounts, which will inhibit biological activity in the POTW, resulting in Interference, but in no case, heat in such quantities that the influent to the sewage treatment works exceeds 104°F (40°C));
 - f. Petroleum oil, nonbiodegradable cutting oil, or products of mineral oil origin in amounts that will cause Interference or Pass Through;
 - g. Pollutants, which result in the presence of toxic gases, vapor, or fumes within the POTW in a quantity that may cause worker health or safety problems;
 - h. Any trucked or hauled pollutants, except at discharge points designated by the POTW;
or
 - i. Any pollutant that causes Pass Through or Interference at the POTW.

PART II
DISCHARGE PERMIT NO. UT0026280
PRETREATMENT

- j. Any specific pollutant which exceeds any Local Limitation established by the POTW.
- E. Categorical Standards. In addition to the general and specific limitations expressed in *Part II. D.* of this section, applicable National Categorical Pretreatment Standards must be met by all Industrial Users discharging into a POTW. These standards are published in the federal regulations at *40 CFR 405 through 471*.

III. BIOSOLIDS REQUIREMENTS

- A. Biosolids Treatment and Disposal. UAC R317-8-1.10 regulates the disposal of sewage sludge (biosolids), which incorporates the federal standards found in 40 CFR Part 503 by reference. However, this is an industrial facility that does not regularly produce regulated biosolids. Therefore, R317-8-1.10 does not apply at this time.
- B. Biosolids – Reopener Provision. This permit may be reopened and modified (following proper administrative procedures) to include the appropriate biosolids limitations (and compliance schedule, if necessary), management practices, other appropriate requirements to protect public health and the environment, or if there have been substantial changes (or such changes are planned) in biosolids use or disposal practices; applicable management practices or numerical limitations for pollutants in biosolids have been promulgated which are more stringent than the requirements in this permit; and/or it has been determined that Permittee's biosolids use or land application practices do not comply with existing applicable state or federal regulations.

PART IV
STORM WATER PERMIT

IV. STORM WATER REQUIREMENTS.

- A. Industrial Storm Water Permit. Based on the type of industrial activities occurring at the Permitted Facility, Permittee is required to maintain separate coverage or an appropriate exclusion under the Multi-Sector General Permit (MSGP) for Storm Water Discharges Associated with Industrial Activities (UTR000000). If the Permitted Facility is not already covered, Permittee has thirty (30) days from when this permit is issued to submit the appropriate Notice of Intent (NOI) for the MSGP or exclusion documentation.
- B. Construction Storm Water Permit. Any construction at the Permitted Facility that disturbs an acre or more of land, including less than an acre if it is part of a common plan of development or sale, is required to obtain coverage under the UPDES Construction General Storm Water Permit (UTRC000000). Permittee must obtain permit coverage prior to land disturbance. If the site qualifies, the Permittee may submit a Low Erosivity Waiver (LEW) Certification instead of permit coverage.

PART V
DISCHARGE PERMIT NO. UT0026280
MONITORING & REPORTING

V. MONITORING, RECORDING & GENERAL REPORTING REQUIREMENTS

- A. Representative Sampling. Permittee shall collect samples in compliance with the monitoring requirements established under *Part I* from the effluent stream prior to discharge into the receiving waters. Samples and measurements shall be representative of the volume and nature of the monitored discharge. Samples of biosolids shall be collected at a location representative of the quality of biosolids immediately prior to the use-disposal practice.
- B. Monitoring Procedures. Monitoring must be conducted according to test procedures approved under UAC R317-2-10, UAC R317-8-4.1(10)(d), and/or 40 CFR § 503 utilizing sufficiently sensitive test methods unless other test procedures have been specified in this permit. Monitoring must be conducted according to the test procedures listed above unless another method is required under 40 CFR Chapter I subchapters N or O. Sufficiently sensitive test method means: (1) The method minimum level (ML) is at or below the level of the effluent limit established in the permit for the measured pollutant or pollutant parameter; or (2) The method has the lowest ML of the analytical methods approved under 40 CFR part 136 or required under 40 CFR chapter I, subchapter N or O for the measured pollutant or pollutant parameter as per 40 CFR 122.44(i)(1)(iv)(A).
- C. Penalties for Tampering. Utah Code § 19-5-115(4) of the Act provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than \$10,000 per day of violation, or by imprisonment for not more than six (6) months per violation, or by both.
- D. Compliance Schedules. Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any Compliance Schedule of this permit shall be submitted no later than fourteen (14) days following each schedule date.
- E. Additional Monitoring by the Permittee. If Permittee monitors any parameter more frequently than required by this permit, using test procedures approved under Permit Part V.B., the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR or the Biosolids Report Form.
- F. Records Contents. Records of monitoring information shall include:
1. The date, exact place, and time of sampling or measurements;
 2. The individual(s) who performed the sampling or measurements;
 3. The date(s) and time(s) analyses were performed;
 4. The individual(s) who performed the analyses;
 5. The analytical techniques or methods used; and,
 6. The results of such analyses.
- G. Retention of Records. Permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least five (5) years from the date of the sample, measurement, report or application. This period may be extended by request of the Director at any time. A copy of this UPDES permit must be maintained on site during the duration of activity at the permitted location
- H. Twenty-four (24) Hour Notice of Noncompliance Reporting.

PART V
DISCHARGE PERMIT NO. UT0026280
MONITORING & REPORTING

1. In accordance with UAC R317-8-4, Permittee shall (orally) report any noncompliance which may endanger health or the environment, including transportation accidents, spills, and uncontrolled runoff from biosolids transfer or land application sites which may seriously endanger health or environment, as soon as possible, but no later than twenty-four (24) hours from the time Permittee first became aware of circumstances. The report shall be made to the DWQ via the 24-hour answering service (801) 536-4123.
 2. The following occurrences of noncompliance shall initially be reported by telephone to the DWQ via the 24-hour answering service as soon as possible but no later than twenty-four (24) hours from the time Permittee becomes aware of the circumstances:
 - a. Any noncompliance which may endanger health or the environment;
 - b. Any unanticipated bypass, which exceeds any effluent limitation in the permit (See *Part VI.G, Bypass of Treatment Facilities.*);
 - c. Any Upset which exceeds any effluent limitation in the permit (See *Part VI.H, Upset Conditions.*);
 - d. Violation of a daily discharge limitation for any of the pollutants listed in the permit. For other permit violations which will not endanger health or the environment, DWQ may otherwise be notified during business hours (801) 536-4300; or,
 - e. Violation of any of the Table 3 metals limits, the pathogen limits, the vector attraction reduction limits or the management practices for biosolids that have been sold or given away.
 3. A written submission shall also be provided within five (5) days of the time that Permittee becomes aware of the circumstances. The written submission shall contain:
 - a. A description of the noncompliance and its cause;
 - b. The period of noncompliance, including exact dates and times;
 - c. The estimated time noncompliance is expected to continue if it has not been corrected;
 - d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance; and,
 - e. Steps taken, if any, to mitigate the adverse impacts on the environment and human health during the noncompliance period.
 4. The Director may waive the written report on a case-by-case basis if the oral report has been received within twenty-four (24) hours by the Division of Water Quality, (801) 536-4300.
 5. Reports shall be submitted to the addresses in *Part I.D, Reporting of Monitoring Results.*
- I. Other Noncompliance Reporting. Instances of noncompliance not required to be reported within twenty-four (24) hours shall be reported at the time that monitoring reports for *Part I.D* are submitted. The reports shall contain the information listed in *Part V.H.3.*

PART V
DISCHARGE PERMIT NO. UT0026280
MONITORING & REPORTING

- J. Inspection and Entry Permittee shall allow the Director, or an authorized representative (including an authorized contractor acting as a representative of the Director) upon the presentation of agency credentials and other documents as may be required by law, to:
1. Enter upon Permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of the permit;
 2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;
 3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit, including but not limited to, biosolids treatment, collection, storage facilities or area, transport vehicles and containers, and land application sites;
 4. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the *Act*, any substances or parameters at any location, including, but not limited to, digested biosolids before dewatering, dewatered biosolids, biosolids transfer or staging areas, any ground or surface waters at the land application sites or biosolids, soils, or vegetation on the land application sites; and,
 5. The Permittee shall obtain permission or clearance from the landowner or leaseholder, if the landowner is someone other than the Permittee, to permit the Director, or authorized representative, to access the permitted facilities and activities for entry and inspection. The Permittee shall make necessary arrangements with any legally interested parties so as to permit the Director, or authorized representative, to enter and inspect without delay.

PART VI
DISCHARGE PERMIT NO. UT0026280
COMPLIANCE

VI. COMPLIANCE RESPONSIBILITIES

- A. Duty to Comply. Permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of *the Act* and is grounds for administrative and civil enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application. Permittee shall give sufficient advance notice to the Director of any planned changes in the Permitted Facility or activity, which may result in noncompliance with permit requirements so as to provide the Director with adequate time to review the changes and potentially appropriate remedies.
- B. Penalties for Violations of Permit Conditions. Utah Code § 19-5-115 of the *Act* provides that any person who violates a permit condition, rule, or order implementing provisions of the *Act* is subject to a civil penalty not to exceed \$10,000 per day of such violation. Except as provided at *Part VI.G, Bypass of Treatment Facilities* and *Part VI.H, Upset Conditions*, nothing in this permit shall be construed to relieve Permittee of the civil or criminal penalties for noncompliance.
- C. Need to Halt or Reduce Activity not a Defense. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.
- D. Duty to Mitigate. Permittee shall take all reasonable steps to minimize or prevent any discharge in violation of this permit, which has a reasonable likelihood of adversely affecting human health or the environment. Permittee shall also take all reasonable steps to minimize or prevent any land application in violation of this permit.
- E. Proper Operation and Maintenance. Permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by Permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems, which are installed by a permittee only when the operation is necessary to achieve compliance with the conditions of the permit.
- F. Removed Substances. Collected screening, grit, solids, sludge, or other pollutants removed in the course of treatment shall be disposed of in such a manner so as to prevent any pollutant from entering any waters of the state or creating a health hazard. Sludge/digester supernatant and filter backwash shall not directly enter either the final effluent or waters of the state by any other direct route.
- G. Bypass of Treatment Facilities.
 - 1. Bypass Not Exceeding Limitations. Permittee may allow any bypass to occur which does not cause Permittee to exceed its permitted effluent limitations, but only if it also is for essential maintenance to assure efficient operation. These bypasses are not subject to paragraph 2 and 3 of this section.
 - 2. Prohibition of Bypass.
 - a. In accordance with Utah Admin. Code R317-8-4.1, bypass is prohibited, and the Director may take enforcement action against Permittee for bypass, unless:

PART VI
DISCHARGE PERMIT NO. UT0026280
COMPLIANCE

- (1) Bypass was unavoidable to prevent loss of human life, personal injury, or Severe Property Damage;
 - (2) There were no feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate backup equipment should have been installed in the exercise of reasonable engineering judgement to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance, and
 - (3) Permittee submitted notices as required under *Part VI.G.3*.
 - b. The Director may approve an anticipated bypass, after considering its adverse effects, if the Director determines that it will meet the three conditions listed in *Parts VI.G.2.a (1), (2) and (3)*.
3. Notice.
- a. *Anticipated bypass.* Except as provided above in *Part VI.G.2* and below in *Part VI.G.3.b*, if Permittee knows in advance of the need for a bypass, it shall submit prior notice, at least ninety (90) days before the date of bypass. The prior notice shall include the following unless otherwise waived by the Director:
 - (1) Evaluation of alternative to bypass, including cost-benefit analysis containing an assessment of anticipated resource damages;
 - (2) A specific bypass plan describing the work to be performed including scheduled dates and times. Permittee must notify the Director in advance of any changes to the bypass schedule;
 - (3) Description of specific measures to be taken to minimize environmental and public health impacts;
 - (4) A notification plan sufficient to alert all downstream users, the public and others reasonably expected to be impacted by the bypass;
 - (5) A water quality assessment plan to include sufficient monitoring of the receiving water before, during and following the bypass to enable evaluation of public health risks and environmental impacts; and,
 - (6) Any additional information requested by the Director.
 - b. *Emergency Bypass.* Where ninety (90) days advance notice is not possible, Permittee must notify the Director, and the director of the Department of Natural Resources, as soon as it becomes aware of the need to bypass and provide to the Director the information in *Part VI.G.3.a.(1) through (6)* to the extent practicable.
 - c. *Unanticipated bypass.* Permittee shall submit notice of an unanticipated bypass to the Director as required under *Part IV.H*, Twenty-Four Hour Reporting. Permittee shall also immediately notify the director of the Department of Natural Resources,

PART VI
DISCHARGE PERMIT NO. UT0026280
COMPLIANCE

the public and downstream users through means reasonably calculated to provide adequate advance notice of the unanticipated bypass and shall implement measures to minimize impacts to public health, safety, and environment to the extent practicable.

H. Upset Conditions.

1. Effect of an Upset. An Upset constitutes an affirmative defense to an action brought for noncompliance with technology-based permit effluent limitations if the requirements of paragraph 2 of this section are met. Director's administrative determination regarding a claim of Upset cannot be judiciously challenged by Permittee until such time as an action is initiated for noncompliance.
2. Conditions necessary for a demonstration of Upset. A permittee who wishes to establish the affirmative defense of Upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:
 - a. An Upset occurred and that the permittee can identify the cause(s) of the Upset;
 - b. The permitted Facility was at the time being properly operated;
 - c. The permittee submitted notice of the Upset as required under *Part V.H, Twenty-four Hour Notice of Noncompliance Reporting*; and,
 - d. The permittee complied with any remedial measures required under *Part VI.D, Duty to Mitigate*.
3. Burden of proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an Upset has the burden of proof.

I. Toxic Pollutants. Permittee shall comply with effluent standards or prohibitions established under 33 U.S.C. § 1317,)(Section 307(a), *The Water Quality Act of 1987*) for toxic pollutants within the time provided in the regulations that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

J. Changes in Discharge of Toxic Substances. Permittee shall provide notice to the Director as soon as Permittee knows of, or has reason to believe:

1. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":
 - a. One hundred micrograms per liter (100 ug/L);
 - b. Two hundred micrograms per liter (200 ug/L) for acrolein and acrylonitrile; five hundred micrograms per liter (500 ug/L) for 2,4-dinitrophenol and for 2-methyl-4, 6-dinitrophenol; and one milligram per liter (1 mg/L) for antimony;
 - c. Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with *UAC R317-8-3.4(7)* or (10); or,

PART VI
DISCHARGE PERMIT NO. UT0026280
COMPLIANCE

- d. The level established by the Director in accordance with *UAC R317-8-4.2(6)*.
- 2. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":
 - a. Five hundred micrograms per liter (500 ug/L);
 - b. One milligram per liter (1 mg/L) for antimony;
 - c. Ten (10) times the maximum concentration value reported for that pollutant in the permit application in accordance with *UAC R317-8-3.4(9)*; or,
 - d. The level established by the Director in accordance with *UAC R317-8-4.2(6)*.

PART VII
DISCHARGE PERMIT NO. UT0026280

VII. GENERAL REQUIREMENTS

- A. Planned Changes. Permittee shall give notice to the Director as soon as possible of any planned physical alterations or additions to the Permitted Facility. Notice is required only when:
1. The alteration or addition to a Permitted Facility may meet one of the criteria for determining whether a facility is a new source in 122.29(b); or
 2. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants which are subject neither to effluent limitations in the permit nor to notification requirements under Utah Admin. Code R317-8-4.1(15).
 3. The alteration or addition results in a significant change in Permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported during the permit application process or not reported pursuant to an approved land application plan. Permittee shall give notice to the Director of any planned changes at least 30 days prior to their implementation.
- B. Anticipated Noncompliance. Permittee shall give advance notice to the Director of any planned changes to the Permitted Facility or activity, which may result in noncompliance with permit requirements.
- C. Permit Actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by Permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.
- D. Duty to Reapply. If Permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, Permittee shall apply for and obtain a new permit. The application shall be submitted at least 180 days before the expiration date of this permit.
- E. Duty to Provide Information. Permittee shall furnish to the Director, within a reasonable time, any information which the Director may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. Permittee shall also furnish to the Director, upon request, copies of records required to be kept by this permit.
- F. Other Information. When Permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Director, it shall promptly submit such facts or information.
- G. Signatory Requirements. All applications, reports or information submitted to the Director shall be signed and certified.
1. All permit applications shall be signed by either a principal executive officer, ranking elected official or duly authorized representative of the signatory. A person is a duly authorized representative only if:

PART VII
DISCHARGE PERMIT NO. UT0026280

- a. The authorization is made in writing by a person described above and submitted to the Director, and,
 - b. The authorization specifies either an individual or a position having responsibility for the overall operation of the Permitted Facility, such as the position of plant manager, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters. A duly authorized representative may thus be either a named individual or any individual occupying a named position.
 - (1) For a corporation. By a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:
 - (a) A president, secretary, treasurer, vice-president or officer of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or
 - (b) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the Permitted Facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
 - (2) For a partnership or sole proprietorship. By a general partner or the proprietor, respectively; or
 - (3) For a municipality, State, Federal, or other public agency. By either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes:
 - (a) The chief executive officer of the agency, or
 - (b) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of EPA).
2. All reports required by the permit and other information requested by the Director shall be signed by a person described above or by a duly authorized representative of that person.
 3. Changes to authorization. If an authorization under *Part VII.G.2* is no longer accurate because a different individual or position has responsibility for the overall operation of the Permitted Facility, a new authorization satisfying the requirements of *Part VII.G.2* must be submitted to the Director prior to or together with any reports, information, or applications to be signed by an authorized representative.
 4. Certification. Any person signing a document under this section shall make the following certification:

PART VII
DISCHARGE PERMIT NO. UT0026280

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant administrative, criminal and civil penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

- H. Penalties for Falsification of Reports. Section 19-5-115(4) of the *Act* provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction be punished by a fine of not more than \$10,000.00 per day of violation, or by imprisonment for not more than six months per violation, or by both.
- I. Availability of Reports. Except for data determined to be confidential under *UAC R317-8-3.2*, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the office of Director. As required by the *Act*, permit applications, permits and effluent data shall not be considered confidential.
- J. Oil and Hazardous Substance Liability. Nothing in this permit shall be construed to preclude Permittee of any legal action or relieve Permittee from any responsibilities, liabilities, or penalties to which Permittee is or may be subject under the *Act*.
- K. Property Rights. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.
- L. Severability. The provisions of this permit are severable, and if any provisions of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.
- M. Transfers. This permit may be automatically transferred to a new permittee if:
 - 1. The current permittee notifies the Director at least 20 days in advance of the proposed transfer date;
 - 2. The notice includes a written agreement between the existing and new permittee's containing a specific date for transfer of permit responsibility, coverage, and liability between them; and,
 - 3. The Director does not notify the existing permittee and the proposed new permittee of his or her intent to modify, or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in paragraph 2 above.
- N. State or Federal Laws. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve Permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable state law or regulation under authority preserved by

PART VII
DISCHARGE PERMIT NO. UT0026280

Sections 19-5-117 and 510 of the Clean Water Act or any applicable Federal or State transportation regulations, such as but not limited to the Department of Transportation regulations.

- O. Water Quality - Reopener Provision. This permit may be reopened and modified (following proper administrative procedures) to include the appropriate effluent limitations and compliance schedule, if necessary, if one or more of the following events occurs:
1. Water Quality Standards for the receiving water(s) to which Permittee discharges are modified in such a manner as to require different effluent limits than contained in this permit.
 2. A final wasteload allocation is developed and approved by the State and/or EPA for incorporation in this permit.
 3. Revisions to the current CWA § 208 areawide treatment management plans or promulgations/revisions to TMDLs (40 CFR 130.7) approved by the EPA and adopted by DWQ which calls for different effluent limitations than contained in this permit.
- P. Toxicity Limitation - Reopener Provision. Use the following paragraph if WET testing is required at the Permitted Facility:

This permit may be reopened and modified (following proper administrative procedures) to include, whole effluent toxicity (WET) limitations, a compliance date, a compliance schedule, a change in the whole effluent toxicity (biomonitoring) protocol, additional or modified numerical limitations, or any other conditions related to the control of toxicants if one or more of the following events occur;

1. Toxicity is detected, as per *Part I.C.4.a/b* of this permit, during the duration of this permit.
2. The TRE results indicate that the toxicant(s) represent pollutant(s) or pollutant parameter(s) that may be controlled with specific numerical limits, and the Director concludes that numerical controls are appropriate.
3. Following the implementation of numerical control(s) of toxicant(s), the Director agrees that a modified biomonitoring protocol is necessary to compensate for those toxicants that are controlled numerically.
4. The TRE reveals other unique conditions or characteristics, which in the opinion of the permit issuing authority justify the incorporation of unanticipated special conditions in the permit.

Use the following paragraph if there is no WET testing is required at the Permitted Facility:

This permit may be reopened and modified (following proper administrative procedures) to include WET testing, a WET limitation, a compliance schedule, a compliance date, additional or modified numerical limitations, or any other conditions related to the control of toxicants if toxicity is detected during the life of this permit.

VIII. DEFINITIONS

A. Wastewater.

1. The “7-day (and weekly) average”, other than for *E. coli* bacteria, fecal coliform bacteria, and total coliform bacteria, is the arithmetic average of all samples collected during a consecutive 7-day period or calendar week, whichever is applicable. Geometric means shall be calculated for *E. coli* bacteria, fecal coliform bacteria, and total coliform bacteria. The 7-day and weekly averages are applicable only to those effluent characteristics for which there are 7-day average effluent limitations. The calendar week, which begins on Sunday and ends on Saturday, shall be used for purposes of reporting self-monitoring data on discharge monitoring report forms. Weekly averages shall be calculated for all calendar weeks with Saturdays in the month. If a calendar week overlaps two months (i.e., the Sunday is in one month and the Saturday in the following month), the weekly average calculated for that calendar week shall be included in the data for the month that contains Saturday.
2. The "30-day (and monthly) average," other than for *E. coli* bacteria, fecal coliform bacteria and total coliform bacteria, is the arithmetic average of all samples collected during a consecutive 30-day period or calendar month, whichever is applicable. Geometric means shall be calculated for *E. coli* bacteria, fecal coliform bacteria and total coliform bacteria. The calendar month shall be used for purposes of reporting self-monitoring data on discharge monitoring report forms.
3. "Average annual discharge limit" means maximum allowable average of monthly discharges over a calendar year, calculated as the sum of all monthly discharges measured during a calendar year divided by the number of monthly discharges measured during the year. The timeframe is defined as from January 1st to December 31st.
4. “Act,” means the *Utah Water Quality Act*.
5. “Acute toxicity” occurs when 50 percent or more mortality is observed for either test species at any effluent concentration (lethal concentration or “LC₅₀”).
6. “Bypass,” means the diversion of waste streams from any portion of a treatment facility.
7. “Chronic toxicity” occurs when the IC₂₅< XX% effluent. The XX% effluent is the concentration of the effluent in the receiving water, at the end of the mixing zone expressed as per cent effluent.
8. "IC₂₅" is the concentration of toxicant (given in % effluent) that would cause a 25% reduction in mean young per female, or a 25% reduction in overall growth for the test population.
9. “Composite Samples” shall be flow proportioned. The composite sample shall, as a minimum, contain at least four (4) samples collected over the compositing period. Unless otherwise specified, the time between the collection of the first sample and the last sample shall not be less than six (6) hours nor more than 24 hours. Acceptable methods for preparation of composite samples are as follows:

PART VIII
DISCHARGE PERMIT NO. UT0026280

- a. Constant time interval between samples, sample volume proportional to flow rate at time of sampling;
 - b. Constant time interval between samples, sample volume proportional to total flow (volume) since last sample. For the first sample, the flow rate at the time the sample was collected may be used;
 - c. Constant sample volume, time interval between samples proportional to flow (i.e., sample taken every "X" gallons of flow); and,
 - d. Continuous sample volume, with sample collection rate proportional to flow rate.
10. "CWA" means *The Federal Water Pollution Control Act*, as amended, by *The Clean Water Act of 1987*.
11. "Daily Maximum" (Daily Max.) is the maximum value allowable in any single sample or instantaneous measurement.
12. "EPA," means the United States Environmental Protection Agency.
13. "Director," means Director of the Division of Water Quality.
14. A "grab" sample, for monitoring requirements, is defined as a single "dip and take" sample collected at a representative point in the discharge stream.
15. An "instantaneous" measurement, for monitoring requirements, is defined as a single reading, observation, or measurement.
16. "Severe Property Damage," means substantial physical damage to property, damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.
17. "Upset," means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee. An Upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

APPENDIX B

Laboratory Data Results

	PROJECT	PROJECTUM	LabName	SAMPLENAME	LASERMAPD	MATERIAL	SAMPLEDATE	ANALYSIS DATE	BATCH	METHODCODE	METHNAME	PREPNAME	ANALYTE	Result	NOL	R	UNC	UNIT	STATUS	BASES	DILUTION	SPEXRECOVERY	UPPERCUT	LOWERCUT	ANALYST	POLICY	NOTE	ANOTE	LATITUDE	LONGITUDE	SComment	SN0T5	SN0T6	SN0T8	SN0T9	SN0T7	SN0T8	SN0T9	SN0T10	ANALYZEDR			
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake - Grab	208054-01	Water	02/06/2023 09:58:00	01/12/2023 10:40:00	02/12/2023 11:50:00	K267473_04G	EPA 1664B	NO PREP	Oil & Grease (HEM)	ND	5	5	mgt/L	FALSE	NA	5						DAN																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Outfall - Grab	208054-02	Water	02/06/2023 10:00:00	01/12/2023 10:40:00	02/12/2023 11:50:00	K267473_04G	EPA 1664B	NO PREP	Oil & Grease (HEM)	ND	5	5	mgt/L	FALSE	NA	5						DAN																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-03	Water	02/06/2023 16:15:00	02/12/2023 12:30:00	02/12/2023 13:07:01	K260461_Mercury(T) 1633	EPA 1631	NO PREP	Aluminum, Total	ND	0.0	0.0	mgt/L	FALSE	NA	5						AB																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-04	Water	02/06/2023 16:00:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Cd(T) 200.7	EPA 200.7	EPA 200.2	Cadmium, Total	ND	1.2	1.5	mgt/L	FALSE	NA	25						AB																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-05	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Cr(T) 200.7	EPA 200.7	EPA 200.2	Baron, Total	ND	0.8	0.8	1.25	mgt/L	FALSE	NA	25						AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-06	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Pb(T) 200.7	EPA 200.7	EPA 200.2	Lead, Total	ND	0.172	0.07	0.02	mgt/L	FALSE	NA	25						AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-07	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Ca(T) 200.7	EPA 200.7	EPA 200.2	Calcium, Total	ND	289	0.7	5	mgt/L	FALSE	NA	25						AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-08	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Ti(T) 200.7	EPA 200.7	EPA 200.2	Titanium, Total	ND	0.002	0.0	0.75	mgt/L	FALSE	NA	25						AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-09	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Li(T) 200.7	EPA 200.7	EPA 200.2	Lithium, Total	ND	65.1	6.403	0.5	mgt/L	FALSE	NA	25						AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-10	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_K(T) 200.7	EPA 200.7	EPA 200.2	Magnesium, Total	133000	2.4	5	mgt/L	FALSE	NA	25							AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-11	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Potassium(T) 200.7	EPA 200.7	EPA 200.2	Potassium, Total	15000	1.2	5	mgt/L	FALSE	NA	25							AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-12	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	K260461_Si(T) 200.7	EPA 200.7	EPA 200.2	Silica, (as SiO2) Total	ND	5.4	4.2	5	mgt/L	FALSE	NA	25						AB																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-13	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:23:00	K260461_Sodium(T) 200.7	EPA 200.7	EPA 200.2	Sodium, Total	79000	343	500	mgt/L	FALSE	NA	500							TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-14	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:23:00	K260461_Chromium(T) 200.7	EPA 200.7	EPA 200.2	Chromium, Total	ND	0.062	0.01	0.025	mgt/L	FALSE	NA	50						TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-15	Water	02/06/2023 16:15:00	02/12/2023 12:30:00	02/12/2023 14:06:52	K260607_Cd(T) 200.8	EPA 200.8	200.8	Cadmium, Total	ND	0.001	0.005	mgt/L	FALSE	NA	25						TH																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-16	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:57:52	K260603_Cr(T) 200.8	EPA 200.8	200.8	Chromium, Total	ND	0.092	0.01	0.025	mgt/L	FALSE	NA	50						TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-17	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 14:06:56	K260603_Cu(T) 200.8	EPA 200.8	200.8	Copper, Total	ND	0.04	0.005	0.025	mgt/L	FALSE	NA	50						TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-18	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 14:06:56	K260603_Lead(T) 200.8	EPA 200.8	200.8	Lead, Total	ND	0.017	0.025	mgt/L	FALSE	NA	50							TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-19	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:57:52	K260603_Manganese(T) 200.8	EPA 200.8	200.8	Manganese, Total	ND	0.0412	0.032	0.035	mgt/L	FALSE	NA	50						TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-20	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 14:06:56	K260603_Nickel(T) 200.8	EPA 200.8	200.8	Nickel, Total	ND	0.007	0.002	0.025	mgt/L	FALSE	NA	50						TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-21	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 14:06:56	K260603_Nickel(T) 200.8	EPA 200.8	200.8	Nickel, Total	ND	0.29	0.022	0.025	mgt/L	FALSE	NA	50						TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-22	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 14:06:56	K260603_Cobalt(T) 200.8	EPA 200.8	200.8	Cobalt, Total	ND	0.08	0.008	0.030	mgt/L	FALSE	NA	50							TH															
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-23	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 14:06:56	K260603_Silver(T) 200.8	EPA 200.8	200.8	Silver, Total	ND	0.017	0.025	mgt/L	FALSE	NA	50							TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-24	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 14:06:56	K260603_Zinc(T) 200.8	EPA 200.8	200.8	Zinc, Total	ND	0.09	0.5	0.5	mgt/L	FALSE	NA	50						TH																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-25	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 15:13:03	K260606_Chloride(IC) 300.0	EPA 300.0	NO PREP	Nitrate as N	10000	100	100	mgt/L	FALSE	NA	100						TH																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-26	Water	02/06/2023 16:15:00	02/12/2023 14:15:00	02/07/2023 16:23:00	K260606_Nitrate	EPA 300.0	NO PREP	Nitrate as N	ND	6.64	10	mgt/L	FALSE	NA	100						EX																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-27	Water	02/06/2023 16:15:00	02/12/2023 14:15:00	02/07/2023 16:23:00	K260606_Sulfate(IC) 300.0	EPA 300.0	NO PREP	Sulfate	17800	347	500	mgt/L	FALSE	NA	500						EX																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-28	Water	02/06/2023 16:15:00	02/12/2023 14:15:00	02/07/2023 16:23:00	K260606_Bromide(IC) 300.0	EPA 300.0	NO PREP	Bromide	ND	144	2.3	5	mgt/L	FALSE	NA	50						EX																
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-29	Water	02/06/2023 16:15:00	02/12/2023 14:15:00	02/07/2023 16:23:00	K260606_Cyanide, Total	EPA 335.4	EPA 9010C	Cyanide, Total	ND	0.022	0.03	mgt/L	FALSE	NA	6						ReB																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-30	Water	02/06/2023 16:15:00	02/12/2023 12:30:00	02/12/2023 17:44:20	K260607_CD	HACH 8000	NO PREP	Chemical Oxygen Demand	4790	1540	100	mgt/L	FALSE	NA	25						LLC																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-31	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/07/2023 16:23:00	K260608_Arsenic(As) 300.0	SM 3230B	NO PREP	Arsenic, Total	ND	0.021	0.03	mgt/L	FALSE	NA	50						TH																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-32	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/07/2023 16:23:00	K260608_Arsenic(As) 300.0	SM 3230B	NO PREP	Alkalinity - Carbonate (as CaCO3)	ND	0.2	1	mgt/L	FALSE	NA	1						HH																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-33	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/07/2023 16:23:00	K260608_Arsenic(As) 300.0	SM 3230B	NO PREP	Alkalinity - Hydroxide (as CaCO3)	ND	0.2	1	mgt/L	FALSE	NA	1						HH																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-34	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/07/2023 16:23:00	K260608_Arsenic(As) 300.0	SM 3230B	NO PREP	Alkalinity - Total (as CaCO3)	ND	565	0.2	1	mgt/L	FALSE	NA	25					HH																	
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-35	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	[CALC] Hardness AP	SM 2140B	[CALC]	Hardness, Total (as CaCO3)	55400	11.7	33.1	mgt/L	FALSE	NA	25																							
Uclat Solutions	Stewie Money	OSLDE Pile Plant	Chechemek-Ford, Inc.	Intake	208054-36	Water	02/06/2023 16:15:00	02/12/2023 10:40:00	02/12/2023 13:22:56	[CALC] Hardness AP	SM 2140B	[CALC]																															

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

APPENDIX C

Biota Monitoring Report

Microbial analyses at the Waterleaf Resources pilot plant, Great Salt Lake, Utah

This reports presents data from an analysis of the microbial communities in the brine flowing into the plant, “influent,” and the post-extraction brine that is in a holding tank before being released back into the lake, “effluent.” The research question at hand is: *what is the impact of introducing post-extraction effluent into the Great Salt Lake north arm.* This analysis includes microscopy, genomic surveys, and inoculation experiments to measure growth in the laboratory.

Sampling:

Influent and effluent samples were obtained at the Utah Waterleaf Lilac facility on February 28, April 24, and June 24, 2025 (Figure 1). At each timepoint, 100 ml each were collected for laboratory analysis.



Figure 1. Samples were taken from the north tank for influent brine (valve circled in yellow) and the south tank for effluent (valve circled in red).

In addition, 100 ml of brine from each sample were filtered through a sterile PVDF membrane pressure filter unit, pore size 0.22 μm , which captures all the cells present in the microbial communities of the brine. The filters were used to extract DNA and create the sequencing libraries (Figure 2).

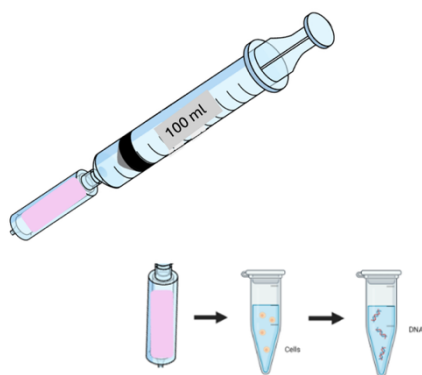


Figure 2. North arm brine from the influent tank and post-extraction effluent brine were filtered separately through a PVDF membrane cartridge to collect all cells in the sample. These filters were subsequently used to isolate DNA with a DNA extraction kit (QIAGEN, Venlo, Netherlands).

Biomass:

The relative biomass of aquatic communities can be assessed by centrifuging at high speeds to force cells to the bottom of the tube. I centrifuged 1 ml of the influent (I) sample and 1 ml of the effluent (E) sample at each sampling. These tubes were allowed to dry for two days. The dry weight was measured. I was unable to do this properly at the February sampling since I did not see a cell pellet in the effluent, only rust flakes, which likely came from corrosion of the holding tank and affected the dry weight. The other samples, however, yielded reliable data, and there were no rust flakes present. The April influent pellet was 3.7 mg of dry mass per milliliter of brine, and the effluent pellet was 4.5 mg per milliliter. The June influent pellet was 5.2 mg of dry mass per milliliter of brine, and the effluent pellet was 4.2 mg per milliliter. All were pink in color, which indicated that halophilic bacteria, archaea, and/or algae (all of which contain carotenoid pigments) were present in abundance in both (Figure 3). ***This colorful cell pellet was a good sign that there was a healthy population in the effluent.***



Figure 3. From the April samples, 1 ml of the influent (I) and effluent (E) were separately centrifuged to pellet the cells in the sample, which were both pink in color, indicating an abundance of halophiles (salt-tolerant bacteria and archaea have carotenoid pigments that make the cells pink).

Cell Counts:

Another way to assess biomass is to count the individual cells. Using a hemacytometer, which provides a grid and special cover glass to control the distributed volume, I estimated the cell density in each of the samples (e.g. Figure 4).

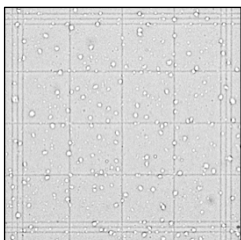


Figure 4. February influent sample on a hemacytometer. Note the grid that allows one to quantify the cells/ml. The cells are translucent but reflect light. They appear as small reflective orbs.

The results are shown in Table 1. The first samples from February demonstrated a robust cell density in the influent sample, but the effluent had very few if any visible cells. It's possible that the cell density was not zero, just low and not detectable by these methods. The April sampling had comparable numbers of cells in the effluent as the influent, the cells per milliliter counts were in the billions. The June samples also showed similar numbers for influent and effluent but higher cell counts.

Table 1. Cell counts by hemacytometer for each sampling

Sampling Date	Influent	Effluent
February 28, 2025	2×10^8 cells per ml	None detected, rust flakes present.
April 24, 2025	3.6×10^9 cells per ml	4.6×10^9 cells per ml
June 24, 2025	8.1×10^9 cells per ml	5.3×10^9 cells per ml

Note the values for April and June are higher at these warmer sampling times likely because the increased temperature supported microbial growth in the brine. The optimal temperature of GSL microorganisms is typically around the same as human cells, 37°C. ***Most importantly, the lithium extraction procedure did not reduce the cell count or have adverse effects on the cells.***

Given the intrusion of rust flakes and the results of the biomass and microscopy assays for the February sampling, I focused on the April and June samplings for addressing the question regarding impact on the extraction process on the microbial community.

Microbial Diversity:

In the GSL north arm, prior studies have revealed evidence for microorganisms in all three domains of life (Figure 5). The eukaryotes have nuclei and a higher-level organization; we typically see low levels of algae and fungi in the hypersaline brine. The prokaryotes have a simpler cell structure, such as salt thriving bacteria. The most prevalent domain in the north arm is archaea, which are abundant in all extreme environments on Earth (Baxter and Zalar, 2019; Ameida-Dalmet and Baxter, 2020).

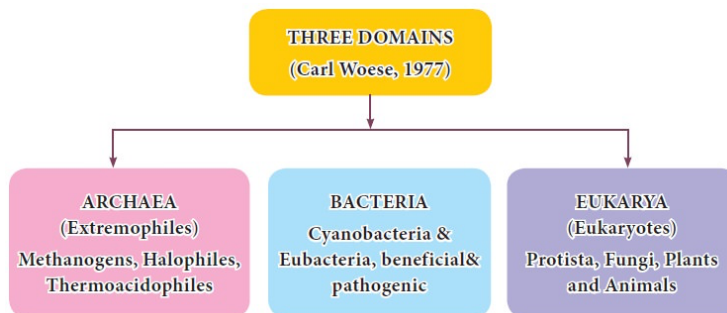


Figure 5. The three domains of life are all represented in the microbial diversity of Great Salt Lake.

To examine the microbial diversity of the influent and effluent, I wanted to sequence all the DNA from the onsite filtration described above. The microbial cells in the brine adhere to the sampling filters while the liquid is pumped through. After filtration, I froze the filters in a dry ice bath so that no degradation would occur, and the samples could be transported back to the lab for extraction. Under sterile conditions, the filter casings were cracked, and DNA was extracted from each membrane. This pool of DNA is derived from all of the life forms in the water sample. The next step is to figure out the species of life that are present. For this I used a consulting lab for

DNA sequencing. They amplify genes (16S rRNA, 18S rRNA, or ITS) associated with either bacteria, archaea, algae, or fungi. The DNA in the regions targeted is very specific, and this allows us to see “who” is present in the community and in what relative abundance. I analyzed the genetic data by first running a programming script that we developed in my lab to prune out any contaminants present in the controls and to connect to a taxonomic database to assign their phylogenetic classification. From here we can produce charts that help in visualizing the data.

Although the February effluent I analyzed did not seem to have cells (by microscopy nor a cell pellet), there were DNA signatures of microorganisms. This could be because the cells were in small numbers and therefore escaped the less sensitive methods, or it could be because there are biosignatures; the DNA from dead cells adhered to the filter but no intact cells did. A quick review of the prokaryotes in these samples indicate a similar community profile in the effluent when compared with the influent community e.g. the most prominent members of the community were common to both data sets.

The cell counts suggested that the April sampling would provide an excellent data set for sequencing analysis. I have confidence in the comparison between influent and effluent communities, and therefore, I have analyzed the April sample species composition below. The prokaryotes were split into bacteria and archaea for visual simplicity. The eukaryotic primers that would reveal algae species gave no hits (apart from plants that were blown in from the surrounding steppe), so there is no chart representing algae for April. We do know of two species that are present in the north arm, but in low numbers and only in warmer temperatures. Fungi require specific primers for reliable sequencing, so they were probed separately. Below I present the taxonomic profiles for each category of microorganisms. I have aligned the data for ease of comparison of the influent versus the effluent (Figure 6).

Archaea. Many of Earth’s extremophiles fall in the category of Archaea, simple prokaryotes that look like bacteria but are genetically distinct. These make up the bulk of the Great Salt Lake north arm microbiota as shown in past studies (Baxter and Zalar, 2019; Almeida-Dalmet and Baxter, 2020). In this experiment, ***The difference between the Waterleaf influent and effluent genera present is negligible*** (Fig. 6, top panel).

Bacteria. In past work, because archaea are more typical in extreme environments, we were surprised to find robust bacterial communities at the north arm (Almeida-Dalmet and Baxter, 2020). ***In the Waterleaf samples, the bacterial genera present were also similar between the influent and effluent*** (Fig. 6, middle panel). Note the bacteria (and archaea) that are present in small abundance, towards the bottom of the graphics, are likely small in number because they prefer more moderate salinity and are introduced by the south arm water. The north arm salinity may suppress their growth.

Microbial Analysis Report

Bonnie K. Baxter, Ph.D.

July 28, 2025

Fungi. Recently my lab has explored the fungal species of the Great Salt Lake north arm (Parrott and Baxter, 2024). The Internal Transcribed Spacer (ITS) segment is widely used as a universal fungal barcode because of its variability between species. In the Waterleaf experiment, this marker revealed only a few species and different yeast taxa present in the influent and effluent (Fig. 6, bottom panel). Some of these species, in our prior study, have been associated with plants, soils or animals from the surrounding landscape. For example, *Alternaria* and *Cryptococcus* were discovered in the plant soil microbiomes. Because the spores of fungi can become airborne, wind can introduce spores to the brine. ***The differences in the fungi present in the Waterleaf influent and effluent are likely not important with regards to the ecosystem since these species do not play a role in nutrient cycling.***

Microbial Analysis Report

Bonnie K. Baxter, Ph.D.

July 28, 2025

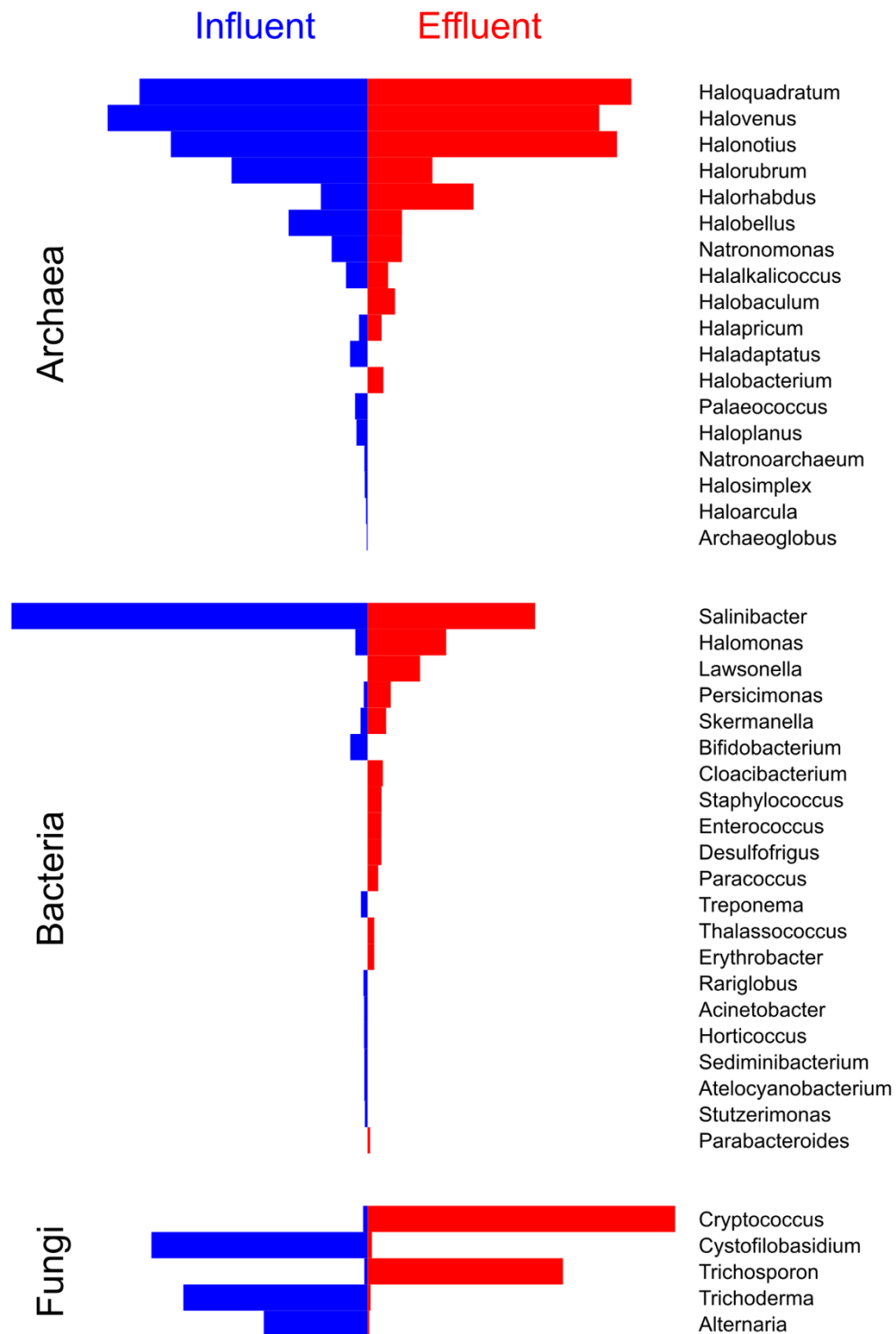


Figure 6. Microbial diversity charts for genera of archaea, bacteria, and fungi. The influent (blue) is shown on the left and effluent (red) on the right with species identity listed to the side. The size of the bars indicate relative abundance within each data set. The top panel shows the archaea community, the middle bacteria, and the bottom fungi.

Inoculation Experiment:

In order to probe more deeply into the potential impacts of discharging the effluent into the Great Salt Lake north arm, I performed a time course growth experiment, growing either influent, effluent, or a mixture. Optical density measurement at a light absorbance of 600nm (A_{600}) is a common methodology in microbiology for following growth of a culture over time (e.g. Stevenson et al. 2016). The cells absorb light at this wavelength, and so the concentration of microbes is proportional to the light absorbed. I used a spectrophotometer to measure the optical density over time, which allows us to see the growth curve of the population as the cells grow and divide. Since the initial levels of microorganisms are very low (and non-existent in the sterile water blank control), this is called the “lag phase.” As the population starts to double rapidly, you can see logarithmic growth for some species “log phase.” Beyond these phases, the bacterial population will stabilize and then decline. Figure 7 shows a standard growth curve for lab model microbes; we would expect slower growth in environmental organisms.

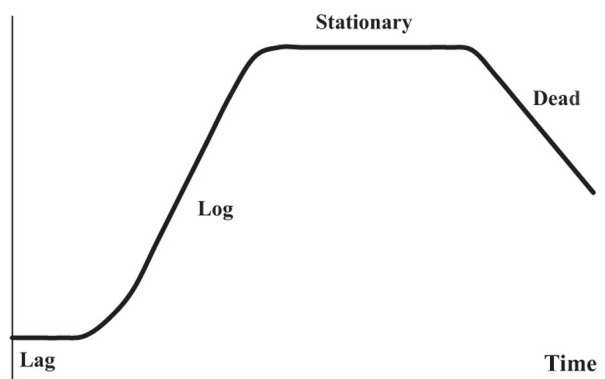


Figure 7. A textbook growth curve to show the expected phases of bacterial proliferation. My goal was to plot log phase in the samples and examine if introducing effluent to influent communities had an impact.

I attempted a couple of early trials to work out conditions, and this revealed that the experiment moved too slowly without growth media to enhance growth rates. The protocol that gave the best results for our timeframe was inoculating 9 ml of 23% salt MGM media (Dyall-Smith, 2025) with 1 ml of sample. The samples were 1) sterile deionized water serving as a control, 2) influent, 3) effluent, 4) a 50:50 mixture of effluent and influent. I did this experiment with brine from all three sampling dates. In each experiment, I used the control as a blank to set the optical density to zero. Thus, any absorbance observed was due to cells proliferating.

In Figure 8, the top panel shows growth curves featuring the February samples inoculated. The influent sample, which was rich in microorganisms, displays a typical growth curve, with a short lag phase, followed by fast growth, and then the beginnings of a plateau (orange line, top panel). The effluent (green line, top panel) by contrast, has delayed growth, but it does appear to have a low-density community that begins to take off albeit slowly. The mixture has a middle of the road growth curve (light blue line, top panel), which means that nothing in the effluent is inhibiting the growth of the microbes in the influent.

Microbial Analysis Report

Bonnie K. Baxter, Ph.D.

July 28, 2025

The middle panel of Figure 8 represents the growth curves of the April samples and the bottom panel is June. *All of the samples from the April and June samplings follow a standard growth curve.* The microbial communities appear to have just reached stationary phase over this period of study. This is expected of healthy cultures. Also to note, *mixing effluent and influent had no visible impact on growth.*

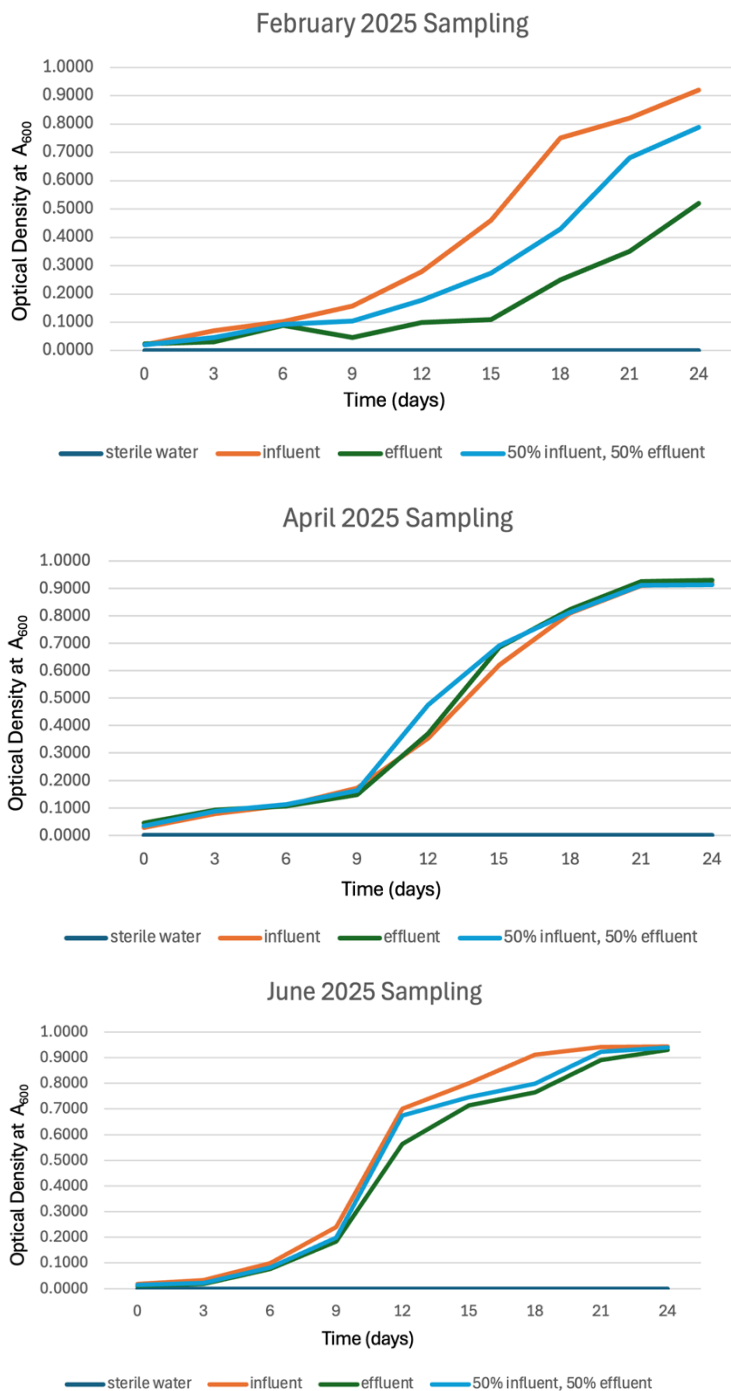


Figure 8. The top panel represents the February sampling at Waterleaf while the middle represents April and the bottom represents June. The sterile water inoculation control, dark blue, served as a blank for the optical density measurements at A₆₀₀ and showed no contamination in the experiment. The influent samples are shown in orange, the effluent in green, and the 50:50 mixture in light blue.

Algae Experiments

In the February and April samples, there was no evidence for the presence of algae. I did not see the larger distinctive cells in the microscopy examinations nor the signature for them in the DNA sequencing for microbial diversity. This is not unusual as the main algae species of the north arm, *Dunaliella salina*, blooms in the warm summer months (Baxter and Zalar, 2019). These eukaryotes do photosynthesis for the lake, accumulate glycerol to balance the inside of the cell with the outside hypersaline water, and make pigments to mediate cellular damage from the extreme environment (Figure 9). Despite being a seasonal participant, they are a key player to supplying nutrients to the north arm microbial community.

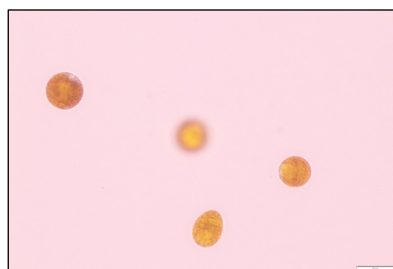


Figure 9. GSL north arm *Dunaliella salina*, a prevalent algae species in the summer months at Rozel. Beta carotene gives them the notable orangish color. A 20 micron scale bar is indicated in the lower right corner. Prokaryotes (bacteria and archaea) are typically only 1-2 microns, for comparison.

In the June sampling, I wanted to examine the impact of effluent on *Dunaliella salina* in the brine. For the DNA sequencing, I probed the broad categories of prokaryotes and eukaryotes. For this experiment, there is no need to distinguish between archaea and bacteria amongst the prokaryote signals and it was not important to track fungi separately amongst the eukaryotes. ***In future experiments for monitoring at this site, this streamlined approach would offer an option for routine checks.*** The results are shown in Figure 10.

The DNA sequencing surveys of the prokaryotes in the influent versus effluent shows the same pattern as before (Figure 6), making this a good control for standardization. The species distribution of the influent are preserved in similar abundances in the post-extraction effluent (Figure 10, top panel). These prokaryotes represent small archaea and bacteria, only ~1-2 microns, which are not filtered in the lithium extraction process. The *Dunaliella salina* algae are high in abundance in the influent as predicted for the summer season, but they are lacking in the effluent (Figure 10 bottom panel). ***These algae are much larger, ~10-20 microns, than the prokaryotes and were likely filtered in the early filtration step of the mineral extraction process.*** Note the small signal of *Dunaliella* in the effluent; this is likely from DNA released from dead cells in the environment, and these molecules would pass through filtration.

Microbial Analysis Report

Bonnie K. Baxter, Ph.D.

July 28, 2025

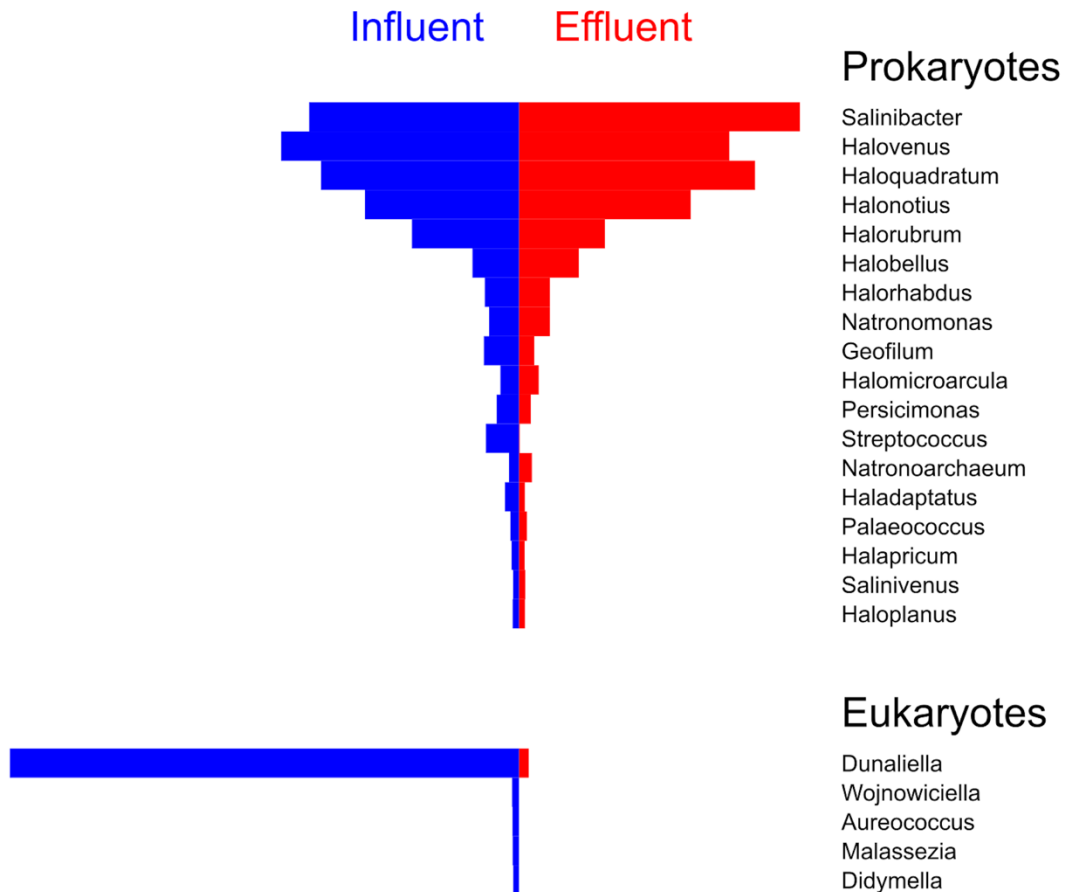


Figure 10. Most abundant taxa of prokaryotes (top panel) and eukaryotes (bottom panel). The influent consortia in shown in blue on the left, and the effluent in red on the right, and the bars represent relative abundance. June sampling for *Dunaliella salina* showed a robust biosignature for the algae in the eukaryotic profile of the influent (bottom). Unlike the smaller prokaryotes (~1-2 microns in size), the algae (~10-20 microns) are likely filtered out in the extraction process filtering step. The small signal for *Dunaliella* observed in the effluent is likely residual DNA from dead cells that passed through the filter.

Conclusions:

Is the extraction process changing the microbial community?

- The biomass analysis (Figure 3), cell counting (Table 1), and DNA sequencing (Figure 6 and 10) demonstrate that the extraction process is allowing prokaryotic microorganisms to remain in and survive in the effluent.
- The inoculation experiment (Figure 8) demonstrated that the effluent brine population is as healthy as the influent. There is no evidence of a longer lag time in the growth curves and they approach log phase at the same rate.
- The archaea and bacteria genera composition and abundance measures are remarkably similar between the influent and effluent (Figures 6 and 10), suggesting the survival/recovery of the microorganisms following the lithium extraction process.
- The fungi, however, have a different composition post extraction (Figure 6). There are only a few species that emerged in our study, but they are different in the influent versus the effluent. Since fungi have amazing dispersal mechanisms, the origin of the fungi we observed may have been introduced from the surrounding landscape, given the species present. There is no need to track fungi for surveying the health of the lake ecosystem.
- Algae were absent in both February and April samples, likely due to time of year. In the June sampling, the *Dunaliella salina* summer bloom was detected in the influent. However, filtration in the lithium extraction process appears to remove the *Dunaliella salina* as it is not present in the effluent (Figure 10).

Would the introduction of effluent to lake brine have impacts on the native biota?

- The inoculation experiment, where the influent and effluent are mixed 50:50, is a proxy for modeling the recovery of the microbial community after discharge. There is no evidence of negative impacts in the 50:50 mixed sample (Figure 8).
- Although the filtration step in the lithium extraction process may remove the *Dunaliella salina*, the absence of algae in the effluent should not be a problem when the effluent is discharged to the lake. The microbial community is not impacted by the introduction of effluent in the inoculation experiments (Figure 8).

Recommendations for future monitoring of the microbial communities:

- Fungal signatures are introduced from the environment and are not valuable for this study. Monitoring of fungi going forward is not necessary.
- Most of the microbial community in the north arm are mesophiles, meaning they are more prolific at moderately warm temperatures, optimal 20 to 45 °C (68 to 113 °F). Summer sampling is recommended for future monitoring efforts, and this approach would also allow you to see the bloom of *Dunaliella salina*.
- Continual monitoring the prokaryotes (the most prolific life forms) would give a nice benchmark for microbial communities surviving in the effluent. Any changes in process, scale up, or seasonal impacts could be followed over time.

References:

Almeida-Dalmet, S. and Baxter, B.K. 2020. Unexpected Complexity at Salinity Saturation: Microbial Diversity of the North Arm of Great Salt Lake. In Baxter, B.K. and Butler J.K., Eds. *Great Salt Lake Biology*. pp. 87-118. Springer, Cham.

Baxter, B.K. and Zalar, P., 2019. The extremophiles of Great Salt Lake: Complex microbiology in a dynamic hypersaline ecosystem. *Model Ecosystems in Extreme Environments*, pp.57-99.

Dyall-Smith, M. 2025. The HaloHandbook. https://haloarchaea.com/wp-content/uploads/2025/02/Halohandbook_2009_REV_v2.pdf (Accessed June 2, 2025).

Parrott Jr, D.L. and Baxter, B.K., 2024. Fungi of Great Salt Lake, Utah, USA: a spatial survey. *Frontiers in Fungal Biology*, 5, p.1438347.

Stevenson, K., McVey, A.F., Clark, I.B., Swain, P.S. and Pilizota, T. 2016. General calibration of microbial growth in microplate readers. *Scientific Reports*, 6(1), p.38828.

APPENDIX B

Waterleaf Phase 1 Groundwater Quality Memorandum

Memo

Date:	Tuesday, August 19, 2025
Project:	Waterleaf GSL Lithium Extraction Commercial Plant
To:	File
From:	Nate Nichols, Karen Nichols, HDR
Subject:	Water Quality analysis of ground water source, existing well @ 41.466255, -112.646907 Waterleaf Resources GSL Phase 1 Lithium Extraction Project

This Memo provides details to support Waterleaf Resources Great Salt Lake (GSL) Lithium Extraction Commercial plant CWA 402 Utah Pollution Discharge Elimination Systems (UPDES permit #0026280 modification application and Anti Degradation Review (ADR). This memo provides water quality data from the proposed groundwater source that is planned to provide process make up water during the operation of the Commercial Plant.

Groundwater Source

Waterleaf Resources provides the following groundwater quality data from the existing agricultural groundwater well located at 41.466255, -112.646907. Water samples were collected from this well by HDR staff on 6/24/2025. Staff performed field calibration for pH, Conductivity and Turbidity. Temp and DO meters were calibrated and verified before entering the field. The Horiba U-52-2 field water quality meter was utilized to monitor flow of the well until the temperature and pH stabilized during a flow- through technique, after which the sample was collected.

Density readings were collected using an Anton-Parr density meter, which was calibrated and field verified using laboratory grade de-ionized water as a reference.

HDR Staff collected grab samples once the team was confident that the well casing had been flushed and the flow was representative of groundwater conditions. Samples were delivered to Chemtech -ford in Sandy Utah within all required hold times.

Water Quality Results

Table 1 below shows both laboratory results, methodology and Minimum Detection Limit for constituents, as well as field collected measurements.

Table 1. Groundwater Quality Results

Constituent	Method	Concentration	Minimum Detection Limit (mg/L unless otherwise noted)
Mercury, Total	EPA 1631	<0.4 ng/L	0.4 (ng/L)
Aluminum, Total	EPA 200.7	<0.05	0.05
Boron, Total	EPA 200.7	0.39	0.02
Barium, Total	EPA 200.7	0.078	0.002
Iron, Total	EPA 200.7	<0.02	0.02
Lithium, Total	EPA 200.7	0.378	0.016
Potassium, Total	EPA 200.7	48.1	0.3
Silica, (as SiO ₂) Total	EPA 200.7	34.9	0.2
Sodium, Total	EPA 200.7	688	6.9
Arsenic, Total	EPA 200.8	0.0043	0.0002
Cadmium, Total	EPA 200.8	<0.00005	0.00005
Chromium, Total	EPA 200.8	0.0048	0.0002
Copper, Total	EPA 200.8	0.0023	0.0007
Lead, Total	EPA 200.8	<0.0003	0.0003
Manganese, Total	EPA 200.8	0.0028	0.0006
Molybdenum, Total	EPA 200.8	0.0017	0.0002
Nickel, Total	EPA 200.8	0.0013	0.0004
Selenium, Total	EPA 200.8	0.00778	0.00057
Silver, Total	EPA 200.8	<0.0003	0.0003
Zinc, Total	EPA 200.8	0.05	0.002
Chemical Oxygen Demand	Hach 8000	<6	6
Total Dissolved Solids (TDS)	SM 2540 C	3830	20
Total Suspended Solids (TSS)	SM 2540 D	<3	3
Biochemical Oxygen Demand	SM 5210 B	<2	2
Field collected parameters			
pH	Horiba U-52-2	8.15	N/A
Temp	Horiba U-52-2	16.59 C	N/A
Dissolved Oxygen	Horiba U-52-2	21.06 mg/L	N/A
Conductivity	Horiba U-52-2	4.23 ms/cm	N/A
Turbidity	Horiba U-52-2	0.000 NTU	N/A
Density	Anton-Parr density meter	0.9906 g/cm ³	N/A

APPENDIX C

Microbialite Survey

Memo

Date: Tuesday, August 26, 2025

Project: Waterleaf Resources Project Gecko

To: Steve Morrey, Ryan Clerico, Project File

From: Nate Nichols, HDR

Subject: Microbialite survey results August 22, 2025

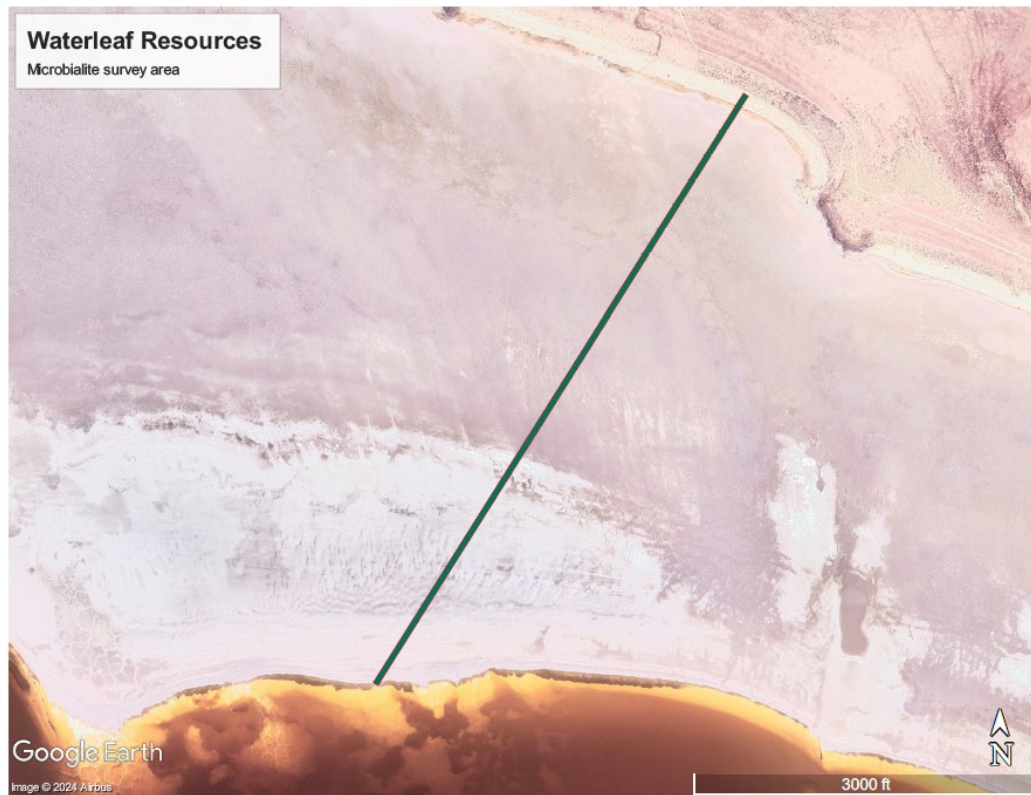
In accordance with Waterleaf Resources' Draft Operator Certification document, HDR conducted a pedestrian survey of Forestry, Fire and State Land easement associated with the Great Salt Lake Phase 1 Lithium Extraction Project (Commercial Plant) intake infrastructure installation area. This data will serve as baseline conditions for installation infrastructure for future commercial operations in the same area.

Background

The intake and outfall infrastructure would be constructed from the Commercial Plant location on the western slope of the Promontory Mountains, to the open waters of the North Arm (Gunnison Bay) of the GSL as shown in the survey area figure below. The infrastructure area can be described as exposed lakebed and hypersaline waters. Recent Utah Geological Survey (UGS) mapping has identified the western, eastern, and southeastern shoreline areas in the North Arm that might contain microbialites (UGS 2021). Microbialite structures provide a food source for brine shrimp and brine flies (Baxter 2020). However, research has documented that, due to limited availability of nutrients, the North Arm microbialite structures have lower mass, productivity, and/or diversity compared to microbialites in the South Arm (Baxter 2020).

Prior to construction of the Commercial lithium Extraction plant, Waterleaf is required to conduct a survey of the construction area to identify the existence of these important habitat structures in the project area. If microbialites are inventoried in the project area, Waterleaf would take measures to avoid impacts to the structures.

Survey Area



Results

Previous to this pedestrian survey, the centerline of the proposed easement on FFSs was staked from the ordinary high-water mark to the GSL water's edge where inlet and outfall structures would be located. From this centerline, a 50-foot buffer on either side was surveyed by foot for any microbialite structures to a depth of 3.5 feet into the GSL. At this point the lake sediments were no longer visible. Any lake sediments which appeared to contain microbialite structures that would be impacted by installation of intake and outfall pipes were noted.

No microbialite structures were noted during the pedestrian survey. Lakebed sediments above the current water level consisted of hard, compacted silty/sand material from GLS OHWM for approximately 0.7 miles (3500 ft). After which, the lake sediments consisted exclusively of loose, sandy material with some salt crusting observed a depth of 3.5 feet into GSL waters

It was noted that a low ground pressure UTV was used to travel the length of the survey area, which was also utilized during the recently completed demonstration plant operation, and did not impact any existing microbialites or habitat.

Representative Photos



Centerline staking, looking West.



Representative of hard packed silty sand material, looking West.



Transition to salt crusted material, looking West, Southwest



Transition into open water, Looking West



Salt Crust and fine sand 0-1 foot of water



1 to 3.5+ feet representative photo looking West