Environmental Footprint Analysis

On behalf of the Nevada Environmental Response Trust (the "Trust" or "NERT"), Ramboll Environ US Corporation (Ramboll Environ) is providing this inventory of the energy and materials used, wastes generated, and activities and services conducted at the NERT site for the purpose of an Environmental Footprint Analysis for July through December 2016. Much of the information used for this analysis was obtained from internal records maintained by the Trust and the current operator of the treatment plant, Envirogen Technologies, Inc. (Envirogen). In addition, existing documents produced by Ramboll Environ (e.g., the 2016 Semi-Annual Remedial Performance Memorandum for Chromium and Perchlorate) and others were used for general treatment process information. As necessary to fill remaining data gaps, Ramboll Environ solicited input from Envirogen and Tetra Tech, Inc. (Tetra Tech). In cases where specific information was not available, estimates have been provided based on professional judgement.

Energy Usage

Energy Used On-Site	Notes	Amount	Units	Source	Ref.
Grid electricity					
Treatment plant	A	2,225,210	kWh	Colorado River Commission of NV	1
Extraction wells and lift stations	B	630,169	kWh	NV Energy	1
Natural gas	C	NA			2
Diesel fuel	D	10	gal	Estimated Value	2
Gasoline	E	1,210	gal	Estimated Value	2/3
Other fuel/energy sources	F	NA			2
Renewable fuel/energy sources	F	NA			2

kWh = kilowatt hours

gal = gallons

NA = Not Applicable

Notes:

A) The Colorado River Commission of Nevada owns, operates, and maintains electrical facilities that support industrial manufacturing at the Black Mountain Industrial (BMI) Complex.

B) NV Energy is listed as the electricity provider on invoices for the off-site extraction wells and pump stations.

C) Natural gas is not used on-site.

D) Personnel with Envirogen Technologies, Inc. (Envirogen) indicated approximately 20 gallons of diesel are used per year for operation of the back up air compressor at the groundwater treatment plant (GWTP).

E) Gasoline usage was estimated based on vehicle usage information provided by Envirogen and Tetra Tech, Inc. (Tetra Tech).

F) Personnel with Envirogen indicated that no additional energy sources are used on-site.

Materials Usage

Materials Used On-Site	Notes	Amount	Units	Location of Manufacture	% from Recycle	Ref.
Ferrous sulfate ($FeSO_4$)	A	5,700	gal	California	Not reported	2
Polymer ICS-2528	A	150	gal	Arizona	Not reported	2
Dry Polymer Dewatering ICS-6545	A	2,300	lbs	Arizona	Not reported	2
DAF polymer ICS-2835B	A	3,000	gal	Arizona	Not reported	2
Lime (hydrated lime)	A	2,700	lbs	Missouri	Not reported	2
Ethanol (190 proof)	A	41,000	gal	Illinois	Not reported	2
Phosphoric acid (H_3PO_4)	A	2,800	gal	China	Not reported	2
pH Adjustment (NaOH)	A	2,000	gal	Nevada	Not reported	2
Micronutrients (VWNA micronutrient)	A	6,200	gal	California	Not reported	2
Hydrogen peroxide (H_2O_2)	A	11,000	gal	Washington	Not reported	2
Ferric chloride ($FeCl_3$)	A	4,700	gal	California	Not reported	2
Ammonia	B	0	gal	NA	NA	2
Granulated activated carbon (GAC)	C	0	lbs	NA	NA	2
Filter materials	D	NA				2
Other consumable materials	E	NA				2

gal = gallons

lbs = pounds

NA = Not Applicable

Notes:

Quantity information was provided by Envirogen personnel based on electronic outputs from their process control systems and inventory ordering information. All information about specifications and formulations was obtained from Safety Data Sheets maintained at the site.

A) Table 1 (below) provides information on the specifications and formulations of process materials.

B) Envirogen personnel reported that ammonia is present in sufficiently high concentrations in extracted water such that an external source of ammonia has not been necessary during this period of performance.

C) According to Envirogen personnel, the GAC is tested annually for potential contaminant breakthrough and is replaced only if breakthrough is observed. The GAC was not replaced during the reporting period.

D) Envirogen personnel reported that there are no waste streams from other filter materials. Sand for the sand filter is continuously removed from the bottom of the filter, cleaned, and returned to the top of the filter.

E) According to Envirogen personnel, no other process materials are used in significant quantities.

Table 1: Specifications and Formulations of Process Materials

Material	Specification	Formulation
Ferrous sulfate ($FeSO_4$)	Aqueous solution; Specific gravity 1.203 @20°C; Density 10.02 lbs/gal	Ferrous sulfate, heptahydrate 30 ± 2% by weight; Sulfuric acid 0.3 ± 0 .1% by weight
Polymer ICS-2528	Viscous liquid mixture; relative density 1.0-1.1	Distillates (petroleum), hydrotreated light 20-45%; Poly(oxy-1,2-ethanediyl), a-tridecyl-w-hydroxy-, branched <3%
Dry Polymer Dewatering ICS-6545	Powder	Not reported
DAF polymer ICS-2835B	Aqueous solution; Specific gravity 1.02-1.03; Density 8.5-8.6 lbs/gal	Light distillate 20-40%; Ethoxylated alcohol 1-10%
Lime (hydrated lime)	Powder; Specific gravity 2.2	Calcium hydroxide; Crystalline silica (quartz) <0.10-0.2%
Ethanol (190 proof)	Aqueous solution; Specific gravity 0.817 @60°F	Ethanol 91.1% by volume; Water 4.8% by volume; Ethyl acetate 4.1% by volume
Phosphoric acid (H_3PO_4)	Aqueous solution; Specific gravity 1.20-1.26 @20°C; Density 10.0-10.5 lbs/gal	Phosphoric acid 30-40% by weight
pH Adjustment (NaOH)	Aqueous solution; Specific gravity 1.33 @20°C; Density 1.33 g/cm^3	Sodium hydroxide 10-30%
Micronutrients (VWNA micronutrient)	Aqueous solution; Specific gravity 1.1075 @20°C; Density 9.24 lbs/gal	Hydrochloric acid; Ferrous sulfate; Sodium molybdate; Manganese sulfate monohydrate; Aluminum sulfate; Copper sulfate; Zinc sulfate monohydrate; Nickel chloride hexahydrate
Hydrogen peroxide (H_2O_2)	Aqueous solution; Specific gravity 1.1327 @18°C; Density 9.44 lbs/gal	Hydrogen peroxide 35% by weight
Ferric chloride ($FeCl_3$)	Aqueous solution; Specific gravity 1.26-1.48	Ferric chloride 37-42%; Hydrochloric acid <=1%

cm^3 = cubic centimeter
°C = degrees Celsius
°F = degrees Fahrenheit
gal = gallons
g = grams
lbs = pounds

Water Usage

Water Used On-Site	Notes	Amount	Units	Use/Fate	Ref.
Groundwater	A	894	gpm	Treat & discharge to LV Wash	4
Lake Mead	B	10,800,000	gal	Treat & discharge to LV Wash	3/5
Other water source	C	NA			2
Losses					
GW-11 evaporation	D	See Table 2 below for evaporation rates			2/6

gpm = gallons per minute

gal = gallons

NA = Not Applicable

Notes:

A) Figure 2 of the 2016 Semi-Annual Performance Memorandum notes an effluent discharge of 877 gpm from the treatment system to the Las Vegas Wash and a groundwater extraction rate of 893 gpm for the three well fields (combined average) from July through December 2016. The discrepancy is due to flow into and out of GW-11 as well as additions of stabilized Lake Mead water, which are used for various maintenance procedures.

B) Lake Mead water is used for GAC backwash events, which occur on average three times per month. Lake Mead water is also used for Fluidized Bed Reactor (FBR) polymer additions, GWTP polymer additions, washing down equipment in the treatment plant, sanitary water, seal water for FBR pumps, AP Area flushing, and AP-5 solids removal. After use, Lake Mead water is discharged to GW-11 and then eventually treated and discharged to the Las Vegas Wash, except for sanitary water which is discharged to an on-site septic system.

C) Personnel with Envirogen indicated that no other sources of water are used at the site.

D) There are no significant water losses other than evaporation from GW-11. No water is discharged to the local Publicly Owned Treatment Works (POTW). Using historic pan evaporation data (Shevenell 1996) and GW-11 stage area estimates by Envirogen, the following evaporation rates were calculated for GW-11 for July through December 2016:

Table 2: Estimated Evaporation Rates for GW-11

Month	Inches	Million gallons
July	15.8	5.5
August	13.7	4.8
September	11.1	4.0
October	7.6	2.6
November	4.6	1.6
December	3.3	1.1
Total	**56.1**	**19.7**

Waste Generated

Waste Generated	Hazardous Waste	Notes	Amount	Units	Treatment/disposal Site	Ref.
FBR sludge	No	A	55	tons	Disposed at Apex Industrial Solid Landfill in Apex, NV	2/7
GWTP sludge	No	B	0	tons	Disposed at Apex Industrial Solid Landfill in Apex, NV	2
Spent GAC	NA	C	0	lbs	Disposal on a non-routine basis	2
Other wastes generated	NA	D	NA			2

lbs = pounds

NA = Not Applicable

Notes:

A) This value represents the total dry tons of FBR sludge disposed of as waste during the period between July and December 2016. This value is based on information provided by Envirogen and compiled as part of the 4th Quarter 2016 National Pollutant Discharge Elimination System (NPDES) permit submittal.

B) According to Envirogen personnel, no GWTP sludge was disposed of during the period between July and December 2016.

C) According to Envirogen personnel, the GAC is tested annually for potential contaminant breakthrough and is replaced only if breakthrough is observed. The GAC was not replaced during the reporting period.

D) According to Envirogen personnel, no other process wastes were generated. Solids captured by the sand filter are recycled in the treatment plant and ultimately disposed of with the FBR sludge.

Personnel Transportation

Personnel/Activities	Notes	Number of Personnel	Estimated Trips to Site per Person	Average One-way Distance to Site (miles)	Ref.
GWETS operations and maintenance		5	84	15	8
		2	120	15	8
		4	150	15	8
Extraction well and conveyance maintenance		2	123	15	8
Groundwater monitoring		1	123	15	8
General site management		2	120	15	8
Director of Remediation		1	125	5	9
Other personnel site visits					
Chicago	A	1	6	1,510	9
Denver	A	1	3	610	10
		3	2		
		1	1		
Las Vegas Area		1	131	10	10
		1	4	15	
Minneapolis	A	1	2	1280	11
Nashville	A	1	4	1590	9
Phoenix	A	1	2	270	11
Sacramento	A	1	4	380	11
Salt Lake City	A	1	1	330	10
San Francisco Bay Area	A	1	5	410	11
	A	2	3		
	A	1	2		
	A	7	1		

Notes:

A) Air travel required.

Laboratory Analyses

Please see Table 3 (below) for a complete list of all analytes tested at the NERT site. The table provides estimated numbers of samples collected and analyzed between July and December 2016. The table was compiled based on information available from the Site's Analytical Database maintained by Ramboll Environ US Corporation (Ramboll Environ), and only includes sampling related to GWETS operations or the groundwater monitoring program. Quality Assurance (QA) and Quality Control (QC) samples, including equipment blanks, field blanks, trip blanks, and field duplicates, are also included.

Certain analytes are grouped as part of an analytical suite, designated in the table as follows:
Organochlorine pesticides (OCPs; 26 analytes): 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, Aldrin, Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260, Chlordane (total), Dieldrin, Endosulfan I, Endosulfan II, Endosulfan sulfate, Endrin, Endrin aldehyde, Heptachlor, Heptachlor epoxide, Methoxychlor, Toxaphene, alpha-BHC, beta-BHC, delta-BHC, gamma-BHC

Semivolatile Organic Compounds (SVOCs; 58 analytes): 1,2,4-Trichlorobenzene, 1,2-Dichlorobenzene, 1,2-Diphenylhydrazine, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 2,4,6-Trichlorophenol, 2,4-Dichlorophenol, 2,4-Dimethylphenol, 2,4-Dinitrophenol, 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, 2-Chloronaphthalene, 2-Chlorophenol, 2-Nitrophenol, 3,3'-Dichlorobenzidine, 4,6-Dinitro-2-methylphenol, 4-Bromophenyl-phenyl ether, 4-Chloro-3-methylphenol, 4-Chlorophenyl-phenyl ether, 4-Nitrophenol, Acenaphthene, Acenaphthylene, Aniline, Anthracene, Benzidine, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Butylbenzylphthalate, Chrysene, Di-n-butylphthalate, Di-n-octylphthalate, Dibenz(a,h)anthracene, Diethylphthalate, Dimethylphthalate, Fluoranthene, Fluorene, Hexachlorobenzene, Hexachlorobutadiene, Hexachlorocyclopentadiene, Hexachloroethane, Indeno(1,2,3-cd)pyrene, Isophorone, Naphthalene, Nitrobenzene, Pentachlorophenol, Phenanthrene, Phenol, Pyrene, bis(2-Chloro-1-methylethyl) ether, bis(2-Chloroethoxy)methane, bis(2-Chloroethyl) ether, bis(2-Ethylhexyl)phthalate, n-Nitroso-di-n-propylamine, n-Nitrosodimethylamine, n-Nitrosodiphenylamine

Table 3: Laboratory Analyses by Analyte, July - December 2016

Chemical	Number of Samples	Chemical	Number of Samples
1,1,1,2-Tetrachloroethane	37	Conductivity	4
1,1,1-Trichloroethane	45	Copper	4
1,1,2,2-Tetrachloroethane	45	Cumene	37
1,1,2-Trichloroethane	45	Cyanide (total)	2
1,1-Dichloroethane	45	Dibromochloromethane	45
1,1-Dichloroethene	45	Dibromomethane	37
1,1-Dichloropropene	37	Dichlorodifluoromethane	37
1,2,3-Trichlorobenzene	37	Dissolved Oxygen	26
1,2,3-Trichloropropane	74	Dissolved Solids (total)	652
1,2,4-Trichlorobenzene	37	Ethyl benzene	45
1,2,4-Trimethylbenzene	37	Ethyl tert-butyl ether	37
1,2-Dibromo-3-chloropropane	37	Field pH	525
1,2-Dibromoethane	37	Hexachlorobutadiene	37
1,2-Dichlorobenzene	37	Hexane extractable material	4
1,2-Dichloroethane	45	Iron	53
1,2-Dichloropropane	45	Lead	4
1,3,5-Trimethylbenzene	37	m,p-Xylene	37
1,3-Dichlorobenzene	37	Manganese	18
1,3-Dichloropropane	37	Mercury	4
1,4-Dichlorobenzene	37	Methylene Chloride	45
1,4-Dioxane	37	Naphthalene	37
2,2-Dichloropropane	37	n-Butylbenzene	37
2,3,7,8-Tetrachlorodibenzofuran	4	Nickel	4
2,3,7,8-Tetrachlorodibenzo-p-dioxin	4	Nitrate	340
2-Butanone	37	Nitrite	97
2-Chloroethylvinyl ether	8	Nitrogen, Nitrate-Nitrite	96
2-Chlorotoluene	37	n-Propylbenzene	37
4-Chlorotoluene	37	OCPs	4
Acrolein	8	Organic Halides (total)	5
Acrylonitrile	8	o-Xylene	37
Ammonia (as N)	81	p-Cymene	37
Antimony	4	Perchlorate	804
Apparent Color	58	pH	59
Arsenic	5	Phenolics, Recoverable (total)	4
Benzene	45	Phosphorus (total)	65
Beryllium	4	sec-Butylbenzene	37
Boron	49	Selenium	5
Bromobenzene	37	Silver	4
Bromochloromethane	37	Sodium	4
Bromodichloromethane	45	Styrene	37
Bromoform	45	Sulfate	38
Bromomethane	45	Sulfide (total)	12
Cadmium	4	SVOCs	4
Calcium	2	tert-Butylbenzene	37
Carbon	4	Tetrachloroethene	45
Carbon tetrachloride	45	Thallium	4
Carbonaceous Biochemical Oxygen Demand	52	Toluene	45
Chlorate	300	Total Inorganic Nitrogen (calculated)	67
Chloride	38	Total Kjeldahl Nitrogen	52
Chlorobenzene	45	Total Suspended Solids	28
Chloroethane	45	trans-1,2-Dichloroethene	45
Chloroform	45	trans-1,3-Dichloropropene	45
Chloromethane	45	Trichloroethene	45
Chromium (total)	700	Trichlorofluoromethane	37
Chromium VI	457	Vinyl chloride	45
cis-1,2-Dichloroethene	45	Weak acid dissociable cyanide	2
cis-1,3-Dichloropropene	45	Zinc	4

Contaminants Removed or Destroyed

Contaminant	Notes	Amount Removed or Destroyed	Units	Ref.
Perchlorate	A	92	tons	4
Total chromium	A	0.6	tons	4

Notes:

A) Mass removal estimates are presented in Table 5 and Table 7 of the 2016 Semi-Annual Performance Memorandum.

References

1) Energy invoices provided by the Nevada Environmental Response Trust.

2) Internal Envirogen documents and correspondence with Envirogen personnel.

3) Correspondence with Tetra Tech personnel.

4) 2016 Semi-Annual Remedial Performance Memorandum for Chromium and Perchlorate.

5) GWETS Field Sheet, maintained by Envirogen and Tetra Tech.

6) Shevenell, Lisa, 1996. Nevada Bureau of Mines and Geology, Report 48: Statewide Potential Evapotranspiration Maps for Nevada.

7) Supporting documentation for quarterly permit submittals for NPDES Permit NV0023060, received from Envirogen.

8) Estimates of travel provided by Envirogen personnel.

9) Estimates of travel provided by the Nevada Environmental Response Trust.

10) Estimates of travel provided by Tetra Tech.

11) Estimates of travel provided by Ramboll Environ.