N.A. Water Systems

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Ref. No: 56007027

Mr. Mark D. Purcell
Superfund Division
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Re: List of Preliminary Assembled Remedial Alternatives
Site-Wide Supplemental Feasibility Study
UNC Mill Tailings Site, Church Rock, NM
Administrative Order (Docket No. CERCLA 6-11-89)

Dear Mr. Purcell:

On behalf of United Nuclear Corporation (UNC), N.A. Water Systems has assembled this list of remedial alternatives for the Site-Wide Supplemental Feasibility Study (SWSFS) that EPA directed UNC to undertake in its June 24, 2005 letter. This interim submittal follows our conference call of July 28, 2006, when we discussed the preliminary proposed content of the SWSFS (per my letter to you of July 27, 2006).

The objective of this letter is to develop and screen remedial alternatives, for all three site hydrostratigraphic units, following the EPA CERCLA Feasibility Study (FS) guidance (EPA, October 1988; full reference citations are provided at the end of this letter). Specifically, we proceed through Section 4.2.6 (Assemble Alternatives) of this EPA guidance document. The alternative development process is presented in the attached tables and figure. Important supplemental information is provided in the text of this letter.

We request informal feedback from you regarding the development and screening of alternatives presented here to ascertain if EPA is in agreement with the general response actions (GRAs), their preliminary screening, and the compilation of alternatives to carry forward. A conference call within approximately two weeks would serve these objectives well so that we may keep on schedule to submit the SWSFS to EPA by November 30, 2006.

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The development and screening of alternatives presented here builds on, rather than replaces, the original site FS (EPA, August 1988). UNC is not authorized to "second-guess" EPA's prior decision-making. For its part, EPA has not reported errors within the original FS, nor has EPA revised or disavowed any of its findings and recommendations. Thus, the original FS, in combination with the knowledge gained during the 17 years of remediation following its issuance, are the underpinnings for the SWSFS. The developing SWSFS deals solely with groundwater impacts in areas outside Section 2, following the explicit focus of the original FS (EPA, August 1988, see their Figure ES-1).

We caution the reviewers of this letter that it is simply not possible to meaningfully comment on this letter without having an intimate familiarity with the original FS.

TABLE 1 -- Identification and First-Order Screening of General Response Actions for Groundwater Remediation

The current list of general response actions (GRAs) that are shown in Table 1 (attached) is based on our letter to you of July 27, 2006, and our related discussion on July 28 during which we received EPA's preliminary concurrence. Table 1 also summarizes the descriptions of the GRAs; the associated groundwater remedial technologies; and the applicability and first-order screening. We are aware of no other GRAs or remedial technologies that are relevant to the site.

The GRAs shown in Table 1 are:

- No further action (except for long-term stewardship by the Department of Energy (DOE) under Title II of the Uranium Mill Tailings Radiation Control Act (UMTRCA))
- Hydraulic containment with extraction and evaporation (this is most similar to the existing site remedy)
- Enhanced extraction (i.e., rapid dewatering)
- Barriers (physical or hydraulic)
- Hydraulic flushing with extraction and evaporation
- Treatment (some of the GRAs must be packaged with potential treatment processes to be effective. UNC will not abandon EPA's chosen treatment technology via evaporation for any recovered groundwater -- evaporation has been very effective and was the correct choice. However, UNC will consider additional measures that may be needed for new GRAs, as discussed below.)
- Institutional Controls (ICs)

- Technical Impracticability (TI) Waiver for sulfate, total dissolved solids (TDS), and manganese

- Revised cleanup standards (primarily for combined radium, chloroform, and uranium)

- Alternate Concentration Limits (ACLs) in select Zone 1 point-of-compliance (POC) wells

Regarding the GRAs, we note note the following explanatory features. MWH (October 2004) submitted a Supplemental FS for the Zone 3 hydrostratigraphic unit, within which they presented a list of eight main screened alternatives (see their page 1). Our initial screening process has retained the following four alternatives from the Supplemental FS for Zone 3: enhanced extraction; cut-off or containment wells; directional wells; and tunnels. A fifth alternative, in-situ chemical fixation, has been modified such that it combines both injection of alkalinity and extraction. The Zone 3 Supplemental FS correctly screened out in-situ chemical fixation without an extraction component because of effectiveness limitations. That analysis indicated concerns about well-fouling and secondary permeability changes that left open the likelihood of spreading out the seepage-impacted groundwater. Such concerns may be dealt with by coordinating injection and extraction well systems much like an in-situ leach mining operation.

UNC has submitted the supporting documentation in accordance with relevant guidance for a TI Waiver request for the Southwest Alluvium (Earth Tech, November 2002) and Zone 1 (Earth Tech, May 2000). As you know, the requested TI Waiver zone in the Southwest Alluvium was modified in 2004 to a configuration representing the 200-year extrapolated location of the seepage-impact front (for example, see Figure 59 in the 2005 site annual report by N.A. Water Systems, December 2005). UNC proposes this 200-year extrapolation to facilitate administrative consideration and review. It is important to understand that none of the groundwater located downgradient of the present seepage-impact front is suitable for drinking, because of the naturally occurring, high concentrations of sulfate and TDS. As explained in the 2005 annual report, the Southwest Alluvium seepage-impact front actually improves the water quality of the Southwest Alluvium as the seepage front migrates downgradient (via geochemical reactions that drive the sulfate and TDS concentrations down). The 200-year front extrapolation is not projecting a future spatial distribution of a "contaminant plume" – rather, it represents a 200-year extrapolation of the Southwest Alluvium remedial action target area.

We generally adopt the original 1988 FS conclusion that vertical physical barriers are not implementable at the site because of the depths of the hydrostratigraphic units. Physical barriers are not implementable for Zone 1 and Zone 3; however, they may be implementable in downgradient locations of the Southwest Alluvium. For this reason, physical barriers are screened out for Zone 1 and Zone 3 at this stage while they are retained for the Southwest Alluvium (see the right-most column of Table 1). Vertical hydraulic barriers (or "fences") are retained for consideration.

The GRA of hydraulic flushing (with extraction and evaporation) is combined with a pre-treatment process to amend the alkalinity of the injectant for the purpose of neutralizing acidic tailings seepage. It is being screened out for the Southwest Alluvium. This is for two reasons: first, the SWA is the most productive hydraulic unit in the area and so there is not another adequate source of sufficiently high quality water to perform effective flushing; and second, there is no value to injecting alkalinity-amended water into the Southwest Alluvium (unlike Zone 1 and Zone 3, the Southwest Alluvium already has neutralized the acidic tailings seepage water).

Regarding the GRA of ACLs in select Zone 1 POC wells, the right-most column in Table 1 indicates this GRA is retained for present consideration in Zone 1 and future consideration in Zone 3. Future applicability in Zone 3 depends on the remedial progress that may derive from the pending in-situ alkalinity stabilization study and its potential adoption as the remedy modification of choice.

Figure 1 – Technical and Adminstrative Implementability Screening of Process Options

In addition to technical and administrative considerations that have been applied to produce Figure 1, qualitative cost or first-order cost estimates have also been applied. This was done so that potential technologies that offer no greater benefits than other technologies, but which may be significantly more expensive, are not carried forward in the analysis.

Under the GRA of hydraulic containment with extraction and evaporation, the process options of directional wells and tunnels have been screened out at this stage. Directional wells are technically inappropriate for the SWA and Zone 1 hydrostratigraphic units. In the Southwest Alluvium, the relief on the underlying top of bedrock is such that complete containment in the lower part of the alluvium would be difficult, or impossible, to achieve. Additional vertical pumping wells (to supplement the existing pumping wells, which are currently shut off) could provide equivalent containment for much lower cost. As well, the Southwest Alluvium groundwater quality downgradient of Section 2 is that of either background (unsuitable for drinking given the

high sulfate and TDS) or is seepage-impacted (better than background quality in generally having lower sulfate and TDS; see N.A. Water Systems, December 2005), and so the benefits of any type of pumping are dubious. Regarding tunnels for the Southwest Alluvium: they cannot be constructed in unconsolidated material.

In Zone 1, over ten years of remedial operations, from 1989 through 1999, had reduced the saturated thickness of seepage-impacted groundwater to the point that all recovery wells were decommissioned (US Nuclear Regulatory Commission (NRC), July 30, 1999). The original FS calculated that a minimum pumping duration of 50 years would be needed to attain Applicable or Relevant and Appropriate Requirements (ARARs). Since the wells were shut off in 2000, the size and concentration of the seepage-impacted groundwater remains in a stable to decreasing trend. It has been shown from the past several years of monitoring and reported in annual reports (most recently N.A. Water Systems, December 2005) that improvements in water quality are at least as great in magnitude under non-pumping conditions as when active pumping took place. Therefore, it would not be wise to alter this hydraulic condition, and it is doubtful that it could be improved upon because of the limited saturated thicknesses. In addition, the complex relief along the base of the central tailings cell (USFilter, January 2004) would make horizontal well installation or tunneling difficult.

Directional (predominantly horizontal) wells are very expensive and, for the Zone 3 setting, at least two directional wells would be required in order to have one function as a backup. The risk of well fouling or collapse is significant. We conservatively estimate that two directional wells placed downgradient in Zone 3 would cost at least $4.4 million (this estimate has been developed by applying a 10% increase to the capital cost presented for this alternative in the Zone 3 FS (MWH, October 2004, see their Table 5)). Various vertical well alternatives will provide equivalent performance at a much lower cost.

Tunnels (with or without drifts) have been screened out as a process option in Zone 3 for reasons including the excessive capital cost (compared with other options). We conservatively estimate that a downgradient tunnel in Zone 3 would cost $7 million (this estimate has been developed by applying a 10% increase to the capital cost presented for this alternative in the Zone 3 FS (MWH, October 2004, see their Table 5)). Various vertical well alternatives will provide suitable performance at a much lower cost.

Tunnels are also screened out because of the difficulties that would be imposed by the need to manage relatively high volumes of investigation-derived wastes. The waste rock and groundwater would have to be managed as hazardous materials (according to the Contained-In-Policy). These wastes could not be handled onsite, nor is there the

infrastructure in the region to manage them at an off-site facility. Transport of the large volumes, over long distances to a suitable treatment, storage, or disposal facility would be cost-prohibitive.

Figure 1 indicates that vertical physical barriers have been screened-out at this stage for the Southwest Alluvium (they were screened out for Zone 1 and Zone 3 earlier). This is because a physical barrier in the Southwest Alluvium will require pumpage in order to avoid spillover. Additional new vertical wells upgradient of the Section 2 boundary will provide more effective hydraulic containment (the objective of physical barriers) at much lower cost.

ICs have been provisionally screened out for Sections 1, 3, and 10 because they are currently administratively infeasible. Sections 1, 3, and 10 are Indian Trust Lands, and the application of IC measures requires certain action on the part of the Navajo Nation and/or the Bureau of Indian Affairs. As early as 2000, UNC engaged the Navajo to discuss ICs. In the ensuing six years, there has been no movement towards the adoption of the basic IC framework that includes an environmental right-of-way and a Tribal Resolution. We refer the reader to the letters from Davis, Graham & Stubbs to various Navajo technical and legal representatives (dated February 29, 2000; March 5, 2001; and March 23, 2001). ICs are retained for application to Section 2 and 36, which are owned by UNC and eventually will be subject to long-term stewardship under the DOE.

Tables 2 Through 4 -- Provisional Lists of Assembled Remedial Alternatives

Having developed and screened GRAs, technologies, and process options, it is appropriate to consider each hydrostratigraphic unit separately in assembling the remedial alternatives. Tables 2, 3, and 4 represent the lists of assembled alternatives as per Section 4.2.6 (Assembled Alternatives) of the EPA CERCLA FS guidance (EPA, October 1988). This is the final level of screening that is being provided to EPA for review. In further developing the SWSFS beyond this submittal, we will continue to follow the EPA guidance through the individual analysis of alternatives, in which each alternative is assessed under the nine criteria specified in Section 6.2.3 (Individual Analysis of Alternatives).

There are four alternatives shown for the Southwest Alluvium in Table 2. Alternative 1 is No Further Action that essentially requires that continued monitoring be performed until the site is transferred into DOE's stewardship program. Alternative 2 comprises a TI Waiver for sulfate, TDS, and manganese plus revised standards for radium, chloroform, and uranium. As with the No Further Action alternative, it is presumed that UNC continues groundwater monitoring in accordance with the NRC Source Materials

License until such time as the license is transferred to DOE as part of long-term stewardship (this is the same for every alternative in the SWSFS). This alternative requires that EPA adopt the recent NRC revised standards for radium and chloroform (NRC, August 9, 2006) and assumes that EPA will abandon the current remedial objective of 5 mg/L and adopt the NRC's more stringent uranium standard from the Source Materials License (0.3 mg/L) as recommended by GE (March 10, 2006).

When performing the detailed analysis of Alternatives 3 and 4, it will be important to consider the fact that any existing and future infiltrating water will continue to exceed the site standards for sulfate and TDS because all site groundwater is in equilibrium with gypsum.

Zone 1 alternatives are summarized in Table 3. For Alternative 1, No Further Action, it is important to note that the former pumping locations in Zone 1 met the decommissioning criteria, and that pumping accomplished no improvement in water quality. Attenuation processes are occurring and the groundwater is being monitored. The seepage-impacted area is stable to decreasing.

Alternative 2 requires that EPA adopt the NRC's modified standards for radium and chloroform. The ACLs that will be proposed will also represent as-low-as-reasonably-achievable (ALARA) goals and be in accordance with appropriate EPA guidance.

Alternative 3 comprises flushing plus a TI Waiver for sulfate, TDS, and manganese.

Zone 3 alternatives are summarized in Table 4. Alternatives 1 through 4 include the component "ICs for Section 36." It should be noted that Section 36 is outside of Section 2; Section 36 is UNC property; and that ICs for Section 36 have not yet been proposed. Government parties have agreed that there is no Zone 3 point-of-exposure (POE) in Section 1 (NRC, September 16, 1999).

Regarding Alternative 4, the hydraulic barrier component requires a sufficient source of injection water that meets New Mexico Environment Department standards (not site standards). Such a hydraulic barrier is presently envisioned as being located downgradient in Zone 3, in the northern part of Section 36, within background water that is unaffected by seepage impact. Some of the injected water would be recovered by extraction wells to the south, and some of this water would not be recovered and it would flow to the north onto Navajo land. One potential source of water, pumped from the Dakota Formation, would require excessive cost for reverse osmosis treatment to achieve injection water quality comparable to background.

Alternative 5 depends upon the pending alkalinity-stabilization pilot study which should be completed by March 2007. The proper way to approach decision-making with

respect to Zone 3 is to withhold a final remedy modification decision until that time. However, it is appropriate to analyze and rank the remaining alternatives in the interim. As a general comment regarding Zone 3 remediation, depending on the remedial progress from the remedy, EPA should leave open the option for ACLs and revised standards.

References Cited

Davis, Graham & Stubbs, February 29, 2000, UNC Church Rock – Institutional Controls.

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U.S. Environmental Protection Agency, August 1988, Public Comment Draft: United Nuclear Corporation Churchrock Site Operable Unit Feasible Study, Gallup, New Mexico.

U.S. Environmental Protection Agency, October 1988, Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA; EPA/540/G-89/004 (OSWER Directive 9355.3-01).

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U.S. Nuclear Regulatory Commission, July 30, 1999, Discontinuing of Pumping of Selected Wells at Church Rock Site, Materials License SUA-1475.

U.S. Nuclear Regulatory Commission, September 16, 1999, Consideration of Temporary Saturation of a Portion of Zone 3 at the Church Rock Site.

USFilter, January 2004, Rationale and Field Investigation Work Plan to Evaluate Recharge and Potential Cell Sourcing to the Zone 3 Plume, Church Rock Site, Gallup, New Mexico.

Very truly yours,

Mark Jancin, P.G.
Project Manager

Attachments:

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cc: Paul Michalak, US NRC
Larry Bush, UNC
Roy Blickwedel, GE

TABLE 1
Identification and First-Order Screening of General Response Actions for Groundwater Remediation

General Response Actions	Description	Associated Groundwater Remedial Technologies	Applicability and First-Order Screening
No Further Action	No further actions taken at the site to remediate impacted target areas (excluding long-term stewardship by DOE under Title II of UMTRCA).	None.	Retained for consideration. Will not meet remediation goals in Zone 3.
Hydraulic Containment with Extraction and Evaporation	Pumping control of seepage-impacted areas with constituent removal and evaporation. Akin to existing remedy.	Groundwater extraction and evaporation. Directional/horizontal wells. Vertical wells. Cut-off tunnels.	Retained for consideration. May be useful for containment or groundwater restoration.
Enhanced Extraction	Rapid dewatering to reduce volume of impacted water.	Relatively large number of vertical wells. Also employs evaporation as the preferred treatment.	Retained for consideration. May be useful for groundwater containment and rapid mass removal.
Barriers	Physical or hydraulic barriers to prevent migration of seepage-impacted water.	Vertical physical barriers. Hydraulic barriers or "fences" from vertical injection well arrays.	Physical barriers retained for consideration in Southwest Alluvium. Hydraulic barriers retained for consideration. May be useful for containment.
Hydraulic Flushing with Alkalinity-Amended Water in Conjunction with Extraction and Evaporation	Water injection matched with controlled extraction and evaporation.	Amended injection water for in-situ constituent stabilization plus displacement and extraction of seepage-impacted water.	Retained for consideration in Zone 3 and Zone 1. Insufficient source of water available to flush Southwest Alluvium.
Treatment	Methods to reduce the mobility, toxicity, or volume of impacted water.	Alkalinity amendments to injection water for in-situ stabilization and flushing. Reverse osmosis (RO) treatment of injection water for flushing and/or hydraulic barrier. All injection and flushing envisioned as combined with extraction and evaporation.	Combines with flushing GRA. RO cost too high to meet demand. Insufficient high-quality water available for SWA. Retained for consideration in Zone 3 and Zone 1. May be useful for containment or groundwater restoration.
Institutional Controls	Legal or governmental controls taken to prevent contact with seepage-impacted water.	Access and use restrictions.	Retained for consideration. Will not meet remediation goals. Can be used as mechanism to prevent exposure.
Technical Impracticability (TI) Waiver for Sulfate, Total Dissolved Solids (TDS), and Manganese	For all seepage-impacted areas outside Section 2. Attainment of ARARs not practicable via technology or engineering since all groundwater is in geochemical equilibrium with gypsum.	None.	Retained for consideration.
Revised Cleanup Standards	Background water quality obviates long-term attainment of current EPA site standards outside Section 2.	None.	Retained for consideration primarily for radium, chloroform, and uranium. TI Waiver is more appropriate for sulfate, TDS, and manganese.
Alternate Concentration Limits (ACLs)	Zone 1 POC wells have ALARA concentrations for chloroform, radium, and uranium.	None.	Retained for consideration in Zone 1 and future in Zone 3. TI Waiver better suited for Southwest Alluvium.

FIGURE 1
Technical and Administrative Implementability Screening of Process Options
Shading Indicates Not Applicable for Further Screening

General Response Actions	Remedial Technology	Process Option	Technical and Administrative Implementability Screening Comments
No Further Action	None	None	Potentially applicable in Southwest Alluvium and Zone 1. Eliminated for Zone 3 because it will not meet remediation goals.
Hydraulic Containment with Extraction and Evaporation	Groundwater Extraction + Flushing + Evaporation + Containment Analysis	Vertical Wells	Potentially applicable. Most similar to current remedy.
		Directional Wells	Unreliable performance due to high probability of well failure (collapse or encrustation). Would require at least two redundant wells resulting in excessive cost. Technically infeasible for SWA and Zone 1.
		Tunnels	Excessive cost. Inability to effectively manage large volumes of generated waste material.
Enhanced Extraction	Relatively Large Number of Vertical Wells + Extraction + Evaporation	Vertical Wells	Potentially applicable. In Zone 3, the flushing alternative may evolve into enhanced pumping if the in-situ alkalinity stabilization pilot test is successful.
Barriers	Vertical Physical Barriers	See Figure 5-3 of EPA 1988 FS for Eleven Process Options	EPA 1988 FS screened-out as not implementable for any of the three hydrostratigraphic units. Vertical physical barrier in Southwest Alluvium requires pumpage to avoid spillover – additional new vertical wells upgradient of Section 2 boundary will provide hydraulic containment with much lower total cost.
	Hydraulic Barriers from Injection Wells	Arrays of Vertical Injection Wells	Potentially applicable.
Hydraulic Flushing with Extraction and Evaporation	Alkalinity-Amended Injection Water	Arrays of Vertical Injection Wells	Potentially applicable; combines with Treatment GRA. Pending in-situ alkalinity stabilization pilot study in Zone 3.
	Injection Water Treated to State Standards	Arrays of Vertical Injection Wells	Potentially applicable; combines with Treatment GRA.
Treatment	Injection + In-Situ Treatment + Flushing + Extraction + Evaporation	Alkalinity Amendments to Injection Waters	Potentially applicable; combines with Flushing GRA. Pending in-situ alkalinity stabilization pilot study in Zone 3.
	Pre-Injection Water Purification + Injection + Flushing + Extraction	Reverse Osmosis Treatment of Injection Waters	Excessive cost to meet demand.
Institutional Controls	Access and Use Restrictions	Navajo Tribal Land-Use Restrictions Environmental Right-of-Way	Administratively infeasible for Sections 1, 3, and 10. Navajo have not responded (since February 2000) on proposed tribal resolution and environmental right-of-way for offsite monitoring. Potentially applicable for Sections 2 and 36.
	Monitoring	Offsite Groundwater Monitoring	
Technical Impracticability Waiver	None	None	Potentially applicable.
Revised Cleanup Standards	None	None	Potentially applicable. NRC (August 9, 2006) has already adopted revised standards for radium and chloroform. EPA and NRC currently have nonuniform site standards for uranium.
Alternate Concentration Limits	None	None	Potentially applicable at present in Zone 1. Future applicability to Zone 3 reserved.

TABLE 3
Provisional List of Assembled Remedial Alternatives for the Zone 1 Hydrostratigraphic Unit

Alternative	Remedial Alternative Description	Comments
Alternative 1	No Further Action (Except for Long-Term Stewardship by DOE).	Source control already accomplished (USFilter, January 2004)); no more tailings seepage. Former pumping locations met decommissioning criteria. Former pumping did not improve groundwater quality. Stable to decreasing area of seepage-impacted water.
Alternative 2	Technical Impracticability (TI) Waiver for Sulfate, TDS, and Manganese. Revised Standards for Radium, Chloroform, and Uranium. Alternate Concentration Limits (ACLs) in select wells for chloroform, uranium, nickel, and cobalt.	EPA adopts NRC (August 2006) modified standards for radium and chloroform. ACLs to be proposed to meet ALARA goals and in accordance with appropriate EPA guidance. Attenuation processes are robust (N.A. Water Systems, December 2005).
Alternative 3	Flushing. TI Waiver for Sulfate, TDS, and Manganese.	Flushing implementability to be further evaluated.

TABLE 4
Provisional List of Assembled Remedial Alternatives for the Zone 3 Hydrostratigraphic Unit

Alternative	Remedial Alternative Description	Comments
Alternative 1	No Further Action (Except for Long-Term Stewardship by DOE). Institutional Controls (ICs) for Section 36.	Source control already accomplished (USFilter, January 2004); no more tailings seepage. Do not have hydraulic control; therefore, will not meet remediation objectives. No Zone 3 point-of-exposure in Section 1 (NRC, September 16, 1999). ICs for Section 36 (UNC property outside of Section 2) have not yet been formally proposed.
Alternative 2	Technical Impracticability (TI) Waiver for Sulfate, TDS, and Manganese. Revised Standards. ICs for Section 36.	Have source control. Revised standards for chloroform, radium, uranium, arsenic, molybdenum, cobalt, nickel, and manganese.
Alternative 3	Hydraulic Containment with Extraction and Evaporation. TI Waiver. ICs for Section 36.	Hydraulic containment may prove to be in perpetuity. Merits of extraction with evaporation using spray misters into ponds was addressed by UNC contribution to Appendix H of the EPA 1988 Feasibility Study.
Alternative 4	Treatment (Purification). Hydraulic Barrier. Hydraulic Containment. TI Waiver. ICs for Section 36.	Downgradient hydraulic barrier requires sufficient source of high quality water. Only some of the hydraulic barrier injection water would be recovered; some will flow onto Navajo land.
Alternative 5	Alkalinity-Amended Flushing with Extraction and Evaporation. TI Waiver.	In-situ alkalinity stabilization pilot study to be reported in approximately March 2007. If pilot study is successful, this alternative may be implemented.