amec

Technical Memorandum			
To:	John Hamrick and Jim Cain, Cotter Corporation	**Project:**	DE 10160100
From:	David Levy	**cc:**	
Tel:	(303) 630-0788		
Fax:	(970) 669-0003		
Date:	September 30, 2011		
Subject:	**Subject: Characterization of Uranium and Molybdenum Concentrations in Dam to Ditch Area Soils**		

INTRODUCTION

A soil leaching column study was previously completed in May, 2011 to characterize uranium (U) and molybdenum (Mo) mobility from subsurface geologic materials in the Cotter Corporation (Cotter) Dam to Ditch Area (DDA) near Cañon City, Colorado (AMEC, 2011). The objective of the column study was to evaluate the potential for DDA soils to contribute U and Mo to groundwater. Leaching results from vadose- and saturated-zone aquifer materials indicated that a portion of the total uranium and molybdenum is readily released upon interaction with either natural precipitation or groundwater. Initial leachate concentrations exceeded CGWQS for U and Mo, but with concentrations that continued to decrease with increased leaching. Based on the observed leachate concentrations from the column study, soil flushing has been considered as a potential remedy for reducing soluble U and Mo concentrations in DDA soils. However, the DDA soils are not believed to represent a significant source to groundwater. For example:

- Molybdenum concentrations in column leachates (highest measured = 0.84 mg/L)) were an order of magnitude lower than those recently observed (2005-present) in DDA groundwater (6 to 9 mg/L).

- Uranium concentrations in column leachates (highest measured = 0.26 mg/L) were also lower than those recently observed (2005-present) in DDA groundwater (0.4 to 0.6 mg/L).

- Total U and Mo concentrations in composite soils from the columns were consistent with background concentrations and below soil screening levels previously established for the Old Ponds Area (OPA) (EMS, 2005). The DDA soil column uranium concentrations ranged from 2.8 to 7.4 mg/kg, compared to the OPA background of 2.1 mg/kg and a screening level of 30 mg/kg. Soil Mo concentrations ranged from 0.26 to 0.93 mg/kg, compared to the OPA background of 2.4 mg/kg and a screening level of 100 mg/kg.

AMEC Environment & Infrastructure
118 E. 29th Street, Suite C
Loveland, Colorado 80538
Tel (303) 630-0788
Fax (970) 669-0003

- High leaching fractions were applied to the columns to evaluate U and Mo mobility on a pore-volume basis, and to obtain adequate volume for analysis. However, the DDA is vegetated and generally arid, with low precipitation and moderately high evaporation rates. Therefore it appears unlikely that the vadose zone is contributing a significant volume of infiltration, and consequently mass of U and Mo to groundwater, especially considering the depth to groundwater (50 ft) and the low soil U and Mo content.

This study was conducted to obtain additional information that can be used to understand the potential contribution of DDA soils to the observed U and Mo in groundwater. The two objectives of this study are to: (1) Conduct a more detailed characterization of U and Mo concentrations in DDA soils and (2) model the infiltration of meteoric water through the DDA vadose zone to assess the potential for soil leaching to transport U and Mo to the water table.

Supplemental Soil Characterization

The initial soil analyses indicating low concentrations (May, 2011) were conducted on soil column samples that represent composites from borings completed from within the northern DDA drainage (AMEC, 2011) (Borings A through K, Figure 1). Supplemental characterization 9September, 2011) consisted of an additional 27 soil U and Mo concentration measurements conducted on samples collected from 200-ft centers across the main DDA. Samples were collected from 0 to 6-inches and placed into collection bags. The soils were then thoroughly mixed by hand and analyzed for total U and Mo using a portable X-ray fluorescence in the Cotter laboratory.

The DDA XRF results show that U and Mo soil concentrations across the entire DDA are near background levels, and therefore do not indicate there is a significant source of U in the soils. All 27 of the soil uranium measurements were below the XRF detection limit (<8 mg/kg) (Figure 1). Using the calibration data supplied by Cotter, the observed concentrations are corrected to <20 mg/kg. These results are also consistent with the total U concentrations (2.8 to 7.4 mg/kg) previously measured in the DDA boring samples (AMEC, 2011).

Only 6 of the 27 (22%) soil samples contained detectable Mo (Figure 1). The XRF concentrations ranged from 10 to 14 mg/kg, corresponding to a maximum corrected concentration of 10 mg/kg. The soil Mo concentrations are also consistent with background levels and therefore do not indicate there is a significant source of Mo in the DDA soils.

Unsaturated Zone Modeling

In addition to the XRF investigation, unsaturated zone modeling is being use to evaluate the hydrologic contribution of vadose zone water and subsequent potential for transport of U and Mo to groundwater in the DDA. Cotter is in the process of evaluating a number of different vadose zone models (SESOIL, AT123D,PESTAN, VLEACH, VST2D, MODFLOW SURFACT, and HELP) and is consulting with CDPHE for their recommendations regarding the model approach. The vadose zone modeling will be completed once the most appropriate modeling program is selected and the site-specific soil and climatic input parameters are compiled.

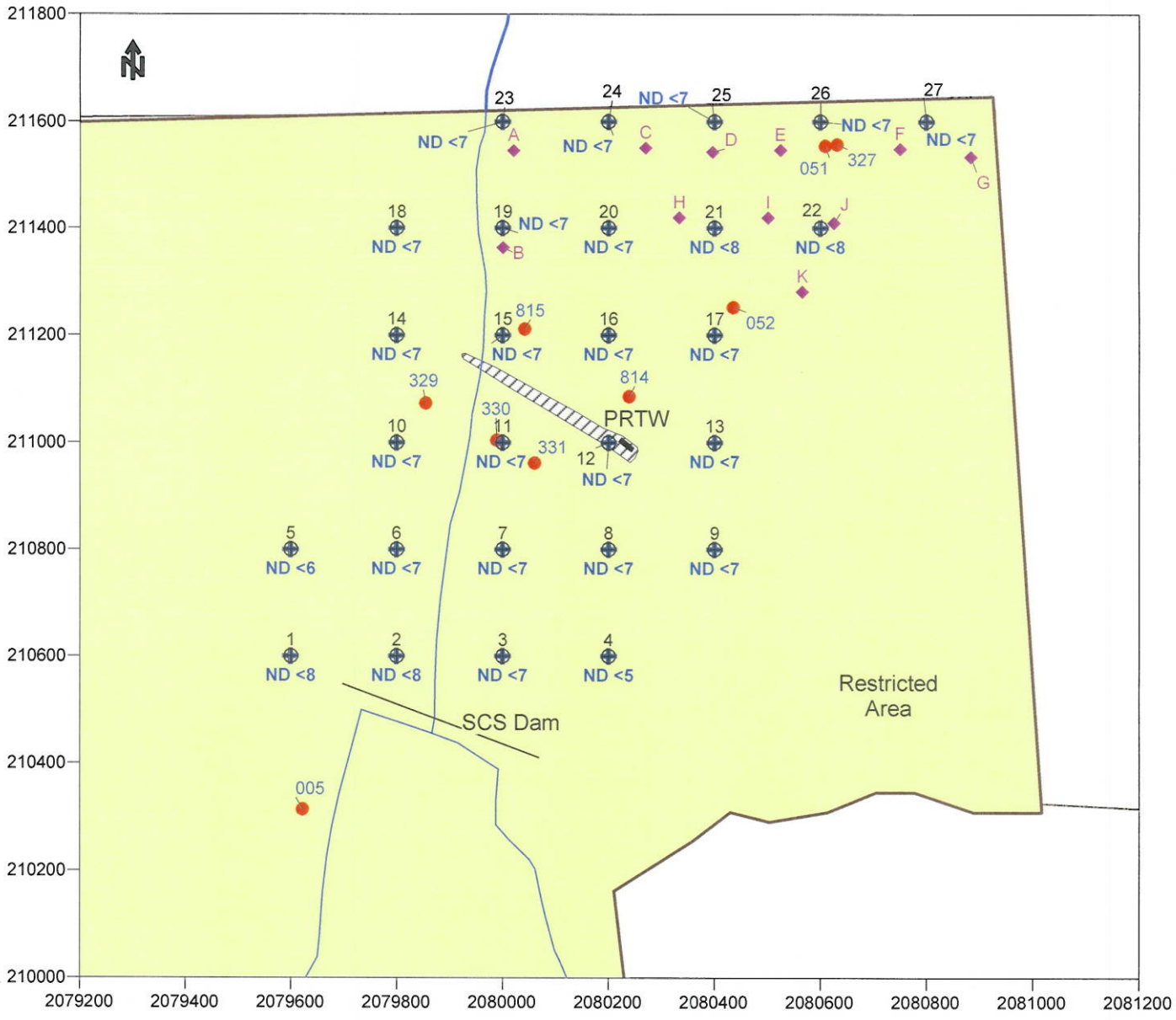
CONCLUSIONS

The concentrations of U and Mo in the DDA soils are consistent with background soil levels. Therefore the appears to be no significant source of U or Mo in the soils which could produce the concentrations observed in downgradient groundwater. In addition, evaporation exceeds precipitation in the area and thus there should be very limited contribution of U and Mo to groundwater from the vadose zone. The results of vadose zone modeling will be incorporated into this assessment and presented in a final memorandum as soon as the data are available.

REFERENCES

AMEC. 2011. Mobility of Uranium and Molybdenum from Subsurface Materials, Dam to Ditch Area, Cotter Uranium Mill, Canon City, Colorado. May 26.

Engineering Management Support, Inc. (EMS). 2005. Alternatives Assessment, Old Ponds Area



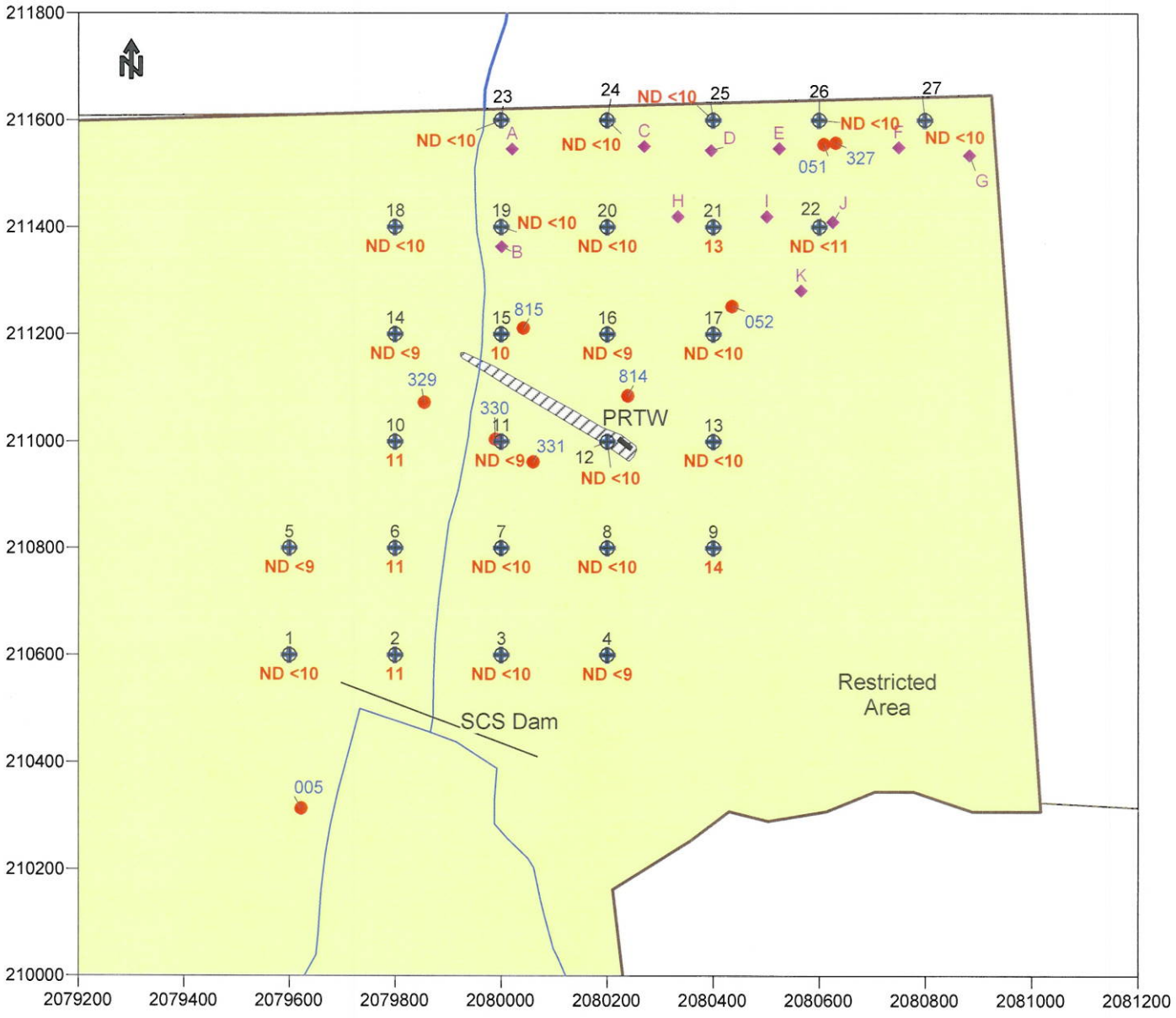
- Monitor Well
  Groundwater Sampling Program
- DDA Soil Boring Location
- 1 Sample ID
- ⊕ XRF Soil Sample Location
- ND < 10 Uranium Concentration (ppm)

Coordinates in ft, NAD27, Central Colorado

COTTER CORPORATION

Figure 1. Uranium Measurements, XRF Soil Samples
Dam to Ditch Area
Canon City Milling Facility, Colorado

By: EPL Checked: JC File ID:DDAXRF.srf Date: 10/3/11



- Monitor Well
  Groundwater Sampling Program
- DDA Soil Boring Location
- 1 Sample ID
- ⊕ XRF Soil Sample Location
- ND < 10 Molybdenum Concentration (ppm)

Coordinates in ft, NAD27, Central Colorado

COTTER CORPORATION

Figure 2. Molybdenum Measurements, XRF Soil Samples
Dam to Ditch Area
Canon City Milling Facility, Colorado

By: EPL Checked: JC File ID:DDAXRF.srf Date: 10/3/11