Salt Migration Study
Conoco/Phillips 2007

Introduction

In November 2007, a drill site, DC Federal #3 located south of Bloomfield, New Mexico, was sampled. The purpose for the sampling was to compare electrical conductivity from soils potentially influenced by drilling pit contents to nearby native soils unaffected by drilling pit contents. The DC Federal #3 drill site was completed in the late 1960's. It represents a well site nearly 40 years old where the drilling pit was not lined. The objective of the project was to determine if soluble salts migrated from the drilling pit into the surface soils and/or leached into the subsurface soils below the drilling pit.

Method

The soils at the DC Federal #3 site, Photo 1, were sampled November 26, 2007 from a high wall pit created by a track hoe, Photo 2. One test-pit was dug through the approximate center of the drilling pit, Photo 3, and the other test-pit was dug approximately 200 ft to the west in a native area unaffected by the original construction of the drill site. Soil samples from the site were collected along a horizontal plane 40 inches wide and in 4 inch increments from the surface to 4 ft and 1 ft increments from 4 ft to 14 ft. Similar soil samples at the native site were collected along a 40 inch horizontal plane and in 1 ft increments from the surface to 13 ft. Samples were bagged and sent to Green Analytical, Durango, Colorado for analysis of Electrical Conductivity (EC).

Results

The mud pit at the drill site was located at a mean depth of 20 inches from the surface and had a mean thickness of 16 inches, Photo 3. The moisture content of the pit contents were about the same as the soils above and below the pit contents. Although soil moisture was not measured, the soils and pit contents were considered "dry" or near a matric potential of 10 bars. The EC of the pit contents were 8.73 dSm^{-1} (mmhos/cm), Table 1. Above the pit contents the EC of the soil was lower 7.12 dSm^{-1} at 16 – 20 inches and 5.30 dSm^{-1} at 12 – 16 inches, Table 1. The three samples from the first foot of cover soil were respectively 0.30 dSm^{-1} (0 – 4inches), 0.45 dSm^{-1}

(4 – 8 inches) and 1.80 dSm^{-1} (8 – 12 inches). These values are similar to the upper 4 ft of native soil respectively 0.22, 1.21, 0.31 and 0.69 dSm^{-1} for the 1 ft increments, Table 1.

Below the pit contents, the 36 – 40 inch increment of soil had an EC of 9.08 dSm^{-1}, slightly higher than the drill pit contents, Table 1. The next two increments 40 – 44 inches and 44 – 48 inches had EC values of 5.64 and 5.24 dSm^{-1} respectively, Table 1. The next 1 ft increments, to a depth of 10 ft, were similar to one another, respectively 6.61, 7.19, 6.02, 8.93, 6.70 and 5.25 dSm^{-1}, Table 1. Below 10 ft (10 – 14 ft) the EC values were comparable to the native soil for the same 1 ft increment depths 1.51, 1.50, 0.51 and 0.63 dSm^{-1} for the drill pit site and 2.62, 0.78 and 0.74 dSm^{-1} for the native site (10 – 13 ft).

Discussion and Conclusion

The native soil represents base line conditions in this study. The original EC values of the pit area soils are believed to be represented by the present day adjacent undisturbed native area. The surface foot and deep (>10') subsoil for the two pits have similar EC values, Figure 1. It appears there has been salt migration from the pit contents both upward and downward. The upward movement extends about 12" above the pit contents to a depth of 8" below the surface. The downward movement extends from 36" to a depth of about 7' below the pit contents or 10' from the surface.

Upward migration of soluble salts has been observed in other studies, Merrill et al. (1983), Barth and Martin (1984), Dollhoph et al. (1992) and Bailey (2001). Soluble salts in these other studies have been shown to migrate 6 – 12 inches upward but were never observed migrating to the surface. Similar results were found in this study. Downward leaching of soluble salts has also been observed in numerous studies. The present day moisture levels of this soil and the pit contents were "dry" at depth; therefore, continued leaching of soluble salts is expected to be substantially reduced in comparison to the first 40 years. Salts generally migrate in the first few years and movement thereafter is minimal (Merrill et al., 1983). The location of soluble salts at this site are expected to be unchanged under the present semi-arid conditions.

These data support the conclusion that soluble salts migrate both upward and downward from an unlined drilling pit. The upward movement is limited and soluble salts do not migrate to the surface. The downward movement of soluble salts occurred as expected. The depth of leaching seemed to be limited to the upper 10 ft after 40 years. Leaching is expected to continue but at a greatly reduced level.

References

Bailey, D.L.H. 2001. Properties of soil profiles over sodic mine spoil 16 years after construction. M.Sc. thesis, Univ. of Alberta, Edmonton, AB.

Barth, R.C. and B.K. Martin. 1984. Soil depth requirements for revegetation of surface-mined areas in Wyoming, Montana and North Dakota. Journal of Environmental Quality 13:399-404.

Dollhoph, D.J., B.E. Olson, and S.R. Jennings. 1992. Coversoil sodication and plant performance on 11-year old minesoils. Reclamation Research Unit Publication No. 9006

Merrill, S.D., E.J. Doering, J.F. Power and F.M. Sandoval. 1983. Sodium movement in soil-minespoil profiles: diffusion and convection. Soil Sci. 136:308-317.

Table 1 Electrical Conductivity for Soil Samples Collected from the DC Federal #3 Drill Site Location and a nearly Native Soil Location

		-------EC dSm^{-1}-------	
	Depth	Drill Site	Native Site
	0-4	0.30	0.22
	4-8	0.45	0.22
	8-12	1.80	0.22
	12-16	5.30	1.21
	16-20	7.12	1.21
Drilling Mud	20-24	8.73	1.21
Drilling Mud	24-36	8.73	0.31
	36-40	9.08	0.69
	40-44	5.64	0.69
	44-48	5.25	0.69
	48-60	6.61	1.11
	60-72	7.19	2.59
	72-84	6.02	3.45
	84-96	8.93	4.51
	96-108	6.70	4.26
	108-120	5.25	3.53
	120-132	1.51	2.62
	132-144	1.50	0.78
	144-156	0.51	0.74
	156-168	0.63	ND

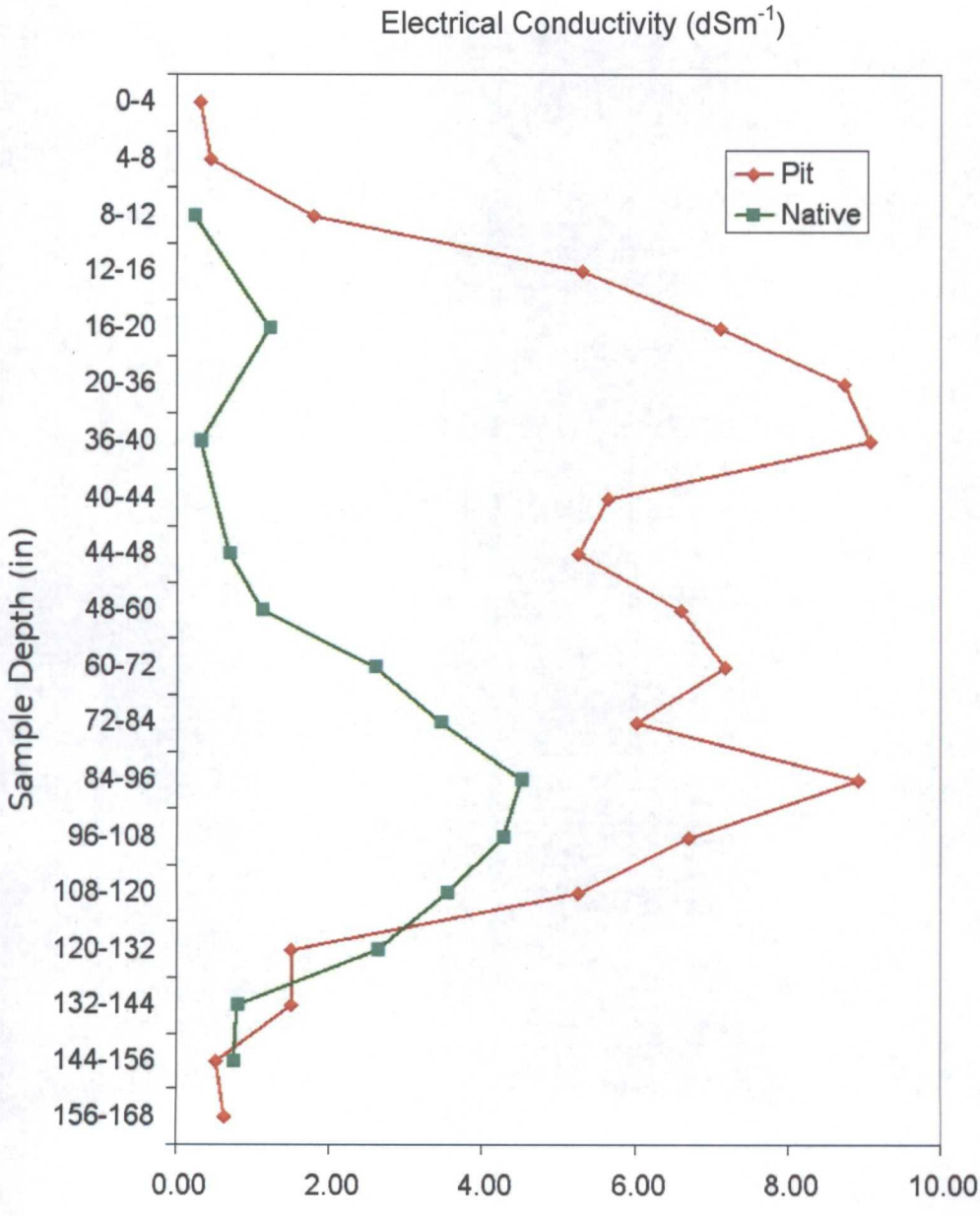

Figure 1 Soil Electrical Conductivity vs. Depth for DC Federal Drilling Pit and Native Site.

Photo 1 DC Federal #3 Drill Site

Photo 2 High Wall Pit for DC Federal #3

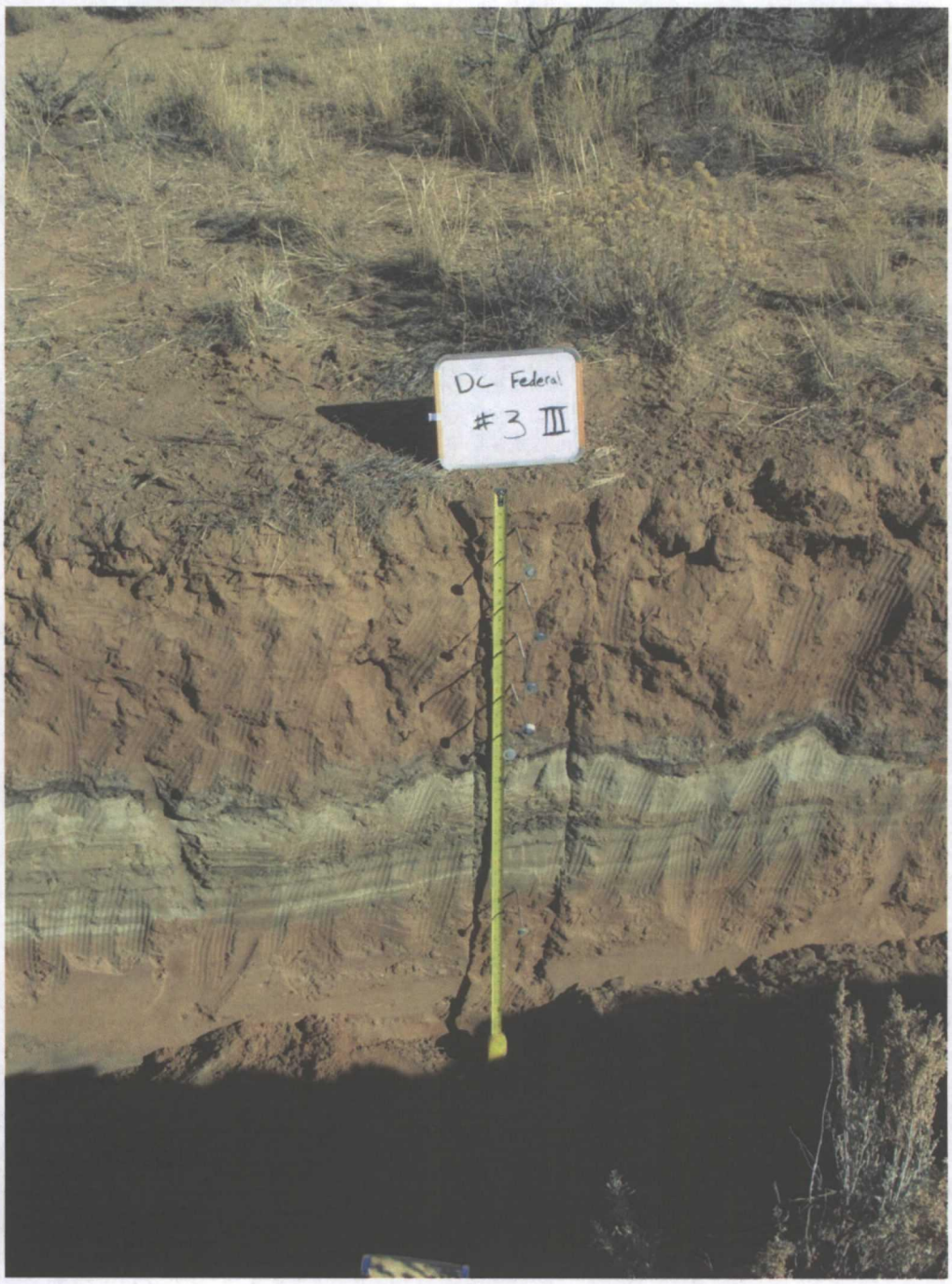

Photo 3 Test Pit showing Drilling Pit Contents