

**OPERATING PERMIT APPLICATION
MONTANA LIMESTONE RESOURCES**

**APPENDIX A-7
BASELINE SOILS REPORT**

October, 2014

**BASELINE SOILS INVENTORY
MONTANA LIMESTONE RESOURCES PROJECT
GRANITE COUNTY, MONTANA**



PREPARED FOR:

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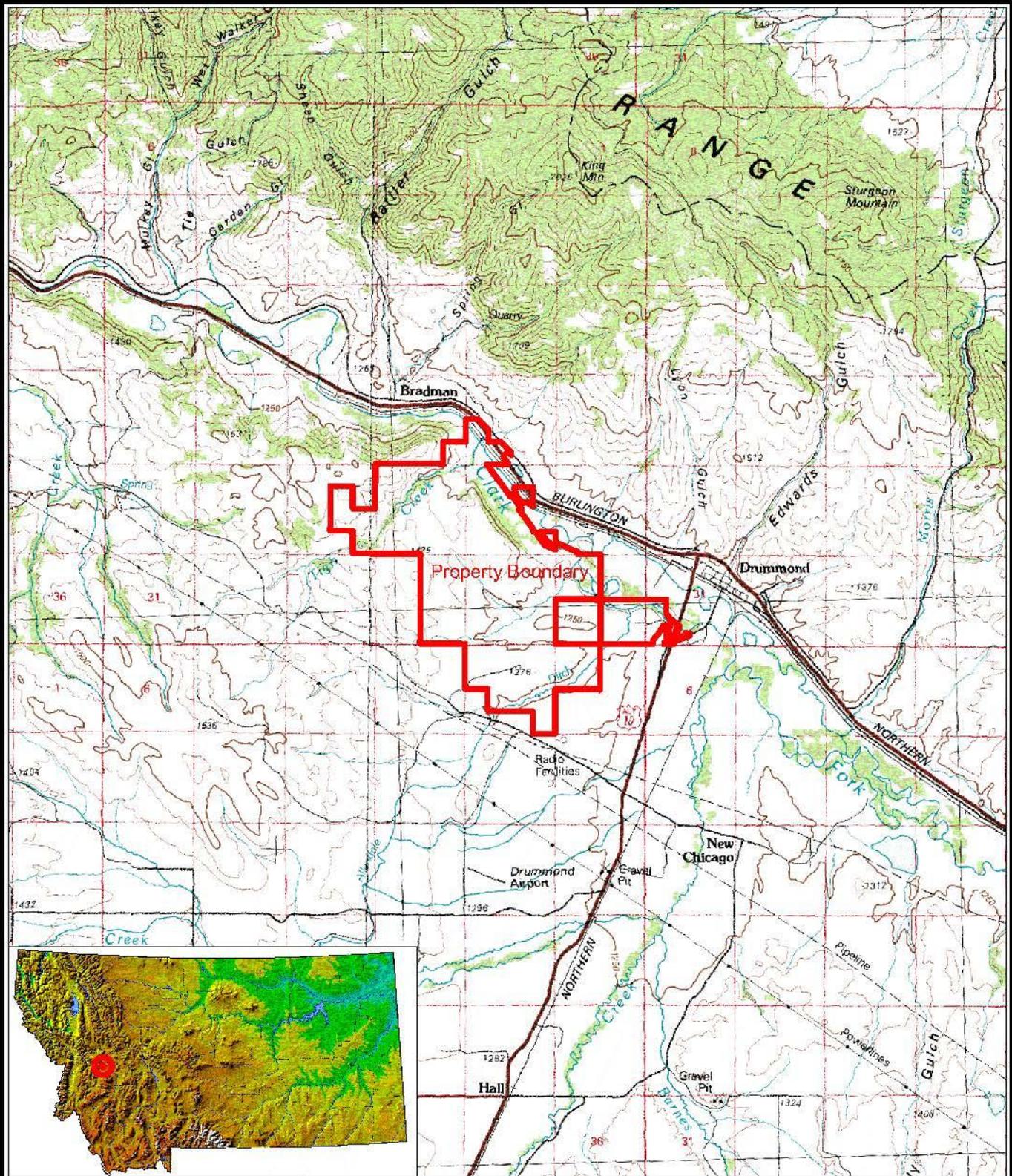
Plate 1 Baseline Soils Map

1.0 INTRODUCTION

Montana Limestone Resources, LLC (MLR) contracted WESTECH Environmental Services, Inc. (WESTECH) to conduct a baseline inventory of soil resources within the proposed project area in northeastern Granite County, approximately one mile west of Drummond, Montana (Figure 1). The study area is located on land comprising the former Bar-Four-Bar Ranch property totaling 3520 acres (5.5 square miles). The soils baseline was designed to provide recommendations for soil salvage, and indicate reclamation limitations related to native soils. This inventory will be used to assist mine permitting and reclamation planning in accordance with the laws and regulations administered by the Montana Department of Environmental Quality Hard Rock Mining Program (MDEQ).

Climate at the project area is continental, consisting of cold winters and warm summers with a growing season extending from April to September in most years. Weather data collected at Drummond were examined for the 30-year period (NRCS 2003). The average annual temperature is 42.9 degrees Fahrenheit (F), ranging from an average minimum of 11.4 degrees F in January to an average maximum of 84.2 degrees F in July. Average temperatures range from 43 to 65 degrees F during the growing season. Precipitation averages 13.4 inches annually, ranging from 0.6 inches in February to 1.9 inches in June, with the greatest precipitation occurring in May and June.

Geology of the area consists of Tertiary sedimentary formations at lower elevations in the southern portion of the study area (Berg 2005). Higher elevations in the northern portion of the study area are comprised of a Mississippian carbonate formation (limestone), and Tertiary igneous formations comprised of andesite, basalt and rhyolite.



Montana Limestone Resources Project Area General Location



USGS 100k: Missoula East



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SCALE: 1:100,000
DATE: 04/25/13
DRAWN BY: DC
CHECKED BY: KS
FILE: MLR13_Location.dwg

FIGURE

1

SHEET: 1 of 1

2.0 METHODS

In 2013, soil profile descriptions and soil material sampling was conducted within the intensive study area of approximately 1336 acres or 2.1 square miles (Figure 1 and Plate 1). The plan of study was reviewed with the Montana Department of Environmental Quality (MDEQ) in the spring of 2013 to solicit agency comments in advance of the field inventory.

Prior to performing on-site soil sampling, a literature review was completed to summarize existing soils data published by the Natural Resources Conservation Service (NRCS). This summary utilized Geographic Information Systems (GIS) data combined with the most current soil survey database. These data were evaluated to identify common soils series in the Project area and to evaluate the diagnostic characteristics of selected soils.

Soil profile descriptions and sampling were conducted in the Project area during September and October, 2013. Soils scientists traversed the project site on foot and placed soil sample sites in representative areas. Soil parameters including depth and thickness of soil horizons and dominant physical/chemical characteristics were described at each site. The extent of each soil type was marked on aerial photo base maps, and later used to establish the boundaries of each soil salvage map unit. Physical and chemical soil properties were characterized using a combination of field observations and laboratory-based analyses.

At the request of MDEQ, separate chemical analyses were conducted to evaluate baseline concentrations of arsenic, cadmium, copper, lead and zinc in native soils within the study area.

3.0 RESULTS

The study area is dominated by moderately deep to deep soils with isolated areas of shallow soils on convex ridges and steep slopes associated with rock outcrops (Plate 1 and Table 1). In general, the soils contain physical and chemical properties suitable for vegetation establishment and growth, such as neutral pH values and adequate organic matter (Table 2 and Table 3). Some isolated horizons were found to contain saline or sodic soils, although the proportion of this material within the project area is very small and would not inhibit soil salvage or reclamation potential. The presence of large coarse fragments in some areas and clay textures in others could restrict soil salvage, and soil handling in general. However, deep soils and suitable soil chemistries could also allow deeper or multiple-lift soil salvage in several areas.

No prime farmland soils were identified in the project area, although Danvers, Martinsdale, Quigley and Winspect soils are classified as farmland of statewide importance.

3.1 SOIL TYPES

Soils within the project exhibit noticeable differences in physical properties such as texture, coarse fragment content, and degree of soil development as a result of diverse parent materials and geologic processes in the area. Native soils were typically formed in colluvium or alluvium derived from various parent materials. Geology in the project area is variable, consisting of Tertiary sedimentary clays along the southern boundary, with basalt and andesite along the western boundary (Berg 2005). In contrast, formations such as Mississippian Madison limestone deposits overlying the Pennsylvanian Amsden and Quadrant Formations occupy the central portion of the project area.

3.2 SOIL MAPPING UNITS

Ten soil map units were identified in the Project area, with eight mapped as dominant series consociations and two mapped as soils complexes (Plate 1 and Table 1). Summary descriptions of the soil map units including dominant soil properties, soil location on the landscape, and potential soil salvage limitations are provided below.

BrTo : Braziel - Tolbert Loams (5-25% slopes)

Braziel and Tolbert soils are associated with igneous geologic deposits located in the southwestern portion of the project area. Braziel soils are deep to very deep soils with low to moderate densities of coarse fragments within the upper 30 inches of the soil profile. Tolbert soils are shallow to moderately deep soils that contain high coarse fragment content throughout the soil profile, including widespread boulders and stone-sized fragments. Within the mapping unit, Braziel soils are typically located on terraces, slopes and swales. Tolbert soils are commonly located on erosive topographies such as shoulders and ridges. Both soils consist of silt loam to loam textures and organic matter contents of four percent or greater, indicating they are suitable for salvage and use in reclamation. However, the

presence of dense and/or large diameter coarse fragment material could limit the effectiveness of salvage and reclamation potential of these soils.

Map Unit Composition: Braziel 50%, Tolbert 35%, Danvers 5%, Martinsdale 5%, Shawmut 5%

Co : Coben clay loam (5-15% slopes)

Coben soils are associated with clayey sedimentary geology on gentle to moderately sloping hills along the southern boundary of the study area. These soils have silty loam textures in near-surface horizons, with heavy clay textures at depths below 24 inches. Although the soil chemistry and organic content of these soils are adequate for plant growth, the fine-grained texture of these soils restricts plant density in native soils and could restrict salvage and handling operations.

Map Unit Composition: Coben 90%, Shawmut 5%, Whitecow 5%

Da : Danvers silty clay loam (5 – 25% slopes)

Danvers soils are deep, highly productive soils formed in colluvium and alluvium from loamy sedimentary parent materials. These soils are located on northern aspects of moderate to steep slopes, and have low densities of coarse fragments. The silty clay loam to clay textures of these soils could restrict soil handling and thus reclamation potential of these soils, especially at depths below the topsoil horizon.

Map Unit Composition: Danvers 80%, Lap 5%, Martinsdale 5%, Shawmut 5%, Whitecow 5%

Lp : Lap gravelly loam (5 – 40 % slopes)

Lap soils are associated with convex topographies on ridges and terraces adjacent to limestone rock outcrops. These soils are shallow, with moderate to high coarse fragment density throughout the profile. Chemical properties of these soils are conducive to plant establishment; however, the proximity of these soils to rock outcrops and large coarse fragments will restrict salvage of this material.

Map Unit Composition: Lap 75%, Windham 10%, Quigley 10%, Whitecow 5%

Ma : Martinsdale gravelly loam (2 – 15% slopes)

Martinsdale soils are located in transitional areas near the periphery of igneous geologic deposits. These silty loam- and clay-textured soils formed in colluvium and alluvium on toeslopes and other depositional areas. Coarse fragment content within these soils varies with topographic position and parent material (i.e., colluvium versus alluvium). These soils would provide suitable reclamation material and salvage volumes in areas with moderate to low coarse fragment content.

Map Unit Composition: Martinsdale 80%, Shawmut 10%, Braziel 5%, Danvers 5%

Qu : Quigley silt loam (2 – 15% slopes)

Quigley soils formed in alluvium and colluvium on concave features associated with limestone ridges, shoulders and slopes. These moderately deep soils typically exhibit silt loam to loam textures and low coarse fragment content at depths shallower than 24 inches. In general, these soils would provide adequate soil salvage and reclamation potential in topsoil and shallow sub-surface horizons. As with other soils in the area, salvage at some sites could be limited by the abundance of coarse fragments and/or shallow bedrock associated with Lap soils.

Map Unit Composition: Quigley 75%, Lap 10%, Windham 10%, Martinsdale 5%

Sh : Shawmut gravelly loam (2 – 15% slopes)

Shawmut soils formed in alluvium and colluvium on terraces and swales adjacent to drainage channels. These soils exhibit variable physical and chemical properties, reflecting the influence of soils and geology of adjacent uplands. In general, these soils are shallow and poorly developed with high densities of coarse fragments and/or exposed bedrock at depths below 15 inches. As a result, salvage and use of these soils for reclamation will be restricted by coarse fragment size and/or density.

Map Unit Composition: Shawmut 75%, Danvers 10%, Martinsdale 10%, Tolbert 5%

Wc-RO: Whitecow – Rock Outcrop (15 – 60% slopes)

Soils in this map unit include Whitecow silt loams formed in colluvium associated with outcroppings of limestone and other sedimentary rocks. These soils are located on steep to very steep slopes and contain a high percentage of coarse fragments, precluding safe and effective soil salvage.

Map Unit Composition: Whitecow 50%, Rock Outcrop 40%, Lap 10%

Wd : Windham skeletal loam (2 – 15% slopes)

Windham soils formed in alluvium and colluvium on shoulders and slopes of limestone formations. These soils are located in the transitional zones between limestone deposits and other geological parent materials. Windham soils are typically moderately deep to deep soils with moderate densities of coarse fragments distributed throughout the soil profile. The physical and chemical and properties of these soils are conducive to salvage and redistribution for reclamation; however, shallow bedrock or high coarse fragment content will be present in some locations.

Map Unit Composition: Windham 75%, Lap 10%, Quigley 10%, Martinsdale 5%

Ws : Winspect skeletal loam (2 – 50 % slopes)

Winspect soils formed in residuum and colluvium on ridges and slopes with sandstone and quartzite outcrops and float. These soils commonly exhibit coarser soil textures and lower organic material content than other soils in the project area, although they would still be suitable for most reclamation purposes. The limiting factor with these soils will be topography, since they are often located on steep slopes and narrow ridges.

Map Unit Composition: Winspect 80%, Lap 10%, Shawmut 5%, Whitecow 5%

3.3 INORGANIC ELEMENTS ANALYSES

Following the agency's review of baseline study plans, MDEQ requested that MLR analyze total concentration by weight of selected metals in the soil samples. Metals requested for laboratory analysis were arsenic, cadmium, copper, lead and zinc. The results of this analysis are presented in Table 4 and summarized below.

Chemical analysis for the inorganic elements listed above did not identify any samples with concentrations in excess of Environmental Protection Agency (EPA) Regional Screening Levels, with the exception of arsenic. Arsenic commonly occurs in concentrations higher than recommended EPA monitoring levels in Montana soils (MDEQ 2005). Due to the elevated baseline concentrations of arsenic in Montana, MDEQ has established a statewide action threshold of 40 milligrams per kilogram (mg/kg) for residential areas. Arsenic concentrations in the MLR project area ranged from 3 to 121 mg/kg, with an average of 16 mg/kg (Table 4). Only two samples contained arsenic concentrations in excess of the 40 mg/kg threshold: the C2 horizon (24-31 inch depth) at site PC-029 and the C horizon (6-20 inch depth) at site CB-10.

4.0 REFERENCES CITED

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TABLES
MONTANA LIMESTONE RESOURCES BASELINE SOILS INVENTORY

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Table 1
Soil Map Unit Acreages

Map Unit Symbol	Map Unit Name	Slopes (percent)	Acres in Project Area¹	Percent of Project Area
BrTo	Braziel-Tolbert loams	5 - 25	274	20
Co	Coben clay loam	5-15	81	6
Da	Danvers silty clay loam	5-25	87	7
Lp	Lap gravelly loam	5-50	121	9
Ma	Martinsdale gravelly loam	2-15	125	9
Qg	Quigley silt loam	2-15	40	3
Sh	Shawmut gravelly loam	2-15	154	12
Wc-RO	Whitecow - Rock Outcrop	15-60	331	25
Wd	Windham skeletal loam	2-15	70	5
Ws	Winspect skeletal loam	2-50	53	4
		Total	1336	100

¹Derived from soils map (Plate 1) in this report.

Table 2
Soils Field Data

Sample Site (SS)	Soil Series	Map Unit Symbol	Soil Horizon	Depth (inches)	Color ¹ (moist)	Structure ²	Coarse Fragment % Volumes				Aspect	Slope %	Roots ³	Effervescence ⁴
							Gravel	Cobbles	Stones	Boulders				
PC-001	Lap	Lp	A	0-9	5YR 3/2	mmsbk	0-5	0	0	0	N	15-20	MF, FM	NE
			C	9-15	5YR 5/3	massive	10-15	0-5	0	0			CF	SL/ST
			R	15-40+	-	-	-	-	-	-			-	ST
PC-002	Windham	Lp	A	0-8	5YR 3/1	wmpr/scabk	0-5	0	0	0	N	5-10	MF	NE
			Bt	8-20	5YR 5/4	wmpr/scabk	0-5	0	0	0			MF	NE
			Bw/C	20-32	5YR 6/3	massive	15-20	0	0	0			FF	SL/ST
			C	32-48	5YR 5/3	massive	10	0	0	0			FF	ST
PC-003	Lap	Lp	A	0-5	5YR 4/2	wfsbk	20	10	0	0	S	5-10	MF	SL/ST
			C	5-14+	5YR 5/3	loose	25	20	0	15			CF	ST
PC-004	Quigley	Qg	A	0-6	5YR 3/2	mmsbk	0	0	0	0	FLAT	0	CF	NE
			Bt	6-12	5YR 5/4	hmabk	5-10	0	0	0			CF	SL/ST
			C	12-24	5YR 6/3	massive	20	0	0	0			FF	VE
PC-005	Quigley	Qg	A	0-8	5YR 3/1	mmpr	0	0	0	0	SW	5-15	MF	NE
			Bw	8-14	5YR 4/3	wmabk	0-5	0	0	0			CF	NE
			C	14-22	5YR 4/2	massive	10-15	0	0	0			FF	NE
PC-006	Quigley	Qg	A	0-4	5YR 3/2	mmpr	0	0	0	0	W	5-10	MF, FM	NE
			Bt	4-10	5YR 4/3	hcabk	0	0	0	0			MF, FM	NE
			Bk1	10-16	5YR 5/3	mmabk	0	0	0	0			FF	SL/ST
			Bk2	16-26	5YR 6/4	wmabk	15	0	0	0			FF	VE
			C	26-34	5YR 6/4	massive	20	0	0	0			-	VE
PC-007	Quigley	Qg	A	0-5	5YR 3/2	mcsbk	0	0	0	0	SW	5	MF	NE
			Bt	5-12	5YR 5/4	hcabk	0	0	0	0			CF	NE
			Bk	12-26	5YR 5/3	wmabk	0-5	0	0	0			FF	VE
			C	26-42	5YR 5/3	massive	10-15	0	0	0			-	VE
PC-008	Windham	Wd	A	0-6	5YR 3/1	mcabk	5-10	0	0	0	FLAT (S)	0	MF, FM	NE
			B	6-12	5YR 4/2	wmsbk	15	0	0	0			MF, FM	SL
			C	12-24	5YR 6/4	massive	15-20	0	0	0			CF	VE
PC-009	Shawmut	Sh	A	0-3	5YR 3/2	mmgr	10	<1	0	0	NE	4	CF, FM	NE
			Bt	3-11	5YR 4/2	mcpr	15	<1	0	0			CF, FM	SL
			C	11-23	5YR 6/2	loose	50	10	0	0			FF	VE

Table 2
Soils Field Data

Sample Site (SS)	Soil Series	Map Unit Symbol	Soil Horizon	Depth (inches)	Color ¹ (moist)	Structure ²	Coarse Fragment % Volumes				Aspect	Slope %	Roots ³	Effervescence ⁴
							Gravel	Cobbles	Stones	Boulders				
PC-010	Shawmut	Sh	A	0-7	5YR 3/2	wfgr	5	0	0	0	N	1	CF, FM, FC	NE
			Bt	7-17	5YR 3/2	wmpr/mmabk	10	0	0	0			CF, FM, FC	NE
			C	17-36	5YR 3/2	massive	40-50	10	0	0			FF, FM	SL
PC-011	Winspect	Ws	A	0-3	5YR 4/4	wfgr	5	0	0	0	S	20-50	CF, FM	ST
			Bk	3-11	-	wcsbk	5	0	0	0			FF, FM	VE
			C	11-27	-	massive	30	0	0	0			-	VE
PC-012	Coben	Co	Not sampled - Same as CB-01				-	-	-	-	NW	4	-	-
PC-013	Braziel	BrTo	A	0-6	5YR 3/2	wfgr	5	0	0	0	FLAT (SE)	0	CF	NE
			Btk	6-12	5YR 4/3	wmpr/hcabk	5	0	0	0			FF	SL
			Bk	12-26	7.5YR 5/3	wmpr/wmabk	5	0	0	0			-	VE
			C	26-40	7.5YR 5/3	massive	15	0	0	0			-	VE
PC-014	Martinsdale	Ma	A/B	0-5	7.5YR 4/3	wmabk	10	0	0	0	SE	10-15	CF, FM	VE
			C1	5-15	7.5YR 5/3	massive	20	0	0	0			FF, FM	VE
			C2	15-32	7.5YR 6/4	loose	40	0	0	0			FF	VE
PC-015	Shawmut	Sh	A	0-5	5YR 3/2	wmsbk	1	0	0	0	NW (varies)	0-2	CF, FM	NE
			Bt	5-20	5YR 4/3	mmpr/hcabk	3	0	0	0			CF, FM	ST
			Bk	20-38	5YR 4/3	mmpr/mmabk	3	0	0	0			FF, FM	VE
			C	38-52	5YR 4/4	massive	25	0	0	0			FF, FM	VE
PC-016	Coben	Co	A	0-5	5YR 3/2	wfgr	<5	0	0	0	N	2-4	CF	NE
			Bt	5-12	5YR 3/2	mcpr/hcabk	<5	0	0	0			CF	NE
			Bk	12-26	7.5YR 5/3	mcpr/mmabk	<5	0	0	0			FF	VE
			C	26-48	7.5YR 5/3	massive	5	0	0	0			FF	VE
PC-017	Danvers	Sh	A	0-6	5YR 2.5/1	mcabk	<5	0	0	0	E	3-10	MF, CM	NE
			Bt	6-15	5YR 3/2	mmpr/mmabk	<5	0	0	0			CF, FM	NE
			C1	15-38	10YR 6/2	massive	<5	0	0	0			FF, FM	ST
			C2	38-52	10YR 6/2	massive	<5	0	0	0			FF	VE
			C3	52-60	10YR 6/2	massive	5	0	0	0			-	VE
PC-018	Tolbert	BrTo	A	0-5	5YR 2.5/2	wfgr	<5	0	0	0	N	2-5	CF, FM	NE
			Bt	5-14	5YR 2.5/2	wmpr/mmabk	<5	0	0	0			CF, FM	NE
			Btk	14-22	5YR 3/2	wmpr/mmabk	5	0	0	0			FF	SL

Table 2
Soils Field Data

Sample Site (SS)	Soil Series	Map Unit Symbol	Soil Horizon	Depth (inches)	Color ¹ (moist)	Structure ²	Coarse Fragment % Volumes				Aspect	Slope %	Roots ³	Effervescence ⁴
							Gravel	Cobbles	Stones	Boulders				
PC-019	Braziel	BrTo	A	0-7	5YR 2.5/2	wfgr	0	0	0	0	N	15-30	MF, FM	NE
			Bw	7-15	5YR 3/2	mcabk	0	0	0	0			CF, FM	NE
			Bt	15-25	7.5 YR 5/3	hfabk	<5	0	0	0			FF	NE
			C1	25-44	10YR 6/4	massive	10	0	0	0			-	VE
			C2	44-58	10YR 6/3	massive	20	0	0	0			-	VE
PC-020	Braziel	BrTo	A	0-6	5YR 4/2	mmabk	0-5	0	0	0	E/SE	5-10	MF, CM	NE
			Btk	6-20	7.5YR 5/2	mmabk	0-5	0	0	0			CF, FM	SL/ST
			C1	20-40	7.5YR 6/2	massive	5-10	0	0	0			FF	ST
			C2	40-52	7.5YR 6/3	massive	5-10	0	0	0			-	ST
PC-021	Braziel	BrTo	A	0-9	5YR 2.5/2	mmabk	0-5	0	0	0	E	10-20	MF, FM	NE
			A2	9-18	5YR 3/2	wfabk	0-5	0	0	0			CF, FM	NE
			C1	18-36	5YR 3/2	massive	0-5	0	0	0			FF	NE
			C2	36-38	5YR 3/2	massive	15-20	0	0	0			-	ST
PC-022	Tolbert	BrTo	A	0-5	5YR 3/1	mmgr	10-20	5-10	0-5	0	S/SE	5-15	MF, CM	NE
			C	5-11	5YR 3/2	massive	5-10	20-30	0-5	0			FF, FM	NE
PC-023	Danvers	Da	A	0-7	5YR 2.5/2	mmgr/wfabk	0-5	0	0	0	E	15-25	MF, CM	NE
			A2	7-11	5YR 2.5/2	wfabk	0	0	0	0			CF, FM	NE
			Btk	11-19	5YR 3/2	wmabk	0	0	0	0			FF	NE
			C1	19-30	5YR 4/3	massive	0	0	0	0			-	NE
			C2	30-53+	5YR 4/3	massive	0-5	0	0	0			-	SL/ST
PC-024	Tolbert	BrTo	A	0-6	5YR 2.5/2	mmgr	5-10	0-5	0	0	E	15-25	MF, CM	SL
			Bt/C	6-11	5YR 3/2	wfabk	10-20	0-5	0	0			CF	ST
			C	11-14	5YR 3/2	massive	20-40	10-20	0-5	0			FF	ST
PC-025	Tolbert	BrTo	A	0-5	5YR 2.5/2	mmgr/wmabk	0-5	0-5	0	0	SE	5-10	MF, CM	SL
			Bt	5-13	5YR 4/2	wfabk	0-5	5-15	0	0			CF	ST
			C	13-23	7.5YR 4/3	massive	15-25	0-5	0	0			FF	ST
PC-026	Shawmut	Sh	A	0-7	5YR 3/2	mmgr/wmabk	0-5	0	0	0	E	0-5	MF, FM	NE
			A/C	7-11	5YR 3/2	wfabk	5-15	0	0	0			CF, FM	NE
			C	11-17	5YR 3/2	massive	20-30	0-5	0-5	0			FF	SL

Table 2
Soils Field Data

Sample Site (SS)	Soil Series	Map Unit Symbol	Soil Horizon	Depth (inches)	Color ¹ (moist)	Structure ²	Coarse Fragment % Volumes				Aspect	Slope %	Roots ³	Effervescence ⁴
							Gravel	Cobbles	Stones	Boulders				
PC-027	Danvers	Da	A	0-8	5YR 2.5/2	mmgr	0	0	0	0	E/NE	10-25	CF, FM	NE
			Bt	8-17	5YR 3/2	msbk	0	0	0	0			CF, FM	NE
			C1	17-29	7.5YR 4/3	massive	5	0	0	0			FF	NE
			C2	29-49	7.5YR 5/4	massive	10-15	0	0	0			-	ST
PC-028	Shawmut	Sh	A	0-4	5YR 2.5/2	mmgr	5	0	0	0	E	2-15	CF, FM	NE
			A2	4-16	5YR 3/2	mmgr/mmsbk	5	1	0	0			CF, FM	NE
			Cr	16+	5YR 3/2	massive	20-30	10	5	0			FF	NE
PC-029	Danvers	Da	A	0-7	5YR 2.5/1	mmgr	5	5	0	0	NE	5-8	CF	NE
			Bt	7-14	7.5YR 5/2	mmsbk	5	5	0	0			CF	SL
			C1	14-24	10YR 6/2	massive	5-10	0	0	0			FF	VE
			C2	24-31	2.5YR 6/6	massive	5	0	0	0			-	ST
			C3	31-49	2.5YR 6/4	massive	5	0	0	0			-	ST
PC-030	Martinsdale	Ma	A	0-8	5YR 2.5/1	mmgr	0	0	0	0	N/NE	2-8	MF, FM	NE
			A2	8-22	5YR 2.5/1	mmgr/mmsbk	0	0	0	0			CF, FM	NE
			C1	22-36	5YR 3/1	massive	0-5	0	0	0			FF	NE
			C2	36-44	7.5YR 6/2	massive	0-5	0	0	0			-	VE
PC-031	Shawmut	Sh	A	0-5	5YR 2.5/1	mmgr	5	5	5	5	N	5-15	CF	NE
			Bt	5-13	5YR 3/2	wfsbk	5-10	5	0	0			CF	NE
			C	13+	5YR 3/2	massive	20-40	20	0	0			FF	NE
PC-032	Martinsdale	Ma	A	0-7	5YR 2.5/2	mmgr/mmpl	0	0	0	0	E	1-5	FF, FM	SL
			Bk	7-14	10YR 6/3	wfabk	0	0	0	0			FF	ST
			C1	14-27	10YR 6/3	massive	0-5	0	0	0			FF	ST
			C2	27-50	10 YR 7/3	massive	0-5	0	0	0			-	VE
CB-01	Coben	Co	A	0-5	5YR 3/2	wfgr	15	5	0	0	W	10-20	MF, MM	NE
			Bt	5-12	5YR 4/4	wmpr/mcabk	0	5	0	0			MF, CM	ME
			Btk	12-24	5YR 5/3	mmabk	0	0	0	0			CF, FM	VE
			Ck	24-46	5YR 6/3	massive	0	0	0	0			FF	ST
			C	46-60+	5YR 6/4	massive	0	0	0	0			FF	NE
CB-02	Whitecow	WC-RO	AC	0-4	5YR 4/4	wfabk/massive	10	0	0	0	NW	5-15	CF, FM	NE
			C1	4-18	5YR 4/3	massive	10	0	0	0			CF, FM	SL
			C2	18-30	5YR 3/4	massive	10	10	10	0			FF	ST

Table 2
Soils Field Data

Sample Site (SS)	Soil Series	Map Unit Symbol	Soil Horizon	Depth (inches)	Color ¹ (moist)	Structure ²	Coarse Fragment % Volumes				Aspect	Slope %	Roots ³	Effervescence ⁴
							Gravel	Cobbles	Stones	Boulders				
CB-03	Winspect	Ws	A	0-4	5YR 3/2	wfgr	10	10	0	0	E	10-20	CF, FM	NE
			B	4-11	5YR 4/3	hmabk	5	10	5	0			FF, FM	NE
			C	11-20	5YR 7/3	massive	40	10	0	0			-	VE
			R	20+	-	-	-	-	-	-			-	-
CB-04	Winspect	Ws	Not sampled - Same as CB-03				-	-	-	-	E	10-15	-	-
CB-05	Windham	Wd	A	0-3	5YR 3/2	wfgr	10	25	5	0	SE	5-15	CF	NE
			Bt	3-10	5YR 5/3	hmabk	10	20	5	0			FF	VE
			C1	10-18	5YR 5/4	massive	20	10	0	0			FF	VE
			C2	18-38	5 YR 4/6	massive	30	10	0	0			FF	VE
CB-06	Coben	Co	A	0-3	5YR 3/2	wfgr	2	2	0	0	SE	2-8	CF, FF	NE
			Bt	3-12	5YR 3/3	hmabk	0	0	0	0			CF, FF	SL
			Btk	12-28	5YR 4/4	mmabk	0	0	0	0			FF	VE
			C	28-46	5YR 5/4	massive	0	0	0	0			-	SL
			Cr	46-62	5YR 5/4	massive	0	0	0	0			-	NE
CB-07	Whitewcow	WC-RO	A	0-4	5YR 3/3	gr	5	5	0	0	NE	20-60	CF, FM	NE
			Bt	4-12	5YR 4/3	wmsbk	5	10	0	0			CF, FM	NE
			C	12-20	5YR 4/4	massive	5	10	15	0			FF	NE
CB-08	Lap	Lp	A	0-5	5YR 2/2	wmsbk	5	5	0	0	N	15-40	CF, FM	NE
			Bt	5-11	5YR 3/2	mmsbk	10	10	0	0			CF, FM	NE
			C	11-17	5YR 4/4	massive	15	15	0	0			FF	NE
CB-09	Lap	Lp	A	0-5	5YR 3/2	wfsbk	10	0	0	0	N	5-20	MF, CM	NE
			B	5-10	5YR 3/3	wmsbk	10	0	0	0			MF, CM	NE
			C	10+	5YR 4/3	massive	15	10	5	5			CF	NE
CB-10	Whitewcow	WC-RO	O	0-2	-	-	10	0	0	0	NW	40-60	-	-
			A	2-6	5YR 2/1	mmabk	15	10	0	0			FF, CM, CC	NE
			C	6-20	5YR 2/2	massive	15	15	15	0			FM,FC	NE
CB-11	Lap	Lp	A	0-7	5YR 3/2	wmsbk	10	0	0	0	NW	5-15	MF, CM	NE
			Bt	7-14	5YR 3/3	mmsbk	20	0	0	0			CF, FM	NE
			Ck	14-24	5YR 4/4	massive	30	10	0	0			CF, FM	VE

**Table 2
Soils Field Data**

Sample Site (SS)	Soil Series	Map Unit Symbol	Soil Horizon	Depth (inches)	Color ¹ (moist)	Structure ²	Coarse Fragment % Volumes				Aspect	Slope %	Roots ³	Effervescence ⁴
							Gravel	Cobbles	Stones	Boulders				
CB-12	Winspect	Ws	A	0-5	7.5YR 4/3	wmsbk	0	0	0	0	S	2-8	MF, FM	NE
			B	5-18	7.5YR 4/4	mmabk	5	0	0	0			CF	NE
			Bk	18-36	7.5YR 4/4	mmabk	20	0	0	0			FF	ST
			C	36+	-	-	-	-	-	-			-	-
CB-13	Lap	Lp	A	0-6	7.5YR 4/3	wfgr	30	10	0	0	S	8-15	MF, CM	VE
			C	6-16	7.5YR 4/4	massive	10	40	0	0			MF, CM	VE
			Cr/R	16+	-	-	-	-	-	-			FF	VE
CB-14	Martinsdale	Ma	Ap	0-5	7.5YR 4/3	wfgr	0	0	0	0	SW	5-15	CF	NE
			Bt	5-16	7.5YR 4/4	wmpr/mcabk	10	0	0	0			CF	SL
			Bc	16-38	7.5YR 5/4	wmpr/wmabk	20	0	0	0			FF	VE
			C	38-46	7.5YR 5/3	massive	30	0	0	0			-	VE

¹Color: Munsell color notations.

²Structure: Grade: m = massive, w = weak, m = moderate, s = strong.

Size: vf = very fine, f = fine, m = medium, c = coarse, vc = very coarse.

Type: gr = granular, pl = platy, pr = prismatic, cl = columnar, abk = angular blocky, sbk = subangular blocky.

³Roots: Abundance: F = few, C = common, M = many.

Size: VF = very fine, F = fine, M = medium, CO = coarse.

⁴Effervescence: NE = non effervescent, VS = very slightly effervescent, SL = slightly effervescent, ST = strongly effervescent, VE = violently effervescent

Table 3
Soils Lab Data

Sample Site (SS)	Soil Series	Map Unit Symbol	Horizon	Depth (inches)	Lab Soil Texture ¹	Sand %	Silt %	Clay %	Percent Saturation %	Organic matter %	pH (std units)	Electrical Conductivity (EC) (mmhos/cm)	Sodium Adsorption Ratio (SAR) (unitless)
PC-005	Quigley	Qg	A	0-8	SiL	16	63	21	57.0	6.3	6.8	0.6	<0.1
			Bw	8-14	SiL	14	67	19	56.2	5.3	7.4	0.4	<0.1
			C	14-22	SiL	12	67	21	51.4	4.1	7.3	0.2	0.2
PC-008	Windham	Wd	A	0-6	SiL	16	69	15	34.0	3.8	6.5	0.5	6.1
			B	6-12	SiL	14	61	25	59.7	3.0	7.9	3.0	17.3
			C	12-24	SiCL	18	45	37	56.9	2.3	8.3	18.9	20.2
PC-009	Shawmut	Sh	A	0-3	SiL	20	56	24	56.3	6.9	6.3	0.4	0.4
			Bt	3-11	SiCL	16	50	34	57.0	4.5	6.4	0.3	0.5
			C	11-23	C	38	20	42	51.6	3.3	7.8	0.5	2.5
PC-011	Winspect	Ws	A	0-3	L	40	46	14	43.0	4.5	7.4	0.7	<0.1
			Bk	3-11	SiL	36	50	14	46.0	3.5	7.6	0.8	1.4
			C	11-27	SL	58	32	10	32.8	1.4	8.1	8.0	6.0
PC-013	Braziel	BrTo	A	0-6	SiL	24	64	12	47.9	5.2	6.4	0.7	1.6
			Btk	6-12	SiL	16	58	26	54.4	3.6	7.2	0.8	7.4
			Bk	12-26	SiL	16	58	26	54.3	2.8	8.0	5.5	10.8
			C	26-40	SiL	18	60	22	46.0	2.2	8.1	6.8	15.8
PC-014	Martinsdale	Ma	A/B	0-5	C	18	36	46	60.3	6.2	7.5	0.6	0.2
			C1	5-15	C	12	24	64	80.7	4.0	8.0	0.9	2.7
			C2	15-32	C	20	20	60	68.8	3.4	8.0	6.5	4.6
PC-017	Danvers	Da	A	0-6	SiCL	20	49	31	66.6	7.2	7.4	0.9	0.8
			Bt	6-15	C	14	37	49	96.3	4.8	8.2	1.3	4.9
			C1	15-38	C	16	13	71	82.7	2.7	8.1	6.8	5.0
			C2	38-52	C	22	33	45	82.6	2.9	7.6	3.0	1.1
			C3	52-60	C	32	25	43	78.7	4.6	7.4	3.2	0.8
PC-020	Braziel	BrTo	A	0-6	SiCL	10	53	37	60.9	6.0	7.1	0.4	<0.1
			Btk	6-20	SiCL	12	55	33	53.5	3.8	7.7	0.4	0.2
			C1	20-40	SiCL	6	57	37	51.4	3.7	7.8	4.2	1.8
			C2	40-52	C	10	37	53	59.0	4.4	7.9	4.8	3.1

Table 3
Soils Lab Data

Sample Site (SS)	Soil Series	Map Unit Symbol	Horizon	Depth (inches)	Lab Soil Texture ¹	Sand %	Silt %	Clay %	Percent Saturation %	Organic matter %	pH (std units)	Electrical Conductivity (EC) (mmhos/cm)	Sodium Adsorption Ratio (SAR) (unitless)
PC-021	Braziel	BrTo	A	0-9	SIL	16	63	21	53.7	6.0	6.3	0.4	0.1
			A2	9-18	SIL	16	65	19	56.7	5.7	6.8	0.3	0.2
			C1	18-36	SIL	18	63	19	55.2	5.7	6.7	0.4	0.2
			C2	36-38	SIL	16	61	23	55.8	5.4	7.2	0.6	0.3
PC-025	Tolbert	BrTo	A	0-5	CL	22	45	33	52.1	5.8	6.1	0.2	0.2
			Bt	5-13	SiCL	18	51	31	51.2	4.5	6.3	0.2	0.3
			C	13-23	L	26	49	25	47.2	3.7	6.5	0.3	0.5
PC-027	Danvers	Da	A	0-8	SiCL	18	43	39	64.5	7.4	5.6	0.3	0.9
			Bt	8-17	SiCL	20	51	29	44.7	4.3	5.6	0.3	2.1
			C1	17-29	SiCL	18	48	34	51.8	3.5	7.2	0.6	3.0
			C2	29-49	SiCL	18	49	33	49.4	2.8	7.9	0.5	4.1
PC-028	Shawmut	Sh	A	0-4	SiCL	20	53	27	45.3	5.6	6.7	0.5	0.1
			A2	4-16	SIL	20	55	25	46.8	5.5	6.8	0.4	0.2
PC-029	Danvers	Da	A	0-7	SiCL	18	47	35	59.2	6.2	6.6	0.6	0.2
			Bt	7-14	C	6	25	69	94.5	5.0	7.6	0.3	0.7
			C1	14-24	C	10	31	59	80.6	3.4	7.8	0.6	1.7
			C2	24-31	C	<1	7	93	134	3.2	7.7	2.8	2.2
			C3	31-49	C	8	11	81	121	2.8	7.7	2.2	2.4
PC-030	Martinsdale	Ma	A	0-8	SIL	17	62	21	74.5	10.8	6.8	0.5	<0.1
			A2	8-22	SIL	14	63	23	67.1	9.5	6.9	0.5	0.1
			C1	22-36	SiCL	16	55	29	51.7	4.1	7.5	1.1	1.4
			C2	36-44	SiCL	14	55	31	53.7	2.5	7.8	0.4	1.6
CB-01	Coben	Co	A	0-5	SIL	28	54	18	48.8	5.2	6.4	0.5	0.8
			Bt	5-12	SiCL	16	56	28	49.8	3.6	6.4	0.2	1.9
			Btk	12-24	C	14	28	58	112	3.4	7.9	1.7	3.5
			Ck	24-46	C	20	14	66	114	3.5	7.6	3.4	2.7
			C	46-60+	C	30	14	56	113	3.1	7.6	2.4	3.2
CB-05	Windham	Wd	A	0-3	L	30	46	24	52.8	4.7	6.5	0.4	0.4
			Bt	3-10	CL	22	46	32	50.5	2.7	7.6	0.4	0.4
			C1	10-18	C	16	30	54	71.0	3.1	7.8	0.4	1.8
			C2	18-38	C	16	38	46	68.2	3.8	7.6	0.7	2.7

**Table 3
Soils Lab Data**

Sample Site (SS)	Soil Series	Map Unit Symbol	Horizon	Depth (inches)	Lab Soil Texture ¹	Sand %	Silt %	Clay %	Percent Saturation %	Organic matter %	pH (std units)	Electrical Conductivity (EC) (mmhos/cm)	Sodium Adsorption Ratio (SAR) (unitless)
CB-06	Coben	Co	A	0-3	SIL	17	67	16	40.0	3.9	6.7	0.3	3.2
			Bt	3-12	SiC	6	54	40	69.2	4.8	7.6	0.5	4.6
			Btk	12-28	SIL	2	72	26	84.4	4.1	7.9	0.6	5.1
			C	28-46	C	<1	16	84	131	4.1	7.8	4.5	6.0
			Cr	46-62	C	<1	10	90	152	4.2	7.8	3.2	6.7
CB-07	Whitecow	Wc-RO	A	0-4	SiCL	20	52	28	38.7	5.1	6.3	0.3	0.4
			Bt	4-12	SiCL	18	54	28	40.2	4.5	6.5	0.1	0.4
			C	12-20	SiCL	20	52	28	41.5	3.9	6.8	0.3	0.4
CB-10	Whitecow	Wc-RO	O	0-2									
			A	2-6	SiCL	20	49	31	58.8	11.5	5.8	0.3	0.7
			C	6-20	SiCL	18	47	35	52.3	8.7	6.2	0.4	1.3
CB-11	Lap	Lp	A	0-7	SIL	20	61	19	83.2	12.6	6.4	0.7	0.1
			Bt	7-14	SIL	16	63	21	62.8	6.6	7.3	0.8	0.4
			Ck	14-24	SiCL	20	47	33	60.5	5.1	7.5	0.9	1.4
CB-12	Winspect	Ws	A	0-5	SIL	16	67	17	50.0	6.1	6.3	0.4	0.6
			B	5-18	SIL	18	67	15	50.6	3.8	7.5	2.3	13.5
			Bk	18-36	SiCL	16	53	31	70.1	2.6	8.4	4.2	16.2
			C	36+									
CB-13	Lap	Lp	A	0-6	SIL	32	50	18	58.6	6.4	7.4	0.8	<0.1
			C	6-16	L	28	46	26	54.3	4.5	7.4	0.7	<0.1
			Cr/R	16+									
CB-14	Martinsdale	Ma	Ap	0-5	SIL	15	67	18	45.5	3.9	6.3	0.5	0.6
			Bt	5-16	SIL	14	66	20	45.8	3.4	6.4	0.8	3.6
			Bc	16-38	SIL	12	66	22	48.2	2.4	8.0	4.3	13.1
			C	38-46	SIL	18	62	20	48.6	2.3	8.0	6.4	14.2

¹ Lab Soil Textures: C = clay, CL = clay loam, L = loam, LS = loamy sand, LFS = loamy fine sand, SIL = silty loam, SiCL = silty clay loam, SiC = silty clay, S = sand, SL = sandy loam, SCL = sandy clay loam, SC = sandy clay

**Table 4
Inorganic Elements Analysis**

Sample Site (SS)	Soil Series	Map Unit Symbol	Horizon	Depth (inches)	Inorganic Element Concentration				
					Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
PC-005	Quigley	Qg	A	0-8	10	<1	21	20	60
			Bw	8-14	10	<1	17	19	56
			C	14-22	10	<1	16	19	54
PC-008	Windham	Wd	A	0-6	16	<1	17	21	46
			B	6-12	13	<1	14	21	59
			C	12-24	15	<1	7	9	19
PC-009	Shawmut	Sh	A	0-3	14	<1	22	20	64
			Bt	3-11	11	<1	18	18	69
			C	11-23	26	<1	18	10	90
PC-011	Winspect	Ws	A	0-3	19	<1	19	15	46
			Bk	3-11	10	<1	10	10	34
			C	11-27	3	<1	4	6	13
PC-013	Braziel	BrTo	A	0-6	12	<1	17	16	48
			Btk	6-12	8	<1	13	15	52
			Bk	12-26	11	<1	16	12	45
			C	26-40	14	<1	16	11	47
PC-014	Martinsdale	Ma	A/B	0-5	24	<1	23	14	70
			C1	5-15	11	<1	17	11	46
			C2	15-32	11	<1	14	9	38
PC-017	Danvers	Da	A	0-6	12	<1	23	18	68
			Bt	6-15	9	<1	21	17	71
			C1	15-38	7	<1	15	16	43
			C2	38-52	8	<1	23	20	56
			C3	52-60	20	<1	41	27	151
PC-020	Braziel	BrTo	A	0-6	16	<1	20	15	53
			Btk	6-20	15	<1	17	14	46
			C1	20-40	33	<1	28	11	50
			C2	40-52	16	<1	18	11	49
PC-021	Braziel	BrTo	A	0-9	20	<1	20	14	62
			A2	9-18	9	<1	12	15	55
			C1	18-36	8	<1	12	15	51
			C2	36-38	10	<1	14	14	53
PC-025	Tolbert	BrTo	A	0-5	13	<1	15	16	58
			Bt	5-13	11	<1	14	16	57
			C	13-23	13	<1	14	17	49
PC-027	Danvers	Da	A	0-8	9	<1	14	11	52
			Bt	8-17	9	<1	14	14	51
			C1	17-29	9	<1	19	12	56
			C2	29-49	6	<1	16	10	56
PC-028	Shawmut	Sh	A	0-4	13	<1	19	19	60
			A2	4-16	17	<1	18	18	55

**Table 4
Inorganic Elements Analysis**

Sample Site (SS)	Soil Series	Map Unit Symbol	Horizon	Depth (inches)	Inorganic Element Concentration				
					Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
PC-029	Danvers	Da	A	0-7	16	<1	17	22	70
			Bt	7-14	10	<1	15	22	74
			C1	14-24	12	<1	12	8	66
			C2	24-31	121	<1	20	29	119
			C3	31-49	38	<1	13	15	78
PC-030	Martinsdale	Ma	A	0-8	9	<1	16	9	63
			A2	8-22	6	<1	17	10	62
			C1	22-36	7	<1	14	17	54
			C2	36-44	17	<1	15	17	42
CB-01	Coben	Co	A	0-5	18	<1	17	16	47
			Bt	5-12	12	<1	17	18	57
			Btk	12-24	18	<1	18	11	41
			Ck	24-46	11	<1	16	10	31
			C	46-60+	11	<1	15	10	31
CB-05	Windham	Wd	A	0-3	31	<1	21	19	54
			Bt	3-10	26	<1	18	14	40
			C1	10-18	25	<1	18	14	45
			C2	18-38	30	<1	19	19	54
CB-06	Coben	Co	A	0-3	7	<1	12	19	54
			Bt	3-12	7	<1	17	15	57
			Btk	12-28	8	<1	20	13	47
			C	28-46	9	<1	22	12	35
			Cr	46-62	4	<1	25	10	19
CB-07	Whitecow	Wc-RO	A	0-4	11	<1	15	20	65
			Bt	4-12	10	<1	15	14	68
			C	12-20	9	<1	15	15	63
CB-10	Whitecow	Wc-RO	O	0-2	-	-	-	-	-
			A	2-6	21	<1	19	15	66
			C	6-20	58	<1	19	13	58
CB-11	Lap	Lp	A	0-7	28	<1	22	14	61
			Bt	7-14	24	<1	16	14	52
			Ck	14-24	35	<1	41	13	41
CB-12	Winspect	Ws	A	0-5	15	<1	15	16	60
			B	5-18	8	<1	13	17	54
			Bk	18-36	14	<1	18	16	46
			C	36+	-	-	-	-	-
CB-13	Lap	Lp	A	0-6	26	<1	21	15	50
			C	6-16	20	<1	13	7	31
			Cr/R	16+	-	-	-	-	-
CB-14	Martinsdale	Ma	Ap	0-5	9	<1	15	15	54
			Bt	5-16	10	<1	15	16	57
			Bc	16-38	13	<1	15	12	49
			C	38-46	11	<1	14	11	47

APPENDIX A

SOILS SAMPLE SITE PHOTOS

MONTANA LIMESTONE RESOURCES BASELINE SOILS INVENTORY



Site PC-001: Lap soils



Site PC-002: Windham soils



Site PC-003: Lap soils



Site PC-004: Quigley soils



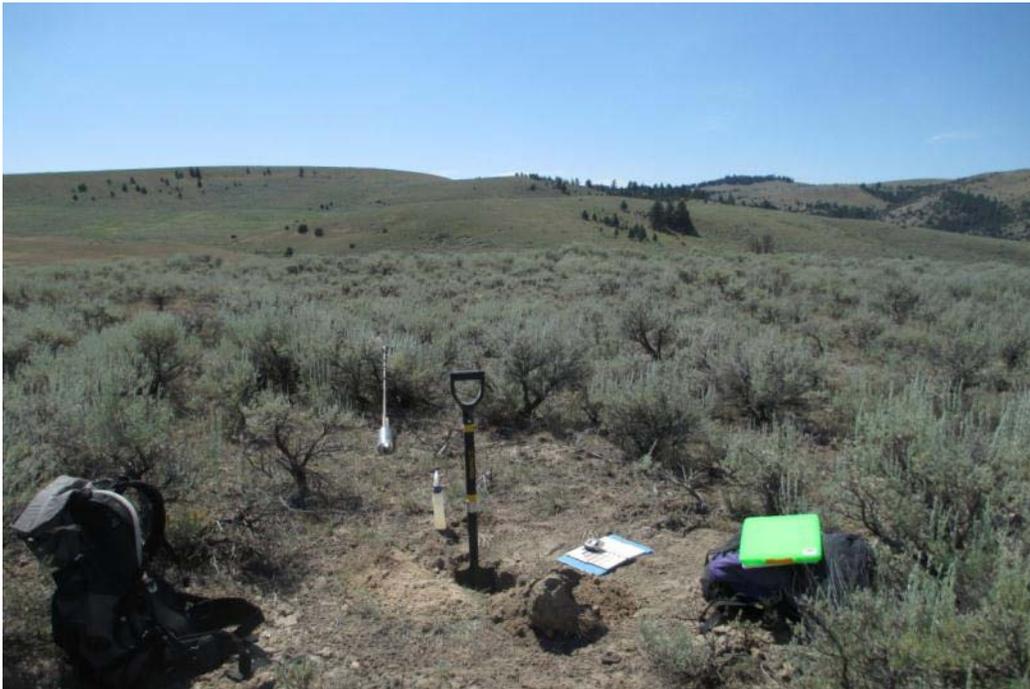
Site PC-005: Quigley soils



Site PC-006: Quigley soils



Site PC-007: Quigley soils



Site PC-008: Windham soils



Site PC-009: Shawmut soils



Site PC-010: Shawmut soils



Site PC-011: Winspect soils



Site PC-012: Coben soils



Site PC-013: Braziel soils



Site PC-014: Martinsdale soils



Site PC-015: Shawmut soils



Site PC-016: Coben soils



Site PC-017: Danvers soils



Site PC-018: Tolbert soils



Site PC-019: Braziel soils



Site PC-020: Braziel soils



Site PC-021: Braziel soils



Site PC-022: Tolbert soils



Site PC-023: Danvers soils



Site PC-024: Tolbert soils



Site PC-025: Tolbert soils



Site PC-026: Shawmut soils



Site PC-027: Danvers soils



Site PC-028: Shawmut soils



Site PC-029: Danvers soils



Site PC-030: Martinsdale soils



Site PC-031: Shawmut soils



Site PC-032: Martinsdale soils



Site CB-01: Coben soils



Site CB-02: Whitecow soils



Site CB-03: Winspect soils



Site CB-05: Windham soils



Site CB-06: Coben soils



Site CB-07: Whitecow soils



Site CB-08: Lap soils



Site CB-09: Lap soils



Site CB-010: Whitecow soils



Site CB-11: Lap soils



Site CB-12: Winspect soils



Site CB-13: Lap soils



Site CB-14: Martinsdale soils