Effects of Alternative Liming Strategies on Leachate Quality and Soil Morphology of Acid-Forming Dredge Materials[1]

Zenah Orndorff*, W. Lee Daniels, Sara Klopf, and Abbey Wick[2]

Abstract: Over 200 M m^3 of dredge materials are removed annually in the USA from a wide array of source environments. Since 2001, > 750,000 m^3 of fresh- and salt-water source dredge materials have been placed and converted to agricultural uses at an upland utilization facility (Weanack Land LLLP) in Charles City County, Virginia. All materials accepted for placement at Weanack must pass a rigorous screening protocol that includes an assessment of their acid-forming potential. To date, we have screened approximately 20 different potential dredge materials and found that approximately 1/3 of the saline source materials contain significant levels of potential acidity. To determine best management practices for one material (Cox Creek; H_2O_2 potential acidity-PPA = -10 Mg CCE per 1000 Mg material; Total S = 1.31%; CCE = 7.13%), we conducted a series of lab (reported to ASMR in 2011) and long-term field experiments. In the field, two lime application methods were tested (bulk-blending and layering; both at 12.5 Mg CCE per 1000 Mg) against an unlimed control treatment. Three zero-tension lysimeters were installed under each plot to monitor pH, EC and metal content of leachates. The pH of both the bulk-blended lime and layered treatments remained between 4.4 and 5.5 over the first four years (2010-2014), but the pH of the leachates under the non-limed control plots dropped to 3.7 after two year, before slowly rising again to approximately 4.2. The initial EC of the leachate samples (6 to 17 dS m^{-1}) indicated an issue with soluble salts across all treatments, but all fell to < 4 dS m^{-1} by the end of the five year monitoring period. The salts initially originated from entrained chlorides, but were enhanced by sulfates over time as sulfides reacted and were neutralized. High levels of Fe (> 10 mg L^{-1}) and Mn (> 100 mg L^{-1}) leached from the non-limed and layered lime treatments in the field, but were significantly lower in the bulk-blended lime treatment. Net sulfuricization processes were noted by the white sulfate salt crust on the soil surface and prominent jarosite mottles with depth in all plots over the first two growing seasons. More recent (2016) soil pit investigations confirmed that jarosite was still present in subsoil horizons, but was no longer as prominent. The exact nature of the phytotoxicity was not directly determined, but we assume that is was due to a combination of (a) very high levels of soluble salts the first two seasons combined with (b) high soil heat levels due to the black color of the exposed surface materials. Finally, for this particular material (Cox Creek saline dredge) the PPA technique for estimating potential acidity was superior to a more conventional acid-base-accounting approach based on Total-S and CCE determinations.

Additional Keywords: Acid sulfate soils, potential acidity, revegetation, jarosite, phytotoxicity, soluble salts.

---

[1] Oral paper presented at the 2017 National Meeting of the American Society of Mining and Reclamation, Morgantown, WV: ***What's Next for Reclamation?*** April 9 - 13, 2017. Published by ASMR, 1305 Weathervane Dr. Champaign, IL 61821.

[2] Zenah Orndorff, Senior Research Associate, W. Lee Daniels, Professor, and Sara Klopf, Crop and Soil Env. Sci, Virginia Tech, Blacksburg, VA 24061-0404; Abbey Wick, Associate Professor, Soil Science Dept., North Dakota State Univ., Fargo, ND 58108-6050