Great Western
OPERATING COMPANY, LLC®

Tower Multi-Well Plan

Topsoil Salvage Plan

Prepared for:

Great Western Operating Company, LLC

Prepared by:

Duraroot, LLC

Date:

July 2020

TOPSOIL SALVAGE PLAN
TOWER MULTI-WELL PAD LOCATION

Site Description

Topsoil depths across the Great Western Operating Company, LLC, Tower Multi-Well Pad location were evaluated and determined by a Duraroot Certified Professional Soil Scientist (CPSS) on July 16, 2020. The Tower Multi-Well Pad location is in the SW ¼ of the NW ¼ of Section 21, Township 1S, Range 67W in Adams County, Colorado (Figure 1).

Soils within the facility location are mapped primarily as either the Renohill loam (*Fine, smectitic, mesic Ustic Haplargids*) or the Ulm loam (*Fine, smectitic, mesic Ustic Haplargids*) soil series. The approximate disturbance area of the facility is 20.34 acres and will be downsized to 6.2 acres for interim reclamation. The pre-disturbance land use is dryland corn.

Site Soils

The location's soils were evaluated to establish topsoil depths across the location that are suitable for reclamation activities. Topsoil salvage practices should avoid mixing topsoil with subsoil and should avoid soil resources with properties that may limit reclamation success. Topsoil depths were collected using a Giddings hydraulic mounted truck probe and evaluated using the following physical properties:

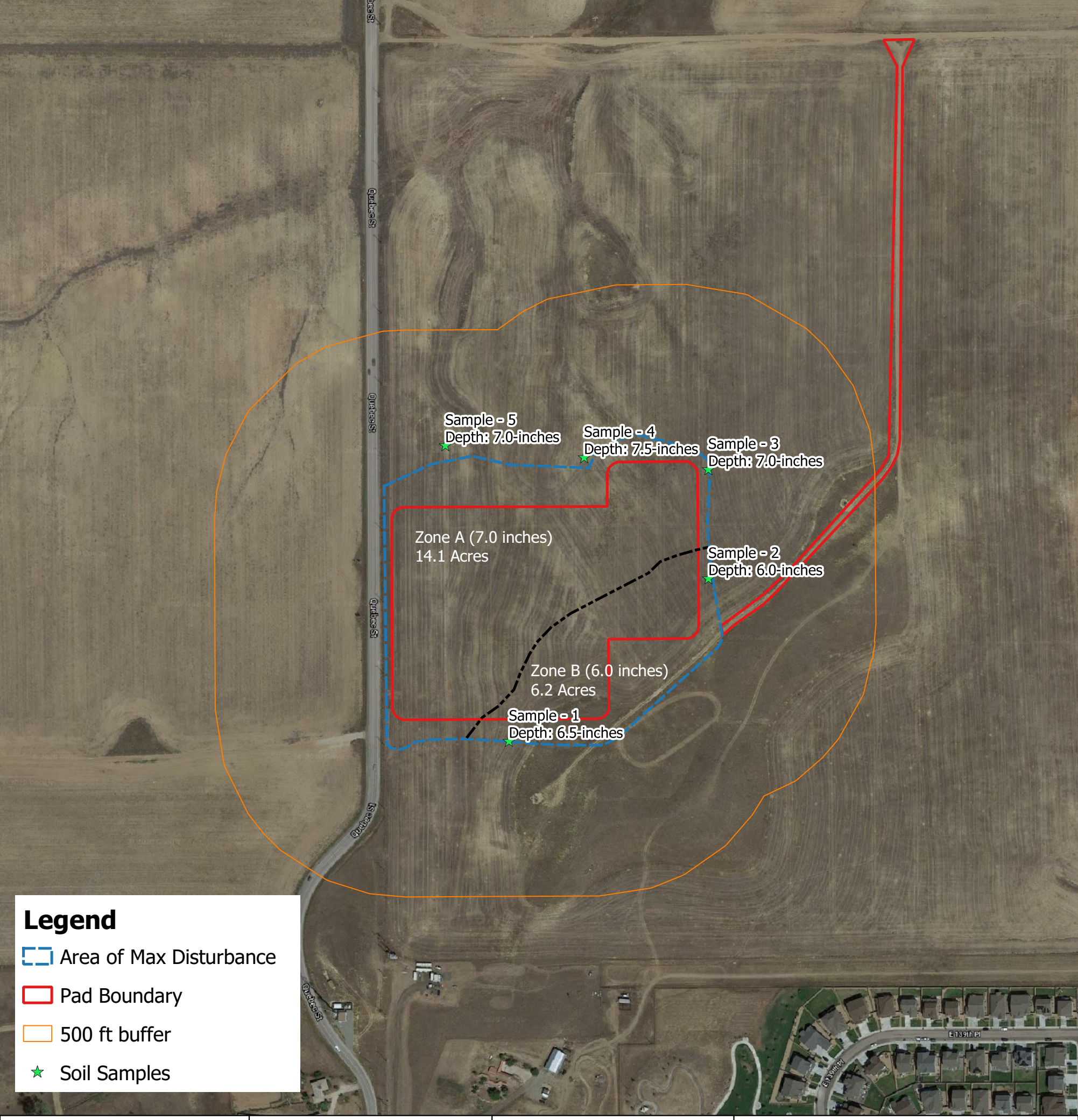
- Horizon depths;
- Soil color;
- Plow depth layer;
- Soil texture and structure;
- Soil effervescence; and,
- Depth to restrictive layer.

A summary of the observed physical soil properties is as follows:

- **Horizon depths:** The topsoil horizon was observed from 6.0 to 7.5-inches deep across the location. The topsoil horizon was typically delineated by changes in soil texture and structure accompanied by an increase in clay and lime content.
- **Soil color:** Soil color was recorded for each soil sample and ranged from 10YR 4/2 to 10YR 5/2 in the topsoil and ranged from 10 YR 4/4 to 10 YR 5/3 in the subsoil.
- **Soil texture and structure:** Soil textures were recorded as either a sandy clay loam or a clay loam in the 0 to 6-inch depth. Subsoil textures were measured as either a clay loam or a clay in the 6 to 12-inch depth, and as either a clay loam or a clay in the 12 to 18-inch depth. Soil structure was consistently recorded as granular throughout the surface horizon. Subsoil structures were consistently recorded as subangular blocky to prismatic at the 9 to 14.5-inch depth.
- **Depth to restrictive layer:** Restrictive layers were not observed in any of the samples.
- **Plow depth layer:** While this location appeared to be in agricultural production, a distinct plow depth was not observed.
- **Soil effervescence:** Effervescence is used to estimate soil lime ($CaCO_3$) content, as HCl reacts with $CaCO_3$ to produce CO_2. Effervescence with 10-percent HCl solution was observed in Samples 1, 4, and 5 throughout each soil core from the surface throughout the soil profile with stronger effervescence reaction observed with depth indicating the presence of $CaCO_3$. Effervescence was observed in the lower subsoil depth in Samples 2 and 3.

Table 1. Approximate location coordinates and topsoil depths for the individual Tower Multi-Well Pad location soil samples.

Sample ID	Latitude	Longitude	Topsoil Depth (inches)
Sample – 1	39.86951	-104.73905	6.5
Sample – 2	39.86540	-104.73863	6.0
Sample – 3	39.86444	-104.73854	7.0
Sample – 4	39.86438	-104.73733	7.5
Sample – 5	39.86440	-104.73644	7.0



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Duraroot, LLC
4626 W CR 65
Keenesburg, CO 80643

Great Western Operating Company, LLC
1001 17th Street, Suite 2000
Denver, CO 80202

Title:
Tower Multi-Well Pad
Topsoil Salvage Plan

Project:
Tower Multi-Well Pad
Topsoil Salvage Plan

Figure:
Figure 1

Location:
Adams County, Colorado

Date:
7/27/2020

TOPSOIL SALVAGE PLAN
TOWER MULTI-WELL PAD LOCATION

Topsoil Salvage Depth

Topsoil salvage depths were evaluated using soil morphological and physical characteristics of five (5) soil samples evaluated across the facility. Evaluation of soil profiles resulted in two (2) topsoil salvage zones, Zone A and Zone B (Table 2; Figure 3). Approximate location coordinates and topsoil depths for the individual Tower Pad location soil samples are in Table 2.

Zone A: Salvage 0 to 7.5-inches. There are no salvage limitations within the top 7.0 to 7.5-inches of soil in Zone A; therefore, it is recommended that the top 7.5-inches (+/- 15%) of soil be salvaged for reclamation. Due to an increase in calcium carbonate ($CaCO_3$; lime), an increase in clay content, firmer soil structure, decreased porosity, and a reduced organic matter content with depth, it is only recommended that the top 7.5-inches of soil be salvaged on the Tower Multi-Well Pad location in Zone A.

Given that the underlying subsoil had a distinct texture change (clay loam to clay), salvaging 7.5-inches would greatly reduce the chances of mixing valuable topsoil resources with the clayey subsoil. Mixing clay textures into the topsoil could have unfavorable effects on reclamation efforts in terms of returning soil tilth and establishing native grass and forb species. The underlying subsoil also had a distinct increase in lime content, which could reduce phosphorus availability and impair reclamation efforts if mixed with topsoil.

Zone B: Salvage 0 to 6.0-inches. There are no salvage limitations within the top 5.0 to 6.0-inches of soil in Zone B; therefore, it is recommended that the top 6.0-inches (+/- 15%) of soil be salvaged for reclamation. Due to an increase in calcium carbonate ($CaCO_3$; lime), an increase in clay content, firmer soil structure, and decreased porosity with depth, it is recommended that the top 6.0-inches of soil be salvaged on the Tower Multi-Well Pad location.

Given that the underlying subsoil had a distinct texture change (sandy clay loam to clay loam and clay), salvaging 6.0-inches would greatly reduce the chances of mixing valuable topsoil resources with the clayey subsoil. Mixing clay textures into the topsoil could have unfavorable effects on reclamation efforts in terms of returning soil tilth and establishing native grass and forb species. The underlying subsoil also had a distinct increase in lime content, which could reduce phosphorus availability and impair reclamation efforts if mixed with topsoil.

Table 2. Topsoil balance and salvage depth for the Tower Multi-Well Pad location.

Zone [1]	Area (acres)	Soil Salvage Depth (inches) [2,3]	Estimated Topsoil Volume		Salvage Limitations [4]
			ft^3	yds^3	
Zone A	14.1	7.0	358,281	13,270	Elevated clay content and lime rating
Zone B	6.2	6.0	135,036	5,001	Elevated clay content and lime rating, and reduced organic matter
Total	**20.3**	**6.7**	**493,317**	**18,271**	--

Notes:
1 The soil stripping zones are shown in Figure 1.
2 Soil salvage depths are estimated based on observed soil parameters. Field conditions will dictate actual soil salvage depths.
3 Soil Salvage Depth Total equals the total depth of salvaged soil post re-application.
4 Salvage Limitations indicate soil quality parameters that limit salvage depths.

During the field investigation, Duraroot collected five (5) soil cores. Soil cores were collected from the wheat field around the perimeter of the Tower Multi-Well Pad location to establish current soil physicochemical properties (Table 3). Three (3) soil cores were collected from within the Ulm soil series and two (2) soil cores were collected within the Renohill soil series. The soil cores were divided into three depths at 0 to 6, 6 to 12, and 12 to 18 inches. Soil samples for each separated depth for each core were submitted to Ward Labortaory in Kearney, NE for the following agronomic soil properties: soil pH (saturated paste), electrical conductivity (EC), organic matter percentage, nitrate-nitrogen, phosphorus, potassium, zinc, iron, manganese, copper, lime, percent calcium carbonate equivalency, sodium adsorption ratio (SAR), and soil texture.

Soil sample results indicate nitrogen and phosphorous levels lower than optimal for typical crop and native grass establishment. Additionally, soil sample results for the location indicate elevated lime ($CaCO_3$) content. Elevated lime contents were observed in Samples 1 (6 to 12 inch depth), 2 (0 to 6 inch depth), 4, and 5 (0 to 18 inch depth). Elevated soil lime may reduce phosphorus availability for native grass germination and establishment. Addtionally, soil results indicate elevated soil clay contents in the 6 to 18 inch depth in Samples 1, 3, and 4, and the 12 to 18 inch depth in Sample 2. Elevated clay will contribute to greater potential soil erosion and deteriorated soil structure. Deteriorated soil structure may result in hard, compacted soils that will limit infiltration and root penetration. There are no other observed soil properties that may interefere with reclamation success.

Figure 2. Field conditions directly southwest of the Tower Multi-Well Pad location.

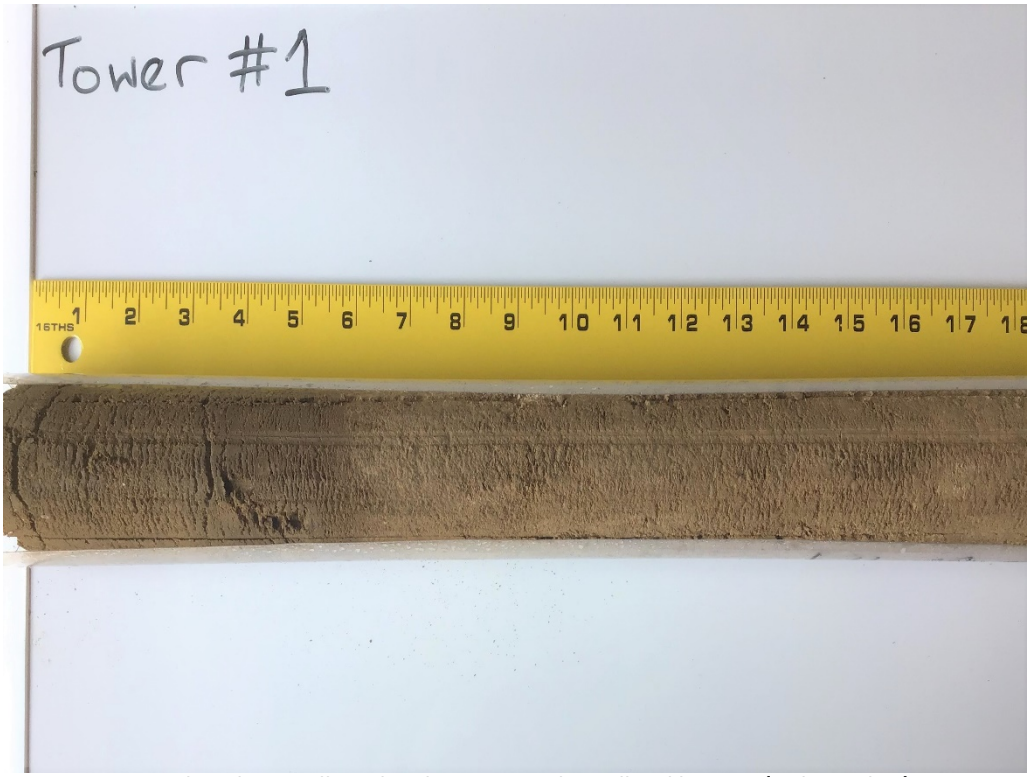

Figure 3. Example soil core collected at the Tower Multi-Well Pad location (Soil Sample 1).

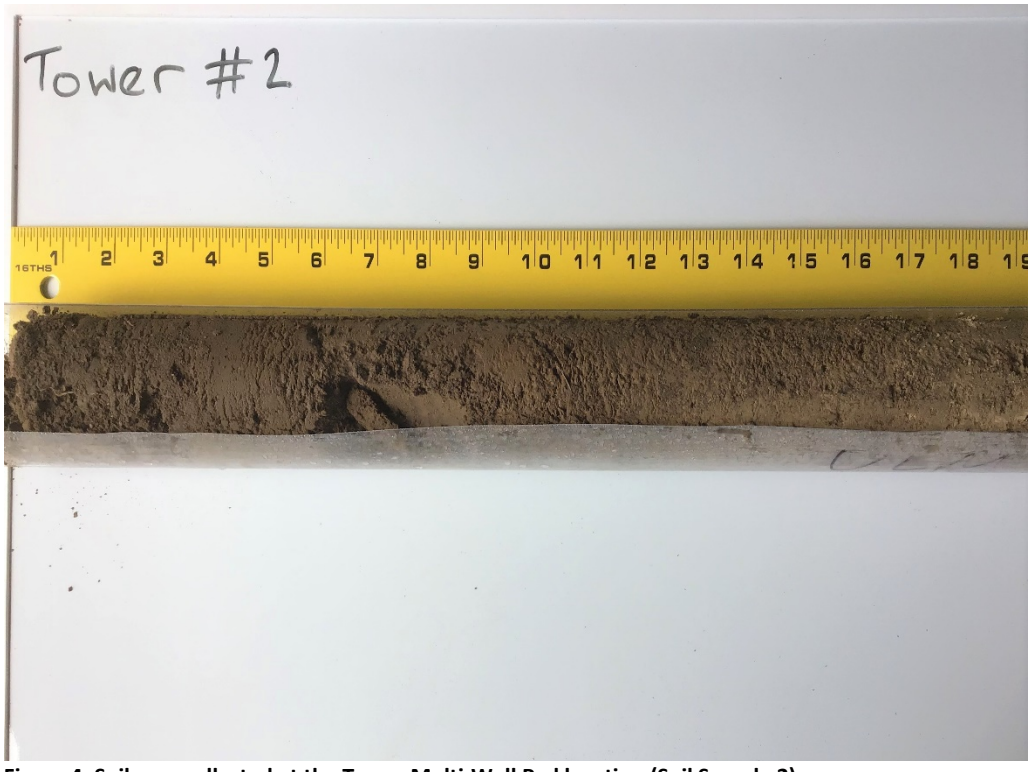

Figure 4. Soil core collected at the Tower Multi-Well Pad location (Soil Sample 2).

Figure 5. Soil core collected at the Tower Multi-Well Pad location (Soil Sample 3).

Figure 6. Soil core collected at the Tower Multi-Well Pad location (Soil Sample 4).

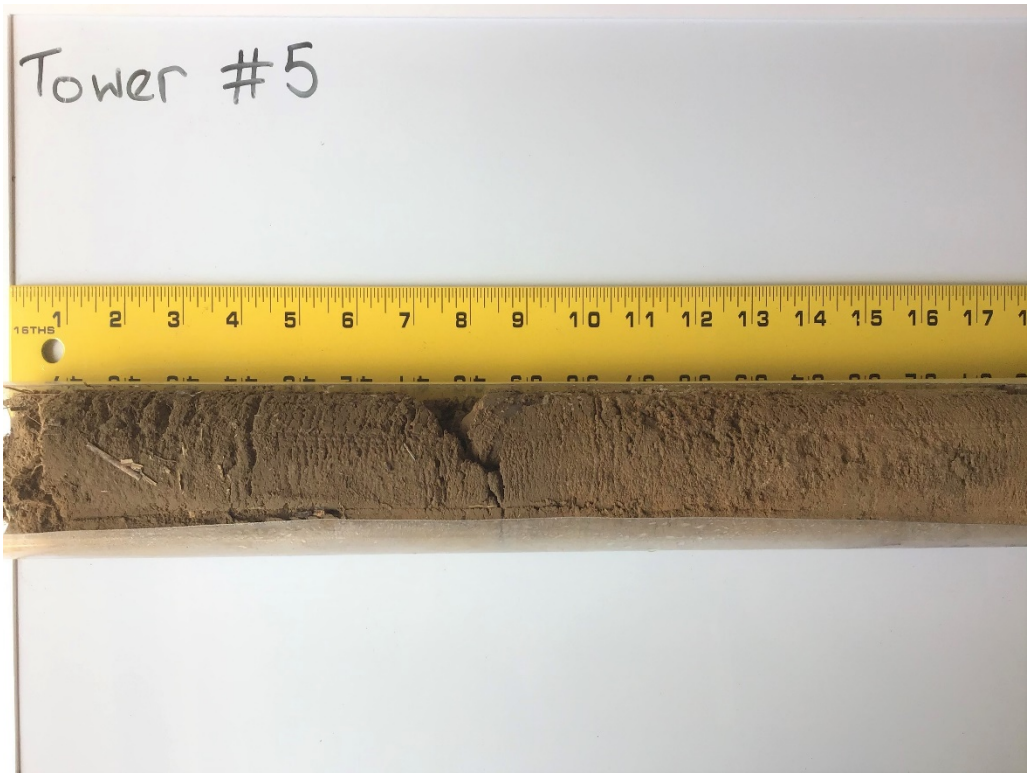

Figure 7. Soil core collected at the Tower Multi-Well Pad (Soil Sample 5).

Figure 8. Location photo showing site conditions at the time of the assessment.

Table 3. Topsoil chemical and physical data for the Tower Multi-Well Pad location. Parameters in red may affect reclamation success.

Depth (inches)	pH (s.u.)	EC (dS/m)	SAR	N-NO_3	N	P	K	Zn	Fe	Mg	Cu	OM	Lime	Saturation	Sand	Silt	Clay	Texture
				lb/acre	(ppm)							%						
Soil Sample 1																		
0-6	7.8	0.50	0.10	9	5.0	6.0	198	0.3	5.3	2.1	0.62	1.3	2.9	38	53	18	29	Sandy Clay Loam
6-12	8.1	0.38	0.20	1.0	0.80	6.0	107	0.1	4.2	1.0	0.78	1.6	10.4	46	27	31	42	Clay
12-18	8.1	0.39	0.40	1.0	0.60	8.0	111	0.1	6.2	0.9	0.80	1.2	9.7	46	28	32	40	Clay
Soil Sample 2																		
0-6	6.9	0.69	0.20	7.0	3.9	8.0	282	0.4	20	11	1.5	1.4	5.9	41	49	21	30	Sandy Clay Loam
6-12	7.0	1.02	0.30	2.0	0.90	4.0	181	0.2	14	5.5	1.5	1.9	0.9	52	38	22	40	Clay Loam
12-18	8.0	0.48	0.60	1.0	0.80	5.0	131	0.1	7.4	1.5	0.85	1.7	3.9	47	33	26	41	Clay
Soil Sample 3																		
0-6	6.3	0.43	0.50	7.0	3.8	16	316	0.4	22	18	1.5	1.4	1.0	42	41	25	34	Clay Loam
6-12	6.9	0.52	1.1	1.0	0.80	5.0	224	0.2	12	5.4	1.4	1.6	1.0	50	33	26	41	Clay
12-18	8.1	0.40	1.8	1.0	0.60	5.0	209	0.1	9.1	1.4	1.0	1.6	3.9	50	27	29	44	Clay
Soil Sample 4																		
0-6	8.1	0.35	0.40	6.0	3.4	10	219	0.3	3.1	1.6	1.0	1.8	7.4	41	40	20	40	Clay Loam
6-12	8.2	0.34	1.0	2.0	1.0	4.0	89	0.1	4.3	1.5	0.72	1.3	15.6	44	35	17	48	Clay
12-18	8.3	0.36	2.6	1.0	0.60	4.0	88	0.1	5.1	0.7	0.69	1.1	11.4	44	31	18	51	Clay
Soil Sample 5																		
0-6	8.1	0.37	0.20	4.0	2.1	17	192	0.2	2.7	1.7	0.82	1.6	7.8	44	38	26	36	Clay Loam
6-12	8.1	0.42	0.20	2.0	1.0	6.0	115	0.2	4.9	1.2	0.86	1.2	6.9	49	39	23	38	Clay Loam
12-18	8.2	0.26	0.60	1.0	0.40	7.0	105	0.1	5.7	0.8	0.77	1.0	5.7	42	37	23	40	Clay Loam