



SOIL MONITORING REPORT

6069 Hannegan Road
Bellingham, Washington 98226



Prepared For:

Jason Reynold
6069 Hannegan Road
Bellingham, WA 98226

December 13, 2019
Project No. PB0305608

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Bellingham, Washington 98226**

Report Prepared for:

**Jason Reynold
6069 Hannegan Road
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by



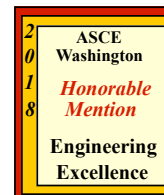
December 13, 2019

Austin X. Huang, Ph.D., P.E., L.G.
Principal

**Project No. PB0305608
December 13, 2019**

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Jason Reynold
Jason@AmCan-QSS.com



Re: Soil Monitoring, Permit #ST00007285
6069 Hannegan Road
Bellingham, Washington 98226

Dear Jason Reynold:

At your request, we have conducted soil monitoring at the above reference site as is required by State Waste Discharge Permit Number ST00007285.

Samples were collected beginning of the growing season on November 8, 2019 in the field. Five (5) sampling locations were selected within the spray field, one (1) site in the center of the spray field and four (4) randomly selected. Samples were collected on one-foot soil increments at 6", 18", 30", and 42" depth. Composite of five (5) core samples at the depth increments have been tested.

The facility and Ecology use the soil monitoring data to monitor and evaluate wastewater application rates and to determine if salts and nutrients are flushing beyond the root zone and leaching to the groundwater. The presence and concentration of certain wastewater related parameters in the soils (e.g., nitrate and salts) can indicate over application of wastewater. The facility must follow the analytical methods provided in Soil, Plant and Water Reference Methods for the Western Region (2003). Constituents proposed for monitoring are those that have the highest potential to result in an impact to soil and/or groundwater.

Results are presented below:

Total Nitrogen

Total Nitrogen (mg/kg)	6" depth	42" depth
April 2019	2780	274
November 2019	4990	270

Total Nitrogen (lb/ac)	6" depth	42" depth
April 2019	5560	548
November 2019	9980	540

Total nitrogen analysis measures N in all organic and inorganic forms. Total N is not used for fertilizer recommendations. Only 1 to 4 percent of total N becomes plant-available during a growing season. (Horneck, 2011) The potential that the total nitrogen has been flushed through root zone is low.

The 6" depth total nitrogen concentration increased from 2780 mg/kg to 4990 mg/kg from April 2019 to November 2019. At 48" depth, it decreased from 274 mg/kg to 270 mg/kg from April 2019 to November 2019.

Sodium Adsorption Ratio

Sodium Adsorption Ratio (%)	6" depth	42" depth
April 2019	5.05	1.53
November 2019	2.35	1.5

When Sodium Adsorption Ratio (SAR) is greater than 13, the soil is called a sodic soil (Sonon, 2016). Excess sodium in sodic soils causes soil particles to repel each other, preventing the formation of soil aggregates. Both 6" and 42" depth SAR are below 13, and do not appear to repel soil particles.

Chloride

Chloride (mg/kg)	6" depth	18" depth	30" depth	42" depth
April 2019	17	21	23	28.7
November 2019	14.1	18.7	20.1	28.8

Chloride is supplied with irrigation water and from organic sources such as manure and compost. Chloride concentration has dropped from over 50 mg/Kg in 2018 to around 20 mg/Kg. The 6" and 18" have medium chloride concentration (10-20 mg/kg). The 30" and 42" depth have high chloride concentration (20-50 mg/kg). According to Chloride soil test categories and suggested fertilizer rate recommendations chart, no fertilizer is recommended (Horneck, 2011).

Sulfate

Sulfate (mg/kg)	6" depth	42" depth
April 2019	17	6.4
November 2019	6.1	9.2

6" and 42" depth have medium soil sulfate concentration (5-20 mg/kg), according to Sulfate-sulfur soil test categories and suggested fertilizer rate recommendations by Horneck, 0-20 lb S/acre fertilizer rate is recommended.

Ammonia – N

Ammonia – N (mg/kg)	6" depth	42" depth
April 2019	234	33
November 2019	255	ND

Ammonia- N does not accumulate in the soil, as soil temperature and moisture conditions suitable for plant growth also are ideal for conversion of ammonia-N to nitrate-N. Ammonia-N concentrations at 6" depth increased from 234 mg/kg to 255 mg/kg from April 2019 to November 2019. At 42" depth, it is not detectable.

pH

pH	6" depth	18" depth	30" depth	42" depth
April 2019	6.38	7.45	7.40	7.14
November 2019	6.12	6.40	6.27	6.5

When pH is within the range of 6.0 to 8.2, crops can grow best. All depths have pH within this range, and pH are neutral. (Laboratories, 2017).

Cation Exchange Capacity

Capacity (Meq/100g)	6" depth	18" depth	30" depth	42" depth
April 2019	18.3	14.1	14.5	12.4
November 2019	18.8	20.4	17.5	10.3

Cation Exchange Capacity (CEC) is a measure of a soil's capacity to retain and release elements such as K, Ca, Mg, and Na. Soils with high clay and/or organic matter content have high CEC. Sandy, low organic matter soils have low CEC. 6" and 18" soil has higher organic matter content, therefore, has higher CEC than other depths.

Soils with CEC in the range of 5 – 15 mg q/100g are usually loam (Laboratories, 2017).

Organic Matter

Organic Matter (%)	6" depth	42" depth
April 2019	5.1	0.7
November 2019	8.5	0.5

Soil organic matter (OM) is a surrogate for soil carbon and is measured as a reflection of overall soil health. When monitored for several years, it gives an indication whether soil quality is improving or degrading. Soil OM is important to a wide variety of soil chemical, physical, and biological properties. Most productive agricultural soils have between 3% and 6% organic matter. (Megan F., 2008) The top soil at 6" has a rich organic matter content may due to area receiving large amounts of compost or other organic residue. (Horneck, 2011)

Exchangeable Sodium Percentage

Exchangeable Sodium Percentage (%)	6" depth	42" depth
April 2019	5.3	12.4
November 2019	12	21.2

The presence of excessive amounts of exchangeable sodium reverses the process of aggregation and causes soil aggregates to disperse into their constituent individual soil particles. At 6" depth soil can be defined as moderately sodic soil (10-15 %); While the 42" depth soil has excessive Exchangeable Sodium Percentage (15-25 %), soil dispersion resulting in poor soil physical condition and poor plant growth are likely (Lamond, 1992).

Moisture In Solids

Moisture In Solids (%)	6" depth	18" depth	30" depth	42" depth
April 2019	30.80	25.17	24.29	21.46
November 2019	41.85	26.64	22.82	25.08

This soil was generally very wet at the time of sample collection, with around 29.10% of moisture content.

Total Nitrate/Nitrite

Total Nitrate/ Nitrite (mg/kg)	6" depth	18" depth	30" depth	42" depth
April 2019	5.2	2.8	1.7	ND
November 2019	7.59	3.56	2.75	1.14

The 6" total nitrate/nitrite concentrations increased from 5.2 mg/Kg to 7.59 mg/Kg from April 2019 to November 2019. The concentration at 18" depth has been increased from 2.8 mg/Kg to 3.56 mg/Kg. The results from deeper soil are similar with the results from previous studies. This may be due to previous fertilization.

Electrical Conductivity

Electrical Conductivity (uS/ cm)	6" depth	18" depth	30" depth	42" depth
April 2019	249	189	229	202
November 2019	277	242	264	212

Electrical conductivity measures the ability of the soil solution to conduct electricity. Increases in soluble salts result in proportional increases in the solution electrical conductivity (Sonon, 2016). According to U.S. Salinity Laboratory Staff (1954), a saline soil has an electrical conductivity of the saturated paste extract of more than 4 dS/m (4000 uS/cm), a value that corresponds to approximately 40 mmol salts per liter. Crops vary in their tolerance to salinity and some may be adversely affected at electrical conductivity less than 4000 uS/cm. (Electrical Conductivity (EC), 2015)

Calcium

Calcium (mg/kg)	6" depth	42" depth
April 2019	5000	5660
November 2019	2610	4210

Magnesium

Magnesium (mg/kg)	6" depth	42" depth
April 2019	4270	4330

Magnesium (mg/kg)	6" depth	42" depth
November 2019	2200	4300

Calcium/Magnesium ratio ranges from 1:1 to 2:1, which can support normal plant growth (Kelling, 1992).

Sodium

Sodium (mg/kg)	6" depth	18" depth	30" depth	42" depth
April 2019	2020	558	861	631
November 2019	678	641	903	580

There is relatively low potential for the sodium to flush beyond the root zone and leach to the groundwater, and result in an impact to soil and/or groundwater.

Soil at depth 30" has the highest sodium concentration, and 42" has the lowest sodium concentration.

Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (mg/kg)	6" depth	42" depth
April 2019	600	274
November 2019	4980	269

There is no requirement for Total Kjeldahl Nitrogen. Total Kjeldahl Nitrogen (TKN) analysis determines both the organic and the inorganic forms of nitrogen.

Conclusion

Based on our review of the soil monitoring data from November 2019, it is our opinion that the soil quality at this time does not raise significant issue or concern.



Thank you for this opportunity to work with you. Please contact us if you have any questions about this report.

Sincerely,

Austin Huang, Ph.D., P.E., LG., F.ASCE, D.GE

Principal

Diplomate - Academy of Geo-Professionals

Fellow - American Society of Civil Engineering

D.GEs provide successful projects that benefit their clients.

The D.GE certification recognizes geotechnical engineers who possess specialty education, extensive experience, integrity, and good judgment.

References

Sonon, L. S. (2016, June 13). Retrieved from Soil Salinity Testing, Data Interpretation and Recommendations: <http://extension.uga.edu/publications/detail.cfm?number=C1019>

D.A. Horneck, D. S. (1996). Soil Test Interpretation Guide. Corvallis: Oregon State University Extension Service.

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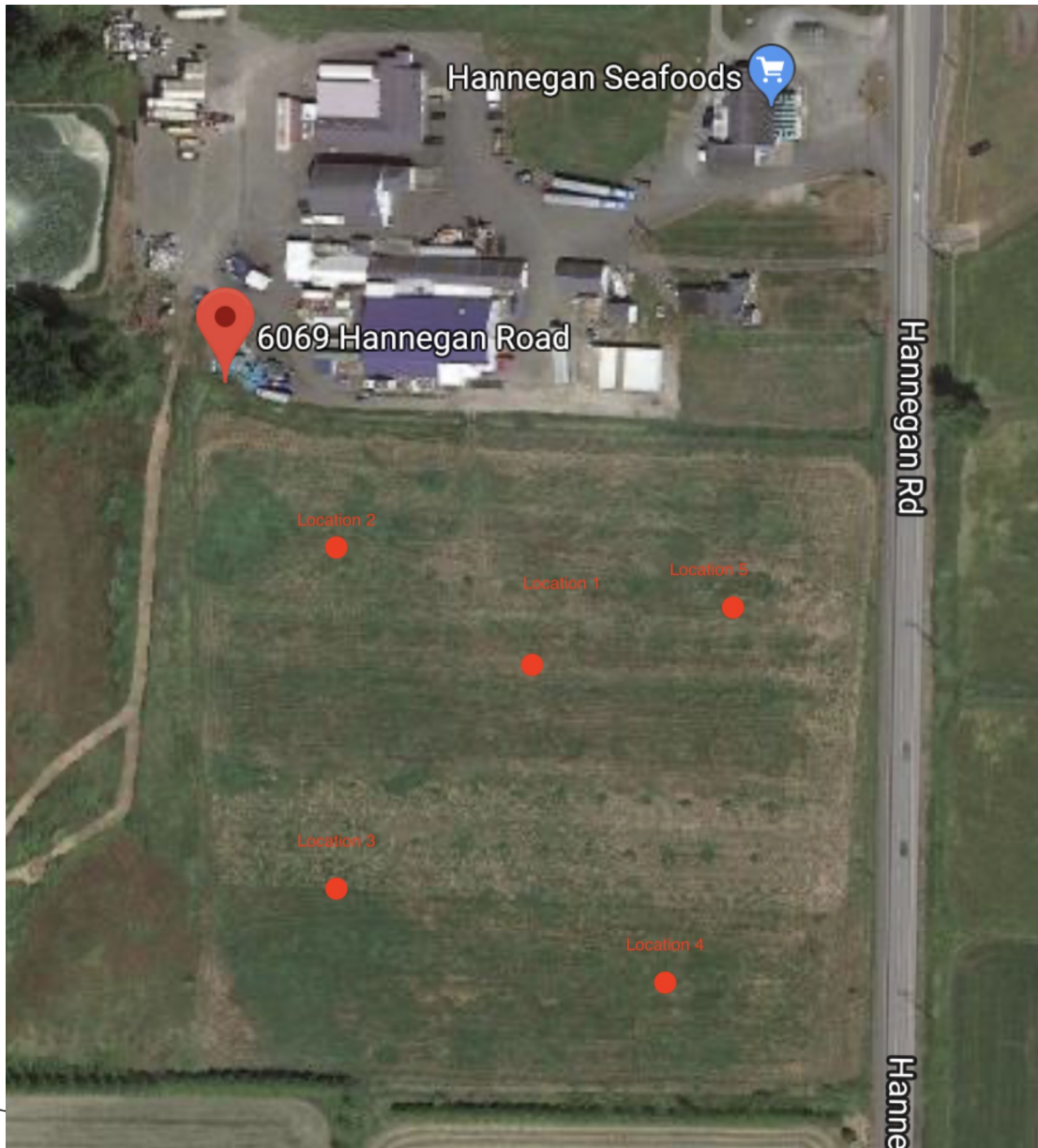
Megan F., C. A. (2008). Cornell University Cooperative Extension Agronomy Fact Sheet Series, Fact Sheet 41. Cornell University Cooperative Extension.


Lamond, R. a. (1992). Management of saline and sodic soils. Kansas State University, Department of Agronomy MF-1022.

Electrical Conductivity (EC) . (June 21 2015) <http://www.aqion.de/site/130>

Kelling, K. A. (1992). Soil and applied calcium. Madison, WI: University of Wisconsin--Extension.

Horneck, Donald A. (2011) "Soil Test Interpretation Guide." Michigan State University Food System, MSU, https://www.canr.msu.edu/foodsystems/uploads/files/soil_test_interpretation.pdf.



Project No. PB0305608	PROJECT LOCATION & VICINITY MAP	Date: 12/13/2019	<i>Figure 1</i>
Soil Monitoring 6069 Hannegan Rd Bellingham, WA 98226	 MERIT ENGINEERING INC. 10129 Main Street #201 Bellevue, Washington 98004 Telephone: (425) 454-2133 http://www.MeritEngineering.com		

For: Jason Reynold



Burlington, WA Corporate Laboratory (a)
1620 S Walnut St - Burlington, WA 98233 - 800.755.9295 • 360.757.1400
Bellingham, WA Microbiology (b)
805 Orchard Dr Ste 4 - Bellingham, WA 98225 - 360.715.1212

Portland, OR Microbiology/Chemistry (c)
9150 SW Pioneer Ct Ste W - Wilsonville, OR 97070 - 503.682.7802
Corvallis, OR Microbiology/Chemistry (d)
1100 NE Circle Blvd, Ste 130 - Corvallis, OR 97330 - 541.753.4946
Bend, OR Microbiology (e)
20332 Empire Blvd Ste 4 - Bend, OR 97701 - 541.639.8425

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Data Report

Client Name: Merit Engineering, Inc.
10129 Main St. Suite 201
Bellevue, WA 98004

Reference Number: **19-43017**
Project: Hannegan Properties Soil
Test

Report Date: 12/5/19

Date Received: 11/8/19

Approved by: ajw,bj,bsp,mle

Authorized by:

Lawrence J Henderson, PhD
Director of Laboratories, Vice President

Sample Description: Composite 6"								Matrix S	Sample Date: 11/8/19 3:17 pm			
Lab Number: 83086		Sample Comment:						Collected By: Judy Zhu				
CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment
NA	TOTAL NITROGEN	4990	1		mg/Kg	1.0	<SUM>	a	11/22/19	BSP	TN_191122	
16887-00-6	CHLORIDE	14.1	1.6		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
14808-79-8	SULFATE	6.1	3.2		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
7664-41-7	AMMONIA-N	255	57		mg/Kg	1.0	350.1	a	11/21/19	BSP	350.1_191121BS	
E-10264	TOTAL KJELDAHL NITROGEN	4980	1426		mg/Kg	50.0	351.2	a	11/21/19	BSP	351.2_191121BS	
7440-70-2	CALCIUM	2610	28		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7439-95-4	MAGNESIUM	2200	28		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7440-23-5	SODIUM	678	28		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
	SODIUM ADSORPTION RATIO	2.35				1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
E-10139	HYDROGEN ION (pH)	6.12			pH Units	1.0	9045D	a	11/18/19	BSP	9045D_191118	Temp (C) : 23.1, 20g:20mL
NA	CATION EXCHANGE CAPACITY	18.8	0.100	0.100	meq/100g	1.0	S-10.10		11/19/19	KEB	soil_191119	
E-10184	ELECTRICAL CONDUCTIVITY	277	10		uS/cm	1.0	S-2.20	a	12/2/19	BSP	EC.S_191202	
NA	ORGANIC MATTER	8.5	0.1	0.1	%	1.0	S-9.10		11/19/19	KEB	soil_191119	
	Exchangeable Sodium Percentage	12	0		%	1.0	SM-		11/19/19	KEB	soil_191119	
	Moisture In Solids	41.58	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10151	TOTAL SOLIDS FOR CALCULATION	58.42	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10128	TOTAL NITRATE/NITRITE	7.59	0.20		mg/Kg	1.0	SM4500-NO3 F	a	11/12/19	BSP	NO3NO2_191112	

Sample Description: Composite 18"								Matrix S		Sample Date: 11/8/19 3:17 pm		
Lab Number: 83087		Sample Comment:						Collected By: Judy Zhu				
CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment
16887-00-6	CHLORIDE	18.7	1.2		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
14808-79-8	SULFATE	4.7	2.5		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
7440-70-2	CALCIUM	3910	33		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7439-95-4	MAGNESIUM	3060	33		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	

Notes:

ND = Not detected above the listed practical quantitation limit (PQL) or not above the Method Detection Limit (MDL), if requested.
PQL = Practical Quantitation Limit is the lowest level that can be achieved within specified limits of precision and accuracy during routine laboratory operating conditions.
D.F. = Dilution Factor

If you have any questions concerning this report contact us at the above phone number.

Form: cRslt_2.rpt

Data Report

7440-23-5	SODIUM	641	33		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7440-23-5	SODIUM	641	33		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
	SODIUM ADSORPTION RATIO	1.86				1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
E-10139	HYDROGEN ION (pH)	6.40			pH Units	1.0	9045D	a	11/18/19	BSP	9045D_191118	Temp (C) : 23.1, 20g:20mL
NA	CATION EXCHANGE CAPACITY	20.4	0.100	0.100	meq/100g	1.0	S-10.10		11/19/19	KEB	soil_191119	
E-10184	ELECTRICAL CONDUCTIVITY	242	10		uS/cm	1.0	S-2.20	a	12/2/19	BSP	EC.S_191202	
	Moisture In Solids	26.64	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10151	TOTAL SOLIDS FOR CALCULATION	73.36	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10128	TOTAL NITRATE/NITRITE	3.56	0.16		mg/Kg	1.0	SM4500-NO3 F	a	11/12/19	BSP	NO3NO2_191112	

Sample Description: Composite 30"								Matrix S	Sample Date: 11/8/19 3:17 pm			
Lab Number: 83088		Sample Comment:						Collected By: Judy Zhu				
CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment

NA	TOTAL NITROGEN	302	1		mg/Kg	1.0	<SUM>	a	11/22/19	BSP	TN_191122	
16887-00-6	CHLORIDE	20.1	1.2		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
14808-79-8	SULFATE	6.2	2.5		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
E-10264	TOTAL KJELDAHL NITROGEN	299	20		mg/Kg	1.0	351.2	a	11/21/19	BSP	351.2_191121BS	
7440-70-2	CALCIUM	4400	38		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7439-95-4	MAGNESIUM	3040	38		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7440-23-5	SODIUM	903	38		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
	SODIUM ADSORPTION RATIO	2.55				1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
E-10139	HYDROGEN ION (pH)	6.27			pH Units	1.0	9045D	a	11/18/19	BSP	9045D_191118	Temp (C) : 23.0, 20g:20mL
NA	CATION EXCHANGE CAPACITY	17.5	0.100	0.100	meq/100g	1.0	S-10.10		11/19/19	KEB	soil_191119	
E-10184	ELECTRICAL CONDUCTIVITY	264	10		uS/cm	1.0	S-2.20	a	12/2/19	BSP	EC.S_191202	
NA	ORGANIC MATTER	1.4	0.1	0.1	%	1.0	S-9.10		11/19/19	KEB	soil_191119	
	Exchangeable Sodium Percentage	20.7	0		%	1.0	SM-		11/19/19	KEB	soil_191119	
	Moisture In Solids	22.82	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10151	TOTAL SOLIDS FOR CALCULATION	77.18	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10128	TOTAL NITRATE/NITRITE	2.75	0.77		mg/Kg	5.0	SM4500-NO3 F	a	11/12/19	BSP	NO3NO2_191112	

Sample Description: Composite 42"								Matrix S	Sample Date: 11/8/19 3:17 pm			
Lab Number: 83089		Sample Comment:						Collected By: Judy Zhu				
CAS ID#	Parameter	Result	PQL	MDL	Units	DF	Method	Lab	Analyzed	Analyst	Batch	Comment

NA	TOTAL NITROGEN	270	1		mg/Kg	1.0	<SUM>	a	11/22/19	BSP	TN_191122	
16887-00-6	CHLORIDE	28.8	1.0		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
14808-79-8	SULFATE	9.2	2.1		mg/Kg	1.0	300.0	a	11/13/19	AJW	IC02_191112A	
7664-41-7	AMMONIA-N	ND	12		mg/Kg	1.0	350.1	a	11/21/19	BSP	350.1_191121BS	
E-10264	TOTAL KJELDAHL NITROGEN	269	50		mg/Kg	5.0	351.2	a	11/21/19	BSP	351.2_191121BS	
7440-70-2	CALCIUM	4210	18		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7439-95-4	MAGNESIUM	4300	18		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
7440-23-5	SODIUM	580	18		mg/Kg	1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	

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Data Report

	SODIUM ADSORPTION RATIO	1.5				1.0	6010D/3051	a	11/13/19	BJ	6010_191113A	
E-10139	HYDROGEN ION (pH)	6.50			pH Units	1.0	9045D	a	11/18/19	BSP	9045D_191118	Temp (C) : 23.0, 20g:20mL
NA	CATION EXCHANGE CAPACITY	10.3	0.100	0.100	meq/100g	1.0	S-10.10		11/19/19	KEB	soil_191119	
E-10184	ELECTRICAL CONDUCTIVITY	212	10		uS/cm	1.0	S-2.20	a	12/2/19	BSP	EC_S_191202	
NA	ORGANIC MATTER	0.5	0.1	0.1	%	1.0	S-9.10		11/19/19	KEB	soil_191119	
	Exchangeable Sodium Percentage	21.2	0		%	1.0	SM-		11/19/19	KEB	soil_191119	
	Moisture In Solids	25.08	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10151	TOTAL SOLIDS FOR CALCULATION	74.92	0.10		%	1.0	SM2540 G	a	11/12/19	AJW	TS_191111	
E-10128	TOTAL NITRATE/NITRITE	1.14	0.13		mg/Kg	1.0	SM4500-NO3 F	a	11/12/19	BSP	NO3NO2_191112	

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