SECOND FIVE-YEAR REVIEW REPORT FOR

FREMONT NATIONAL FOREST/WHITE KING AND LUCKY LASS URANIUM MINES (USDA) SUPERFUND SITE

LAKE COUNTY, OREGON

Prepared by

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9/23/15

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Acronyms and Abbreviations

AEC	Atomic Energy Commission
AWQC	Federal Ambient Water Quality Criteria
ARAR	applicable or relevant and appropriate requirement
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	contaminant of concern
DEIS – RI/FS	Draft Environmental Impact Statement – Remedial Investigation/Feasibility Study
EPA	United States Environmental Protection Agency
ESD	Explanation of Significant Differences
FS	feasibility study
GCL	geosynthetic clay liner
HI	Hazard Index
IC	institutional control
LTM	long term monitoring
MCL	maximum contaminant level
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
O&M	operations and maintenance
ODEQ	Oregon Department of Environmental Quality
ODE	Oregon Office of Energy
OMMP	Operations Maintenance and Monitoring Plan
PRP	Potentially Responsible Party

Acronyms and Abbreviations (continued)

RA	remedial action
RAO	remedial action objective
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RPM	Remedial Project Manager
RPO	Remedial Process Optimization
SARA	Superfund Amendments and Reauthorization Act
USFS	U.S. Department of Agriculture Forest Service
UMTRCA	Uranium Mill Tailings Radiation Control Act
WNI	Western Nuclear, Inc.

EXECUTIVE SUMMARY

This document summarizes the second five-year review for the White King / Lucky Lass Mines Site (Mines Site) located near Lakeview, Oregon. The results of the five-year review indicate that the remedies described in the September 2001 Record of Decision (ROD) and revised by an Explanation of Significant Differences (ESD) in 2006 are protective of human health and the environment. Overall, the remedial actions (RAs) are functioning as designed, and no deficiencies were identified that impact the protectiveness of the remedies. The protectiveness of the RAs is being verified by the long-term monitoring (LTM) and maintenance as described in the Operations, Maintenance and Monitoring Plan (OMMP). In accordance with the OMMP, groundwater concentrations of selected contaminants of concern (COCs) have been monitored and reported and regular inspection and maintenance of the mine waste repository covers, stormwater drainage, fencing and warning signs has occurred.

Based on the monitoring data and maintenance information, informal interviews with federal and state remedial project managers (RPMs), and the observed integrity of the repository covers, the remedies continue to remain protective. The ROD and ESD-prescribed RAs continue to contain contaminants, and there have been no changes in the physical conditions of the Mines Site that affect protectiveness.

The review of documents, applicable or relevant and appropriate requirements (ARARs), and exposure assumptions indicates that the remedial actions implemented at the White King/Lucky Lass Mines Site are functioning as intended in the ROD and ESD and meet the intent of the ROD and ESD.

The remedial actions at the Site are complete and protective of human health and the environment. Long-term protectiveness of the RAs will continue to be ensured and verified by Institutional Controls (ICs), LTM and the OMMP.

Implementation of the OMMP has been undertaken by Western Nuclear, Inc. (WNI) and Fremont Lumber Company (Fremont) since Tronox Inc. (Tronox) filed for protection under Chapter 11 of the U.S. Bankruptcy Code in January 2009 (Tronox is the

corporate successor to Kerr McGee Chemical Worldwide LLC.). EPA asserted a claim in the Tronox bankruptcy and received a recovery based on its asserted claim.

The **Human Exposure Environmental Indicator Status** for the Mines Site remains "Under Control". The Consolidated Stockpile has been capped, significant erosion is not occurring on or near the stockpile, and groundwater is not in use at the Site.

The **Groundwater Migration Environmental Indicator Status** for the Site remains "Under Control" because groundwater contaminant levels for most of the constituents have not statistically changed from previous sampling efforts and continue to meet remedial action objectives (RAOs). Concentrations of Radium-226 (Ra-226) were found to have a statistically significant increase in both upgradient and downgradient monitoring wells at both White King and Lucky Lass mine sites in 2014 compared to 2005 and 2011. However, concentrations were higher in upgradient wells than in the downgradient wells indicating this is likely naturally occurring and unrelated to the mining. The higher concentrations compared to prior sampling could be due to the low groundwater levels in the wells, the interval between monitoring, and turbidity in samples. Dissolved concentrations of Ra-226 from 2014 were more comparable to prior years' unfiltered samples.

Cross Program Revitalization Measure Status: The Site remains fenced to prevent cattle from damaging vegetation in restored valley bottom and constructed wetlands. Fencing and warning signs are maintained to prevent access to the repository.

Ongoing Monitoring and Maintenance: LTM is being conducted in accordance with the OMMP and is adequate to verify the ongoing protectiveness of the remedy. EPA, WNI and Fremont are negotiating an amendment to the 2006 Consent Decree that will govern how Tronox settlement funds will be used to fund future LTM and OMMP.

The following five-year review form presents the summary of this review:

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Fremont National Forest/White King and Lucky Lass Uranium Mines (USDA)		
EPA ID: **OR7122307658**		
Region: 10	**State:** OR	**City/County:** Lakeview/Lake
SITE STATUS		
NPL Status: Final		
Multiple OUs? No	**Has the site achieved construction completion?** Yes	
REVIEW STATUS		
Lead agency: EPA **If "Other Federal Agency" was selected above, enter Agency name:** Click here to enter text.		
Author name (Federal or State Project Manager): David Einan		
Author affiliation: EPA		
Review period: January 2015 – June 2015		
Date of site inspection: July 31, 2014		
Type of review: Statutory		
Review number: 2		
Triggering action date: May 18, 2010		
Due date *(five years after triggering action date)*: May 18, 2015		

FIVE-YEAR REVIEW SUMMARY FORM (continued)

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
No issues/recommendations are identified for this site in this Five-Year Review.

Protectiveness Statement(s)

Operable Unit:	*Protectiveness Determination:*	*Addendum Due Date: (if applicable)*
Whole Site	Protective	N/A

Protectiveness Statement:

The remedial actions at the Mines Site are protective of human health and the environment.

Based upon the review of relevant documents and the site inspections, the remedy is functioning as intended by the ROD and ESD. There have been no changes in the physical condition of the Site that would affect the protectiveness of the remedy. Long-term protectiveness of the RAs will continue to be ensured and verified by Institutional Controls (ICs) and implementation of the OMMP. The OMMP contains the criteria for long-term monitoring and maintenance, including monitoring and periodic neutralization of White King Pond; inspection and maintenance of the White King Consolidated stockpile and the Lucky Lass stockpile caps, fences and warning signs; and an additional round of groundwater monitoring prior to the next five-year review.

OTHER COMMENTS

The **Superfund Long-Term Human Exposure Environmental Indicator Status** for the White King/Lucky Lass Mines Site remains "Under Control and Protective Remedy In Place" because the Site is Construction Complete, the remedy is operating as intended, and the required engineering and institutional controls are in place and effective.

The **Groundwater Migration Environmental Indicator Status** for the Mines Site remains "Under Control" because groundwater contaminant levels for most constituents from 2014 sampling do not exhibit a statistically significant increase from prior sampling efforts and are below the RAOs for drinking water and aquatic water quality criteria (AWQC) to be protective of surface water. Concentrations of Radium-226 (Ra-226) were found to have a statistically significant increase in both upgradient and downgradient monitoring wells at both White King and Lucky Lass mine sites in 2014 compared to 2005 and 2011. However, concentrations were higher in upgradient wells than in the downgradient wells indicating this is likely naturally occurring and unrelated to the mining. The higher concentrations compared to prior sampling could be due to the low groundwater levels in the wells, the interval between monitoring, and turbidity in samples. Dissolved concentrations of Ra-226 from 2014 were more comparable to prior years unfiltered samples. Institutional controls are in place to prevent the installation of drinking water wells within the footprint of the White King and Lucky Lass consolidated repositories.

Cross Program Revitalization Measure Status: The Site was designated "Ready for Anticipated Use" in 2006 because all remedial actions are complete and all required engineering and institutional controls are in place and effective. The Site is in reuse for agricultural purposes, except the valley bottom adjacent to Augur Creek, constructed wetlands and consolidated stockpiles, which are fenced to promote healthy vegetation.

1. INTRODUCTION

This document presents the second five-year review for the White King / Lucky Lass Mines Site (Mines Site) located near Lakeview, Oregon. The purpose of a five-year review is to determine whether the remedy at a site remains protective of human health and the environment. The methods, findings, and conclusions of the review are documented in this five-year review report. In addition, this report identifies issues found during the review and provides recommendations to address them. Figure 1 presents the Mines Site vicinity map. Figure 2 shows the major site features following completion of the remedial actions. The Mines Site consists of one Operable Unit; therefore, this five-year review covers site-wide conditions.

This five-year review report was prepared pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) §121 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

CERCLA §121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgment of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such reviews.*

The NCP in 40 Code of Federal Regulations (CFR) §300.430(f)(4)(ii) further states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use*

and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

The United States Environmental Protection Agency (EPA), Region 10 is the lead agency for this National Priorities List (NPL) site and has conducted this five-year review in accordance with existing five-year review guidance (EPA, 2001). USFS, Oregon Department of Energy, and Oregon Department of Environmental Quality (ODEQ) are the respective Federal and state support agencies and have assisted with this review. This is the second five-year review for the Mines Site. The triggering actions used for this statutory review are the actual remedial action on-site construction start date of May 18, 2005; and the issuance of the first five-year review report dated May 18, 2010. The five-year review at the Mines Site is required because hazardous substances, pollutants, or contaminants remain at the site above levels that allow for unlimited use and unrestricted exposure. At the time of this five-year review, full implementation of the site remedy has been completed. The Institutional Controls (ICs) outlined in the ROD and ESD have been implemented. The final Construction Completion Report was completed in May 2007. Long term monitoring in accordance with the OMMP has been implemented and annual site inspections have been conducted.

All available information pertaining to the Mines Site that has been generated subsequent to the first five-year review has been reviewed during the performance of this five-year review, including, but not limited to, groundwater monitoring reports (Golder 2010a, Golder 2011a, Golder 2012a; Golder 2015); a report of Augur Creek sediment and benthic invertebrate monitoring (Golder 2010b); reports of White King Pond benthic invertebrate monitoring (Golder 2010c, Golder 2012b); results of pH monitoring in White King Pond (Attachment 1); annual inspection reports (Golder 2010d, Golder 2011c, Golder 2012c, Golder 2013, and Golder 2014); and other correspondence with the various parties involved with the response actions.

2. SITE CHRONOLOGY

Table 2-1 summarizes significant events and documents from the time the Mines Site were first identified through 2014. Recurring activities, such as post-RA long-term groundwater monitoring and site operations and maintenance (O&M) activities are also presented in Table 2-1. Figure 2 presents the Mines Site map.

Table 2-1: Chronology of Significant Events

Event	Date
Draft Environmental Impact Statement Remedial Investigation/Feasibility Study for the Cleanup and Rehabilitation of the White King and Lucky Lass Uranium Mines (DEIS) was prepared by/for the USFS in August 1991, and a revised DEIS was issued in 1994.	1991
Property is listed on the NPL.	1995
Administrative Order on Consent with Kerr McGee Corporation to implement RI/FS	1995
RI Report is completed.	1997
Pond Neutralization Study Conducted	1998
FS is conducted to evaluate remedial alternatives.	1999
A remedy for the site is selected and a ROD is signed.	2001
White King Pond neutralization	2004
Remedial Action Work Plan is completed	2005
Consent Decree with Kerr McGee Chemical Worldwide LLC, Fremont and WNI to implement remedial design and remedial action	2006
ESD Completed to document changes in the site remedial technical basis and specific remedial goals	2006
Remedial Action Conducted	2005-2006
Remedial Action Construction Completion Report	2007
United States Department of Health and Human Services Public Health Assessment report is conducted, concluding that the remedy will be protective of public health	2007
White King Pond neutralization	2009
Groundwater monitoring, site inspections and O&M are conducted.	2004-2014
First Five-Year Review	2010

3. SITE BACKGROUND

This section presents background information and describes the remedial activities conducted at the Mines Site.

3.1. Site Location and History

The Mines Site is located in south-central Oregon, approximately 17 miles northwest of Lakeview, Oregon (Figure 1). The Site consists of two former uranium mines located within one mile of each other, the White King Mine and the Lucky Lass Mine, which collectively encompass approximately 140 acres (Figure 2). Portions of the Site are within the Fremont National Forest, managed by the United States Forest Service (USFS), and portions are on private lands owned by Fremont Lumber and the Coppin family trust. See Figure 3 for a property map of the Mines Site. The majority of the White King consolidated stockpile and all of the Lucky Lass site are on National Forest lands.

Both the White King and Lucky Lass Mines have had several operators, mineral claims holders, leasers and property owners. Mining began at the Mines Site in 1955. Initial mining at White King was underground via mine shafts developed up to 312 feet below the surface. In 1959, due to problems with infiltration of water, underground mining was abandoned for open-pit mining techniques which were used until active mining stopped around 1965. Open-pit mining techniques were used at the Lucky Lass Mine from the beginning of operations.

An extensive exploratory drilling program was carried on at both mines through 1979. Since then, little activity has taken place on these claims Available records indicate that the White King Mine produced about 138,146 tons of ore and Lucky Lass produced about 5,450 tons of ore during their period of operation. A total of 140 acres have been disturbed by mining, 120 acres at the White King Mine and 20 acres at the Lucky Lass Mine. Disturbance included stockpiling of ore, overburden, and the water-filled White King and Lucky Lass mine pits.

Prior to remedial action, major features at the White King Mine included the White King Pond (formed when water collected in the open-pit mine), the “Protore Stockpile”, and the “Overburden Stockpile”. Both stockpiles consisted of overburden material and contained a combined volume of almost one million cubic yards (CY). The pit pond occupies approximately 13 acres and contains approximately 80 million gallons of water.

Augur Creek runs southward through the eastern side of the White King area, and receives discharge from the White King Pond.

Major features at the Lucky Lass Mine include the Lucky Lass Pond and the associated overburden stockpile. This pond covers approximately 5 acres. The Lucky Lass Stockpile covers approximately 14 acres and contains approximately 260,000 CY of material.

A *Draft Environmental Impact Statement Remedial Investigation/Feasibility Study for the Cleanup and Rehabilitation of the White King and Lucky Lass Uranium Mines* (DEIS) was prepared by/for the USFS in August 1991, and a revised DEIS was issued in 1994. Upon review of the 1994 DEIS-RI/FS Report, EPA determined that further investigation and analysis of remedial alternatives was needed to support a remedial action decision under CERCLA. Kerr-McGee Corporation conducted a Remedial Investigation (RI) and a Feasibility Study (FS) pursuant to an Administrative Order on Consent. The RI Report was finalized in 1997 (Weston 1997) and the FS Report was finalized in 1999 (Weston 1999). The EPA then issued a Record of Decision (ROD) for the Site in 2001 (EPA 2001).

Subsequent to the ROD, a group of Potentially Responsible Parties (PRPs) agreed to take primary responsibility for implementing remedial action and specified post-remediation monitoring at the Site in accordance with a Consent Decree (effective date January 20, 2006). The PRPs retained Golder Associates Inc. (Golder) to perform remedial design, construction management, and construction quality assurance (CQA)

monitoring for the remedial action. Golder prepared the following reports for the PRPs in preparation for remedial action:

- Remedial Design Workplan (Golder 2004a)
- Geotechnical Investigation Report (Golder 2004b)
- Gamma Radiation Survey Report (Golder 2004c)
- Workplan for 2004 Preparatory Field Activities (Golder 2004d)
- White King Pond and Augur Creek Study Workplan (Golder 2004e)
- Remedial Design Report (Golder 2005a)
- Construction Quality Assurance Plan (Golder 2005b)
- Field Sampling Plan (Golder 2005d)
- Operations, Maintenance and Monitoring Plan (Golder 2005e)
- Site Health and Safety Plan for Remedial Action (Golder 2005f)
- Quality Assurance Project Plan for Soil, Sediment, and Surface Water Monitoring (Golder 2005g)
- Remedial Action Workplan (Golder 2005h)
- Construction Completion Report (Golder 2007)

In addition to implementing the remedy, the PRPs agreed to perform a Supplemental Environmental Project (SEP), which is documented in a separate report (Golder 2006b). The SEP consisted of creating wetland areas in the White King meadow which were constructed in conjunction with remedial action construction.

The PRPs also performed studies of the White King Pond and Augur Creek, as documented in several reports (Golder 2006c, Golder 2009a, Golder 2010b, Golder 2010c, Golder 2011b, and Golder 2012b).

3.2. Summary of Site Contamination

The primary constituents of concern (COCs) for the Site are uranium isotopes and radium (Ra-226). Arsenic is a COC for the White King portion of the Site, but not for the Lucky Lass portion of the Site.

Site Risks

An evaluation of the potential risks to human health and the environment from site contaminants was conducted and is discussed in the ROD. The objectives of the risk assessment were to:

- Identify COCs for human health and ecological risk;
- Provide a basis for determining residual chemical levels that are adequately protective of human health and the environment;
- Help determine if response actions are necessary at the site; and
- Provide a basis for comparing the various remedial alternatives and potential effects on human health.

Table 3-1 presents the potential risks identified for the Mines Site. The risk assessment concluded that hazardous substances were present on the Mines Site and that the actual or threatened release of these substances may present an imminent substantial endangerment to public health, welfare or the environment if a response action were not taken.

Table 3-1: Summary of Cancer Risks and Hazard Indices for Soil at the Mines Site

	Cancer Risks	Hazard Indices
Exposure Scenario	**RME**	
Future On-Site Resident	$3x10^{-1}$	$2x10^{3}$
Future Recreational User (child)	$4x10^{-4}$	11
Future On-Site Worker	$2x10^{-4}$	Below 1

Notes: RME = Reasonable Maximum Exposure

The primary drivers for adverse carcinogenic and noncarcinogenic risks were ingestion of arsenic in soil and shallow groundwater and exposure to radiation from radium-226 in

soil. The predominant risks from groundwater were associated with selected wells within the overburden stockpile.

The ecological risk assessment was conducted under a tiered or phased approach. The assessment showed some potential adverse impacts, based on screening level assessment only for selected terrestrial receptors and plants exposed to non-radionuclides such as arsenic, selenium, and antimony in surface and subsurface soils at the White King mine. The risk assessment also identified potential adverse impacts, based on screening level assessment only, for aquatic invertebrates exposed to non-radionuclide COPCs in the sediments of the White King pond and Augur Creek. The ROD recommended further evaluation of the potential adverse impacts to aquatic biota in the White King pond sediments (arsenic only) and Augur Creek sediments (arsenic and manganese).

4. REMEDIAL ACTIONS

4.1 Remedy Selection

The ROD for the Site was signed on September 28, 2001. The remedial action objectives (RAOs) for both the White King and Lucky Lass areas (ROD Section 8.2) are:

- Soils
  - Reduce exposure to stockpiles and contaminated off-pile soil by humans (ingestion and external exposure) and ecological receptors (ingestion). Demonstrate protectiveness to an excess risk level of 1 x 10-6 for carcinogenic risk (or a non-cancer HQ of 1) based on reasonable maximum exposure for an individual, or background concentration whichever is higher.
  - Reduce and eliminate the release and migration of contaminants from soils to groundwater or surface water via erosion, oxidation, or leaching to protect for beneficial uses (recreational, agricultural, and aquatic habitat).
  - Prevent the removal or use of stockpile soils for any purpose.
- White King Pond
  - Protect the potential beneficial use(s) (aquatic life) of the White King pond from exposure to COCs above applicable standards (Oregon's State water quality standards (OAR 340-41-925), or background concentrations (if background concentrations are higher than the applicable standard).
  - Maintain a neutral pH in the White King pond water in order to reduce the toxicity of the acidic water and lower the concentrations of dissolved metals in the water.
- Augur Creek
  - Reduce exposure to aquatic invertebrates and recreational users from COC's in Augur Creek surface water and sediments above protective risk-based levels for recreational users, applicable standards (Oregon's State water quality standards (OAR 340-41-925), or background concentrations (if background concentrations are higher than the applicable standard or protective level).
  - Monitor surface water to ensure that the potential beneficial uses of surface water are maintained and/or to establish a trend toward background concentrations.
- Groundwater
  - Prevent any human exposure and future use of ground water beneath the stockpile with contaminant concentrations in excess of Federal and State drinking water standards or protective levels.

- Monitor ground water upgradient and downgradient of the stockpile to ensure that the potential beneficial uses of ground water (discharge to surface water) meet applicable standards (Oregon's State water quality standards (OAR 340-41-925) at the boundary of the waste management area with Augur Creek and/or to establish a trend toward background concentrations.

4.2 Remedy Implementation

To meet the RAOs, the remedial action included the following major components:

- Re-contouring the White King Protore Stockpile so that it is no longer within the Auger Creek 500-year floodplain.
- Removal of designated soils from the White King Mine haul road and certain "off-pile" areas where there was mine-related waste above Site remediation levels, and placement of these materials on the regraded Protore Stockpile, referred to in the design documents as the Consolidated Stockpile.
- Excavation of the White King Overburden Stockpile and placement of the material on the Consolidated Stockpile.
- Placement of 20 inches of cover soil and 4 inches of a topsoil / armor gravel mixture on the Consolidated Stockpile surface sufficient to support vegetation, and seeding of the stockpile surface.
- Placement of 3 inches of topsoil and reseeding of those areas where soil has been removed.
- Installation of fencing and warning signs around the Consolidated Stockpile to physically inhibit access.
- Land use restrictions to prevent undesirable uses.
- Restrictions to use of Site groundwater for drinking water.
- As documented in an Explanation of Significant Difference (ESD), "off-pile" material was consolidated in the Lucky Lass Stockpile, and the stockpile covered with clean soil.
- Groundwater and surface water monitoring.
- Continued in-situ neutralization of the White King Pond; neutralization is conducted when pH in the mixed pond water is <5.5.

The ROD estimate for remedial action construction was $6,330,182 for White King and $349,000 for Lucky Lass, totaling $6,679,182. Actual remedial action construction costs were $4,920,474, not including costs to establish institutional controls.

4.2.1. Institutional Controls

The Mines Site extends over federal lands managed by the USFS and privately-owned lands held by the Coppin Family Trust and Fremont Lumber. Figure 3 shows the location of the respective properties. In addition to the consolidation and covering of impacted soils on site, institutional controls (ICs) were established to help meet the Remedial Action Objectives (RAOs). The ICs were established to prevent human exposure to soils and groundwater that exceed established standards and are discussed below. The ICs were put into place for the private land, and a Forest Plan amendment was put into place for the portions of the Site on USFS land. The Forest Plan amendment prohibits residential use of the Mines Site, drinking water well drilling, permanent recreation sites, removal of stockpile material, and any other uses that impact the integrity of the mine waste repositories, including grazing and off-road vehicle use. Due to the nature of the contaminants (radionuclides), institutional controls are expected to remain in place indefinitely for the Mines Site.

A title search for the private properties was conducted in December 2009 and documented in a Preliminary Title Report that was issued for each property. The title reports show that and Easement and Equitable Servitude document was recorded in Lake County deed records for both the Fremont property and the Coppin Trust property. These documents include: (1) restrictions on the use of groundwater as long as the contaminant concentrations exceed risk-based standards, (2) protection of the wetland areas, and (3) land use restrictions that prevent residential and agricultural (food crops) use of the properties.

Institutional controls for the site include both physical and administrative controls. As described in section 3, fencing was installed around the mine waste repositories and Site boundary to restrict Site access. Signs showing contact numbers for USFS and prohibiting unauthorized access were posted on the fence surrounding the mine waste repositories.

Copies of the executed agreements are included in the Title Search as Attachment 4 to the First Five-Year Review Report. To ensure that current and future property owners

are subject to the same restrictions and are required to provide the same access, the equitable servitude was recorded with the County Clerk for Lake County, State of Oregon.

Inspections conducted at the Sites since 2006 indicate that the long-term ICs required by the ROD and ESD are being implemented.

4.3. SYSTEM OPERATIONS/OPERATION and MAINTENANCE (O&M)

Consistent with the ROD, after completion of the remedial action, ICs, groundwater monitoring, White King Pond benthic invertebrate and pH monitoring, Augur Creek sediment and benthic invertebrate monitoring, and other O&M activities were initiated to manage exposure pathways that could result in unacceptable risks. The OMMP developed by Golder (Golder, 2005e), describes the site activities to be performed after completion of the RA.

Long Term Monitoring and O&M of the remedy at the Sites has been conducted by the PRPs per the Consent Decree. Monitoring has included groundwater (annually through 2011 and in 2014), White King Pond pH (twice per year, normally in July and October), White King Pond benthic invertebrates (through 2011), and Augur Creek sediments and benthic invertebrates (2009).

Operations, maintenance, and monitoring requirements for the Sites are described in the OMMP (Golder 2005e). Elements of the OMMP include the following activities:

- Inspection and maintenance of the White King and Lucky Lass stockpiles
- Groundwater monitoring for the White King Consolidated Stockpile
- Groundwater monitoring for the Lucky Lass Stockpile
- Physical institutional controls (fencing and access controls).
- Augur Creek monitoring as part of monitoring the stockpiles
- Monitoring White King Pond.

Monitoring performed at the Sites since the first five-year review report has been documented in several reports including: groundwater monitoring reports (Golder

2010a, Golder 2011a, Golder 2012a; Golder 2015); a report of Augur Creek sediment and benthic invertebrate monitoring (Golder 2010b); reports of White King Pond benthic invertebrate monitoring (Golder 2010c, Golder 2012b); results of pH monitoring in White King Pond (Attachment 1); annual inspection reports (Golder 2010d, Golder 2011c, Golder 2012c, Golder 2013, and Golder 2014);. A summary of monitoring results and findings is presented in this section.

4.3.1. Inspection and Maintenance

The USFS performs regular inspections at the Sites to identify any O&M issues. The USFS also conducts routine maintenance on access roads and fences in the vicinity of the sites. The USFS notifies the PRPs of maintenance needs identified by the inspections. At least once a year the federal and state RPMs, in conjunction with the PRPs and Golder, perform a site visit to evaluate overall Sites conditions. Inspection and maintenance of the stockpiles includes:

- Preventing/repairing erosion of the stockpile covers and sideslopes
- Repairing holes in the cover from uprooted trees
- Preventing/repairing settlement in the cover leading to ponding on the stockpile
- Determining condition of the cover vegetation
- Preventing/repairing erosion of stormwater drainage ditches
- Repairing and securing physical institutional controls (fencing, gates, locks, and warning signs).

Areas of significant erosion or settlement are to be repaired by backfilling with clean cover soil, covered by topsoil, and revegetated in a manner that restores the original cover thickness. Areas where sparse vegetation is not providing sufficient erosion control are to be revegetated by reseeding. The OMMP states that no mowing or tree removal will be performed on the stockpiles. However, if trees become large enough there is the potential that when they fall their roots could compromise the covers on the stockpiles. Therefore, woody shrubs or trees will be identified and removed before

deep roots are established. There have been no uprooted trees on the stockpile covers to date.

Fences, gates, locks, and warning signs are repaired or replaced as needed to maintain their effectiveness. The remedial design includes 3-strand barbed wire fencing.

Summaries of the annual inspection reports subsequent to the last five-year review were provided in Golder 2010d, Golder 2011b, Golder 2012c, Golder 2013, and Golder 2014). A checklist for the most recent inspection along with a memorandum summarizing the inspection is provided in Attachment 3.

4.3.2. Groundwater Monitoring

Groundwater monitoring is performed to verify that the covered stockpiles remaining after completion of remedial action are not adversely affecting the water quality in Augur Creek (i.e., via groundwater discharge to the creek). These stockpiles are:

- White King Consolidated Stockpile
- Lucky Lass Stockpile.

Monitoring is conducted upgradient and downgradient at each of the two stockpiles, using the existing wells. At the White King mine there are three upgradient wells and seven downgradient wells. At the Lucky Lass mine there is one upgradient well and five downgradient wells. One sample is obtained from each groundwater monitoring well for each monitoring event. Field meters are used to measure pH, conductivity, temperature, dissolved oxygen, oxidation-reduction potential, and turbidity for each monitoring well. Water samples from each monitoring well are sent to a qualified laboratory for analysis of hardness, alkalinity, total dissolved solids (TDS), calcium and magnesium, uranium (U-Nat, U-235, U-238), and radium (Ra-226). In addition, analysis for arsenic is included for the White King wells.

Groundwater monitoring was performed in 2005 and 2006 to provide a baseline. Groundwater monitoring was performed annually from 2006 through 2011, and most recently in 2014. The OMMP provided for groundwater monitoring to continue until five

years following completion of remedial action (i.e., until 2011). In 2012 EPA and the support agencies agreed that annual monitoring could be discontinued until 2014 when a round of monitoring would be conducted to provide additional data to support this five-year review report (Golder 2012c). Groundwater monitoring reports are provided in Golder 2009a, Golder 2010a, Golder 2011a, Golder 2012a, and Golder 2015. Results are discussed in Section 6.4. An additional round of groundwater monitoring will be performed prior to the next five-year review to confirm the remedy remains protective for groundwater and discharges to surface water.

4.3.3. White King Pond

Post-remediation monitoring of White King Pond includes the following:

- Monitor pH annually (twice per year) to determine whether application of additional neutralizing agents will be necessary.
- Biosurvey of benthic macroinvertebrates to support bioassessment of the pond.

4.3.3.1 pH Monitoring

The pH criteria for White King Pond are:

- pH suitable for establishing and maintaining a benthic biological community.
- pH such that the pond discharge does not cause pH in Augur Creek to go outside the water quality limits.

If the pond becomes too acidic to meet the above criteria, then pond re-neutralization is performed by adding hydrated lime (or other suitable alkaline agent) to raise the pH of the upper 10 ft of the pond sufficient to meet the criteria discussed above. Benthic pH monitoring determines if the pH has dropped too low for healthy aquatic habitat. A pH of <5.5 is taken as a sign that the pH may be too low for healthy aquatic habitat. The pond was last neutralized in 2009 and reported in the Construction Completion Report (Golder 2009c). Monitoring from 2009 through 2014 has shown that the pH has remained above the criterion and neutralization has not been required. Results of pH monitoring are presented in Attachment 1.

4.3.3.2 Habitat Monitoring in White King Pond

Habitat monitoring in White King Pond consisted of benthic invertebrate sampling and taxonomic analysis. Because of the lack of an appropriate reference pond, the post-remediation samples were compared with pond baseline data acquired via the White King Pond and Augur Creek Study (Golder 2006a). Comparison of yearly monitoring data during the maintenance period with the baseline data gathered in 2004 and 2005 allowed evaluation of the status of the benthic invertebrate community in the pond vis-à-vis the focus on maintaining a benthic community and providing a food source for wildlife. Habitat (benthic invertebrate) monitoring was performed annually until five years following completion of remedial action (i.e., until 2011).

During a meeting with EPA and the support federal and state agencies during the 2012 annual site inspection, the agencies agreed that benthic macroinvertebrate surveys in the White King Pond were no longer needed (Golder 2012c). The final bio survey of the pond was conducted in 2011 (Golder 2012b).

4.3.4 AUGUR CREEK

Augur Creek is the compliance point for surface water quality standards. No inspection and maintenance is required for Augur Creek. Augur Creek has been monitored to:

- Ensure that following completion of the Remedial Action, COCs do not migrate into Augur Creek via surface runoff from the stockpiles. This was accomplished by sampling and analysis of upgradient and downgradient samples of both water and sediments from Augur Creek.
- Ensure that the pH in White King Pond has not caused the pH in the creek to decrease below ODEQ's Goose Lake standard (Goose Lake Basin standard for pH is 7-9).

Monitoring of surface water and sediments in Augur Creek was performed once in 2007 (one year after completion of remedial action) to assess residual effects of remedial action construction (Golder 2008). Because of questions concerning the validity of the

water quality data, additional sampling and analysis of water in Augur Creek was performed in 2008 (Golder 2009a).

The OMMP specifies that additional Augur Creek monitoring will be performed only if a breach of either the White King or Lucky Lass stockpile covers is identified by the stockpile inspection (i.e., potential for contaminated material from the stockpiles being washed into the creek in stormwater runoff), or if groundwater monitoring indicates that stockpile leachate has the potential to adversely affect Augur Creek water quality. Although these conditions have not occurred, at the request of ODEQ, a study was conducted in 2009 (Golder 2010b) to assess the relative health of the benthic macroinvertebrate communities in Augur Creek upstream and downstream from the White King consolidated stockpile. ODEQ made this request due to concern that elevated arsenic concentration in sediments may be impacting Augur Creek biota. Results are discussed in Section 6.6.

5. PROGRESS SINCE THE LAST REVIEW

Previous Five-Year Review Protectiveness Statement and Issues

The protectiveness statement from the 2010 FYR stated the following:

> *The remedial actions at the Site are complete and protective of human health and the environment. Based upon the review of relevant documents and the site inspection, the remedy is functioning as intended by the ROD and ESD. There have been no changes in the physical condition of the Site that would affect the protectiveness of the remedy. Long-term protectiveness of the RAs will continue to be ensured and verified by Institutional Controls (ICs), LTM, and O&M, which includes monitoring of groundwater COC concentrations and inspection and maintenance of the integrity of the White King Consolidated stockpile and the Lucky Lass stockpile caps and fences.*

The 2010 FYR included one issue and recommendation, which is listed in the table below.

Issues from previous FYR		Recommendations	Action Taken and Outcome	Date of Action
1	Continued Neutralization of the White King Pond on approximately a five year interval in order to maintain stable pH.	Continued neutralization of the White King Pond on approximately a five-year interval in order to maintain stable pH.	Monitoring of the pH in the White King Pond has shown that the pH is still within the target range. Therefore no neutralization has been required.	N/A

6. FIVE-YEAR REVIEW PROCESS

The first five-year review was completed May 18, 2010 (EPA 2010). The second five-year review process for the Mine Sites was initiated in January 2015. The Mine Sites five-year review team was led by the EPA Remedial Project Manager (RPM) for the Mines Site (Mr. Dave Einan). Additional support was provided by the ODEQ RPM (Mr. Bob Schwarz), the ODE RPM (Mr. Dale Engstrom), and the USFS RPMs (Mr. Waiyen "Yogi" Yee).

The following activities were conducted during the five-year review:

- After completion of the five-year review, copies of the report will be made available via the administrative record. A public notice to announce the availability of the report will be printed in the Lakeview County Examiner and Klamath Falls Herald and News newspapers.
- A site inspection was conducted by representatives from EPA, ODEQ, ODOE, the USFS, WNI and Golder.
- Informal input was received from the federal and state RPMs as well as comments on the draft five-year review report.

The five-year review team conducted a technical assessment of the Mine Sites and the findings and recommendations are provided in this report.

6.1. Document and Data Review

This five-year review consisted of a review of relevant documents that included, but were not limited to, RI reports, remedial action and construction completion reports, O&M reports, monitoring reports, inspection reports, and the first five-year review report. The applicable groundwater cleanup levels specified in the ROD were also reviewed. The groundwater monitoring data are presented in Attachment 2.

A Title Search was conducted in December 2009 by Tronox for EPA for the first Five-Year Review. An evaluation of the Title Report by EPA confirmed that Institutional Controls were recorded on all the parcels and is documented in Attachment 4 of the first Five-Year Review Report.

6.2. Site Inspection

An inspection of the Mine Sites was performed on July 31, 2014, by EPA (Mr. Dave Einan), ODEQ (Mr. Bob Schwarz), ODE (Mr. Dale Engstrom), USFS (Messrs. Waiyen Yee, Jonathan Heyl, and Dennis Scott), Golder (Doug Dunster and Frank Shuri) and the PRPs (Barb Nielsen of WNI). The purpose of the inspection was to assess the protectiveness of the remedy, including the access restrictions at the Site.

The site inspection checklist and memorandum from the 2014 inspection is included in Attachment 3. The White King Consolidated Stockpile and Lucky Lass Stockpile caps, fencing, and side slopes were inspected. No significant issues affecting the protectiveness of the remedy were noted. The team agreed that deed restrictions and continued annual site inspection to evaluate the need for O&M activities are adequately addressing exposure issues at the Sites. The primary issues identified during the most recent site inspection were the need for periodic maintenance of Sites fencing and warning signs. In addition to fence vandalism, grazing trespassing and sign damage, there was evidence of snow machines within the perimeter fence and vehicle tire tracks on the stockpile. Reports of annual inspections are prepared to document the inspections and include photographs of items inspected and requiring repair and maintenance.

6.3. Stockpile Inspection and Maintenance

Surface water management facilities have performed well. Lined ditches show no signs of erosion or other damage.

As recommended in the first Five-Year Review Report, annual inspections were conducted between 2010 and 2014 to verify that erosion damage has not occurred and to identify whether additional maintenance was required. These annual inspections have confirmed that the repairs and modifications conducted during 2009 are functioning as intended. No additional damage due to erosion has been observed that has required repair or maintenance during this second five-year review period.

6.4. Groundwater Monitoring

Groundwater monitoring was conducted annually until 2011. Per the OMMP approved by the EPA, if no statistically significant increase in downgradient groundwater concentrations of Site radium, uranium, or arsenic (White King only) was observed, groundwater monitoring could be discontinued.

In the 2011 groundwater monitoring, arsenic was observed in some White King wells at higher concentrations than had been reported previously (Golder 2012a). The higher arsenic concentrations may be attributable to the presence of iron hydroxides in the samples. The samples were unfiltered, and the field notes from the monitoring event reported that the water sample was orange colored and there were visible particulates. Arsenic readily sorbs to iron hydroxides. As a result of these findings, EPA requested that one additional round of groundwater monitoring be conducted during 2014. During this round of monitoring, samples were collected using techniques to reduce turbidity in the samples and both filtered and unfiltered samples were collected. Arsenic concentrations in 2014 were similar to pre-2011 values.

Groundwater monitoring data for the Site from 2005 through 2014 is presented in the most recent monitoring report (Golder 2015). The analytical results from the report are summarized in Attachment 2, Tables 1 and 2 for White King, and Tables 3 and 4 for Lucky Lass.

At White King, the total arsenic concentrations in groundwater were all below the 33 µg/L remediation level specified in the ROD. Uranium (U-Nat, U-235, and U-238) concentrations reported in White King and Lucky Lass groundwater were consistent with historical results. At Lucky Lass, the uranium concentrations observed in the upgradient well are greater than those observed in downgradient wells. There is no remediation goal or water quality standard for uranium in OAR 340-41-0145 (water quality standards for Goose Lake and Summer Lake basins).

Elevated total Ra-226 concentrations were observed in White King and Lucky Lass groundwater samples during the 2014 sampling event, with the highest concentration

observed in the Lucky Lass upgradient well (4.03 pCi/L). While there is no cleanup level specified in the ROD, the MCL is 5 pCi/L. Historical high concentrations of Ra-226 were observed in 8 of 10 White King wells and 2 of 4 Lucky Lass wells. Elevated concentrations during 2014 may be attributable to slightly turbid groundwater samples (ranging from 0.46 to 11.8 nephelometric turbidity units [NTU]) or potentially due to a 3-year dormancy in monitoring wells between groundwater sample events. Additionally, groundwater elevations observed during sample collection in 2014 were at or near historical lows, which may have an impact on the concentrations observed in 2014 compared to prior years when groundwater elevations were higher.

Dissolved Ra-226 groundwater samples were also collected from the White King and Lucky Lass wells. Dissolved Ra-226 concentrations were comparable to historical total Ra-226 concentrations with the exception of White King monitoring well WK-05-2-SB. The dissolved Ra-226 concentration was greater than the total concentration at this location (1.49 pCi/L and 0.915 pCi/L, respectfully).

The elevated total Ra-226 concentrations in downgradient groundwater at White King resulted in a statistically significant increase when comparing 2011 results to 2014 results. Elevated total Ra-226 concentrations at Lucky Lass also resulted in statistically significant increases when comparing 2005 results to 2014 results, and 2011 results to 2014 results.

6.5. White King Pond pH Monitoring and Neutralization

The White King Pond was initially neutralized in1999, and has been re-neutralized twice since (2004 and 2009). There is a presumed source of acidity at the bottom of the deepest part of the pond, at the location of the submerged main shaft of the former underground mine workings. Monitoring of pH in the pond has shown a gradual decrease in the pH following re-neutralization. Based on the monitoring through 2009 it appeared that ongoing re-neutralization at approximately five-year intervals may be necessary to maintain a pH in the pond that allows continuation of the current good biological habitat (> 5.5 pH). However, monitoring since 2009 through 2014 indicates

that pH > 5.5 has maintained beyond 5 years from the last neutralization event in White King Pond. It now appears that neutralization will not be necessary at the frequency assumed when the first five-year review was completed.

6.6. White King Pond Biological Monitoring

Biological monitoring of White King Pond (benthic invertebrate sampling and taxonomic analysis) was performed for the initial study in 2004 and 2005 (Golder 2006a), and annually since completion of remedial action through 2011 (Golder 2008; Golder 2009c, Golder 2010c, Golder 2011b, 2012b).

White King Pond's benthic community appears to be relatively healthy and appears to have improved, in some ways, following neutralization. The 2011 survey (Golder 2012b) provided the following summary of findings:

- The density of benthic invertebrates in littoral habitats greatly exceeds the minimum density of 50 to 100 individuals/m^2 (and averages more than 1000/m^2).
- Diversity is reasonable and reflects a community typical of what would be expected in a pond with similar physical characteristics to the White King Pond. Although chironomid larvae and works comprise most of the organisms present, this is normal in littoral lentic habitats with soft substrates.
- The number, variety, and diversity of macroinvertebrates are similar pre- and post-neutralization, although the proportion of predators in the community dropped after neutralization and the actual composition of taxa has shifted somewhat between years.
- Abundance and proportions of ephemeroptera, plecoptera, and trichoptera (EPT) taxa over the period of record indicate that these sensitive organisms remain important components of the benthic community, and have become an increased proportion of the commonly identificed taxa. There is no evidence of adverse responses to these taxa.

- Several individual taxa that were present in the pond before neutralization disappeared afterward. However, a greater number of taxa were either absent or present in small numbers pre-neutralization increased in abundance following neutralization. The net response of the community is considered to be net neutral and well within the decision rule narratives set forth in the work plan. In addition, there are some indications of improvement of conditions. For example, snails were absent from the pond before neutralization, but present afterwards. These organisms have shells made from calcium carbonate, which is easily dissolved under acidic conditions. Their presence post-neutralization is an indicator of the return of the pond water to more neutral pH. The first appearance of pea clams (Pisdium sp.: Bivalvia: Sphaeriidae) in the 2009 samples and subsequent increase in Sphaeriids in 2010 and 2011 may also be a response to stable netural pH.

Benthic macroinvertebrate monitoring was discontinued following completion of the 2011 sampling event.

6.7. Augur Creek Sediments

As discussed in Section 4.2.4, sediment and benthic invertebrate monitoring was conducted in 2009 to evaluate whether elevated arsenic concentrations in Augur Creek sediments were having a detrimental effect. The monitoring report concluded that it was not possible to distinguish between potential effects of elevated arsenic and impacts from cattle grazing and recommended that no additional remedial actions for sediments were warranted (Golder 20010b).

6.8. Institutional Controls, Fencing and Warning Signs

As stated in Section 4.1, a title search for the private properties was conducted in December 2009 and documented in a Preliminary Title Report issued for each property (Attachment 4 of the First Five-Year Review). The title reports show that an Easement and Equitable Servitude document was recorded in the Lake County deed records for both the Fremont property and the Coppin Trust property. These documents include (1)

restrictions on the use of groundwater as long as the contaminant concentrations exceed risk based standards, (2) protection of the wetland areas, and (3) land use restrictions that prevent residential and agricultural (food crops) use of the properties.

No groundwater wells have been installed on the Mines Site with the exception of monitoring wells installed as part of the post-closure monitoring program. Fencing has been installed around the White King consolidated stockpile, and fencing exists around the perimeter of the entire Mines Site. Additional fencing exists around each of the three wetland areas. Access gates from Forest Road 3780 are in place and locked. The fencing is in generally good condition with some minor repairs necessary due to heavy snow in the winter and cattle in the summer. Warning signs also require periodic replacement. There was no evidence of tampering with the soils in the consolidated stockpile.

Cattle have periodically been found grazing on the property indicating the need to continue to inspect and maintain the fencing. Human access appears to continue to be limited by the fencing, locked gate, and warning signs.

In summary, the necessary institutional controls and fencing are in place to prevent exposure to COCs in the soil and groundwater at the Site and appear to be effective.

6.8.1. Fence and Warning Sign Inspection and Maintenance

During the 2014 inspection, some broken or cut wires were observed in the barbed wire fences surrounding the White King meadow and a few cows were observed in the meadow. However, only a few cattle were observed and damage to the vegetation in the meadow appeared to be negligible. Keeping cattle from remediated areas is important to the continued success of the remedy, as well as the biological health of the adjacent areas (e.g., the White King Meadow and Augur Creek). It would be desirable from the standpoint of remedy reliability and the biological health of the Site if cattle could be permanently prohibited from grazing near the stockpiles (including any grazing being far enough removed to not rely on Site fencing). However, as the vegetation on the cover and in the White King Meadow becomes more established, it will become

more resistant to the effects of cattle. If cattle cannot be prohibited, then ongoing fence maintenance by the USFS will remain important for at least the near future.

During the 2014 inspection one of the warning signs that was supposed to be on the fence surrounding the White King consolidated stockpile was found damaged and lying on the ground. There was also evidence of snow machines within the perimeter fence and vehicle tire tracks on the stockpile. The USFS will provide ongoing maintenance of the warning signs. Signs are to be placed at 200 foot intervals and contain the warning "Hazardous Area – Keep Out".

Although not required in the ROD, EPA and the other agencies have discussed the possibility of installing an Information Kiosk at the Mines Site to present a history of the mining activities and the cleanup work that has been completed.

6.8.2. Legal/Regulatory Controls

Kerr McGee, Fremont, and WNI entered into a Consent Decree with EPA for Remedial Design and Remedial Action, which was approved by the Court on January 20, 2006. The Consent Decree obligates the three Settling Defendants to perform the Remedial Design and Remedial Action required at the Mines Site. The work performed required by the Consent Decree was initially conducted by Kerr McGee or Tronox on behalf of the Settling Defendants. Tronox was spun off from Kerr McGee in 2006 and retained the liability for performance of the Consent Decree. On January 12, 2009, Tronox filed a petition for voluntary reorganization under Chapter 11 of the U.S. Bankruptcy Code, which was effective as of February 14, 2011. Since that time WNI and Fremont have implemented the O&M activities at the Mines Site.

EPA asserted a claim in the Tronox bankruptcy and received a recovery based on its asserted claim.

EPA, WNI and Fremont are negotiating an amendment to the 2006 Consent Decree that will govern how Tronox settlement funds will be used to fund future work at the Sites. The amendment may provide for USFS to perform the work.

6.9. Input on Five-Year Review Report

Review and input on the Five-Year review report was provided by the Dale Engstrom (ODE), Bob Schwarz (ODEQ), Jonathan Heyl (Forest Service), Waiyen Yee (Forest Service) and Barb Nielsen (WNI).

7. TECHNICAL ASSESSMENT

In accordance with current EPA guidance (EPA, 2001), a five-year review should determine whether the remedy at the site is protective of human health and the environment. The technical assessment of a remedy examines three questions that provide a framework for organizing and evaluating data and information and ensures that all relevant issues are considered when determining the protectiveness of the remedy. These questions are presented in the following sections.

7.1. Question A:

Is the remedy functioning as intended by the decision document?

Yes. The review of the OMMP, monitoring reports, and site inspection results indicates that the remedies are functioning as intended in the ROD and ESD and have met the intent of the ROD and ESD.

The soil covers over the stockpiles and off-pile areas show no significant erosion, and only minor erosion that did not penetrate the cover was observed in a few areas. Stockpile slopes are stable and vegetation is becoming established. This indicates that the remedy is performing as expected with respect to preventing direct exposure of contaminated soils to humans and the environment. This also indicates that contaminants are not migrating via erosion. Institutional and engineering controls are in place and functioning as intended by the ROD.

7.2. Question B:

Are the exposure assumptions regarding toxicity data, cleanup levels, and remedial action objectives used at the time of the remedy selection still valid?

Yes. The exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection are still valid for the stockpile consolidation (the primary component of the remedy; see Section 4.1 for details).

For White King Pond the ROD required maintenance of the pond, surface water management and monitoring. A study of White King Pond completed in 2006 (Golder

2006a) concluded that no remediation of the pond is needed. According to the report, "The results (both Phases 1 and 2) indicate that there was no need for additional remedial action targeted at sediments, because there was an established benthic invertebrate community that provides food for wildlife and because estimated risks to wildlife due to White King Pond were below the acceptable risk threshold of HQ=1." This conclusion has been substantiated in subsequent monitoring of White King Pond (see Section 6.1.4).

The toxicity data, cleanup levels, and RAOs used at the time of the remedy selection are still valid. There have been no changes in the potential exposure pathways at the Sites. The exposure assumptions used to develop the human health risk assessments remain valid. There has been no change in the toxicity factors for the primary COCs (arsenic, radium-226, and uranium).

There have been no changes in the physical conditions of the Mines Site that would affect the protectiveness of this remedy.

7.3. Question C:

Has any other information come to light that could call into question the protectiveness of the remedy?

No. There is no new information that would question the protectiveness of the remedy.

7.4. Technical Assessment Summary

Based on a review of the historical site (remedial investigation, remedial action and LTM) data, the remedy is functioning as intended and remains protective. The physical conditions of the Mines Site have not changed, and the cleanup goals cited in the ROD for soil and groundwater are being met.

The only issues identified which could potentially affect future protectiveness are: 1) the need for continued periodic neutralization of the White King Pond; 2) maintenance of fencing and warning signs; and 3) maintenance of stockpile covers. All of these are currently addressed in the O&M plan. An additional round of groundwater monitoring is

needed prior to the next five-year review to confirm the remedy remains protective for groundwater and discharges to surface water.

During the first five-year review it was thought that neutralization would be needed at approximately five year intervals in order to maintain a stable pH. However, the pond was last neutralized in 2009 and monitoring since then has shown the pH to remain stable. It now appears that neutralization will be needed less frequently.

Inspection and on-going maintenance are needed for the fencing and warning signs. The fencing is required to keep cattle from remediate areas to maintain the biological health of the White King Meadow. Warning signs should be maintained to limit humans from entering and disturbing the White King consolidated stockpile and the Lucky Lass stockpile.

Inspection of the White King consolidated stockpile and Lucky Lass stockpile are needed to ensure that erosion has not compromised the covers. Repairs should be made if significant erosion is observed. No significant erosion requiring maintenance has been required since repair work was conducted during 2009. Native vegetation including trees is becoming established on both stockpiles. If trees become large enough, there is the potential that when they fall their roots could compromise the covers on the stockpiles. Woody shrubs and trees should be periodically removed to prevent deep roots from damaging the covers on the stockpiles.

The groundwater monitoring data indicate that groundwater contaminant concentrations have not exceeded standards (since 2005). Although Ra-226 concentrations exhibited a statistically significant increase in 2014 compared to prior years, the increase occurred in both upgradient and downgradient wells and the highest concentrations were observed in upgradient wells. The review of O&M and performance monitoring data indicates that the ICs and O&M activities at the Mines Site continue to be protective.

8. ISSUES

No issues which affect protectiveness were identified in this five-year review for the Mines Site. It was expected that groundwater monitoring would be discontinued, but at least one additional round of monitoring is appropriate before the next Five-Year Review for this site. The Ra-226 concentrations at both upgradient and downgradient wells in the last sampling round were elevated compared to the last several values, but were still below the MCL. Land use and groundwater restrictions remain in place and ensure protectiveness.

9. RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Included below are actions that do not affect current or future protectiveness, but will improve and ensure continued effectiveness of the remedial action:

- Continued inspections of the covers and fences as required by the OMMP.
- Additional groundwater monitoring to evaluate apparent Ra-226 concentration changes.
- Although not required in the ROD, EPA and the other agencies have discussed the possibility of installing an Information Kiosk at the Mines Site to present a history of the mining activities and the cleanup work that has been completed. This idea will be discussed and a determination of whether it will be done will be made by the parties involved.

10. PROTECTIVENESS STATEMENT

The remedial actions at the Mines Site are protective of human health and the environment.

Based upon the review of relevant documents and the site inspections, the remedy is functioning as intended by the ROD and ESD. There have been no changes in the physical condition of the Site that would affect the protectiveness of the remedy. Long-term protectiveness of the RAs will continue to be ensured and verified by Institutional Controls (ICs) and implementation of the OMMP. The OMMP contains the criteria for long-term monitoring and maintenance, including monitoring and periodic neutralization of White King Pond; inspection and maintenance of the White King Consolidated stockpile and the Lucky Lass stockpile caps, fences and warning signs; and an additional round of groundwater monitoring prior to the next five-year review.

11. NEXT REVIEW

The next five-year review for the Site will be completed by September 2020. All aspects of the remedy will be reviewed at that time to ensure continued protectiveness.

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FIGURES

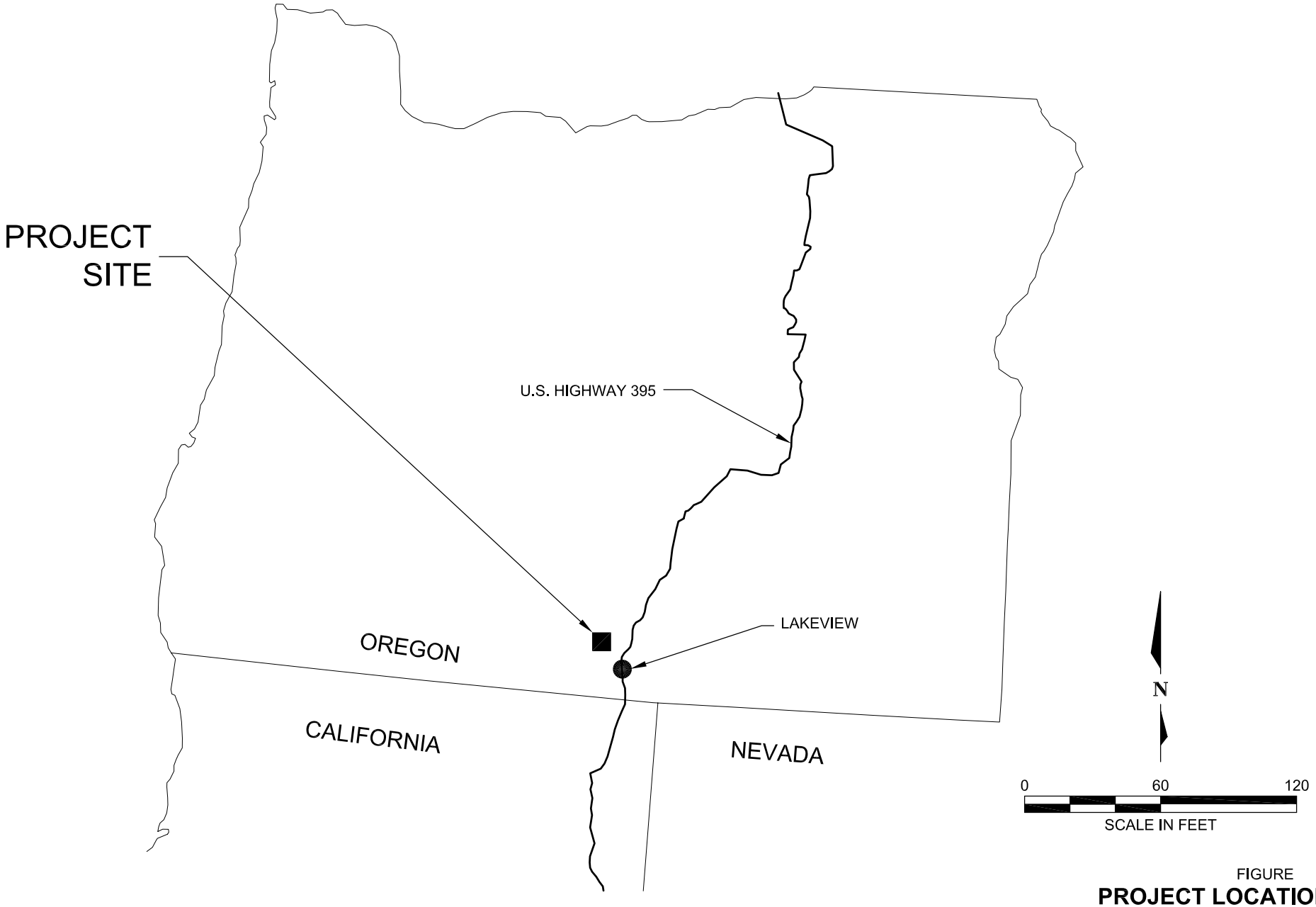


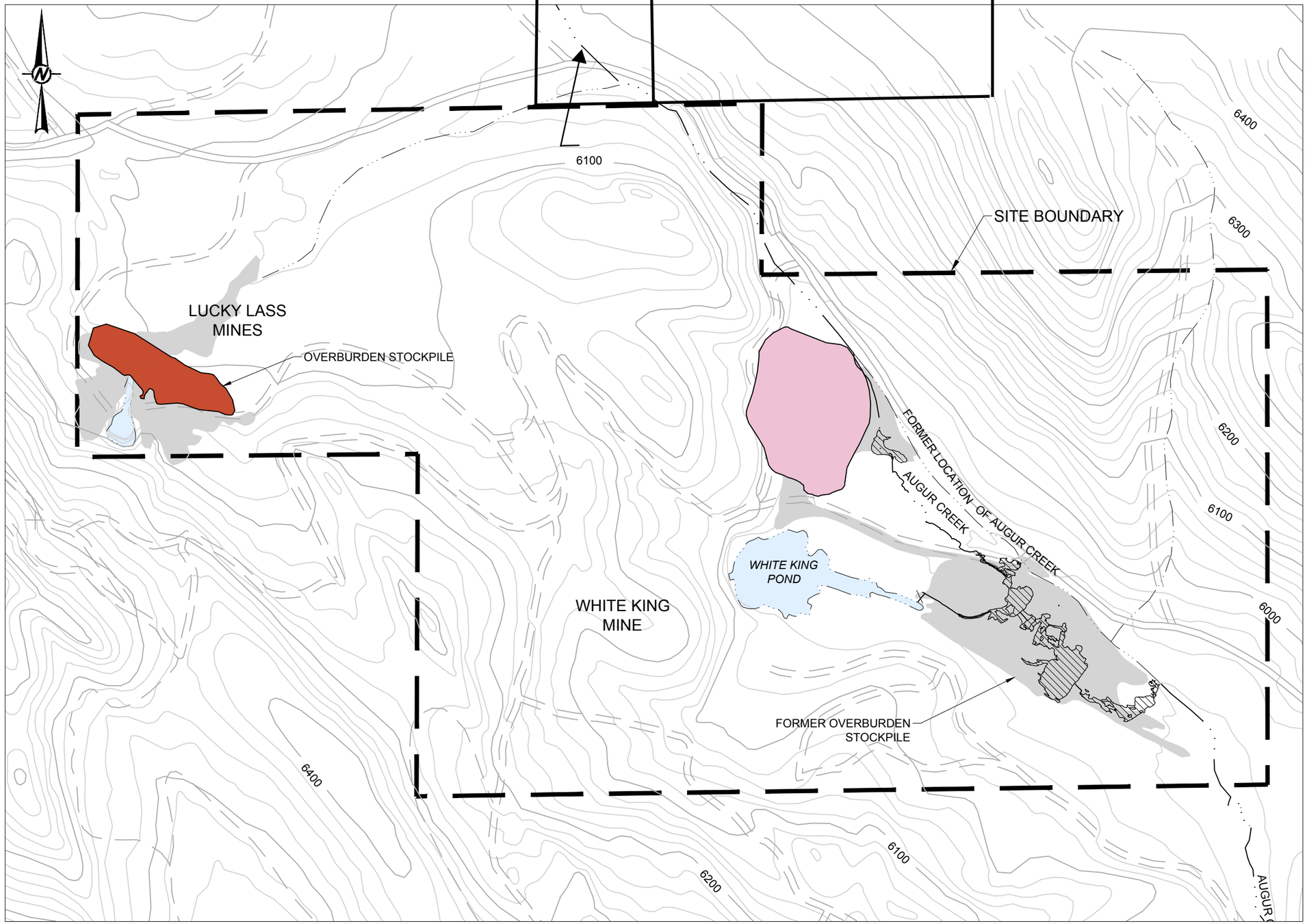
FIGURE 1

PROJECT LOCATION

WHITE KING - LUCKY LASS / OR

K:□CAD□Projects□2003□0331398□x001□700□0331398001700F01.dwg | Layout1 | Mod: 12/05/2006, 15:32 | Plotted: 12/05/2006, 15:32 | afordier

Golder Associates



LEGEND

- WHITE KING CONSOLIDATED STOCKPILE
- LUCKY LASS STOCKPILE
- WETLAND AS-BUILT AREA
- FORMER STOCKPILE AREA
- PIT
- ROADS
- CONTOUR INTERMEDIATE 20 FOOT INTERVAL
- CONTOUR INDEX 100 FOOT INTERVAL
- CREEK

0 400 800
SCALE FEET

NOTES

1. TOPOGRAPHIC CONTOURS FROM USGS, 1980 COMPILED BY GOLDER ASSOCIATES.
2. BASE INFORMATION (ROADS, MINES, PITS AND PILES) FROM KERR-MCGEE, 1997.

CLIENT
WESTERN NUCLEAR, INC.

PROJECT
WHITE KING AND LUCKY LASS MINE SITE

CONSULTANT
Golder Associates

YYYY-MM-DD	2015-01-08
PREPARED	REDMOND
DESIGN	N/A
REVIEW	DD
APPROVED	DD

TITLE
SITE FEATURES

PROJECT No.	PHASE	Rev.	FIGURE
0331398002	610	A	2

4,908,000 4,914,000 4,920,000

246,000 240,000 234,000

R. 18 E. R. 19 E.

TRONOX

White King / Lucky Lass Mines Site

Property Map

Fremont Lumber (parcel 1) — Property Boundary with Owner Name and Parcel Number

Scale 1 in. = 1,200 ft.

0 1,200 2,400 Feet

N

NOTE :

DATES : MAP PRODUCED - FEB. 3, 2010

COORDINATES : (NAD 83) ST PLN - OREGON SOUTH - FT

FILE : LAKEVIEW_WKING_PROP_JAN10.MXD

Collins Timber Company, LLC Tax Lot 37-18-300 560.00+/- Acres

Collins Timber Company, LLC 37-19-300 8282.49 +/- Acres

Fremont Lumber Co., Govt. Lot 4 (parcel 2?) Tax Lot 37-19-301 40.31+/- Acres

Fremont Lumber (parcel 1)

Coppin Trust

Fremont Lumber (parcel 3)

Fremont Lumber (parcel 3)

Fremont Lumber (parcel 4)

Fremont Lumber (parcel 4)

Fremont Lumber (parcel 4)

24 19 20

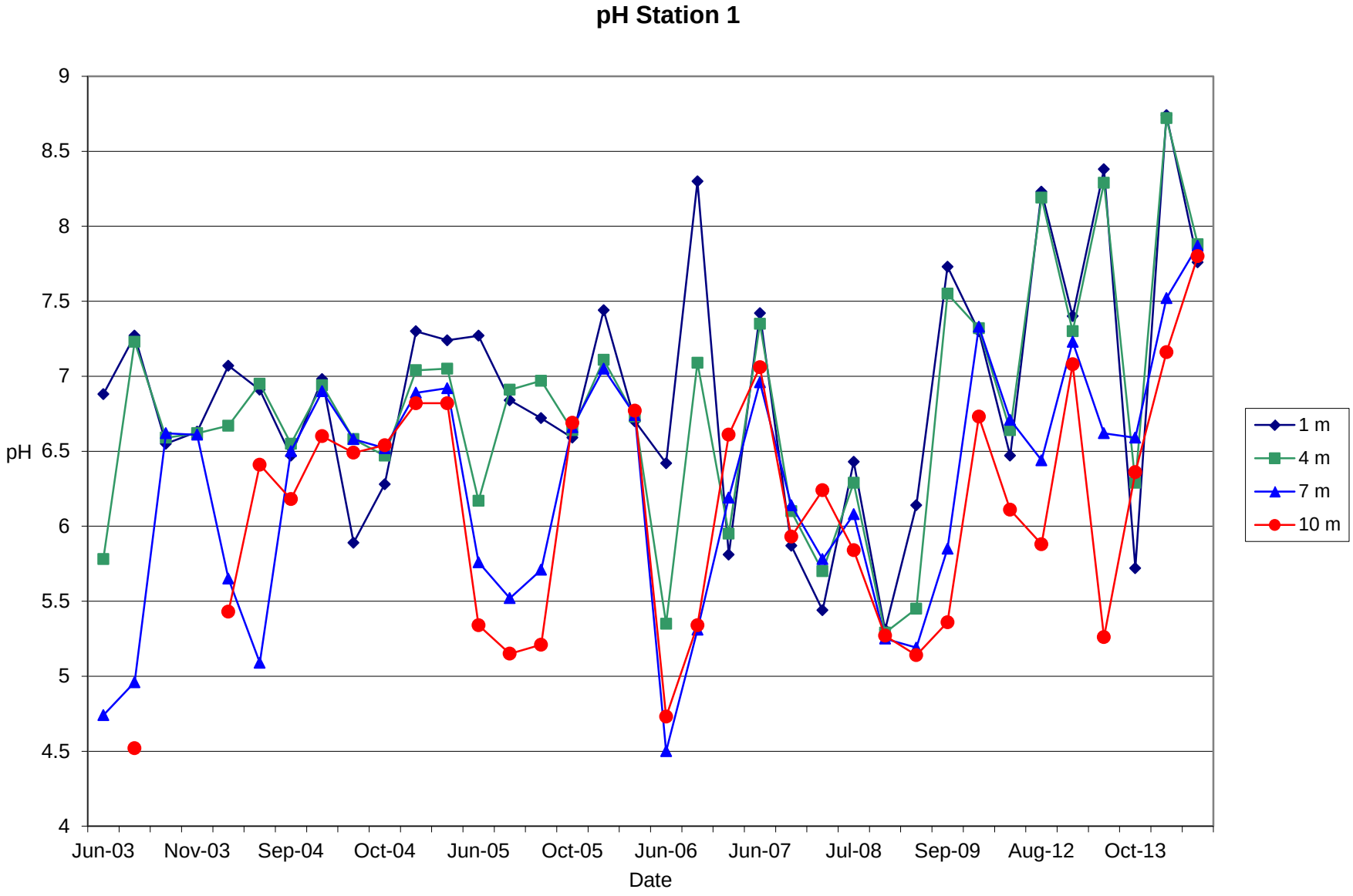
25 30 29

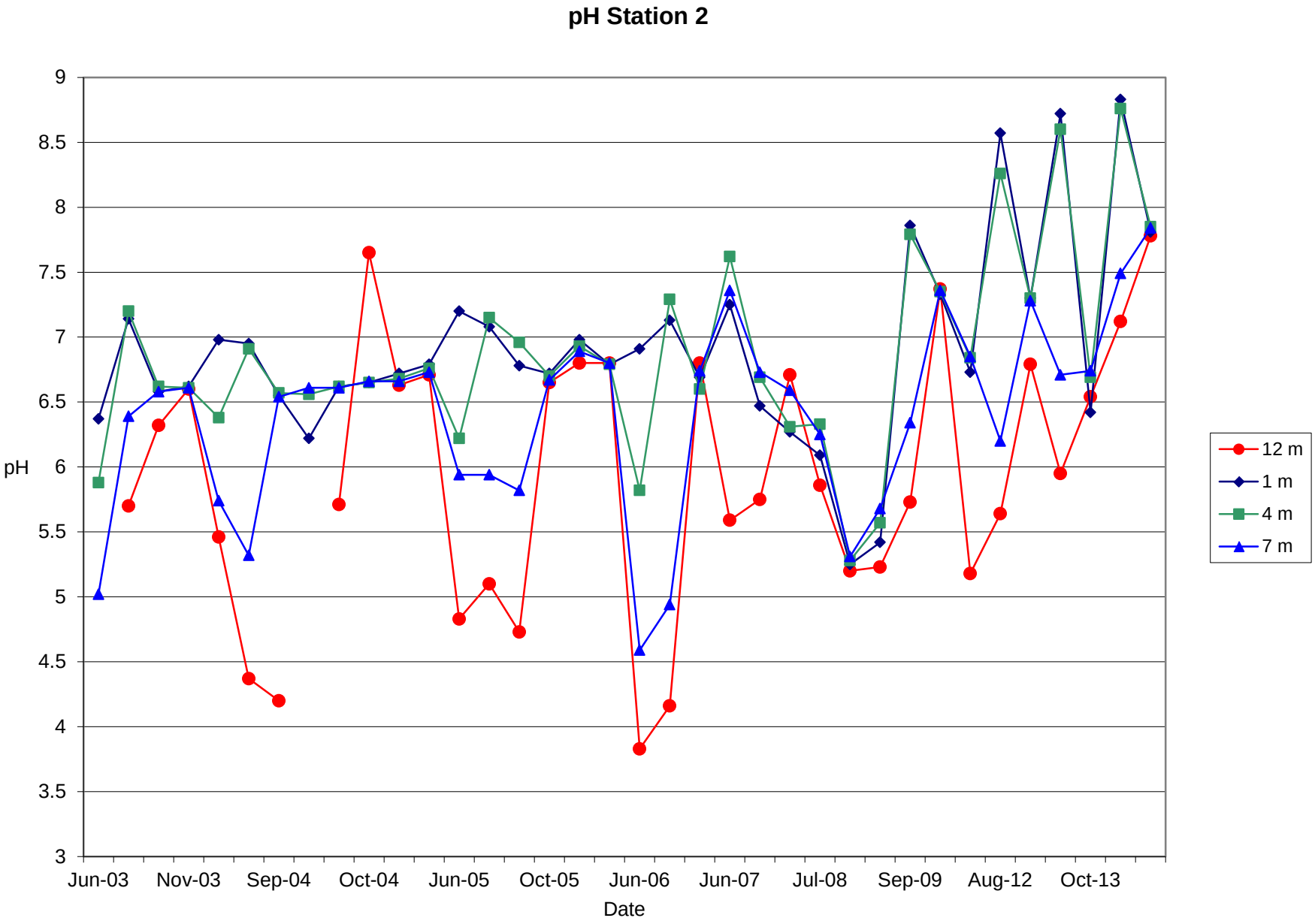
36 31 32

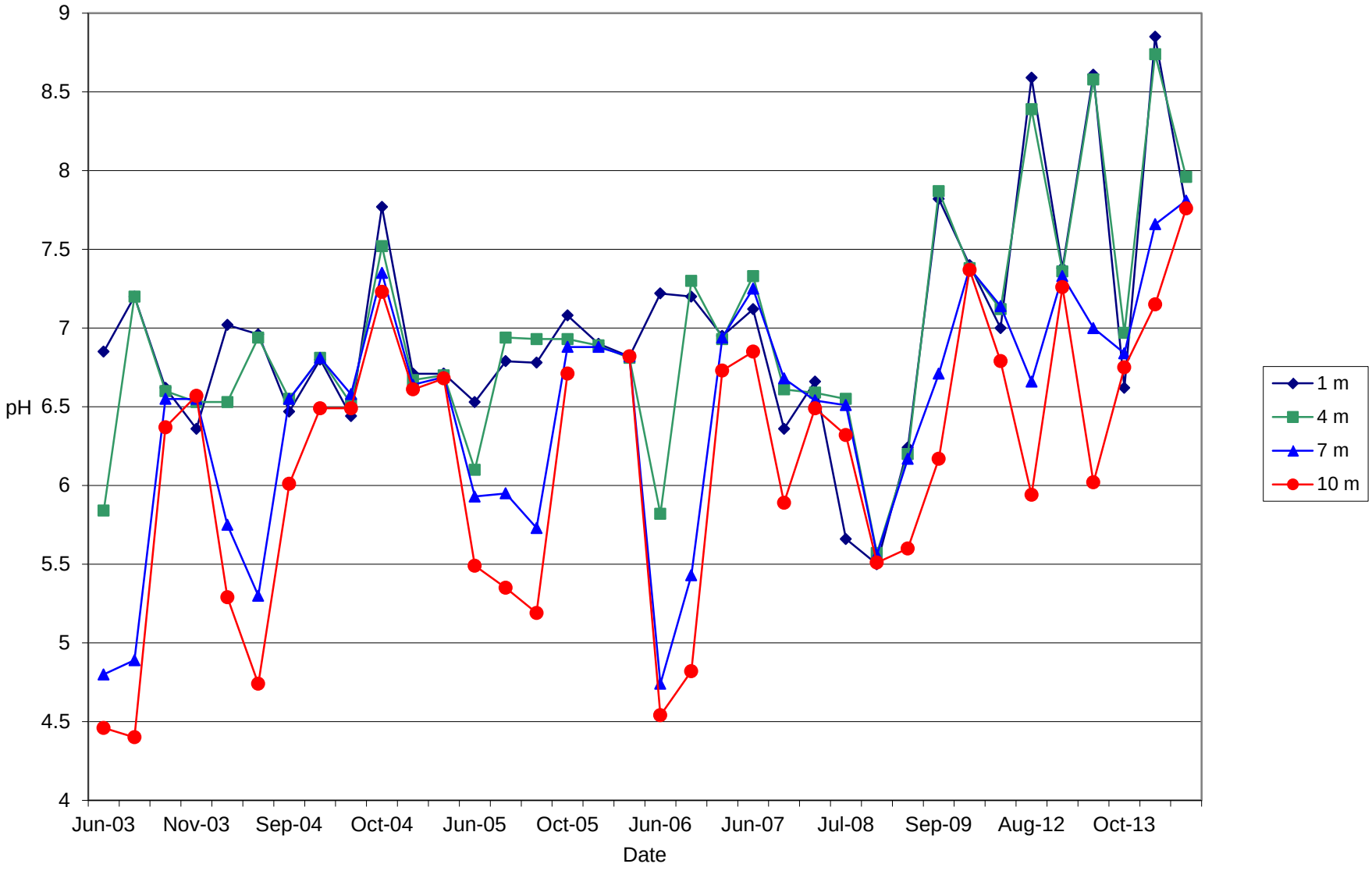
T. 37 S.

T. 38 S.

Attachment 1: WHITE KING POND pH MONITORING RESULTS


pH Station 1
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
pH
Jun-03
Nov-03
Sep-04
Oct-04
Jun-05
Oct-05
Jun-06
Jun-07
Jul-08
Sep-09
Aug-12
Oct-13
Date
1 m
4 m
7 m
10 m


pH Station 2
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
pH
Jun-03
Nov-03
Sep-04
Oct-04
Jun-05
Oct-05
Jun-06
Jun-07
Jul-08
Sep-09
Aug-12
Oct-13
Date
12 m
1 m
4 m
7 m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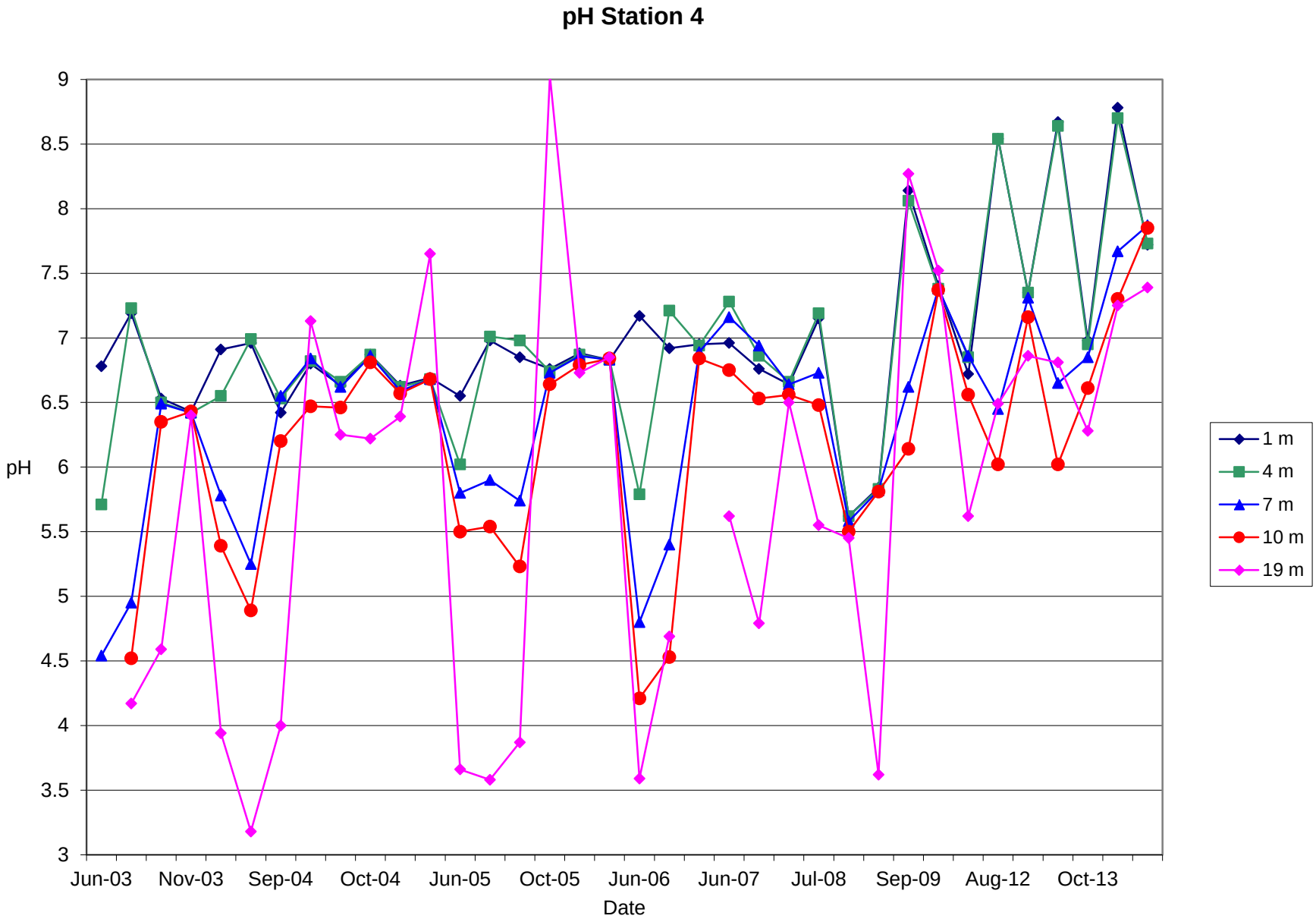
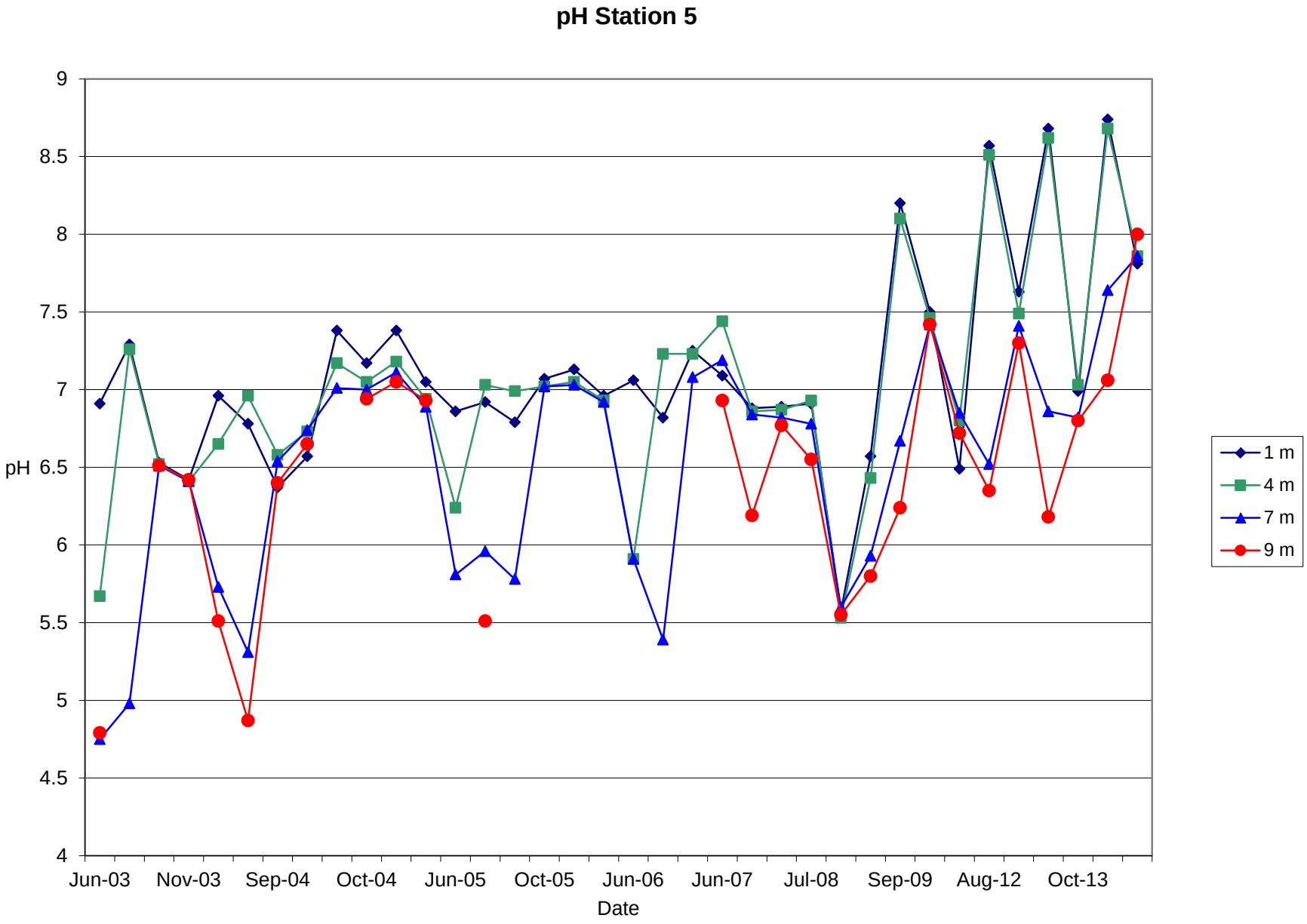
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
pH
Jun-03
Nov-03
Sep-04
Oct-04
Jun-05
Oct-05
Jun-06
Jun-07
Jul-08
Sep-09
Aug-12
Oct-13
Date
1 m
4 m
7 m
10 m


pH Station 4
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
pH
Jun-03
Nov-03
Sep-04
Oct-04
Jun-05
Oct-05
Jun-06
Jun-07
Jul-08
Sep-09
Aug-12
Oct-13
Date
1 m
4 m
7 m
10 m
19 m


pH Station 5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
pH
Jun-03
Nov-03
Sep-04
Oct-04
Jun-05
Oct-05
Jun-06
Jun-07
Jul-08
Sep-09
Aug-12
Oct-13
Date
1 m
4 m
7 m
9 m

Attachment 2: WHITE KING AND LUCKY LASS GROUNDWATER MONITORING RESULTS

Table 1: White King Groundwater Analytical Results
White King / Lucky Lass Mines Superfund Site

Well ID	Date Sampled	Lab Report	Field Measurements				Physical Tests			Metals (total)			Radionuclides (total)				Radionuclides (dissolved)
			pH (s.u.)	Conductivity (mS/m)	Temperature (°C)	Turbidity (NTU)	Total Dissolved Solids (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Calcium (ug/L)	Magnesium (ug/L)	Arsenic * (ug/L)	Ra-226 (pCi/L)	U-235 (ug/L)	U-238 (ug/L)	U-nat (ug/L)	Ra-226 (pCi/L)
Upgradient Wells																	
12A-S	10/21/2005 10/24/05	148733 148972	5.8	0.125	10.6	-	121	NA	38.9	9,650	3,590	*2.34*	<0.419	<0.01	<0.05	<0.05	-
	5/30/2006	164282 164283	5.6	9	6.1	-	109	33.8	25.4	6,800	2,040	<1.5	<0.388	<0.01	0.123 J	0.124 J	-
	9/18/2007	194233 194590 194603	6.53	10	14.3	-	118	56.2	38.5	9,690	3,480	*4.52*	<0.438	<0.01	0.125 J	0.129 J	-
	10/6/2008	217288 217358	6.76	11.9	13.7	-	106	55.5	37.4	9,350	3,410	*2.6*	<0.381	<0.01	0.125 J	0.125 J	-
	9/21/2009	237826	6.61	-	13.9	-	108	57	36.4	9,030	3,350	*2.41*	0.654 J	<0.01	0.149 J	0.149 J	-
	10/18/2010	265157 265162	6.57	8.7	12.3	-	124	58.1	39.8	10,000	3,590	*2.86*	<0.475	<0.010	0.135 J	0.135	-
	10/24/2011	288989 289212 289219	6.35	8.7	11.0	-	111	55.5	42.2	10,600	3,820	*2.89*	<0.430	<0.010	0.0733 J	0.0733 J	-
	7/23/2014	353489 353494 353501	6.09	15	13.5	9.83	57.1	53.7	39	9,730	3,580	*3.09 J*	1.4	<0.01	0.141 J	0.141 J	0.562
12A-D	10/21/2005	148733 148972	6.48	0.14	9.3	-	140	58.1	49	11,100	5,140	*2.25*	<0.381	<0.01	0.058 J	0.059 J	-
	5/30/2006	164282 164283	5.7	12	9.1	-	131	56.3	47.5	10,700	5,080	*2.1*	0.462 J	<0.01	0.11 J	0.111 J	-
	9/18/2007	194233 194590 194603	6.53	8.4	10.4	-	120	65.4	48.4	10,800	5,190	*4.2*	<0.426	<0.01	0.082 J	0.082 J	-
	10/6/2008	217288 217358	6.81	13.4	9.9	-	120	65.4	47.2	10,600	5,050	<1.5	<0.421	<0.01	0.13 J	0.13 J	-
	9/21/2009	237826	6.4	-	9.5	-	118	69.2	45.1	10,300	4,710	*1.65*	0.406 J	<0.01	0.09 J	0.09 J	-
	10/18/2010	265157 265162	6.64	9.6	9.8	-	124	64.7	51	11,500	5,400	*2.87*	<0.359	<0.010	0.128 J	0.128 J	-
	10/24/2011	288989 289212 289219	6.4	10	8.7	-	116	66.9	54.3	12,400	5,650	*3.7*	<0.365	<0.010	0.0978 J	0.0978 J	-
	7/23/2014	353489 353494 353501 353498	6.17	10.6	10.7	0.52	114	62.3	49.3	11,100	5,250	*1.81 J*	2.47	<0.01	0.0844 J	0.0844 J	0.428
16A	2005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5/30/2006	164282 164283	6.3	10	9.0	-	132	85.9	59	16,700	4,220	*3.06*	0.452 J	<0.01	0.145 J	0.146 J	-
	9/19/2007	194233 194590 194603	6.5	14.9	10.4	-	190	148	116	31,700	9,060	*4.87*	<0.436	<0.01	0.113 J	0.114 J	-
	10/6/2008	217288 217358	6.89	14.8	13.3	-	114	75.9	56.4	15,400	4,360	*3.0*	0.558 J	<0.01	0.97 J	0.97 J	-
	9/22/2009	237826	6.49	-	13.1	-	103	63.4	43.9	12,400	3,130	<1.6	0.45 J	<0.01	0.078 J	0.078 J	-
	10/19/2010	265157 265162	6.33	12	11.3	-	103	56.1	45.7	12,900	3,280	<1.6	<0.264	<0.010	0.0874 J	0.0874 J	-
	10/25/2011	288989 289212 289219	6.6	12.7	8.6	-	87	57	50.6	14,200	3,660	3.7	<0.264	<0.010	0.141 J	0.141 J	-
	7/22/2014	353489 353494 353501 353498	5.47	10	14.4	10.2	126	71	57.3	15,800	4,350	*3.82 J*	0.877	<0.01	0.0847 J	0.0847 J	0.223 J
Downgradient Wells																	
WK-05-1-A	10/23/2005	148962 148972	6.6	0.263	8.7	-	200	51.5	79.7	19,700	7,390	*3.16*	<0.365	0.018 J	2.59	2.61	-
	5/31/2006	164282 164283	6.7	22	10.6	-	185	75.7	68.1	16,500	6,510	*4.09*	0.514 J	0.035 J	5.84	5.88	-
	9/18/2007	194233 194590 194603	6.85	13.8	13.5	-	180	79.7	74.7	17,800	7,350	7.74	0.645 J	0.033 J	4.69	4.72	-
	10/6/2008	217288 217358	6.79	25.6	12.6	-	198	66.5	81.1	19,600	7,800	*4.2*	<0.411	0.022 J	3.70	3.70	-
	9/21/2009	237826	6.5	-	13.8	-	199	81.3	69.0	16,100	6,980	5.19	<0.308	0.024	3.84	3.87	-
	10/18/2010	265157 265162	6.62	18.7	12.5	-	197	82.4	90.7	21,200	9,190	5.5	0.704 J	0.0309 J	4.38	4.41	-
	10/24/2011	288989 289212 289219	6.55	19.5	11.1	-	190	88.1	101.0	23,700	10,100	9.33	<0.337	0.0282 J	3.93	3.96	-
	7/23/2014	353489 353494 353501 353498	7	22.3	15.69	4.41	167	75.1	82.8	19,100	8,530	5.57	1.97	0.0128 J	1.87	1.89	0.73
WK-05-1-SB	10/23/2005	148962 148972	7.36	0.257	11.3	-	150	75.8	79	17,000	8,880	5.17	1.75	<0.01	0.363	0.366	-
	5/31/2006	164282 164283	6.8	24	11.7	-	195	83.9	80.4	17,300	9,030	*4.25*	0.408 J	<0.01	0.316	0.318	-
	9/18/2007	194233 194590 194603	7.03	14.9	12.3	-	196	88.4	83.1	18,100	9,200	*4.16*	0.684 J	<0.01	0.208	0.209	-
	10/6/2008	217288 217358	6.76	23.7	12.4	-	185	87.4	86.3	18,600	9,650	5.2	0.269 J	<0.01	0.19 J	0.19 J	-
	9/21/2009	237826	6.78	-	12.8	-	157	90.3	79	17,000	8,900	*4.29*	0.956 J	<0.01	0.172 J	0.172 J	-
	10/18/2010	265157 265162	6.55	19.4	12.7	-	208	89.5	102	22,200	11,300	6.44	0.725 J	<0.01	0.204 J	0.204 J	-
	10/24/2011	288989 289212 289219	6.61	20.1	12.1	-	184	92.8	109	23,200	12,300	6.78	0.453 J	<0.01	0.178 J	0.178 J	-
	7/23/2014	353489 353494 353501 353498	6.2	23.7	13.3	0.46	166	84.2	88.8	19,300	9,880	4.55 J	3.23	<0.01	0.162 J	0.162 J	0.811

Table 1: White King Groundwater Analytical Results
White King / Lucky Lass Mines Superfund Site

Well ID	Date Sampled	Lab Report	Field Measurements				Physical Tests			Metals (total)			Radionuclides (total)				Radionuclides (dissolved)
			pH (s.u.)	Conductivity (mS/m)	Temperature (°C)	Turbidity (NTU)	Total Dissolved Solids (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Calcium (ug/L)	Magnesium (ug/L)	Arsenic * (ug/L)	Ra-226 (pCi/L)	U-235 (ug/L)	U-238 (ug/L)	U-nat (ug/L)	Ra-226 (pCi/L)
WK-05-2-A	10/27/2005	149142 149144	6.59	1.32	8.0	-	1,100	161	633	148,000	63,700	*1.73*	0.65 J	0.135	19.3	19.4	-
	5/31/2006	164282 164283	6.4	0.15	7.3	-	1,100	163	688	161,000	69,500	<1.5	0.689 J	0.114	18.3	18.4	-
	9/18/2007	194233 194590 194604	6.54	86.7	11.0	-	1,120	59.2	676	162,000	66,200	<1.5	0.686 J	0.035 J	4.9	4.94	-
	10/6/2008	217288 217358	6.71	0.187	10.2	-	1,410	149	1010	243,000	96,500	<1.5	<0.454	0.031 J	4.7	4.7	-
	9/21/2009	237826	6.18	-	11.0	-	1,500	132	929	220,000	92,100	*2.03*	0.185 J	0.025 J	4.03	4.06	-
	10/18/2010	265157 265162	6.07	1.273	10.0	-	1,600	139	889	212,000	87,100	*<1.6*	1.58	0.0266 J	3.57	3.6	-
	10/24/2011	288989 289212 289219	6.06	1.45	10.1	-	1,740	133	1220	303,000	113,000	*8.5*	<0.232	0.0261 J	3.42	3.44	-
	7/23/2014	353489 353494 353501 353498	6.82	129.9	10.7	4.23	1,050	133	656	162,000	61,000	<1.7	0.425	0.0163 J	2.33	2.34	0.723
WK-05-2-SB	10/27/2005	149142 149144	7.22	0.277	7.2	-	180	127	642	151,000	64,500	*1.55*	0.39 J	0.138	19.4	19.6	-
	5/31/2006	164282 164283	6.6	31	9.1	-	216	138	105	22,000	12,200	*2.42*	<0.327	0.041 J	6.72	6.76	-
	9/18/2007	194233 194590 194605	7.05	19.1	9.8	-	210	138	92.9	19,600	10,700	*1.99*	<0.474	0.014 J	1.96	1.98	-
	10/6/2008	217288 217358	6.69	30.6	9.7	-	203	138	104	22,100	11,800	*4*	<0.371	0.012 J	2.00	2.00	-
	9/21/2009	237826	6.75	-	10.4	-	208	136	86.5	18,300	9,920	*2.25*	<0.259	0.011 J	1.66	1.67	-
	10/18/2010	265157 265162	6.54	21.4	10.4	-	212	138	92	19,100	10,700	*1.81*	<0.334	0.0107 J	1.53	1.54	-
	10/24/2011	288989 289212 289219	6.56	21.7	9.6	-	201	144	103	21,400	12,000	*2.31*	<0.281	<0.010 J	1.26	1.26	-
	7/23/2014	353489 353494 353501 353498	7.29	28.1	12.3	1.28	183	133	86.7	18,400	9,910	*2.71 J*	0.915	<0.01	1.06	1.06	1.49
WK-05-3-A	10/28/2005	149142 149144	7.26	1.47	8.1	-	1,190	240	673	148,000	73,900	<1.5	<0.489	0.049 J	7.19	7.24	-
	5/31/2006	164282 164283	6.5	0.19	8.2	-	1,380	205	676	155,000	70,300	*1.55*	0.613 J	0.03 J	4.78	4.81	-
	9/18/2007	194233 194590 194605	6.77	0.112	13.6	-	1,340	221	575	131,000	60,400	<1.5	<0.417	0.022 J	3.08	3.1	-
	10/6/2008	217288 217358	6.51	0.18	12.1	-	1,340	194	753	169,000	80,400	<1.5	0.557 J	0.018 J	2.70	2.80	-
	9/21/2009	237826	6.28	-	14.9	-	1,430	193	797	177,000	85,900	<1.6	<0.435	0.017 J	2.68	2.7	-
	10/18/2010	265157 265162	6.2	13.13	12.3	-	1,470	164	848	181,000	96,300	<1.6	0.31 J	0.0166 J	2.3	2.31	-
	10/24/2011	288989 289212 289219	6.13	13.54	11.8	-	1,560	140	983	218,000	106,000	8.5	0.566 J	0.0114 J	1.53	1.54	-
	7/23/2014	353489 353494 353501 353498	6.76	139.7	13.8	1.67	1,120	102	644	146,000	68,100	<1.7	<0.31	<0.01	0.527	0.527	0.371 J
WK-05-3-SB	10/23/2005	148962 148733 148734	7.29	0.785	9.2	-	506	109	306	70,800	31,400	6.51	<0.399	<0.01	1.29	1.3	-
	5/31/2006	164282 164283	6.6	91	10.5	-	10	116	333	74,100	35,800	7.3	<0.477	<0.01	1.03	1.04	-
	9/18/2007	194233 194590 194605	6.91	66.4	10.9	-	823	119	500	107,000	56,700	*4.32*	0.557 J	<0.01	0.776	0.782	-
	10/6/2008	217288 217358	6.7	0.127	10.5	-	888	125	572	123,000	64,500	*3*	<0.368	<0.01	1.00	1.00	-
	9/21/2009	237826	6.53	-	11.8	-	947	136	591	128,000	66,100	*3.53*	<0.333	<0.01	1.20	1.20	-
	10/18/2010	265157 265162	6.26	9.27	11.1	-	1,030	134	654	135,000	77,100	*2.36*	<0.289	0.0103 J	1.40	1.41	-
	10/24/2011	288989 289212 289219	6.34	9.62	10.8	-	1,090	139	723	154,000	82,100	*11.1*	0.486 J	0.0108 J	1.45	1.46	-
	7/23/2014	353489 353494 353501 353498	7.19	139.1	12.0	1.24	1,120	145	723	157,000	80,100	*3.13 J*	0.922	0.0138 J	1.98	1.99	0.243 J
WK-05-4-A	10/28/2005	149142 149144	6.84	1.89	7.7	-	1,510	243	939	201,000	106,000	20.9	0.469 J	0.059 J	8.53	8.59	-
	5/30/2006	164282 164283	6.6	0.18	8.8	-	1,420	233	848	186,000	93,200	*3.4*	<0.389	0.057 J	9.36	9.42	-
	9/19/2007	194233 194590 194605	6.9	0.13	8.5	-	210	226	806	170,000	92,900	*2.01*	<0.460	0.039 J	5.75	5.79	-
	10/6/2008	217288 217358	6.74	0.214	11.2	-	1,490	264	1,140	244,000	129,000	<1.5	0.594 J	0.057 J	8.7	8.8	-
	9/21/2009	237826	6.51	-	12.4	-	1,600	302	950	193,000	114,000	<1.6	<0.441	0.039 J	6.35	6.39	-
	10/18/2010	265157 265162	6.48	1.385	10.8	-	1,650	285	1,060	216,000	126,000	*3.85*	0.42 J	0.0536 J	7.75	7.8	-
	10/24/2011	288989 289212 289219	6.35	1.365	10.0	-	1,710	292	1,260	261,000	147,000	*8.5*	<0.357	0.0475 J	6.17	6.22	-
	7/23/2014	353489 353494 353501 353498	7.18	187	12.5	2.56	1,600	267	1,080	230,000	123,000	*<1.7*	0.866	0.0408 J	5.85	5.89	0.423
WK-05-4-AD	9/21/2009	237826	6.51	-	12.4	-	1,560	283	1,100	218,000	135,000	<1.6	0.45 J	0.048 J	7.50	7.55	-
	10/18/2010	265157 265162	6.48	1.385	10.8	-	1,680	286	1,110	224,000	134,000	*1.68*	<0.266	0.0516 J	7.73	7.78	-
	10/24/2011	288989 289212 289219	6.35	1.365	10.0	-	1,710	292	1,270	261,000	151,000	*8.67*	<0.266	0.0477 J	6.40	6.45	-
	7/23/2014	353489 353494 353501 353498	7.18	187	12.5	2.56	1,590	265	1,080	230,000	122,000	*<1.7*	0.308	0.041 J	6.03	6.08	0.829

Notes:
* Many arsenic values reported by laboratory affected by arsenic detected in blanks, as discussed in data validation report for the year analyzed.
- = Not Analyzed
J = Values are laboratory estimates, less than the practical quantitation limit (PQL).
< = analytical result was not detected above the method reporting limit shown
The remediation goal for arsenic is 33 ug/L.

Table 2: White King Groundwater Statistical Summary
White King / Lucky Lass Mines Superfund Site

Average Concentration	Total Metals/Total Radionuclides				
	Arsenic (ug/L)	Ra-226 (pCi/L)	U-235 (ug/L)	U-238 (ug/L)	U-nat (ug/L)
Upgradient					
2005 Average Concentration	2.3	0.40	<0.01	0.05	0.05
2006 Average Concentration	2.2	0.43	<0.01	0.13	0.13
2007 Average Concentration	4.5	1.75	<0.01	0.11	0.11
2008 Average Concentration	2.4	0.45	<0.01	0.41	0.41
2009 Average Concentration	1.9	0.50	<0.01	0.11	0.11
2010 Average Concentration	2.9	0.20	<0.01	0.12	0.12
2011 Average Concentration	3.4	0.53	0.02	0.32	0.10
2014 Average Concentration	2.9	1.58	<0.01	0.10	0.10
Statistically Significant Increase 2005 to 2014	No	No	No*	No	No
Statistically Significant Increase 2011 to 2014	No	Yes	No*	No	No
Downgradient					
2005 Average Concentration	5.8	0.64	0.06	8.4	8.4
2006 Average Concentration	3.5	0.49	0.04	6.6	6.7
2007 Average Concentration	3.3	0.56	0.02	3.1	3.1
2008 Average Concentration	3.0	0.43	0.02	3.3	3.3
2009 Average Concentration	2.9	0.42	0.02	2.8	2.9
2010 Average Concentration	4.0	0.59	0.02	3.0	3.0
2011 Average Concentration	7.9	0.30	0.02	2.6	2.6
2014 Average Concentration	3.0	1.2	0.02	2.0	2.0
Statistically Significant Increase 2005 to 2014	No	No	No	No	No
Statistically Significant Increase 2011 to 2014	No	Yes	No	No	No

Notes:
Averages used MDL (or MDA) for non-detects.
Where all values < MDL (or MDA), averages reported as "< MDL".
Wilcoxon Mann-Whitney test used to determine statistical significance.
* All historical data is non-detect; no Mann-Whitney analysis performed.

Table 3: Lucky Lass Groundwater Analytical Results
White King / Lucky Lass Mines Superfund Site

Well ID	Date Sampled	Lab Report	Field Measurements				Physical Tests			Metals (total)		Radionuclides (total)				Radionuclides (dissolved)
			pH (s.u.)	Conductivity (S/m)	Temperature (°C)	Turbidity (NTU)	Total Dissolved Solids (mg/L)	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Calcium (ug/L)	Magnesium (ug/L)	Ra-226 (pCi/L)	U-235 (ug/L)	U-238 (ug/L)	U-nat (ug/L)	Ra-226 (pCi/L)
Upgradient																
LL-05-1-SB	10/28/2005	149142 149144	8.14	0.589	6.9	-	329	261	200	54,300	15,500	0.322 J	0.053 J	7.56	7.61	-
	5/31/2006	164282 164283	7.10	52	9.6	-	379	379	265	73,900	19,700	0.544 J	0.035 J	5.7	5.74	-
	9/19/2007	194233 194590 194603	6.87	28.4	7.4	-	350	247	219	59,500	17,100	<0.354	<0.01	1.14	1.15	-
	10/6/2008	217288 217358	6.74	46.5	9.0	-	340	235	213	55,300	18,100	<0.340	<0.01	1.1	1.1	-
	9/21/2009	237826	6.74	NA	8.2	-	331	240	166	42,800	14,300	0.428 J	<0.01	0.974	0.974	-
	10/19/2010	265157 265162	6.67	28.8	8.2	-	329	212	181	47,500	15,100	0.439 J	<0.010	0.959	0.959	-
	10/25/2011	289212 288989 289219	6.47	27.4	7.2	-	327	201	170	43,800	14,800	0.406 J	<0.010	0.691	0.691	-
	7/23/2014	353489 353494 353501 353498	6.04	45.8	10.1	7.47	314	220	183	47,300	15,700	4.03	<0.01	0.926	0.926	<0.061
Downgradient																
6A-S	10/26/2005	148962 148972	6.60	0.295	7.6	-	201	129	67.1	18,300	5,190	<0.38	<0.01	<0.05	<0.05	-
	5/30/2006	164282 164283	6.50	19	8.1	-	176	102	55.7	15,200	4,310	<0.326	<0.01	0.108 J	0.109 J	-
	9/19/2007	194233 194590 194603	7.03	17.9	10.8	-	168	130	67.1	18,300	5,220	<0.281	<0.01	0.104 J	0.105 J	-
	10/6/2008	217288 217358	6.65	22	11.0	-	166	113	51.9	14,000	4,120	<0.364	<0.01	0.088 J	0.088 J	-
	9/22/2009	237826	6.68	NA	11.8	-	159	112	42.5	11,600	3,300	0.463 J	<0.01	0.106 J	0.106 J	-
	10/19/2010	265157 265162	6.79	1.6	11.0	-	174	113	44	12,000	3,400	<0.308	<0.010	0.146 J	0.146 J	-
	10/25/2011	288989 289212 289219	6.54	1.53	10.6	-	163	104	36.6	10,000	2,810	<0.341	<0.010	0.11 J	0.11 J	-
	7/22/2014	353489 353494 353501 353498	6.09	18.5	9.6	3.9	131	89.2	32.4	8,920	2,460	1	<0.01	0.076 J	0.076 J	0.494
18A-S	10/26/2005	149142 149144	7.21	0.237	8.3	-	150	106	70.9	16,500	7,210	<0.423	<0.01	0.376	0.379	-
	5/30/2006	164282 164283	6.50	19	7.0	-	176	98.2	65.9	15,200	6,800	<0.423	<0.01	0.396	0.398	-
	9/19/2007	194233 194590 194603	7.00	15.3	11.6	-	189	126	93.3	21,700	9,530	0.535 J	<0.01	0.60	0.605	-
	10/6/2008	217288 217358	6.69	22.3	11.1	-	193	130	102	23,800	10,400	<0.414	0.014 J	2.31	2.33	-
	9/22/2009	237826	6.73	NA	12.3	-	174	116	73.9	17,400	7,420	0.676 J	<0.01	0.657	0.657	-
	10/19/2010	265157 265162	6.59	1.58	10.7	-	169	115	87.2	20,400	8,800	0.218 J	<0.01	0.683	0.683	-
	10/25/2011	288989 289212 289219	6.61	1.57	9.1	-	161	104	79.4	18,300	8,160	0.386 J	<0.010	0.342	0.342	-
	7/22/2014	353489 353494 353501 353498	6.60	20.5	12.2	11.8	171	96	69	16,000	7,030	0.67	<0.01	0.327	0.327	<0.237
LL-05-1A	10/27/2005	149142 149145	6.87	0.122	6.7	-	120	55.6	33.1	8,230	3,040	<0.385	<0.01	0.12 J	0.121 J	
	5/30/2006	164282 164283	5.60	11	5.8	-	123	56.3	33.9	8,380	3,160	0.503 J	<0.01	0.091 J	0.092 J	-
	9/19/2007	194233 194590 194603	6.76	7.3	7.7	-	116	55.7	33.3	8,060	3,190	0.507 J	<0.01	0.087 J	0.088 J	-
	10/6/2008	217288 217358	6.74	11.7	8.4	-	114	56	31.3	7,760	2,890	<0.373	<0.01	0.078 J	0.078 J	-
	9/22/2009	237826	6.42	NA	8.2	-	119	56.5	31.3	7,690	2,950	0.362 J	<0.01	0.105 J	0.105 J	-
	10/19/2010	265157 265162	6.44	7.9	7.9	-	119	54.6	33.9	8,440	3,120	<0.317	<0.010	0.111 J	0.111 J	-
	10/25/2011	288989 289212 289219	6.13	8.2	6.1	-	107	56.6	35.4	8,780	3,260	<0.330	<0.010	0.067 J	0.067 J	-
	7/22/2014	353489 353494 353501 353498	5.57	9.1	8.6	0.86	123	52.3	34.1	8,540	3,100	0.788	<0.01	0.0848 J	0.0848 J	0.649

Notes:
Arsenic is not a constiuent of concern (COC) for Lucky Lass.
NA = Not Analyzed
J = Values are laboratory estimates, less than the practical quantitation limit (PQL).

Table 4: Lucky Lass Groundwater Statistical Summary
White King / Lucky Lass Mines Superfund Site

Average Concentrations	Total Radionuclides			
	Ra-226 (pCi/L)	U-235 (ug/L)	U-238 (ug/L)	U-nat (ug/L)
Upgradient				
2005 Concentration	0.322	0.053	7.56	7.61
2006 Concentration	0.554	0.035	5.7	5.74
2007 Concentration	<0.354	<0.01	1.14	1.15
2008 Concentration	<0.34	<0.01	1.1	1.1
2009 Concentration	0.43	<0.01	0.97	0.97
2010 Concentration	0.44	<0.01	0.96	0.96
2011 Concentration	0.406	<0.01	0.691	0.691
2014 Concentration	4.03	<0.01	0.926	0.926
Downgradient				
2005 Average Concentration	0.40	<0.01	0.18	0.18
2006 Average Concentration	0.42	<0.01	0.20	0.20
2007 Average Concentration	0.44	<0.01	0.26	0.27
2008 Average Concentration	0.38	0.011	0.83	0.83
2009 Average Concentration	0.50	<0.01	0.29	0.29
2010 Average Concentration	0.18	<0.01	0.31	0.31
2011 Average Concentration	0.24	0.01	0.17	0.17
2014 Average Concentration	0.82	<0.01	0.16	0.16
Statistically Significant Increase 2005 to 2014	Yes	No*	No	No
Statistically Significant Increase 2011 to 2014	Yes	No*	No	No

Notes:
Arsenic is not a constiuent of concern (COC) for Lucky Lass.
Averages used MDL (or MDA) for non-detects.
Where all values < MDL (or MDA), averages reported as "< MDL".
Mann-Whitney test used to determine statistical significance.
Upgradient year-to-year statistical comparison not possible with only one sampling point.
* All historical data is non-detect; no Mann-Whitney analysis performed.

Attachment 3: 2014 SITE INSPECTION CHECKLIST AND MEMORANDUM

TECHNICAL MEMORANDUM

Date: August 4, 2014 **Project No.:** 033-1398.002.610

To: White King/Lucky Lass Site Distribution

From: Doug Dunster & Frank Shuri

cc: Lee Holder

RE: WHITE KING/LUCKY LASS SITE ANNUAL SITE INSPECTION

This memorandum provides a summary of the annual site inspection conducted at the White King/Lucky Lass Site on July 31, 2014.

1.0 SITE INSPECTION PARTICIPANTS

Dave Einan, USEPA	Waiyen Yee, USFS
Bob Schwarz, ODEQ	Dale Engstrom, ODE
Jonathan Heyl, USFS	Dennis Scott, USFS
Frank Shuri, Golder	Doug Dunster, Golder
Barbara Nielsen, Western Nuclear	

2.0 INITIAL MEETING IN USFS LAKEVIEW OFFICE

We began with introductions since Jonathan Heyl and Dennis Scott had not participated in prior site inspections. Following introductions we discussed the following topics prior to departing for the site inspection:

- Bob Schwarz noted that he had been contacted by Chris Zinda, a Lakeview resident who had sent him an email message requesting improvements to signage at the site to notify of hazards and also requested installation of an interpretative exhibit. We discussed this, and didn't come to a conclusion on improvements to signage. Bob indicated he would forward the message from Zinda with the language for warning signs he had requested. We agreed there might be some value to installing an interpretative exhibit.

- Waiyen Yee mentioned that a reporter from the Klamath Falls Herald and News had visited the site last week.

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- Dennis Scott indicated the recent interest by the news media may be in part due to potential mining at Quartz Mountain about 20 miles west of Lakeview.

- We discussed the Tronox and Anadarko settlements – the settlements together are over $10 million for the White King / Lucky Lass Site. Dave Einan indicated it would still likely be next year before he knows how the funds are to be distributed. Barb Nielsen mentioned that Western Nuclear would like to see the funds used for future site costs and possibly exploring the idea of setting the funds up for the USFS, or another agency, to take over future monitoring and maintenance of the site and release Western Nuclear from further liability.

- Waiyen mentioned that there had been a request from the rancher with the grazing rights near the site to pump water from White King pond for his cattle, as flows in Augur Creek have dried up. The USFS declined the request.

- Doug Dunster mentioned that we had completed groundwater and White King pond pH monitoring last week. We didn't have the complete pH results yet, but the preliminary report was that the levels were still high enough that it didn't look like we would need to be adjusting pH soon.

- We discussed whether trees should be allowed to grow on the repository or periodically removed. No definitive consensus was reached.

- We discussed whether there was a need for future inspections that required the presence of the entire group. Dave suggested that maybe we could substitute with a conference call for most of the group. Barb indicated that Western Nuclear would continue annual inspections with Golder as long as Western Nuclear continues to have any responsibility at the site.

- We discussed the upcoming five-year review. It is due in May 2015. Golder will prepare a draft for EPA to use.

3.0 OBSERVATIONS OF SITE INSPECTION

An inspection checklist with accompanying photos is attached. Not all items on the checklist were evaluated during this site inspection.

We initially stopped along the road along the meadow near the middle constructed wetland. Vegetation in the meadow outside of the wetlands continues to do well even with the dry year so far in 2014.

The inspection continued from the site entrance gate to the White King Consolidated Stockpile. Someone had placed a non-USFS lock on the entrance gate, which Waiyen removed with bolt cutters. We walked

around the perimeter of the repository along the upper bench. No significant erosion was observed on the White King stockpile, with the exception of the minor rilling erosion in one area on the north side of the pile that had been observed during prior years. As was noted in prior reports this erosion does not appear to have increased since it was originally noted. Vegetation on the White King stockpile was noted to be doing very well with several different species of plants naturally recolonizing the area including pine trees and willows. The surface water drainage ditches on and around the Consolidated Stockpile do not show any signs of erosion or excessive sediment accumulation. From the top of the repository looking toward the meadow we observed what appeared to be some cattle that may have been within the fenced area from which they are supposed to be excluded. As we left the repository area we noted that one of the warning signs had been damaged and was lying on the ground.

We drove around White King Pond to the meadow near the east end of the pond, and walked to the upstream edge of the middle construction wetland. Vegetation in the meadow continues to re-establish and is thriving in places, sagebrush is becoming established on some of the higher ground in the meadow, and willows are spreading beyond the wetlands. Dale Engstrom indicated that he thought he saw a cow and calf in some trees on the south side of the meadow. When we reached that location the cows had left, but we saw evidence of fresh cow manure. We also observed some recent tracks from cows in a location near the upstream edge of the middle constructed wetland. We then observed some locations where fencing appeared to have been cut. There was no evidence that a large number of cattle had been in the area we observed and damage to vegetation was not evident.

We then drove to the Lucky Lass stockpile area. Vegetation on the stockpile and adjacent benches where cover was placed appears to be continuing to improve from prior years. Frank Shuri noted that the fence was broken and there was evidence of cattle intrusion at the toe of the repository. The minor erosion noted along the face of the stockpile in prior years (beginning in 2011) has stabilized. Surface water features appear to be functioning as designed and do not show any signs of erosion or significant sediment accumulation. Some vegetation and woody debris were noted in the stormwater ditch on the backside of the repository. Vegetation in the Lucky Lass Meadow is becoming re-established.

4.0 ACTION ITEMS

The following action item was identified at the conclusion of the site inspection:

- Golder will provide an annual site inspection summary on behalf of Western Nuclear and Fremont.
- Waiyen Yen will arrange to have the fencing repaired at both the White King and Lucky Lass areas and the damaged warning sign observed at the White King stockpile (as well as any others that are damaged or missing) replaced.
- Golder will prepare a draft five-year review report following receipt of the groundwater monitoring data.

White King - Lucky Lass Mines Super Fund Site
ANNUAL INSPECTION CHECKLIST

Item No.	Inspection Item	Inspector	Date	Photo. No.	Overall Condition **G/F/P**	Deterioration Observed **N/Y**	Severity **0/1/2**	Comments
White King Mine Site - Map 1								
1	White King Entrance Gate	See Note	7/31/2014		P	Y	1	Someone had placed a non-USFS lock on the gate. Waiyen Yee cut the lock off and a USFS lock will need to be replaced.
2	Wetland Gate from FR 3780							
	Gate, Lock & Sign							
3	Augur Creek in WK Meadow	See Note	7/31/2014	Photo 1	G	N	0	Augur Creek was dry in portions of the meadow due to drought
4	Augur Creek from White King Pond	See Note	7/31/2014	Photo 2	G	N	0	
5	Augur Creek to natural channel	See Note	7/31/2014	Photo 3	G	N	0	
6	Fencing	See Note	7/31/2014		P	Y	1	Fencing around the meadow and at the wetlands appeared to have been cut in a couple locations. Some cattle were observed in the meadow.
7	Wetland 5934 Spillway	See Note	7/31/2014		G	N	0	
8	Wetland 5931 Spillway							
9	Wetland 5927 Spillway							
10	Pond Spillway & Berm	See Note	7/31/2014	Photo 4	G	N	0	
White King Stockpile - Map 2								
1	Stockpile							
	Vegetation Cover	See Note	7/31/2014	Photo 5	G	N	0	Continues to improve every year
	Erosion	See Note	7/31/2014	Photo 6	G	N	0	Minor rilling present since 2011 has stabilized
	Settlement	See Note	7/31/2014		G	N	0	
2	Stormwater Ditches	See Note	7/31/2014	Photos 7, 8	G	N	0	Typical stormwater ditches
3	Fencing	See Note	7/31/2014	Photo 9	G	N	0	
4	Warning Signs	See Note	7/31/2014		P	Y	1	Warning next to the gate to the stockpile was on the ground and needs to be replaced
5	Gates	See Note	7/31/2014		G	N	0	
6	Monitoring Wells (12 Total)	J. Jones	7/23/2014		G	N	0	Wells were inspected and sampled by Golder on 7/22 and 7/23
Lucky Lass Mine Site - Map 3								
1	Lucky Lass Stockpile							
	Vegetation	See Note	7/31/2014	Photo 10	G	N	0	
	Erosion	See Note	7/31/2014	Photo 11	G	N	0	
	Settlement	See Note	7/31/2014		G	N	0	
2	Stormwater Ditches	See Note	7/31/2014	Photo 12	G	N	0	
3	Pond Outlet Channel	See Note	7/31/2014	Photo 13	G	N	0	
4	Fencing	See Note	7/31/2014	Photo 14	P	Y	1	Fencing needs repair at west side toe of stockpile.
5	Warning Signs	See Note	7/31/2014		G	N	0	
6	Gates & Locks	See Note	7/31/2014		G	N	0	
7	Monitoring Wells (6 total)	J. Jones	7/23/2014		G	N	0	Wells were inspected and sampled by Golder on 7/22 and 7/23

Notes/Comments

Inspectors during the 2014 site visit include: Waiyen Yee, Dale Engstrom, Dave Einan, Bob Schwarz, Dennis Scott, Jonathan Hyle, Frank Shuri, Barb Nielsen, Doug Dunster

G = Good **F** = Fair **P** = Poor **0** = none to little **1** = moderate **2** = high