Water and Waste Department • Service des eaux et des déchets

Summit Landfill Soil Fabrication Pilot Project

Year One Annual Report

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Prepared For:

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Introduction

The City produces approximately 50,000 tonnes of biosolids at the North End Sewage Treatment Plant (NEWPCC) per year. In 2014, the City released a Biosolids Master Plan that outlined strategies to maximize nutrient recovery and recycling, and the beneficial reuse of biosolids.

On May 7, 2018 the City of Winnipeg received approval from Manitoba Sustainable Development (MSD) under the Exemption Clause (6) of the *Classes of Development Regulation* to commence the three year Summit Soil Fabrication pilot project, 2018-2020, examining the viability of fabricating soil with biosolids to complete the cap system at Summit Landfill. This annual report covers the initial preparation work and results from the first operational year. The main goals for Year One were to establish site logistics, and operational efficiency through testing equipment and processes.

The main findings from Year One are:

- Soil fabrication at Summit Road Landfill has the capacity to accept all biosolids loads during operation
- Soil fabrication operations produced no odour, dust or vector issues
- Fabricated soil mixed and spread by a manure spreader met the allowable industrial criteria for soil quality based on the CCME Guidelines for the protection of Environment and Human Health.

Soil fabrication allows the City to divert more biosolids from being buried at the Brady Road Resource Management Facility (BRRMF). Utilizing biosolids and other organic residuals in soil fabrication and vegetation establishment can reduce the cost of landfill closure, the need to import non-renewable sources of topsoil from other sites, and provide a beneficial use opportunity for multiple regionally generated residuals.

Vision and Goals

The vision for this project is an operational-scale demonstration of an all-season, ongoing operation that utilizes residuals as feedstocks to fabricate soil blends tailored to complete the cap system at Summit Landfill while protecting human health and the environment. Using biosolids, street sweepings, and wood chips, the soil blends are designed to be environmentally protective, support vegetative growth, while restoring the landfill to a native prairie landscape.

In order to achieve this vision, the City of Winnipeg has designed this pilot project with three primary goals:

- Demonstrate that biosolids fabricated soil is a viable, environmentally sound option for completion of the cap system of Summit landfill, specifically producing a growing media that can

be placed as a topsoil layer to permanently support a vegetated prairie ecosystem of native grasses and forbs

- Demonstrate soil fabrication is an operationally viable multi-season beneficial use option for biosolids, and a diversion option for several other residuals, including wood waste from City arboriculture, and mineral material from street sweepings and other sources.
- Produce sufficient information to complete a business case for an ongoing soil fabrication operation, provide and support capacity development opportunities for City staff, and identify interdepartmental operational efficiencies and shared benefits.

Timeline

This pilot project will span three years, from 2018 to 2020. Each study year will be informed by previous results and timelines and designs may change. Mixing operations, timing and volumes in Year Two and Three will be informed by results obtained during Year One. Year One of the study consisted of a rough timeline of:

a) Winter: Plan development and operational preparation
b) May 28 to June 22: Operational phase
c) Summer: monitoring, analysis and preparation for second operational phase
d) November 5 to November 30: Second operational phase

Year One had one warm weather and one cold weather operational phase. The original plan for each operational year was to include one warm and one cold weather phase. However, with further discussion and coordination with the Land Application pilot project, it was determined that a focus on cold weather operations for soil fabrication would maximize the volume of biosolids able to be diverted across both operations. Whereas land application can only happen at certain times and under certain conditions during the year, soil fabrication can operate during all seasons. Soil fabrication operations in Year Two and Three will focus on times of the year not conducive to land application.

Feedstocks Volumes

Biosolids fabricated soil consists of three main feedstocks: biosolids, a mineral source, and a carbon source. Year One operations utilized biosolids from NEWPCC, wood chips, and street sweepings.

Biosolids: wastewater residuals that have been treated and stabilized through digestion and dewatering. A total of 7,005 tonnes, which is approximately 7,005 m^3 were used in Year One.

Mineral Source: The mineral source for Year One is screened street sweepings. Each year this process produces approximately 16,000 m^3 of sand, depending on the nature of the preceding winter. Approximately 21,000m^3 were used in Year One.

Carbon Source: Year One focused on wood waste from the Public Works Department tree management program. This includes, but is not limited to, elm and ash wood waste. Wood chips were also accepted from other contracted operations. Approximately 14,000m^3 were used in Year One.

A wood chipping operation pilot project was established at Summit Landfill in July of 2018. This commercial operation accepted Dutch Elm diseased wood which was chipped on site. Wood chips from this operation will be used in the next phases of soil fabrication.

Fabricated Soil: Based on drone surveys, a total of 30,000 m^3 of fabricated soil was produced in Year One. Fabricated soil volume is a result of biosolids and street sweepings filling the voids in wood chip volumes. Additionally, windrowed fabricated soil has shown to have approximately 30% volume settlement. This volume 'fluffs up' during spreading, but then settles again over time.

Operations

The soil blend of 1(biosolids):2(wood chips):3(sweepings) was determined by bench scale testing (Technical Memorandum Bench-Scale Soil Fabrication for Use at Summit Landfill May 11, 2018). Feedstock ratios were tracked through loader bucket counts.

Year One operations utilized 7,005 m^3 of biosolids, approximately 14,000 m^3 of wood chips and 20,000 m^3 of street sweepings. The material for both phases was layered and left in windrows before spreading. Approximately half of the fabricated soil (Y1P1) was spread, using a manure spreader, in the fall of 2018. The soil plot covered 3.5 ha. Year One Phase Two (Y1P2) fabricated soil was windrowed and will be spread in spring of 2019. The Y1P2 windrow area covers approximately 5 ha.

Site layout and photographs from the operation can be found in Appendix A and B, respectively.

Environmental Results

Weather

Operational conditions in Year One ranged from 35°C to -21°C. Operations were manageable across the temperature range. Cold weather conditions were conducive to operations due to solid travel surfaces.

Odour

Biosolids odour was detected in the operating area during receiving operations. Odours were observed to be reduced after mixing biosolids with woodchips and street sweepings. No odours were reported at the street sweepings area (20-300m south of the soil operating area) during mixing operations.

On June 18th, a stronger ammonia odour was observed during the manure spreader trial. Winds on this day were west-north-west. Street sweepings operators reported they observed the ammonia odour on this day. No odours were detected offsite during the biosolids receiving or soil spreading operations.

No odour complaints were received through 311 or other public sources.

Soil

Background soil samples of the clay cap of the Y1P1 plot, and the control plot were taken on May 7th and 8th, 2018 and analysed (Appendix C).

On June 18th, 2018 a manure spreader was used to mix and spread fabricated soil to a depth of 0.6m on designated plots. The purpose of this test was to see if this equipment could adequately provide a secondary mix and spread the fabricated soil to the required depth.

Manure Spreader Test

The manure spreader was tested using fresh material delivered to the site that day and placed into layered piles, as well as material that had been preliminarily mixed and stockpiled over a couple of weeks. Two test plots approximately 20m wide by 30m long were spread with these two separate mixes. Soil samples were taken at a depth of 0-60 cm from these test plots. These samples were examined in field for bulk density and texture, and then sent to the lab for further testing. Soil trace element concentrations meet the industrial standards for CCME Soil Quality Guidelines for the Protection of Environmental and Human Health (Appendix C). With the exception of zinc, the soil samples also meet the British Columbia criteria for biosolids growing media, which was used as a guide in developing the soil mix ratio. In the fall, once all the soil is spread evenly across the plot at a depth of 0.6m, soil samples will be taken to assess Y1P1 soil quality.

Compost Turner Test

A test windrow was created at the Brady Road Resource Management Facility (BRRMF), biosolids composting facility to test a pull behind compost turner. The leaf and yard waste compost turner was used to mix the test windrow. Two passes of the turner effectively mixed together all the material. The turner operator reported no concerns moving through the material.

Vegetation

Vegetation was observed on fabricated soil windrows over the summer, as well as on the stockpiled street sweepings. Vegetation growth on the fabricated soil windrows was mostly annual weeds, brought in through the street sweepings. Vegetation growth was most prominent on windrows which had been preliminarily mixed, versus windrows where the material had been placed in layered piles. Some mushrooms and other fungi were observed on all windrows. Interestingly, tomato, corn and bean plants were all observed in the mixed windrows, most likely introduced from the street sweepings.

On the plots spread by the manure spreader, two 4m x 4m test plots were seeded to check the viability of the soil to grow native species. On half of the plots a cover crop of oats was used to see if this

improved the success rate of the native grasses. These plots were planted in the middle of July, and due to the dry summer required additional irrigation to improve germination. The plots were successful in germinating native grasses, particularly the side with the cover crop which reduced annual weeds from growing (Appendix D). Vegetation sampling will be done in the autumn of 2019 once Year One material has all been spread and seeded.

Surface Water

The project is located within the boundaries of the Summit Road Landfill leachate and surface water collection and containment system. Surface water was not sampled around the windrow stockpiles. Surface water will be sampled after the material is spread and seeded. The first samples will be taken in spring of 2019.

Vectors

No vectors were observed during the operational phase.

Dust, noise, nuisance

There were no dust, noise or nuisance concerns during operations.

Year Two

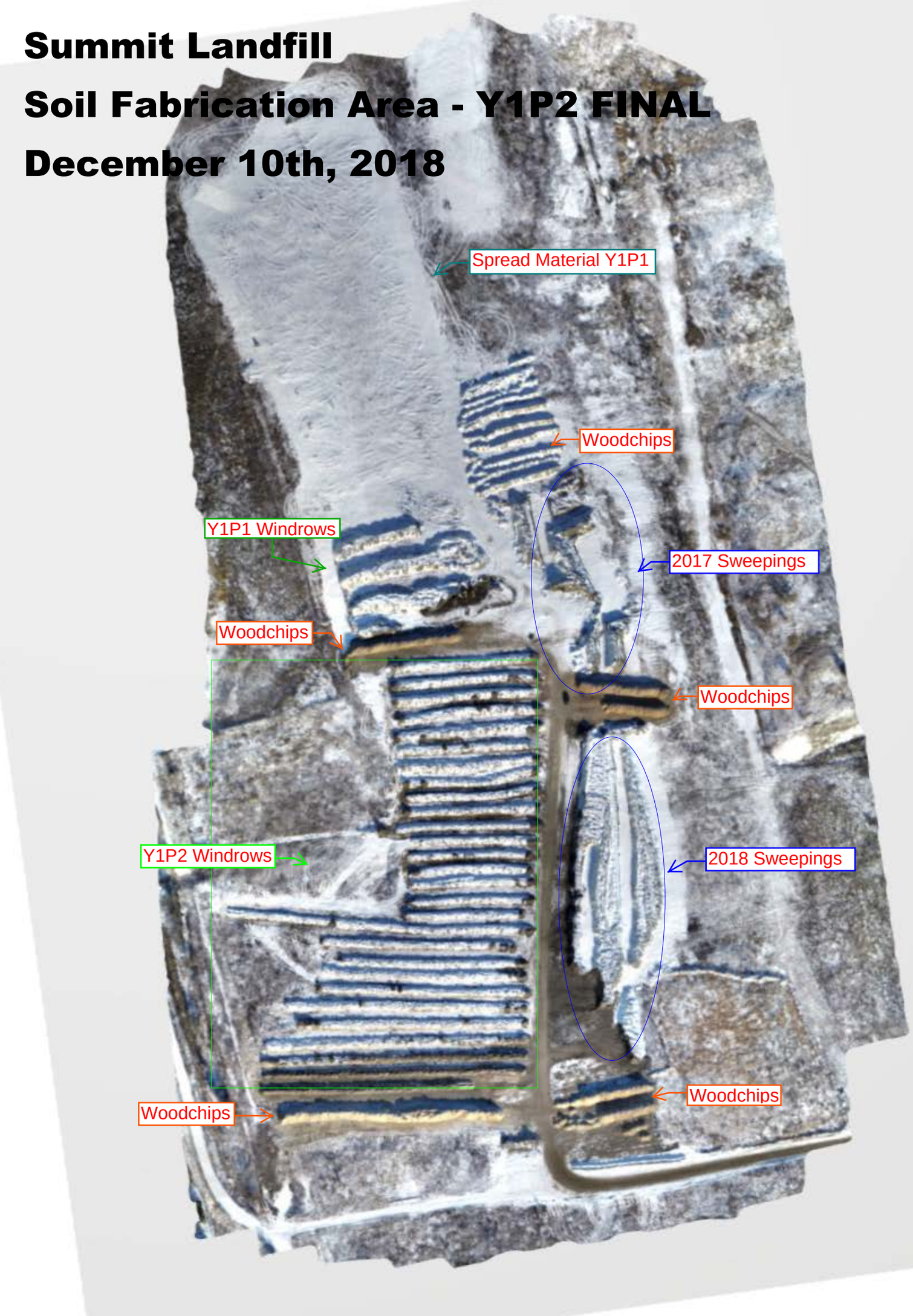
Year Two will double the volume of biosolids received over two, two-month long operational phases. Year Two will include spreading and seeding operations, and environmental monitoring including surface water, soil, and vegetation monitoring and analysis. Additionally, testing of additional mineral feedstocks is expected in 2019. The timeline is roughly as follows:

- Y2P1 Biosolids receiving operation: February 4 to March 29th
- Y1P1 soil plot seeding: early spring
- Y1P2 and Y2P1 secondary mixing, spreading, and seeding: May and early June
- Surface water and soil sampling: Spring
- Mineral Source Testing: Spring, Summer
- Y2P2 Biosolids receiving operation: October 14 to December 13th, 2019

Summit Landfill

Soil Fabrication Area - Y1P2 FINAL

December 10th, 2018



Summit Landfill

Soil Fabrication Area - Y1P2 START

November 5th, 2018

Year One - Ratio Pile Formations

"Beaver Hut" Formation vs. "Taco" Windrows.

With the beaver hut style of ratio piles the wood chips were placed directly at the base of the pile. Either on the ground or on top of an existing pile.

Biosolids are placed directly on top of the wood chips

Street sweepings are placed on top of the biosolids.
The issue with this is that the sweepings push the biosolids over the woodchips and out the side of the pile, resulting in exposed biosolids.

With the taco style of ratio piles, the wood chips are placed side by side. Creating an envelope for the biosolids to sit in.

Biosolids are placed in the middle of the woodchips

Street sweepings are than placed on top of the biosolids covering all of the material. This reduces the risk of biosolids seeping out of the piles.

	Sample No.	Date	Parameter															
			Loss on Ignition @ 375 C	Moisture	Organic Matter	pH (1:1 soil:water)	Total Kjeldahl Nitrogen	Total Organic Carbon	C:N Ratio	Available Ammonium-N	Available Nitrate-N	Available Phosphate-P	Available Potassium	Available Sulfate-S	Conductivity Sat. Paste	% Saturation	Mercury
	Units		%	%	%	pH units	%	%		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	dS/m	%	
	CCME GUIDELINES (INDUSTRIAL)																50
	CCME GUIDELINES (AGRICULTURAL)																6.6
Background Samples Taken of Clay Cap:	SS.18.0 (Control)	5/8/2018	3.6	15.3	3.1	8.5	0.121	3.06	25.29 : 1	6.3	1.4	5.4	319	38.3	0.887	65.5	
	SS.18.1.1 (Plot 1)	5/7/2018	4.2	18.8	3.6	8.59	0.136	2.97	21.84 : 1	5.8	1.7	6.4	299	131	1.61	83.3	
	SS.18.1.2 (Plot 1)	5/7/2018	3.2	11.1	2.8	8.44	0.11	2.73	24.82 : 1	7.7	1.1	2.9	302	64	0.958	80.6	
	SS.18.1.3 (Plot 1)	5/8/2018	3.1	14.8	2.7	8.38	0.096	2.76	28.75 : 1	5.1	1.5	3.7	283	196	1.56	65.4	
	SS.18.1.4 (Plot 1)	5/8/2018	3	13.2	2.6	8.7	0.098	3.08	31.43 : 1	4.3	1.3	4.8	254	36.8	0.778	64.3	
Samples of Spread Mixture:	SPREAD #1 (Beaverhuts)	6/18/2018	7.5	25.7	6.1	N/A	0.347	6.58	18.96 : 1	1.1	125 *	540 *	444	8.48	6.85	63	0.0853
	SPREAD #2 (Excavator Mix)	6/18/2018	6.3	18.6	5.2	N/A	0.279	6.37	22.83 : 1	14.5	101 *	490 *	389	7.16	6.96	53	0.101

METALS

Aluminum (Al)	Antimony (Sb)	Arsenic (As)	Barium (Ba)	Beryllium (Be)	Bismuth (Bi)	Boron (B)	Cadmium (Cd)	Calcium (Ca)	Chromium (Cr)	Cobalt (Co)	Copper (Cu)	Iron (Fe)	Lead (Pb)	Magnesium (Mg)	Manganese (Mn)	Molybdenum (Mo)	Nickel (Ni)	Phosphorus (P)	Potassium (K)	Selenium (Se)	Silver (Ag)	Sodium (Na)	Strontium (Sr)	Thallium (Tl)	Tin (Sn)	Titanium (Ti)	Uranium (U)	Vanadium (V)	Zinc (Zn)
mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
	40	12	2000	8		N/A	22		87	300	91		600			40	89			2.9	40			1	300		300	130	410
	20	12	750	4		2	1.4		64	40	63		70			5	45			1	20			1	5		23	130	250
13900	0.33	4.99	138	0.59	0.155	13	0.195	78900	30.7	8.04	19.3	16900	19.4	36400	353	0.62	24.4	420	2710	<0.50	<0.10	267	64	0.18	<5.0	119	0.818	41.6	56
15400	0.44	5.97	141	0.65	0.182	13	0.208	66800	37.1	8.57	23.5	18900	24.8	29500	362	0.74	28.8	470	3040	<0.50	<0.10	336	63.9	0.22	<5.0	139	0.984	45.7	80
16500	0.53	5.79	161	0.7	0.181	15	0.222	62800	33.6	8.93	29.7	20000	105	28100	410	0.66	27.8	470	3230	<0.50	<0.10	384	70.1	0.22	<5.0	185	0.995	49.6	77
14400	0.44	5.29	152	0.6	0.163	15	0.246	77000	31.7	8	22.4	17400	36.9	33800	362	0.67	25.6	480	2850	<0.50	<0.10	360	73.9	0.2	<5.0	157	1.13	44	82
13000	0.41	4.74	132	0.57	0.148	14	0.21	78900	33.4	7.35	20.8	16500	23.7	34000	340	0.75	24.3	410	2600	<0.50	<0.10	322	68.9	0.18	<5.0	148	0.96	38.9	65
3590	0.72	1.88	55	0.14	1.66	<10	0.329	92400	47	2.98	61.6	11200	14.3	39400	184	2.01	15.4	2060	1190	<0.50	0.63	460	56.4	<0.10	<5.0	53.6	1.29	13	213
6940	0.64	3.39	89.1	0.31	0.9	11	0.272	91000	45.9	4.64	43.5	12300	69.4	37300	244	1.48	17	1190	1750	<0.50	0.42	576	62.9	<0.10	<5.0	80.7	1.23	23.2	149

100 Above Agriculatural Guidelines
100 Above Industrial Guidelines
* Detection Limit Raised: Dilution required due to high concentration of test analyte(s)

Year One - Vegetation Test Plots

Year One, Phase One - Soil Fabrication Plots

June 25th, 2018
Naturalist Services crew placing down burlap, seeding and watering 12' x 12' plots.

June 26, 2018
The burlap is used to keep moisture on the plot given the dry summer conditions. Half the plot is seeded with native grasses with a cover crop (oats) the other half is just native grasses.

June 26th, 2018
Fabricated soil from our Year One Phase One operation was spread using a manure spreader, both plots were seeded with the same mix.

July 20th, 2018
The cover crop is growing on west side of plots . Some native grasses are starting to germinate on both sides of the plots

August 9th, 2018
The cover crop is thriving, some annual weeds have begun to sprout on the east side of the plot. The cover crop was effective in preventing weeds from germinating

August 9th, 2018
The fabricated soil was very efficient in suppressing weeds from the clay cap. Native grasses begun to germinate on both sides of the plot.