FIFTH FIVE-YEAR REVIEW REPORT FOR THE TAR CREEK SUPERFUND SITE OTTAWA COUNTY, OKLAHOMA

September 2015

Prepared By:
Oklahoma Department of Environmental Quality
Oklahoma City, Oklahoma
For U.S. Environmental Protection Agency

FIFTH FIVE-YEAR REVIEW REPORT
Tar Creek Superfund Site
EPA ID No. OKD980629844
Ottawa County, Oklahoma

DETERMINATION

I have determined the following:

- The remedy at Operable Unit (OU) 1 is protective of human health and the environment with respect to groundwater. With respect to surface water, the remedy at OU1 does not meet applicable or relevant and appropriate requirements (ARAR), but those ARARs have been waived under 40 *Code of Federal Regulations* (CFR) § 300.430(1)(i)(C)(6).
- The remedy at OU2 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date at 2,940 residential yards and at areas frequented by children (high-access areas [HAA]) have adequately addressed in those yards and HAAs all exposure pathways that could result in unacceptable risks in these areas. There are approximately 19 residential yards that are currently scheduled to be sampled to determine if remediation will be required, and the U.S. Environmental Protection Agency (EPA) estimates that it will take one year to complete remediation if necessary for the 19 residential yards. The Oklahoma Department of Environmental Quality (ODEQ) will continue to evaluate additional residential properties and HAAs as they become known and assess the need for sampling and remediation under a Cooperative Agreement.
- The remedy at OU3 is protective of human health and the environment.
- The remedy at OU4 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks at: the smelter site; all rural residential yards; chat piles CP058, CP059, CP088, CP091, CP092, CP093, CP093-S1, CP093-S2, CP093-S3, CP093-S4, CP093-S5, CP094, CP094-S1, CP097, CP098, CP099, CP100, CP101, CP102, CP103, CP104, and CP105; at the following chat bases: CB011, CB044, CB046, CB048, CB049, CB053, CB143, CB146, CB147, CB156, CB157, CB216, CB219, CB221, CB222, CB223, CB230, CB231, CB232, CB233, CB234, CB235, CB236, CB237, CB238, CB239, CB240, CB241, CB241-S1, CB241-S2, CB242, and CB243; and the fine tailings deposit FT063. There are 83 chat piles, 213 chat

bases, and 62 fine tailings deposits that still must be addressed; EPA estimates that it will take 30 years to complete this work.

- EPA has begun the remedial investigation and feasibility study process at OU5; it has not completed a baseline human health risk assessment or an ecological risk assessment at this date. Consequently, no protectiveness determination can be made for OU5.

Pam Phillips, Acting

Carl E. Edlund, P.E.
Director, Superfund Division
U.S. Environmental Protection Agency, Region 6

9/29/15
Date

CONCURRENCES

FIFTH FIVE-YEAR REVIEW
Tar Creek Superfund Site
EPA ID# OKD980629844

By: _____ Date: 9/23/15
Robert Sullivan, Remedial Project Manager
Superfund Remedial Branch

By: _____ Date: 9/23/15
Blake Atkins, Chief
LA/NM/OK Section, Superfund Remedial Branch

By: _____ Date: 9/23/15
John Meyer, Associate Director
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James E. Costello, Practice Group Leader
Superfund Branch, Office of Regional Counsel

By: _____ Date: 09/23/15
Mark Peycke, Chief
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By: _____ Date: 9/29/15
Pam Phillips, Deputy Director
Superfund Division

RECOMMENDATIONS TO ADDRESS CURRENT SITE ISSUES

Issue	Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Actions: Affects Protectiveness (Y/N)	
					Current	Future
ODEQ research has found references to abandoned wells that need to be assessed to determine whether these wells should be plugged (this issue is carried over from the fourth five-year review). The OU1 record of decision (ROD) recognized that additional abandoned wells completed in the Roubidoux aquifer might be identified after completion of the OU1 remedial action (RA). The ROD stated that the need to plug additional wells would be evaluated as wells were identified. The existence of the wells, which were found by ODEQ's research in historical documents, has not been verified. Field work will be necessary to verify the existence of these wells and determine whether they are completed in the Roubidoux aquifer and in need of plugging.	ODEQ shall undertake actions to determine whether the wells that ODEQ found in the literature actually exist, and evaluate whether plugging these wells is necessary. Each well location found in the literature should be investigated, located, assessed, and, if necessary and technically feasible, plugged in accordance with the OU1 ROD. Since the last five-year review, ODEQ has plugged two wells.	ODEQ	EPA	9/30/2020	N	Y
While significant progress has been made, and 2,940 residential properties have been addressed, work remains before the OU2 RA is complete (this issue is carried over from the fourth five-year review). Residential yard remediation has been completed in the towns of Afton, Fairland, Narcissa, Peoria, Miami, Wyandotte, Picher, Quapaw, North Miami, Commerce and Cardin. The EPA continues to take calls from Ottawa County residents for residential yard remediation. The next five-year review should consider	ODEQ shall undertake remaining actions to complete the OU2 RA. Currently, EPA operates a telephone hotline for Ottawa County residents to request soil sampling. The next five-year review should consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site.	ODEQ	EPA	9/30/2020	N	Y

Issue	Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Actions: Affects Protectiveness (Y/N)	
					Current	Future
whether OU2 can be deleted from the National Priorities List (NPL). This deletion of OU2 from the NPL would be a partial deletion of the site.						
An assessment of the surface water and sediment data for Tar Creek should be completed to verify if a human health or ecological threat exists (this issue is carried over from the fourth five-year review). The third and fourth five-year reviews recommended that the current surface water and sediment data for Tar Creek be evaluated to verify that no threat to human health exists in Tar Creek.	The EPA should complete the evaluation of current surface water and sediment data for Tar Creek and other site streams to verify that no unacceptable risks to human health and the environment exist in Tar Creek and the other streams. Numerous studies of the Tar Creek Superfund Site have been conducted over the past decade. These studies have collected surface water and sediment data in Tar Creek and other site streams. EPA should perform a data gap analysis to determine whether gathering additional surface water and sediment data is necessary. If EPA finds that additional surface water and sediment data are needed, then it should collect enough additional data to determine whether there are risks to human health and the environment associated with exposure to surface water and sediments in streams of the Tar Creek Superfund Site.	EPA	EPA	9/30/2020	N	Y
The soil cover at the Hockerville subsidence area is settling, has been vandalized, and is in need of repair. The Hockerville subsidence area was filled with construction and demolition debris in 2012. During the site inspection, which was part of this five-year review, the soil cover was found to have visible damage that was due to general settling of the cap, and also due to vandalism in the form of tire tracks made by all-terrain vehicles.	ODEQ should repair the cover at the Hockerville subsidence area. Additional soil should be added to repair the soil cover, and the cover grade should be re-established. EPA cooperative agreements with ODEQ and the Quapaw Tribe include repository operations and maintenance.	ODEQ	EPA	9/30/2017	N	N

Issue	Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Actions: Affects Protectiveness (Y/N)	
					Current	Future
The Central Mill Repository, which was constructed to handle OU4-related source material, requires general maintenance. Engineering options for preventing water from seeps at the Central Mill Repository from entering Tar Creek should be evaluated.	ODEQ and the Quapaw Tribe should conduct general maintenance at the Central Mill Repository. EPA cooperative agreements with ODEQ and the Quapaw Tribe include repository operations and maintenance. The Central Mill Repository has received source material from distal properties as part of the OU4 RA since 2010; it is at approximately 20% capacity.	ODEQ/Quapaw Tribe	EPA	9/30/2017	N	N
ODEQ should evaluate the need to continue the groundwater monitoring program under state funded OU1 operations and maintenance (O&M). EPA intends to work toward completing RA activities at OU1 after well plugging is complete.	ODEQ should complete an evaluation of the need to continue the groundwater monitoring program under state-funded OU1 O&M, and revise the O&M plan if necessary.	ODEQ	ODEQ	9/30/2020	N	N
EPA has begun the OU4 soil amendment pilot studies based on the recommendation of the September 2014 RAO report.	EPA will develop the short and long term performance standards and metrics to measure and determine protectiveness.	EPA	EPA	9/30/2020	N	N

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LIST OF ABBREVIATIONS

μg/dL	micrograms per deciliter
μg/L	micrograms per liter
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	United States Agency for Toxic Substances and Disease Registry
ATV	all-terrain vehicle
BC	background concentration
BERA	baseline ecological risk assessment
BHHRA	baseline human health risk assessment
BIA	United States Bureau of Indian Affairs
BMP	best management practice
CAA	Clean Air Act
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMFTP	Central Mill Fine Tailings Pond
CMR	Central Mill Repository
COC	contaminant of concern
COPC	contaminant of potential concern
CY	cubic yard
CWA	Clean Water Act
DOI	United States Department of the Interior
EPA	United States Environmental Protection Agency
ERCS	Emergency Response Cleanup Services
ESD	Explanation of Significant Differences
FS	feasibility study
FTPS	fine tailings pilot study
HAA	high-access area
HI	hazard index
IAG	Inter-Agency Agreement
IC	institutional control
ITEC	Inter-Tribal Environmental Council
KDHE	Kansas Department of Health and Environment
LEAD	Local Environmental Action Demanded
LICRAT	Lead Impacted Communities Relocation Assistance Trust
LTM	long-term monitoring
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
MK	Morrison Knudson Corporation
MRTPS	Mayer Ranch Passive Treatment System
MW	monitor well
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPL	National Priorities List
OAC	Oklahoma Administrative Code
OCHD	Ottawa County Health Department

O&M	operations and maintenance
OCLPP	Oklahoma Childhood Lead Poisoning Prevention Program
ODEQ	Oklahoma Department of Environmental Quality
OSDH	Oklahoma State Department of Health
OSRTI	Office of Superfund Remediation and Technology Innovation
OSWER	Office of Solid Waste and Emergency Response
OU	operable unit
OWQS	Oklahoma Water Quality Standard
OWRB	Oklahoma Water Resources Board
ppm	part per million
PPP	pollution prevention plan
PRP	potentially responsible parties
QAPP	quality assurance project plan
QTEO	Quapaw Tribe Environmental Office
QTO	Quapaw Tribe of Oklahoma
QSA	Quapaw Service Authority
RA	remedial action
RAO	remedial action objective
RAR	remedial action report
RD	remedial design
RfC	reference concentration
RI	remedial investigation
RSL	Regional Screening Level
ROD	record of decision
RSKERL	Robert S. Kerr Environmental Research Laboratory
RWD	Rural Water District
SARA	Superfund Amendments and Reauthorization Act
SCPTS	Southeast Commerce Passive Treatment System
SDWA	Safe Drinking Water Act
SHPO	State Historic Preservation Officer
SI	site inspection
SLERA	Screening Level Ecological Risk Assessment
SMCL	secondary maximum contaminant level
START	Superfund Technical Assessment and Response Team
TBC	"To Be Considered" standards
TCAAM2	Tar Creek After Action Monitoring Part 2
TDS	total dissolved solids
TL	tolerance limit
TRA	Treece Relocation Assistance
TSMD	Tri-State Mining District
TZ	transition zone
UIC	underground injection control
USACE	United States Army Corps of Engineers
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WIC	U.S. Department of Agriculture's Women, Infant, and Children Program

EXECUTIVE SUMMARY

Under the statutory requirements of Section 121(c) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 United States Code (U.S.C.) § 9621(c), as amended by the Superfund Amendments and Reauthorization Act (SARA), P. L. 99-499, and under the implementing regulatory provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 *Code of Federal Regulations* (CFR) § 300.430(f)(4)(ii), five-year reviews are required for sites where hazardous substances remain on-site above levels that allow for unrestricted use and unrestricted exposure. In addition, United States Environmental Protection Agency (EPA) policy, as stated in the current five-year review guidance, provides that five-year reviews will be conducted at sites where a pre-SARA remedial action (RA) leaves hazardous substances on-site above concentration levels that allow for unrestricted use and unrestricted exposure. EPA policy also provides that five-year reviews will be conducted at pre- or post-SARA sites where the RA, once completed, will not leave hazardous substances on-site above concentration levels that allow for unrestricted use and unrestricted exposure but will require more than five years to complete. Previous five-year reviews of the site were performed as a matter of EPA policy, because the record of decision (ROD) for Operable Unit (OU) 1 was signed prior to the enactment of SARA, and the OU2 ROD stated that five-year reviews were not required. An Explanation of Significant Difference (ESD) to the OU2 ROD was signed in August 2007 requiring a five-year review of the OU2 remedy; subsequent five-year reviews of OU2 are, therefore, required by statute. The OU4 ROD was signed in February 2008. An ESD, explaining significant changes to the OU4 ROD, was signed in April 2010. The ESD explained that EPA was adding the residents of Treece, Kansas to the voluntary relocation of site residents described in the ROD. The first five-year review of the response actions for the site was completed in April 1994, the second five-year review was completed in April 2000, the third five-year review was completed in September 2005, and the fourth five-year review was completed in September 2010.

Pursuant to Section 121(c) of CERCLA, 42 U.S.C. § 9621(c), the fifth five-year review of the remedy in place at the Tar Creek Superfund Site ("site") located in Ottawa County, Oklahoma, and Treece, Kansas, was completed in September 2015. The results of the five-year review indicate that the response actions completed to date are currently protective of human health and the environment in the short term. Except as noted in previous five-year reviews regarding the ineffectiveness of the OU1 remedy designed to decrease mine water discharges to Tar Creek, the remedial response actions that have been performed appear to be functioning as designed, and the site has been maintained appropriately. No deficiencies were noted that impact the immediate protectiveness of the remedy, although several issues were identified that require further action to ensure the continued protectiveness of the remedy.

As a result of the complex nature of contamination associated with the site, remediation has been handled through various removal response actions and RAs. Five OUs have been designated at the site. The five OUs include: 1) OU1 (surface water/groundwater); 2) OU2 (residential properties and high-access areas [HAA]); 3) OU3 (Eagle-Picher Office Complex – abandoned mining chemicals); 4) OU4 (chat piles, other mine and mill waste, and smelter waste); and 5) OU5 (sediment and surface water).

During the fifth five-year review period, operation and maintenance (O&M) and groundwater monitoring activities continued at the site. Through the RA defined by the ROD for OU1, dikes

and diversion channels were constructed at three abandoned mine openings (identified as Muncie, Big John, and Admiralty) to prevent the inflow of surface water into the abandoned mine workings. The Oklahoma Department of Environmental Quality (ODEQ) has developed an updated O&M plan for the Admiralty site. The O&M plan covers annual inspections of the dikes and diversion channels, abnormal occurrence response plans, performance standards, and annual cost estimates of O&M. The mining was conducted in the Boone aquifer, which is contaminated with hazardous substances including lead, cadmium, and zinc. To get to the drinking water in the Roubidoux aquifer, which underlies the Boone, wells must pass through the Boone. The lack of integrity in the casings of certain abandoned wells completed in the Roubidoux aquifer may enable contaminants from the overlying Boone aquifer to migrate into the Roubidoux; consequently, the OU1 ROD calls for these wells to be plugged. EPA and ODEQ are plugging these wells to stop the migration of contamination to the Roubidoux.

The ODEQ, in cooperation with the EPA, continued to evaluate the plugging of abandoned wells through the Roubidoux groundwater monitoring program for OU1. The Roubidoux groundwater monitoring program was implemented to: determine whether the well plugging actions were effective at preventing contamination of the Roubidoux aquifer, and evaluate trends in water quality of the Roubidoux aquifer. The Roubidoux aquifer has been monitored for 21 years, and neither the EPA nor ODEQ have identified any public drinking water wells at the site that fail to meet the maximum contaminant levels (MCL) established under the Safe Drinking Water Act. However, data show that secondary (aesthetically based) maximum contaminant levels (SMCL) for the indicator parameters (sulfate and iron) were exceeded in four wells completed in the Roubidoux, indicating that there may be potential mine water impacts to the Roubidoux aquifer from the contaminated portion of the overlying Boone aquifer at these four wells (ODEQ, 2014).The drinking water supplied from the Roubidoux aquifer continues to meet the health-based primary drinking water standards (MCLs), and it is still considered safe as a drinking water supply.

In addition, the Mayer Ranch passive treatment system (MRPTS) has been successful in treating mine water discharges to Tar Creek, located in southeast Commerce. The ODEQ is partnering with the University of Oklahoma under an EPA grant to construct an additional passive treatment system to treat mine water discharges to the Tar Creek up-gradient of the MRPTS. Treating mine water discharge via passive treatment appears to be economically feasible. The fourth five-year review stated that passive treatment would be evaluated to determine its effectiveness at reducing the risks posed by mine water discharge at the site; it also stated that the fund balancing applicable or relevant and appropriate requirements (ARAR) waiver included in the OU1 ROD may no longer be valid and should be reevaluated. EPA is working toward completion of the RA for OU1. It will be appropriate for O&M to begin once the requirements of the NCP at 40 CFR 300.435(f) are met. ODEQ is evaluating options for continuing the Roubidoux groundwater monitoring program established under the OU1 ROD.

OU2 addresses residential yard and HAA contamination. OU2 remediation has been completed in Afton, Cardin, Commerce, Fairland, Miami, Narcissa, North Miami, Peoria, Picher, Quapaw, and Wyandotte. OU2 was addressed through two removal response actions and a RA. Through the removal response actions and RA, contaminated soils at 2,940 residential properties and HAAs have been remediated to the goal of 500 parts per million (ppm) for lead. The excavated soil was disposed of at permanent on-site repositories. In addition, the Oklahoma Childhood Lead Poisoning Prevention Program (OCLPPP), which is carried out by the Ottawa County Health Department in conjunction with the Oklahoma State Department of Health, has provided

childhood lead poisoning prevention education through community and tribal health fairs, Head Start and child care programs, and community organizations and events. The OU2 RA activities and the OCLPPP have worked together to create significant reductions in blood lead levels of children in Tar Creek and Ottawa County. In an April 2015 cooperative agreement, EPA and DEQ agreed that DEQ would undertake the OU2 RA, as described in the OU2 ROD, at the remaining OU2 properties. In September 2014, EPA held an OU2 milestone cleanup event, recognizing the reduction of blood lead levels in Ottawa County children.

OU3 involved a removal response action undertaken to clean up abandoned laboratory chemicals at the former Eagle-Picher Office Complex, located in Cardin, Oklahoma. This removal resulted in the disposal of 120 containers of laboratory chemicals. EPA determined that no further action was necessary to address OU3.

The OU4 ROD was signed in February 2008. OU4 addresses the generally undeveloped rural and urban areas of the site where mine and mill residues and smelter wastes have been placed, deposited, stored, disposed of, or otherwise come to be located as a result of mining, milling, smelting, or related operations. Under the OU4 ROD, the residents of the on-site towns of Picher, Cardin, and Hockerville were relocated because the areas have high concentrations of source materials (that is, the mill tailings known as chat and fines). As explained in a 2010 ESD, EPA expanded the relocation effort to include the residents of Treece, Kansas. EPA funded the Lead Impacted Communities Relocation Assistance Trust (LICRAT), through ODEQ. LICRAT purchased the Ottawa County properties at issue, and carried out the relocation effort with minimal EPA oversight. A similar trust, the Treece Relocation Assistance (TRA) was established in Kansas to address the Treece relocation. The LICRAT buyout began in 2009 and was completed in 2011. The Treece buyout was completed in 2012. A total of 628 residences, 74 businesses, and 125 renters were relocated from the impacted areas in Picher, Cardin, Hockerville, and Treece. The other OU4 RA activities began in 2009 and are ongoing. OU4 RA activities include the remediation of rural residential yards not included in OU2 RA, remediation of a former lead smelter, removal and disposal of chat piles and chat bases in distal areas, the construction of the Central Mill Repository from a former fine tailings pond, and a fine injection pilot study. Additionally, subsidence areas are being used as repositories for the permanent disposal of chat. Chat sales and reuse are also part of the OU4 selected remedy and are ongoing at the site. EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated transition zone (TZ) soil. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the Central Mill Repository (EPA, 2014d).

To date, as part of OU4, approximately 53 chat piles, chat bases, and fine tailings ponds (totaling approximately 1.6 million tons of chat, TZ soils, and fine tailings) have been remediated and 309,787 tons of chat have been sold (section 4.1, RA Performance). OU4 RA is ongoing.

A screening-level ecological risk assessment (SLERA) has been completed at the site. The SLERA documents that site contaminants in surface water, sediments, pore water, and soils within riparian and aquatic habitats pose a potential risk to ecological receptors at the site. The

SLERA also suggests cleanup goals for lead, cadmium, and zinc in site sediments. EPA is presently conducting a remedial investigation (RI) for OU5. No OU5 remedy has been selected.

For the fifth five-year review, a data review, a site inspection, interviews, and technology assessment have been performed. Based on the findings from these activities, it appears the remedies are functioning in a manner that is consistent with the decision documents. To ensure continued protectiveness, seven issues are identified, as described in the following paragraphs. These are:

1. ODEQ research has found references to abandoned wells that need to be assessed to determine whether these wells should be plugged (this issue is carried over from the fourth five-year review). The OU1 ROD recognized that additional abandoned wells completed in the Roubidoux aquifer might be identified after completion of the OU1 RA. The ROD stated that the need to plug additional wells would be evaluated as wells were identified. The existence of the wells, which were found by ODEQ's research in historical documents, has not been verified. Field work will be necessary to verify the existence of these wells and determine whether they are completed in the Roubidoux aquifer and in need of plugging.
2. While significant progress has been made, and 2,940 residential properties have been addressed, work remains before the OU2 RA is complete (this issue is carried over from the fourth five-year review). Residential yard remediation has been completed in the towns of Afton, Fairland, Narcissa, Peoria, Miami, Wyandotte, Picher, Quapaw, North Miami, Commerce, and Cardin. The EPA continues to take calls from Ottawa County residents for residential yard remediation. The next five-year review should consider whether OU2 can be deleted from the National Priorities List (NPL). This deletion of OU2 from the NPL would be a partial deletion of the site.
3. An assessment of the surface water and sediment data for Tar Creek should be completed to verify if a human health or ecological threat exists (this issue is carried over from the fourth five-year review). The third and fourth five-year reviews recommended that the current surface water and sediment data for Tar Creek be evaluated to verify that no threat to human health exists in Tar Creek.
4. The soil cover at the Hockerville subsidence area is settling, has been vandalized, and is in need of repair. The Hockerville subsidence area was filled with construction and demolition debris in 2012. During the site inspection, which was part of this five-year review, the soil cover was found to have visible damage resulting from general settling of the cap, and also due to vandalism in the form of tire tracks made by all-terrain vehicles.
5. The Central Mill Repository, which was constructed to handle OU4-related source material, requires general maintenance. Engineering options for preventing water from seeps from entering Tar Creek should be evaluated.
6. ODEQ should evaluate the need to continue the groundwater monitoring program under state-funded OU1 O&M. EPA intends to work toward completing RA activities at OU1 after well plugging is complete.
7. EPA has begun the OU4 soil amendment pilot studies based on the recommendation of the September 2014 RAO report.

To address the issues identified during the fifth five-year review, the following recommendations and follow-up actions have been identified for the site.

1. ODEQ shall undertake actions to determine whether the wells that ODEQ found in the literature actually exist, and evaluate whether plugging these wells is necessary. Each well location that ODEQ found in the literature should be investigated, located, assessed, and, if necessary and technically feasible, plugged in accordance with the OU1 ROD. Since the last five-year review, ODEQ has plugged two wells.
2. ODEQ shall undertake remaining actions to complete the OU2 RA. Currently, EPA operates a telephone hotline for Ottawa County residents to request soil sampling. The next five-year review should consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site.
3. The EPA should complete the evaluation of current surface water and sediment data for Tar Creek and other site streams to verify that no unacceptable risks to human health and the environment exist in Tar Creek and the other streams. Numerous studies of the Tar Creek Superfund Site have been conducted over the past decade. These studies have collected surface water and sediment data in Tar Creek and other site streams. EPA should perform a data gap analysis to determine whether gathering additional surface water and sediment data is necessary. If EPA finds that additional surface water and sediment data are needed, then it should collect enough additional data to determine whether there are risks to human health and the environment associated with exposure to surface water and sediments in streams of the Tar Creek Superfund Site.
4. ODEQ should repair the cover at the Hockerville subsidence area. Additional soil should be added to repair the soil cover, and the cover grade should be re-established. EPA cooperative agreements with ODEQ and the Quapaw Tribe include repository O&M.
5. ODEQ and the Quapaw Tribe should conduct general maintenance at the Central Mill Repository. EPA cooperative agreements with ODEQ and the Quapaw Tribe include repository O&M. The Central Mill Repository has received source material from distal properties as part of the OU4 RA since 2010; it is at approximately 20 percent capacity.
6. ODEQ should complete an evaluation of the need to continue the groundwater monitoring program under state funded OU1 O&M and revise the O&M plan if necessary.
7. EPA will develop the short and long term performance standards and metrics to measure and determine protectiveness.

Government Performance and Results Act Measures Review

As part of this five-year review, the Government Performance and Results Act Measures have also been reviewed. The measures and their status are as follows:

Environmental Indicators
Human Health: Long-term human health protection has not been achieved. Blood lead levels of Ottawa County children have been significantly reduced from approximately 35 percent to 3.7 percent above the new CDC blood lead reference level of 5 μg/dL.
Groundwater Migration: Groundwater migration is not under control. There is currently not sufficient data to make a determination.

Sitewide Ready for Anticipated Use
The site has not achieved Sitewide Ready for Anticipated Use status.

FIVE-YEAR REVIEW SUMMARY FORM

SITE IDENTIFICATION		
Site Name: Tar Creek Superfund Site		
EPA ID: OKD980629844		
Region: 6	**State:** OK	**City/County:** Ottawa County
SITE STATUS		
NPL Status: Final		
Remediation status: Under Construction; Operating		
Multiple OUs? Yes	**Has the site achieved construction completion?** Yes The OU1 dikes were completed in Dec. 1986	
Has site been put into reuse? Yes (partially)		
REVIEW STATUS		
Lead agency: State **If "Other Federal Agency" selected above, enter Agency name:** Click here to enter text.		
Author name: Oklahoma Department of Environmental Quality		
Review period: 9/2010 – 9/2015		
Date of site inspection: 1/14-16/2015		
Type of review: Statutory		
Review number: 5		
Triggering action: Other: Previous Five-Year Review Report		
Triggering action date (from WasteLAN): 9/29/2010 (date fourth five-year review report was signed)		
Due date *(five years after triggering action date)*: 9/29/2015		

Issues/Recommendations

OU(s) without Issues/Recommendations Identified in the Five-Year Review:
OU3

Issues and Recommendations Identified in the Five-Year Review:

OU(s): OU1	Issue Category: Remedy Performance			
	Issue: ODEQ research has found references to abandoned wells that need to be assessed to determine whether these wells should be plugged (this issue is carried over from the fourth five-year review). The OU1 ROD recognized that additional abandoned wells completed in the Roubidoux aquifer might be identified after completion of the OU1 RA. The ROD stated that the need to plug additional wells would be evaluated as wells were identified. The existence of the wells, which were found by ODEQ's research in historical documents, has not been verified. Field work will be necessary to verify the existence of these wells and determine whether they are completed in the Roubidoux aquifer and are in need of plugging.			
	Recommendation: ODEQ shall undertake actions to determine whether the wells found in the literature actually exist, and evaluate whether plugging these wells is necessary. Each well location found in the literature should be investigated, located, assessed, and, if necessary and technically feasible, plugged in accordance with the OU1 ROD. Since the last five-year review, ODEQ has plugged two wells.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	9/30/2020

OU(s): OU2	Issue Category: Remedy Performance			
	Issue: While significant progress has been made, and 2,940 residential properties have been addressed, work remains before the OU2 RA is complete (this issue is carried over from the fourth five-year review). Residential yard remediation has been completed in the towns of Afton, Fairland, Narcissa, Peoria, Miami, Wyandotte, Picher, Quapaw, North Miami, Commerce, and Cardin. The EPA continues to take calls from Ottawa County residents for residential yard remediation. The next five-year review should consider whether OU2 can be deleted from the National Priorities List (NPL). This deletion of OU2 from the NPL would be a partial deletion of the site.			
	Recommendation: ODEQ shall undertake remaining actions to complete the OU2 RA. Currently, EPA operates a telephone hotline for Ottawa County residents to request soil sampling. The next five-year review should consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	9/30/2020

OU(s): OU1/OU5	Issue Category: Changed Site Conditions			
	Issue: An assessment of the surface water and sediment data for Tar Creek should be completed to verify if a human health or ecological threat exists (this issue is carried over from the fourth five-year review). The third and fourth five-year reviews recommended that the current surface water and sediment data for Tar Creek be evaluated to verify that no threat to human health exists in Tar Creek.			
	Recommendation: The EPA should complete the evaluation of current surface water and sediment data for Tar Creek and other site streams to verify that no unacceptable risks to human health and the environment exist in Tar Creek and the other streams. Numerous studies of the Tar Creek Superfund Site have been conducted over the past decade. These studies have collected surface water and sediment data in Tar Creek and other site streams. EPA should perform a data gap analysis to determine whether gathering additional surface water and sediment data is necessary. If EPA finds that additional surface water and sediment data are needed, then it should collect enough additional data to determine whether there are risks to human health and the environment associated with exposure to surface water and sediments in streams of the Tar Creek Superfund Site.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	EPA	EPA	9/30/2020

OU(s): OU4	Issue Category: Operations and Maintenance			
	Issue: The soil cover at the Hockerville subsidence area is settling, has been vandalized, and is in need of repair. The Hockerville subsidence area was filled with construction and demolition debris in 2012. During the site inspection, which was part of this five-year review, the soil cover was found to have visible damage that was due to general settling of the cap, and also due to vandalism in the form of tire tracks made by all-terrain vehicles.			
	Recommendation: ODEQ should repair the cover at the Hockerville subsidence area. Additional soil should be added to repair the soil cover and the cover grade should be re-established. EPA cooperative agreements with ODEQ and the Quapaw Tribe include repository operations and maintenance.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	State	EPA	9/30/2017

OU(s): OU4	Issue Category: Operations and Maintenance			
	Issue: The Central Mill Repository, which was constructed to handle OU4 related source material, requires general maintenance. Engineering options for preventing water from seeps from entering Tar Creek should be evaluated.			
	Recommendation: ODEQ and the Quapaw Tribe should conduct general maintenance at the Central Mill Repository. EPA cooperative agreements with ODEQ and the Quapaw Tribe include repository O&M. The Central Mill Repository has received source material from distal properties as part of the OU4 RA since 2010; it is at approximately 20% capacity.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	Yes	State	EPA	9/30/2017

OU(s): OU1	Issue Category: Monitoring			
	Issue: ODEQ should evaluate the need to continue the groundwater monitoring program under state funded OU1 O&M. EPA intends to work toward completing RA activities at OU1 after well plugging is complete.			
	Recommendation: ODEQ should complete an evaluation of the need to continue the groundwater monitoring program under state-funded OU1 O&M and revise the O&M plan if necessary.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	State	State	9/30/2020

OU(s): OU4	Issue Category: Remedy Performance			
	Issue: EPA has begun the OU4 soil amendment pilot studies based on the recommendation of the September 2014 RAO report.			
	Recommendation: EPA will develop short and long term performance standards and metrics to measure and determine protectiveness.			
Affect Current Protectiveness	**Affect Future Protectiveness**	**Implementing Party**	**Oversight Party**	**Milestone Date**
No	No	EPA	EPA	9/30/2020

Sitewide Protectiveness Statement	
Protectiveness Determination: Short-term Protective	*Addendum Due Date (if applicable):* *Not applicable*

Protectiveness Statement:

- The remedy at OU1 is protective of human health and the environment with respect to groundwater. With respect to surface water, the remedy at OU1 does not meet ARARs, but those ARARs have been waived under 40 CFR § 300.430(1)(i)(C)(6).
- The remedy at OU2 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date at residential yards and at areas frequented by children (HAAs) have adequately addressed all exposure pathways that could result in unacceptable risks in these areas. There are approximately 19 residential yards that are currently scheduled to be sampled to determine if remediation will be required; EPA estimates that it will take one year to complete remediation if necessary for the residential yards. ODEQ will continue to evaluate additional residential properties and HAAs as they become known, and will assess the need for sampling and remediation under a cooperative agreement.
- The remedy at OU3 is protective of human health and the environment.
- The remedy at OU4 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks at: the smelter site, all rural residential yards, chat piles CP058, CP059, CP088, CP091, CP092, CP093, CP093-S1, CP093-S2, CP093-S3, CP093-S4, CP093-S5, CP094, CP094-S1, CP097, CP098, CP099, CP100, CP101, CP102, CP103, CP104, and CP105; at the following chat bases: CB011, CB044, CB046, CB048, CB049, CB053, CB143, CB146, CB147, CB156, CB157, CB216, CB219, CB221, CB222, CB223, CB230, CB231, CB232, CB233, CB234, CB235, CB236, CB237, CB238, CB239, CB240, CB241, CB241-S1, CB241-S2, CB242, and CB243; and the fine tailings deposit FT063. There are 83 chat piles, 213 chat bases, and 62 fine tailings deposits that still must be addressed; EPA estimates that it will take 30 years to complete this work.
- EPA has begun the remedial investigation and feasibility study process at OU5 and has not completed a baseline human health risk assessment or an ecological risk assessment at this date; consequently, no protectiveness determination can be made.

Well plugging called for in the selected OU1 remedy addressed the primary route of potential human exposure by protecting the Roubidoux aquifer, and, in this way, preventing the possibility that

hazardous substances would be ingested in drinking water drawn from the Roubidoux. EPA/ODEQ has plugged and abandoned 85 wells as part of the OU1 remedy. Sampling data indicate that the Roubidoux aquifer continues to meet all health-based primary drinking water standards. Exceedances of secondary drinking water standards for iron and sulfate at four wells have been identified. Secondary drinking water standards are aesthetically based values. The previous five-year review established that some of the exposure assumptions and the potential risks posed to human health and the environment for surface water and sediments at the site that were described in the OU1 ROD are no longer valid (EPA, 2010c). Fish tissue data collected by ODEQ demonstrate that risks to human health exist through consumption of fish caught from Tar Creek, the Spring and Neosho Rivers, and Grand Lake (DEQ, 2008b). Metals contained within site sediments are biologically available and pose risks to ecological receptors (MacDonald, 2009). In Tar Creek, Lytle Creek, and Elm Creek at the Tar Creek Site, EPA found that cadmium, lead, and zinc concentrations in surface water samples exceed the OWQS chronic toxicity standard; zinc concentrations also exceed the acute toxicity standard. With the exceptions noted above for OU1, the Roubidoux groundwater monitoring program, and O&M activities for the Tar Creek Superfund Site are all protective for the short and long term.

The remedy at OU2 is expected to be protective of human health and the environment in all areas where remediation has been completed. Over 2,940 properties have been remediated during the OU2 RA and during the removal actions that preceded the RA. Remaining properties in need of remediation are being evaluated. The RA for OU2 is ongoing and is scheduled to be completed by the next five-year review. Human health and the environment are being protected by the remedy for OU2.

The action implemented during the removal action for OU3 is protective of human health and the environment. The laboratory chemicals left at the former Eagle-Picher Office Complex were removed from the site and properly disposed.

The RA for OU4 is currently ongoing. The remedy at OU4 is expected to be protective of human health and the environment upon completion. In the interim, exposure pathways that could result in unacceptable risks are being controlled. The LICRAT voluntary relocation in Picher, Cardin, and Hockerville, Oklahoma, was completed in 2011. The voluntary relocation in Treece, Kansas, was completed in 2012, under a Kansas trust—the Treece Relocation Assistance (TRA). Chat sales continue at the site. Appendix H of the OWQS 785 OAC 45 was amended to limit the use of groundwater from the Boone aquifer. RAs on three rural residential properties, a smelter site, and multiple distal groups (which include chat piles and chat bases) have been completed. EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments that are high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated TZ soil. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the Central Mill Repository (EPA, 2014d).

EPA is presently conducting a RI for OU5. No OU5 remedy has been selected.

Fifth Five-Year Review Report
for
Tar Creek Superfund Site

The United States Environmental Protection Agency (EPA) has conducted the fifth five-year review of the remedial actions (RA) being implemented at the Tar Creek Superfund Site (site), for the period between September 2010 (when the fourth five-year review was completed) to September 2015. The purpose of a five-year review is to evaluate the implementation and performance of a remedy in order to determine if the remedy is or will be protective of human health and the environment. Protectiveness is generally defined in the National Contingency Plan (NCP) by the risk range and the hazard index (HI). Evaluation of the remedy and the determination of protectiveness should be based on and sufficiently supported by data and observations. This fifth five-year review report documents the results of the review for the site, conducted in accordance with the EPA guidance on five-year reviews. EPA guidance on conducting five-year reviews is provided by the Office of Solid Waste and Emergency Response (OSWER) Directive 9355.7-03B-P, *Comprehensive Five-Year Review Guidance* (EPA, 2001).

The site is primarily located in Ottawa County, Oklahoma, in the far northeastern corner of the state (*see* Figure 1). It consists of five Operable Units (OU): OU1 (surface water/groundwater); OU2 (residential properties and high-access areas [HAA]); OU3 (Eagle-Picher Office Complex – abandoned mining chemicals); OU4 (chat piles, other mine and mill waste, and smelter waste); and OU5 (sediment and surface water). As explained in an Explanation of Significant Differences (ESD) issued by EPA in April 2010, OU4 was expanded to include Treece, Kansas. The ESD explains that, consistent with the OU4 record of decision (ROD), EPA decided to complete a voluntary relocation of residents in Treece, Kansas as part of the OU4 RA (EPA, 2010a).

1.0 Introduction

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code (USC) § 9601 *et seq.* and the NCP, 40 *Code of Federal Regulations* (CFR) 300 *et seq.*, call for five-year reviews of certain CERCLA RAs. The statutory requirement to conduct a five-year review was added to CERCLA as part of the Superfund Amendments and Reauthorization Act of 1986 (SARA), P.L. 99-499. EPA may also conduct five-year reviews as a matter of policy for sites not addressed specifically by the statutory requirement. EPA classifies each five-year review as either "statutory" or "policy" depending on whether it is being required by statute or is being conducted as a matter of policy. The fifth five-year review for the site is a statutory review.

As specified by CERCLA and the NCP, statutory reviews are required for sites where, after RAs are complete, hazardous substances, pollutants, or contaminants will remain on site at levels that will not allow for unrestricted use or unrestricted exposure. Statutory reviews are required for such sites if the ROD was signed on or after the effective date of SARA. CERCLA § 121(c), as amended, 42 USC § 9621(c), 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.

The implementing provisions of the NCP, as set forth in the CFR, state at 40 CFR § 300.430(f)(4)(ii):

> 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.

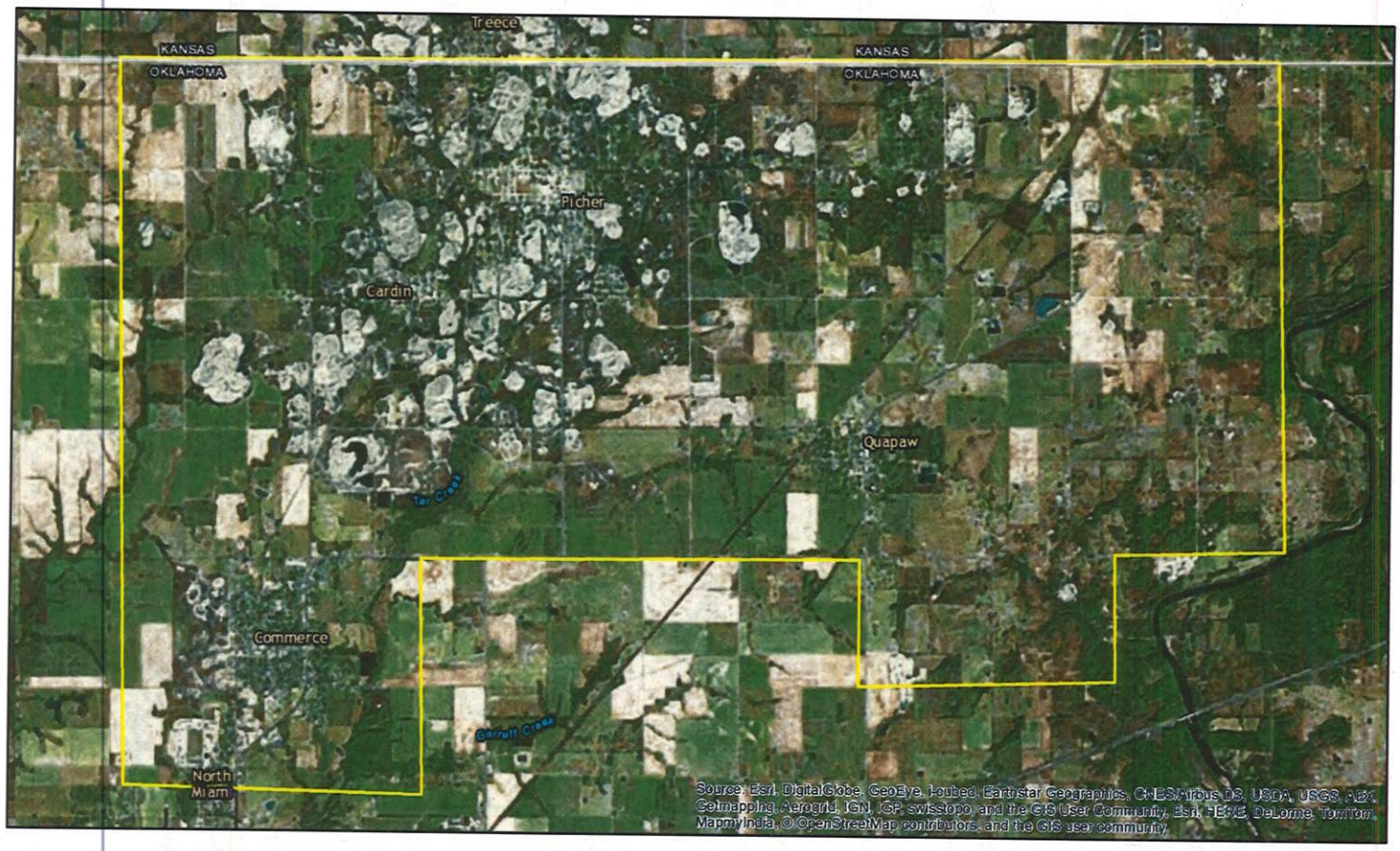
Five-year reviews generally should be conducted as a matter of policy for the following types of actions:

- A pre- or post-SARA remedial action that, upon completion, will not leave hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure, but requires five years or more to complete;
- A pre-SARA remedial action that leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure; or
- A removal-only site on the National Priorities List (NPL) where a removal action leaves hazardous substances, pollutants, or contaminants on site above levels that allow for unlimited use and unrestricted exposure and where no remedial action has or will take place (EPA, 2001).

This fifth five-year review for the site is required by statute. EPA signed an ESD for the OU2 ROD in August 2007 that requires a statutory five-year review of the OU2 remedy (EPA, 2007). The OU4 ROD, signed in February 2007, explicitly states that a statutory review will be conducted. Previous five-year reviews for the site were conducted as a matter of EPA policy because the ROD for OU1 was signed prior to the effective date of SARA, and the original OU2 ROD stipulated that a five-year review was not required. Although RODs for OU3 and OU5 have not been completed, actions associated with OU3 and OU5 are also described in this five-year review report as components of the site.

This is the fifth five-year review for the site. The first five-year review was completed in April 1994; the second five-year review was completed in April 2000; the third five-year review was completed in September 2005; and the fourth five-year review was completed in September 2010. The triggering action for this statutory review is the signed date of the fourth five-year review report, which was September 29, 2010.

Figure 1 Tar Creek Superfund Site Boundary



We make every effort to provide and maintain accurate, complete, usable, and timely information. However, some data and information on this map may be preliminary or out of date and is provided with the understanding that it is not guaranteed to be correct or complete. Conclusions drawn from, or actions undertaken on the basis of, such data and information are the sole responsibility of the user.

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Legend

Superfund Area

Figure 1:
Tar Creek Superfund
Site Boundary

N W E S

Map Created by Brent Stone
on 5/12/2015

0 1 2 4 Miles

2.0 Progress Since the Last Five-Year Review

The fourth five-year review of the site was completed in September 2010. The fourth five-year review report concluded that the RAs implemented at the site were protective of human health and the environment. The fourth five-year review report stated that for OU1, the Roubidoux aquifer continued to meet all health-based primary drinking water standards and is still considered safe for use as a drinking water supply, but noted that the data collected through the sampling program indicated that the Roubidoux aquifer is impacted locally by acid mine water from the Boone aquifer. In addition, the report stated that wells identified as being completed through the Boone into the Roubidoux need to be plugged. The report also said that the operations and maintenance (O&M) plan for the diversion and diking at the Admiralty Mine Site needed to be updated (EPA, 2010c).

For OU2, the fourth Five-Year Review Report stated that the OU2 remedy being implemented is protective of human health and the environment in the remediated areas and this is demonstrated by blood lead data collected from children at the site, with only 2.8 percent of children between the ages of one and five residing at the site at that time having a blood lead level that exceeds 10 micrograms per deciliter (μg/dL). The RA for OU2 is still in progress but in 2010 2,295 properties had been remediated, and others were still to be identified and remediated (EPA, 2010c). In addition, the report stated that final closure of the two soil repositories should be performed in accordance with the OU2 ROD. The report also said that the institutional controls (ICs) called for in the OU2 ROD should be filed in the property records (EPA, 2010c).

For OU4, the fourth five-year review report stated that RA activities began in 2009 and the voluntary relocation being performed under the Lead Impacted Communities Relocation Assistance Trust (LICRAT) was in progress. The voluntary relocation removed most residents from the central core of the mining area and reduced the potential for exposure to site-related contamination. In addition, the report stated that ICs still needed to be filed. The purposes of the ICs are to restrict use of properties where fine tailings were covered, where on-site repositories were constructed, and where properties were acquired by LICRAT. Also, the fourth five-year review report pointed out that the OU4 ROD required an IC to restrict future uses of groundwater from the portion of the Boone aquifer where the mine workings were located. Under the ROD, the IC restricting groundwater was to be implemented under the Oklahoma Water Quality Standard (OWQS) Title 785, Chapter 45, Appendix H (EPA, 2010c).

The fourth five-year review included six issues and recommendations. This report summarizes each recommendation and its current status in Table 1.

Table 1: Actions Taken Since Fourth Five-Year Review

Number	Issue from Fourth Five-Year Review	Fourth Five-Year Review Recommendations/Follow-Up Actions	Party Responsible	Action Taken	Date of Action
1	No O&M plan exists for the dike and diversion channel for the Admiralty Mine Site (this issue is carried over from the third five-year review). The ODEQ's O&M plan for the dike and diversion channel constructed at the Admiralty Mine Site as part of the OU1 remedy was written in 1987 and facts have arisen that make it outdated. The ODEQ is responsible for maintaining the dike and diversion channel at the Admiralty Mine Site, as part of ODEQ's O&M for OU1. The dike at the Admiralty site requires some maintenance to repair damage noted during the site inspection and mowing.	Develop an O&M Plan for the dike and diversion channel at the Admiralty Mine Site. The ODEQ indicated in the third and fourth five-year reviews that the last O&M plan developed for the diversion dike and channel at the Admiralty Mine Site was prepared in 1987 and new facts may have made it outdated. The O&M plan prepared for the Admiralty Mine Site should be updated. Maintenance needs to be performed to the dike at the Admiralty site. The maintenance items identified during the fourth five-year review site inspection should be performed. ODEQ should provide to EPA a schedule that indicates when the O&M plan will be revised and when the necessary maintenance will be completed. This follow-up action should be completed no later than September 2012.	ODEQ	ODEQ developed an updated O&M plan for the Admiralty Mine Site. The O&M plan covers annual inspections items, abnormal occurrence response plans, performance standards, and annual cost estimates of O&M (ODEQ, 2012a). The annual O&M inspections have identified minor issues that have been rectified by the landowner. The reports state that overall the dike and diversion channel are functioning as intended (ODEQ, 2015d and ODEQ, 2015e).	November 2, 2012
2	A determination regarding the effectiveness of the well plugging program, which was intended to prevent mine water infiltration into the Roubidoux aquifer has not been completed (this issue is carried over from the third five-year review). The Roubidoux Groundwater Monitoring Program has collected data for a period of over 20 years since the RA to plug abandoned Roubidoux	Complete the evaluation of the effectiveness of the well plugging program that is intended to prevent mine water infiltration into the Roubidoux aquifer. It would be beneficial to future long-term decision making if, under the Roubidoux Groundwater Monitoring Program, all the analytical results available from the Roubidoux aquifer were compiled into a single database. The database could then be used to perform statistical and trend analyses on the data to assess long-term changes to the water quality of the Roubidoux	ODEQ	The Roubidoux Groundwater Monitoring Program has included annual sampling events conducted by ODEQ from March 2010 through October 2013. All the analytical results from these sampling events and historical data stretching back to 1997 have been compiled into a single table as an attachment to each report. This table has been used to perform limited statistical and trend analyses on the data	December 2014

Number	Issue from Fourth Five-Year Review	Fourth Five-Year Review Recommendations/Follow-Up Actions	Party Responsible	Action Taken	Date of Action
	wells was completed. In the past, it was believed that the Roubidoux aquifer was being impacted by the mine water; however, only certain indicator parameters were found, and subsequent data collection over twenty years has not found any more reason to believe that the mine water is degrading the Roubidoux. It should be noted that neither EPA nor ODEQ have identified any public drinking water wells at the site that fail to meet the health-based primary drinking water standards (Maximum Contaminant Levels [MCL]) established under the Safe Drinking Water Act (SDWA), and the drinking water supplied from the Roubidoux aquifer at the site is safe for all uses. Nonetheless, all available information indicates that the primary mechanism for mine water to enter the Roubidoux aquifer is infiltration through unplugged abandoned wells or infiltration through wells that have faulty well casings and/or poor seals across the Boone Formation; consequently, it is essential that plugging of abandoned wells continue.	aquifer. If additional data are required to complete the evaluation, then such data should be collected. Recommendations should then be developed regarding the need for continued monitoring and/or additional actions to protect the Roubidoux aquifer if necessary. The evaluation of the effectiveness of the well plugging program should be completed by September 2014 (prior to the next five-year review).		for certain wells in order to assess the long-term changes to the water quality of those particular Roubidoux wells. Each report has listed recommendations with the final report recommending continued monitoring of the Roubidoux aquifer because the mine pool is a potential source of contamination, and because iron and sulfate concentration trends for the Picher wells are increasing (ODEQ, 2014a).	

Number	Issue from Fourth Five-Year Review	Fourth Five-Year Review Recommendations/Follow-Up Actions	Party Responsible	Action Taken	Date of Action
3	ODEQ research has found references to 19 abandoned wells that need to be assessed for plugging (this issue is carried over from the third five-year review). The OU1 ROD recognized that additional abandoned wells completed in the Roubidoux aquifer might be identified after completion of the OU1 RA. The ROD stated that the need to plug additional wells would be evaluated as wells were identified. The existence of the wells found by ODEQ's research in historical records are found, ODEQ should determine whether the well is completed in the Roubidoux aquifer, and ODEQ should plug those abandoned wells completed in the Roubidoux aquifer where it is found to be technically feasible to do so. EPA will assist ODEQ to plug as many wells as can be located. This follow-up action should be completed by September 2012.	Undertake fieldwork to determine whether the 19 wells that ODEQ found in literature actually exist, and evaluate whether plugging any wells found is warranted or feasible. Each well location the ODEQ found in literature should be investigated, located, assessed, and if necessary and technically feasible, plugged in accordance with the OU1 ROD. As additional potential abandoned well locations are found, field work should be undertaken to locate any wells that exist. If any wells are found, ODEQ should determine whether the well is completed in the Roubidoux aquifer, and ODEQ should plug those abandoned wells completed in the Roubidoux aquifer where it is found to be technically feasible to do so. EPA will assist ODEQ to plug as many wells as can be located. This follow-up action should be completed by September 2012.	ODEQ	The ODEQ continues to identify and plug wells. Since the last five year review, ODEQ has plugged two wells (Tulsa Mine and Powerhouse). ODEQ also identified three additional wells, two of which were identified through Sanborn maps (Birthday and Vantage) and one that was uncovered during OU4 RA activities (Netta-White). In addition, two of the 19 wells are identified as public water supplies (Quapaw#2 and Quapaw#5) and are part of the Roubidoux Groundwater Monitoring Program. However, these two wells show impacts from the Boone and should be plugged at earliest opportunity. Nine of the 17 wells are on restricted property and EPA and ODEQ may require assistance from local tribal authorities to access and evaluate the nine wells. Eight wells are in the process of being investigated and evaluated for plugging (ODEQ, 2015a).	Ongoing
4	Remaining actions should be taken to complete the OU2 RA. These actions include, but may not be limited to: 1)assessment of chat in driveways and alleyways in areas of Ottawa County,	Remaining actions should be taken to complete the OU2 RA. These actions include, but may not be limited to: 1)assessment of chat in driveways and alleyways in areas of Ottawa County, including Miami, that are outside of the mining area (approximately 450 in	ODEQ	The fourth five year review report recommended that the remaining OU2 RA be completed. This included the assessment of chat in driveways and alleyways in areas of Ottawa County that are outside	Ongoing

Number	Issue from Fourth Five-Year Review	Fourth Five-Year Review Recommendations/Follow-Up Actions	Party Responsible	Action Taken	Date of Action
	including Miami, that are outside of the mining area (approximately 450 in Miami and 50 in other areas of Ottawa County); 2) assessment of the footprints of homes demolished as part of the voluntary relocation (approximately 450 properties); 3) remediation of residential properties located outside of the boundary of the OU4 voluntary buyout, where access was previously denied, and where soil lead concentrations exceed the remediation goal established in the OU2 ROD (approximately 140 properties). Owners of residential properties where access was previously denied will be offered a final opportunity to have their property re-sampled and remediated if necessary. The next five-year review should also consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site. This follow-up action should be completed by September 2015.	Miami and 50 in other areas of Ottawa County); 2) assessment of the footprints of homes demolished as part of the voluntary relocation (approximately 450 properties); 3) remediation of residential properties located outside of the boundary of the OU4 voluntary buyout, where access was previously denied, and where soil lead concentrations exceed the remediation goal established in the OU2 ROD (approximately 140 properties). Owners of residential properties where access was previously denied will be offered a final opportunity to have their property re-sampled and remediated if necessary. The next five-year review should also consider whether OU2 can be deleted from the National Priorities List (NPL). This deletion of OU2 from the NPL would be a partial deletion of the site. This follow-up action should be completed by September 2015.		of the mining area, assessment of the footprints of homes demolished as part of the voluntary relocation, and remediation of residential properties located outside of the boundary of the OU4 voluntary buyout. The fourth five-year review report also stated that the fifth five-year review should consider whether OU2 can be deleted from the NPL. The RA activities for OU2 are nearly complete. It is estimated that approximately 19 properties still require sampling and removal. In September 2014, EPA held an OU2 Milestone Cleanup Event recognizing reduced blood lead in Ottawa County Children. Remedial activities that occurred under OU2 include the remediation of residential yards, residential driveways, public alleyways, churches, city parks, schools, and other HAAs. ODEQ will undertake OU2 RA activities under a cooperative agreement with EPA for the remaining residential property remediation. This will include assessing new properties as they arise, sampling current properties set for remediation, and carrying out remediation for properties deemed appropriate. At this time it is inappropriate	

Number	Issue from Fourth Five-Year Review	Fourth Five-Year Review Recommendations/Follow-Up Actions	Party Responsible	Action Taken	Date of Action
				to delete OU2 from the NPL. However, the next five-year review should consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site.	
5	The EPA should complete the evaluation of current surface water and sediment data for Tar Creek to verify that no unacceptable risks to human health and the environment exist in Tar Creek. Numerous studies have been conducted since the third five-year review. These studies have collected surface water and sediment data in Tar Creek and other site streams. If necessary, EPA should collect enough additional data to determine whether potential risks are posed to human health and the environment by the surface water and sediments in streams of the site. The risks should be quantified through a risk assessment. If unacceptable risks are identified, then potential remedial alternatives will be evaluated to address the identified risks. Potential remedial alternatives may include engineered remedies, such as passive treatment through constructed wetlands.	The EPA should complete the evaluation of current surface water and sediment data for Tar Creek to verify that no unacceptable risks to human health and the environment exist in Tar Creek. Numerous studies have been conducted since the third five-year review. These studies have collected surface water and sediment data in Tar Creek and other site streams. If necessary, the EPA should collect enough additional data to determine whether potential risks are posed to human health and the environment by the surface water and sediments in streams of the Tar Creek site. The risks should be quantified through a risk assessment. If unacceptable risks are identified, then potential remedial alternatives will be evaluated to address the identified risks. Potential remedial alternatives may include engineered remedies, such as passive treatment through constructed wetlands. A determination may also be made that it is still technically impractical to address surface water and sediment through an engineered remedy and/or that no further action is required. The risk assessment portion of this follow-up action should be completed by	EPA	This task has not been completed. However, a Screening Level Ecological Risk Assessment (SLERA) has been completed and has suggested preliminary remediation goals that may be appropriate for lead, cadmium, and zinc in sediments (McDonald, 2009).	Ongoing

Number	Issue from Fourth Five-Year Review	Fourth Five-Year Review Recommendations/Follow-Up Actions	Party Responsible	Action Taken	Date of Action
	A determination may also be made that it is still technically impractical to address surface water and sediment through an engineered remedy and/or that no further action is required. The risk assessment portion of this follow-up action should be completed by September 2012. If necessary, an evaluation of remedial alternatives should be completed by September 2014 (prior to the next five-year review).	September 2012. If necessary, an evaluation of remedial alternatives should be completed by September 2014 (prior to the next five-year review).			
6	The IC restricting potable and domestic use of shallow ground water including the Boone aquifer as specified in the OU4 ROD should be implemented. The OU4 ROD calls for ICs restricting the use of the Boone aquifer and also restricting the use of any ground water that is shallower than the Boone. Specifically, the ROD calls for ICs restricting the potable and domestic use of such ground water where concentrations of site-related contaminants exceed the remediation goals established in the ROD. The IC is to be implemented through the OWQS (785 OAC 45 Appendix H).	The IC restricting potable and domestic use of shallow ground water including the Boone aquifer as specified in the OU4 ROD should be implemented. The OU4 ROD calls for ICs restricting the use of the Boone aquifer and also restricting the use of any ground water that is shallower than the Boone. Specifically, the ROD calls for ICs restricting the potable and domestic use of such ground water where concentrations of site-related contaminants exceed the remediation goals established in the ROD.	ODEQ	The OU4 ROD called for ICs restricting the use of the Boone aquifer and also restricting the use of any groundwater that is shallower than the Boone. Specifically, the OU4 ROD called for ICs restricting the potable and domestic use of such groundwater where concentrations of site-related contaminants exceed the remediation goals established in the ROD.	September 2012

	6	Appendix H of the OWQS states that toxic metals are present and that special well construction methods are required within the OU4 boundary due to contamination in the Boone aquifer, but there are currently no limitations placed on the use of ground water from the Boone aquifer (or other shallower ground water) for potable use, including domestic supply. ODEQ has indicated that it will explore placing a restriction in Appendix H of the OWQS limiting ground water use from the mine pool and the Boone aquifer in the immediate vicinity of the mine pool for public water supply, or domestic use. ODEQ's restriction will include treatment requirements to remove any lead above the MCL of 15 µg/l. EPA suggests that the State of Oklahoma review this IC. This follow-up action should be completed by September 2011.	The IC is to be implemented through the OWQS (785 OAC 45 Appendix H). Appendix H of the OWQS states that toxic metals are present and that special well construction methods are required within the OU4 boundary due to contamination in the Boone aquifer, but there are currently no limitations placed on the use of ground water from the Boone aquifer (or other shallower ground water) for potable use, including domestic supply. The ODEQ has indicated that it will explore placing a restriction in Appendix H of the OWQS limiting ground water use from the mine pool and the Boone aquifer in the immediate vicinity of the mine pool for public water supply, or domestic use. ODEQ's restriction will include treatment requirements to remove any lead above the MCL of 15 micrograms per liter. EPA suggests that the State of Oklahoma review this IC. This follow-up action should be completed by September 2011.	ODEQ	In accordance with the OU4 ROD, ODEQ submitted a proposal to change the "Beneficial Use Designations for Certain Limited Areas of Groundwater" (OWQS 785 Chapter 45, Appendix H). This task was completed in September 2012. The changes specifically stated that special well construction is required to obtain water for potable use and that groundwater testing is required to meet potable use standards for lead, arsenic, and cadmium (ODEQ, 2012b).	September 2012

3.0 Five-Year Review Process

This fifth five-year review for the site has been conducted in accordance with EPA's Comprehensive Five-Year Review guidance dated June 2001 (EPA, 2001). Interviews were conducted with relevant parties; a site inspection was conducted; and applicable data and documentation covering the period of the review were evaluated. The activities conducted as part of this review and specific findings are described in the following paragraphs.

3.1 Administrative Components

The five-year review for this site was initiated by EPA. The review team was led by EPA Region 6 with support provided by ODEQ. The components of the review included community involvement, document review, data review, a site inspection, interviews, and development of this five-year review report, as described in the following paragraphs.

3.2 Community Involvement

A public notice announcing initiation of the five-year review was published in the *Miami News Record* on December 11, 2014. Upon signature, the fifth five-year review report will be placed in the information repositories for the site, including the Miami Public Library in Miami, and at the EPA Region 6 office in Dallas, Texas. A notice will then be published in the *Miami News Record* to summarize the findings of the review and announce the availability of the report at the information repositories. A copy of the public notice is provided as Appendix C to this report.

3.3 Document Review

This fifth five-year review for the site included a review of relevant site documents, including decision documents, construction and implementation reports, sampling reports, and related monitoring data. Documents reviewed are listed in Appendix B.

3.4 Data Review

The Roubidoux Groundwater Monitoring Program continued during the five-year review period that is the subject of this report, and sampling was conducted from March 2010 to October 2013. Thirteen wells were used in the monitoring program, including five monitor wells (MW) installed by ODEQ as part of the Roubidoux Groundwater Monitoring Program (Commerce #5, Quapaw #5, Picher #5, Picher #6, and Picher #7), one municipal supply well located within the mining area (Cardin #1), four wells located on the edge of the mining area (Commerce #4, Ontario Smelter (a private well), Quapaw #4, and the Rural Water District #4 Well #3 [RWD4 #3]), and three wells located outside of the mining area (Miami #3 [replaced Miami #1 in program], Miami #11, and RWD7 #2). However, the Ontario smelter (private) well ceased to be sampled after 2012 due to access issues (ODEQ, 2014a). The locations of the wells are shown on Figure 2.

The 2010 to 2013 results from the Roubidoux Groundwater Monitoring Program are included in Table 2. ODEQ classified wells that produce water with concentrations in excess of the tolerance

limits for all three indicator parameters (indicator parameters are compounds that indicate possible mine water impacts — sulfate, iron and zinc; *see* pertinent concentrations at the end of this paragraph) as "impacted" by mine water, a well that produces water with concentrations in excess of the background concentrations for all three indicator parameters and above the tolerance limits for two of the indicator parameters as "probably impacted" by mine water, and a well that produces water with concentrations in excess of the background concentrations for two of the three indicator parameters and above the tolerance limits for one of the indicator parameters as "possibly impacted" by mine water. ODEQ classified wells as "Background" if all three indicator parameters were below background concentrations and "Non-impacted" if all three indicator parameters were below tolerance limits but at least one parameter was above background concentrations. The tolerance limits (TL) and background concentrations (BC) for the indicated parameters of mine water contamination are provided. The indicator parameters are sulfate (TL/BC = 82 milligrams per liter [mg/L] and 25 mg/L), iron (0.27 mg/L and 0.062 mg/L), and zinc (0.043 mg/L and 0.009 mg/L) (ODEQ, 2014a).

Two wells sampled in the groundwater monitoring program can be classified as "impacted" by mine water. The Quapaw #5 well results indicate that the average concentrations for sulfate (420.8 mg/L), iron (3.044 mg/L), and zinc (0.143 mg/L) all exceed background concentrations and tolerance limits. In addition, dissolved concentrations of sulfate and iron appear to be increasing since 2000 (ODEQ, 2014a). The Ontario Smelter well sample results indicate that the average concentrations for sulfate (97.74 mg/L), iron (0.401 mg/L) and zinc (0.249 mg/L) exceed tolerance limits established for the Roubidoux. However, the Ontario Smelter well was not able to be sampled in 2012 and 2013 due to access issues.

One well sampled in the groundwater monitoring program can be classified as "probably impacted" by mine water. The Picher #6 well sampling results indicated that within the last five-year review period the average concentrations for sulfate (198.1 mg/L) and iron (0.518 mg/L) exceeded TLs established for the Roubidoux (ODEQ, 2014a).

Four wells sampled in the groundwater monitoring program can be classified as "possibly impacted" by mine water. The Cardin #1, Commerce #4, Picher #5, and Picher #7 wells sample results indicated that average concentrations for sulfate (97.69 mg/L, 135.5 mg/L, 106 mg/L, and 184.5 mg/L, respectively) all exceeded the tolerance limit established for the Roubidoux. However, the last two rounds of sampling indicated that iron concentrations in Picher #7 had exceeded tolerance limits. If this trend continues, Picher #7 may be downgraded to "probably impacted" by mine water (ODEQ, 2014a).

One well sampled in the groundwater monitoring program can be classified as "not impacted" by mine water and five wells were below background. The Commerce #5 well exceeded background concentrations for iron and zinc. The RWD4 #3, Quapaw #4, Miami #11, Miami #3, and RWD7 #2 all had concentrations of indicator parameters either at or below background concentrations established for the Roubidoux (ODEQ, 2014a). No well has an average concentration that exceeds any MCLs.

In 2009, a groundwater monitoring program was started at the future site of the Central Mill Repository (CMR) to determine the impacts of the CMR to the perched groundwater chemistry.

The sampling program began in 2009 (before the construction of the CMR) and concluded in 2011 (after the construction of the CMR). The program was based on three MWs (FT059-MW1, FT059-MW2, and FT059-MW3). The three wells are completed in the shallow perched groundwater that underlies the CMR. The three wells were sampled three times in 2009, two times in 2010, and three times in 2011 (Table 3). In 2009, exceedances of secondary maximum contaminant levels (SMCL) for iron and manganese were detected in all MWs, while exceedances of MCLs for lead were detected in two MWs, and an exceedance of the MCL for arsenic was detected in one MW. In 2010, exceedances of SMCLs for iron and manganese were detected in all MWs, while exceedances of MCLs for lead were detected in two MWs, and an exceedance of MCL for arsenic was detected in one MW. In 2011, exceedances of SMCLs for iron and manganese were detected in all MWs, while exceedances of MCLs for lead and arsenic were only detected in one MW. These data indicate that metal concentrations in the groundwater had not increased since the construction and operation of the repository began in 2010; however, FT059-MW1 was not sampled in 2011 (CH2M HILL, 2012c and Table 3).

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
Cardin #1																										
10/30/2013	Totals	415	18.88	7.05	0.81	131	<10	57.5	221	191	41.4	19.7	12.1	2.6	<0.002	<0.002	<0.002	<0.01	0.153	<0.005	0.008	<0.00005	<0.01	<0.01	<0.001	0.013
	Dissolved	-	-	-	-	-	-	-	-	-	37.5	18.3	10.9	2.4	<0.002	<0.002	<0.002	<0.01	0.155	<0.005	0.008	<0.00005	<0.01	<0.01	<0.001	<0.005
11/6/2012	Totals	400	18.86	7.34	0.9	111.5	<10	59.9	214	184	40.6	18.2	10.9	2.3	<0.002	<0.002	<0.002	<0.01	0.164	<0.005	0.008	<0.00005	<0.01	<0.01	<0.001	0.037
	Dissolved	-	-	-	-	-	-	-	-	-	40.2	18.4	10.7	2.3	<0.002	<0.002	<0.002	<0.01	0.146	<0.005	0.008	<0.00005	<0.01	<0.01	<0.001	<0.005
11/1/2011	Totals	457	20.06	7.42	1.05	132	10.7	71.9	239	180	44.4	21.6	10.7	2.5	<0.002	<0.002	<0.002	<0.01	0.104	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	44.6	21.4	11	2.6	<0.002	<0.002	<0.002	<0.01	0.109	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/10/2010	Totals	685	20.39	**6.08**	3.57	146	29.8	176	406	297	68.6	32.6	16.9	3	<0.002	<0.002	<0.002	<0.01	0.0869	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.011
	Dissolved	-	-	-	-	-	-	-	-	-	69.5	31.9	17.5	3	<0.002	<0.002	<0.002	<0.01	0.077	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
3/23/2010	Totals	597	19.49	**6.47**	2.72	144	28.8	150	430	302	67.4	31.6	16.6	3	<0.002	<0.002	<0.002	<0.01	0.145	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.023
	Dissolved	-	-	-	-	-	-	-	-	-	66.4	31.2	15.7	2.9	<0.002	<0.002	<0.002	<0.01	0.117	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.005
4/21/2008	Totals	467	20.85	7.2	1.35	126	13.7	78.2	242	205	46.6	21.3	11.7	2.6	<0.002	<0.002	<0.002	<0.01	0.193	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
	Dissolved	-	-	-	-	-	-	-	-	-	47.4	21.8	11.5	2.5	<0.002	<0.002	<0.002	<0.01	0.169	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.027
10/23/2007	Totals	442	19.05	7.33	0.9	132	11	56.5	216	189	40.7	18.6	10	2.3	<0.002	<0.002	<0.002	<0.01	0.132	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.007
	Dissolved	-	-	-	-	-	-	-	-	-	40.8	19	10	2.3	<0.002	<0.002	<0.002	<0.01	0.118	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
5/8/2007	Totals	384	18.85	7.56	1.12	125	<10	28.2	167	157	38.7	18.4	11.1	2.7	<0.002	<0.002	<0.002	<0.01	0.0957	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	32.2	15.6	9.1	2.3	<0.002	<0.002	<0.002	<0.01	0.076	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	634	21.79	7.2	1.32	160	28	156	375	293	64	29	15	3	<0.002	<0.002	<0.002	<0.01	0.103	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	60	28	15	3	<0.002	<0.002	<0.002	<0.01	0.094	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/11/2006	Totals	368	18.8	7.28	5.32	111	13.5	78.8	238	201	43	20	11	3	<0.002	<0.002	<0.002	<0.01	0.14	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	43	20	11	3	<0.002	<0.002	<0.002	<0.01	0.121	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/17/2005	Totals	487	19.2	7.8	0.9	127	20.8	107	308	262	60	27	13	3	<0.002	<0.002	<0.002	<0.01	0.17	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	69	29	13	3	<0.002	<0.002	<0.002	<0.01	0.156	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
4/25/2005	Totals	510	18.3	7.56	1.58	177	21	111	347	260	59	27	14	3	<0.002	<0.002	<0.002	<0.01	0.193	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.036
	Dissolved	-	-	-	-	-	-	-	-	-	58	26	13	3	<0.002	<0.002	<0.002	<0.01	0.152	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/12/2004	Totals	498	18.3	7.62	1.82	199	20.4	107	333	250	59	27	14	3	<0.002	<0.002	<0.002	<0.01	0.139	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.009
	Dissolved	-	-	-	-	-	-	-	-	-	56	26	13	3	<0.002	<0.002	<0.002	<0.01	0.114	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/27/2004	Totals	334	19.6	7.43	3.48	150	14.5	93.3	319	231	50	24	12	3	<0.01	<0.01	<0.005	<0.005	0.132	<0.01	0.009	0.00005	<0.01	<0.01	<0.01	0.033
	Dissolved	-	-	-	-	-	-	-	-	-	50	24	12	3	<0.01	<0.01	<0.005	<0.005	0.112	<0.01	0.009	<0.00005	<0.01	<0.01	<0.01	<0.005
11/6/2003	Totals	595	17.6	**6.47**	NA	145	27.1	134	388	281	61	30	17	3	<0.002	<0.002	<0.002	<0.01	0.101	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.022
	Dissolved	-	-	-	-	-	-	-	-	-	61	30	17	3	<0.002	<0.002	<0.002	<0.01	0.098	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500	-					0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Averages	485	19.3	7.19	1.92	141	18	**97.69**	296	232	52	24	13	2.8	0.003	0.003	0.002	0.01	0.129	0.005	0.01	0.00005	0.01	0.01	0.002	0.011
Commerce #4																										
10/30/2013	Totals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/7/2012	Totals	907	18.61	7.04	5.5	147	59.8	206	565	388	87.5	34.3	45	3.4	<0.002	<0.002	<0.002	<0.01	0.358	<0.005	0.016	<0.00005	<0.01	<0.01	<0.001	0.0702
	Dissolved	-	-	-	-	-	-	-	-	-	86.6	34.3	46.1	3.4	<0.002	<0.002	<0.002	<0.01	0.124	<0.005	0.015	<0.00005	<0.01	<0.01	<0.001	0.051
11/2/2011	Totals	862	19.41	7.09	3.65	169	53.4	188	**504**	375	79.9	35.7	34.4	3.4	<0.002	<0.002	<0.002	<0.01	0.212	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	0.0303
	Dissolved	-	-	-	-	-	-	-	-	-	85.4	36	35.7	3.6	<0.002	<0.002	<0.002	<0.01	0.161	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	0.0157
11/10/2010	Totals	837	19.8	6.54	3.87	152	78.5	190	**508**	316	74	30.3	47.6	3.3	<0.002	<0.002	<0.002	<0.01	0.171	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	0.0101
	Dissolved	-	-	-	-	-	-	-	-	-	75.7	30.7	47.8	3.3	<0.002	<0.002	<0.002	<0.01	0.132	<0.005	0.012	<0.00005	<0.01	<0.01	<0.001	<0.01
3/24/2010	Totals	745	17.85	6.76	4.97	161	54.4	192	**553**	354	84.2	33.1	41.2	3.6	<0.002	<0.002	<0.002	<0.01	0.184	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.0135
	Dissolved	-	-	-	-	-	-	-	-	-	81.4	32.5	41	3.6	<0.002	<0.002	<0.002	<0.01	0.165	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.0071
4/22/2008	Totals	727	20.41	7.2	4.22	146	78.5	113	432	256	61.3	25.8	46.1	3.2	<0.002	<0.002	<0.002	<0.01	0.112	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.0119
	Dissolved	-	-	-	-	-	-	-	-	-	58.1	24.7	43.1	3	<0.002	<0.002	<0.002	<0.01	0.0942	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/23/2007	Totals	676	18.32	7.35	2.47	131	<10	61.9	219	186	42.9	19.1	18	2.6	<0.002	<0.002	<0.002	<0.01	0.0944	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.0268
	Dissolved	-	-	-	-	-	-	-	-	-	47.1	21.2	36.5	2.7	<0.002	<0.002	<0.002	<0.01	0.084	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
5/8/2007	Totals	710	20.03	7.37	3.6	136	75.3	125	432	291	71.9	30.9	43.1	3.4	<0.002	<0.002	<0.002	<0.01	0.151	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.0277
	Dissolved	-	-	-	-	-	-	-	-	-	68.8	29.5	41.5	3.3	<0.002	<0.002	<0.002	<0.01	0.129	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	769	20.92	7.11	4.41	162	48.7	161	448	307	74	28	31	4	<0.002	<0.002	<0.002	<0.01	0.106	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	0.015
	Dissolved	-	-	-	-	-	-	-	-	-	66	28	30	4	<0.002	<0.002	<0.002	<0.01	0.103	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	0.009
4/11/2006	Totals	412	20.1	8.41	3.54	164	56.5	166	437	311	70	29	36	4	<0.002	<0.002	<0.002	<0.01	0.079	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	0.027
	Dissolved	-	-	-	-	-	-	-	-	-	72	30	37	4	<0.002	<0.002	<0.002	<0.01	0.079	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/18/2005	Totals	356	19.4	7.95	0.6	117	<10	66	250	189	44	19	9	3	<0.002	<0.002	<0.002	<0.01	0.132	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	45	20	9	3	<0.002	<0.002	<0.002	<0.01	0.104	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/26/2005	Totals	577	19.4	7.7	1.8	NA	60.5	76	342	214	49	22	34	3	<0.002	<0.002	<0.002	<0.01	0.077	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	48	21	34	3	<0.002	<0.002	<0.002	<0.01	0.072	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/12/2004	Totals	614	19	7.47	1.61	183	43.5	126	403	270	65	27	29	3	<0.002	<0.002	<0.002	<0.01	0.09	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	63	26	29	3	<0.002	<0.002	<0.002	<0.01	0.086	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/27/2004	Totals	403	18.7	7.75	3.39	218	59.5	107	409	252	54	24	35	3	<0.01	<0.01	<0.005	<0.005	0.087	<0.01	0.009	<0.00005	<0.01	<0.01	<0.01	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	56	25	35	3	<0.01	<0.01	<0.005	<0.005	0.085	<0.01	0.01	<0.00005	<0.01	<0.01	<0.01	<0.005
11/6/2003	Totals	615	17.9	**6.42**	NA	153	37.9	119	383	260	61	26	28	3	<0.002	<0.002	<0.002	<0.01	0.095	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	57	25	27	3	<0.002	<0.002	<0.002	<0.01	0.086	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Averages	658	19.3	7.3	3.36	157	51.9	135.5	420	284	65	27	35	3.2	0.003	0.003	0.002	0.01	0.123	0.005	0.011	0.00005	0.01	0.01	0.002	0.014
Commerce #5																										
10/30/2013	Totals	293	19.99	7.3	1.47	114	12.1	14.9	128	128	27.4	13.7	10.1	1.9	<0.002	<0.002	<0.002	<0.01	0.034	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27.7	13.9	10.2	9.5	<0.002	<0.002	<0.002	<0.01	0.032	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
11/7/2012	Totals	304	18.47	7.6	1.89	106.5	15.5	15.9	145	130	27.8	13	10.7	1.8	<0.002	<0.002	<0.002	<0.01	0.08	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28	13.2	10.8	1.9	<0.002	<0.002	<0.002	<0.01	0.031	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
11/2/2011	Totals	308	19.52	7.78	0.57	107	17.2	13.9	156	109	27.6	13.9	10	1.9	<0.002	<0.002	<0.002	<0.01	0.036	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	28.5	14	10.6	2	<0.002	<0.002	<0.002	<0.01	0.032	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/2/2011	Totals	308	19.52	7.78	0.57	107	17.7	14.1	158	111	27.7	13.9	10	1.9	<0.002	<0.002	<0.002	<0.01	0.042	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.365
	Dissolved	-	-	-	-	-	-	-	-	-	28.5	14	10.8	2	<0.002	<0.002	<0.002	<0.01	0.037	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/10/2010	Totals	292	20.05	6.12	1.58	108	<10	17.5	136	119	27.6	13.2	8.9	1.8	<0.002	<0.002	<0.002	<0.01	0.047	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	28.2	13.3	8.8	1.9	<0.002	<0.002	<0.002	<0.01	0.035	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
3/24/2010	Totals	284	19.42	7.5	1.25	109.5	17.9	15.7	160	126	28.1	13.5	11.1	2	<0.002	<0.002	<0.002	<0.01	0.043	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27.5	13.1	11.2	2	<0.002	<0.002	<0.002	<0.01	0.033	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/22/2008	Totals	279	20.65	7.47	1.11	109	10.5	13.7	157	127	27.1	13	8.2	1.8	<0.002	<0.002	<0.002	<0.01	0.045	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27.3	13	8.1	1.8	<0.002	0.002	<0.002	<0.01	0.035	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/23/2007	Totals	283	18.58	7.65	0.78	109	11.4	14.2	149	129	27.9	13.4	8.3	1.9	<0.002	<0.002	<0.002	<0.01	0.04	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25	12.3	7.6	1.7	<0.002	0.002	<0.002	<0.01	0.031	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.0076
5/8/2007	Totals	308	20.04	7.74	1.49	103	20	12.1	155	135	27.8	13.8	11.8	2	<0.002	<0.002	<0.002	<0.01	0.042	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27.4	13.8	12	2.1	<0.002	<0.002	<0.002	<0.01	0.031	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	313	21.2	7.74	2.12	115	18	17.4	157	129	28	13	11	2	<0.002	<0.002	<0.002	<0.01	0.033	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	26	13	10	2	<0.002	<0.002	<0.002	<0.01	0.028	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/11/2006	Totals	301	19.9	8.57	1.44	107	15.3	14.6	138	124	26	13	10	2	<0.002	<0.002	<0.002	<0.01	0.038	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27	13	10	2	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/18/2005	Totals	269	20.4	7.81	0.1	145	10.3	13.7	173	130	29	14	8	2	<0.002	<0.002	<0.002	<0.01	0.043	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	31	14	8	2	<0.002	<0.002	<0.002	<0.01	0.023	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/26/2005	Totals	268	18.4	8.17	5.18	NA	<10	13.9	150	121	28	13	8	2	<0.002	<0.002	<0.002	<0.01	0.07	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28	13	8	2	<0.002	<0.002	<0.002	<0.01	0.034	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/12/2004	Totals	260	17.9	8.64	5.65	152	<10	13	154	124	28	13	8	2	<0.002	<0.002	<0.002	<0.01	0.092	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28	13	8	2	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
4/27/2004	Totals	252	18.9	7.82	5.75	158	<10	11.8	158	122	25	13	8	2	<0.01	<0.01	<0.005	<0.005	0.093	<0.01	<0.01	0.00005	<0.01	<0.01	<0.01	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25	13	8	2	<0.01	<0.01	<0.005	<0.005	0.034	<0.01	<0.01	<0.00005	<0.01	<0.01	<0.01	<0.005
4/27/2004	Totals	252	18.9	7.82	5.75	158	<10	11.8	158	123	25	13	8	2	<0.01	<0.01	<0.005	<0.005	0.114	<0.01	<0.01	0.00005	<0.01	<0.01	<0.01	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	26	13	8	2	<0.01	<0.01	<0.005	<0.005	0.039	<0.01	<0.01	0.00005	<0.01	<0.01	<0.01	<0.005
11/6/2003	Totals	294	17.7	7.29	NA	108	15.6	12	155	127	26	13	11	2	<0.002	<0.002	<0.002	<0.01	0.08	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	26	13	11	2	<0.002	<0.002	<0.002	<0.01	0.048	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.01
4/18/2002	Totals	294	20.6	7.5	NA	80	15	11.6	149	128	28	14	11	2	<0.002	<0.002	<0.002	<0.01	0.116	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	27	14	10	2	<0.002	<0.002	<0.002	<0.01	0.082	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
12/13/2001	Totals	282	17.7	7.48	NA	86.5	9.2	40.9	123	126	27	13	10	2	<0.002	<0.002	<0.002	<0.01	0.159	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	27	13	10	2	<0.002	<0.002	<0.002	<0.01	0.12	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
3/9/2001	Totals	296	15.6	7.75	NA	100	13	12.4	165	125	28	14	10	2	<0.002	<0.002	<0.002	<0.01	0.197	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	28	14	10	2	<0.002	<0.002	<0.002	<0.01	0.137	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
10/13/2000	Totals	333	21	7.68	2.89	110	15.7	10.3	174	129	28	14	12	2	<0.002	<0.002	<0.002	<0.01	0.22	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	27	14	11	2	<0.002	<0.002	<0.002	<0.01	0.178	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Averages	289	19.2	7.68	2.33	115	13.5	15.02	152	125	27	13	10	2.1	0.003	0.003	0.002	0.01	0.065	0.005	0.01	0.00014	0.01	0.01	0.002	0.015
Ontario Smelter																										
10/29/2013	Totals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/6/2012	Totals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dissolved	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/1/2011	Totals	258	17.07	7.65	0.45	109	<10	21.1	130	109	26.8	14.4	4.6	1.4	<0.002	<0.002	<0.002	<0.01	**0.401**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.117
	Dissolved	-	-	-	-	-	-	-	-	-	28.1	14.6	4.8	1.5	<0.002	<0.002	<0.002	<0.01	**0.4**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.023
11/10/2010	Totals	273	17.12	**6.35**	0.43	118	<10	41.8	159	147	29.3	14.9	5	1.5	<0.002	<0.002	<0.002	<0.01	**0.714**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.294
	Dissolved	-	-	-	-	-	-	-	-	-	30.5	15.3	5	1.5	<0.002	<0.002	<0.002	<0.01	**0.641**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
3/24/2010	Totals	835	15.59	**6.4**	1.04	171	<10	142	385	287	72.5	33.7	9.7	2.7	<0.002	<0.002	<0.002	<0.01	**0.495**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.35
	Dissolved	-	-	-	-	-	-	-	-	-	75.3	35	10.1	2.7	<0.002	<0.002	<0.002	<0.01	**0.481**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.183
4/21/2008	Totals	407	20.26	7.2	1.57	120	<10	62.2	207	185	41	20	6	1.9	<0.002	<0.002	<0.002	<0.01	**0.447**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.308
	Dissolved	-	-	-	-	-	-	-	-	-	39	19	6	1.8	<0.002	<0.002	<0.002	<0.01	**0.386**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.065
10/23/2007	Totals	997	16.23	6.92	1.21	181	<10	111	324	273	112	52	16	4.2	<0.002	<0.002	<0.002	<0.01	**0.549**	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	1.08
	Dissolved	-	-	-	-	-	-	-	-	-	60	29	12	3.2	<0.002	<0.002	<0.002	<0.01	**0.526**	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	0.231
5/7/2007	Totals	951	18.38	6.81	1.75	206	<10	**285**	**679**	522	113	54	15	3.9	<0.002	<0.002	<0.002	<0.01	**0.681**	<0.005	0.012	<0.00005	<0.01	<0.01	<0.001	0.999

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	106	51	14	3.7	<0.002	<0.002	<0.002	<0.01	**0.477**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	378	18.8	7.3	1.06	132	<10	57.2	206	184	41	18	6	2	<0.002	<0.002	<0.002	<0.01	**0.35**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.273
	Dissolved	-	-	-	-	-	-	-	-	-	36	18	6	2	<0.002	<0.002	<0.002	<0.01	**0.334**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.039
4/10/2006	Totals	239	17.8	6.69	1.43	153	<10	130	306	262	25	13	5	2	<0.002	<0.002	<0.002	<0.01	**0.302**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.09
	Dissolved	-	-	-	-	-	-	-	-	-	26	14	5	2	<0.002	<0.002	<0.002	<0.01	0.277	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/17/2005	Totals	404	17.1	7.59	2.5	155	<10	125	348	274	61	29	8	2	<0.002	<0.002	<0.002	<0.01	**0.393**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.251
	Dissolved	-	-	-	-	-	-	-	-	-	68	30	8	2	<0.002	<0.002	<0.002	<0.01	**0.391**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.14
4/25/2005	Totals	402	15.8	7.27	1.4	180	<10	72.5	241	199	44	21	7	2	<0.002	<0.002	<0.002	<0.01	**0.63**	<0.005	0.011	<0.00005	<0.01	<0.01	<0.001	0.689
	Dissolved	-	-	-	-	-	-	-	-	-	43	21	7	2	<0.002	<0.002	<0.002	<0.01	**0.526**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.321
1/28/2005	Totals	756	12.1	7.03	2.63	NA	<10	**282**	**648**	477	-	-	49	13	NA	NA	<0.002	<0.005	**0.512**	<0.005	0.013	NA	NA	NA	NA	1.2
10/11/2004	Totals	445	15.4	7.41	2.09	128	<10	92.4	284	219	57	27	8	2	<0.002	<0.002	<0.002	<0.01	**0.349**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.244
	Dissolved	-	-	-	-	-	-	-	-	-	56	26	8	2	<0.002	<0.002	<0.002	<0.01	**0.343**	0.015	<0.01	<0.00005	<0.01	<0.01	<0.001	0.148
10/11/2004	Totals	445	15.4	7.41	2.09	128	<10	115	327	248	57	27	8	2	<0.002	<0.002	<0.002	<0.01	**0.358**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.251
	Dissolved	-	-	-	-	-	-	-	-	-	54	25	7	2	<0.002	<0.002	<0.002	<0.01	**0.318**	0.021	<0.01	<0.00005	<0.01	<0.01	<0.001	0.169
4/29/2004	Totals	427	17.3	7.5	2.27	134	<10	56.3	233	185	43	22	7	2	<0.01	<0.01	<0.005	<0.005	**0.359**	<0.01	0.006	0.00006	<0.01	<0.01	<0.01	0.299
	Dissolved	-	-	-	-	-	-	-	-	-	28	15	6	2	<0.01	<0.01	<0.005	<0.005	**0.238**	0.012	<0.005	<0.00005	<0.01	<0.01	<0.01	0.089
4/29/2004	Totals	427	17.3	7.5	2.27	134	<10	103	328	236	39	20	7	2	<0.01	<0.01	<0.005	<0.005	**0.359**	<0.01	0.006	<0.00005	<0.01	<0.01	<0.01	0.228
	Dissolved	-	-	-	-	-	-	-	-	-	28	15	6	2	<0.01	<0.01	<0.005	<0.005	**0.249**	<0.01	<0.005	<0.00005	<0.01	<0.01	<0.01	0.037
12/19/2003	Totals	415	14.8	6.64	NA	125	<10	85.5	274	213	46	23	8	2	<0.002	<0.002	<0.002	<0.01	**0.319**	0.026	<0.01	<0.00005	<0.01	<0.01	<0.001	0.236
	Dissolved	-	-	-	-	-	-	-	-	-	46	24	8	2	<0.002	<0.002	<0.002	<0.01	**0.464**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.464
11/4/2003	Totals	252	17.1	7.83	NA	115	<10	16.4	138	126	27	14	5	2	<0.002	<0.002	<0.002	<0.01	**0.316**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.083
	Dissolved	-	-	-	-	-	-	-	-	-	27	14	5	2	<0.002	<0.002	<0.002	<0.01	0.246	0.013	<0.01	<0.00005	<0.01	<0.01	<0.001	0.07
10/6/2003	Totals	257	18.3	7.08	NA	130	<10	14	148	124	26	14	5	2	<0.002	<0.002	<0.002	<0.01	0.208	0.017	<0.01	<0.00005	<0.01	<0.01	<0.001	0.05
	Dissolved	-	-	-	-	-	-	-	-	-	26	14	5	2	<0.002	<0.002	<0.002	<0.01	0.288	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.067
10/6/2003	Totals	257	18.3	7.08	NA	130	<10	16.4	132	126	26	14	5	2	<0.002	<0.002	<0.002	<0.01	0.287	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.065
	Dissolved	-	-	-	-	-	-	-	-	-	26	14	5	2	<0.002	<0.002	<0.002	<0.01	0.224	0.008	<0.01	<0.00005	<0.01	<0.01	<0.001	0.033
7/30/2003	Dis Met	370	18.2	8.19	NA	NA	11.1	126	368	NA	60	29	8	2	NA	NA	NA	NA	**0.41**	0.056	<0.01	NA	<0.01	NA	NA	0.239
	Averages	460	16.9	7.19	1.61	142	10.1	97.74	293	231	47	23	8	2.4	0.003	0.003	0.002	0.009	**0.401**	0.009	0.01	0.00005	0.01	0.01	0.002	0.249
Miami #1																										
4/27/2004	Totals	413	19.6	8.27	3.3	120	78.8	12.6	265	133	29	14	47	3	<0.01	<0.01	<0.005	<0.005	**1.13**	<0.01	0.012	0.00005	<0.01	<0.01	<0.01	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28	14	45	2	<0.01	<0.01	<0.005	<0.005	0.042	<0.01	<0.005	0.00005	<0.01	<0.01	<0.01	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond.	Temp.	pH	D.O.	Alk (Field)	Chloride	Sulfate	Tot Dis Sol	Hardiness	Calcium	Magnesium	Sodium	Potassium	Antimony	Arsenic	Cadmium	Chromium	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Thallium	Zinc
		(Field)	(Field)	(Field)	(Field)	$CaCO_3$	Cl	SO_4	TDS	$CaCO_3$	Ca	Mg	Na	K	Sb	As	Cd	Cr	Fe	Pb	Mn	Hg	Ni	Se	Tl	Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
11/4/2003	Totals	500	15.7	7.15	NA	NA	83.6	12.4	262	133	30	15	50	3	<0.002	<0.002	<0.002	<0.01	**0.372**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.01
	Dissolved	-	-	-	-	-	-	-	-	-	30	15	50	3	<0.002	<0.002	<0.002	<0.01	0.062	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/4/2003	Totals	500	15.7	7.15	NA	NA	84.5	12.5	264	135	29	14	49	3	<0.002	<0.002	<0.002	<0.01	0.057	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	30	15	50	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Averages	471	17	7.52	3.3	120	82.3	12.5	264	134	29	15	49	3	0.005	NA	0.003	0.008	0.281	0.007	0.01	0.00005	0.01	0.01	0.004	0.008
Miami #3																										
10/30/2013	Totals	538	19.97	7.13	1.82	128	84.7	12.9	254	136	29.1	14.1	65	3	<0.002	<0.002	<0.002	<0.01	0.065	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	29	14.5	62.1	2.9	<0.002	<0.002	<0.002	<0.01	0.035	<0.005	<0.005	0.00006	<0.01	<0.01	<0.001	<0.005
11/7/2012	Totals	546	15.97	7.47	1.91	105.5	90	15.8	268	136	29	13.4	57.6	2.6	<0.002	<0.002	<0.002	<0.01	0.03	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28.1	13.2	55.7	2.5	<0.002	<0.002	<0.002	<0.01	0.024	<0.005	<0.005	0.00006	<0.01	<0.01	<0.001	<0.005
11/2/2011	Totals	546	18.28	7.76	0.58	115	92.3	14.1	268	113	29.1	14.2	51.5	2.7	<0.002	<0.002	<0.002	<0.01	0.077	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	29.3	14.2	54.2	2.8	<0.002	<0.002	<0.002	<0.01	0.084	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/10/2010	Totals	563	19.12	6.17	0.75	111	95	16.7	261	126	29.1	13.7	55.5	2.8	<0.002	<0.002	<0.002	<0.01	0.021	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	30.4	13.9	56.5	2.8	<0.002	<0.002	<0.002	<0.01	0.037	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
3/24/2010	Totals	436	16.8	7.09	3.22	109	81	15.5	262	128	28.4	13.4	49.8	2.8	<0.002	<0.002	<0.002	<0.01	0.031	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27.9	13.2	51.3	2.9	<0.002	<0.002	<0.002	<0.01	0.023	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/22/2008	Totals	537	20.06	7.22	0.66	107	96.9	13.7	286	137	29.5	13.8	58.1	2.8	<0.002	<0.002	<0.002	<0.01	0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	29.1	13.7	56.3	2.8	<0.002	<0.002	<0.002	<0.01	0.113	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/23/2007	Totals	533	16.94	7.28	1.47	114	90.4	14.1	274	138	29.9	14	52.6	2.7	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27.9	13.4	50.6	2.7	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
5/8/2007	Totals	523	19.5	7.35	0.49	108	87.5	11.5	266	144	28.7	13.8	53.7	2.9	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28.6	13.9	52.1	2.8	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	538	18.56	7.52	1.51	116	95.6	16.8	275	129	27	14	54	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27	13	52	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/11/2006	Totals	547	20.1	8.51	2.14	155	94.3	15.3	256	131	28	14	57	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	29	14	57	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/18/2005	Totals	492	19.3	7.7	0.7	125	92.8	12.9	263	138	31	14	54	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	31	14	55	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/18/2005	Totals	492	19.3	7.7	0.7	125	91.6	13.7	258	138	32	14	54	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	34	15	54	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/26/2005	Totals	527	18.8	7.77	1.47	NA	96.8	14	282	131	30	14	56	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	29	14	57	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/26/2005	Totals	527	18.8	7.77	1.47	NA	97.4	15.4	283	130	29	14	56	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	29	14	56	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/12/2004	Totals	506	16.5	8	1.65	102	97.2	13.4	293	134	30	14	57	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	32	15	56	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/12/2004	Totals	506	16.5	8	1.65	102	95.7	13.6	291	132	28	13	54	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	30	14	56	3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Averages	522	18.4	7.53	1.39	116	92.5	14.34	271	133	29.3	14	55	2.9	0.002	0.002	0.002	0.01	0.03	0.005	0.009	0.00005	0.01	0.01	0.001	0.006
Miami #11																										
10/30/2013	Totals	332	19.6	7.35	2.72	104	23.7	12.2	164	121	25.7	13.3	21	1.7	<0.002	<0.002	<0.002	<0.01	0.05	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25.6	13.6	21.3	1.6	<0.002	<0.002	<0.002	<0.01	0.047	<0.005	<0.005	<0.00015	<0.01	<0.01	<0.001	<0.005
11/7/2012	Totals	324	18.33	7.55	1	99	25.4	14.2	164	122	25.5	12.5	18.5	1.5	<0.002	<0.002	<0.002	<0.01	0.045	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	0.021
	Dissolved	-	-	-	-	-	-	-	-	-	24.7	12.4	18.2	1.4	<0.002	<0.002	<0.002	<0.01	0.038	<0.005	<0.005	<0.00015	<0.01	<0.01	<0.001	<0.005
11/2/2011	Totals	337	19.23	7.82	0.84	105	25.6	13	151	101	25.6	13	17.2	1.5	<0.002	<0.002	<0.002	<0.01	0.051	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	25.5	13.2	18.4	1.6	<0.002	<0.002	<0.002	<0.01	0.063	<0.005	<0.01	<0.00015	<0.01	<0.01	<0.001.	<0.01
11/10/2010	Totals	322	18.8	6.37	4.51	105	23.2	14.4	146	113	25.3	12.6	17	1.5	<0.002	<0.002	<0.002	<0.01	0.043	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	26.5	12.9	17.3	1.6	<0.002	<0.002	<0.002	<0.01	0.042	<0.005	<0.01	<0.00015	<0.01	<0.01	<0.001	<0.01
3/24/2010	Totals	290	17.4	7.35	2.24	104	26.8	14.2	171	116	25.9	13	20.1	1.6	<0.002	<0.002	<0.002	<0.01	0.071	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25.2	12.7	20.5	1.6	<0.002	<0.002	<0.002	<0.01	0.05	<0.005	<0.01	<0.00015	<0.01	<0.01	<0.001	<0.005
5/8/2007	Totals	345	19.1	7.73	1.3	104	33.2	11.8	168	128	24.9	13	24.2	1.6	<0.002	<0.002	<0.002	<0.01	0.065	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	24.7	12.9	23.5	1.6	<0.002	<0.002	<0.002	<0.01	0.035	<0.005	<0.01	<0.00015	<0.01	<0.01	<0.001	<0.005
5/8/2007	Totals	345	19.1	7.73	1.3	104	34.4	11.4	171	127	25.2	13	24.3	1.6	<0.002	<0.002	<0.002	<0.01	0.055	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25.1	13	23.2	1.6	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	353	19.4	7.74	1.24	111	35.9	15.6	178	117	22	12	22	2	<0.002	<0.002	<0.002	<0.01	0.081	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	22	12	22	2	<0.002	<0.002	<0.002	<0.01	0.058	<0.005	<0.01	0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	353	19.4	7.74	1.24	275	35.1	15.5	183	115	23	12	23	2	<0.002	<0.002	<0.002	<0.01	0.08	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	23	12	23	2	<0.002	<0.002	<0.002	<0.01	0.05	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Averages	333	18.9	7.49	1.82	123	29.3	13.59	166	118	25	13	21	2	0.002	0.002	0.002	0.01	0.053	0.005	0.009	0.00008	0.01	0.01	0.001	0.007
Picher #5 - MW																										
10/30/2013	Totals	703	19.17	6.82	1.11	147	23	171	426	329	70.4	34.1	21.4	3.3	<0.002	<0.002	<0.002	<0.01	0.168	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	71.6	34.2	21.8	3.5	<0.002	<0.002	<0.002	<0.01	0.138	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond.	Temp.	pH	D.O.	Alk (Field)	Chloride	Sulfate	Tot Dis Sol	Hardiness	Calcium	Magnesium	Sodium	Potassium	Antimony	Arsenic	Cadmium	Chromium	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Thallium	Zinc
		(Field)	(Field)	(Field)	(Field)	$CaCO_3$	Cl	SO_4	TDS	$CaCO_3$	Ca	Mg	Na	K	Sb	As	Cd	Cr	Fe	Pb	Mn	Hg	Ni	Se	Tl	Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
10/30/2013	Totals	688	19.24	6.72	1.83	173	25.9	169	425	328	70.6	34.9	21.8	3.2	<0.002	<0.002	<0.002	<0.01	0.172	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	71.1	33.6	21.8	3.4	<0.002	<0.002	<0.002	<0.01	0.137	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005
11/7/2012	Totals	671	17.43	6.98	1.29	121	26.1	160	413	301	67.7	30.6	20	3	<0.002	<0.002	<0.002	<0.01	0.144	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	65.4	29.8	19.4	2.9	<0.002	<0.002	<0.002	<0.01	0.129	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005
11/7/2012	Totals	671	17.43	6.98	1.29	121	26.1	163	399	306	68.6	31.1	20.3	3	<0.002	<0.002	<0.002	<0.01	0.146	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	62.9	28.8	18.8	2.7	<0.002	<0.002	<0.002	<0.01	0.13	<0.005	0.007	<0.00005	<0.01	<0.01	<0.001	<0.005
11/1/2011	Totals	431	20.18	7.66	0.71	117	30	48.4	223	146	36.8	18.2	19.5	2.6	<0.002	<0.002	<0.002	<0.01	0.239	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	38	18.8	20	2.7	<0.002	<0.002	<0.002	<0.01	0.223	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	<0.01
11/1/2011	Totals	431	20.18	7.66	0.71	117	29.6	48.4	213	146	36.9	18	19.6	2.6	<0.002	<0.002	<0.002	<0.01	0.238	<0.005	0.012	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	37.8	18.7	19.7	2.6	<0.002	<0.002	<0.002	<0.01	0.216	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	<0.01
11/10/2010	Totals	601	19.43	**5.61**	1.14	128	25.7	153	362	258	60.1	27.6	18	2.9	<0.002	<0.002	<0.002	<0.01	0.141	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	61.7	27.9	17.8	2.9	<0.002	<0.002	<0.002	<0.01	0.102	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/10/2010	Totals	601	19.43	**5.61**	1.14	128	26.1	155	354	260	60.8	28.1	18.3	2.9	<0.002	<0.002	<0.002	<0.01	0.144	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	63.2	28.5	18.2	2.8	<0.002	<0.002	<0.002	<0.01	0.102	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
3/24/2010	Totals	412	18.76	7.25	1.35	124	31.3	69.5	286	198	34.5	16.6	21.7	2.6	<0.002	<0.002	<0.002	<0.01	0.119	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	33.5	16.2	22	2.6	<0.002	<0.002	<0.002	<0.01	0.096	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
3/24/2010	Totals	412	18.76	7.25	1.35	124	31.1	72.3	287	198	35	17	21.6	2.6	<0.002	<0.002	<0.002	<0.01	0.112	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	33	15.9	22.3	2.6	<0.002	<0.002	<0.002	<0.01	0.09	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/22/2008	Totals	604	21.67	7.26	2.35	135	26	135	383	264	59.5	27.5	17	2.8	<0.002	<0.002	<0.002	<0.01	0.113	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	59.6	27.8	16.8	2.8	<0.002	<0.002	<0.002	<0.01	0.11	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/23/2007	Totals	605	19.25	7.17	2.5	137	30	119	332	265	57.4	26.5	17.9	2.9	<0.002	<0.002	<0.002	<0.01	0.118	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	58.2	27.3	17.5	2.9	<0.002	<0.002	<0.002	<0.01	0.115	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.042
10/23/2007	Totals	605	19.25	7.17	2.5	137	28.9	122	356	268	57.9	26.8	17.6	2.9	<0.002	<0.002	<0.002	<0.01	0.118	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	53.2	25	16.4	2.6	<0.002	<0.002	<0.002	<0.01	0.101	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
5/8/2007	Totals	442	20.03	7.59	1.56	119	38.9	57.2	256	194	40.9	20.1	25.8	2.8	<0.002	<0.002	<0.002	<0.01	0.116	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	37.4	18.7	23.5	2.9	<0.002	<0.002	<0.002	<0.01	0.11	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2006	Totals	635	21.46	7.23	0.88	139	27.4	141	373	282	64	28	17	3	<0.002	<0.002	<0.002	<0.01	0.118	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	58	27	17	3	<0.002	<0.002	<0.002	<0.01	0.108	<0.005	<0.01	<0.00015	<0.01	<0.01	<0.001	<0.005
4/11/2006	Totals	483	23.9	8.51	2.68	157	34.4	68.3	243	189	39	19	21	3	<0.002	<0.002	<0.002	<0.01	**0.629**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	41	20	21	3	<0.002	<0.002	<0.002	<0.01	0.112	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/11/2006	Totals	483	23.9	8.51	2.68	157	34.4	69.8	245	189	40	20	21	3	<0.002	<0.002	<0.002	<0.01	**0.227**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	42	20	21	3	<0.002	<0.002	<0.002	<0.01	0.1	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/17/2005	Totals	544	21.8	7.81	0.3	124	27.1	119	332	264	60	27	18	3	<0.002	<0.002	<0.002	<0.01	0.098	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	71	30	18	3	<0.002	<0.002	<0.002	<0.01	0.046	<0.005	<0.01	0.00015	<0.01	<0.01	<0.001	<0.005
10/17/2005	Totals	544	21.8	7.81	0.3	124	28.3	118	307	265	61	27	18	3	<0.002	<0.002	<0.002	<0.01	0.107	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	73	30	18	3	<0.002	<0.002	<0.002	<0.01	0.043	<0.005	<0.01	0.0001	<0.01	<0.01	<0.001	0.009
4/25/2005	Totals	581	18.5	7.56	2.91	132	25.4	132	373	273	61	28	17	3	<0.002	<0.002	<0.002	<0.01	0.093	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	62	28	17	3	<0.002	<0.002	<0.002	<0.01	0.061	<0.005	<0.01	0.00011	<0.01	<0.01	<0.001	<0.005
10/12/2004	Totals	569	18.3	7.68	2.33	122	26.4	140	398	279	63	29	17	3	<0.002	<0.002	<0.002	<0.01	0.171	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	62	28	17	3	<0.002	<0.002	<0.002	<0.01	0.151	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/27/2004	Totals	536	20.7	7.33	3.19	142	28.3	126	384	253	55	26	19	3	<0.01	<0.01	<0.005	<0.005	**0.433**	<0.01	0.007	0.00005	<0.01	<0.01	<0.01	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	55	27	18	3	<0.01	<0.01	<0.005	<0.005	**0.39**	<0.01	0.007	0.00008	<0.01	<0.01	<0.01	<0.005
11/5/2003	Totals	590	14	6.52	NA	NA	25.6	135	381	278	61	29	18	3	<0.002	<0.002	<0.002	<0.01	**0.232**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	59	28	18	3	<0.002	<0.002	<0.002	<0.01	**0.213**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
4/18/2002	Totals	591	19.9	7.11	NA	136	25	121	377	271	62	29	17	3	<0.002	<0.002	<0.002	<0.01	**0.332**	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	62	29	17	3	<0.002	<0.002	<0.002	<0.01	**0.323**	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
12/13/2001	Totals	527	15.4	7.21	NA		35.6	94.8	429	216	49	24	23	3	<0.002	<0.002	<0.002	<0.01	**0.54**	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	49	24	23	3	<0.002	<0.002	<0.002	<0.01	**0.393**	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	0.014
3/9/2001	Totals	580	19.1	7.22	NA		24.3	119	375	266	58	28	17	3	<0.002	<0.002	<0.002	<0.01	0.173	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	57	28	17	3	<0.002	<0.002	<0.002	<0.01	0.156	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
10/11/2000	Totals	571	20.2	7.15	NA		24.3	101	366	280	55	27	17	3	<0.002	<0.002	<0.002	<0.01	0.218	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	56	27	17	3	<0.002	<0.002	<0.002	<0.01	0.206	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
2/25/2000	Totals	621	20.2	7.07	NA	130	30	129	379	284	60	28	19	2	<0.002	<0.002	<0.002	<0.01	0.223	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	59	28	18	3	<0.002	<0.002	<0.002	<0.01	0.216	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
8/12/1999	Totals	550	23	7.45	1.95	140	23.9	118	106	268	62	28	19	2	<0.002	<0.002	<0.002	<0.01	0.169	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7/22/1999	Totals	490	19.5	7.05	1.39	135	24.5	120	370	262	64	29	22	3	<0.002	<0.002	<0.002	<0.01	0.146	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	64	29	21	3	<0.002	<0.002	<0.002	<0.01	0.116	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
3/25/1999	Totals	440	15	7.04	5.64	130	30.4	107	342	292	55	26	19	2.7	<0.002	<0.002	<0.002	<0.01	0.21	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	55	25	18	2.7	<0.002	<0.002	<0.002	<0.01	<0.01	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
12/15/1998	Totals	380	20	7.25	NA	NA	36.5	34	273	191.7	40	19	19	1.3	<0.002	<0.002	<0.002	<0.01	0.068	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	40	19	19	2	<0.002	<0.002	<0.002	<0.01	0.044	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
8/25/1998	Totals	480	21	7.06	NA	NA	37.1	60	345	236	55	25	19	3	<0.002	<0.002	<0.002	<0.01	0.122	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	55	25	19	3	<0.002	<0.002	<0.002	<0.01	0.069	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
7/31/1998	Totals	485	21	7.07	NA	NA	31.7	38	352	260	57	27	19	3	<0.002	<0.002	<0.002	<0.01	0.08	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	57	27	17	3	<0.002	<0.002	<0.002	<0.01	0.064	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
3/20/1998	Totals	325	17	7.06	NA	NA	59.7	29.9	42	180	39	18	19	3	<0.002	<0.002	<0.002	<0.01	0.096	<0.005	NA	<0.0005	<0.025	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	38	17	18	3	<0.002	<0.002	<0.002	<0.01	0.058	<0.005	NA	<0.0005	<0.025	<0.01	<0.001	<0.005
12/4/1997	Totals	400	18	7.17	NA	NA	34.5	41.1	271	220	49	21	18	3	<0.002	<0.002	<0.002	<0.01	0.08	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	48	21	17	3	<0.002	<0.002	<0.002	<0.01	0.075	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
9/16/1997	Totals	550	22	6.94	NA	NA	31.7	105.3	371	283	57	26	17	3	<0.002	<0.002	<0.002	<0.01	0.136	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	55	25	16	3	<0.002	<0.002	<0.002	<0.01	0.133	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
8/15/1997	Totals	550	22	7.3	NA	NA	44	117	375	248	60	27	17	3	<0.002	<0.002	<0.002	<0.01	0.145	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	59	26	17	3	<0.002	<0.002	<0.002	<0.01	0.069	<0.005	NA	<0.0005	<0.01	<0.01	<0.001	<0.01
	Averages	536	19.7	7.21	1.8	133	30.2	106	330	250	55	25	19	3	0.002	0.002	0.002	0.01	0.159	0.005	0.01	0.00023	0.01	0.01	0.001	0.008
Picher #6 - MW																										
10/29/2013	Totals	787	19.84	6.66	2.79	186	10.6	**284**	**599**	474	98.2	46	22.1	3.2	<0.002	<0.002	<0.002	0.01	**0.454**	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	0.008
	Dissolved	-	-	-	-	-	-	-	-	-	95.7	48.7	21.2	3.4	<0.002	<0.002	<0.002	<0.01	**0.534**	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	0.005
11/6/2012	Totals	945	18.63	7.12	3.37	154	11.4	324	644	508	106	49.9	20.5	3.2	<0.002	<0.002	<0.002	0.01	**0.554**	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	0.014
	Dissolved	-	-	-	-	-	-	-	-	-	102	48.9	20.5	3.1	<0.002	<0.002	<0.002	<0.01	**0.509**	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	0.014
11/6/2012	Totals	945	18.63	7.12	3.37	154	11.2	**328**	**628**	510	105	49.7	20.6	3.1	<0.002	<0.002	<0.002	0.011	**0.546**	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	0.013
	Dissolved	-	-	-	-	-	-	-	-	-	102	48.9	20.3	3.1	<0.002	<0.002	<0.002	<0.01	**0.5**	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	0.014
11/1/2011	Totals	874	22.25	7.25	2.53	170	10.4	**266**	**574**	476	90.3	45.3	17	3	<0.002	<0.002	<0.002	<0.01	**0.796**	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	0.018
	Dissolved	-	-	-	-	-	-	-	-	-	97.4	47	17.7	3.1	<0.002	0.002	<0.002	<0.01	**0.827**	<0.005	0.015	<0.00005	<0.01	<0.01	<0.001	0.02
11/9/2010	Totals	790	20.06	**5.55**	3.96	161	<10	**262**	**541**	397	87.7	41.4	17.1	2.8	<0.002	<0.002	<0.002	<0.01	**0.418**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.010
	Dissolved	-	-	-	-	-	-	-	-	-	89.1	41.4	17	2.8	<0.002	<0.002	<0.002	<0.01	**0.404**	<0.005	0.011	<0.00005	<0.01	<0.01	<0.001	<0.010
11/9/2010	Totals	790	20.06	**5.55**	3.96	161	<10	**271**	**536**	398	88.2	41.7	17.1	2.8	<0.002	<0.002	<0.002	<0.01	**0.423**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.010
	Dissolved	-	-	-	-	-	-	-	-	-	89.2	41.4	16.9	2.8	<0.002	<0.002	<0.002	<0.01	**0.412**	<0.005	0.01	<0.00005	<0.01	<0.01	<0.001	<0.010
3/23/2010	Totals	773	20.71	**5.98**	4.06	155	10.3	244	**533**	371	85.5	40.3	16.4	2.8	<0.002	<0.002	<0.002	<0.01	**0.427**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.01
	Dissolved	-	-	-	-	-	-	-	-	-	84.5	39.5	16.2	2.8	<0.002	<0.002	<0.002	<0.01	**0.402**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.009
3/23/2010	Totals	773	20.71	**5.98**	4.06	155	10.4	243	**534**	374	83.7	39.7	16.2	2.8	<0.002	<0.002	<0.002	<0.01	**0.427**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.001
	Dissolved	-	-	-	-	-	-	-	-	-	84.6	39.8	16.2	2.8	<0.002	<0.002	<0.002	<0.01	**0.401**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.009
4/21/2008	Totals	662	21.89	7.1	4.24	136	<10	186	405	312	69	32.6	14.4	2.4	<0.002	<0.002	<0.002	<0.01	**0.369**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.008

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	68.6	32.9	14	2.4	<0.002	<0.002	<0.002	<0.01	**0.339**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.007
4/21/2008	Totals	662	21.89	7.1	4.24	136	<10	184	397	313	70.9	33.5	14.8	2.4	<0.002	<0.002	<0.002	<0.01	**0.379**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.009
	Dissolved	-	-	-	-	-	-	-	-	-	70.3	33.4	14.3	2.4	<0.002	<0.002	<0.002	<0.01	**0.355**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.007
10/22/2007	Totals	619	16.4	7.25	4.05	143	10.2	171	387	312	68.9	31.9	13.5	2.3	<0.002	<0.002	<0.002	<0.01	**0.351**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.008
	Dissolved	-	-	-	-	-	-	-	-	-	66.7	31.8	13.5	2.3	<0.002	<0.002	<0.002	<0.01	**0.275**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.009
10/22/2007	Totals	619	16.4	7.25	4.05	143	10.2	170	406	310	68.4	31.9	13.4	2.3	<0.002	<0.002	<0.002	<0.01	**0.35**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.014
	Dissolved	-	-	-	-	-	-	-	-	-	66.5	31.5	13.4	2.3	<0.002	<0.002	<0.002	<0.01	0.259	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.011
5/7/2007	Totals	616	20.06	7.22	1.97	138	<10	177	375	286	63.6	30.8	13.7	2.4	<0.002	<0.002	<0.002	<0.01	**0.325**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	63.7	30.8	14	2.4	<0.002	<0.002	<0.002	<0.01	**0.302**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
5/7/2007	Totals	616	20.06	7.22	1.97	138	<10	175	381	290	64	30.9	13.6	2.3	<0.002	<0.002	<0.002	<0.01	**0.327**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	63.4	30.4	13.8	2.3	<0.002	<0.002	<0.002	<0.01	**0.307**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/7/2006	Totals	602	21.4	6.94	4.17	141	<10	144	339	273	56	27	12	2	<0.002	<0.002	<0.002	<0.01	**0.302**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.008
	Dissolved	-	-	-	-	-	-	-	-	-	55	27	12	2	<0.002	<0.002	<0.002	<0.01	0.274	<0.005	<0.01	0.00005	<0.01	<0.01	<0.001	0.008
4/10/2006	Totals	511	20.3	8.11	2.62	134	10	142	315	258	56	26	13	2	<0.002	<0.002	<0.002	<0.01	**0.309**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	59	27	13	2	<0.002	<0.002	<0.002	<0.01	0.284	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/10/2006	Totals	511	20.3	8.11	2.62	134	10	143	316	258	54	25	13	2	<0.002	<0.002	<0.002	<0.01	**0.301**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	57	26	13	2	<0.002	<0.002	<0.002	<0.01	0.222	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/27/2005	Totals	453	17.8	7.73	3.79	125	10	125	313	249	58	26	12	2	<0.002	0.002	<0.002	<0.01	0.296	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	59	26	12	2	<0.002	0.002	<0.002	<0.01	0.238	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/27/2005	Totals	453	17.8	7.73	3.79	125	10	125	307	251	63	27	12	2	<0.002	0.002	<0.002	<0.01	0.298	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
	Dissolved	-	-	-	-	-	-	-	-	-	59	26	12	2	<0.002	<0.002	<0.002	<0.01	0.282	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
4/25/2005	Totals	510	18.6	7.77	3.24	NA	<10	125	333	251	60	26	12	2	<0.002	0.002	<0.002	<0.01	**0.345**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
	Dissolved	-	-	-	-	-	-	-	-	-	58	26	12	2	<0.002	0.002	<0.002	<0.01	**0.341**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.007
4/25/2005	Totals	510	18.6	7.77	3.24	NA	<10	126	336	251	61	26	12	2	<0.002	0.002	<0.002	<0.01	**0.338**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
	Dissolved	-	-	-	-	-	-	-	-	-	56	25	12	2	<0.002	0.002	<0.002	<0.01	**0.331**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.006
10/11/2004	Totals	553	19.1	7.44	2.06	193	<10	170	417	303	71	30	13	2	<0.002	0.002	<0.002	<0.01	**0.531**	<0.005	0.012	<0.00005	<0.01	<0.01	<0.001	0.021
	Dissolved	-	-	-	-	-	-	-	-	-	71	30	13	2	<0.002	0.002	<0.002	<0.01	**0.507**	<0.005	0.012	<0.00005	<0.01	<0.01	<0.001	0.02
4/27/2004	Totals	555	20.9	7.26	4.92	157	<10	156	407	293	63	29	14	2	<0.01	<0.01	<0.005	<0.005	**0.444**	<0.01	0.011	0.00005	<0.01	<0.01	<0.01	0.015
	Dissolved	-	-	-	-	-	-	-	-	-	62	29	13	2	<0.01	<0.01	<0.005	<0.005	**0.414**	<0.01	0.011	0.00005	<0.01	<0.01	<0.01	0.019
12/9/2003	Totals	537	18.2	6.83	NA	135	<10	150	380	280	65	29	13	2	<0.002	0.002	<0.002	<0.01	**0.464**	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	0.016
	Dissolved	-	-	-	-	-	-	-	-	-	60	27	12	2	<0.002	0.002	<0.002	<0.01	**0.337**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.015

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond.	Temp.	pH	D.O.	Alk (Field)	Chloride	Sulfate	Tot Dis Sol	Hardiness	Calcium	Magnesium	Sodium	Potassium	Antimony	Arsenic	Cadmium	Chromium	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Thallium	Zinc
		(Field)	(Field)	(Field)	(Field)	$CaCO_3$	Cl	SO_4	TDS	$CaCO_3$	Ca	Mg	Na	K	Sb	As	Cd	Cr	Fe	Pb	Mn	Hg	Ni	Se	Tl	Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
12/9/2003	Totals	537	18.2	6.83	NA	135	<10	150	381	277	64	29	13	2	<0.002	0.002	<0.002	<0.01	**0.46**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.014
	Dissolved	-	-	-	-	-	-	-	-	-	61	27	12	2	<0.002	0.002	<0.002	<0.01	**0.337**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.016
4/18/2002	Totals	565	20.3	7.24	NA	105	7.1	86	364	280	63	27	13	2	<0.002	<0.002	<0.002	<0.01	**0.6**	<0.005	0.011	<0.0005	<0.01	<0.01	<0.001	0.015
	Dissolved	-	-	-	-	-	-	-	-	-	65	27	12	2	<0.002	<0.002	<0.002	<0.01	**0.563**	<0.005	0.011	<0.0005	<0.01	<0.01	<0.001	0.017
12/13/2001	Totals	569	18.9	7.13	NA	110	6.7	152	370	276	65	27	13	2	<0.002	0.003	<0.002	<0.01	**0.677**	<0.005	0.012	<0.0005	0.01	<0.01	<0.001	0.016
	Dissolved	-	-	-	-	-	-	-	-	-	65	27	13	2	<0.002	0.003	<0.002	<0.01	**0.653**	<0.005	0.012	<0.0005	<0.01	<0.01	<0.001	0.016
2/26/2001	Totals	863	19.1	7.08	NA	165	8.8	358	623	483	111	42	16	3	<0.002	0.004	<0.002	<0.01	**1.669**	<0.005	0.024	<0.0005	0.032	<0.01	<0.001	0.079
	Dissolved	-	-	-	-	-	-	-	-	-	111	42	16	3	<0.002	0.004	<0.002	<0.01	**1.659**	<0.005	0.025	<0.0005	0.032	<0.01	<0.001	0.078
10/17/2000	Totals	900	20.5	6.94	2.72	110	6.7	307	836	874	153	57	17	3	<0.002	0.004	<0.002	<0.01	**2.304**	<0.005	0.027	<0.0005	0.03	<0.01	<0.001	0.11
	Dissolved	-	-	-	-	-	-	-	-	-	152	57	17	3	<0.002	0.004	<0.002	<0.01	**2.295**	<0.005	0.028	<0.0005	0.033	<0.01	<0.001	0.112
	Averages	659	19.6	7.08	3.41	144	9.8	198.1	447	351	76	34	15	2	0.002	0.002	0.002	0.01	**0.518**	0.005	0.012	0.00011	0.012	0.01	0.001	0.016
Picher #7																										
10/29/2013	Totals	855	19.25	6.74	2.9	172	12.2	**346**	**681**	551	109	55.4	18.2	3.6	<0.002	<0.002	<0.002	0.01	**0.278**	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	109	54.8	17.9	3.9	<0.002	<0.002	<0.002	<0.01	**0.325**	<0.005	0.018	<0.00005	<0.01	<0.01	<0.001	<0.005
10/29/2013	Totals	858	19.55	6.68	2.18	181	12	**334**	**676**	552	109	54.9	18.2	3.6	<0.002	<0.002	<0.002	0.01	**0.276**	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	109	54.7	17.9	3.9	<0.002	<0.002	<0.002	<0.01	**0.326**	<0.005	0.015	<0.00005	<0.01	<0.01	<0.001	<0.005
11/6/2012	Totals	933	19.24	7	1.42	162.5	12.9	**351**	**689**	565	114	53.6	16.9	3.5	<0.002	<0.002	<0.002	0.01	**0.537**	<0.005	0.017	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	110	52.3	16.6	3.4	<0.002	<0.002	<0.002	<0.01	**0.431**	<0.005	0.017	<0.00005	<0.01	<0.01	<0.001	<0.005
11/1/2011	Totals	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Dissolved	-	-	-	-	-	-	-	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11/9/2010	Totals	835	21.74	5.96	1.59	165	12.1	**277**	**545**	419	90.3	43.2	14.7	3.1	<0.002	<0.002	<0.002	<0.01	0.204	<0.005	0.014	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	92.8	43	14.7	3	<0.002	<0.002	<0.002	<0.01	0.201	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
3/23/2010	Totals	829	20.82	6.28	2.96	176	11.3	**263**	**651**	467	100	48.1	14.2	3.4	<0.002	<0.002	<0.002	<0.01	**0.317**	<0.005	0.013	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	102	49.4	14.3	3.4	<0.002	<0.002	<0.002	<0.01	0.285	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/21/2008	Totals	779	22.21	7.09	1.92	155	11	240	490	393	85.3	41.9	12.5	3.1	<0.002	<0.002	<0.002	<0.01	0.176	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	81	40.4	11.6	2.9	<0.002	<0.002	<0.002	<0.01	0.187	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/22/2007	Totals	700	16.05	7.3	1.38	151	12	194	447	347	73.4	35.8	11.7	2.8	<0.002	<0.002	<0.002	<0.01	0.079	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	68.5	34.4	11.3	2.8	<0.002	<0.002	<0.002	<0.01	0.071	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
5/8/2007	Totals	647	19.65	7.41	1.14	148	11.8	198	405	307	67.5	34.3	12.2	2.9	<0.002	<0.002	<0.002	<0.01	0.08	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	66.9	34.5	11.9	2.8	<0.002	<0.002	<0.002	<0.01	0.075	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/7/2006	Totals	652	19.81	7.04	2.04	153	12.3	175	397	329	65	33	12	3	<0.002	<0.002	<0.002	<0.01	0.124	<0.005	0.006	<0.00005	<0.01	<0.01	<0.001	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	60	31	11	3	<0.002	<0.002	<0.002	<0.01	0.113	<0.005	0.006	<0.00005	<0.01	<0.01	<0.001	<0.005
4/11/2006	Totals	482	19.6	8.2	1.43	117	17.5	103	257	216	44	23	13	3	<0.002	<0.002	<0.002	<0.01	0.079	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	47	23	13	3	<0.002	<0.002	<0.002	<0.01	0.065	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/17/2005	Totals	527	20.4	7.82	0.2	179	11.4	137	326	280	62	30	11	3	<0.002	<0.002	<0.002	<0.01	0.064	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	72	32	11	3	<0.002	<0.002	<0.002	<0.01	0.062	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/25/2005	Totals	524	18.3	7.71	1.87	174	10.1	125	341	261	59	28	11	3	<0.002	<0.002	<0.002	<0.01	0.09	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	56	28	11	3	<0.002	<0.002	<0.002	<0.01	0.09	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/12/2004	Totals	483	17.9	7.83	1.31	129	13.5	112	306	244	54	26	12	3	<0.002	<0.002	<0.002	<0.01	0.127	<0.005	<0.01	0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	55	27	12	3	<0.002	<0.002	<0.002	<0.01	0.121	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/27/2004	Totals	480	20.2	7.5	4.35	105	12.6	112	335	237	51	26	12	3	<0.01	<0.01	<0.005	<0.005	0.078	<0.01	0.005	0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	49	26	12	3	<0.01	<0.01	<0.005	<0.005	0.072	<0.01	<0.005	0.00005	<0.01	<0.01	<0.001	<0.005
11/5/2003	Totals	563	14.7	6.89	NA	NA	<10	141	374	284	60	31	12	3	<0.002	<0.002	<0.002	<0.01	0.166	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	59	31	12	3	<0.002	<0.002	<0.002	<0.01	0.16	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
4/19/2002	Totals	525	20.2	7.38	NA	95	14.1	112	332	255	54	27	13	3	<0.002	<0.002	<0.002	<0.01	0.092	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	53	27	13	2	<0.002	<0.002	<0.002	<0.01	0.073	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
12/13/2001	Totals	455	16.9	7.6	NA	98	18	93.3	241	211	45	23	14	3	<0.002	<0.002	<0.002	<0.01	0.063	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	45	23	13	3	<0.002	<0.002	<0.002	<0.01	0.049	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
3/9/2001	Totals	546	17.7	7.48	NA	115	14.6	121	351	257	55	28	13	2	<0.002	<0.002	<0.002	<0.01	0.173	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	54	28	13	2	<0.002	<0.002	<0.002	<0.01	0.16	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
10/17/2000	Totals	453	16.9	7.25	NA	125	15.7	71.1	282	215	45	22	13	2	<0.002	<0.002	<0.002	<0.01	0.163	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	45	22	13	2	<0.002	<0.002	<0.002	<0.01	0.159	<0.005	<0.01	<0.0005	<0.01	<0.01	<0.001	<0.01
	Averages	638	19	7.22	1.91	144	12.9	184.5	428	336	70	35	13	3	0.002	0.002	0.002	0.01	0.163	0.005	0.011	0.00014	0.01	0.01	0.001	0.007
Quapaw #4																										
10/31/2013	Totals	295	19.12	7.09	1.49	117	11.6	14.3	129	126	26.4	14.2	7.8	1.5	<0.002	<0.002	<0.002	<0.01	0.025	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	22.9	11.9	7.7	1.4	<0.002	<0.002	<0.002	<0.01	0.02	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2012	Totals	284	18.23	7.34	0.58	101	10.8	15.5	144	128	26.5	13.2	6.1	1.3	<0.002	<0.002	<0.002	<0.01	0.031	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	0.007
	Dissolved	-	-	-	-	-	-	-	-	-	25.7	12.9	5.8	1.3	<0.002	<0.002	<0.002	<0.01	0.036	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
11/8/2012	Totals	284	18.23	7.34	0.58	101	10.8	15.7	134	127	26.3	13	6	1.3	<0.002	<0.002	<0.002	<0.01	0.032	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	0.006
	Dissolved	-	-	-	-	-	-	-	-	-	25	12.6	5.6	1.2	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
11/3/2011	Totals	276	15.3	7.72	0.8	110	17.6	14.3	128	104	26.4	13.6	6.3	1.4	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	26.3	13.8	6.9	1.4	<0.002	<0.002	<0.002	<0.01	0.034	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
11/11/2010	Totals	263	17.89	5.73	0.48	NA	<10	15.7	142	117	26.2	13.2	5.3	1.3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	26	13	5.1	1.3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/11/2010	Totals	263	17.89	5.73	0.48	NA	<10	15.2	141	116	25.8	13.1	5.2	1.3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	26	13	5.1	1.3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	0.019	<0.001	<0.01
3/25/2010	Totals	228	17.16	6.97	0.86	105	<10	14.7	141	121	26.4	13.2	7.2	1.5	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.031
	Dissolved	-	-	-	-	-	-	-	-	-	25.8	12.9	7.6	1.6	<0.002	<0.002	<0.002	<0.01	0.021	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
3/25/2010	Totals	228	17.16	6.97	0.86	105	<10	14.8	142	119	26.7	13.3	7.1	1.5	<0.002	<0.002	<0.002	<0.01	0.022	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.012
	Dissolved	-	-	-	-	-	-	-	-	-	25.9	13.2	7.4	1.5	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/22/2008	Totals	263	20.35	7.54	1.35	102	<10	13.2	144	123	26.4	13.4	5.6	1.4	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25.6	13.1	5.3	1.3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/24/2007	Totals	280	17.87	7.4	1.46	109	10.8	14.3	137	127	27.1	13.7	6.7	1.5	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	23.4	12	5.8	1.3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.01
5/9/2007	Totals	287	19.85	7.28	1.12	104	13.4	12.6	145	132	26.2	13.7	9	1.7	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.043
	Dissolved	-	-	-	-	-	-	-	-	-	26.6	13.4	8.6	1.6	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.041
11/9/2006	Totals	276	19.12	7.39	0.52	118	18.6	20	160	134	29	14	12	2	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27	13	11	2	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/12/2006	Totals	270	18.8	8.53	1.03	92	<10	15.2	118	118	24	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/18/2005	Totals	258	19.9	7.96	1.58	96	18.6	16.4	184	136	30	14	11	2	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	30	14	11	2	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/26/2005	Totals	261	16.8	8.04	1.57	NA	<10	13.5	138	119	26	13	6	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	25	13	6	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/13/2004	Totals	242	17.4	7.86	1.43	124	<10	12.7	149	121	27	14	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.005
10/13/2004	Totals	242	17.4	7.86	1.43	124	<10	12.8	147	121	27	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	27	14	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/28/2004	Totals	275	19.4	7.31	2.29	146	<10	11.8	152	122	25	13	8	2	<0.01	<0.01	<0.005	<0.005	<0.02	<0.01	<0.005	0.00005	<0.01	<0.01	<0.01	0.005
	Dissolved	-	-	-	-	-	-	-	-	-	24	13	7	2	<0.01	<0.01	<0.005	<0.005	<0.02	<0.01	<0.005	<0.00005	<0.01	<0.01	<0.01	<0.005
11/6/2003	Totals	249	17.7	7.03	NA	107	<10	11.1	129	120	25	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	24	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/6/2003	Totals	249	17.7	7.03	NA	107	<10	11.1	131	121	24	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	25	13	5	1	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Averages	264	18.2	7.31	1.11	110	11.6	14.25	142	123	26	13	7	1	0.002	0.002	0.002	0.01	0.022	0.005	0.009	0.00005	0.01	0.01	0.001	0.009
Quapaw #5																										
10/31/2013	Totals	1627	18.94	6.42	1.79	308	96.5	**467**	**1120**	822	185	83.6	65.3	8.2	<0.002	0.005	<0.002	<0.01	**4.02**	<0.005	**0.052**	<0.00005	<0.01	<0.01	<0.001	0.186
	Dissolved	-	-	-	-	-	-	-	-	-	158	78.1	64.3	8.6	<0.002	0.006	<0.002	<0.01	**3.83**	<0.005	**0.05**	<0.00005	<0.01	<0.01	<0.001	0.168
10/31/2013	Totals	1643	19.17	6.46	1.23	292	95.5	**470**	**1110**	824	187	83.8	66.2	8.4	<0.002	0.005	<0.002	<0.01	**4.05**	<0.005	**0.052**	<0.00005	<0.01	<0.01	<0.001	0.187
	Dissolved	-	-	-	-	-	-				164	81.3	66.5	8.7	<0.002	0.006	<0.002	<0.01	**3.96**	<0.005	**0.052**	<0.00005	<0.01	<0.01	<0.001	0.175
11/8/2012	Totals	1694	19.65	6.49	1.29	256	98.6	552	**1170**	842	170	80.8	65.1	8.6	<0.002	0.008	<0.002	<0.01	**4.75**	<0.005	**0.067**	<0.00005	0.01	<0.01	<0.001	0.21
	Dissolved	-	-	-	-	-	-	-	-	-	172	81.8	64.4	8.6	<0.002	0.006	<0.002	<0.01	**4.6**	<0.005	**0.066**	<0.00005	0.011	<0.01	<0.001	0.2
11/3/2011	Totals	1599	15.66	6.76	1.29	294	104	**514**	**1130**	684	161	80.8	55.6	9.1	<0.002	0.008	<0.002	<0.01	**3.94**	<0.005	**0.052**	<0.00005	<0.01	<0.01	<0.001	0.135
	Dissolved	-	-	-	-	-	-	-	-	-	172	82.5	56.8	9.4	<0.002	0.006	<0.002	<0.01	**3.96**	<0.005	**0.055**	<0.00005	<0.01	<0.01	<0.001	0.139
11/11/2010	Totals	1532	18.93	**6.13**	3.53	NA	97.2	**544**	**1110**	708	166	76.2	57.1	8.8	<0.002	<0.002	<0.002	<0.01	**3.01**	<0.005	0.037	<0.00005	<0.01	<0.01	<0.001	0.123
	Dissolved	-	-	-	-	-	-	-	-	-	168	75.4	55.9	8.8	<0.002	0.007	<0.002	<0.01	**3**	<0.005	0.036	<0.00005	<0.01	<0.01	<0.001	0.128
3/25/2010	Totals	1227	14.93	**6.39**	3.28	260	94.4	**465**	**1110**	732	162	71.4	54.1	9.1	<0.002	0.004	<0.002	<0.01	**3.14**	<0.005	0.028	<0.00005	<0.01	<0.01	<0.001	0.132
	Dissolved	-	-	-	-	-	-	-	-	-	160	71.6	54.7	9	<0.002	0.003	<0.002	<0.01	**2.8**	<0.005	0.023	<0.00005	<0.01	<0.01	<0.001	0.122
4/23/2008	Totals	1497	21.15	6.5	1.8	265	99.1	**456**	**1080**	807	158	74.2	56.9	8.4	<0.002	0.004	<0.002	<0.01	**2.88**	<0.005	0.026	<0.00005	<0.01	<0.01	<0.001	0.135
	Dissolved	-	-	-	-	-	-	-	-	-	156	73.4	54.8	8.3	<0.002	0.006	<0.002	<0.01	**2.77**	<0.005	0.036	<0.00005	<0.01	<0.01	<0.001	0.126
4/23/2008	Totals	1497	21.15	6.5	1.8	265	98.5	**464**	**1100**	808	161	75.9	57.5	8.4	<0.002	0.005	<0.002	<0.01	**2.92**	<0.005	0.031	<0.00005	<0.01	<0.01	<0.001	0.138
	Dissolved	-	-	-	-	-	-	-	-	-	158	73.2	54.9	8.3	<0.002	0.006	<0.002	<0.01	**2.79**	<0.005	0.034	<0.00005	<0.01	<0.01	<0.001	0.129
10/24/2007	Totals	1503	17.23	6.8	5.94	279	95.4	**429**	**1040**	703	158	73.5	53	8.3	<0.002	0.005	<0.002	<0.01	**2.77**	<0.005	0.033	<0.00005	<0.01	<0.01	<0.001	0.13
	Dissolved	-	-	-	-	-	-	-	-	-	144	67.6	48.1	7.4	<0.002	0.005	<0.002	<0.01	**2.42**	<0.005	0.032	<0.00005	<0.01	<0.01	<0.001	0.126
10/24/2007	Totals	1503	17.23	6.8	5.94	279	95.4	**459**	**1020**	707	160	75.1	53.2	8.4	<0.002	0.005	<0.002	<0.01	**2.81**	<0.005	0.034	<0.00005	<0.01	<0.01	<0.001	0.132
	Dissolved	-	-	-	-	-	-	-	-	-	142	66.6	48.9	7.4	<0.002	0.004	<0.002	<0.01	**2.33**	<0.005	0.03	<0.00005	<0.01	<0.01	<0.001	0.116
5/9/2007	Totals	1477	20.6	6.7	1.46	264	92.9	**264**	**1000**	716	154	75	54.2	8.6	<0.002	<0.002	<0.002	<0.01	**2.62**	<0.005	0.026	<0.00005	<0.01	<0.01	<0.001	0.121
	Dissolved	-	-	-	-	-	-	-	-	-	154	74	53.5	8.4	<0.002	0.004	<0.002	<0.01	**2.45**	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.114
11/9/2006	Totals	1446	19.93	6.78	1.39	272	95.4	**391**	**968**	709	156	69	50	8	<0.002	0.004	<0.002	<0.01	**2.48**	<0.005	0.035	<0.00005	<0.01	<0.01	<0.001	0.113
	Dissolved	-	-	-	-	-	-	-	-	-	143	69	49	8	<0.002	0.004	<0.002	<0.01	**2.42**	<0.005	0.035	0.00005	<0.01	<0.01	<0.001	0.11
4/12/2006	Totals	1497	20.3	7.7	1.29	244	93.6	**434**	**992**	767	151	69	54	8	<0.002	<0.002	<0.002	<0.01	**2.62**	<0.005	0.027	<0.00005	<0.01	<0.01	<0.001	0.118
	Dissolved	-	-	-	-	-	-	-	-	-	150	68	53	8	<0.002	0.005	<0.002	<0.01	**2.57**	<0.005	0.037	<0.00005	<0.01	<0.01	<0.001	0.112
4/12/2006	Totals	1497	20.3	7.7	1.29	244	93.8	**422**	**993**	764	150	69	54	8	<0.002	<0.002	<0.002	<0.01	**2.61**	<0.005	0.026	<0.00005	<0.01	<0.01	<0.001	0.119
	Dissolved	-	-	-	-	-	-	-	-	-	147	67	53	8	<0.002	<0.002	<0.002	<0.01	**2.53**	<0.005	0.037	<0.00005	<0.01	<0.01	<0.001	0.11

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
10/18/2005	Totals	1378	20.8	7.11	3.8	308	95.1	**417**	**1020**	358	162	72	53	8	<0.002	0.005	<0.002	<0.01	**2.44**	<0.005	0.036	<0.00005	<0.01	<0.01	<0.001	0.139
	Dissolved	-	-	-	-	-	-	-	-	-	168	73	50	7	<0.002	0.005	<0.002	<0.01	**2.34**	<0.005	0.038	<0.00005	<0.01	<0.01	<0.001	0.143
4/26/2005	Totals	1350	19.2	7.1	1.93	NA	92.4	**412**	**1020**	733	159	72	52	7	<0.002	0.005	<0.002	<0.01	**2.86**	<0.005	0.039	<0.00005	<0.01	<0.01	<0.001	0.167
	Dissolved	-	-	-	-	-	-	-	-	-	152	68	51	7	<0.002	0.005	<0.002	<0.01	**2.68**	<0.005	0.039	<0.00005	<0.01	<0.01	<0.001	0.159
10/13/2004	Totals	1341	18.6	7.01	2.43	247	95.9	**410**	**1010**	739	159	70	53	7	<0.002	0.005	<0.002	<0.01	**3.06**	<0.005	0.043	<0.00005	<0.01	<0.01	<0.001	0.178
	Dissolved	-	-	-	-	-	-	-	-	-	144	65	48	7	<0.002	0.005	<0.002	<0.01	**2.75**	<0.005	0.042	<0.00005	<0.01	<0.01	<0.001	0.16
4/28/2004	Totals	1372	21.7	6.87	1.75	260	104	**455**	**1083**	754	148	71	59	8	<0.01	<0.01	<0.005	<0.005	**3.68**	<0.01	**0.05**	<0.00005	<0.01	<0.01	<0.01	0.208
	Dissolved	-	-	-	-	-	-	-	-	-	147	72	58	7	<0.01	**0.011**	<0.005	<0.005	**3.58**	<0.01	0.049	<0.00005	<0.01	<0.01	<0.01	0.194
11/6/2003	Totals	1427	18.5	6.41	NA	265	102	**401**	**1050**	751	146	70	58	8	<0.002	**0.005**	<0.002	<0.01	**3.72**	<0.005	0.046	<0.00005	<0.01	<0.01	<0.001	0.222
	Dissolved	-	-	-	-	-	-	-	-	-	147	71	59	8	<0.002	**0.005**	<0.002	<0.01	**3.69**	<0.005	0.047	<0.00005	<0.01	<0.01	<0.001	0.213
4/18/2002	Totals	1231	21	6.77	NA	160	86.6	**305**	**890**	665	135	63	47	7	<0.002	**0.003**	<0.002	<0.01	**3.072**	<0.005	0.037	<0.0005	<0.01	<0.01	<0.001	0.08
	Dissolved	-	-		-			-	-	-	130	61	46	7	<0.002	**0.003**	<0.002	<0.01	**2.943**	<0.005	0.037	<0.0005	<0.01	<0.01	<0.001	0.08
12/14/2001	Totals	1237	15.3	6.96	NA	185	80.3	**376**	**828**	610	133	61	49	7	<0.002	**0.003**	<0.002	<0.01	**2.762**	0.012	0.037	<0.0005	<0.01	<0.01	<0.001	0.135
	Dissolved	-	-		-			-	-	-	126	59	48	7	<0.002	**0.004**	<0.002	<0.01	**2.619**	<0.005	0.037	<0.0005	<0.01	<0.01	<0.001	0.141
3/9/2001	Totals	1144	20.2	7	NA	200	69.2	**293**	**814**	558	124	57	41	6	<0.002	**0.003**	<0.002	<0.01	**2.325**	<0.005	0.036	<0.0005	<0.01	<0.01	<0.001	0.118
	Dissolved	-	-		-			-	-	-	148	74	33	3	<0.002	**0.003**	<0.002	<0.01	**2.599**	<0.005	0.036	<0.0005	<0.01	<0.01	<0.001	0.115
10/13/2000	Totals	1166	21.5	7.02	3.21	230	71.3	**279**	**825**	907	NA	NA	42	NA	<0.002	**0.003**	<0.002	<0.01	**2.832**	<0.005	0.036	<0.0005	<0.01	<0.01	<0.001	0.132
	Dissolved	-	-	-	-	-	-	-	-	-	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Averages	1,430	19.2	6.8	2.44	256	93.4	**420.8**	**1,021**	725	154	72	54	8	0.002	0.005	0.002	0.01	**3.044**	0.005	0.039	0.00012	0.01	0.01	0.001	0.143
RWD4 #3																										
10/31/2013	Totals	308	18.55	7.3	0.7	110	20.7	11.2	140	137	27.7	16.1	8.3	1.7	<0.002	<0.002	<0.002	<0.01	0.023	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28	16.3	9.2	8.6	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.005	<0.00005	<0.01	<0.03	<0.001	<0.005
11/8/2012	Totals	305	19.47	7.5	1.59	101.5	19.8	11.6	145	137	27.6	14.8	8.2	1.6	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28.2	15	8.1	1.6	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.005	<0.00005	<0.01	<0.03	<0.001	<0.005
11/3/2011	Totals	305	16.03	7.77	2.3	109	24.1	11	140	115	27.3	15.5	7.3	1.6	<0.002	<0.002	<0.002	<0.01	0.023	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	26.9	16.3	7.3	1.6	<0.002	<0.002	<0.002	<0.01	0.025	<0.005	<0.01	<0.00005	<0.01	<0.03	<0.001	<0.01
11/3/2011	Totals	305	16.03	7.77	2.3	109	18.4	10	144	114	27.5	15.5	7.1	1.6	<0.002	<0.002	<0.002	<0.01	0.023	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	27.3	15.6	7.3	1.6	<0.002	<0.002	<0.002	<0.01	0.025	<0.005	<0.01	<0.00005	<0.01	<0.03	<0.001	<0.01
11/11/2010	Totals	300	19.11	6.58	1.12	NA	16.8	10.8	158	127	27.5	14.9	7.5	1.6	<0.002	<0.002	<0.002	<0.01	0.022	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	28.2	15.2	7.6	1.6	<0.002	<0.002	<0.002	<0.01	0.025	<0.005	<0.01	<0.00005	<0.01	<0.03	<0.001	<0.01
3/25/2010	Totals	245	15.66	7.13	2.78	108	18.2	11.9	151	135	27.3	14.9	7.2	1.6	<0.002	<0.002	<0.002	<0.01	0.023	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond. (Field)	Temp. (Field)	pH (Field)	D.O. (Field)	Alk (Field) $CaCO_3$	Chloride Cl	Sulfate SO_4	Tot Dis Sol TDS	Hardiness $CaCO_3$	Calcium Ca	Magnesium Mg	Sodium Na	Potassium K	Antimony Sb	Arsenic As	Cadmium Cd	Chromium Cr	Iron Fe	Lead Pb	Manganese Mn	Mercury Hg	Nickel Ni	Selenium Se	Thallium Tl	Zinc Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
	Dissolved	-	-	-	-	-	-	-	-	-	27.2	15	7.3	1.6	<0.002	<0.002	<0.002	<0.01	0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/23/2008	Totals	297	21.47	7.05	0.98	107	18.1	<10	157	135	28.1	15.3	6.9	1.6	<0.002	<0.002	<0.002	<0.01	0.039	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	26.8	14.7	6.6	1.6	<0.002	<0.002	<0.002	<0.01	0.033	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/24/2007	Totals	295	18.31	7.58	0.55	113	17.7	<10	141	137	27.1	15.1	6.8	1.6	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	24.3	13.6	6	1.3	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
5/9/2007	Totals	298	19.75	7.52	0.93	125	17.8	<10	151	141	26.8	15.1	7.2	1.5	<0.002	<0.002	<0.002	<0.01	0.024	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	26.6	15	7.1	1.6	<0.002	<0.002	<0.002	<0.01	0.021	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
5/9/2007	Totals	298	19.75	7.52	0.93	125	17.7	<10	147	143	26.5	15	7	1.5	<0.002	<0.002	<0.002	<0.01	0.022	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	26.6	15	7.1	1.6	<0.002	<0.002	<0.002	<0.01	0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/9/2006	Totals	299	20.28	7.69	1.25	116	18.1	11	160	135	27	15	7	2	<0.002	<0.002	<0.002	<0.01	0.025	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	26	15	7	2	<0.002	<0.002	<0.002	<0.01	0.022	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/12/2006	Totals	309	19.4	7.98	0.86	99	17.9	10.5	134	130	25	15	7	2	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	27	15	7	2	<0.002	<0.002	<0.002	<0.01	0.022	<0.005	0.015	<0.00005	<0.01	<0.01	<0.001	<0.005
10/18/2005	Totals	295	20.4	8.09	1.05	141	17.7	10.4	168	140	29	16	7	2	<0.002	<0.002	<0.002	<0.01	0.025	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	28	15	6	2	<0.002	<0.002	<0.002	<0.01	0.022	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/26/2005	Totals	282	18.4	8.01	1.91	NA	16.5	10.2	157	133	28	15	6	2	<0.002	<0.002	<0.002	<0.01	0.031	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-		-	-	-	28	15	6	2	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/13/2004	Totals	275	18.9	7.97	2.3	157	16.6	10.2	154	132	29	16	7	2	<0.002	<0.002	<0.002	<0.01	0.026	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	28	15	6	2	<0.002	<0.002	<0.002	<0.01	<0.02	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
4/28/2004	Totals	273	19.9	7.42	3.34	124	15.2	<10	160	135	26	15	6	2	<0.01	<0.01	<0.005	<0.005	0.026	<0.01	<0.005	0.00005	<0.01	<0.01	<0.01	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	26	15	6	2	<0.01	<0.01	<0.005	<0.005	0.027	<0.01	<0.005	0.00005	<0.01	<0.01	<0.01	<0.005
4/28/2004	Totals	273	19.9	7.42	3.34	124	15.2	<10	159	132	25	15	6	2	<0.01	<0.01	<0.005	<0.005	0.025	<0.01	<0.005	0.00005	<0.01	<0.01	<0.01	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	26	15	6	2	<0.01	<0.01	<0.005	<0.005	0.029	<0.01	<0.005	<0.00005	<0.01	<0.01	<0.01	<0.005
11/7/2003	Totals	283	17.7	6.65	NA	110	14.8	<10	133	135	27	15	6	2	<0.002	<0.002	<0.002	<0.01	0.044	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	27	15	6	2	<0.002	<0.002	<0.002	<0.01	0.038	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/7/2003	Totals	283	17.7	6.65	NA	110	14.6	<10	136	134	27	16	6	2	<0.002	<0.002	<0.002	<0.01	0.045	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	27	16	6	2	<0.002	<0.002	<0.002	<0.01	0.038	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Averages	291	18.8	7.45	1.66	117	17.7	10.46	149	133	27	15	7	2	0.003	0.003	0.002	0.009	0.026	0.006	0.009	0.00005	0.01	0.013	0.002	0.006
RWD7 #2																										
10/31/2013	Totals	1202	21.1	7.59	1.21	139	**266**	12.8	**579**	169	35.3	17.9	205	5.5	<0.002	<0.002	<0.002	<0.01	0.154	<0.005	0.005	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	35.1	17.6	205	5.5	<0.002	<0.002	<0.002	<0.01	0.115	<0.005	0.005	<0.00005	<0.01	<0.01	<0.001	<0.005

Table 2: Analytical Data for Tar Creek Roubidoux Groundwater Monitoring Program

Analysis		Cond.	Temp.	pH	D.O.	Alk (Field)	Chloride	Sulfate	Tot Dis Sol	Hardiness	Calcium	Magnesium	Sodium	Potassium	Antimony	Arsenic	Cadmium	Chromium	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Thallium	Zinc
		(Field)	(Field)	(Field)	(Field)	$CaCO_3$	Cl	SO_4	TDS	$CaCO_3$	Ca	Mg	Na	K	Sb	As	Cd	Cr	Fe	Pb	Mn	Hg	Ni	Se	Tl	Zn
Unit		µS/cm	°C		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
MCL/(SMCL)				(6.5 – 8.5)			250	250	500						0.006	0.01	0.005	0.1	0.3	0.015	0.05	0.002	0.1	0.05	0.002	5
Roub. T.L.								82											0.207							0.043
Roub. Back								25											0.062							0.009
11/8/2012	Totals	1191	20.4	7.59	5.2	126.5	**273**	14.3	**580**	165	35.1	16.3	187	5.4	<0.002	<0.002	<0.002	<0.01	0.231	<0.005	0.006	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	35.7	16.8	188	5.3	<0.002	<0.002	<0.002	<0.01	0.117	<0.005	0.006	<0.00005	<0.01	<0.01	<0.001	<0.005
11/3/2011	Totals	1197	20.4	7.78	0.55	141	**278**	11.8	**571**	143	35.5	17.1	164	5.4	<0.002	<0.002	<0.002	<0.01	0.145	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	35.2	17.2	169	5.6	<0.002	<0.002	<0.002	<0.01	0.108	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
11/11/2010	Totals	1175	21.3	6.97	0.47	NA	**262**	17.6	**586**	155	35.4	16.7	179	5.6	<0.002	<0.002	<0.002	<0.01	0.124	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.01
	Dissolved	-	-	-	-	-	-	-	-	-	35.7	16.7	179	5.6	<0.002	<0.002	<0.002	<0.01	0.105	<0.005	<0.01	<0.00005	<0.01	0.021	<0.001	<0.01
3/25/2010	Totals	1047	18.7	7.36	1.09	144	**269**	13.7	**602**	159	35.7	16.6	179	5.7	<0.002	<0.002	<0.002	<0.01	0.141	<0.005	<0.01	<0.00005	<0.01	0.014	<0.001	0.028
	Dissolved	-	-	-	-	-	-	-	-	-	34.4	16.4	180	5.7	<0.002	<0.002	<0.002	<0.01	0.113	<0.005	<0.01	<0.00005	<0.01	0.011	<0.001	<0.005
5/9/2008	Totals	1169	22.5	7.37	3.55	148	**277**	12.4	**392**	171	35.3	16.7	176	5.7	<0.002	<0.002	<0.002	<0.01	0.0784	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	35.2	16.5	175	5.6	<0.002	<0.002	<0.002	<0.01	0.105	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
10/24/2007	Totals	1189	20.2	7.72	0.39	142	**277**	13.4	**596**	168	36.2	17.4	177	5.7	<0.002	<0.002	<0.002	<0.01	0.144	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.012
	Dissolved	-	-	-	-	-	-	-	-	-	32.5	15.7	162	5.2	<0.002	<0.002	<0.002	<0.01	0.0811	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	0.007
5/9/2007	Totals	1181	22.4	7.62	1.41	143	**272**	13	**573**	170	35.3	17.4	184	6.2	<0.002	<0.002	<0.002	<0.01	0.118	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	34.6	17.5	182	6	<0.002	<0.002	<0.002	<0.01	0.0946	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/9/2006	Totals	1446	20	6.78	1.39	270	**286**	18.6	**606**	159	37	16	172	6	<0.002	<0.002	<0.002	<0.01	0.087	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	32	16	164	5	<0.002	<0.002	<0.002	<0.01	0.076	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
11/9/2006	Totals	1446	20	6.78	1.39	275	**287**	18.8	**598**	160	36	16	171	6	<0.002	<0.002	<0.002	<0.01	0.09	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Dissolved	-	-	-	-	-	-	-	-	-	33	16	167	6	<0.002	<0.002	<0.002	<0.01	0.075	<0.005	<0.01	<0.00005	<0.01	<0.01	<0.001	<0.005
	Averages	1,224	20.7	7.36	1.67	170	275	14.6	**568**	162	35	16.7	178	5.6	0.002	0.002	0.002	0.01	0.115	0.005	0.009	0.00005	0.01	0.011	0.001	0.008

Notes:

Cond. = conductivity

Temp. = temperature

Alk = alkalinity

µs/cm = microSiemens per centimeter

°C = degree Celsius

mg/L = milligram per liter

MCL = maximum containment levels as of May, 2009 (EPA, 2009)

SMCL = secondary maximum containment levels as of May, 2009 (EPA, 2009)

Roub. T. L. = Roubidoux tolerance limit

Roub. Back = Roubidoux background

Bold = indicates an MCL or SMCL exceedance

NA = not analyzed

- = not relevant

Table 3: Metal Concentrations in Groundwater Samples Central Mill (FT059)/Repository Monitor Wells

		Aluminum	Antinomy	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Analysis		Al	Sb	As	Ba	Be	Cd	Ca	Cr (total)	Co	Cu	Fe	Pb	Mg	Mn	Hg	Ni	K	Se	Ag	Na	Tl	V	Zn
Unit		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
MCL/(SMCL)		(50 – 200)	6	10	2000	4	5	Na	100	Na	1300/(1000)	300	15[a]	Na	-50	2	Na	Na	50	100	Na	2	Na	5000
Acute*		Na	Na	360	Na	Na	161	Na	Na	Na	71	Na	477	Na	Na	2	4582	Na	20	44	Na	1400	Na	379
Chronic*		Na	Na	190	Na	Na	3	Na	50	Na	42	Na	19	Na	Na	1	509	Na	5	Na	Na	Na	Na	343
FT059-MW1		**Dissolved Metals**																						
5/6/2009	Result	100	1	5.4	14.5	5	5	549000	10	20	31.7	**139000**	1	19000	**1040**	0.2	20	4950	1	10	11000	1	20	51.7
	Qualifier	U	U	JH	=	U	U	=	U	U	JH	**JH**	U	=	=	=	U	=	U	U	=	U	U	JH
7/28/2009	Result	100	2	9.2	11.8	5	5	488000	10	20	20	**11400**	2	13200	**843**	0.2	20	3510	2	10	6280	2	20	20
	Qualifier	U	U	=	=	U	U	=	U	U	U	**J**	U	=	**J**	=	U	=	U	U	=	U	U	U
10/14/2009	Result	100	5	7.9	14.6	5	5	590000	10	20	20	**12200**	5	112200	**968**	0.2	20	3640	5	10	6330	5	20	27.5
	Qualifier	U	U	=	=	U	U	=	U	U	U	=	U	=	**J**	U	U	=	U	U	=	U	U	JH
9/1/2010	Result	100	0.2	4	10.1	5	5	544000	10	20	20	**14600**	0.4	8110	**840**	0.2	20	2690	0.4	10	4220	0.2	20	20
	Qualifier	U	U	=	=	U	U	=	U	U	U	=	U	=	=	=	U	=	U	U	=	U	U	U
FT059-MW1		**Total Metals**																						
5/6/2009	Result	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Qualifier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/28/2009	Result	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Qualifier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/14/2009	Result	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Qualifier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/1/2010	Result	100	0.2	**10.4**	10.9	5	5	522000	10	20	20	**23000**	**19.3**	8080	**822**	0.2	20	2770	0.4	10	4070	0.2	20	42.7
	Qualifier	U	U	=	=	U	U	=	U	U	U	=	=	=	=	=	U	=	U	U	=	U	U	=
FT059-MW2		**Dissolved Metals**																						
5/7/2009	Result	100	1	7.9	24.8	5	5	511000	10	20	20	**42900**	1	47600	**2790**	0.2	20	10600	1	10	60000	1	20	**506**
	Qualifier	U	U	JH	=	U	U	=	U	U	U	=	U	=	=	=	U	=	U	U	=	U	U	**JH**
7/28/2009	Result	100	2	**13.1**	18.2	5	5	491000	10	20	20	**39700**	2	40100	**2010**	0.2	20	10100	2	10	30000	2	20	**493**
	Qualifier	U	U	=	=	U	U	=	U	U	U	=	U	=	=	=	U	=	U	U	=	U	U	**J**
10/14/2009	Result	100	5	**10.5**	19.3	5	5	597000	10	20	20	**33200**	5	28300	**865**	0.2	20	11600	5	5	20900	5	20	**270**
	Qualifier	U	U	=	=	U	U	=	U	U	U	=	U	=	=	U	U	=	U	U	=	U	U	**JH**
8/31/2010	Result	100	0.2	**15.5**	15.4	5	5	535000	10	20	20	**37000**	0.4	22600	**523**	**0.2**	20	11000	0.4	10	18800	0.2	20	**308**
	Qualifier	U	U	=	=	U	U	=	U	U	U	=	U	=	=	=	U	=	U	U	=	U	U	=
12/8/2010	Result	500	2	**11.2**	50	25	25	595000	50	100	100	**34200**	2	24400	**590**	0.2	100	11400	2	50	18500	2	100	**310**
	Qualifier	U	U	=	U	U	U	=	U	U	U	=	U	=	=	U	U	=	U	U	=	U	U	=
6/16/2011	Result	20	2	**12.6**	14.1	1	1	550000	2	1	**6.6**	**38900**	1	21300	**439**	0.2	**8.9**	9300	5	1	17900	1	5	**282**
	Qualifier	U	U	=	=	U	U	=	U	U	=	=	U	=	=	U	=	J	U	U	=	U	U	=
9/29/2011	Result	**441**	2	**21.1**	16.1	1	1	604000	**3.1**	**2.9**	**2.5**	**40300**	**34.4**	24200	**552**	0.2	**6.1**	10100	5	1	18000	1	5	**374**
	Qualifier	**J+**	U	=	=	U	U	=	=	=	=	**J**	=	=	=	U	=	=	U	U	=	U	U	=

Table 3: Metal Concentrations in Groundwater Samples Central Mill (FT059)/Repository Monitor Wells

Analysis		Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
		Al	Sb	As	Ba	Be	Cd	Ca	Cr (total)	Co	Cu	Fe	Pb	Mg	Mn	Hg	Ni	K	Se	Ag	Na	Tl	V	Zn
Unit		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
MCL/(SMCL)		(50 – 200)	6	10	2000	4	5	Na	100	Na	1300/(1000)	300	15[a]	Na	-50	2	Na	Na	50	100	Na	2	Na	5000
Acute*		Na	Na	360	Na	Na	161	Na	Na	Na	71	Na	477	Na	Na	2	4582	Na	20	44	Na	1400	Na	379
Chronic*		Na	Na	190	Na	Na	3	Na	50	Na	42	Na	19	Na	Na	1	509	Na	5	Na	Na	Na	Na	343
12/7/2011	Result	200	4	9.8	20	2	2	614000	4	2.4	1.3	33500	2	24500	629	0.2	15.7	10500	10	2	19800	2	10	246
	Qualifier	U	U	=	U	U	U	=	U	=	U	=	U	=	=	U	J	=	U	U	=	U	U	=
FT059-MW2	Total Metals																							
5/7/2009	Result	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Qualifier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/28/2009	Result	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Qualifier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/14/2009	Result	100	2	12.9	19.7	5	5	564000	10	20	27	30900	45.7	26200	811	0.2	20	10500	2	10	18700	2	20	347
	Qualifier	U	U	=	=	U	U	=	U	U	JH	=	=	=	=	U	U	=	U	U	=	U	U	JH
8/31/2010	Result	100	0.2	17	14.6	5	5	515000	10	20	20	37200	10.9	21800	493	0.2	20	10700	0.4	10	18000	0.2	20	343
	Qualifier	U	U	=	=	U	U	=	U	U	U	=	=	=	=	=	U	=	U	U	=	U	U	=
12/8/2010	Result	500	2	12.3	50	25	25	592000	50	100	100	37000	5.5	24200	587	0.2	100	11100	2	50	18300	2	100	325
	Qualifier	U	U	=	U	U	U	=	U	U	U	=	=	=	=	U	U	=	U	U	=	U	U	=
6/16/2011	Result	20	2	15.8	14.1	1	1	546000	2	1	2	39500	5.4	20600	451	0.2	8.4	8940	5	1	16300	1	5	305
	Qualifier	U	U	=	=	U	U	=	UJ	U	U	=	=	=	=	U	J	=	U	U	=	U	U	=
9/29/2011	Result	599	2	42	15.4	1	2.9	603000	3.5	2.8	24.8	61000	349	28000	619	0.2	5.4	9980	5	1	18400	1	5	964
	Qualifier	=	U	=	=	U	=	=	=	=	=	J	=	=	=	U	J	=	U	U	=	U	U	=
12/7/2011	Result	200	2	13.7	18	1	1	702000	2	2.8	1.5	35000	4.8	23600	556	0.022	14.9	10400	5	1	19200	2	5	262
	Qualifier	U	U	=	=	U	U	J	U	=	U	J	=	=	J	U	J	=	U	U	=	U	U	J
FT059-MW3	Dissolved Metals																							
5/6/2009	Result	100	1	8.7	30.5	5	5	357000	10	31	25.8	55400	1	59900	6160	0.2	20	6310	1	10	81300	1	20	253
	Qualifier	U	U	JH	=	U	U	=	U	=	JH	=	U	=	=	=	U	=	U	U	=	U	U	JH
7/28/2009	Result	100	2	7.6	24.2	5	5	272000	10	48.6	20	63400	2	55000	9570	0.2	20	3970	2	10	69800	2	20	94
	Qualifier	U	U	=	=	U	U	=	U	=	U	=	U	=	=	=	U	=	U	U	=	U	U	J
10/14/2009	Result	100	5	8.4 =	30.5 =	5	5	344000	10	41.3	20	60400	5	67400	9140	0.2	20	5650	5	10	86900	5	20	80.9
	Qualifier	U	U	=	=	U	U	=	U	=	U	=	U	=	=	U	U	=	U	U	=	U	U	JH
8/31/2010	Result	100	0.2	4	32.2	5	5	304000	10	22.2	20	34500	0.4	60600	5530	0.2	20	5120	0.4	10	76600	0.2	20	20
	Qualifier	U	U	=	=	U	U	=	U	=	U	=	U	=	=	=	U	=	U	U	=	U	U	U
12/8/2010	Result	500	2	3.8	50	25	25	314000	50	100	100	60300	2	62900	9600	0.2	100	5000	2	50	77200	2	100	100
	Qualifier	U	U	=	U	U	U	=	U	U	U	=	U	=	=	U	U	U	U	U	=	U	U	U
6/14/2011	Result	20	2	2.2	29.3	1	1	308000	2	58.2	2	86200	1	62200	12500	0.2	12.5	3900	5	1	77200	1	5	26.8
	Qualifier	U	U	J+	=	U	U	=	U	=	U	=	U	=	=	U	=	J	U	U	=	U	U	UC
9/29/2011	Result	278	2	9.6	24.7	1	1	397000	7.4	28.7	2	49900	1	58200	7370	0.2	5.7	5720	5	1	72900	1	2.4	91.1
	Qualifier	UC	U	=	=	U	U	=	=	=	U	J	U	=	=	U	=	=	U	U	=	U	U	=

Table 3: Metal Concentrations in Groundwater Samples Central Mill (FT059)/Repository Monitor Wells

Analysis		Aluminum	Antinomy	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
		Al	Sb	As	Ba	Be	Cd	Ca	Cr (total)	Co	Cu	Fe	Pb	Mg	Mn	Hg	Ni	K	Se	Ag	Na	Tl	V	Zn
Unit		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
MCL/(SMCL)		(50 – 200)	6	10	2000	4	5	Na	100	Na	1300/(1000)	300	15*	Na	-50	2	Na	Na	50	100	Na	2	Na	5000
Acute*		Na	Na	360	Na	Na	161	Na	Na	Na	71	Na	477	Na	Na	2	4582	Na	20	44	Na	1400	Na	379
Chronic*		Na	Na	190	Na	Na	3	Na	50	Na	42	Na	19	Na	Na	1	509	Na	5	Na	Na	Na	Na	343
12/7/2011	Result	200	4	4.8	30.2	2	2	386000	4	26.4	1.7	**36400**	2	57200	**6030**	0.2	**14.5**	5780	10	2	70600	2	10	149
	Qualifier	U	U	=	J	U	U	=	U	=	U	=	U	=	=	U	**J**	=	U	U	=	U	U	=
FT059-MW3		**Total Metals**																						
5/6/2009	Result	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Qualifier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7/28/2009	Result	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Qualifier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10/14/2009	Result	128	2	9.8	48	5	5	344000	10	46.8	29.4	**64600**	**76.4**	66400	**9340**	0.2	20	5310	2	10	81400	2	20	317
	Qualifier	=	U	=	=	U	U	=	U	=	JH	=	=	=	=	U	U	=	U	U	=	U	U	JH
8/31/2010	Result	100	0.2	9.2	41	5	5	314000	10	21.7	20	**56300**	**15.2**	62200	**5390**	0.2	20	5340	0.4	10	79200	0.2	20	61.8
	Qualifier	U	U	=	=	U	U	=	U	=	U	=	=	=	=	=	U	=	U	U	=	U	U	=
12/8/2010	Result	500	2	3.7	50	25	25	325000	50	100	100	**59000**	2.2	65100	**9350**	0.2	100	5000	2	50	78800	2	100	100
	Qualifier	U	U	=	U	U	U	=	U	U	U	=	=	=	=	U	U	U	U	U	=	U	U	U
6/14/2011	Result	20	2	3.3	28.7	1	1	302000	2	60.6	2	**92100**	1.3	61600	**13100**	0.2	**13.2**	3810	5	1	77400	1	5	30.6
	Qualifier	U	U	=	=	U	U	=	UJ	=	U	=	UC	=	=	U	**J**	=	U	U	=	U	U	UC
9/29/2011	Result	250	2	8.6	19.4	1	1	396000	4.6	21	2	**49900**	1.6	57000	**4950**	0.2	**4.3**	5700	5	1	70400	1	5	78.9
	Qualifier	UC	U	=	=	U	U	=	=	=	U	**J**	=	=	=	U	**J**	=	U	U	=	U	U	=
12/7/2011	Result	200	4	5.2	28.8	2	2	395000	4	25	0.89	**41300**	2	58700	**6020**	0.2	**13.2**	6050	10	2	72300	2	10	144
	Qualifier	U	U	=	=	U	U	J	U	=	U	**J**	U	J	**J**	U	**J**	=	U	U	=	U	U	J

Notes:

* = Oklahoma Water Quality Standards obtained from 785 OAC 45 Appendix G. Values for Cadmium, copper, lead, nickel, silver, and zinc are calculated based on a hardness of 400 mg/L, which is the maximum default recommended by EPA in calculating water quality standards.

*Remediation goal from OU4 ROD – also the MCL

µg/L = microgram per liter

MCL = maximum containment level

SMCL = secondary maximum containment level

bold = MCL/SMCL exceedance

shaded = Water Quality Standard exceedance

- = analysis not performed

= = detected concentration

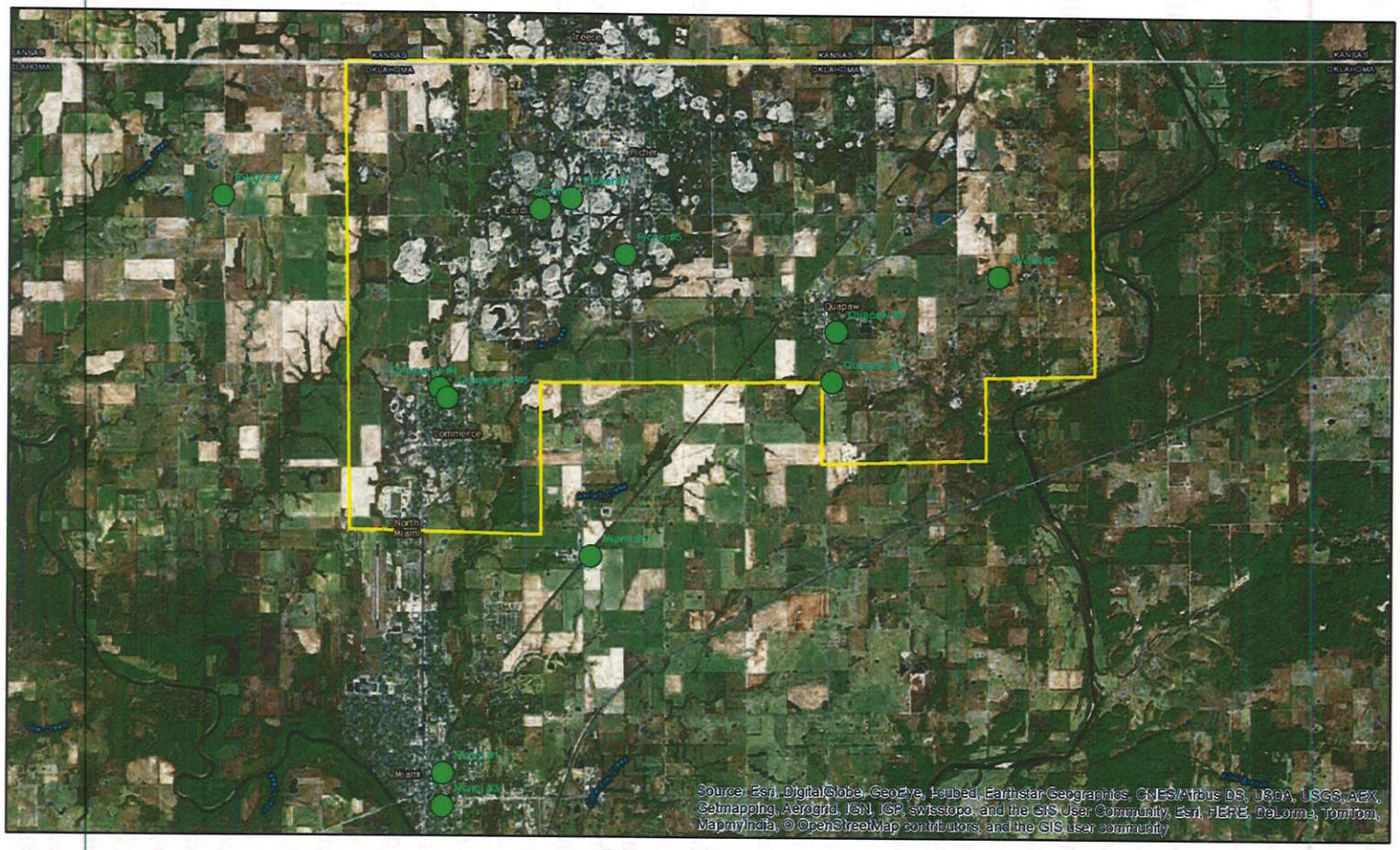
J = estimated concentration

JH = estimated concentration, results biased high

NA = not applicable

U = not detected

Figure 2: Roubidoux Monitoring Well Locations



We make every effort to provide and maintain accurate, complete, usable, and timely information. However, some data and information on this map may be preliminary or out of date and is provided with the understanding that it is not guaranteed to be correct or complete. Conclusions drawn from, or actions undertaken on the basis of, such data and information are the sole responsibility of the user.

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Legend

- Monitoring Wells
- Superfund Area

Figure 2:
Roubidoux Monitoring
Well Locations

N
W E
S

Map Created by Brent Stone
on 5/15/2015

0 1.5 3 6 Miles

3.5 Site Inspections

An SI was conducted at the site from January 14 to 16, 2015. The completed SI checklist is provided in Appendix E. Photographs taken during the SI are provided in Appendix F.

The Admiralty Mine Site dike and diversion channel at Douthat Bridge was visited during the SI. The stream channel improvements that divert Lytle Creek to an upper reach of Tar Creek appeared to be functioning as designed. There were no signs that the stream was eroding the channel. Riprap was present along the cut-banks of the channel. The dike was in good condition and there was no evidence of erosion, slides, burrows, or sloughing.

Five wells (Tulsa Mine, Powerhouse well, Quapaw #5, Quapaw #2, and Picher #5) that enter the Roubidoux aquifer were visited during the SI. The Tulsa Mine and Powerhouse wells were plugged in January 2015. Plugging these wells is imperative to protect the Roubidoux aquifer from Boone aquifer contamination. The three additional wells are municipal water supply wells. After action monitoring documents that Quapaw #5 exceeds indicator parameter criteria for determining impacted wells. Quapaw #2 is a backup well for Quapaw and while it does not exceed MCLs it has shown historical exceedances of indicator parameters and has a connection to the Roubidoux. ODEQ has concerns about these two wells (*i.e.,* Quapaw #5 and Quapaw #2), and intends to have discussions with the City of Quapaw regarding plugging these wells.

The Roubidoux Groundwater Monitoring Program has sampled approximately 13 wells completed in the Roubidoux aquifer. The results of the Roubidoux Groundwater Monitoring Program are documented in After Action Monitoring Reports and described in Section 3.4.

The OU2 ROD addresses lead-contaminated soil in residential yards and HAAs. HAAs are areas which are areas frequented by children, such as parks and schoolyards. Contaminated soils excavated from residential yards and HAAs were disposed at two on-site repositories (South Repository and state-line Repository). Both OU2 repositories were secured by locked gates and barbed wire fence. Although the SI occurred during winter, it was apparent that the repositories are well vegetated. Remediation of residential yards for OU2 was completed in the towns of Afton, Cardin, Commerce, Fairland, Miami, Narcissa, North Miami, Peoria, Picher, Quapaw, and Wyandotte. Drive-by inspections of remediated properties were conducted in Quapaw, Commerce, and Miami. Remediated properties included yards, driveways, and alleyways. Yards that were inspected appeared to be in good condition and had vegetation. Driveways and alleyways that were inspected also appeared in good condition and were easily identified from the presence of fresh limestone. Existing data on blood lead levels in children at the site have demonstrated that the OU2 remediation has been effective.

The OU4 ROD addresses source materials, smelter wastes, rural residential yard contamination, transition zone soil contamination, and contamination in water drawn from rural residential wells. The voluntary buyout (LICRAT) conducted under OU4 was completed in 2011. Residents of Picher, Cardin, and Hockerville, Oklahoma were relocated through the LICRAT program. The LICRAT buyout for residents of Picher, Cardin, and Hockerville was completed in 2011. Treece, Kansas, was later added to the buyout. The Treece buyout was documented in an ESD regarding the OU4 ROD. In 2009, EPA provided $3.5 million to the Kansas Department of Health and

Environment (KDHE) to fund the buyout of qualified occupants in Treece. The Treece buyout was handled by the Treece Relocation Assistance (TRA) Trust with the support of KDHE. The Treece buyout was completed in 2012.

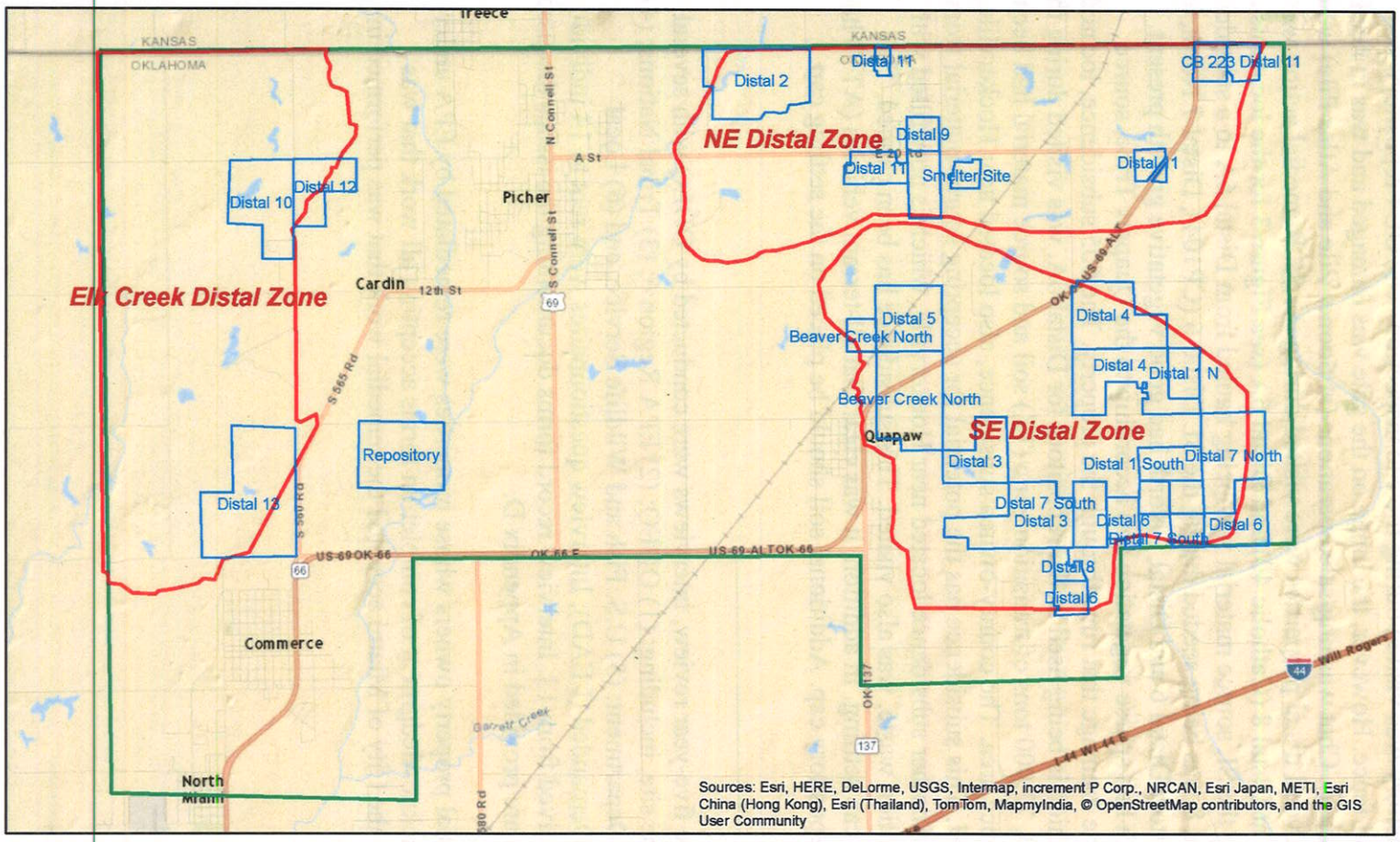
Source material from rural residential yard cleanups was placed in the OU4 repository located on E 40 Rd. The OU4 repository was visited during the site inspection. The OU4 repository was behind a locked gate and fence. However, the hinge on the gate was damaged and was in need of repair (*has since been fixed*). Chat washing/sale operations (at Sooner Pile and Atlas Pile) were visited during the SI. Several distal properties were visited during the SI. Remedial action was occurring during the SI at Distal 8 (Catholic 40) and Distal 6A (*see* Figure 3 for the locations of the distal areas). During the SI, source material was being hauled from Distal 6A to a subsidence area on S 605 Rd. Distal 8 was being seeded during the SI. Distal 6 (CP104), Distal 7 North, and Distal 1 North were visited. Distal 6 and Distal 1 North had good vegetative growth present. However, Distal 7 North had sparse vegetation and according to the Quapaw Tribe, source material was left near the drainage that runs through the property. The 605 subsidence, located near Hockerville and which is being used as the repository for Distal 6A, was visited during the SI. At the time of the SI, 72,000 tons of transition zone (TZ) soil and source material had been placed into this subsidence area. The county-owned subsidence, also located near Hockerville, was visited during the SI. This subsidence has the potential for accepting source material from other distal properties. Another subsidence located near Hockerville, which is now filled with construction and demolition waste, was also visited. This subsidence has been capped. This repository had obvious cap settling. In addition, it was clear that all-terrain vehicles (ATV) had been driving over the repository cap. Additional soil should be placed on the settling cap.

3.5 Interviews

During the course of the five-year review, interviews were conducted by ODEQ with several parties involved with the site, including: (1) ODEQ; (2) EPA Region 6; (3) Tribal Nations; (4) Ottawa County Health Department; (5) U.S. Fish and Wildlife Service; and (6) Local Environmental Action Demanded (LEAD); Interview questionnaires were sent to 14 individuals, and responses were received from 13. Interview record forms documenting the issues discussed during these interviews are provided in Appendix D.

Ottawa County residential property owners whose properties were remediated by EPA under OU2 and OU4 signed acknowledgment of completion forms accepting all work that was performed. In addition, the City of Miami accepted the remedial work that was performed in their alleyways.

Figure 3. Distal Areas



We make every effort to provide and maintain accurate, complete, usable, and timely information. However, some data and information on this map may be preliminary or out of date and is provided with the understanding that it is not guaranteed to be correct or complete. Conclusions drawn from, or actions undertaken on the basis of, such data and information are the sole responsibility of the user.

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Legend
- Distal Areas
- Distal Zones
- Superfund Area

Figure 3:
Distal Areas

N W E S

Map Created by Brent Stone
on 5/14/2015

0 1 2 4 Miles

Overall, the interviewees had a favorable impression of the work completed at Tar Creek OU2. The fact that children's blood lead levels have been significantly reduced was an important factor. However, there are mixed feelings about the work completed in OU4, and several individuals interviewed expressed frustration with the progress of the project. Frustration has been focused on the amount of unfinished work, cost overruns stemming from inadequate site characterization, and the lack of usable land due to the removal of transition zone soils. EPA and ODEQ are in the process of addressing the concerns expressed in the interview records through implementation of the September 2014 RAO Report (as discussed in Section 4.4). Additionally, some concerns were expressed about the lack of addressing the contamination in Tar Creek proper and the use of subsidence areas as repositories.

Effects on the community have been perceived as generally positive due to the removal of chat and contaminated soils on residential properties, decreased blood lead levels in children, and an overall reduction in risk. Additionally, an economic benefit has been experienced in the community due the Superfund jobs training initiative. However, some negative effects were reported by interviewees which mainly focused on unfinished work and the loss of TZ soils related to the OU4 RA some property owners are reported to be upset and this is creating access issues. EPA and ODEQ are presently addressing individual property owner concerns.

Community concerns surround mine water discharge and seeps and water from the CMR that flows into Tar Creek, which eventually empties into Spring River and Grand Lake. Traffic and dust issues related to the heavy use of the county roads have become a concern in the community. Additionally, concerns remain within the community about the impacts to the Roubidoux aquifer. The Roubidoux aquifer meets MCLs and is safe for use as a drinking water supply.

When solicited for suggestions and recommendations, many interviewees responded with an assortment of ideas and suggestions. These suggestions can be generally described as either technical or managerial. Technical suggestions included installing passive treatment systems to reduce contaminant of concern (COC) loading rates to Tar Creek, encapsulating chat under paved roads, and addressing TZ soils in manner that makes them more viable. Managerial suggestions mainly focused on a stronger EPA presence at the site and increased information sharing amongst the stakeholders. Many of the downstream Tribes believed they were not entirely informed about actions at the site.

Generally, ODEQ believes it is informed about actions at the site. In addition, many tribal responses indicated that the tribes generally believe that they have been informed about progress at the site, but admit they would like to see increased information sharing. There are, however, tribal members that believe that they are not being informed. These tribal members also request increased information sharing. Other stakeholders gave mixed responses as to whether they believed they were well informed. Regardless, it is clear that all parties involved would like more substantial information sharing. EPA continues to conduct numerous scheduled conference calls and in-person meeting with site stakeholders.

The tribes would like to see EPA reduce the amount of unilateral decision making. ODEQ would like a more substantial role in the decision making process. EPA has Cooperative Agreements with both ODEQ and the Quapaw Tribe to further engage them in the RA process.

4.0 Technical Assessment

The five-year review must determine whether the remedy at a site is protective of human health and the environment. EPA guidance lists three questions to be used to provide a framework for organizing and evaluating data and information and to ensure all relevant issues are considered when determining the protectiveness of a remedy. These questions are answered for the site in the following paragraphs. At the end of the section is a summary of the technical assessment.

4.1 Question A: Is the Remedy Functioning as Intended by the Decision Documents?

The documents that memorialize the remedy selection decisions for the site are the June 1984 ROD for OU1, the August 1997 ROD for OU2, the March 2000 Action Memorandum for OU3, the February 2008 ROD for OU4, and the April 2010 ESD for the OU4 ROD. For OU1, O&M at the Admiralty Mining Site is ongoing and the Roubidoux Groundwater Monitoring Program was completed in 2014. The RA for OU2 continues under a Cooperative Agreement with ODEQ. OU3 was a removal response action and requires no further action. The remedial design (RD)/RA for distal properties and several Phase 1 RA activities have been completed or are currently ongoing under OU4. The OU4 RA began in 2009 and it is projected to take 30 years to complete. This section discusses the RA performance, O&M, costs, ICs, monitoring activities, opportunities for optimization, and early indicators of potential remedy problems.

RA Performance

Based on the data review, the SI, document reviews, and site interviews it appears that the various Tar Creek Superfund Site remedies selected in the OU1, OU2, and OU4 RODs are functioning as intended.

As noted in previous five-year reviews, the diking and diversion work performed as part of the OU1 remedy was not successful at reducing the discharges of acid mine water to Tar Creek; however, it did affect recharge to the mines associated with rainfall events. Therefore, the diking and diversion portion of the remedy was at best only partially effective (EPA, 1994). Since the last five-year review, ODEQ has plugged two wells identified at the site that were completed in the Roubidoux aquifer. EPA and ODEQ continue to evaluate the need to plug abandoned Roubidoux wells as they are identified and located. ODEQ discovered three additional wells potentially completed in the Roubidoux aquifer. There are still 19 wells that require further evaluation and possibly plugging if it is technically feasible (ODEQ, 2006a and ODEQ, 2015a). Two of the 19 wells are part of the Roubidoux Groundwater Monitoring Program and are identified as probably and potentially impacted by the overlying mine workings. In addition, nine of the remaining 17 wells are located on restricted property and are not accessible by ODEQ. Therefore, eight wells still require investigation and assessment to determine the feasibility of being plugged. As noted in a July 22, 2014 letter, EPA considers the OU1 RA complete as soon as well plugging activities have been completed, and all future activities will fall under O&M (EPA, 2014c).

Remedial action for OU2 is still ongoing and there are still activities necessary to assess potential soil contamination associated with chat present in yards, alleyways and driveways in portions of

Ottawa County outside the mining area. The RA for OU2 is still in progress under the cooperative agreement EPA has entered into with ODEQ regarding OU2. Under that agreement, ODEQ will undertake the remediation of OU2 with EPA oversight. EPA continues to take calls from Ottawa County residents for residential yard remediation.

Until 2012, the Centers for Disease Control (CDC)'s blood lead level of concern in children six years old and younger was 10 μg/dL, but that has changed and now the CDC is saying that there is no safe blood lead level for young children.[1] EPA has used a blood lead level of 5 μg/dL as a benchmark in its recent analyses. In Ottawa County, the percentage of children with blood lead levels that exceed 5 μg/dL has decreased from 11.6 to 3.7 percent from 2007 to 2014. The 3.7 percent calculated for 2014 is slightly higher than the average for Oklahoma (2.4 percent) (Oklahoma State Department of Health [OSDH], 2015). However, the blood lead data collected from children have demonstrated that the OU2 RA has been effective.

Final closure of the OU2 South Repository (adjacent to the CMR) has been completed and a deed notice was filed on the property in 2014. At the time of this report, the OU2 County Repository is undergoing final closure and a deed notice will be filed on the property. Final closure has been performed in accordance with the OU2 ROD.

The voluntary relocation performed by LICRAT and funded by EPA as part of the OU4 remedy has been completed in Ottawa County. The Treece, Kansas buyout was handled by the TRA Trust with the support of KDHE. The Treece buyout was completed in 2012. The voluntary relocation has removed 628 residences, 74 businesses, and 125 renters from the most impacted portions of the mining area and has reduced the potential for exposure to site-related contamination.

RA activities for OU4 began in late 2009 and to date 56 chat piles and chat bases totaling approximately 1.6 million tons of chat, transition zone soils, and fine tailings have been remediated and 309,787 tons of chat sold, and four subsidence features have been filled. OU4 RA is ongoing.

Operation and Maintenance

The ROD for OU1 does not specifically state what O&M activities were to occur at the site. However, the ROD does mention O&M and costs related to the dikes and diversion work. O&M activities are currently underway at the Admiralty Mining Site near Douthat Bridge. O&M activities are being performed for the dikes and diverted creek channels at the site. The updated O&M plan was completed in 2012. Annual inspections are performed for the diversion and dike remedy at the Admiralty site and annual inspections items include; abnormal occurrence response plans, performance standards, and annual cost estimates of O&M (ODEQ, 2012a). As

[1] *See* Centers for Disease Control, *Preventing Lead Poisoning in Young Children* (1991) at p. 7 ("Blood lead levels at least as low as 10 μg/dL are associated with adverse effects"). Later the CDC revised its position saying that there was no safe level for lead in young children. *See CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention"* (November 26, 2013) ("CDC will emphasize that the best way to end childhood lead poisoning is to prevent, control or eliminate lead exposures. Since no safe blood lead level in children has been identified, a blood lead "level of concern" cannot be used to define individuals in need of intervention.".)

mentioned in the previous five-year review the Muncie and Big John sites located in Kansas will no longer require O&M (EPA, 2010). In a letter dated July 22, 2014, EPA indicated that it was moving toward OU1 RA completion, with completion of ODEQ well-plugging activities being the last RA activity for OU1. Once the RA is complete, OU1 will move entirely into O&M (EPA, 2014c).

The RA for OU2 is ongoing. The OU2 ROD calls for O&M to maintain the repositories. It also calls for supplemental ICs (discussed below). Both soil repositories used for OU2 have been vegetated to prevent or reduce erosion. The OU2 ROD calls for a clean soil cap on any parts of the repositories where the soil lead concentrations exceed the remediation goal (500 parts per million [ppm]).

The RA for OU4 is ongoing. However, the CMR and other areas where source materials are disposed (*e.g.*, subsidence features) will require O&M activities once the OU4 RA is complete.

Costs of O&M

The OU1 ROD states that O&M costs related to the diking and diversion portion of the selected remedy would be approximately $5,000 per year. No costs associated with the Roubidoux Groundwater Monitoring Program were provided in the OU1 ROD. O&M costs associated with the O&M of the Admiralty Mine Site dike and stream diversion provided by ODEQ totaled $1,221. Maintenance of the dikes and diversion channels has been minimal since the OU1 RA was completed. The Roubidoux Groundwater Monitoring Program has been revised through the years to obtain the data necessary to assess the water quality of the aquifer. Sampling of the Roubidoux currently occurs on an annual basis to ensure that the drinking water supply is safe.

The OU2 ROD states that O&M associated with maintaining the soil repositories and ICs would be $60,000 per year. RA activities are ongoing, and no O&M costs have been incurred associated with OU2.

O&M associated with the selected OU4 remedy will be approximately $375,000 per year from Year 3 through Year 22 of the remedy, eventually decreasing to $125,000 per year in about Year 23 of OU4 response actions (EPA, 2008).

Implementation of ICs

ICs are generally defined as non-engineered instruments such as administrative and legal tools that do not involve construction or physically changing the site and that help minimize the potential for human exposure to contamination and/or protect the integrity of a remedy by limiting land and/or resource use (EPA, 2005). ICs may include deed notices, easements, covenants, restrictions, or other conditions on deeds, and/or groundwater and/or land use restriction documents (EPA, 2001). The following paragraphs describe the ICs implemented at the site, the potential effect of future land use plans on ICs, and any plans for changes to site contamination status.

The OU1 ROD did not call for the use of ICs (EPA, 1984). Potential ICs for OU2 are listed in the OU2 ROD (EPA, 1997).

The OU2 ROD stipulated that all ICs may not be necessary, or that some would only be used in special circumstances as dictated by conditions encountered at a specific property during the RA. In addition, the ROD stated that authorities of other government entities might be required to implement some of the ICs *(e.g.,* zoning restrictions would require the municipal authority, lease restrictions might require DOI authority, etc.). The OU2 ROD further stated that many ICs, such as community-wide health education, community-wide blood lead monitoring, and community-wide lead-contaminated dust reduction activities were appropriate for application in residential areas throughout Ottawa County (EPA, 1997).

As noted in the preceding five-year review, the following ICs have been implemented under OU2:

1. EPA issued fact sheets describing the safe uses of mine tailings;
2. The Oklahoma Childhood Lead Poisoning Prevention Program (OCLPPP) carried out by the Ottawa County Health Department (OCHD) in conjunction with the OSDOH has provided childhood lead poisoning prevention education through community and tribal health fairs, Head Start and child care programs, and community organizations and events;
3. The OCHD has conducted blood lead screenings; and,
4. ODEQ has placed deed notices on residential properties (as part of the voluntary relocation for OU4) and repositories calling property owner's attention to the presence of contamination.

To help ensure that site chat sales continue and that chat is used in a manner that is protective of human health and the environment under the OU4 ROD, chat that is used on-site or off-site must be managed according to the criteria provided in the Chat Rule, 40 CFR Part 278, and its preamble.[2] Under the remedy selected in the OU4 ROD, only the uses described in the preamble (including EPA's June 2007 fact sheet; EPA530-F-07-016B) and the transportation construction project uses described in 40 CFR Part 278 will be allowed for site chat. The OU4 ROD provides that chat sales are part of the remedy for OU4 chat (EPA, 2008).

The ICs concerning blood lead monitoring, health education, and lead-contaminated dust reduction activities are currently being implemented through agreements between the EPA, ODEQ, and OCHD or as part of the OU2 RA. EPA funds the OCHD to perform blood lead screening and health education activities at the site (EPA, 2010b). Outside of the RA work, lead-contaminated dust reduction activities are part of the ongoing community education efforts. Once the RA activities for OU2 are completed, EPA will work with the various authorities (city, county, state, and federal) to implement any of the additional ICs necessary to maintain the protectiveness of the OU2 remedy.

[2] The Chat Rule can be found at 72 Fed. Reg. 39235 (July 18, 2007). It can also be found at http://www.epa.gov/epaoswer/other/mining/chat/.

As part of the ICs for OU2, a deed notice has been filed on the South Repository (Flint property) regarding the presence of chat and soils exceeding the 500-milligram per kilogram (mg/kg) remediation goal. The deed notice was filed in 2012 after the final inspection and closure of the South Repository. The South Repository was visited during the SI and the repository cap was well vegetated with a good stand of grass. After final inspection and closure of the County Repository, a deed notice will be filed on that property. This task should be completed during 2015. The remedy selected in the OU4 ROD calls for ICs and O&M activities to be implemented at locations where source materials are covered in place. Locations where ICs and O&M activities are to be implemented under the OU4 ROD include tailing ponds that are covered and the on-site repositories and that would be covered when closure is completed. These and other ICs included in the selected remedy for OU4 are detailed in Table 4. The table also describes the status of the IC as determined during this five-year review:

Table 4: Status of Institutional Controls

Location/Area IC Applied	IC Objective	IC Instrument	Responsible Organization	Current Status
Covered Fine Tailings	Restrict future use of the property to protect the integrity of the engineered cover system.	Deed Notice and Easement filed pursuant to Oklahoma Statute 27A § 2-7-123(B)	ODEQ For property where DOI is the trustee, ICs will be established in coordination with DOI.	No status change since ROD issued.
On-site Repositories	Restrict future use of the property to protect the integrity of the engineered containment system.	Deed Notice and Easement filed pursuant to Oklahoma Statute 27A § 2-7-123(B)	ODEQ For property where DOI is the trustee, ICs will be established in coordination with DOI.	Deed notices have been filed on two subsidence area repositories: CB223 and CB143/146/147. The deed notices were filed in 2014.
Property Acquired via Voluntary Relocation	Restrict future use of the property to prevent exposure of residential or commercial inhabitants to chemicals above the Final Remediation Goals.	Deed Notice and Easement filed pursuant to Oklahoma Statute 27A § 2-7-123(B)	ODEQ The controls shall be in effect until the state determines that the area is safe for reuse.	Deed notices have been filed on properties acquired via the voluntary relocation.
Shallow Groundwater	Restrict future uses of groundwater from the portion of the Boone aquifer (or shallower) for potable or domestic supply that is impacted by site-related contaminants	OWQS Title 785, Chapter 45, Appendix H	ODEQ	ODEQ changed the "Beneficial Use Designations for Certain Limited Areas of Groundwater" (OWQS 785 Chapter 45, Appendix H). Under this change, special well construction is required to obtain water for potable use and groundwater testing is

Location/Area IC Applied	IC Objective	IC Instrument	Responsible Organization	Current Status
	above the Final Remediation Goals.			required to meet potable use standards for lead, arsenic, and cadmium (ODEQ, 2012b and OWRB, 2013).

Monitoring Activities

The Roubidoux Groundwater Monitoring Program under OU1 has continued through 2014. The program has been implemented by ODEQ and funded by EPA to assess and monitor the effectiveness of the well plugging portion of the remedy in terms of protection of the Roubidoux aquifer. EPA is working toward completion of the RA for OU1. It will be appropriate for O&M to begin once the requirements of the NCP in 40 CFR 300.435(f) are met (EPA, 2014c). ODEQ will consider continuing the Roubidoux Groundwater Monitoring Program under state funding. The data collected through the sampling indicate that the Roubidoux aquifer is impacted locally by acid mine water. The mechanism for acid mine water migration into the Roubidoux is not totally clear. To-date, the data collected regarding the connection between the Boone and Roubidoux aquifers indicate that the primary pathway for groundwater and contaminants to migrate into the Roubidoux aquifer from the Boone aquifer and mine workings has been through abandoned wells, wells that have faulty casings and/or poor seals across the Boone Formation, and through unplugged abandoned boreholes (CH2M HILL, 2008, and ODEQ, 2006a). The drinking water supplied from the Roubidoux aquifer in the mining area continues to meet the health-based primary drinking water standards (i.e., MCLs) and is considered safe for use as a drinking water supply.

Opportunities for Optimization

Optimization means efforts at any phase of the removal or remedial response to identify and implement specific actions that improve the effectiveness and cost-efficiency of that phase. Such actions may also improve the remedy's protectiveness and long-term implementation, which may facilitate progress towards site completion. To identify these opportunities, regions may use a systematic site review by a team of independent technical experts or apply other approaches to identify opportunities for greater efficiency and effectiveness. In September 2014, EPA and the Office of Superfund Remediation and Technology Innovation (OSRTI) finalized the RAO Report prepared for OU1 and OU4. In the report, several optimization opportunities are outlined for OU1 and OU4. For OU1 the optimization team recommended that all efforts be continued to protect the Roubidoux aquifer. Protection of the aquifer is far simpler than remediation of the aquifer should it become impacted; consequently, protection of the Roubidoux aquifer should remain a high priority for all stakeholders. Tasks that will assist in the protection of the Roubidoux aquifer include: (1) plugging wells connecting the Boone to the Roubidoux immediately upon discovery; (2) ceasing the practice of injecting the high concentration, highly leachable, chat fines into the Boone aquifer; and (3) continuing to monitor the hydrodynamics between the Boone and Roubidoux aquifers (EPA, 2014d).

Recommendations identified as a priority by the optimization report for OU4 include prioritizing remedial activities based on COC loading rates, and stopping the loading of COCs to the watershed and riparian areas. A wide variety of loading rates exist from the various mine-related

wastes that are considered source material. Bull rock and larger chat fractions have lower COC concentrations and lower rates of leaching. The main concerns with regard to loading rates are the seeps from the mines and chat piles adjacent to surface water. For this reason, stabilizing these seeps from chat piles/bases and mines should be a primary objective. In addition, according to the optimization team, steps should be taken to prevent additional surface erosion and stormwater runoff from chat piles and chat bases bordering surface waters. The optimization team also suggested working with the trustees (including the USFWS) to begin the remediation and restoration of riparian areas (EPA, 2014d).

EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated TZ soils. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the CMR (EPA, 2014d).

Early Indicators of Potential Remedy Problems

As noted in previous five-year reviews, the discharges of acid mine water to Tar Creek have not decreased significantly since the construction of the dikes and diversion channels. No other problems were noted during the SI.

4.2 Question B: Are the Exposure Assumptions, Toxicity Data, Cleanup Levels, and RAOs Used at the Time of the Remedy Selection Still Valid?

This section addresses changes in environmental standards, newly promulgated standards, and "To Be Considered" standards (TBC), changes in exposure pathways, changes in toxicity and other contaminant characteristics, and changes in risk assessment methods during the five-year review period, and progress toward meeting RAOs.

Changes in Standards, Newly Promulgated Standards, and TBCs

Applicable or Relevant and Appropriate Requirements (ARAR) for this site were identified in the RODs for OU1, OU2 and OU4; previous five-year review reports; and site documents. This five-year review included identification of and evaluation of changes in the ROD-specified ARARs and TBCs to determine whether such changes may affect the protectiveness of the selected remedy. The ARARs and TBCs identified by the RODs for the site include chemical-, action-, and location- requirements. These ARARs and TBCs are described below.

OU1 ROD (signed on June 6, 1984)

Chemical-Specific Requirements:

No contaminant-specific requirements were identified in the OU1 ROD. However, the first five-year review report identified the following chemical specific ARARs for the OU1 remedy:

1. OWQS, Oklahoma Administrative Code (OAC) 785:45.

2. Regulations regarding the discharge of wastewater to surface waters, Water Quality Criteria, 40 CFR §131.
3. National Primary Drinking Water Standards, 40 CFR §141.
4. National Secondary Drinking Water Standards, 40 CFR §143.

Action-Specific Requirements:

No action-specific requirements were identified in the OU1 ROD.

Location-Specific Requirements:

The following location-specific ARARs were identified in the OU1 ROD:

1. Executive Order on Floodplain Management, Executive Order No. 11988.
2. Executive Order on Protection of Wetlands, Executive Order No. 11990.

However, these location-specific ARARs are only applicable to the construction of the diking and diversion structures, and this construction is no longer occurring at the site. Therefore, as a practical matter, they are not applicable to site remediation; should additional construction activities occur that affects flood plains or wetlands, these ARARs may be applicable.

OU2 ROD (signed on August 27, 1997)

Chemical-Specific Requirements:

No chemical-specific requirements were identified in the OU2 ROD.

Action-Specific Requirements:

1. Regulations regarding the transportation of hazardous materials, 49 CFR §107, and §171-§177.
2. CWA requirements regarding the use of best management practices (BMP) and monitoring of discharges to ensure compliance with effluent discharge limitations, 40 CFR §122.41 and §125.100.
3. Clean Air Act (CAA) requirements to control particulate emissions to ambient air, 40 CFR §50 and §60.

Location-Specific Requirements:

1. National Historic Preservation Act requirements to minimize effects to historic landmarks and to coordinate activities with the State Historic Preservation Officer (SHPO), 16 USC 470, et. Seq. and 40 CFR §6.301.
2. Archeological and Historic Preservation Act requirements to minimize effects on historical and archeological data and to coordinate activities with the SHPO, 16 USC 469, 40 CFR §6.301(b), and 36 CFR §800.

3. Historic Sites, Buildings, and Antiquities Act requirements to avoid undesirable impacts to such landmarks and to coordinate activities with the SHPO, 16 USC 461-467, and 40 CFR §6.301(a).
4. Endangered Species Act of 1973, Federal Migratory Bird Act, and Oklahoma Wildlife Statutes regulations and requirements requiring that endangered species and their habitat be conserved, and that consultation occur with the DOI and the Oklahoma State Department of Wildlife if such areas are affected, 16 USC 1531-1543, 50 CFR Parts 17 and 402, 40 CFR §6.302(h), 16 USC 703-712, and Oklahoma Statutes Title 29, Section 5-412.
5. Oklahoma Water Statutes limitations on the placement or discharge of deleterious, noxious, or toxic substances into affected waters of Oklahoma, Oklahoma Statutes Title 29, Section 7-401.
6. Rivers and Harbors Act of 1899 and CWA Section 404 requirements related to the Nationwide Permit for discharge of dredged or fill materials, 33 CFR §330 and 33 USC 1344.

OU4 ROD (signed on February 20, 2008)

Chemical-Specific Requirements:

Federal Safe Drinking Water Act MCL of 0.015 mg/L for lead, 40 CFR §141.8.

Action-Specific Requirements:

1. Regulations regarding the transportation of hazardous materials, 49 CFR §107, and §171-§177.
2. CWA requirements regarding the use of pollution prevention plans (PPP) and BMPs and monitoring of discharges to assure compliance with effluent discharge limitations, 40 CFR §122.26.
3. CAA requirements to control particulate emissions to ambient air, 40 CFR §50.6 (PM_{10}) and §50.12 (Lead).
4. SDWA addressing the UIC regulations for a Class V injection well, regarding injection of source materials into mine rooms, 40 CFR §144 UIC Program.
5. Oklahoma Solid Waste Management Act, monitoring of injected fluid, 27A O.S. §2-6-701 et seq., Management of Solid Waste, Title 252 OAC, Chapter 652 UIC.
6. CWA, a watershed-based approach will be taken to address the potential effects RAs may have on the local watersheds, §404 33 CFR §320-§330 and 40 CFR §230.
7. OWQS, monitoring wells installed during RA will be designed to comply with standards, OAC 785:45 Appendix H Beneficial Use Designations for Certain Limited Areas of Groundwater.
8. Oklahoma Statutes, ODEQ will file the deed notice upon completion of construction at each individual property requiring engineering controls, 27A §2-7-123(B).

9. Oklahoma Solid Waste Management Act and Management of Solid Waste, the design and construction of the repositories and covers for fine tailing ponds in the remedy will comply with established requirements, 27A O.S. §2-10-101 et seq., Title 252 OAC, Chapter 515.

Location-Specific Requirements:

1. National Historic Preservation Act requirements to minimize effects to historic landmarks, 16 USC 470, et. Seq., and 40 CFR §6.301(b).
2. Endangered Species Act of 1973 regulations and requirements requiring that endangered species and their habitat be conserved, 16 USC 1531-1544, 40 CFR §6.302(h).

Newly/Updated Promulgated Standards:

Action-Specific Requirements:

1. Criteria for the Safe and Environmentally Productive Use of Granular Mine Tailings known as "Chat." Chat Rule. 40 CFR §260 and §278.
2. Special Well Construction and Testing for the Boone Aquifer at the Tar Creek Superfund Site Ottawa County, Oklahoma. OAC 785:45, Appendix H.

To help ensure that site chat sales continue and that chat is used in a manner that is protective of human health and the environment, under the OU4 ROD, chat that is used on-site or off-site must be managed according to the criteria provided in the Chat Rule, 40 CFR Part §278, and its preamble.[3] Under the remedy selected in the OU4 ROD, only the uses described in the preamble (including EPA's June 2007 fact sheet; EPA530-F-07-016B) and the transportation construction project uses described in 40 CFR Part §278 will be allowed for site chat. The OU4 ROD provides that chat sales are part of the remedy for OU4 chat (EPA, 2008).

The update to the OWQS was an action item for ODEQ in the previous five-year review report. The OU4 ROD required that groundwater be restricted via the OWQS Title 785, Chapter 45, Appendix H. Appendix H states that the Boone aquifer in Ottawa County is a Class II groundwater source suitable for use as a water supply, for agriculture, and municipal and industrial processes. In accordance with the OU4 ROD, the ODEQ submitted a proposal to change the "Beneficial Use Designations for Certain Limited Areas of Groundwater" (OWQS 785 Chapter 45, Appendix H). The changes specifically state "Acidic conditions, mine voids, and toxic metals (arsenic, lead, and cadmium) may be present in the Boone aquifer." Therefore, special protective well construction is required to seal off the Boone from the underlying Roubidoux aquifer. For Boone wells, competent groundwater testing is required for potable and domestic use; and treatment may be required when groundwater exceeds the MCLs for lead (15 μg/L), arsenic (10 μg/L), and cadmium (5 μg/L) (OWRB, 2013).

[3] The Chat Rule can be found at 72 Fed. Reg. 39235 (July 18, 2007). It can also be found at http://www.epa.gov/epaoswer/other/mining/chat/.

The ODEQ, OWRB, and federal regulations have not been revised to the extent that the effectiveness of the remedy at the site would be called into question. No new regulations have been issued by the State of Oklahoma or the federal government that would call into question the effectiveness of the remedy.

Changes in Exposure Pathways

There are no changes to the human health and ecological exposure pathways since completion of the previous five-year review. There are no new exposure pathways not identified in the RODs.

Future land uses are not expected to change, and agricultural uses and rural residential uses will remain dominant on the site.

Changes in Toxicity and Other Contaminant Characteristics.

There have been no changes in toxicity characteristics or other contaminant characteristics for the site that would impact the protectiveness of the remedy.

Until 2012, the CDC's blood lead level of concern in children six years old and younger was 10 µg/dL, but that has changed and now the CDC is saying that there is no safe blood lead level for young children.[4] EPA has used a blood lead level of 5 µg/dL as a benchmark in its recent analyses.

In May 2013, the cadmium reference concentration (RfC) was updated in EPA's Regional Screening Levels (RSL) table to 1.0E-05 milligrams per cubic meter (mg/m^3) from the United States Agency for Toxic Substances and Disease Registry (ATSDR). Interestingly, the cadmium RfC was reported to be changed to this exact value in 2009 and is documented in the previous five-year review (EPA, 2010c). The May 2013 change appears to be from an RfC value of 2.0E-05 mg/m^3 established by the California Environmental Protection Agency. Based on the assessment derived in the previous five-year review report for the change in cadmium's RfC, this change in toxicity characteristics does not impact the protectiveness of the remedy (EPA, 2013b).

Progress Toward Meeting the RAOs

The well plugging efforts performed for OU1 have been effective at removing this pathway for migration of acid mine water into the Roubidoux aquifer. Although data indicate that the Roubidoux aquifer is impacted locally, primary drinking water standards have not been exceeded in public water supply wells and the Roubidoux aquifer remains a usable source of drinking water.

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[4] *See* Centers for Disease Control, *Preventing Lead Poisoning in Young Children* (1991) at p. 7 ("Blood lead levels at least as low as 10 µg/dL are associated with adverse effects"). Later the CDC revised its position saying that there was no safe level for lead in young children. *See CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention"* (November 26, 2013) ("CDC will emphasize that the best way to end childhood lead poisoning is to prevent, control or eliminate lead exposures. Since no safe blood lead level in children has been identified, a blood lead "level of concern" cannot be used to define individuals in need of intervention.".)

The OU2 RA has attained the RAOs where remediation has been completed. Data indicate that the percentage of children residing at the site with elevated blood lead levels has declined significantly since the OU2 RA began. The OU2 RA is ongoing, and the remaining areas of the site to be addressed will meet the RAOs once the RA is complete.

The OU4 RA is ongoing and certain RAOs have been met where the remediation has been completed. The LICRAT buyout and the TRA Trust buyout have removed most children and adolescents from the site areas with the largest concentrations of source materials (*i.e.*, the areas with the most chat piles, most chat bases, and most fine tailings deposits), and has prevented them from coming in direct contact, through ingestion or inhalation, with soils and source material that exceed 500 ppm.

Water drawn from two rural residential wells completed in the Boone aquifer exceeded the groundwater lead remediation goal established in the OU4 ROD. These wells were GW2429-4 and GW2429-8. The property owner at GW2429-4 allowed access for confirmation sampling, but declined access for the remediation described in the ROD. The property owner at GW2429-8 declined access for both confirmation sampling and remediation. Therefore, no RA activities to address the rural residential wells were conducted (CH2M HILL, 2011a). In addition, another resident was identified in the site interviews of this five-year review as having contaminated groundwater. Therefore, it appears that the RAO of preventing site residents from the ingestion of water from private wells that contains lead in concentrations exceeding the National Primary Drinking Water Standards is not being met.

The RAO that aimed to prevent terrestrial fauna from coming in direct or indirect contact, through the ingestion exposure pathway, with cadmium-, lead-, or zinc-contaminated source materials and soils where concentrations exceed their respective remediation goals of 10-mg/kg, 500-mg/kg, and 1,100-mg/kg goals has been met on properties where TZ soils have been completely removed. This is only a small part of the site, however. It is not known whether the ongoing soil amendment pilot study being performed on the Catholic 40 and Distal 6A (*see* Figure 3) will meet the this RAO, which is directed at protecting fauna. This determination will be made at the conclusion of the pilot study.

The RAO aimed at preventing riparian biota including waterfowl from coming into contact, through the ingestion exposure pathway, with unacceptable concentrations of cadmium, lead, and zinc in surface water and sediment by eliminating all discharges of cadmium, lead, and zinc from source materials to surface water has not been met. Progress is being made towards this goal through the RA efforts to remove source materials at the site.

4.3 Question C: Has any Other Information Come to Light that Could Call into Question the Protectiveness of the Remedy?

The type of other information that might call into question the protectiveness of the remedy include potential future land use changes in the vicinity of the site or other expected changes in site conditions or exposure pathways. No other information has come to light as part of this fifth five-year review for the site that would call into question the protectiveness of the site remedy. EPA is

presently conducting a remedial investigation (RI) for OU5, including a baseline human health risk assessment (BHHRA).

4.4 Technical Assessment Summary

The technical assessment, based on the data review, SI, technical evaluation, and interviews indicates that the RAs selected for the site have been implemented as intended by the DDs. Various other federal, state, tribal, and local government agencies are conducting studies and carrying out actions at the site to address the many environmental, health, and safety concerns associated with the site.

The drinking water supplied from the Roubidoux aquifer meets MCLs and is safe for use as a drinking water supply. However, sampling data from the Roubidoux Groundwater Monitoring Program show local impacts to the Roubidoux aquifer evidenced by exceedances of TLs developed for specific indicator parameters. The Roubidoux Groundwater Monitoring Program has been used to evaluate the effectiveness of the well plugging portion of the OU1 remedy at preventing acid mine water migration from the Boone aquifer to the Roubidoux aquifer. Statistical trend analysis of the data collected between 2003 and 2006 indicates that the aquifer is relatively stable with respect to the analytes measured by sampling, including the indicator parameters (CH2M HILL, 2007d). No statistical trend analysis was performed on data collected from 2010-2013 but a cursory review of data presented in the Final Tar Creek After Action Monitoring Report indicate that iron and sulfate (two indicator parameters) concentrations are generally increasing in several MWs since 2006 (ODEQ, 2014a).

The OU1 ROD stipulated that EPA would evaluate the need to plug additional abandoned wells at the site as they were identified. ODEQ, in conjunction with EPA, continues to identify, evaluate, and plug wells where technically feasible. ODEQ plugged two wells since the last five-year review. At least nine wells identified as potential candidates for plugging are on restricted property.

The O&M plan for the diking and diversion channel at the Admiralty site has been updated by ODEQ. The O&M plan covers annual inspections of the diking and diversion channel, abnormal occurrence response plans, performance standards, and annual cost estimates of O&M (ODEQ, 2012a). The annual O&M inspections for OU1 have identified minor issues that have been rectified by the landowner. The reports state that overall the dike and diversion channel are functioning as intended (ODEQ, 2015d and ODEQ, 2015e). However, after the closure of RA activities at OU1, the O&M plan may need to be updated to include Roubidoux groundwater monitoring.

Until the fourth five-year review (2010), EPA's five-year review reports found that the fund balancing ARARs waiver related to surface water, as determined by the OU1 ROD, continued to be appropriate for the site. The 2010 five-year review, however, found that some of the exposure assumptions and the potential risks posed to human health and the environment for surface water and sediments at the site, as stated in the OU1 ROD, are no longer valid. Specifically, fish tissue data collected by ODEQ demonstrated at that time that potential risks to human health exist through consumption of fish caught from Tar Creek, the Spring and Neosho Rivers, and Grand

Lake. It was also determined at that time that metals contained within site sediments are biologically available and pose risks to ecological receptors. Likewise, it was found that the concentrations of site-related contaminants in Tar Creek surface water continue to exceed the OWQS, and this is still the case in 2015. The narrative and numerical criteria in the OWQS are designed to maintain and protect the beneficial surface water use classification of "Fish and Wildlife Propagation." Under the OWQS there are numerical "Toxic Substance" concentration limits for surface water with both "acute" and "chronic" standards listed. Under 785 OAC 45 OWQS, "acute toxicity" means the surface water concentration of a toxic substance is such that it means greater than or equal to 50 percent lethality to appropriate test organisms in a test sample. Under those same standards, "chronic toxicity" means the surface water concentration of a toxic substance is such that there is a statistically significant difference (at the 95 percent confidence level) between longer term survival and/or reproduction or growth of the appropriate test organisms in a test sample and a control. Teratogenicity and mutagenicity are considered to be effects of chronic toxicity. In Tar Creek, Lytle Creek, and Elm Creek at the site, EPA stated in the 2010 five-year review that cadmium, lead, and zinc concentrations in surface water samples exceed the OWQS chronic toxicity standard, and zinc concentrations also exceed the acute toxicity standard. This is still the case in 2015. Finally, the 2010 five-year review report stated that initial construction costs for the constructed passive wetland southeast of Commerce are considered reasonable and may indicate that such a system could be an economically feasible engineered remedy for surface water at the site. For these reasons, in the 2010 fourth five-year review, EPA stated that the fund balancing ARARs waiver included in the OU1 ROD may no longer be appropriate and should be reevaluated. Accordingly, EPA has initiated the RI/feasibility study (FS) for OU5.

The remediation work conducted under the RA for OU2 is still ongoing. In various Ottawa County residential areas, chat found in alleyways and driveways has been excavated and disposed at several OU2 repositories or at the CMR. EPA has continued to address any remaining properties that may require remediation due to the presence of chat or contaminated soils with concentrations of lead above the remediation goals established in the OU2 ROD. In April 2015, EPA entered into a cooperative agreement with ODEQ under which ODEQ will address the remaining aspects of the OU2 RA. Some of the repositories used for the disposal of contaminated soils from OU2 have been closed in accordance with the requirements of the OU2 ROD, and deed notices have been filed on the properties (except for the County Repository, which is still in the process of being closed).

In addition, the OCLPP carried out by the Ottawa County Health Department in conjunction with the OSDH has provided childhood lead poisoning prevention education through community and tribal health fairs, Head Start and child care programs, and community organizations and events. The OU2 RA activities and the OCLPP have worked together to create significant reductions in blood lead levels of children in Tar Creek and Ottawa County. Until 2012, the CDC's blood lead level of concern in children six years old and younger was 10 µg/dL, but that has changed and now the CDC is saying that there is no safe blood lead level for young children.[5] EPA has used a

[5] *See* Centers for Disease Control, *Preventing Lead Poisoning in Young Children* (1991) at p. 7 ("Blood lead levels at least as low as 10 µg/dL are associated with adverse effects"). Later the CDC revised its position saying that there was no safe level for lead in young children. *See CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of*

blood lead level of 5μg/dL as a benchmark in its recent analyses. In Ottawa County, the percentage of children with blood lead levels that exceed 5μg/dL has decreased from 11.6 percent to 3.7 percent from 2007 to 2014. The 3.7 percent calculated for 2014 is slightly higher than the average for Oklahoma (2.4 percent) (OSDH, 2015). However, the blood lead data collected from children demonstrated that the OU2 RA has been effective.

The voluntary relocation performed by LICRAT in Ottawa County, Oklahoma, was completed in 2011. The voluntary relocation performed by the TRA Trust in Treece, Kansas, was completed in 2012. The voluntary relocation removed most of the residents from the most impacted areas at the site, reducing the risk of exposure to site contaminants. A total of 628 residences, 74 businesses, and 125 renters were relocated from impacted areas to the surrounding communities. Chat sales will continue to remove source materials from the site, limiting the volume of chat that will have to be addressed as part of the OU4 RA and limiting the land area that will be restricted as part of the OU4 RA. To date, 309,787 tons of chat and developmental rock have been sold to nearby chat processors.

The OU4 ROD calls for ODEQ to restrict groundwater under the authority of the OWQS Title 785, Chapter 45, Appendix H. Appendix H states that the Boone aquifer in Ottawa County is a Class II groundwater source suitable for use as a water supply for agriculture, and municipal and industrial processes. This information is amended with a remark stating "Toxic metals, special well construction required." However, the method of special well construction is not specified, nor is any statement made regarding how the toxic metals are to be discovered or addressed if they are found in water (EPA, 2008). In accordance with the OU4 ROD, the ODEQ revised the "Beneficial Use Designations for Certain Limited Areas of Groundwater" (OWQS 785 Chapter 45, Appendix H). The changes generally state that special well construction is required to obtain water for potable use and that groundwater testing is required to meet potable use standards for lead, arsenic, and cadmium (OWRB, 2013).

In September 2014, EPA and OSRTI finalized the RAO Report prepared for OU4 and OU1. In the report, several optimization opportunities are outlined for OU1 and OU4. For OU1 the optimization team recommended that all efforts be continued to protect the Roubidoux aquifer including; plugging wells, ceasing fine injections into the Boone aquifer, and monitoring the Roubidoux aquifer (EPA, 2014d).

Recommendations identified as a priority by the optimization report for OU4 include prioritizing remedial activities based on COC loading rates and to stop the loading of COCs to the watershed and riparian areas. The main contributors to loading rates are the seeps from the mines, and from the chat piles and chat bases adjacent to surface water. For this reason, stabilizing these seeps from chat piles/bases and mines should be a primary objective. In addition, steps should be taken to prevent additional surface erosion and storm water runoff from chat piles and chat bases bordering surface waters (EPA, 2014d).

Primary Prevention" (November 26, 2013) ("CDC will emphasize that the best way to end childhood lead poisoning is to prevent, control or eliminate lead exposures. Since no safe blood lead level in children has been identified, a blood lead "level of concern" cannot be used to define individuals in need of intervention.".)

EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated TZ soil. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the CMR (EPA, 2014d).

5.0 Issues

Table 5 summarizes the current site issues.

Table 5: Issues Identified During the Fifth Five-Year Review

Issues	Affects Current Protectiveness	Affects Future Protectiveness
ODEQ research has found references to abandoned wells that need to be assessed to determine whether these wells should be plugged (this issue is carried over from the fourth five-year review). The OU1 ROD recognized that additional abandoned wells completed in the Roubidoux aquifer might be identified after completion of the OU1 RA. The ROD stated that the need to plug additional wells would be evaluated as wells were identified. The existence of the wells, which were found by ODEQ's research in historical documents, has not been verified. Fieldwork will be necessary to verify the existence of these wells and to determine whether they are completed in the Roubidoux aquifer and are in need of plugging.	No	Yes
While significant progress has been made, and 2,940 residential properties have been addressed, there is work remaining before the OU2 RA is complete (this issue is carried over from the fourth five-year review). Residential yard remediation has been completed in the towns of Afton, Fairland, Narcissa, Peoria, Miami, Wyandotte, Picher, Quapaw, North Miami, Commerce, and Cardin. EPA continues to take calls from Ottawa County residents for residential yard remediation. The next five-year review should consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site.	No	Yes
An assessment of the surface water and sediment data for Tar Creek should be completed to verify if a human health or ecological threat exists (this issue is carried over from the fourth five-year review). The third and fourth five-year reviews recommended that the current surface water and sediment data for Tar Creek be evaluated to verify that no threat to human health exists in Tar Creek.	No	Yes
The soil cover at the Hockerville subsidence area is settling, has been vandalized, and is in need of repair. The Hockerville subsidence area was filled with construction and demolition debris in 2012. During the SI, which was part of this five-year review, the soil cover was found to have visible damage that was due to general settling of the cap, and also due to vandalism in the form of tire tracks made by ATVs.	No	No
The CMR, which was constructed to handle OU4 related source material, requires general maintenance. Engineering options for preventing water from seeps from entering Tar Creek should be evaluated.	No	No
ODEQ should evaluate the need to continue the groundwater monitoring program under state-funded OU1 O&M. EPA intends to work toward completing RA activities at OU1 after well plugging is complete.	No	No
EPA has begun the OU4 soil amendment pilot studies based on the recommendation of the September 2014 RAO report.	No	No

6.0 Recommendations and Follow-up Actions

Table 6 provides recommendations to address the current site issues.

Table 6: Recommendations to Address Current Site Issues

Issue	Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Actions: Affects Protectiveness (Y/N)	
					Current	Future
ODEQ research has found references to abandoned wells that need to be assessed to determine whether these wells should be plugged (this issue is carried over from the fourth five-year review). The OU1 ROD recognized that additional abandoned wells completed in the Roubidoux aquifer might be identified after completion of the OU1 RA. The ROD stated that the need to plug additional wells would be evaluated as wells were identified. The existence of the wells, which were found by ODEQ's research in historical documents, has not been verified. Fieldwork will be necessary to verify the existence of these wells and to determine whether they are completed in the Roubidoux aquifer and are in need of plugging.	ODEQ shall undertake actions to determine whether the wells that ODEQ found in the literature actually exist, and evaluate whether it is necessary to plug these wells. Each well location found in the literature should be investigated, located, assessed, and if necessary and technically feasible, plugged in accordance with the OU1 ROD. Since the last five-year review, ODEQ has plugged two wells.	ODEQ	EPA	9/30/2020	N	Y
While significant progress has been made, and 2,940 residential properties have been addressed, work remains before the OU2 RA is complete (this issue is carried over from the fourth five-year review). Residential yard remediation has been completed in the towns of Afton, Fairland, Narcissa, Peoria, Miami, Wyandotte, Picher, Quapaw, North Miami, Commerce and Cardin. EPA continues to take calls from Ottawa County residents for residential yard remediation. The next five-year review should consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site.	ODEQ shall undertake remaining actions to complete the OU2 RA. Currently, EPA operates a telephone hotline for Ottawa County residents to request soil sampling. The next five-year review should consider whether OU2 can be deleted from the NPL. This deletion of OU2 from the NPL would be a partial deletion of the site.	ODEQ	EPA	9/30/2020	N	Y

Issue	Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Actions: Affects Protectiveness (Y/N)	
					Current	Future
An assessment of the surface water and sediment data for Tar Creek should be completed to verify if a human health or ecological threat exists (this issue is carried over from the fourth five-year review). The third and fourth five-year reviews recommended that the current surface water and sediment data for Tar Creek be evaluated to verify that no threat to human health exists in Tar Creek.	EPA should complete the evaluation of current surface water and sediment data for Tar Creek and other site streams to verify that no unacceptable risks to human health and the environment exist in Tar Creek and the other streams. Numerous studies of the site have been conducted over the past decade. These studies have collected surface water and sediment data in Tar Creek and other site streams. EPA should perform a data gap analysis to determine whether gathering additional surface water and sediment data is necessary. If EPA finds that additional surface water and sediment data are needed, EPA should collect enough additional data to determine whether there are risks to human health and the environment associated with exposure to surface water and sediments in streams of the site.	EPA	EPA	9/30/2020	N	Y
The soil cover at the Hockerville subsidence area is settling, has been vandalized, and is in need of repair. The Hockerville subsidence area was filled with construction and demolition debris in 2012. During the site inspection, which was part of this five-year review, the soil cover was found to have visible damage that was due to general settling of the cap, and also due to vandalism in the form of tire tracks made by ATVs.	ODEQ should repair the cover at the Hockerville subsidence area. Additional soil should be added to repair the soil cover and the cover grade should be re-established. EPA Cooperative Agreements with ODEQ and the Quapaw Tribe includes repository O&M.	ODEQ	EPA	9/30/2017	N	N
The CMR, which was constructed to handle OU4 related source material, requires general maintenance. Engineering options for	ODEQ and the Quapaw Tribe should conduct general maintenance at the CMR. EPA Cooperative Agreements with ODEQ and the Quapaw Tribe includes repository operations	ODEQ/ Quapaw Tribe	EPA	9/30/2017	N	N

Issue	Recommendations/Follow-Up Actions	Party Responsible	Oversight Agency	Milestone Date	Follow-Up Actions: Affects Protectiveness (Y/N)	
					Current	Future
preventing water from seeps from entering Tar Creek should be evaluated.	and maintenance. The CMR has received source material from distal properties as part of the OU4 RA since 2010 and is at approximately 20 percent capacity.					
ODEQ should evaluate the need to continue the groundwater monitoring program under state funded OU1 O&M. EPA intends to work toward completing RA activities at OU1 after well plugging is complete.	ODEQ should complete an evaluation of the need to continue the groundwater monitoring program under state-funded OU1 O&M and revise the O&M plan if necessary.	ODEQ	ODEQ	9/30/2020	N	N
EPA has begun the OU4 soil amendment pilot studies based on the recommendation of the 2014 RAO report.	EPA will develop the short and long term performance standards and metrics to measure and determine protectiveness.	EPA	EPA	9/30/2020	N	N

7.0 Protectiveness Statement

The remedy at OU1 is protective of human health and the environment with respect to groundwater. With respect to surface water, the remedy at OU1 does not meet ARARs, but those ARARs have been waived under 40 CFR § 300.430(1)(i)(C)(6).

The remedy at OU2 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date at residential yards and at areas frequented by children (*i.e.,* HAAs) have adequately addressed all exposure pathways in those yards and HAAs that could result in unacceptable risks in these areas. There are approximately 19 residential yards that are currently scheduled to be sampled to determine if remediation will be required, and EPA estimates that it will take one year to complete remediation if necessary for the residential yards. ODEQ will continue to evaluate additional residential properties and HAAs as they become known and assess the need for sampling and remediation under a Cooperative Agreement.

The remedy at OU3 is protective of human health and the environment.

The remedy at OU4 is expected to be protective of human health and the environment upon completion. In the interim, remedial activities completed to date have adequately addressed all exposure pathways that could result in unacceptable risks at the smelter site, at all rural residential yards, at the following chat piles: CP058, CP059, CP088, CP091, CP092, CP093, CP093-S1, CP093-S2, CP093-S3, CP093-S4, CP093-S5, CP094, CP094-S1, CP097, CP098, CP099, CP100, CP101, CP102, CP103, CP104, and CP105; at the following chat bases: CB011, CB044, CB046, CB048, CB049, CB053, CB143, CB146, CB147, CB156, CB157, CB216, CB219, CB221, CB222, CB223, CB230, CB231, CB232, CB233, CB234, CB235, CB236, CB237, CB238, CB239, CB240, CB241, CB241-S1, CB241-S2, CB242, and CB243; and at the following fine tailings deposits: FT063. There are 83 chat piles, 213 chat bases, and 62 fine tailings deposits that still must be addressed, and EPA estimates that it will take 30 years to complete this work.

EPA has begun the RI/FS process at OU5 and has not completed a BHHRA or a baseline ecological risk assessment (BERA) at this date; consequently, no protectiveness determination can be made.

Well plugging called for in the selected OU1 remedy addressed the primary route of potential human exposure by protecting the Roubidoux aquifer, and, in this way, preventing the possibility that hazardous substances would be ingested in drinking water drawn from the Roubidoux. EPA/ODEQ has plugged and abandoned 85 wells as part of the OU1 remedy. Sampling data indicate that the Roubidoux aquifer continues to meet all health-based primary drinking water standards. Exceedances of secondary drinking water standards for iron and sulfate at four wells have been identified. Secondary drinking water standards are aesthetically based values. The previous five-year review established that some of the exposure assumptions and the potential risks posed to human health and the environment for surface water and sediments at the site that were described in the OU1 ROD are no longer valid (EPA, 2010c). Fish tissue data collected by ODEQ demonstrate that risks to human health exist through consumption of fish caught from Tar

Creek, the Spring and Neosho Rivers, and Grand Lake (ODEQ, 2008b). Metals contained within site sediments are biologically available and pose risks to ecological receptors (MacDonald, et al., 2009). In Tar Creek, Lytle Creek, and Elm Creek at the Tar Creek Site, EPA found that cadmium, lead, and zinc concentrations in surface water samples exceed the OWQS chronic toxicity standard, and zinc concentrations also exceed the acute toxicity standard. With the exceptions noted above for OU1, the Roubidoux Groundwater Monitoring Program, and O&M activities for the site are all protective for the short and long terms.

The remedy at OU2 is expected to be protective of human health and the environment in all areas where remediation has been completed. There have been 2,940 properties remediated during the OU2 RA and during the removal actions that preceded the RA. Remaining properties in need of remediation are being evaluated. The RA for OU2 is ongoing and is scheduled to be completed by the next five-year review. Human health and the environment are being protected by the remedy for OU2.

The action implemented during the removal action for OU3 is protective of human health and the environment. The laboratory chemicals left at the former Eagle-Picher Office Complex were removed from the site and properly disposed.

The RA for OU4 is currently ongoing. The remedy at OU4 is expected to be protective of human health and the environment upon completion, and, in the interim, exposure pathways that could result in unacceptable risks are being controlled. The LICRAT voluntary relocation in Picher, Cardin, and Hockerville, Oklahoma, was completed in 2011. The voluntary relocation in Treece, Kansas, was completed in 2012, under a Kansas trust—the TRA Trust. Chat sales continue at the site. Appendix H of the OWQS 785 OAC 45 was amended in order to limit the use of groundwater from the Boone aquifer. RA on three rural residential properties, a smelter site, and multiple distal groups (which include chat piles and chat bases) has been completed. EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated TZ soils. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the CMR (EPA, 2014d).

EPA is presently conducting an RI for OU5. No OU5 remedy has been selected.

8.0 Next Review

The next five-year review, the sixth for the site, should be completed during or before September 2020.

Appendix A: Existing Site Information

1.0 Site Chronology

A chronology of significant site events and dates is included in Table 7. Sources of this information are listed in Appendix B.

Table 7: Chronology of Site Events

EVENT	DATE
Lead and zinc mining activities began in the Picher field of the Tri-State Mining District.	Early 1900's
Mining activities ceased in the Picher field.	1970's
Acid mine water began flowing to the surface and draining into Tar Creek.	November 1979
Governor of Oklahoma appointed the Tar Creek Task Force to investigate the environmental impacts associated with the acid mine drainage.	June 1980
First investigations conducted by several government agencies under the Tar Creek Task Force to assess the environmental impacts associated with the acid mine drainage at the site.	1980 and 1981
The Tar Creek site is proposed to the National Priorities List (NPL).	July 27, 1981
Report submitted to the Tar Creek Task Force documenting the impacts of acid mine drainage within the Tar Creek basin.	October 1981
EPA signs a Cooperative Agreement with the OSDH to conduct the RI/FS for OU1.	June 16, 1982
The Remedial Investigation for OU1 is conducted.	July 1982 – March 1983
The Feasibility Study for OU1 is conducted.	May –December 1983
The Tar Creek site is formally added to the NPL.	September 8, 1983
A ROD for OU1 is signed. The selected remedy included surface water diversion and construction of dikes at 3 locations, plugging abandoned Roubidoux wells, and a 2 year after action monitoring program to evaluate the effectiveness of the selected remedies.	June 6, 1984
The EPA sends RD/RA notice letters to 7 companies and 8 individuals as PRPs to allow them to complete the RD/RA for OU1.	June 15, 1984
The OWRB lowers the designated use of Tar Creek to habitat limited fishery and secondary recreation water body.	1985
RA construction for OU1 is completed.	December 22, 1986
A two year surface and ground water monitoring program is implemented by the OWRB to assess the effectiveness of the OU1 remedy.	1987 – 1988
EPA signs a referral to the US Department of Justice to implement cost recovery against 7 companies identified as PRPs.	December 30, 1987
The Roubidoux Groundwater Monitoring Program is begun at the site by the OWRB to assess potential impacts of acid mine water on the Roubidoux Aquifer.	1991
EPA enters into a Consent Decree with 6 PRPs to recover costs related to the RI/FS, ROD, and emergency response actions related to OU1.	June 10, 1991
US Public Health Service's Indian Health Service notifies EPA by letter that 34% of children routinely tested near the Tar Creek site have blood lead levels that exceed the CDC's level of 10 μg/dL.	January 21, 1994
EPA completes the First Five-Year Review for the Tar Creek Site. The First Five-Year Review recommends continuing the Roubidoux	April 1994

EVENT	DATE
Groundwater Monitoring Program. Also, the creation of a second OU is recommended to address human health concerns related to mining wastes.	
EPA conducts sampling at the Tar Creek site in support of a Baseline Human Health Risk Assessment and RI/FS for the residential portion of OU2.	August 1994 – July 1995
EPA issues an action memorandum authorizing a removal response action to address lead contaminated soils at High Access Areas.	August 15, 1995
EPA issues notice to the PRPs and DOI providing them the opportunity to conduct or finance the removal action at the High Access Areas.	August 25, 1995
EPA conducts removal response action at HAAs.	September – December 1995
EPA issues Special Notices to PRPs providing them the opportunity to undertake the RI/FS/RD for the residential portion of OU2.	November 17, 1995
EPA issues an action memorandum authorizing a removal response action to address lead contaminated soils at 300 residential properties.	March 21, 1996
Remediation of HAAs and residences conducted as a removal response action by the USACE.	June 1996 – December 1997
EPA issues the Baseline Human Health Risk Assessment for OU2. It indicates that lead in soil is the primary contaminant of concern and oral ingestion of soil is the primary exposure route of concern.	August 1996
EPA issues RI report for residential portion of OU2.	January 1997
EPA issues FS report for residential portion of OU2.	February 1997
A ROD for OU2 is signed. The selected remedy included excavation of soils in residential yards contaminated with lead above 500 ppm down to a depth of 18 inches, replacement of the contaminated soil with clean backfill, and disposal of the contaminated soil in an on-site repository.	August 27, 1997
Removal action for remediation of the High Access Areas and residential yards continues as a Remedial Action conducted by the USACE.	January 1998
EPA enters into cooperative agreements with the ITEC, Quapaw Tribe, and ODEQ to provide funding for RI/FS activities for nonresidential portions of OU2.	1998 & 1999
EPA issues an action memorandum authorizing a removal response action to remove laboratory chemicals stored at the Eagle-Picher Office Complex in Cardin, Oklahoma, and designates this response as OU3.	March 2, 2000
EPA conducts the removal response for OU3. EPA determines that No Further Action is warranted to address OU3.	March 28 – May 23, 2000
The EPA completes the Second Five-Year Review for the Tar Creek Site.	April 2000
The USACE completes remediation of the 1,300th residential property under the RA for OU2. The USACE work for OU2 is completed. The EPA hires the RACs contractor to continue the residential yard remediation work for the OU2 RA.	July 2000
The ODEQ issues report documenting results of the Roubidoux Groundwater Monitoring Program for OU1.	September 2002
The EPA, USACE, and DOI sign a Memorandum of Understanding for the Tar Creek site.	May 1, 2003
The ODEQ continues the Roubidoux Groundwater Monitoring Program based on recommendation from their May 2003 report.	November 2003
An AOC is signed with the DOI and 2 mining companies to conduct the RI/FS for OU4.	December 9, 2003
The ODEQ plugs 5 abandoned Roubidoux wells at the site.	April 2004
The EPA completes the Third Five-Year Review for the Tar Creek site.	September 2005
Field work for the OU4 RI/FS is conducted.	April – October 2005
LICRAT was established and began the voluntary buyout.	July 2006
EPA publishes the RI/FS for OU4.	July 2007

EVENT	DATE
EPA signs the ROD for OU4.	February 20, 2008
EPA begins OU4 RA.	October 2009
Construction of Central Mill Repository begins.	January 2010
EPA signs ESD for OU4 ROD.	April 2010
The EPA completes the Fourth Five-Year Review for the Tar Creek site.	September 2010
LICRAT Buyout Complete under OU4 ROD.	November 2011
Treece Buyout Complete under OU4 ESD.	September 20, 2012
ODEQ completes Tar Creek After Action Monitoring Part 2 of Roubidoux aquifer.	October 2013
EPA proposes to transfer OU2 from EPA lead to ODEQ lead.	July 2014
EPA proposed completion of remedial action of OU1.	July 2014
Remedial Action Optimization Report completed.	September 2014
EPA completed remediation of 10 Distal packages, the former smelter property, 4 residences, and construction of the Central Mill Repository under OU4.	January 2010 – September 2014
EPA completed remediation of 579 properties through implementation of 9 RA projects under OU2.	2009-September 2014
EPA completed remediation of 2,940 total properties under OU2.	September 2014
EPA OU2 Milestone Cleanup Event.	September 2014
RAC Reports submitted.	2009-2014
EPA and ODEQ sign CA for Distal 6a.	April 2015
EPA signed the first CA with the Quapaw Tribe for OU4 RA activities.	April 2015
OU5 RI/FS activities begin.	July 2015
RA Reports for CB223, CB143/CB146/CB147 group, Distal 5, Distal 6, Distal 7 North, and Distal 7 South approved.	September 2015

2.0 Background

This section describes the physical setting of the site, including a description of the land use, resource use, and environmental setting. This section also describes the history of contamination associated with the site, the initial response actions taken at the site, and the basis for each of the initial response actions. RAs performed subsequent to the initial response actions for each of the OUs defined for the site are described in Section 3 below.

2.1 Physical Characteristics

The Tar Creek Superfund Site is primarily located in Ottawa County, Oklahoma, in the far northeastern corner of the state (Figure 1). In April 2010, EPA decided to add Treece, Kansas, to the site. Specifically, EPA decided to relocate the residents of Treece, KS to help prevent exposure to the source material deposits at the site. The decision to relocate the residents of Treece, KS was documented in an ESD regarding the OU4 ROD issued in April 2010 (EPA, 2010a). The Tar Creek Superfund Site has no distinct boundaries, but it includes the Oklahoma portion of the Tri-State Mining District (TSMD) along with other areas in Ottawa County where mining waste has come to be located. The TSMD is located in the border region of Kansas, Missouri, and Oklahoma. The Picher Field was the Oklahoma portion of the TSMD centered on the town of Picher, Oklahoma. Extensive lead and zinc mining took place in the Picher Field between the early 1900's and the 1970's. The Tar Creek Superfund Site is about 40 square miles in size. The principal communities within the mining area include Picher, Quapaw, Cardin, Commerce, Miami, and North Miami. The residents of Picher and Cardin were relocated under OU4 and those communities are now generally abandoned. The contamination at the site resulted from past mining activities. The Cherokee County Superfund Site in Kansas and the Oronogo-Duenweg and Newton County Superfund Sites in Missouri comprise the Kansas and Missouri portions of the TSMD (EPA, 1994).

Tar Creek and its primary tributary Lytle Creek comprise the principal drainage system within the Picher Field. Tar Creek is characterized as a small ephemeral stream with standing pools. The headwaters of Tar Creek are located in Cherokee County, Kansas (located north of Ottawa County on the Kansas-Oklahoma border). Tar Creek then flows southward through the Picher Field between the towns of Picher and Cardin, to the east of Commerce and Miami, and it then flows to its confluence with the Neosho River. Tar Creek and Lytle Creek drain approximately 53 square miles. Other principal drainage features near the site in Ottawa County include the Neosho River (located south of the site), the Spring River (located east of the site), and Grand Lake (located in southern Ottawa County) (EPA, 1994).

The Picher Field (including most of the Tar Creek Superfund Site) is located on the eastern edge of the Central Lowland Provinces. Eastern portions of the site are located in the Ozark Plateau. The Central Lowland Province is a nearly flat, treeless prairie. The Ozark Plateau is a broad, low structure dome centered in southwestern Missouri and northwestern Arkansas. The natural land surface at the site is mostly flat and gently slopes to the south towards the Neosho River, to the east towards the Spring River, and to the west towards Elm Creek. However, much of the land surface has been modified by the mining activities. There are numerous large tailings piles, composed of primarily limestone and chert, present on the land surface. In addition, numerous

collapsed structures from subsidence and cave-ins of mine shafts are also present on the land surface (EPA, 1984).

Contaminated groundwater at the site occurs within the Boone Formation (also known as the Boone aquifer). The Boone Formation is composed primarily of limestone, dolomite, and chert, with lesser amounts of sandstone and shale. Lead and zinc ore were mined from various members of the Boone Formation. Within the mining area, water quality within the Boone aquifer is poor due to acidity and high dissolved metals concentrations. The Boone aquifer is not used as a primary source of drinking water at the site. However, the OU4 RI did identify 13 private residential wells completed in the Boone aquifer that were being used as a source of drinking water at the site. Of the 13 wells tested during the RI, only two were found to be impacted above the final remediation goals (Section 4.2, Progress Toward Meeting the RAOs). The OU4 ROD includes provisions for these two residences to be provided with an alternate drinking water supply as part of the OU4 RA (EPA, 2008). Outside of the mining district, the Boone aquifer is used as a primary drinking water source. In areas where the Boone Formation outcrops at the surface, the aquifer is unconfined. Where the Boone Formation is overlain by confining strata, the aquifer is confined. At the Tar Creek Superfund Site, the Boone aquifer is both unconfined and confined. In the southern portion of the site, the potentiometric surface within the aquifer exceeds the land surface elevation. This results in artesian conditions, and groundwater discharges from abandoned wells, boreholes, mine shafts, and collapsed structures. This groundwater is acidic and contains high metals concentrations, and hence it is referred to as acid mine water or acid mine discharge. This discharge then flows into Tar Creek (EPA, 1994).

Also of interest at the site is the Roubidoux aquifer. The Roubidoux aquifer is composed of cherty limestone with several sand sequences near its base. The Roubidoux aquifer lies beneath the Boone aquifer, and the two are separated by 410 feet to 520 feet of limestone and shale of the Chattanooga Shale, the Jefferson City Dolomite, and the Cotter Dolomite. Where present, the Chattanooga Shale acts as an aquitard and restricts groundwater flow between the Boone aquifer and Roubidoux aquifer. The Chattanooga Shale is absent in most portions of the site. Hydrologically, the Cotter and Jefferson City Dolomites are considered a part of the Roubidoux aquifer (ODEQ, 2006b). The Roubidoux aquifer is a major source of drinking water in the area of the site (EPA, 1994). The cities of Quapaw, Commerce, Miami, and several rural water districts obtain their water supplies from the Roubidoux aquifer (EPA, 1984).

2.2 Land and Resource Use

Land ownership at the Site can be classified as private or Indian-owned. Under an 1833 treaty, the United States set aside the Quapaw Reserve, located in Ottawa County, Oklahoma, consisting of approximately 12,600 acres of land. A majority of these lands are individually owned allotted lands with 'restrictions against alienation.' These lands are managed under the supervision of the United States Bureau of Indian Affairs (BIA) (BIA, 2005).

Due to the size of the site, land use is varied. The site encompasses residential, commercial, and industrial areas within the towns, while most land use outside of towns is agricultural (EPA, 1997). Approximately 19,500 people lived in the mining area or close proximity to the mining area (EPA, 2008). Tar Creek flows approximately through the center of the site, and it discharges into the Neosho River south of the site. The Neosho River discharges into Grand Lake in southern Ottawa County. Groundwater under the site is found within both the Boone aquifer and Roubidoux aquifer. The Boone aquifer at the site is not currently used as a drinking water supply, but there are some private wells completed within the Boone aquifer. The Roubidoux aquifer is regionally used as a water supply (EPA, 1994).

2.3 History of Contamination

Lead and zinc mining activities first began at the site in the early 1900's. During the early mining period, most mining was conducted by small operators on 20 to 40 acre tracts. Each operator conducted their own mining, drilling, and milling activities (EPA, 1984). Mining activities occurred within a 50 to 150 foot thick ore bearing zone within the Boone Formation. The maximum depth of mining was approximately 385 feet below ground surface. Mining was accomplished using room and pillar techniques. To remove the ore, large rooms, some with ceilings as high as 100 feet, were connected by horizontal tunnels known as drifts. Pillars were left within the rooms to support the ceilings (EPA, 1994). The lead and zinc ores were milled locally and generally sent to locations outside of Ottawa County for smelting (except for the small smelter that operated in Hockerville, OK). Rapid expansion of mining activities occurred during the 1920's, and mining activities reached their peak around 1925. Each mine holding usually had its own mill. During the 1930's, large central mills came into operation, and most mining operations ceased operating their own mills. During the peak of mining activities, 130,410 tons of lead and 749,254 tons of zinc were produced annually. Large scale underground mining activities ended in 1958 (Brown and Root, 1997). Smaller mining operations continued in the Picher Field through the 1960's, and all mining activities at the site ceased in the 1970's (EPA, 2000b).

Zinc smelting operations were not known to have occurred in the Tar Creek area. Lead smelting of the material mined in the Tar Creek area was dominated by the Eagle-Picher Company, which operated a smelter in nearby Joplin, Missouri. However, the Ontario Smelting Company did operate a lead smelter near Hockerville, Oklahoma. Ontario Smelting Company operated this smelter from 1918 until 1924. The smelter was then purchased by the Eagle-Picher Company, who operated the smelter until the early 1930's, when the smelting operations ceased. There were no other smelting operations known to have occurred in the Tar Creek area (USACE, 2002).

Groundwater infiltration into the mines was a continual problem. This groundwater inflow was controlled through the use of pumps (EPA, 1984). When mining operations ceased, it is estimated that underground cavities with a volume of 100,000 acre-feet (161,000,000 cubic yards) had been created. In addition, approximately 100,000 exploratory boreholes were located within the Picher Field, mostly in Oklahoma. 1,064 mine shafts existed within the Oklahoma portion of the mining district. In addition, numerous water wells, used for milling operations, were abandoned (EPA, 2000b).

During the active mining period, large scale pumping had created a large cone of depression, effectively dewatering the Boone aquifer in the mining area. Exposed sulfide minerals, primarily marcasite and pyrite (both iron sulfide), were oxidized by exposure to the moist air in the mines. When mining activities ceased, pumping was also ceased, and the abandoned mines began to flood. The oxidized sulfide minerals were now much more soluble in water. As the mines filled with groundwater, the oxidized sulfide minerals began to dissolve, generating acid mine water. The acid mine water then reacted with the surrounding rock, and many of the metals present began to leach from the rock into the groundwater. As a result, the acid mine water contained high concentrations of zinc, lead, cadmium, sulfate, and iron (EPA, 1994).

In addition to the acid mine water, the mining activities at the site resulted in the accumulation on the ground surface of mining wastes. Large volume tailings piles (known as 'chat'), some as high as 200 feet, were left at the site. Many of the tailings piles are still present across the site, mostly around the towns of Picher and Cardin. In addition, numerous abandoned floatation ponds filled with fine sediments from milling and chat processing operations are also present at the site (EPA, 2008).

Three general types of mining wastes are present at the site. 'Development' rock is large diameter (4" to 2') rock that was generated during the opening of mine shafts or drifts. Development rock generally poses no contamination problem. 'Chat' is mine tailings from the milling process. Chat contains a mixture of gravel (typically 3/8" in diameter) and finer-grained materials. Fine tailings or "fines" are the fine-grained sediments collected in the flotation ponds (EPA, 2000b). The fine tailings present in chat and flotation ponds typically pose an environmental concern.

In March 2004, the chat piles at the site contained approximately 51.2 million tons of waste (AATA, 2005). The chat has historically been used as a source material for the concrete and asphalt industries and as a gravel source. Other uses of the chat have included railroad ballast, sandblasting and sandbag sand, roadway, driveway, alleyway, and parking lot aggregate, general fill material in residential areas, and impact absorbing material in playgrounds. Sales of chat have been a significant source of income in the local area. Based on estimates of historical aerial photographs, less than 50 percent of the original volume of chat remains in the area. The fines were collected into flotation ponds as part of the gravity separation milling process. Most of the ponds have since evaporated and are now dry. An inventory conducted in 2005 as part of the Remedial Investigation (RI) for OU4 identified 83 chat piles occupying 767 acres with 31 million cubic yards of mine waste, and 243 chat bases (or former piles) occupying 2,079 acres with an estimated 6.7 million cubic yards mine waste. Fine tailings generated from milling and

washing chat were found in 63 ponds occupying 820 acres and totaled approximately 9 million cubic yards of mine waste (EPA, 2008).

Historical mining activities within the TSMD have also contaminated sediments at the Tar Creek Superfund Site. An Advanced Screening Level Ecological Risk Assessment (SLERA) performed in 2009 documented exceedances of site specific toxicity thresholds for sediments in Spring and Neosho River basins (MacDonald et al., 2010). This study indicated that contaminants of potential concern (COPCs) present in surface water, sediments, pore water, and soils within riparian and aquatic habitats posed a potential risk to ecological receptors at the site. The assessment indicated that exposure to metals in sediments poses moderate to high risks to benthic invertebrates at approximately 45% of the locations sampled during the study, including portions of Tar Creek and Lytle Creek (MacDonald et al., 2010).

2.4 Initial Response

By 1979, the abandoned mines had become completely flooded due to groundwater infiltration and due to surface water inflow into the abandoned mine shaft openings and subsidence features. In low-lying areas along the southern portion of the site (near Commerce), the potentiometric surface exceeded the ground surface. This resulted in the surface discharge of acid mine water from abandoned boreholes and mine shafts (EPA, 2000b). This surface discharge then emptied into Tar Creek and other surface water bodies in the watershed. As a result, most of the downstream biota in Tar Creek was killed. The bottom of the creek became stained red due to ferric hydroxide deposition, and red stains appeared on bridge abutments and cliffs in the Neosho River downstream of its confluence with Tar Creek (EPA, 1994).

In 1980, the Governor of Oklahoma established the Tar Creek Task Force to investigate the effects of the acid mine discharge. The Task Force was composed of various local, state, and federal agencies. The OWRB was appointed as the lead state agency. The initial investigations were conducted by the Task Force in 1980 and 1981. The conclusions from the Tar Creek Task Force's studies included the following:

- There were no significant health risks associated with the air pathway at the Tar Creek Superfund Site;
- The Neosho River, Spring River, and Grand Lake could be used as a raw water source for public water supplies;
- The fish from areas sampled in these water bodies were safe for consumption; and,
- Most of the metals present in the acid mine water were precipitated out of the water and into the sediments in Tar Creek prior to its confluence with the Neosho River. The sediments in Tar Creek provided a long-term sink for metals that effectively removed them from most biological processes, and the sediments did not pose a health risk. Other than aesthetic alteration at the confluence of Tar Creek and the Neosho River, there was no impact on the Neosho River from the acid mine drainage in Tar Creek.
- The Task Force identified the primary threat at the site as the potential for contamination of the Roubidoux aquifer (EPA, 1994).

The EPA proposed the Tar Creek Superfund Site to the NPL in July 1981, based on information from the Task Force's investigations. The NPL is the list, compiled by EPA, of uncontrolled hazardous substance releases in the United States that are priorities for long-term remedial evaluation and response. On June 16, 1982, the EPA provided funding through a Cooperative Assistance Agreement with the Oklahoma State Department of Health (OSDH) to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the site. The OSDH was the principal Oklahoma agency at the site for the State of Oklahoma. The OWRB, under an interagency agreement with the ODSH, conducted the RI/FS for the Site. The site was listed on the NPL on September 8, 1983. The EPA signed a ROD for the site on June 6, 1984 (EPA, 1994). The remedy selected and implemented under the ROD is discussed in Section 3.

In 1994, the EPA conducted the first five-year review of the Tar Creek Superfund Site. While conducting this five-year review, the Indian Health Service in Miami, Oklahoma, notified the EPA by letter of elevated blood lead levels in children routinely tested as part of their participation in the United States Department of Agriculture's (USDA) Women, Infant, and Children (WIC) program. The letter stated that 34% of the 192 children tested had blood lead levels above 10 micrograms per deciliter (µg/dL), which is the level above which the Centers for Disease Control (CDC) considered at that time to be elevated in children.[6] The letter stated that although location did not appear to be a factor, a majority of the children did live within 5 miles of a chat pile (EPA, 1994). Also, EPA Region 7 had been conducting investigations of the Cherokee County (Kansas), and the Oronogo-Duenweg (Missouri) Superfund Sites. Data obtained from EPA Region 7's investigations indicated that mine wastes (including chat piles) represented an unacceptable risk to human health and the environment (EPA, 1994).

In the summary portion of the first five-year review, EPA stated that the studies conducted for the 1984 ROD did not include a risk assessment. Risk assessment guidance had not been developed at the time the 1984 ROD was signed, and the primary emphasis at the Tar Creek Superfund Site was on groundwater and surface water impacts related to the acid mine water. The first five-year review recommended that a second OU be designated at the site for the mining wastes. It was also recommended that studies be undertaken to determine the impacts of the chat piles and flotation ponds on human health and the environment. The studies were to include blood lead studies, environmental sampling of High Access Areas (HAAs are frequented or likely to be frequented by young children such as schools, playgrounds, day cares, and parks), mapping of all mine wastes, classification of surface mine wastes through environmental sampling and testing, sampling of leachate from mine wastes, and sampling of airborne particulates near mine wastes (EPA, 1994). As a result of the five-year review recommendations, surface and groundwater contamination at the site became OU1, and impacts related to the mining waste, including HAAs and residential properties, became OU2 (EPA, 2000b).

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[6] *See* Centers for Disease Control, *Preventing Lead Poisoning in Young Children* (1991) at p. 7 ("Blood lead levels at least as low as 10 µg/dL are associated with adverse effects"). Later the CDC revised its position saying that there was no safe level for lead in young children. *See CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention"* (November 26, 2013) ("CDC will emphasize that the best way to end childhood lead poisoning is to prevent, control or eliminate lead exposures. Since no safe blood lead level in children has been identified, a blood lead "level of concern" cannot be used to define individuals in need of intervention.".)

EPA addressed HAAs and residential areas of OU2 first. From August 1994 through July 1995, the EPA conducted sampling through its removal program (the removal program is, generally speaking, the part of the Superfund program generally responsible for conducting emergency and early response activities) to determine the nature and extent of the contamination in residential areas of the site. The Phase I sampling for OU2 addressed HAAs, and the Phase II sampling for OU2 took place at residences that were inhabited or potentially inhabited by children. Twenty-eight HAAs and 2,070 residential properties were sampled as part of the OU2 site assessment. The data were used to complete the OU2 Baseline Human Health Risk Assessment (BHHRA) and Residential RI Reports. The OU2 BHHRA concluded that lead in soil was the primary contaminant of concern and that ingestion of contaminated soil was the only exposure pathway that posed a significant risk to human health. These activities led the EPA to conclude that the lead contaminated soil in residential areas posed an imminent and substantial endangerment to human health (EPA, 2000b).

Due to the concerns related to exposures to lead contaminated soil, the EPA issued an action memorandum on August 15, 1995, that authorized removal response actions at HAAs at the Site (EPA, 2000b). The removal response action began in September 1995 and was completed in December 1995. The removal response action for the HAAs was known as the Phase I removal action. The Phase I removal action was conducted by EPA through its Emergency Response Cleanup Services (ERCS) contractor, Reidel Environmental Services, and by its Superfund Technical Assessment and Response Team (START) contractor, Ecology and Environment, Inc. (Washington Group International, 2002).

The removal response action beginning in September 1995 included the excavation of lead and/or cadmium contaminated surface soils with concentrations exceeding 500 parts per million (ppm) and 100 ppm respectively from 0 to 12 inches below ground surface (bgs) and 1,000 ppm lead and/or 100 ppm cadmium from 12 to 18 inches bgs. This means that in areas where the lead concentration exceeded 500 ppm from 0 to 12 inches bgs and/or the cadmium concentration exceeded 100 ppm, the soil was excavated. When the lead concentration exceeded 1,000 ppm and/or the cadmium concentration exceeded 100 ppm in the 12 to 18 inch bgs interval, then soil from that interval was also excavated. On large properties where unauthorized excavation could be controlled, such as parks and schools, the criteria were modified to 500 ppm lead and/or 100 ppm cadmium from 0 to 12 inches bgs (the 12 to 18 inch increment was dropped). When contamination remained above the cleanup levels at 18 inches bgs, a barrier (orange construction fence material) was place in the bottom of the excavation as a warning that contamination remained below the barrier. Each excavation was then backfilled with clean soil. Seventeen of the 28 HAAs that were evaluated required a response action (EPA, 2000b).

The EPA issued an action memorandum on March 21, 1996, that authorized a removal response action at residences at the Site (EPA, 2000b). This removal response action was known as the Phase II removal action, and it included both residential properties and HAAs. The EPA entered into an Interagency Agreement (IAG) with the United States Army Corps of Engineers (USACE) to conduct the Phase II removal action. The USACE contracted with Morrison Knudson Corporation (MK) to complete the work (USACE, 2002).

This removal action was conducted in a manner similar to the removal conducted at the HHA under Phase I, except that a cleanup level of 500 ppm for lead was chosen. This cleanup level

was based on the BHHRA and EPA Region 6 experience at other lead cleanup sites. Approximately 2,070 residential homes in Picher, Cardin, Quapaw, Commerce, and North Miami were evaluated. The second five-year review stated that approximately 65% of these properties contained soil lead in residential yards at concentrations that exceeded 500 ppm in at least one part of the yard. The Phase II removal response activities were conducted from June 1996 until December 1997. The following criteria were used to prioritize the properties:

- Top priority was given to homes with children less than 6 years of age who had blood lead levels in excess of 10 μg/dL, and where the soil lead concentrations had been determined to be a significant contributor to elevated blood lead levels; and,
- The next highest priority was given to homes where the soil lead concentration exceeded 1,500 ppm (EPA, 2000b).

During the Phase I (HAAs) and Phase II (residential properties) removal response actions, remediation was performed at 20 HAAs, one commercial property (used by the EPA, USACE, and their various contractors for on-site support facilities), and 227 residential properties. Approximately 84,417 cubic yards of soil were removed from these properties during the removal actions (E&E, 2000, USACE, 2002, and Washington Group International, 2002).

In September 1998, the Quapaw Tribe of Oklahoma requested assistance from the EPA to conduct response activities at an abandoned office complex located in Cardin, Oklahoma. The land was owned by the Quapaw tribe, and had been leased by Eagle-Picher Industries, Inc. from 1945 until 1981. A drum containing residual cyanide had been discovered in one of the site buildings during work conducted in 1998. EPA performed evaluations of the atmosphere inside this building and determined that no cyanide above background levels were present (EPA, 2000a).

In March 1999, the Inter-Tribal Environmental Council (ITEC) conducted a site reconnaissance of the Eagle-Picher Industries, Inc. office complex property in advance of the completion of an RI/FS being conducted by the ITEC and Quapaw Tribe for the EPA. During this Site reconnaissance, 120 containers of laboratory chemicals were discovered at the site. The EPA conducted a Hazardous Characterization, again at the request of the ITEC, in May and June 1999. These chemicals were inventoried, categorized, segregated, and over-packed in preparation of future disposal by the BIA. The BIA informed the EPA that it did not have the funding or expertise to remove the chemicals from the Site (EPA, 2000a).

On March 2, 2000, an action memorandum was issued by EPA approving a time-critical removal action at the Eagle-Picher Office Complex – Abandoned Mining Chemicals. This portion of the Site was designated OU3. The action memorandum determined that the chemicals posed an imminent and substantial endangerment to the public health or welfare or the environment. This determination was made on the basis that the containers in which the chemicals were stored had to be placed outside, where they were exposed to the elements. The EPA was concerned that eventually the containers would deteriorate, releasing the chemicals into the environment (EPA, 2000a).

On March 28, 2000, the emergency removal action was conducted. The laboratory chemicals were removed from the Site and transported to facilities appropriate for their disposal. The EPA

was unable to dispose of some low-level, radioactive uranyl acetate. The EPA remobilized to the Site on May 23, 2000. This material was removed from the site and transported to an off-site location for treatment and disposal (EPA, 2000c, and EPA 2000d). The EPA determined that no further action was required in relation to OU3 (EPA, 2004).

On December 9, 2003, the EPA signed an Administrative Order on Consent (AOC) with three Potentially Responsible Parties (PRPs), including the U.S. Department of the Interior (DOI), Blue Tee Corp., and Gold Fields Mining Corporation, to conduct the RI/FS for OU4. Under the terms of the AOC, the EPA prepared the risk assessments for OU4 based on data collected by the PRPs and EPA. A three-phased Site Reconnaissance was conducted from March 29 to April 28, 2005. Field sampling and investigations were conducted in May and concluded in October 2005. The RI/FS reports were issued in July 2007 (EPA, 2008).

During the course of the OU4 investigations, EPA performed a pilot project consisting of several field studies regarding injection of chat and fine tailings into flooded mine cavities to determine whether this could be a cost-effective disposal technique. Following the pilot injection, EPA found that the physical placement of chat and fine tailings in flooded mine rooms does initially impact mine water; however, the data indicated that the mine water chemistry rapidly begins to return to pre-placement conditions (EPA, 2008). In another pilot under the RI/FS, the United States Department of the Interior (DOI), with the cooperation of the Quapaw Tribe, is promoting responsible chat sales, using Best Management Practices (BMP) to reduce the volume of millions of tons of mining waste. Both pilots, Indian-owned chat sales and the disposal of chat in mine cavities, were response action alternatives considered in the OU4 FS (EPA, 2008).

In April 2009, EPA proceeded with OU2 RA activities within Ottawa County aimed at identifying residents that may not have had an opportunity to participate in past property remediation programs under OU2. The program identifies properties where landowners wanted to have their properties sampled and remediated. Due to the large scope of work, the remedial construction was performed over time through discrete "RA Projects". RA Projects completed during this program include: (1) South Repository Closure Modifications, (2) Southeast Commerce Site, (3) Ottawa County Towns RA, (4) City of Miami Ward 3 RA, (5) City of Miami Phase II RA, (6) City of Miami Phase III RA, (7) Ottawa County RA, (8) Ottawa County Phase III, and (9) Ottawa County Phase IV. These OU2 RA Projects were completed on properties that consisted of residential driveways, residential yards, HAAs, public alleyways, parks, and churches. EPA remediated 579 properties, resulting in the removal of 31,011 cubic yards, restoring approximately 62.6 acres. This set of OU2 RA projects was completed by September 2014 (EPA, 2013a and EPA, 2014a).

OU4 includes the parts of the Site (both urban and rural) that are not currently used for residential purposes or which are sparsely used for residential purposes, where mine and mill wastes and smelter waste have been deposited, stored, disposed of, placed, or otherwise come to be located. OU4 Source Material RA began in October 2009 and is currently ongoing. OU4 addresses the core mining areas of the Site where the largest chat and fines deposits are located, it also addresses distal areas where the population is sparse and the chat piles are smaller and generally dispersed. All of these areas have mining, milling, smelting, or other operation related wastes. The OU4 distal area is divided into three distinct distal areas (Figure 3): (1) Northeast

Distal Area, (2) Southeast Distal Area, and (3) Elm Creek Distal Area. Within these distinct distal areas, source material locations were grouped together to form distal groups where work can be conducted. There are sixteen (16) distal groups containing numerous chat piles, chat bases, and fine tailing ponds (Figure 3). The Central Mill Repository was constructed in 2010 and is the final resting place of waste from distal group remediation (CH2M HILL, 2011). To date, the CMR has received 993,171 tons of chat, 418,349 tons of transition zone soils, 200,082 tons of fine tailings, and 22,698 tons of smelter debris (Table 8).

EPA is presently conducting a Remedial Investigation (RI) for OU5. No OU5 remedy has been selected.

Table 8: Annual Production Summary

	Destination: Processor (Reuse), Tons			Destination: Repository, Tons									Destination: Repository, CY		
Production Period	Chat	Reuse Woodchips	Development Rock	Chat	TZ Soils	Fine Tailings	Wood/Scrap Metal/Concrete	Root balls and tree roots	Residential Soil	Development Rock	Imported Gravel classified as Dirty after removal from the site	Smelter Waste	OU2 Residential Soil, CY	Quapaw Tribe Loads, CY	Commerce Loads, CY
2010	46940.52	317.61	21653.12	496072.07	303919.39	116562.00	17446.51	2698.35	3556.28	10053.65	NA	0.00	0.00	NA	0.00
2011	199724.02	0.00	0.00	205989.25	36760.05	50551.10	39086.83	759.03	0.00	0.00	NA	10017.96	7788.20	NA	0.00
2012	2995.19	0.00	0.00	82753.01	34993.68	30016.39	5342.72	346.17	346.17	0.00	NA	12680.23	7071.00	NA	5796.00
2013	38473.87	0.00	0.00	137058.61	29845.44	2903.03	0.00	461.97	0.00	0.00	899.29	0.00	8849.50	540.00	0.00
2014	0.00	0.00	0.00	71298.37	13830.34	0.00	0.00	13.71	0.00	0.00	287.91	0.00	0.00	0.00	0.00
Total	288133.60	317.61	21653.12	993171.31	419348.90	200032.52	61876.06	4279.23	3902.45	10053.65	1187.20	22698.19	23708.70	540.00	5796.00

	Destination: CB223 (Subsidence Feature), Tons		C&D Debris, CY	Hockerville, Tons	605 Hole
Production Period	Recycled Limestone to CB223	Chat, Fine Tailings & Development Rock	To the Repository (Estimated)	TZ Soils	
2010	388.38	44908.61	0.00	0.00	
2011	Filled and Capped	Filled and Capped	42932.00	4434.53	
2012	-	-	3492.00	Filled and Capped	
2013	-	-	Filled and Capped	-	
2014	-	-	-	-	

Notes:
NA = Not available

2.5 Basis for Taking Action

The purpose of the response actions conducted at the Tar Creek Superfund Site was to protect public health and welfare and the environment from releases or threatened releases of hazardous substances from the site. Discharges of acid mine water from the abandoned mines to surface water and possible direct migration to the underlying Roubidoux aquifer threatened human health and the environment. In addition, exposure to lead contamination in residential soils was determined to be associated with human health risks higher than the acceptable range. The primary threats that the Tar Creek Superfund Site posed to public health and safety and the environment were: the potential contamination of water supply wells completed in the Roubidoux aquifer from acid mine water (no such contamination has been found to date); possible direct dermal contact with acid mine water where groundwater discharges at the surface; severe ecological impacts to Tar Creek (the stream) as a result of the acid mine water discharges; incidental ingestion of lead contaminated soils; incidental ingestion of drinking water; and incidental ingestion of fine particles that are interspersed with the larger chat particles, incidental ingestion of fine tailings materials, and incidental ingestion of smelter wastes in soil (EPA, 1984, EPA, 1997, and EPA, 2008).

3.0 Remedial Actions

This section provides a description of the remedy objectives, remedy selection, and remedy implementation for the three OUs (OU1, OU2, and OU4) for which RODs have been signed by EPA for the site. It also describes the ongoing operation and maintenance (O&M) activities performed at the site in the period since completion of the fourth five-year review. The three OUs for which RODs have been signed are: (a) OU1 (surface water/groundwater); (b) OU2 (residential properties and HAAs); and (c) OU4 (chat piles, distal properties, mine and mill waste, and smelter waste). Two additional OUs have been designated at the site: (a) OU3 (Eagle-Picher Office Complex - abandoned mining chemicals); and (b) OU5 (sediments and surface water). OU3 was addressed through a removal action, and the EPA has determined that no further action is necessary. EPA is presently conducting a Remedial Investigation (RI) for OU5. No OU5 remedy has been selected yet.

<u>Remedial Action Objectives</u>
The specific remedial objectives of the OU1 RA were:

- Mitigate the potential threat to public health and the environment by preventing contamination of the Roubidoux aquifer from acid mine water; and,
- Minimize the damage to Tar Creek [the stream] from acid mine water discharges (EPA, 1994).

The specific remedial objective of the OU2 RA was:

- Reduce ingestion by humans, especially children, of surface soil in residential areas contaminated with lead at a concentration greater than or equal to 500 ppm (EPA, 1997).

The specific remedial objectives of the OU4 RA are:

- Prevent children and adolescents from coming in direct contact, through the ingestion and inhalation exposure pathways, with lead contaminated source material where lead concentrations exceed 500 ppm;
- Prevent terrestrial fauna from coming in direct or indirect contact, through the ingestion exposure pathway, with cadmium-, lead-, or zinc-contaminated source materials and soils where cadmium, lead, and zinc concentrations exceed their respective remediation goals of 10.0 mg/kg, 500 mg/kg, and 1100 mg/kg respectively;
- Prevent riparian biota including waterfowl from coming into contact, through the ingestion exposure pathway, with unacceptable concentrations of cadmium, lead, and zinc in surface water and sediment by eliminating all discharges of cadmium, lead, and zinc from source materials to surface water;
- Prevent children from direct contact, through the ingestion and inhalation exposure, with lead-contaminated soil where soil lead concentrations exceed 500 ppm; and,
- Prevent site residents from the ingestion of water from private wells that contains lead in concentrations exceeding the National Primary Drinking Water Standards (EPA, 2008).

3.1 Remedy Selection

Three RODs have been issued by EPA for the Tar Creek Superfund Site. The OU1 ROD addressed the impacts associated with surface water discharges of acid mine water and the migration of acid mine water from the Boone aquifer to the underlying Roubidoux aquifer. The ROD for OU2 addressed surface soil contamination in residential areas at the site. The OU4 ROD addressed mining waste including chat piles and tailings ponds, smelter wastes, soils contaminated by mining and smelter wastes, a limited number of residential properties with lead-contaminated soils (that were not addressed under OU2), and private residential wells impacted by site related contaminants. The site has also been addressed through other response actions (the two removal response actions for OU2 and the removal action for OU3) as described in Section 2.4.

The ROD for OU1 was signed on June 6, 1984, to address the mitigation of surface water and groundwater discharges of acid mine water to Tar Creek and to prevent the potential contamination of the Roubidoux aquifer through acid mine water migration from the overlying Boone aquifer. Elements of OU1 included response actions to address contaminated groundwater as a result of acid mine water seepage, and actions to address contaminated surface water as a result of acid mine water discharges (EPA, 1984).

The remedy described in the 1984 ROD for OU1 included the following elements:

- Abandoned wells completed in the Roubidoux aquifer were to be plugged. Each well was to be cleared of obstructions. The wells were then to be plugged from the bottom to the surface using acid resistant cement.
- Surface water diversion and diking structures were to be constructed around two major inflow areas to prevent surface water inflow into the abandoned mines. The two inflow areas were identified as the abandoned mine shafts called Muncie and Big John. These

two inflow areas combined were thought to represent 75% of the total surface inflows into the abandoned mines. It was thought that the elimination of these inflow points would cause the groundwater levels in the mines to drop and, as a result the amount of acid mine water discharged to the surface would be reduced or eliminated. It was predicted that the Admiralty location would become an inflow point after the initial diking and diversion work was completed, so the ROD allowed for additional diking and surface water diversion around this location if deemed necessary.

- A surface water and groundwater monitoring program was to be conducted for two years. The purpose of the monitoring was to assess the effectiveness of the RAs at preventing contamination of the Roubidoux aquifer and reducing the acid mine water discharges into Tar Creek.
- A fund-balancing waiver to certain Applicable or Relevant and Appropriate Requirements (ARARs) was granted. The waiver was invoked in the ROD declaration based on the prohibitively high costs that would be associated with other engineered solutions to address the surface water contamination in Tar Creek. It was determined that these costs would drain the Superfund and put at risk the EPA's ability to address other releases under CERCLA and the NCP (EPA, 1984, and EPA, 2000b).
- The ROD stated that future RAs would be required if the selected alternatives did not adequately mitigate the risk to human health (EPA, 1984).

The ROD for OU2, residential areas, was signed on August 27, 1997. This ROD addressed soils in residential yards and HAAs contaminated with lead (EPA, 1997).

The remedy described in the ROD for OU2 (residential areas) included the following elements:

- Excavation of soils in residential areas and HAAs containing lead with concentrations greater than or equal to 500 ppm up to a depth of 18 inches. If lead concentrations exceed 500 ppm below 18 inches, a marker consisting of geotextile fabric or other suitable material would be placed in the excavation prior to backfilling to warn of contamination below the barrier. Each excavation was backfilled with clean top soil.
- Excavation of obvious hot spots (places where chat contamination was readily observable at the surface).
- Establishing new vegetation using sod or re-seeding.
- Backfilling of traffic areas and driveways with road base materials.
- On site disposal of excavated materials at a permanent long-term disposal area.
- Institutional controls (ICs) which may include the following:

    1. Restrictions and management controls on unsafe uses of mine tailings;
    2. Restrictions and management controls on activities that would cause recontamination of remediated properties;
    3. Restrictions and management controls on activities that would contaminate clean site property with mine tailings;

4. Restrictions and management controls intended to prevent future exposure of children to unacceptable levels of lead in the soil at new residential developments that are located in areas with high lead levels in soil;
5. Restrictions and management controls on building and construction activities in order to prevent building and construction practices that would increase exposure to lead-contaminated soils;
6. Restrictions and management controls on access to contaminated property through physical barriers (e. g., fencing) or notices (e. g., warning signs);
7. Public health and environmental ordinances and controls related to lead exposure and management of mine tailings;
8. Placing notices in property deeds regarding contamination;
9. Sampling and analysis of lead sources;
10. Blood lead monitoring;
11. Health education; and,
12. Lead-contaminated dust reduction activities.

- Measures to prevent the recontamination of residential properties, or that would reduce the potential for recontamination of residential properties included:

    1. Vegetating poorly vegetated or unvegetated areas;
    2. Capping with soil;
    3. Capping with base coarse material or paving;
    4. Applying dust suppressants or other dust control measures;
    5. Controlling drainage;
    6. Consolidation of source materials;
    7. Containment of source materials; and,
    8. Abating lead sources to prevent releases into the environment that would recontaminate remediated areas (EPA, 1997).

The OU2 ROD also included several provisions to address lead contaminated soils at the site and within Ottawa County. The ROD expanded the site to include all portions of Ottawa County that were impacted by mining wastes, including HAAs outside the mining area and the entire floodplain of Tar Creek. The ROD contained a provision to cover or replace chat material in alleyways, parking lots, roads, driveways, and other such areas located near residences with road base materials such as gravel or crushed limestone. The ROD called for expanding the use of physical barriers to restrict access to mining wastes located near residences as deemed appropriate (EPA, 1997).

The ROD for OU2 provided for the establishment of ground cover, such as grass, in bare contaminated soils at certain residences, located generally outside the mining area but within Ottawa County. Finally, the ROD stipulated that, at certain residences located generally outside the mining area but within Ottawa County, where medical monitoring has found that a resident has elevated blood lead levels close to or above 10 μg/dL, and where the residential yard is contaminated with lead at concentrations at or above 500 ppm, the soil would be excavated and replaced as called for under the selected remedy (EPA, 1997).

The ROD for OU4 was signed on February 20, 2008. This ROD addressed source materials (*i.e.,* chat, fine tailings, and smelter wastes), rural residential yard soil contamination, transition zone soil contamination (*i.e.,* the soil under and extending outward from a chat base or a tailings pond), and contamination in water drawn from rural residential wells. The OU4 ROD stated that the remedy would be implemented in two phases over a period of 30 years (EPA, 2008).

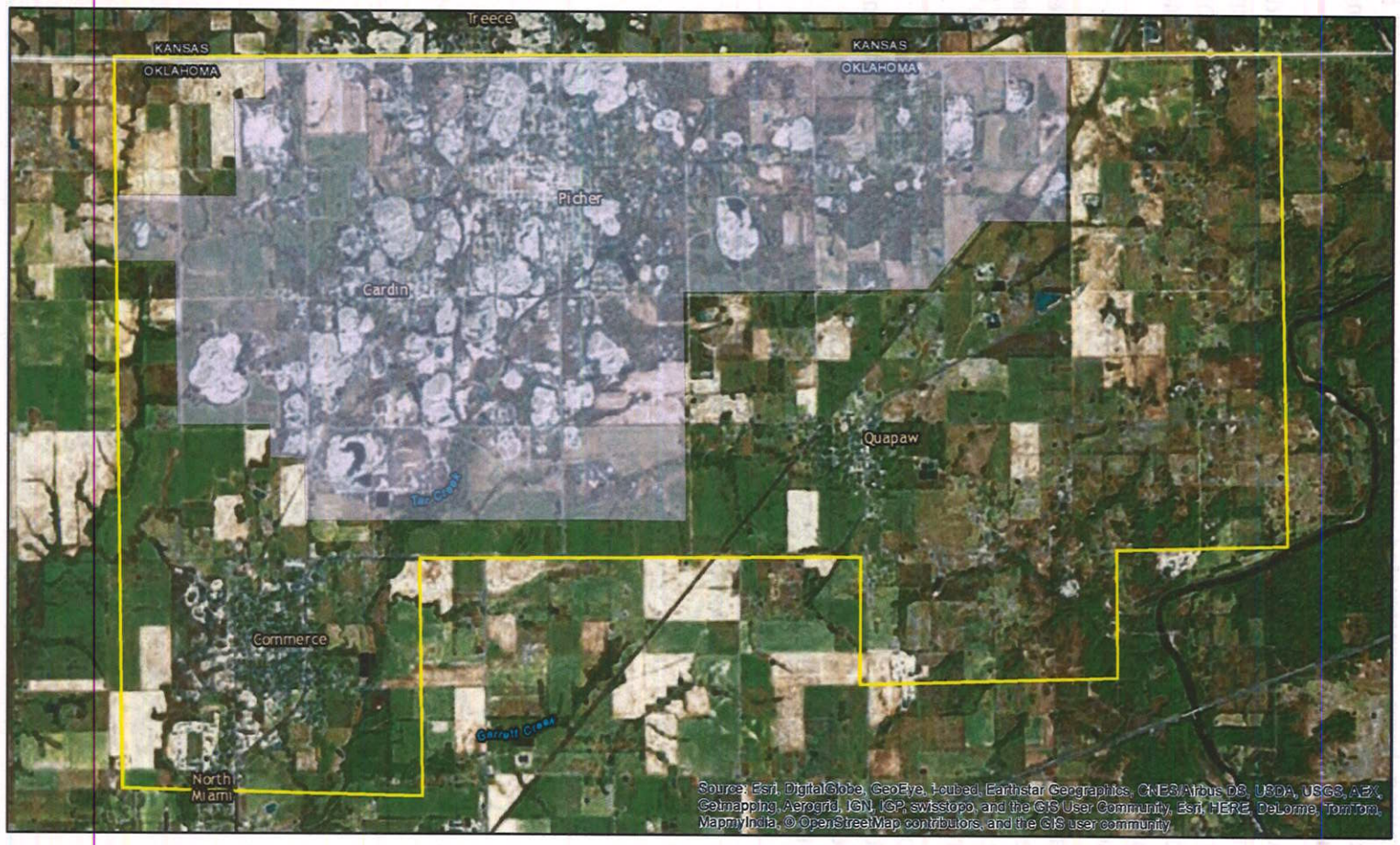
The remedy described in the ROD for OU4 included the following elements:

Phase 1 of the remedy selected under the OU4 ROD addresses voluntary relocation of residents in the area shown in Figure 4. Phase 1 also provides for chat sales. Phase 1 addresses source materials in a manner that reduces the overall footprint of contamination and reduces the need for land use restrictions, ICs, and O&M.

- Residents located in Picher, Cardin and Hockerville were voluntarily relocated following the procedures and priorities established by the Lead Impacted Communities Relocation Assistance Trust (LICRAT) (Residents of Treece, KS were added to the relocation, under a Kansas trust—the Treece Relocation Assistance (TRA) Trust , in 2010 –see below)
- Chat and chat bases from distal areas, including associated historic chat covered haul roads and non-operating railroad grades, are being excavated to the underlying native soil, transported and released to an on-site chat processor or future processing location located in a previously contaminated area of the site, injected into the mine workings, or disposed in an on-site repository.
- Transition Zone (TZ) soils (soils around and underneath source materials) are being addressed by excavation followed by natural soil rebuilding. [Note: EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated TZ soil. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the CMR (EPA, 2014d).
- Smelter wastes were all excavated and disposed in an on-site repository. Smelter affected soils were managed in the same manner as transition zone soils.
- Fine tailings are being injected into mine workings or covered in place, with the latter being the predominant disposal method. The covered fine tailings are being consolidated to reduce the footprint of the final cover.

- Source material in Tar, Lytle, Elm or Beaver Creek or other site waterways, was given priority under the OU4 ROD, but, generally speaking, EPA has emphasized cleaning up the distal areas. The optimization plan that EPA is now following emphasizes addressing source material in site waterways on a priority basis through either excavation and/or the installation of a flexible membrane liner, as needed as determined by EPA. As an interim measure, sheet piling, berms, constructed wetlands, or other engineering controls will be installed for near-stream source materials to help prevent contamination from migrating to surface water.
- An alternative water supply would be provided to any household where mining-related contaminants in water drawn from rural residential wells exceed 0.015 milligrams/liter (mg/L) for lead for rural households. Rural households that were within the area that had been designated for relocation under the LICRAT relocation program, but which did not elect to participate in the relocation program, have been included in the households receiving an alternative water supply (estimated to be two residences).
- Rural residential yard soil that was found to have concentrations of soil lead that exceed 500 ppm has been excavated to a maximum depth of 12 inches, and the excavated area has been backfilled with clean soil, contoured to promote drainage, and revegetated. This includes some residential yards that were identified for relocation.
- On-site repositories have been constructed to accept site source materials for final disposal. On-site repositories will be closed when they reach capacity or at completion of the RA. Closure will be accomplished by covering the repositories with a soil cover, contouring to promote drainage, and revegetating the soil cover. (EPA, 2008).

Figure 4: LICRAT Buyout Areas



We make every effort to provide and maintain accurate, complete, usable, and timely information. However, some data and information on this map may be preliminary or out of date and is provided with the understanding that it is not guaranteed to be correct or complete. Conclusions drawn from, or actions undertaken on the basis of, such data and information are the sole responsibility of the user.

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

Figure 4:
LICRAT Buyout
Area

Legend
- LICRAT Buyout Area
- Superfund Area

N W E S

Map Created by Brent Stone
on 5/12/2015

0 1 2 4 Miles

Phase 2 of the remedy selected under the OU4 ROD addresses certain source areas that remain after Phase 1 cleanup activities. These areas may include unmarketable chat bases, tailings ponds, and chat that remain undisposed and unsold in distal areas of the site. Chat sales will continue until the last five years of Phase 2.

- The remedy will be reviewed, at a minimum, every five years since hazardous substances would remain on site with concentrations that exceed concentration levels that allow for unrestricted use and unrestricted exposure. The remedy will be reviewed to ensure protection of human health and the environment. As part of the five-year review, EPA will evaluate the progress of chat sales. Chat piles and bases remaining after 10 years will be evaluated for commercial viability. This determination will be made using input from the chat/land owners, appropriate tribal representatives, and the commercial operators.
- Unmarketable chat piles and bases will be excavated, transported and released to an on-site chat processor or future processing location in a previously contaminated area of the site, injected into mine workings, or disposed of in an on-site repository. Where chat/land owners will not release the unmarketable chat, they will be asked to provide a plan, including a schedule, for its final disposition consistent with the OU4 ROD. If EPA finds that the plan or schedule is unacceptable, EPA may take legal action. Scheduled disposition under the owners' plans must be completed within five years.
- Historic haul roads and non-operating railroad grades that are contaminated will be managed the same as chat bases.
- ICs and O&M activities will be implemented, as needed as determined by EPA, at repositories and covered, fine tailings ponds.
- Environmental monitoring will be conducted, as needed as determined by EPA, to test for contamination in ambient and near source air, surface water, groundwater, and sediment during remediation activities.
- Other actions included in the selected remedy for OU4 are discussed below.

Chat sales were selected as part of the CERCLA remedy. The OU4 ROD states that although EPA does not own and will not purchase chat, it will assist chat sales participants. The responsible sale of chat under the Chat Rule, 40 CFR Part 278, will decrease the amount of chat on site in a way that brings added benefits to the community while reducing exposure risks.

As part of the OU4 ROD, a watershed-based approach is being taken, including development of a baseline hydrology model to reflect the existing land uses in the basin and to reflect any rainfall storage within the source materials. Runoff is expected to increase as the capacity of the soil to absorb rainfall on site decreases, and the model may be used in the future to manage increased runoff and stream flow.

Under the selected remedy, ICs include deed notices placed on land parcels that are contained in the site. Such ICs would notify current and potential future deed holders of the presence of any wastes left on site. The IC instrument to restrict land use is a Deed Notice and Easement filed pursuant to Oklahoma Statute 27A § 2-7-123(B). An additional IC is to be implemented to restrict use of groundwater from the Boone aquifer (or shallower) for potable or domestic supply

when that water source is impacted with site-related contaminants above the final remediation goals. The IC instrument for groundwater is to be implemented through the Oklahoma Water Quality Standards (OWQS) Title 785, Chapter 45, Appendix H (EPA, 2008). Appendix H currently states that toxic metals are present in the Boone Aquifer and that special well construction methods and sampling are required within the OU4 boundary due to contamination in the Boone aquifer.

To ensure that injection of chat complies with Underground Injection Control (UIC) regulations for a mine backfill well, a site-wide hydrogeological study was performed (CH2M HILL, 2010). The study addressed the requirements of the regulations and examined whether there is hydraulic connectivity between the Picher Field and the Commerce mine workings. The study also identified strategic subsurface locations for injection in order to maximize the number of potential injection sites and evaluate the long-term effectiveness of this method.

As part of addressing in-stream source materials, removed source materials will be returned to the nearby chat piles, chat bases, or tailings ponds from which it appears that they came, as determined by EPA, prior to remediation of such chat piles, bases or tailings ponds. When in-stream chat outside of the distal area is returned to its point of origin, the owners of the chat may sell it or dispose of it as is outlined in the OU4 ROD (EPA, 2008).

In April 2010, EPA issued an ESD describing a change that was made to the remedy selected under the OU4 ROD. The ESD explains that, consistent with the OU4 ROD, EPA decided to complete a voluntary relocation of residents in Treece, Kansas as part of the OU4 RA (EPA, 2010a).

3.2 Remedy Implementation

After the ROD for OU1 was issued, the surface water diversion and diking work at the Big John and Muncie Mine sites proceeded as part of the RA. The diking and diversion work at the Admiralty Mine site also proceeded. The construction at these three sites was completed on December 22, 1986 (EPA, 1994).

The work to clear and plug the 66 abandoned Roubidoux wells identified in the OU1 ROD began in September 1985, when IT Corporation was contracted by the OWRB to conduct the work. Of the 66 identified wells, 4 wells could not be located, 7 wells were found to be shallow (not completed in the Roubidoux aquifer), 3 wells were still in use, 2 wells had been properly plugged and abandoned, and access was not granted at one well location. In addition, 2 wells were not plugged due to high cost, and at 4 of the wells, it was not physically feasible to plug the entire well, so a cement plug was placed at the floor of the mine workings. The remaining 43 wells were properly plugged and abandoned (IT, 1985). After completion of the initial work, 17 additional wells were identified. The OWRB contracted with Engineering Enterprises, Inc. to conduct the additional work. Of the 17 wells, 13 were plugged and abandoned. Two wells were determined to be shallow vent holes or dewatering wells, and were not plugged. Two wells were not plugged due to technical difficulties. The additional work was completed in October 1986 (EEI, 1986).

Following construction activities at OU1, a two-year monitoring and surveillance program was conducted to assess the effectiveness of the RA activities at mitigating the acid mine drainage discharges to Tar Creek and at preventing the migration of the acid mine water to the Roubidoux aquifer. Surface water flow measurements and water quality data were collected at locations along and near Tar Creek to determine if the pollutant loading to Tar Creek had changed as a result of the RA construction activities. Water levels were monitored in the Blue Goose Mine (considered to be indicative of the water levels within the Boone aquifer and related to the discharge volumes from the mines to Tar Creek) to determine if the water levels within the Boone aquifer and the mine workings had decreased. Finally, water quality data were collected from public water supply wells completed within the Roubidoux aquifer to assess the water quality after completion of the well plugging activities. These monitoring activities were conducted in 1987 and 1988. The results of the monitoring and surveillance program were detailed in a report submitted by the OWRB to the EPA in 1991 and summarized in the first Five-Year Review Report (EPA, 1994). Further discussion regarding the results of this monitoring are provided in Section 3.4.

After the OU2 ROD was issued, the removal actions being conducted for the HAAs and residential properties were transitioned into the RA for OU2. The EPA and the USACE signed an IAG in September 1999. The USACE conducted the OU2 Remedial Design RD/RA under the direction of the EPA. MK was the contractor selected by the USACE to perform the RD/RA for OU2 (USACE, 2002).

MK began remediation at the site in February 1998. During assessment activities conducted between 1996 and 2000, approximately 2,774 properties were identified that required assessment sampling for lead in soils. Of these properties, 2,380 were assessed for lead contamination, and 2,106 exceeded the 500 ppm remediation goal for lead (88% of the assessed properties) (Washington Group International, 2002). The USACE and MK conducted remediation at 1,300 properties during the RA. These 1,300 properties were the original properties identified by the OU2 ROD as requiring remediation. The USACE and MK completed the RA for the 1,300 properties identified at the time the OU2 ROD was signed in July 2000. MK and the USACE demobilized from the site in September, 2000 (USACE, 2002).

After July 2000, the EPA contracted directly with CH2M HILL, Inc. to complete the RA for the remaining 565 properties still to be addressed at the site. A total of 649 properties were remediated by CH2M HILL. The remediation efforts at these properties were conducted from September 2000 to March 2006. This number includes 140 properties administered by the BIA, 495 additional residential properties, and 14 additional HAAs (7 schools located in Miami, one school located in Picher, 1 school playground located in Picher, 4 daycare facilities located in Miami, and the Mutt Mantle Ball Field in Ottawa County) (CH2M HILL, 2007a). During the various sampling efforts conducted during this period, certain properties were determined to be contaminated but the cities that had these properties within their boundaries elected to perform the remediation work. The City of Afton elected to remediate the Afton Little League Ball Park, and the City of Fairland elected to remediate the Fairland Little League Ball Parks. The remediation was accomplished by paving over each of the identified contaminated areas. The City of Miami completed remediating multiple park properties under an agreement with EPA. In 2005, the City of Commerce, under an agreement with ODEQ, began implementing the

remediation of the 98 remaining properties that were located within the city limits. Through January 2010, more than 2,295 residential properties and HAAs were remediated as part of either the removal response actions or the OU2 RA (EPA, 2010b).

In April 2009, EPA proceeded with the OU2 RA within Ottawa County. This OU2 RA program was aimed at identifying residents that may not have had an opportunity to participate in past property remediation programs under OU2. The goals of the program were to assess and identify properties in need of remediation and to carry out the needed remediation. This program relied on public participation, calling on residents to contact EPA and notify EPA of areas that the residents would like to have remediated. Due to the large scope of work, the RA was performed over time, through discrete RA projects. Properties cleaned up through this program included residential yards, residential driveways, public alleyways, and HAAs (EPA, 2013A).

The City of Commerce, under an agreement with ODEQ, continued implementing the remediation of properties that were located within city limits. The City of Commerce remediated approximately 54 properties and excavated 5,796 CY. Properties were backfilled and covered with sod (Commerce, 2011 and Commerce 2012).

OU2 RA projects began in late 2009 and were completed by September 2014. In all, these OU2 RA projects were responsible for remediating 579 properties, excavating 31,011 CY, and restoring 62.6 acres (EPA, 2013a and EPA, 2014a).

In April 2015 cooperative agreement, EPA and ODEQ agreed that ODEQ would undertake the OU2 remedial action, as described in the OU2 ROD, at the remaining OU2 properties it is estimated that approximately 19 properties still require remediation. Since 1994, approximately 2,940 residential properties and HAAs have been remediated under the RA for OU2 (EPA, 2014a). In September 2014, EPA celebrated the OU2 Milestone Cleanup Event recognizing the reduction of blood lead levels in Ottawa County children.

The ROD for OU4 was signed on February 20, 2008. The OU4 ROD addressed source materials (*i.e.,* chat, fine tailings, and smelter wastes), rural residential yard soil contamination, transition zone soil contamination (*i.e.,* the soil under and extending outward from a chat base or a tailings pond), and contamination in water drawn from rural residential wells. The OU4 ROD stated that the remedy would be implemented in two phases over a period of 30 years (EPA, 2008).

OU4 addresses the undeveloped rural and urban areas of the Site where mining and mill residues and smelter wastes have been placed, deposited, stored, disposed of, or otherwise come to be located as a result of mining, milling, smelting, or related operations. OU4 includes rural residential years located in Ottawa County outside of city or town limits, except for yards that were addressed under OU2. The RD for OU4 Source Removal consisted of a four part design package that included the *Final Remedial Design Report, Residential Yards and Wells and Smelter Site Remedy* (CH2M HILL, 2009a), *Final Remedial Design Report, Distal Areas* (CH2M HILL 2009b), *Final Remedial Design Report, Chat in Stream* (CH2M HILL, 2009c), and *Final Remedial Design Report, Central Mill Fine Tailings Pond and Repository* (CH2M HILL, 2011b).

Phase 1 of the remedy selected under the OU4 ROD addresses voluntary relocation of residents in the area shown in Figure 4. Phase 1 also provides for chat sales. Phase 1 addresses source materials in a manner that reduces the overall footprint of contamination and reduces the need for land use restrictions, ICs, and O&M. Phase 2 of the OU4 remedy addresses certain source areas that will remain after the Phase 1 cleanup activities are complete. These areas may include chat bases, tailings ponds, unmarketable chat piles and bases, and the chat that remains from the consolidation of distal area chat. Chat sales will continue.

Several Phase 1 RA construction activities have been completed under OU4. Under the OU4 ROD, the residents of the on-site towns of Picher, Cardin, and Hockerville were relocated from these areas which have high concentrations of source materials (*i.e.,* the mill tailings known as chat and fines). As explained in a 2010 ESD, EPA expanded the relocation effort to include the residents of Treece, Kansas. EPA funded the Lead Impacted Communities Relocation Assistance Trust (LICRAT), through ODEQ, and LICRAT purchased the Ottawa County properties at issue, and carried out the relocation effort with minimal EPA oversight. A similar trust—the TRA Trust—was established in Kansas to address the Treece relocation. The LICRAT buyout began in 2009 and was completed in 2011. The Treece buyout was completed in 2012. A total of 628 residences, 74 businesses, and 125 renters were relocated from impacted areas (ODEQ, 2011). The Central Mill Repository (CMR) was constructed from the Central Mill Fine Tailings Pond (CMFTP). The CMR is being constructed in a phased build-out approach. The Phase I construction is complete, and the CMR is receiving source material. The CMR is capable of receiving an estimated 7.6 million CY of source material and will be the repository for much of the OU4 RA activities (CH2M HILL, 2011b). Three rural residential yards were remediated under the Phase 1 RA in 2010. Approximately 3,556 tons of soils containing lead concentrations that exceed the remediation goal of 500 mg/kg were excavated from the rural residential yards and transported to the CMR (CH2M HILL, 2011a). The smelter site remediation was completed in November 2011. Approximately, 42,889 tons of source material was transported from the smelter site to the CMR (CH2M HILL, 2012). The fine tailings pilot study (FTPS) was completed in January 2012. The FTPS met the overall objectives set for the project. In particular, the volume of tailings that was injected per well exceeded the projected volume. The FTPS injected approximately 58,063 CY of fine tailings. However, the cost involved with executing the injections exceeded those estimated in the OU4 ROD, and key assumptions outlined in the OU4 ROD were not met (CH2M HILL, 2013). In addition, multiple chat piles and chat bases from several distal groups have been excavated and transported to the CMR and have been consolidated in subsidence features (CH2M HILL 2011a, CH2M HILL 2012, CH2M HILL 2012b, CH2M HILL 2013b, CH2M HILL 2014, and CH2M HILL 2015).

Several Phase 1 RA construction activities under OU4 are ongoing. EPA/ODEQ continues to excavate and transport chat bases and chat piles from distal areas. Marketable chat sales are ongoing and chat piles and bases can be purchased at the following website http://projects.ch2m.com/TCOU4chat/. To date, 309,787 tons of chat and developmental rock have been sold to nearby chat processors (Table 8). All chat purchased must be used in accordance with the Chat Rule as provided in the OU4 ROD. The OU4 ROD stipulated that transition zone (TZ) soils be excavated along with source material. The volume of transition zone soil found to be contaminated has greatly exceeded estimates in the RI/FS. In addition, removal of contaminated transition zone soil has essentially removed certain remediated

properties of topsoil. Consequently, EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated TZ soil. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the Central Mill Repository (EPA, 2014d). If this pilot project is successful, and soil amendments successfully remediate transition zone soil, this remediation approach may become the EPA's principal means of addressing contaminated transition zone soil. The OU4 ROD already provides for the use of soil amendments to help revegetate excavated areas. The OU4 ROD does not contemplate the use of soil amendments as the principal remediation technique for the transition zone soils. Consequently, if the pilot project is successful, EPA may take administrative actions, consistent with the NCP, to make this soil amendment technique part of the remedy. The pilot project is being conducted by the Quapaw Tribe of Oklahoma on its land known as the Catholic 40 and on the distal area of the site known as Distal 6A (Figure 3).

Phase 2 RA construction activities under OU4 are yet to be implemented due to the ongoing activities of Phase 1. Phase 2 activities will be implemented during the last 5 years of the remedy, years 26 through 30, to make the remedy more cost efficient.

3.3 Operation and Maintenance and Long-Term Monitoring

The State of Oklahoma, through the OWRB and, since 1993, the ODEQ (the ODEQ was formed in 1993 and took over Superfund responsibilities in the State of Oklahoma from the ODSH and OWRB at that time), is responsible for conducting the Roubidoux Groundwater Monitoring Program (also referred to in site documents as the Long-Term Monitoring [LTM] Program or After Action Monitoring [AAM] Program) activities, well plugging activities, and O&M for OU1. These activities are conducted through a Cooperative Agreement between the ODEQ and EPA.

The ROD for OU1 does not specifically state what O&M activities were to occur at the site. However, the ROD does mention O&M and costs related to the dikes and diversion work. The ROD also stipulated that a two-year monitoring and surveillance program would be conducted after construction of the selected remedies to assess the effectiveness of the RA at mitigating the acid mine discharges to Tar Creek and at preventing the migration of the acid mine water to the Roubidoux aquifer (EPA, 1984). The results of the two-year monitoring and surveillance program were summarized and presented in the first five-year review report. After completion of the two-year monitoring program, it was determined that the Roubidoux Groundwater Monitoring Program would continue for OU1 to further investigate potential impacts to the Roubidoux aquifer from acid mine water. The First Five-Year Review Report stated that after completion of this program, monitoring of the water quality in the Roubidoux aquifer would be accomplished through the normal sampling conducted by the various water supply operators as required by the Safe Drinking Water Act (SDWA) (EPA, 1994). The Roubidoux Groundwater Monitoring Program was conducted in two phases. Phase I activities were presented in the

Second Five-Year Review Report (EPA, 2000b). The results of Phase II were presented in the Third Five-Year Review (EPA, 2005).

After completion of the Phase II Roubidoux Groundwater Monitoring Program, the ODEQ implemented a follow-up groundwater monitoring program with the approval of the EPA. The ODEQ determined that the monitoring conducted by local water supply operators was inadequate for purposes of monitoring the water quality in the Roubidoux aquifer. The ODEQ's reasons for this conclusion were: the analytical parameters and frequency of sampling vary between individual water suppliers; the sampling procedures are not consistent between water suppliers; and the sampling is conducted without an approved Quality Assurance Project Plan (QAPP). The ODEQ therefore recommended the groundwater monitoring program to provide consistent analytical testing procedures and sampling schedules and to ensure the quality and consistency of the data (ODEQ, 2002a).

Beginning in November 2003, the Roubidoux Groundwater Monitoring Sampling Program involved the sampling of 14 wells located at or near the site. These wells included 3 monitoring wells installed by the ODEQ, 10 municipal supply wells, and one private well. Each well was sampled twice a year for 5 years. During implementation, several changes were made to the sampling program. Well Miami #1 became inoperable before the October 2004 sampling event and was replaced by Miami #3. Wells Miami #11 and RWD7 #2 were added as background wells in November 2006, the former because of its location between the mine area and Miami, and the latter because of its westerly location (ODEQ, 2009). This phase of sampling under the Roubidoux Groundwater Monitoring Program concluded in April 2008 (ODEQ, 2008a). In 2009, the ODEQ entered a new cooperative agreement with EPA to continue the Roubidoux Groundwater Monitoring Program, which was named the Tar Creek After-Action Monitoring Part 2 (TCAAM2). The former (Part 1) being completed under the previous cooperative agreement. TCAAM2 consisted of five rounds of groundwater sampling beginning in March 2010 and ending in October 2013 (ODEQ, 2014).

It should be noted that neither the EPA nor ODEQ have identified any public drinking water wells at the site that fail to meet the Maximum Contaminant Levels (MCLs) established under the SDWA. However, data do indicate that secondary (aesthetically-based) maximum contaminant levels (SMCLs) for the indicator parameters sulfate and iron (indicator parameters are compounds that indicate possible mine water impacts) were exceeded in four wells completed in the Roubidoux. In one of these wells indicator parameters were so high that it is certain that the well is impacted by mine water from the Boone aquifer. In two other wells the indicator parameters are so high that it is probable that the wells are impacted by mine water from the Boone aquifer. (ODEQ, 2014). It should be noted that neither the EPA nor ODEQ have identified any public drinking water wells at the site that fail to meet the Maximum Contaminant Levels (MCLs) established under the SDWA.

The ROD for OU1 recognized that additional abandoned Roubidoux wells might be identified in the future. The ROD contained provisions calling for evaluation of the need to plug additional wells that were discovered if warranted (EPA, 1984). The ODEQ identified 19 wells that required further assessment (ODEQ, 2006b). The ODEQ completed plugging efforts of the Tulsa Mine well and the powerhouse piezometer in February 2015. Both wells were plugged with Type 1 Portland cement. In addition, the ODEQ discovered two additional wells, one located in north

Picher and the other located on the Distal 8 property (Catholic 40) (*see* Figure 3) that require evaluation. Future wells that the ODEQ would like to plug include the Quapaw #5 and Quapaw #2 wells (ODEQ, 2015). The EPA and ODEQ continue to evaluate the need to plug abandoned Roubidoux wells when wells are identified and located.

The third and fourth five-year review reports both identified the lack of an O&M plan for the dike and diversion channel at the Admiralty Mine as an issue. Based on recommendations, ODEQ developed an updated O&M plan for the Admiralty Mine site. The O&M plan was completed on November 2, 2012. Under the O&M plan, annual inspections are performed for the diversion and dike remedy at the Admiralty Mine site and annual inspection elements include: an Abnormal Occurrence Response Plan, Performance Standards, and annual cost estimates of O&M (ODEQ, 2012). Annual inspection elements also include: (1) inspecting the sealed mine shaft for settlement and for depressions which could collect runoff and permit percolation into the sealed shaft, (2) checking slopes of diversion dike for deterioration and inspecting the crown for settlement and for depressions that could hold water, and (3) inspecting the diversion channel for blockage of flow by flood debris, vegetation, or beaver dams.

As part of the Admiralty Site O&M plan, an Abnormal Occurrence Response Plan was developed. In the Abnormal Occurrence Response Plan, "abnormal occurrence" is defined as a 100-year flood event. Abnormal situations that may occur as the result of a 100-year flood include: (1) failure to contain flow behind the dike, (2) breaking of the dike, (3) areas of deteriorated vegetation, and (4) identification of new subsidence areas. Under the abnormal occurrence response plan, if damage is minimal, the necessary minor repairs are executed. If major damage has occurred, the plan initially calls for temporary repairs to contain the damage. Once the damage is contained, the plan calls for an investigation to determine the cause of the damage. Once cause is determined, a solution including permanent repairs is developed.

The Admiralty Site O&M plan also includes Performance Standards. These Performance Standards are considered adequate under normal weather conditions and include the following provisions: (1) flow from the watershed should be contained in the channel, (2) storm flows should rarely top the dike, (3) water should not accumulate over the sealed shaft areas, (4) depressions, ruts, holes, or breaches in the dike and the absence of vegetation on the dike that may lead to erosion should be corrected (ODEQ, 2012). The dikes and stream channel diversion work completed at the Admiralty Mine site was inspected as part of the site inspection for this five-year review.

In a letter dated July 22 2014, EPA indicated that the OU1 RA was moving toward completion, with completion of ODEQ well-plugging activities being the last RA activity for OU1. Once RA is complete, OU1 will move entirely into O&M (EPA, 2014c).

The OU2 ROD selected remedy called for excavated contaminated soil to be disposed of at an on-site repository. Consistent with the OU2 ROD, EPA constructed on-site repositories in areas that were already contaminated. Then EPA disposed of the contaminated residential area soil in these repositories. To close the repositories, EPA made sure that the surface of the disposal areas had soil lead concentrations less than 500 ppm, and vegetated the disposal areas. Also consistent with the OU2 ROD, EPA worked with ODEQ to ensure that ICs were placed on the repositories.

ICs included an environmental easement prohibiting certain practices on the repositories that would damage the soil cover. The ICs provided ODEQ with future access to inspect the repositories. ICs also included deed notices to alert purchasers of the repositories and of the prohibitions. The repositories used during the course of the RA, now closed, are presently being used as pasture land for grazing. The North Repository, used and operated by previous contractors at the site, was closed by CH2M HILL (CH2M HILL, 2007a). At the request of EPA, CH2M HILL installed a fence and gates to prevent unauthorized access onto the County Repository, which will be used by Ottawa County employees and local residents to deposit impacted soil from county road maintenance and excavation for local utility work (CH2M HILL, 2007b). The South Repository was closed in 2006 through a process of final site grading, leveling, removal of bulk debris, and vegetative cover establishment. After the work was completed, the property owner expressed concern that the vegetative cover was not well established. On June 4, 2010 an agreement was executed between the property owner and EPA outlining the modifications necessary to restore the property to a condition that would be suitable for cattle grazing or raising hay. The site modifications at the South Repository restored approximately 23 acres. The restoration efforts were completed by May 2011 (EPA, 2013A). On October 19, 2012 the ODEQ filed an executed deed notice that outlined the land use restrictions for the property and identified suitable re-uses for the land (EPA, 2013A).

The EPA determined that no further action was warranted to address OU3, and O&M activities are not required for OU3 (EPA, 2000a).

The RA is currently ongoing for OU4 and no OU4 O&M activities are currently occurring at the Site. However, ICs in the form of Deed Notices have been filed on all the properties that participated in the LICRAT buyout. Deed Notices were filed on all properties and a database of the notices is located in Table 9a. The Kansas Department of Health and Environment has filed Environmental Use Controls on all the properties that participated in the TRA buyout, which are listed in Table 9b.

Table 9a: Deed Notices of LICRAT Buyout

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
1	P1G1001	704 S Francis	5/17/2007	839	500	1-2007-002560	5/17/2007	6660-00-009-001-0-000-00
2	P1G1002	120 E 9th St	9/9/2008	873	222	1-2008-005292	9/10/2008	6700-00-001-004-0-000-00
3	P1G1004-L	737 S Oneida	12/29/2008	879	541	1-2008-007370	12/30/2008	6720-00-018-013-0-000-00
4	P1G1005	125 Tar River	8/21/2009	893	787	1-2009-004344	8/24/2009	6020-00-006-001-0-000-00
5	P1G1006	106 River	5/29/2007	840	192	1-2007-002746	5/29/2007	6020-00-007-005-0-000-0
6	P1G1007	1281 S 605 Rd	8/30/2007	847	257	1-2007-004765	8/30/2007	0000-14-029-023-0-008-00
7	P1G1008	208 River	7/20/2007	844	28	1-2007-003840	7/20/2007	6020-00-002-001-0-000-00
8	P1G1012	502 N Netta	8/28/2007	847	73	1-2007-004699	8/29/2007	6540-00-004-001-0-001-00
9	P1G1013	312 S College	5/24/2007	840	61	1-2007-002692	5/24/2007	6720-00-001-011-0-000-00
10	P1G1014	710 N Picher	6/5/2007	840	781	1-2007-002908	6/5/2007	6540-00-001-004-0-000-00
11	P1G1015	504 N Picher	6/14/2007	841	424	1-2007-003110	6/14/2007	6540-00-005-009-0-000-00
12	P1G1017	104 Main St	5/29/2007	840	187	1-2007-002743	5/29/2007	6010-00-013-001-0-000-00 6010-00-013-005-0-000-00
13	P1G1019	514 S Francis	5/22/2007	839	644	1-2007-002630	5/22/2007	6660-00-001-029-0-000-00
14	P1G1020	501 N Main	5/17/2007	839	502	1-2007-002561	5/17/2007	6540-00-007-007-0-000-00
15	P1G1021	404 W A St	4/29/2010	907	732	1-2010-002036	4/29/2010	6620-00-006-001-0-000-00 6620-00-007-008-0-000-00
16	P1G1022	206 E 12 St	10/4/2007	850	419	1-2007-005661	10/4/2007	6700-00-010-015-0-000-00
17	P1G1023	123 E 9th St	7/12/2007	843	568	1-2007-003737	7/16/2007	6700-00-006-001-0-000-00
18	P1G1025	701 N Picher	8/28/2007	847	167	1-2007-004735	8/29/2007	6540-00-002-004-0-000-00
19	P1G1027A	100 S Columbus	2/2/2007	903	348	1-2010-000570	2/3/2010	6210-00-002-001-0-000-00
20	P1G1029	210 S Picher	5/29/2007	840	190	1-2007-002745	5/29/2007	6180-00-013-004-0-000-00
21	P1G1030	590 2 St	5/17/2007	839	506	1-2007-002563	5/17/2007	6010-00-002-016-0-000-00
22	P1G1031-L	733 S Oneida	12/29/2008	879	543	1-2008-007321	12/30/2008	6720-00-018-013-0-000-00
23	P1G1032	712 N Picher	6/5/2007	840	777	1-2007-002906	6/5/2007	6540-00-001-003-0-001-00
24	P1G1033	509 N Main	5/17/2007	839	508	1-2007-002564	5/17/2007	6540-00-007-004-0-000-00
25	P1G1035	213 E 11th St	8/14/2008	871	524	1-2008-004785	8/14/2008	6700-00-007-012-0-000-00
26	P1G1036	221 N Main	5/17/2007	839	504	1-2007-002562	5/17/2007	6010-00-005-013-0-000-00
27	P1G1038	701 S Ottawa	9/25/2007	849	499	1-2007-005403	9/25/2007	6720-00-007-017-0-000-00
28	P1G1039	512 N Columbus	5/24/2007	840	63	1-2007-002693	5/24/2007	6540-00-007-009-0-000-00
29	P1G1040	104 N Columbus	5/17/2007	839	498	1-2007-002559	5/17/2007	6210-00-002-002-0-000-00
30	P1G1041	313 N Treece	9/25/2009	896	59	1-2009-004993	9/25/2009	6620-00-003-002-0-000-00
31	P1G1044	301 E 11th St	6/5/2007	840	779	1-2007-002907	6/5/2007	6700-00-008-011-0-000-00
32	P1G1045	675 E 2 St	5/22/2007	839	642	1-2007-002629	5/22/2007	6010-00-007-006-0-001-00
33	P1G1046	515 N Picher	2/14/2008	859	303	1-2008-000929	2/15/2008	6540-00-006-003-0-000-00
34	P1G1048	900 S Gladys St	6/14/2007	841	428	1-2007-003112	6/14/2007	6700-00-006-004-0-000-00
35	P1G2046	621 E 2 St.	6/7/2007	841	105	1-2007-002961	6/7/2007	6010-00-007-006-0-000-00
36	P1G2047	600 S Cherokee	10/11/2007	851	126	1-2007-005831	10/11/2007	6720-00-008-001-0-001-00

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
37	P1G2049	739 S Main	6/14/2007	841	426	1-2007-0031111	6/14/2007	6540-00-007-003-0-000-00
38	P1G2050	329 Treece	12/6/2007	855	156	1-2007-007017	12/7/2007	6620-00-003-001-0-000-00
39	P1G2051	216 N D St	8/30/2007	847	252	1-2007-004762	8/30/2007	6620-00-005-007-0-000-00
40	P1G2052	135 S Frisco	6/7/2007	841	103	1-2007-002960	6/7/2007	6540-00-005-008-0-000-00
41	P1G2053	301 S Cherokee	7/26/2007	844	315	1-2007-003945	7/27/2007	6555-00-000-018-0-000-00 6555-00-000-022-0-000-00
42	P1G2054	800 S Connel	4/2/2009	885	414	1-2009-001745	4/3/2009	6720-00-001-019-0-000-00
43	P1G2056-L	200 N Treece	9/16/2008	873	677	1-2008-005450	9/17/2008	6620-00-005-005-0-000-00
44	P1G2058	200 S Frusco	9/25/2007	849	494	1-2007-005399	9/25/2007	6180-00-009-002-0-000-00 6180-00-009-003-0-000-00 6180-00-009-001-0-000-00
45	P1G2060	124 N Vantage	6/14/2007	841	422	1-2007-003109	6/14/2007	6555-00-000-005-0-000-00 6555-00-000-008-0-000-00 6555-00-000-009-0-000-00
46	P1G2062-L	700 N Main	12/29/2008	879	539	1-2008-007319	12/30/2008	6540-00-002-006-0-001-00
47	P1G2063	501 W A St	6/14/2007	841	430	1-2007-003113	6/14/2007	6630-00-000-003-0-000-00
48	P1G2066	205 N Vantage	9/5/2007	847	745	1-2007-004946	9/10/2007	6620-00-005-002-0-000-0
49	P1G2068-L	200 E 9th St	10/16/2008	875	533	1-2008-006048	10/16/2008	6700-00-002-009-0-000-00
50	P1G2070	530 E 7th St	9/7/2007	847	743	1-2007-004945	9/10/2007	6660-00-011-017-0-000-00
51	P1G2071-L	190 Wade St	10/2/2008	874	672	1-2008-005785	10/3/2008	6010-00-006-015-0-000-00
52	P1G2074-L	603 N Netta	8/29/2007	847	157	1-2007-004728	8/29/2007	6550-00-001-001-0-000-00
53	P1G2076	730 S Cherokee	8/9/2007	845	440	1-2007-004276	8/9/2007	6720-00-007-011-0-000-00
54	P1G2077	207 E 10th St	8/9/2007	845	442	1-2007-004277	8/9/2007	6700-00-007-007-0-000-00
55	P1G2079	314 N Treece	8/6/2007	845	233	1-2007-004207	8/8/2007	6620-00-002-008-0-000-00
56	P1G2080	988 E 1st St	9/6/2007	847	620	1-2007-004893	9/7/2007	6020-00-005-004-0-000-00
57	P1G2082	705 W Carl Patterson	12/27/2007	856	98	1-2007-007333	12/28/2007	6200-00-004-010-0-000-00 6200-00-004-007-0-000-00
58	P1G2083	200 S Picher	8/6/2007	845	231	1-2007-004206	8/8/2007	6180-00-013-001-0-000-00
59	P1G2085	203 N Vantage	8/29/2007	847	163	1-2007-004732	8/29/2007	6620-00-005-003-0-000-00
60	P1G2086	160 N Main	10/30/2009	898	30	1-2009-005604	10/30/2009	6010-00-007-001-0-000-00 6610-00-007-001-0-000-00
61	P1G2087	309 N Treece	8/6/2007	845	235	1-2007-004208	8/8/2007	6620-00-003-003-0-000-00
62	P1G2088	204 S Netta	2/14/2008	859	301	1-2008-000928	2/15/2008	6180-00-012-001-0-000-00
63	P1G2089	465 S Ethel	8/1/2007	844	684	1-2007-004061	8/1/2007	6520-00-019-013-0-000-00
64	P1G2090-L	531 N Netta	11/7/2008	877	528	1-2008-006690	11/19/2008	6540-00-005-001-0-000-00
65	P1G2091-L	515 S Francis	10/28/2008	876	337	1-2008-006308	10/30/2008	6660-00-002-011-0-000-00
66	P1G2092	548 W A St	10/4/2007	850	415	1-2007-005659	10/4/2007	6620-00-007-001-0-000-00
67	P1G2094	209 N Vantage	3/18/2008	861	271	1-2008-001520	3/19/2008	6620-00-005-001-0-000-00
68	P1G2095	631 N Netta	10/30/2007	852	590	1-2007-006270	11/1/2007	6550-00-001-008-0-000-00 6550-00-001-007-0-000-00 6550-00-001-006-0-000-00

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
69	P1G2096	205 E 10th St	8/28/2007	847	79	1-2007-004702	8/29/2007	6700-00-007-006-0-000-00
70	P1G2099	302 E 11th St	8/30/2007	847	255	1-2007-004764	8/30/2007	6700-00-009-001-0-000-00
71	P1G2100	107 E 11th St	9/14/2007	848	457	1-2007-005125	9/17/2007	6700-00-0100-006-0-000-00
72	P1G2101	503 N Main	8/23/2007	846	574	1-2007-004593	8/24/2007	6540-00-007-006-0-000-00
73	P1G2102	133 N Frisco	10/2/2008	874	670	1-2008-005784	10/3/2008	6555-00-000-002-0-000-00
74	P1G2103	806 S Gladys	8/29/2007	847	160	1-2007-004730	8/29/2007	6700-00-001-003-0-000-00
75	P1G2104-L	307 S Cherokee	12/19/2008	879	266	1-2008-007210	12/19/2008	6720-00-001-025-0-000-00
76	P1G2105	500 N Columbus	8/29/2008	847	155	1-2007-004727	8/29/2007	6540-00-007-008-0-000-00
77	P1G2107	800 S Gladys	9/14/2007	848	455	1-2007-005124	9/17/2007	6700-00-001-002-0-000-00 6700-00-001-001-0-000-00
78	P1G2108	528 N Cornell	11/15/2007	853	674	1-2007-006596	11/15/2007	6710-17-029-023-0-022-00
79	P1G2111	201 E 11th St	9/6/2007	847	622	1-2007-004894	9/7/2007	6700-00-010-008-0-000-00
80	P1G2113	601 N Netta	8/29/2007	847	157	1-2007-004728	8/29/2007	6550-00-001-001-0-000
81	P1G2116	202 E 11th St	8/28/2007	847	77	1-2007-004701	8/29/2007	6700-00-007-014-0-000-00
82	P1G2117	140 Frisco	8/21/2007	846	379	1-2007-004527	8/22/2007	6630-00-000-011-0-000-00
83	P1G2118	125 N Frisco	8/23/2007	846	570	1-2007-004591	8/24/2007	6555-00-000-011-0-000-00
84	P1G2119	151 N Main ST	9/14/2007	848	461	1-2007-005127	9/17/2007	6010-00-006-019-0-000-00 6010-00-006-008-0-000-00
85	P1G2120	1122 S Ella St	9/12/2007	848	463	1-2007-005128	9/17/2007	6710-21-029-023-0-022-00
86	P1G2122	216 E 12th St	8/28/2007	847	75	1-2007-004700	8/29/2007	6700-00-010-012-0-000-00
87	P1G2123	600 S College	6/16/2009	889	632	1-2009-003072	6/17/2009	6720-00-005-001-0-000-00
88	P1G2124	623 E 2nd St	4/23/2010	907	746	1-2010-002043	4/29/2010	6010-00-007-004-0-000-00
89	P1G2125	101 E 10th St	8/23/2007	846	572	1-2007-004592	8/24/2007	6700-00-007-001-0-000-00
90	P1G2126-L	511 N Picher	10/23/2007	876	68	1-2008-006189	10/24/2007	6540-00-006-004-0-000-00
91	P1G2127-L	179 N Main St	10/9/2008	875	187	1-2008-005918	10/9/2008	6010-00-006-017-0-000-00
92	P1G2128	704 W 2nd St	11/13/2007	853	587	1-2007-006547	11/14/2007	6200-00-004-001-0-000-00
93	P1G2129-L	110 River	11/6/2008	877	74	1-2008-006500	11/7/2008	6020-00-007-004-0-000-00
94	P1G2132	504 N Main	3/25/2010	905	753	1-2010-001395	3/26/2010	6540-00-006-004-0-002-00 6540-00-006-005-0-000-00
95	P1G2133L	801 N Netta	5/20/2010	909	42	1-2010-002449	5/21/2010	6580-00-006-007-0-000-00
96	P1G2134	4101 S 69 Hwy	11/12/2008	877	252	1-2008-006579	11/13/2008	000-32-029-023-0-0003-00
97	P1G2135	1280 S 605 Rd	7/15/2008	869	663	1-2008-004126	7/15/2008	0000-14-029-023-0-004-00
98	P1G2137-L	509 N Columbus	10/28/2008	876	335	1-2008-006307	10/30/2008	6540-00-008-006-0-000-00
99	P1G2138	720 S Cherokee	6/26/2008	868	708	1-2008-003810	6/27/2008	6720-00-007-006-0-000-00
100	P1G2139	500 W A Street	5/28/2009	888	621	1-2009-002737	5/28/2009	Personal Property tax-Leased land
101	P1G2140A	711 N Netta	3/30/2010	906	150	1-2010-001489	3/31/2010	6550-00-002-004-0-000-00
102	P1G2140	711 N. Netta	11/29/2007	854	582	1-2007-006876	11/29/2007	6550-00-002-001-0-000-00
103	P1G2141	500 S Emily	1/8/2008	856	665	1-2008-000129	1/8/2008	6660-00-002-017-0-000-00
104	P1G2142	211 E 10th St	10/4/2007	850	417	1-2007-005660	10/4/2007	6700-00-007-010-0-000-00
105	P1G2145	180 S Vantage	9/18/2007	848	713	1-2007-005212	9/19/2007	6555-00-000-023-0-001-00

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
106	P1G2145	180 S Vantage	9/18/2007	848	713	1-2007-005212	9/19/2007	6555-00-000-020-0-000-00 6555-00-000-023-0-000-00
107	P1G2146-L	160 Wade St	10/9/2008	875	189	1-2008-005919	10/9/2008	6010-00-006-011-0-000-00
108	P1G2147-L	210 N Main St	10/9/2008	875	191	1-2008-005920	10/9/2008	6010-00-008-001-0-000-00
109	P1G2148	1101 S. Pearl St	10/31/2007	852	584	1-2007-006268	10/31/2007	6700-00-010-010-0-000-00
110	P1G3001	517 S Emily	2/14/2008	859	297	1-2008-00926	2/15/2008	6660-00-003-013-0-000-00
111	P1G3002	306 River	11/8/2007	853	321	1-2007-006449	11/9/2007	6020-00-002-001-0-000-00
112	P1G3003	507 S Cherokee	9/14/2007	848	459	1-2007-005126	9/17/2007	6720-00-003-018-0-000-00
113	P1G3008	260 N Wade St	11/13/2007	853	591	1-2007-006549	11/14/2007	6010-00-005-003-0-000-00
114	P1G3009	213 E 9th St	11/6/2008	853	178	1-2007-006397	11/7/2007	6700-00-005-003-0-000-00
115	P1G3012	216 S Alta	5/13/2008	865	497	1-2008-002781	5/14/2008	6520-00-009-021-0-000-00
116	P1G3013	271 S Wade St	9/27/2007	849	731	1-2007-005484	9/28/2007	6010-00-002-011-0-000-00
117	P1G3019	505 S Francis	10/23/2007	852	1	1-2007-006077	10/23/2007	6660-00-0020-007-0-000-00
118	P1G3021	215 S Netta	10/9/2007	850	728	1-2007-005750	10/9/2007	6180-00-0013-014-0-000-00
119	P1G3022	106 N Onedia	2/14/2008	859	299	1-2008-000927	2/15/2008	6200-00-001-008-0-000-00 6200-00-001-003-0-000-00
120	P1G3023	314 N Treece	10/11/2007	851	129	1-2007-005833	10/11/2007	6700-00-009-011-0-000-00
121	P1G3025 P1G3025A	321 S Emily	12/9/2009	901	207	1-2009-006539	12/23/2009	6520-00-012-010-0-000-00 6520-00-012-012-0-000-00
122	P1G3026	600 S Alta	12/6/2007	855	160	1-2007-007019	12/7/2007	6660-00-006-017-0-000-00
123	P1G3027	303 E 11th St	1/9/2008	856	713	1-2008-000160	1/9/2008	6700-00-008-009-0-001-00
124	P1G3028		11/20/2007	854	199	1-2007-006732	11/20/2007	6700-00-009-009-0-000-00
125	P1G3029	305 N Main St	11/13/2007	853	597	1-2007-006552	11/14/2007	6010-00-004-015-0-000-00
126	P1G3030	100 N Ella Street	5/20/2009	889	353	1-2009-002962	6/12/2009	6520-00-002-019-0-000-00
127	P1G3031	397 N Main St	9/16/2008	873	681	1-2008-005452	9/17/2008	6010-00-004-009-0-000-00
128	P1G3033	103 Wade St	5/27/2010	909	445	1-2010-002594	5/28/2010	6010-00-001-007-0-000-00
129	P1G3035	314 S Alta	11/15/2007	853	672	1-2007-006595	11/15/2007	6520-00-012-020-0-000-00
130	P1G3036	445 S Emily	11/29/2007	854	580	1-2007-006875	11/29/2007	6520-00-020-005-0-000-00
131	P1G3037		1/28/2008	858	186	1-2008-00557	1/29/2008	6700-00-004-001-0-000-00
132	P1G3038	300 E 8th St	11/13/2008	877	313	1-2008-006595	11/13/2008	6710-21-029-023-0-001-00
133	P1G3041	700 S Ottawa	10/31/2007	852	582	1-2007-006267	10/31/2007	6720-00-018-001-0-000-00
134	P1G3045	701 S Cherokee	11/6/2007	853	175	1-2007-006395	11/7/2007	6720-00-006-017-0-000-00
135	P1G3047	212 S Alta	4/10/2008	863	216	1-2008-002019	4/11/2008	6520-00-009-017-0-000-00
136	P1G3049	208 S Vantage	11/8/2007	853	319	1-2007-006448	11/9/2007	6180-00-010-004-0-000-00
137	P1G3050	620 S Cherokee	1/6/2010	902	8	1-2010-000081	1/7/2010	6720-00-008-005-0-000-00 720-00-008-005-0-001-00
138	P1G3051	105 E 11th St	11/8/2007	853	312	1-2007-006444	11/9/2007	6700-00-010-004-0-000-00
139	P1G3053		11/20/2007	854	195	1-2007-006730	11/20/2007	6700-00-010-019-0-000-00
140	P1G3054	322 N Connell	12/27/2007	856	100	1-2007-007334	12/28/2007	6660-00-005-014-0-000-00
141	P1G3056-L	313 S Emily	10/6/2008	876	343	1-2008-006311	10/30/2008	6520-00-012-002-0-000-00

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142	P1G3059	322 S Alta	11/6/2007	853	173	1-2007-006394	11/7/2007	6520-00-012-023-0-000-00
143	P1G3060		12/6/2007	855	162	1-2007-007020	12/7/2007	6700-00-005-012-0-000-00
144	P1G3061A	505 North Connell	11/10/2009	898	739	1-2009-005829	11/12/2009	6710-16-029-023-0-015-00
145	P1G3063	255 N Wade St	11/8/2007	853	317	1-2007-006447	11/9/2007	6010-00-002-015-0-000-00 6010-00-002-014-0-000-00 6010-00-002-012-0-000-00
146	P1G3064	1061 S 605 Rd	1/17/2008	857	483	1-2008-000361	1/18/2008	0000-14-029-023-0-007-00
147	P1G3065-L	720 - 722 S College	11/25/2008	878	67	1-2008-006811	11/26/2008	6720-00-006-008-0-000-00
148	P1G3066	621 S Cherokee	12/6/2007	855	169	1-2007-007024	12/7/2007	6720-00-005-028-0-000-00
149	P1G3069-L	302 N River	10/28/2008	876	339	1-2008-006309	10/30/2008	6020-00-001-003-0-000-00
150	P1G3070	314 E 8th St.	3/18/2008	861	273	1-2008-001521	3/19/2008	6710-21-029-023-0-014-00
151	P1G3071	312 E 8th St	3/18/2008	861	269	1-2008-001519	3/19/2008	6710-21-029-023-0-013-00
152	P1G3073-L	170 N Harlin	10/28/2008	876	341	1-2008-006310	10/30/2008	6010-00-001-001-0-000-00
153	P1G3075	300 S Alta	11/13/2007	853	593	1-2007-006550	11/14/2007	6520-00-012-013-0-000-00
154	P1G3077	136 2nd St	5/20/2008	866	83	1-2008-002945	5/21/2008	6010-00-011-001-0-000-00 6010-00-011-002-0-000-00
155	P1G3078	247 River	2/17/2009	882	485	1-2009-000843	2/18/2009	6010-00-011-012-0-000-00
156	P1G3081	601 S Oneida	4/10/2008	863	218	1-2008-002020	4/11/2008	6720-00-017-021-0-000-00
157	P1G3082	310 S Alta	11/13/2007	853	595	1-2007-006551	11/14/2007	6520-00-012-018-0-000-00
158	P1G3085	308 E 8th St	3/18/2008	861	267	1-2008-001518	3/19/2008	6710-21-029-023-0-012-00
159	P1G3086	413 S Emily	1/28/2008	858	193	1-2008-000561	1/29/2008	6520-00-017-007-0-000-00
160	P1G3087	454 S Alta	12/20/2007	855	739	1-2007-007237	12/21/2007	6520-00-020-023-0-000-00
161	P1G3088	614 S Oneida	6/17/2008	868	115	1-2008-003537	6/18/2008	6720-00-020-001-0-001-00
162	P1G3094	463 S Connell	2/14/2008	859	289	1-2008-000921	2/15/2008	6520-00-022-015-0-000-00
163	P1G3096	230 McGhee St	1/8/2008	856	662	1-2008-000127	1/8/2008	6010-00-011-007-0-000-00
164	P1G3098	466 S Francis	2/26/2008	860	61	1-2008-001131	2/26/2008	6520-00-022-031-0-000-00
165	P1G3098A	466 S Francis	5/13/2010	908	551	1-2010-002316	5/14/2010	6520-00-022-022-0-000-00 6520-00-022-026-0-000-00 6520-00-022-028-0-000-00
166	P1G3099	504 S Alta	12/6/2007	855	165	1-2007-007022	12/7/2007	6660-00-003-017-0-000-00
167	P1G3101	216 E 9th	11/15/2007	853	670	1-2007-006594	11/15/2007	6700-00-002-007-0-000-00
168	P1G3102	390 1st St	11/29/2007	854	585	1-2007-006878	11/29/2007	6010-00-007-001-0-000-00
169	P1G3103	528 S Ottawa	12/20/2007	855	743	1-2007-007240	12/21/2007	6720-00-016-008-0-000-00
170	P1G3104	161 Wade St	1/3/2008	856	455	1-2008-000059	1/4/2008	6010-00-001-019-0-001-00
171	P1G3105	508 S Francis	12/4/2007	855	18	1-2007-006970	12/5/2007	6660-00-001-021-0-000-00
172	P1G3108	113 McGhee St	12/27/2007	856	92	1-2007-007330	12/28/2007	6010-00-008-011-0-000-00
173	P1G3110	214 E 9th St	12/27/2007	856	94	1-2007-007331	12/28/2007	6700-00-002-007-0-001-00 6520-00-002-016-0-000-00
174	P1G3111	606 S Emily	12/6/2007	855	167	1-2007-007023	12/7/2007	6660-00-007-023-0-000-00
175	P1G3113	411 S Emily	12/18/2007	855	625	1-2007-007201	12/18/2007	6520-00-017-004-0-000-00

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176	P1G3115	607 S Emily	12/4/2007	855	16	1-2007-006969	12/5/2007	6660-00-006-009-0-000-00
177	P1G3117	115 N Ethel	3/18/2008	861	275	1-2008-001522	3/19/2008	6520-00-000-002-0-000-00 6520-00-001-004-0-000-00
178	P1G3119	514 S Emily	12/18/2007	855	627	1-2007-007202	12/18/2007	6660-00-002-031-0-000-00
179	P1G3121	512 S Ella St	2/5/2008	858	665	1-2008-000742	2/6/2008	6660-00-004-025-0-000-00
180	P1G3124	305 N River	4/17/2008	863	749	1-2008-002203	4/18/2008	6010-00-010-012-0-000-00
181	P1G3125	619 3rd St.	2/14/2008	859	291	1-2008-000922	2/15/2008	6010-00-008-007-0-000-00
182	P1G3126	416 S Emily	2/5/2008	859	163	1-2008-000866	2/13/2008	6520-00-016-024-0-000-00
183	P1G3127	456 Ella St	2/26/2008	860	59	1-2008-001130	2/26/2008	6520-00-019-025-0-000-00 6520-00-019-027-0-000-00
184	P1G3128	408 S Emily	1/28/2008	858	188	1-2008-000558	1/29/2008	6520-00-016-020-0-000-00
185	P1G3130	104 N Ella St	2/12/2008	859	165	1-2008-000867	2/13/2008	6520-00-002-014-0-000-00
186	P1G3134	522 N Picher	2/14/2008	859	293	1-2008-000923	2/15/2008	6540-00-005-012-0-000-00
187	P1G3137	2170 S 570 Rd	5/1/2008	864	679	1-2008-002520	5/2/2008	0000-02-029-023-0-001-02
188	P1G3138	4275 S Hwy 69	9/5/2008	873	57	1-2008-005219	9/5/2008	0000-32-029-023-0-002-00
189	P1G3139	201 McGhee St	5/29/2008	866	658	1-2008-003132	5/30/2008	6010-00-008-016-0-000-00
190	P1G3140	116 N Oneida	8/19/2008	871	691	1-2008-004866	8/19/2008	6200-00-001-001-0-001-00
191	P1G3142	314 S Emily	4/15/2008	863	483	1-2008-002118	4/16/2008	6520-00-013-018-0-000-00
192	P1G3143	629 S Cherokee	5/16/2008	865	667	1-2008-002853	5/19/2008	6720-00-005-034-0-000-00
193	P1G3144A	620 South Ottawa	5/13/2010	908	553	1-2010-002317	5/14/2010	6720-00-017-001-0-000-00
194	P1G3144-L	627 S Ottawa	1/20/2009	880	702	1-2009-000291	1/21/2009	6720-00-008-033-0-000-00
195	P1G3146	418 S College	5/8/2008	865	305	1-2008-002713	5/8/2008	6720-00-002-010-0-000-00
196	P1G3147	113 N Ethel	5/1/2008	864	682	1-2008-002522	5/2/2008	6520-00-001-007-0-000-00
197	P1G3148	198 Harlin	5/13/2008	865	491	1-2008-0022778	5/14/2008	6010-00-001-014-0-000-00 6010-00-001-015-0-000-00
198	P1G3149	322 S Francis	10/16/2008	875	535	1-2008-006049	10/16/2008	6520-00-014-023-0-000-00
199	P1G3150	501 S Emily	8/20/2009	893	724	1-2009-004319	8/21/2009	6660-00-003-001-0-000-00
200	P1G3151	715 S Francis	4/15/2009	863	481	1-2008-002117	4/16/2008	6660-00-010-011-0-000-00
201	P1G3153	463 S Emily	5/16/2008	865	669	1-2008-002854	5/19/2008	6520-00-020-013-0-000-00
202	P1G3155	608 S Alta	5/8/2008	865	307	1-2008-002714	5/8/2008	6660-00-006-026-0-000-00
203	P1G3156	531 S Ethel	5/20/2008	866	86	1-2008-002947	5/21/2008	6660-00-004-014-0-001-00
204	P1G3156A	531 S Ethel	7/21/2009	892	49	1-2009-003761	7/21/2009	6660-00-004-014-0-001-00
205	P1G3158	737 1/2 S Oneida	12/29/2008	880	546	1-2009-000277	1/15/2009	6720-00-019-008-0-000-00
206	P1G3159	314 N Netta	6/26/2008	868	705	1-2008-003809	6/27/2008	6620-00-003-007-0-000-00 6620-00-003-008-0-000-00
207	P1G3161	466 S Emily	4/10/2008	863	214	1-2008-002018	4/11/2008	6520-00-021-031-0-000-00
208	P1G3162	801 S Pearl	7/14/2008	870	707	1-2008-004499	8/4/2008	6700-00-003-001-0-000-00
209	P1G3164	507 W Carl Patterson	4/17/2008	863	747	1-2008-002202	4/18/2008	6180-00-010-017-0-000-00
210	P1G3164A	507 W Carl Patterson	5/19/2009	888	248	1-2009-002602	5/19/2009	6180-00-010-014-0-000-00

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211	P1G3165	707 S Francis	11/25/2008	878	80	1-2008-006818	11/16/2008	6660-00-010-008-0-000-00 6660-00-010-004-0-000-00
212	P1G3166	600 S Ella St	3/12/2010	905	255	1-2010-001225	3/12/2010	6660-00-005-017-0-000-00 6660-00-005-022-0-000-00
213	P1G3171	538 S College	7/10/2008	869	500	1-2008-004038	7/10/2008	6720-00-004-004-0-000-00
214	P1G3172	923 W A St	5/29/2008	866	656	1-2008-003131	5/30/2008	6200-00-001-001-0-000-00
215	P1G3175	604 S Ottawa	5/20/2008	866	93	1-2008-002952	5/21/2008	6720-00-017-001-0-001-00
216	P1G3176	213 S Vantage	6/17/2008	868	113	1-2008-003536	6/18/2008	6180-00-011-019-0-000-00
217	P1G3177	130 McGhee St	5/20/2008	866	95	1-2008-002953	5/21/2008	6010-00-011-008-0-000-00
218	P1G3178	301 N Wade St	6/26/2008	868	703	1-2008-003808	6/27/2008	6010-00-003-001-0-000-00 6010-00-003-015-0-000-00 6010-00-003-016-0-000-00
219	P1G3178A	301 North Wade	3/4/2010	904	723	1-2010-001097	3/4/2010	6010-00-002-008-0-000-00
220	P1G3182-L	57300 E 30 Rd	11/12/2008	877	258	1-2008-006582	11/13/2008	0000-20-029-023-0-003-0
221	P1G3183	59401 E 20 Rd	5/13/2008 8/22/2008	865 872	493 96	I-2008-002779 1-2008-004953	5/14/2008 8/22/2008	0000-22-029-023-0-007-00
222	P1G3185	601 S Emily	1/29/2009	881	398	1-2009-000318	1/30/2009	6660-00-006-001-0-000-00
223	P1G3185A	605 South Emily	12/29/2009	901	408	1-2009-006614	12/29/2009	6660-00-006-006-0-000-00
224	P1G3186	265 N River	8/19/2008	871	693	I-2008-004867	8/19/2008	6010-00-011-010-0-000-00 6010-00-011-011-0-000-00
225	P1G3187	443 S Francis	5/20/2008	866	88	1-2008-002948	5/21/2008	6520-00-021-004-0-000-00
226	P1G3188	400 S Emily	6/5/2008	868	111	1-2008-003535	6/18/2008	6520-00-016-017-0-000-00
227	P1G3189	508 S Ella St	10/16/2008	875	538	1-2008-006051	10/16/2008	6660-00-004-019-0-000-00
228	P1G3191	638 S College	6/6/2008	867	418	1-2008-003358	6/9/2008	6720-00-005-012-0-000-00
229	P1G3193	425 S Emily	5/29/2008	866	660	1-2008-003133	5/30/2008	6520-00-017-011-0-000-00 6520-00-017-014-0-000-00
230	P1G3195	512 S Alta	8/12/2008	871	30	1-2008-004728	8/13/2008	6660-00-003-029-0-000-00 6660-00-003-024-0-000-00
231	P1G3196	616 N Picher	5/29/2008	866	654	1-2008-003130	5/30/2008	6540-00-003-003-0-000-00
232	P1G3196A P1G3196AA	616 North Picher	5/27/2010	909	447	1-2010-002595	5/28/2010	6550-00-001-005-0-000-00 6550-00-001-004-0-000-00
233	P1G3198	100 N Connell	7/22/2008	870	253	1-2008-004312	7/22/2008	6560-00-000-001-0-000-00
234	P1G3200	103 E 10th	2/17/2009	882	489	1-2009-000845	2/18/2009	6700-00-007-004-0-000-00
235	P1G3200	103 E 10th	6/5/2008	867	241	1-2008-003288	6/6/2008	6700-00-007-002-0-000-00
236	P1G3201	610 S Emily	6/5/2008	867	233	1-2008-003284	6/6/2008	6660-00-007-030-0-000-00
237	P1G3202	506 S Emily	7/15/2008	869	661	1-2008-004125	7/15/2008	6660-00-002-019-0-000-00
238	P1G3203	308 E 11th	6/5/2008	867	235	1-2008-003285	6/6/2008	6700-00-009-004-0-000-00
239	P1G3204	430 S Alta	7/10/2008	869	504	1-2008-004040	7/10/2008	6520-00-020-017-0-000-00
240	P1G3204	430 S Alta	11/7/2008	878	71	1-2008-006813	11/26/2008	6590-00-020-021-0-000-00
241	P1G3205	500 S College	6/5/2008	867	239	1-2008-003287	6/6/2008	6720-00-003-002-0-000-00
242	P1G3209	318 E 12th	6/5/2008	867	237	1-2008-003286	6/6/2008	6700-00-009-007-0-000-00
243	P1G3209A	316 E 12th	5/20/2010	909	46	1-2010-002451	5/21/2010	6700-00-009-008-0-000-00

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
244	P1G3210	428 S Alta	11/18/2008	877	534	1-2008-006693	11/19/2008	6520-00-017-031-0-000-00
245	P1G3211	306 McGhee St	6/26/2008	868	701	1-2008-003807	6/27/2008	6010-00-010-001-0-000-00
246	P1G3212	186 Wade St	7/21/2008	870	249	1-2008-004309	7/22/2008	6010-00-001-017-0-000-00
247	P1G3213	217 S Emily	7/10/2008	869	502	1-2008-004039	7/10/2008	6520-00-009-008-0-000-0
248	P1G3215	750 E 1st St	8/28/2008	873	194	1-2008-005276	9/8/2008	6010-00-013-018-0-000-00
249	P1G3216-L	620 S Oneida	11/15/2008	878	658	1-2008-007044	12/10/2008	6720-00-020-008-0-000-00
250	P1G3217	208 N Netta	8/7/2008	871	105	1-2008-004622	8/8/2008	6620-00-004-004-0-000-00
251	P1G3218	700 S Cherokee	5/29/2008	866	652	1-2008-003129	5/30/2008	6720-00-007-001-0-001-00
252	P1G3220	111 N Ethel	7/10/2010	913	564	I-2010-003920	8/13/2010	6520-00-002-001-0-000-00
253	P1G3220A-2	102 E Central	2/25/2010	904	501	I-2010-001009	2/26/2010	6520-00-001-009-0-000-00 6520-00-001-010-0-000-00 6520-00-001-011-0-000-00 6520-00-001-016-0-000-00
254	P1G3222		4/10/2008	863	212	1-2008-002017	4/11/2008	6540-00-002-003-0-000-00
255	P1G3223	1290 S 607 Rd	8/25/2008	875	435	1-2008-006014	10/15/2008	0000-14-029-023-0-009-00
256	P1G3224	1290 S 607 Rd	5/13/2008	865	495	1-2008-002780	5/14/2008	1380-00-000-000-0-001-00
257	P1G3225	60551 E 13 Rd	4/15/2008	863	485	I-2008-002119	4/16/2008	0000-14-029-023-0-010-00
258	P1G3226	58601 E 30th Rd	2/10/2009	882	179	I-2009-000708	2/10/2009	0000-28-029-023-0-008-01
259	P1G3B02	222 W A St	1/15/2010	902	484	I-2010-000287	1/20/2010	6620-00-004-002-0-000-00
260	P1G3B03-L	3401 S Hwy 69	2/26/2009	883	268	I-2009-001045	2/26/2009	0000-29-029-023-0-004-01
261	P1G3B04	3401 S Hwy 69	3/6/2008	860	489	I-2008-001277	3/7/2008	0000-29-029-023-0-004-0
262	P1G3B06	212 W Picher	2/26/2008	860	63	I-2008-00132	2/26/2008	6180-00-013-009-0-000-00
263	P1G3B07	150 S Vantage	2/2/2010	903	350	I-2010-000571	2/3/2010	6555-00-000-012-0-000-00
264	P1G3B09	631 S Francis	2/28/2008	864	329	I-2008-002367	4/25/2008	6660-00-010-001-0-000-00
265	P1G3B10	2 & Wade	11/20/2007	854	197	I-2007-006731	11/20/2007	6010-00-006-014-0-000-00
266	P1G3B11	77 1st St	11/8/2007	853	315	i-2007-006446	11/9/2007	6010-00-001-001-0-000-00
267	P1G3B12	214 Treece	1/17/2008	857	481	I-2008-000360	1/18/2008	
268	P1G3B13	607 Rd - Quapaw	12/4/2007	855	12	I-2007-006967	12/5/2007	1380-00-003-005-0-000-00
269	P1G3B14	526 N Connell	3/25/2010	905	751	I-2010-001394	3/26/2010	6640-00-008-003-0-001-00
270	P1G3B15	318 N Netta	12/4/2007	855	14	I-2007-006968	12/5/2007	6620-00-003-009-0-000-00
271	P1G3B16	508 N Connell	4/15/2008	863	478	I-2008-002116	4/16/2008	6540-00-008-008-0-000-00
272	P1G3B17	208 N Vantage	4/29/2010	908	555	I-2010-002318	5/14/2010	6620-00-006-003-0-000-00
273	P1G3B19	202 S Netta	7/31/2008	870	713	I-2008-004502	8/4/2008	6180-00-013-011-0-000-00
274	P1G4B01	215 S Francis	11/12/2008	877	254	I-2008-006580	11/13/2008	6520-00-008-009-0-000-00 6520-00-008-001-0-000-00
275	P1G4B02	505 N Connell	3/18/2009	884	532	I-2009-001482	3/18/2009	6710-21-029-023-0-002-00
276	P1G4B03	200 S Connell	12/10/2008	878	660	I-2008-007045	12/10/2008	6180-00-016-001-0-000-00;
277	P1G4B04	315 E 3 St	4/9/2009	886	44	I-2009-001902	4/9/2009	6520-00-007-020-0-000-00
278	P1G4B04A	315 E 3 St	5/27/2010	909	437	I-2010-002590	5/28/2010	6520-00-007-009-0-000-00 6520-00-007-011-0-000-00

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
279	P1G4B05	515 S Connell	5/18/2010	909	452	I-2010-002598	5/28/2010	6660-00-001-011-0-000-00 6660-00-001-015-0-000-00
280	P1G4B06	131 S Connell	12/29/2008	879	547	I-2008-007323	12/30/2008	6520-00-006-009-0-000-00
281	P1G4B07	109 W A St	11/25/2008	878	75	I-2008-006815	11/26/2008	6560-00-000-00H-0-000-00
282	P1G4B08	127 N Connell	1/29/2009	881	392	I-2009-000515	1/30/2009	6710-21-029-023-0-005-00
283	P2-1	318 South Alta	9/15/2009	895	410	I-2009-004819	9/15/2009	6520-00-012-021-0-000-00
284	P2-101	103 South Ethel	7/30/2009	892	587	I-2009-003958	8/3/2009	6520-00-003-001-0-000-00
285	P2-107	2300 South 590 Rd	6/25/2009	890	295	I-2009-003264	6/26/2009	0000-22-029-023-0-006-01
286	P2-109L	437 South Connell	5/27/2010	909	439	I-2010-002591	5/28/2010	6520-00-022-001-0-000-00
287	P2-111	110 South Ella	10/28/2009	897	685	I-2009-005548	10/28/2009	6520-00-002-023-0-000-00
288	P2-113	101 North Ethel	12/15/2009	900	695	I-2009-006417	12/16/2009	6520-00-002-010-0-000-00
289	P2-113A	101 North Ethel	4/29/2010	907	736	I-2010-002038	4/29/2010	6520-00-002-021-0-000-00
290	P2-116	213 South Emily	8/3/2009	892	593	I-2009-003961	8/3/2009	6520-00-009-007-0-000-00
291	P2-118	590 East 20 Rd	6/30/2009	890	498	I-2009-003334	7/1/2009	0000-22-029-023-0-009-00
292	P2-119	109 South Ethel	6/30/2009	890	496	I-2009-003333	7/1/2009	6520-00-003-003-0-000-00
293	P2-12	104 North Oneida	3/19/2009	884	594	I-2009-001503	3/20/2009	6200-00-001-005-0-000-00
294	P2-120	212 South Emily	7/30/2009	892	584	I-2009-003956	8/3/2009	6520-00-008-018-0-000-00
295	P2-122	200 South Emily	8/25/2009	894	682	I-2009-004598	9/2/2009	6520-00-008-013-0-000-00
296	P2-123T	403 South Francis						
297	P2-125	60545 East 20 Rd	4/13/2010	906	706	I-2010-001697	4/13/2010	0000-23-029-023-0-002-00
298	P2-126T	214 South Francis						
299	P2-130	506 West 2 St	8/24/2009	894	183	I-2009-004399	8/26/2009	6180-00-010-011-0-000-00
300	P2-131L	116 South Emily	9/1/2009	895	168	1-2009-004728	9/10/2009	6640-00-000-032-0-000-00
301	P2-132	214 South Frisco	8/21/2009	893	789	1-2009-004345	8/24/2009	6180-00-009-004-0-001-00
302	P2-134	208 South Treece	11/10/2009	898	737	1-2009-005828	11/12/2009	No records in tax assessor office
303	P2-135	607 West Carl Patterson	2/17/2010	904	169	1-2010-000845	2/18/2010	6200-00-005-001-0-000-00 6200-00-005-002-0-000-00
304	P2-136	216 South Vantage	8/25/2009	894	181	1-2009-0004398	8/26/2009	6180-00-0010-009-0-001-00
305	P2-137T	209 South Vantage						
306	P2-138	214 South Vantage	9/10/2009	895	162	1-2009-004725	9/10/2009	6180-00-010-008-0-000-00
307	P2-13T	321 East 12 St						
308	P2-142L	218 South Netta	9/10/2009	895	164	1-2009-004726	9/10/2009	6180-00-012-009-0-000-00
309	P2-144L	526 South College	8/10/2009	893	791	1-2009-004346	8/24/2009	6720-00-003-011-0-000-00
310	P2-15	412 South Francis	2/17/2009	882	487	I-2009-000844	2/18/2009	6520-00-15-017-0-000-00
311	P2-19	111 South Ethel	1/21/2009	882	767	1-2009-00942	2/23/2009	6520-00-003-006-0-000-00
312	P2-2	300 South Emily	2/27/2009	883	414	1-2009-001091	2/27/2009	6520-00-013-013-0-000-00 6520-00-013-013-0-001-00
313	P2-22	200 South Treece	2/2/2009	881	514	1-2009-000565	2/2/2009	6180-00-011-001-0-000-00
314	P2-23A		4/13/2010	906	703	1-2010-001695	4/13/2010	6780-00-009-003-0-000-00
315	P2-24	322 South Emily	3/24/2009	884	814	1-2009-0001600	3/25/2009	6520-00-013-023-0-000-00

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
316	P2-25	286 Main St	1/20/2009	880	707	1-2009-000294	1/21/2009	6010-00-008-006-0-000-00
317	P2-29	200 West F St	1/29/2009	881	394	1-2009-000516	1/30/2009	6540-00-003-001-00-000-00
318	P2-30L	308 North Netta	5/27/2010	909	450	I-2010-002597	5/28/2010	6620-00-003-006-0-000-00
319	P2-32A	706 West State Line Rd	9/1/2009	894	678	1-2009-004596	9/2/2009	6680-00-003-002-0-000-00
320	P2-33	60751 East 10th Rd	2/27/2009	883	411	1-2009-001089	2/27/2009	0000-14-029-0236-0-012-00
321	P2-35 (P2N-1A?)	702 West State Line Rd	4/14/2009	886	613	1-2009-0021435	4/22/2009	6680-00-004-001-0-001-00
322	P2-37	56251 East 10 Rd	3/30/2009	885	228	1-2009-001681	3/31/2009	0000-18-029-023-0-007-00
323	P2-51	524 North Picher	4/9/2009	886	46	1-2009-001903	4/9/2009	6540-00-005-012-0-001-00
324	P2-51(B) LOT	165 Wade	12/29/2009	901	412	1-2009-006616	12/29/2009	6010-00-001-019-0-000-00
325	P2-51B		9/1/2009	894	677	I-2009-004595	9/2/2009	6010-00-001-018-0-000-00
326	P2-55	521 North Picher	5/19/2009	888	246	1-2009-002601	5/19/2009	6540-00-006-001-0-000-00 6540-00-006-001-0-000-00
327	P2-59	204 River St	5/27/2009	888	619	1-2009-002736	5/28/2009	6020-00-02a-000-0-000-00 6020-00-003-001-0-001-00
328	P2-61	34 2nd St	5/28/2009	888	623	1-2009-002739	5/28/2009	6020-00-004-003-0-000-00
329	P2-62	357 1/2 Cardin Lane	6/16/2009	889	634	1-2009-003073	6/17/2009	0000-30-029-023-0-026-01
330	P2-64A	285 Main St	6/25/2009	890	285	1-2009-003259	6/26/2009	6010-00-005-009-0-000-00
331	P2-65	104 North Wade	5/27/2009	888	613	1-2009-002730	5/28/2009	6010-00-006-001-0-000-00
332	P2-56L	202 River St	8/13/2009	893	449	1-2009-004198	8/14/2009	6020-00-003-002-0-000-00
333	P2-67	303 McGhee	6/11/2009	889	355	1-2009-002963	6/12/2009	6010-00-009-012-0-000-00
334	P2-68	183 Tar River	8/5/2009	893	217	1-2009-004126	8/10/2009	6020-00-006-001-0-001-00
335	P2-70	2501 South 550 Rd	7/1/2009	890	565	1-2009-003353	7/1/2009	0000-20-029-023-0-005-00 0000-23-029-022-0-001-00
336	P2-71	631 3rd St	10/30/2009	898	32	1-2009-005605	10/30/2009	6010-00-008-009-0-000-00
337	P2-72	55800 East 30 Rd	8/24/2009	894	176	1-2009-004395	8/26/2009	0000-24-029-022-0-017-00
338	P2-74	184 Tar River	6/11/2009	889	357	1-2009-002964	6/12/2009	6020-00-005-001-0-001-00
339	P2-76	221 McGhee	9/10/2009	895	166	1-2009-004727	9/10/2009	6010-00-008-014-0-000-00
340	P2-77	402 2nd St	5/19/2009	888	250	1-2009-002603	5/19/2009	6010-00-002-001-0-000-00
341	P2-78	701 McGhee	7/7/2009	891	108	1-2009-003474	7/8/2009	6010-00-012-003-0-001-00
342	P2-79	190 Tar River	5/28/2009	888	622	1-2009-002738	5/28/2009	6020-00-006-002-0-000-00 6020-00-005-002-0-000-00 6020-00-007-001-0-001-00
343	P2-79A P2-79AA	ES River bet 1st & 2nd	4/13/2010	906	705	1-2010-001696	4/3/2010	6020-00-005-002-0-000-00 6020-00-007-001-0-001-00
344	P2-81L	501 3rd St	6/25/2009	890	291	1/2009-003262	6/26/2009	6010-00-005-007-0-000-00
345	P2-82L	274 Wade St	6/25/2009	890	287	1-2009-003260	6/26/2009	6010-00-005-007-0-000-00
346	P2-83	302 Wade St	6/25/2009	890	289	1-2009-003261	6/26/2009	6010-00-004-001-0-000-00
347	P2-86	191 River St	7/14/2009	891	587	1-2009-003657	7/16/2009	6010-00-012-006-0-000-00
348	P2-87L	214 Main St	6/25/2009	890	293	1-2009-003263	6/26/2009	6010-00-008-005-0-000-00
349	P2-88T	231 McGhee						

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350	P2-9	202 South Vantage	1/22/2009	881	93	I-2009-000389	1/23/2009	6180-00-010-001-0-000-00
351	P2-92	WS Emily bet Cntrl & 6	12/22/2009	901	209	I-2009-006540	12/23/2009	6660-00-002-023-0-000-00
352	P2-93L	456 South Alta	7/21/2009	892	46	I-2009-003759	7/21/2009	6520-00-020-026-0-000-00
353	P2-95L	455 South Ethel	6/18/2009	892	44	I-2009-003758	7/21/2009	6520-00-019-009-0-000-00
354	P2-96	109 North Ethel	8/14/2009	893	489	I-2009-004210	8/14/2009	6520-00-002-003-0-000-00
355	P2-97	216 South Emily	11/5/2009	898	403	I-2009-005740	11/6/2009	6520-00-008-019-0-000-00 6520-00-008-021-0-000-00
356	P2-B1	301 South Connell	11/5/2009	898	405	I-2009-005741	11/6/2009	6520-00-014-001-0-000-00 6520-00-014-013-0-000-00
357	P2-B10	120 North Connell	12/15/2009	900	685	I-2009-006412	12/16/2009	6560-00-000-00D-0-000-00
358	P2-B11L	57785 East 40 Rd	3/30/2010	906	144	I-2010-001486	3/31/22010	0000-32-029-0230-002-02
359	P2-B16	128 North Connell						
360	P2-B18	100 South Connell	11/10/2009	899	63	I-2009-005892	11/16/2009	6210-00-001-001-0-000-00
361	P2-B1A	301 South Connell	2/25/2010	904	498	I-2010-001007	2/26/2010	6520-00-014-005-0-000-00 6520-00-014-020-0-000-00
362	P2-B21	207 West 2nd St	5/13/2010	908	547	I-2010-002314	5/14/2010	6210-00-001-006-0-0100-00
363	P2-B24	617 East 1st St	8/4/2009	893	445	I-2009-004195	8/14/2009	6010-00-013-011-0-000-00
364	P2-B25	3010 South 560 Rd	12/11/2009	901	410	I-2009-006615	12/29/2009	0000-25-029-022-0-003-00
365	P2-B26	47 1st St	8/4/2009	892	840	I-2009-004044	8/4/2009	6010-00-012-011-0-000-00
366	P2-B28	200 F Northeast	7/31/2009	892	591	I-2009-003960	8/3/2009	6600-00-007-006-0-000-00
367	P2-B28A	200 F Northeast	2/17/2010	904	173	I-2010-000847	2/18/2010	6600-00-007-006-0-000-00
368	P2-B3 P1G3010	419 s Connell	2/2/2010	903	340	I-2010-000565	2/3/2010	6520-00-015-004-0-000-00
369	P2-B3A	125 North Connell	9/15/2009	895	408	I-2009-004818	9/15/2009	6710-21-029-023-0-006-00
370	P2-B5	2nd & Emily	1/19/2010 12/22/2009	902 902	486 14	I-2010-000288 I-2010-000084	1/20/2010 1/7/2010	6520-00-005-010-0-000-00 6520-00-005-021-0-000-00
371	P2-B52A	207 South Connell	12/29/2009	901	406	I-2009-006613	12/29/2009	6520-00-007-004-0-000-00
372	P2-B52B	514 West A St	10/16/2009	897	383	I-2009-005415	10/16/2009	6620-00-007-004-0-001-00
373	P2-B6	319 South Connell	10/16/2009	897	379	I-2009-005413	10/16/2009	6520-00-014-008-0-000-00
374	P2-B7	321 1/2 East 12th St	1/19/2010	902	476	I-2010-000283	1/20/2010	0000-28-029-023-0-007-00
375	P2-B8	323 South Connell	2/17/2010	904	175	I-2010-000848	2/18/2010	6520-00-014-010-0-000-00
376	P2-B88	55904 East 30 Rd	3/10/2010	905	85	I-2010-001170	3/10/2010	0000-24-029-022-0-017-01
377	P2-B8A	323 South Connell	4/29/2010	907	733	I-2010-002039	4/29/2010	6520-00-014-010-0-000-00
378	P2N-15	607 North Connell Ave	2/27/2009	883	412	I-2009-001090	2/27/2009	6710-16-029-023-0-013-00
379	P2N-6	1301 South 592 Rd	8/13/2009	893	447	I-2009-004196	8/14/2009	0000-15-029-023-0-005-00
380	P2N-9	61500 East 20 Rd	7/14/2009	891	458	I-2009-003618	7/15/2009	0000-13-029-023-0-013-01 0000-13-029-023-0-013-02
381	P3-1	436 South Francis	3/26/2010	906	20	I-2010-001424	3/26/2010	6520-00-022-017-0-000-00
382	P31-1	515 South Ethel	10/16/2009	897	375	I-2009-005411	10/16/2009	6660-00-004-010-0-000-00
383	P3-2	150 South Frisco	5/27/2010	909	443	I-2010-002593	5/28/2010	6630-00-000-014-0-000-00
384	P32-3T	273 Wade						
385	P32-4L	105 North Ethel	1/6/2010	902	12	I-2010-000083	1/7/2010	6520-00-002-007-0-000-00

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386	P32-6	714 North Picher	9/1/2009	894	671	I-2009-004591	9/2/2009	6540-00-001-002-0-000-00
387	P32-6A	WS Picher bet G & H St	3/31/2010	906	252	I-2010-001511	4/1/2010	6540-00-001-003-0-000-00
388	P32-7	720 North Picher	9/1/2009	894	675	I-2009-004594	9/2/2009	6540-00-001-001-0-000-00
389	P3-33L	934 North Connell	1/20/2010	904	179	I-2009-000850	2/18/2010	6580-00-001-001-0-000-00
390	P3-4	167 Main	10/19/2009	897	446	I-2009-005441	10/20/2009	6010-00-006-016-0-000-00
391	P3-4A		11/5/2009	898	408	I-2009-005743	11/6/2009	6540-00-002-008-0-000-00
392	P3-54UL	430 South Francis	10/23/2009	897	596	I-2009-005489	10/23/2009	6520-00-015-031-0-000-00
393	P3-56UL	228 Meghee	8/25/2009	894	177	I-2009-004396	8/26/2009	6010-00-011-006-0-000-00
394	P3-57UL	153 West F	8/8/2009	896	681	I-2009-005223	10/9/2009	6540-00-002-006-0-001-00
395	P3-58	SS K St & W Ottawa	12/22/2009	901	211	I-2009-006541	12/23/2009	6680-00-002-003-0-001-00
396	P3-58AB	WS Emily bet 5 & Cntrl	2/25/2010	904	502	I-2010-001010	2/26/2010	6520-00-009-020-0-000-00
397	P3-6	501 North Netta	10/16/2009	897	377	I-2009-005412	10/16/2009	6540-00-005-006-0-000-00
398	P3-60AB	511 South Francis	4/27/2010	908	792	I-2010-002415	5/18/2010	6660-00-002-011-0-000-00
399	P3-63U	201 South Emily	2/3/2010	903	346	I-2010-000569	2/3/2010	6520-00-009-001-0-000-00
400	P3-63UA	169 Main	3/31/2010	906	250	I-2010-001510	4/1/2010	6010-00-006-018-0-000-00
401	P3-65AB	630 South Cherokee	4/22/2010	907	331	I-2010-001888	4/23/2010	6720-00-008-017-0-000-00
402	P3-66AB	442 S Emily	4/27/2010	907	744	I-2010-002042	4/29/2010	6520-0-021-020-0-000-00
403	P3-67AB	440 South Emily	4/27/2010	907	742	I-2010-0002041	4/29/2010	6520-00-021-017-0-000-00
404	P37-1	711 South Emily	11/13/2009	899	66	I-2009-005893	11/16/2009	6660-00-011-008-0-000-00
405	P37-2	423 South Francis	1/4/2010	902	482	I-2010-000286	1/20/2010	6520-00-016-012-0-000-00
406	P37-3	206 South Alta	12/15/2009	900	689	I-2009-006414	12/16/2009	6520-00-007-003-0-000-00 6520-00-009-015-0-000-00
407	P37-4	301 South Emily	3/12/2010	905	258	I-2010-001227	3/12/2010	6520-00-012-001-0-000-00 6520-00-012-004-0-000-00
408	P37-5	462 South Emily	3/3/2010	905	256	I-2010-001226	3/12/2010	6520-00-021-029-0-000-00
409	P37-6	316 South Emily	12/17/2009	901	404	I-2009-006612	12/29/2009	6520-00-013-021-0-000-00
410	P37-7	701 South Oneida	12/8/2009	900	383	I-2009-006303	12/9/2009	6720-00-018-017-0-000-00 6720-00-018-017-0-000-00
411	P37-8	620 North Connell	12/18/2009	902	10	I-2010-000082	1/7/2010	6600-00-008-001-0-000-00
412	P39-2	SS 2st bet McGhee & River 5/20/10		909	48	I-2010-002452	5/21/2010	6010-00-012-003-0-000-00 6010-00-002-003-0-000-00
413	P39-3	592 Rd - Quapaw	11/10/2009	989	734	I-2009-005826	11/12/2009	1200-00-002-006-0-000-00
414	P39-5	218 South Picher	3/30/2010	906	148	I-2010-001488	3/31/2010	6180-00-013-010-0-000-00
415	P39-7	WS River bet 2 & 3 st	4/29/2010	908	561	I-2010-002321	5/14/2010	6010-00-011-009-0-000-00
416	P3-B20	220 South Connell	5/13/2010	908	549	I-2010-002315	5/14/2010	6180-00-016-009-0-000-00
417	P3-B34	321 East 12th St	1/19/2010	902	478	I-2010-000284	1/20/2010	0000-28-029-023-0-005-00
418	P3-B35	214 South Connell	2/25/2010	904	500	I-2010-001008	2/26/2010	6180-00-016-007-0-001-00
419	P3-B36	NS of 1st Bet Harlin &	5/28/2010	909	448	I-2010-002596	5/28/2010	6010-00-001-005-0-000-00
420	P3-B38	SS of Harlin & Cardin	5/27/2010	909	441	I-2010-002592	5/28/2010	0000-30-029-023-0-026-00
421	P3-B39AB	213 South Connell	2/17/2010	904	171	I-2010-000846	2/18/2010	6520-00-007-006-0-000-00 6520-00-007-007-0-000-00

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422	P3-B40	203 South Connell	3/26/2010	906	18	1-2010-001423	3/26/2010	6520-00-007-002-0-000-00
423	P3-B46AB	217 & 217 1/2 S. Connell	5/20/2010	909	44	1-2010-002450	5/21/2010	6520-00-007-008-0-000-00
424	F3-B47	218 North Connell	2/2/2010	903	344	1-2010-000568	2/3/2010	6180-00-016-008-0-000-00
425	F3-B49	219 North Connell	2/17/2010	904	727	1-2010-001101	3/4/2010	6180-00-016-007-0-000-00
426	F3-B51	212 S Connell	4/22/2010	907	328	1-2010-001886	4/23/2010	6180-00-016-005-0-000-00
427	P3G0001	458 South Emily	11/19/2009 11/9/2009 11/9/2009	900 900 900	308 310 312	I-2009-006271 I-2010-006272 I-2010-006273	12/8/2009 12/8/2009 2/16/2010	6520-00-021-027-0-000-00
428	P3G0003	624 North Picher	2/11/2010	904	30	1-2010-000776	2/16/2010	6540-00-003-002-0-000-00
429	P3G0005	212 South Alta	12/15/2009	900	693	1-2009-006416	12/16/2010	652-00-009-017-0-000-00
430	P3G0006	205 S Emily	10/30/2009	898	140	1-2009-005640	11/2/2009	6520-00-009-003-0-000-00
431	P3G0012	306 S Alta	2/11/2010	904	32	I-2010-000777	2/16/2010	6520-00-012-016-0-000-00
432	P3G0014	514 S Ella St	5/13/2010	908	557	1-2010-002319	5/14/2010	6660-00-004-028-0-000-00
433	P3G0014A	514 S Ella St	5/13/2010	908	559	1-2010-002320	5/14/2010	6660-00-004-017-0-000-00
434	P3G0018	637 S Oneida	12/26/2009	904	177	1-2010-000849	2/18/2010	6720-00-017-035-0-000-00 6720-00-017-001-0-000-00
435	P3G0020	417 South Francis	10/16/2009	897	381	1-2009-005414	10/16/2009	6520-00-016-008-0-000-00
436	P3G0021	11630 Road	3/30/2010	906	146	1-2010-001487	3/31/2010	1200-00-002-001-0-000-00 1200-00-002-009-0-000-00
437	P3G0021A	1751 S 592 Rd	3/30/2010	906	146	1-2010-001487	3/31/2010	1200-00-002-001-0-000-00 1200-00-002-009-0-000-00
438	PFB-1	437 South Ethel, Picher	6/24/2005	788	603	I-2005-003893	7/1/2005	6520-00-019-001-0-000-00
439	PFB-15	600 East 2nd Street, Picher	5/4/2005 7/7/2005	784 789	308 301	1-2005-002655 I-2005-004074	5/6/2005 7/8/2005	6520-00-010-001-0-000-00
440	PFB-17	2200 South 610 Road, Quapaw	7/13/2005 3/23/2009	789 884	567 712	I-2005-004186 I-2009-001570	7/14/200 3/23/2009	0000-24-029-023-0-007-00
441	PFB-20	602 North Picher, Picher	6/17/2005	787	517	I-2005-003589	6/17/2005	6540-00-003-005-0-000-00
442	PFB-22	609 South Emily, Picher	5/13/2005	785 788	45 198	1-2005-002839 I-2005-003771	5/13/2005	6660-00-006-012-0-000-00
443	PFB-25	127 North Frisco, Picher	8/1/2005 8/1/2005	786 791	580 518	I-2005-003313 I-2005-004795	8/9/2005	6555-00-000-003-0-000-00
444	PFB-26	509 South Emily, Picher	6/17/2005	787	515	I-2005-003588	6/17/2005	6660-00-003-009-0-000-00
445	PFB-27	201 South Vintage, Picher	5/13/2005 6/24/2005	785 788	47 605	1-2005-002840 I-2005-003894	5/13/2005 07/01/2005	6180-00-011-011-0-000-00
446	PFB-28	601 West Carl Patterson Avenue, Picher	6/3/2005 6/30/2005 6/30/2005	786 788 789	585 600 246	I-2005-003316 I-2005-003891	7/1/2005	6180-00-009-008-0-000-00
447	PFB-35	126 North Connell, Picher	5/27/2005 6/30/2005	786 788	266 595	I-2005-003179 I-2005-003887	7/1/2005	6560-00-000-00E-0-000-00
448	PFB-45	503 North Main, Picher	8/23/2007	846	574	I-2007-004593	8/24/2007	6540-00-007-006-0-000-00
449	PFB-54	200 South Ella, Picher	6/3/2005 8/14/2005	786 793	588 2	I-2005-003318 I-2005-005168	6/6/2005 8/26/2005	6520-00-010-013-0-000-00 6520-00-010-016-0-000-00
450	PFB-56	606 South Alta, Picher	undated	787	63	I-2005-003439	6/10/2005	6660-00-006-021-0-000-00
451	PFB-6	700 West 2nd Street, Picher	7/12/2005	790	120	I-2005-004326	7/20/2005	6200-00-004-003-0-000-00

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			5/19/2005	785	589	I-2005-003002	5/20/2005	
452	PFB-60	270 North Wade, Cardin	5/13/2005 7/7/2005	785 789	41 299	I-2005-002837 I-2005-004073	5/13/2005 07/08/2005	6010-00-005-006-0-000-00
453	PFB-61	710 South Emily, Picher	7/28/2005	791	211	I-2005-004668	8/2/2005	6660-00-010-025-0-000-00
454	PFB-64	408 South Alta Street, Picher	6/3/2005 7/13/2005	786 789	582 595	I-2005-003314 I-2005-004197	6/6/2005 7/14/2005	6520-00-017-017-0-000-00
455	PFB-66	200 South Alta, Picher	5/13/2005 7/14/2005	785 790	43 118	I-2005-002838 I-2005-004325	5/13/2005 07/20/2005	6520-00-009-013-0-000-00
456	TV-10	504 S College	8/22/2008	872	97	I-2008-004954	8/22/2008	6720-00-003-004-0-000-00
457	TV-100	401 South Emily	1/22/2009	881	95	I-2009-000390	1/23/2009	6520-00-017-003-0-000-00 6520-00-017-001-0-000-00
458	TV-101L	420 South Emily	9/4/2009	895	170	I-2009-004729	9/10/2009	6520-00-016-027-0-000-00
459	TV-103L	412 South Emily	9/4/2009	895	172	I-2009-004730	9/10/2009	6520-00-016-022-0-000-00
460	TV-104	449 S Connell	10/20/2008	874	666	I-2008-005782	10/3/2008	6520-00-022-003-0-000-00
461	TV-107L	603 East 2nd St	7/30/2009	892	585	I-2009-003957	8/3/2009	6520-00-003-010-0-000-00
462	TV-109L	513 South Connell	11/23/2009	899	750	I-2009-006124	11/30/2009	6660-00-001-008-0-000-00
463	TV-110	58700 E 30 Rd	12/29/2008	879	553	I-2008-007326	12/30/2008	0000-21-029-023-0-013-00
464	TV-111L	424 South Emily	12/15/2009	900	687	I-2009-006413	12/16/2009	6520-00-016-030-0-000-00 6520-00-016-028-0-000-00
465	TV-112L	311 East 10th St	3/30/2010	906	142	I-2010-001485	3/31/2010	6700-00-008-050-0-000-00
466	TV-116	402 E 12th St	9/4/2008	873	12	I-2008-005193	9/5/2008	0000-21-029-023-0-010-00
467	TV-118	445 S Francis	9/16/2008	873	679	I-2008-005451	9/17/2008	6520-00-021-006-0-000-00
468	TV-11A	301 East 10th St	3/6/2009	883	724	I-2009-001224	3/9/2009	6700-00-008-001-0-000-00
469	TV-11C	701 S Emily	8/7/2008	871	100	I-2008-004619	8/8/20009	6660-00-011-001-0-000-00
470	TV-122	323 E 12th St	10/23/2008	876	66	I-2008-006188	10/24/2008	0000-20-029-023-0-006-00
471	TV-123L	435 S Francis	12/12/2008	878	819	I-2008-007102	12/15/2008	6520-00-021-001-0-000-00
472	TV-12A	206 East 10th St	11/12/2008	877	256	I-2008-006581	11/13/2008	6700-00-005-011-0-000-00
473	TV-12B	212 East 10th St	8/13/2009	893	448	I-2009-004197	8/14/2009	6700-00-005-007-0-000-00
474	TV-12C	609 S Oneida	8/14/2008	871	520	I-2008-004783	8/14/2008	6720-00-017-027-0-000-00
475	TV-13	717 S Francis	7/21/2009	892	42	I-2009-003757	7/21/2009	6660-00-010-013-0-000-00
476	TV-14	457 S Emily	9/25/2008	874	668	I-2008-005783	10/3/2008	6520-00-020-011-0-000-00
477	TV-16	447 S Ethel	12/29/2008	879	555	I-2008-007327	12/30/2008	6520-00-019-003-0-000-00 6520-00-019-008-0-000-00
478	TV-16A	447 South Ethel	2/2/2010	903	352	I-2010-000572	2/3/2010	6520-00-019-017-0-000-00
479	TV-18L	542 South College	11/20/2009	899	443	I-2009-006011	11/20/2009	6720-00-004-009-0-000-00
480	TV-1L	718 S College	11/25/2008	878	69	I-2008-006812	11/26/2008	6720-00-006-008-0-000-00
481	TV-2	316 East 10th St	8/14/2008	871	522	I-2008-004787	8/14/2008	6720-00-004-006-0-000-00
482	TV-21	604 South Ella	3/5/2009	883	644	I-2009-001197	3/6/2009	6660-00-005-022-0-000-00
483	TV-23	501 S Francis	11/5/2008	876	771	I-2008-006453	11/6/2008	6660-00-002-001-0-000-00
484	TV-25	315 South Francis	1/15/2009	880	544	I-2009-000226	1/15/2009	6520-00-013-007-0-000-00
485	TV-26	603 S Ethel	11/5/2008	876	779	I-2008-006456	11/6/2008	6660-00-005-001-0-000-00

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486	TV-30	411 South Francis	1/20/2009	880	705	I-2009-000293	1/21/2009	6520-00-016-006-0-000-00
487	TV-31	501 S Connell	7/31/2008	870	709	I-2008-004500	8/4/2008	6660-00-001-001-0-000-00
488	TV-32L	309 East 9th St	12/29/2008	879	551	I-2008-007325	12/30/2008	6700-00-004-005-0-000-00 6700-00-004-001-0-000-00
489	TV-36	310 S Cherokee	8/28/2008	872	502	I-2008-005058	8/29/2008	6720-00-002-020-0-000-00
490	TV-37	459 S Francis	8/28/2008	872	498	I-2008-005056	8/29/2009	6520-00-021-012-0-000-00
491	TV-38	100 East 10th St	9/30/2008	874	530	I-2008-005739	10/1/2008	6700-00-006-007-0-000-00
492	TV-39	313 East 8th St	12/29/2008	879	549	I-2008-007324	12/30/2008	6700-00-002-005-0-000-00 6700-00-002-006-0-000-00
493	TV-4	620 S College	9/4/2008	873	8	I-2008-005190	9/5/2008	6720-00-005-006-0-000-00
494	TV-40	453 S Connell	8/12/2008	871	364	I-2008-004725	8/13/2008	6520-00-022-008-0-000-00
495	TV-41L	509 South Francis	4/27/2010	907	740	I-2010-002040	4/29/2010	6660-00-002-011-0-000-00
496	TV-46	448 South Emily	1/20/2009	880	709	I-2009-000295	1/21/2009	6520-00-021-022-0-000-00
497	TV-47	443 S Emily	8/28/2008	880	548	I-2009-000228	1/15/2009	6200-00-003-001-0-000-00
498	TV-48	509 S Emily	11/18/2008	877	530	I-2008-006691	11/19/2008	6660-00-004-003-0-000-00 6660-00-004-006-0-000-00
499	TV-49	455 S Emily	8/7/2008	871	107	I-2008-004623	8/8/2008	6520-00-020-008-0-000-00
500	TV-50	805 S Pearl	1/20/2009	880	711	I-2009-000296	1/21/2009	6700-00-003-003-0-000-00
501	TV-52	110 East 10th St	1/15/2009	880	542	I-2009-000225	1/15/2009	6700-00-006-005-0-000-00
502	TV-53	308 E 5th St	8/7/2008	871	102	I-2008-004620	8/8/2008	6660-00-001-017-0-000-00
503	TV-54	709 S Emily	12/10/2008	880	699	I-2009-000289	1/21/2009	6660-00-011-004-0-000-00 6660-00-011-006-0-000-00
504	TV-55	708 S Francis	12/2/2008	878	260	I-2008-006892	12/2/2008	6660-00-009-022-0-000-00
505	TV-56	700 S Emily	1/29/2009	881	396	I-2009-000517	1/30/2009	6660-00-010-017-0-000-00
506	TV-57	638 S Oneida	8/19/2008	871	673	I-2008-004854	8/19/2008	6720-00-020-017-0-000-00
507	TV-60	466 S Ella	9/25/2008	874	288	I-2008-005649	9/26/2008	6520-00-019-031-0-000-00
508	TV-61	551 S Oneida	7/31/2008	870	711	I-2008-004501	8/4/2008	6720-00-016-020-0-000-00
509	TV-62A	102 East 12th St	9/25/2009	896	57	I-2009-004992	9/25/2009	6700-00-010-021-0-000-00
510	TV-62B	101 East 11th St	12/15/2009	900	683	I-2009-006411	12/16/2009	6700-00-010-001-0-000-00
511	TV-63	304 East 10th St	undated	873	59	I-2009-005220	9/5/2008	6700-00-004-007-0-000-00
512	TV-64	713 S Ottawa	12/15/2009	900	691	I-2009-006415	12/16/2009	6720-00-007-023-0-000-00
513	TV-65	505 S Emily	8/12/2008	871	368	I-2008-004727	8/13/2008	6660-00-003-005-0-000-00
514	TV-68	102 East 11th St	12/12/2008	878	817	I-2008-007101	12/15/2008	6700-00-007-018-0-000-00 6700-00-007-017-0-000-00
515	TV-69	309 East 10th St	11/5/2008	876	775	I-2008-006454	11/6/2008	6700-00-008-003-0-000-00
516	TV-7	307 East 11th St	undated	870	255	I-2008-004313	7/22/2008	6700-00-008-007-0-000-00
517	TV-70	526 S Cherokee	8/28/2008	872	500	I-2008-005057	8/29/2008	6720-00-009-001-0-000-00
518	TV-71	708 S Emily	11/25/2008	878	77	I-2008-006816	11/26/2008	6660-00-010-021-0-000-00
519	TV-72	604 S Emily	9/9/2008	873	224	I-2008-005293	9/10/2008	6660-00-007-017-0-000-00
520	TV-73	714 S Francis	11/25/2008	878	73	I-2008-006814	11/26/2008	6660-00-009-030-0-000-00
521	TV-79		10/2/2008	874	664	I-2008-005781	10/3/2008	6700-00-007-020-0-000-00

	LICRAT Parcel Number	Address	Deed Date	Deed Book Number	Deed Page Number	Document Number	Deed Recording Date	Assessor Parcel Number
522	TV-8	415 S Emily	8/12/2008	871	366	I-2008-004726	8/13/2008	6520-00-017-009-0-000-00
523	TV-82	612 S Ella	12/1/2008	900	7	I-2009-006148	12/1/2009	6660-00-005-025-0-000-00
524	TV-84	712 S Francis	11/18/2008	877	532	I-2008-006692	11/19/2008	6660-00-009-026-0-000-00
525	TV-86	200 East 12th St	7/7/2009	891	110	I-2009-003475	7/8/2009	6700-00-010-018-0-000-00
526	TV-87	2071 S 570 Rd	9/25/2008	874	290	I-2008-005650	9/26/2008	0000-20-029-023-0-001-01
527	TV-87A	2170 South 570 Rd	11/5/2009	898	401	I-2009-005739	11/6/2009	0000-20-029-023-0-001-04
528	TV-88	613 S Ottawa	8/14/2008	871	526	I-2008-004786	8/14/2008	6720-00-008-027-0-000-00
529	TV-89U	601 S Cherokee	12/8/2009	900	387	I-2009-006305	12/9/2009	6720-00-005-021-0-000-00
530	TV-90L	412 S Alta	11/25/2008	878	79	I-2008-006817	11/26/2008	6520-00-017-027-0-000-00
531	TV-94	614 S Ella	8/28/2008	872	504	I-2008-005059	8/29/2008	6660-00-005-029-0-000-00
532	TV-96	323 South Francis	3/13/2009	884	231	I-2009-001360	3/13/2009	6520-00-013-010-0-000-00
533	TV-99	603 S Ottawa	undated	873	14	I-2008-005194	9/5/2008	6720-00-008-021-0-000-00 6720-00-009-020-0-000-00

Notes

"Addition" and "Legal Description" fields have been omitted for posterity

Table 9b: Kansas Department of Health and Environment Bureau of Environmental Remediation Identified Sites List Information

Treece, KS, Relocation
305 Main St., Treece, KS
Project Code C301172724

-	EUCA Number	Date Recorded	Land Use Restrictions	Water Use Restrictions	Notification to Agency
1	12-EUC-0012	7/19/2012	No public area uses Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	restriction on water well construction	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation excavations prohibited unless for highway infrastructure or utilities and when proper soil management is undertaken.
2	12-EUC-0027	3/1/2013	No public area uses Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
3	12-EUC-0028	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
4	12-EUC-0029	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
5	12-EUC-0030	1/16/2014	Other land use restriction: no non-residential use purposes. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	restriction on water well construction	Notification to workers prior to excavation Other activity requiring notification: prior written approval from KDHE for installation of water wells. Excavation for adjacent highway infrastructure or utilities when proper soil management is undertaken.

6	12-EUC-0031	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
7	12-EUC-0032	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
8	12-EUC-0033	1/31/2013	Other land use restriction: no excavation or scraping. No non-residential uses. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except minimal livestock grazing, pasturing, and haying. no residential uses	Other water use restriction: prior written approval from KDHE required restriction on water well construction engineer to prevent contamination of any underlying deep aquifer from any contaminated shallow aquifer.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
9	12-EUC-0034	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
10	12-EUC-0035	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.

11	12-EUC-0036	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
12	12-EUC-0037	3/1/2013	No public area uses Other land use restriction: no non-residential uses, scraping or excavation except for adjacent highway infrastructure or utilities. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses except for minimal livestock grazing, pasturing, and haying. no residential uses	Restriction on water well construction written approval from KDHE required prior to installation.	Notification prior to land use changes Notification prior to property transfer Notification to workers prior to excavation associated with excavations for highway infrastructure or utilities as long as proper soil management is undertaken with KDHE.
13	12-EUC-0038	10/3/2013	Other land use restriction: no soil disturbances unless granted written approval by KDHE, no non-residential uses allowed. Preserve survey markers and/or monitoring stations Restrict the Construction of Buildings or Other Physical Structures no agricultural uses limited livestock grazing, pasturing, and haying allowed. no residential uses	Other water use restriction: prior approval from KDHE required. Restriction on water well construction design must prevent contamination of any underlying deep aquifer.	Notification to workers prior to excavation

Notes

The State of Kansas created a public state trust to oversee the voluntary relocation of residents in and around Treece, KS that were affected by impacts from historical mining operations and the loss of infrastructure when relocation occurred in neighboring Picher, OK. Residents outside of Treece, but served by the City of Treece public water system are also included in the relocation efforts.

Federal funding was approved in October 2009 and the state trust and funding finalized in May 2010. $3,888,888 is available for the relocation program. Property appraisals began in October 2010 and initial offers are anticipated in late November to December 2010. All residents seeking the buyout were moved as of 2013. Remaining vacant lands were purchased and sold at auction in 2014 with an Environmental Use Control restricting occupancy. Project was completed in 2014.

3.4 Progress Since Initiation of Remedial Action

A two-year monitoring and surveillance program was conducted for the OU1 remedy during 1987 and 1988 by the OWRB. The data obtained from these activities were reviewed by the EPA's Robert S. Kerr Environmental Research Laboratory (RSKERL). RSKERL submitted a report in September 1989 (RSKERL, 1989). The OWRB documented the results and findings, including a summary of the conclusions of the RSKERL review, in a report submitted to the EPA in April 1991 (OWRB, 1991). The OWRB provided the following conclusions, which were summarized in the first five-year review report:

- The volume of the acid mine water discharged to Tar Creek was not significantly impacted by the OU1 RA;
- The concentrations of most constituents in the acid mine water discharges were decreasing. The cause of the decreasing concentrations was not known, but the OWRB stated the decreases were most likely the result of natural processes;
- The surface water quality was not significantly improved in Tar Creek, and the diking and diversion work was at best only partially effective; and,
- Although some public water supply wells in the Roubidoux aquifer were affected by acid mine water, insufficient data existed to evaluate the effectiveness of the well plugging activities. Neither EPA nor ODEQ identified any public drinking water wells at the site that failed to meet the MCLs established under the SDWA, and the drinking water at the site was determined to be safe for all uses.

The EPA concurred with these findings (EPA, 1994).

The EPA provided further findings and conclusions based on the data in the first five-year review report. These findings and conclusions included the following:

- The surface water data collected from Tar Creek were insufficient to perform statistical analysis due to the short monitoring period following construction;
- Monitoring data from the acid mine water discharges indicated that the contaminant concentrations were decreasing;
- The data indicated that the pollutant loading in Tar Creek was decreasing. The OWRB calculated that only 15% of the total metals loading to Tar Creek was from identified major discharges;
- The sediment data were erratic and conclusions on the effectiveness of the remediation could not be drawn; and,
- The data from the monitoring of water levels in the Blue Goose mine showed that overall, the long term average water level in the Boone aquifer had not been reduced. However, the diking and diversion work had reduced short-term rises in water levels in the mines in response to precipitation events (EPA, 1994).

The EPA's overall conclusion in the first five-year review was that other sources of recharge were contributing more to the acid mine water discharges to Tar Creek than previously estimated. The EPA concluded that the diking and diversion structures were effective at reducing surface water inflows into the mines in relation to specific precipitation events. However, the diking and diversion structures were at best only partially effective at achieving decreases in acid mine water discharges to Tar Creek (EPA, 1994).

The first five-year review report recommended that the post remediation groundwater monitoring program be extended to evaluate the success of the well plugging program at preventing contamination of the Roubidoux aquifer (this program was already in progress). Also, 15 additional abandoned wells were identified after completion of the second well plugging program. The EPA recommended evaluating the need to plug these wells based on the results of the post remediation groundwater monitoring program. Due to changes in the designated uses for Tar Creek, as stated in the OWQS, the EPA recommended no further RA or monitoring of Tar Creek. The other recommendations of the First Five-Year Review, related to OU1, are discussed in Section 2.4 (EPA, 1994).

The Phase I Roubidoux Groundwater Monitoring Program began in 1991 to determine the quality of the water in the Roubidoux aquifer and to assess the effectiveness of the well plugging activities. The goal of the program was to determine if acid mine water had contaminated the public water supply obtained from the Roubidoux aquifer. The program included wellhead sampling of municipal supply wells and discrete sampling of the Roubidoux aquifer. The wellhead sampling program was performed by the USGS for the OWRB between August 1992 and January 1993. Ten wells inside the mining area and one well outside the mining area (used to determine background concentrations) were sampled monthly during this period (EPA, 1994). The OU1 ROD did not set criteria to act as a "trigger" for action or decision regarding the effectiveness of the well plugging program. To provide such a trigger, in January 1993, an additional 10 wells outside the mining area were also sampled. By using wells outside the mining area, more statistically reliable data on background conditions could be gathered and indicator parameters that could be used to indicate the presence of acid mine water influx could be determined. Indicator parameters are compounds that indicate possible mine water impacts - sulfate, iron and zinc. Once background concentrations of contaminants were determined, if background concentrations of key contaminants were exceeded in water drawn from the Roubidoux aquifer, then that was an indication of the need for action or decision. Specifically, zinc, iron, and sulfate were chosen as indicator constituents of acid mine water influx due to large concentration differences for these constituents when comparing acid mine water to the background Roubidoux aquifer concentrations (EPA, 1994). In addition to calculating background concentrations for the indicator parameters, the ODEQ established tolerance limits (statistically derived values representative of the upper limit of background concentrations) for each parameter (ODEQ, 1993). The background concentrations and tolerance limits for these indicator parameters are provided in Table 2.

The results of the wellhead sampling for wells completed in the Roubidoux were documented in a report submitted in July 1993. The data showed that all 21 wells sampled were meeting the MCLs. The five wells failed SCML testing for iron, and one of those wells also failed the SCML for sulfate. Three of the five wells were located in Picher, one well was located in Commerce,

and one well was located in Quapaw. The EPA determined that these five wells were impacted by acid mine water from the Boone aquifer. At least one well (of the five) was clearly impacted by mine water from the Boone, and two (of the five) were probably impacted by mine water from the Boone. It could not be determined, however, whether the impact was related to widespread infiltration of acid mine water into the Roubidoux from the Boone aquifer or due to well integrity problems (ODEQ, 1993 and EPA, 1994). In one of these wells indicator parameters were so high that it is certain that the well is impacted by mine water from the Boone aquifer. In two other wells the indicator parameters are so high that it is probable that the wells are impacted by mine water from the Boone aquifer (ODEQ, 2014). It should be noted that neither the EPA nor ODEQ have identified any public drinking water wells at the site that fail to meet the MCLs established under the SDWA. However, data do indicate that SMCLs (SMCLs are aesthetically based) for the indicator parameters (sulfate, iron, and zinc) were exceeded in five wells completed in the Roubidoux.

Discrete sampling of the Roubidoux aquifer was conducted by the ODEQ from 1996 until 2002. The ODEQ obtained samples from the five impacted drinking water supply wells in Picher, Commerce, and Quapaw that were not meeting the aesthetic SMCLs (These wells meet MCLs and water drawn from these wells is safe to drink). After completion of Phase II, the ODEQ implemented continued monitoring in November 2003 as described in Section 3.4, this phase of sampling under the Roubidoux Groundwater Monitoring Program concluded in April 2008 (ODEQ, 2008a).

In 2009, the ODEQ entered a new cooperative agreement with EPA to continue the Roubidoux Groundwater Monitoring Program, which was named the Tar Creek After-Action Monitoring Part 2 (TCAAM2). The former, Part 1, (consisting of Phase I and Phase II) being completed under the previous cooperative agreement. Five sampling events were collected from the Roubidoux Monitoring Program wells from March 2010 to October 2013 as Part 2 of the TCAAM2. Reports were generated for each of the five sampling events and include tables of analytical results, maps of the well locations (Figure 2), graphs of iron and sulfate concentrations, piper diagrams for the water samples, a list of the wells with completion data, and water level measurements.

Reports from the five sampling events have similar results, conclusions, and recommendations, with some variation. Below is a summary of the conclusions from the fifth and final event:

- Piper diagrams indicate Commerce #5, Miami #3, Miami #11, Quapaw #4, RWD4 #3, and RWD7 #2 show no impacts from mine water.
- Quapaw #5 is considered contaminated by mine water since all three indicator parameters are greater than tolerance limits.
- Picher #6 is probably impacted by mine water with exceedances of two indicator parameters above tolerance limits.
- Picher #7 is probably impacted by mine water with exceedances of two indicator parameters above tolerance limits.
- Picher #5 and Cardin#1 show signs of possible impacts from mine water with one of

three parameters exceeding the tolerance limit.

- The Roubidoux water levels within the mining area have mostly increased, as seen in the slight increasing trend over more than 15 years at Picher #5 (ODEQ, 2014).

Recommendations from the TCAAM2 Reports include:

- Quapaw #5 be tested for casing leaks that may allow mine water to flow into the well and impact the Roubidoux.
- Abandon and plug Quapaw #2.
- Continued monitoring of the Roubidoux is suggested by the increasing trends shown at the Picher wells. Also, as long as the mine pool represents a potential source of contamination to the Roubidoux, continued monitoring is recommended.
- Continue to assess wells that still need to be plugged including those on BIA restricted land (ODEQ, 2014).

As documented in the previous five-year review, a fish consumption study was completed in 2007 by the ODEQ. The ODEQ collected and analyzed fish from the Neosho and Spring Rivers, Grand Lake, and local ponds in Ottawa County receiving mine waste runoff. It concluded that the consumption of some preparations of fish caught in waters affected by contaminated runoff from abandoned lead and zinc mines in the Oklahoma portion of the TSMD have levels of lead that could potentially cause adverse health effects. Separate advisory levels were determined for both residents living within and those living outside of the Tar Creek area using different background exposure assumptions (ODEQ, 2007). Results were compiled into a revised fish consumption advisory, released August 5, 2008. The advisory breaks out fish consumption suggestions on an easy-to-read chart for residents and non-residents of Tar Creek based on type of fish and based on the location from which the fish was caught (ODEQ, 2008b). This study is an indication that consumption of fish does pose a potential risk to human health, which contradicts the finding of the OU1 ROD.

Finally, the Mayer Ranch passive treatment system (MRPTS) has improved surface water quality in Tar Creek downstream of the treatment system by addressing approximately 20% of the contaminant mass loading from the mine water discharges (Nairn, 2012). In addition, sensitive fish species have begun to recolonize the formerly impacted portions of the stream directly downstream from the MRPTS (Nairn, pers. comm.). Given the success, feasibility, and cost effectiveness of treating acid mine water discharge with passive treatment, the process may be an engineered remedy for contaminated surface water at the site. For these reasons, the fund balancing ARARs waiver contained in the OU1 ROD may no longer be appropriate, and should be reevaluated.

There have been 2,940 residential properties and HAAs remediated as part of the removal response actions and OU2 RA (EPA, 2014a). The RA activities for OU2 are nearly complete. It is estimated that approximately 19 properties still require sampling and removal if necessary. In September 2014, EPA celebrated the Milestone Cleanup Event for OU2 recognizing the reduction of blood lead levels in Ottawa County children. Remedial activities that occurred under

OU2 include the remediation of residential yards, residential driveways, public alleyways, churches, City Parks, schools, and other HAAs. ODEQ will, under a cooperative agreement with EPA, perform future OU2 RA (EPA, 2014b and ODEQ, 2014b). ODEQ's role will include assessing new properties as they arise, sampling current properties set for remediation, and carrying out remediation for properties as appropriate, under EPA oversight.

Since the Record of Decision in 1997, cleanup activities carried out as part of OU2 have been a major contributor to creating a healthier environment, and have been instrumental in protecting human health in Ottawa County. With funding from EPA, initially through ASTDR, and more recently through ODEQ, the Ottawa County Health Department (OCHD) has provided ongoing community health education to families and the public on childhood lead poisoning prevention and blood lead screening of children from 6 months to 6 years of age residing in affected areas. Specifically, OCHD has provided childhood lead poisoning prevention education through community and tribal health fairs, Head Start and child care programs, community organizations and events, and the major county health department programs serving children. Monitoring and follow up of children with elevated blood lead levels in Ottawa County is carried out by the OCHD in conjunction with the Oklahoma Childhood Lead Poisoning Prevention Program (OCLPPP) of the Oklahoma State Department of Health. Children with elevated blood lead levels receive follow-up screening, education, and, as indicated, home environmental investigations to determine the source of lead exposure in accordance with the guidelines of the Centers for Disease Control and Prevention (CDC). Since the implementation of the programs and the OU2 RA, significant reductions have occurred in blood lead levels of children in Ottawa County (OSDH, 2015 and Table 10).

In 2004, the U. S. Agency for Toxic Substances and Disease Registry (ATSDR) published a report on blood-lead levels in children at the Tar Creek Superfund Site. The ATSDR concluded that the available evidence indicated that mine tailings in residential soils was the primary exposure pathway and source of lead in children's blood at the Site (ATSDR 2004a). The report stated that the percentage of children between the ages of 1 and 5 at the site with elevated blood lead levels had decreased between 1995 and 2003. The report stated that 2.8 percent of the children tested had elevated blood lead levels (above 10 μg/dL), which was only slightly higher than the percentage of children in the United States as a whole (2.2 percent).

Until 2012, the CDC's blood lead level of concern in children six years old and younger was 10 micrograms per deciliter (10μg/dL), but that has changed and now the CDC is saying that there is no safe blood lead level for young children.[7] EPA has used a blood lead level of 5μg/dL as a benchmark in its recent analyses. In Ottawa County, the percentage of children with blood lead levels that exceed 5μg/dL has decreased from 11.6 percent to 3.7 percent from 2007 to 2014. The 3.7 percent calculated for 2014 is slightly higher than the average for Oklahoma (2.4 percent)

[7] *See* Centers for Disease Control, *Preventing Lead Poisoning in Young Children* (1991) at p. 7 ("Blood lead levels at least as low as 10 μg/dL are associated with adverse effects"). Later the CDC revised its position saying that there was no safe level for lead in young children. *See CDC Response to Advisory Committee on Childhood Lead Poisoning Prevention Recommendations in "Low Level Lead Exposure Harms Children: A Renewed Call of Primary Prevention"* (November 26, 2013) ("CDC will emphasize that the best way to end childhood lead poisoning is to prevent, control or eliminate lead exposures. Since no safe blood lead level in children has been identified, a blood lead "level of concern" cannot be used to define individuals in need of intervention.".)

(OSDH, 2015). However, the blood lead data collected from children has demonstrated that the OU2 RA has been effective.

The reductions in blood lead level in both Tar Creek Superfund Site and Ottawa County can be directly related to RA under OU2 and education and monitoring efforts by OCHD.

The RI for OU4 was completed in December 2005, and the FS for OU4 was completed in July 2007 (AATA, 2005 and CH2M HILL, 2007c). In lieu of conducting a Baseline Ecological Risk Assessment (BERA) for OU4, the Ecological Remediation Goals developed by EPA for the Cherokee County Superfund Site (located across the state line in Kansas) were considered because of numerous similarities between the two sites including location, ecological sub region and province (Osage Plains section of the Central Lowland Province), and similar concentrations of lead, cadmium, and zinc. Other similarities between the sites including climate, topography, flora and fauna, made the determination to use the Cherokee County site BERA appropriate for OU4 (EPA, 2008). The ROD for OU4 was signed on February 20, 2008.

OU4 addresses the generally undeveloped rural and urban areas of the site where mine and mill residues and smelter wastes have been placed, deposited, stored, disposed, or otherwise come to be located as a result of mining, milling, smelting, or related operations. OU4 RA activities also include the remediation of some rural residential yards that were not included in OU2. OU4 also includes remediation of a former lead smelter, excavation and disposal of chat piles and chat bases in distal areas, the construction of the Central Mill Repository from a former fine tailings pond, and a fine injection pilot study. Additionally, subsidence areas are being used as chat repositories, and chat sales/reuse continues at the site. The LICRAT buyout was completed in 2011, and Treece, Kansas was included as part of the buyout, which was documented in an Explanation of Significant Difference (ESD) of the OU4 ROD. A separate Kansas trust—the TRA Trust—handled the Treece buyout. A soil amendment pilot project is currently underway. The purpose of the pilot project is to find out whether the addition of soil amendments works to address contamination in transition zone soils. If successful, this approach to transition zone soils should reduce the amount of soil that has to be excavated and disposed in the Central Mill Repository. To date, as part of OU4, 56 chat piles and chat bases totaling approximately 1.6 million tons of chat, transition zone soils, and fine tailings have been remediated and 309,787 tons of chat sold. OU4 RA is ongoing.

As part of OU4, a pilot study involving the injection of fine tailings washed from chat at a commercial chat washing plant was performed as part of the remedy. The fine tailings pilot study (FTPS) started on September 2011 and was completed in January 2012. The work included site reconnaissance, surveying, installation of three mine pool borings for use as water extraction wells and tailings injection wells, installation of a Boone aquifer monitoring well, pilot study mobilization, tailings excavation and processing, slurry mixing, tailings injection, and demobilization. The FTPS met the overall objectives set for the project, including exceeding the volume estimated to be injected per well. The FTPS injected approximately 58,063 CY of fine tailings into one boring. However, the cost involved with executing the injections exceeded the costs estimated in the OU4 ROD, and it also exceed the cost of hauling the material to a repository. In addition, the key assumption that all tailings would be injected as one major

project, thereby realizing significant economies of scale, as outlined in the OU4 ROD, was not met (CH2M HILL, 2013).

The Central Mill Repository (CMR) is located within the footprint of Central Mill Tailings Pond (CMTP), and is currently used for disposal of source materials generated during remedial activities performed for OU4. The CMTP was a surface impoundment used during previous milling processes at the former Central Mill. The pond evaporated, leaving behind fine tailings. The remedy for the CMTP was to convert it into the CMR, which will ultimately be covered with soil that meets the remediation goals consistent with the OU4 ROD. Construction and operation of the CMR began in January 2010. The CMR is being constructed in a phased build-out approach and while construction is not complete, the CMR is receiving source material. The CMR is capable of receiving an estimated 7.6 million CY of source material and will be the repository for much of the OU4 RA activities. In 2009, a groundwater monitoring program began at the future site of the CMR to determine the impacts of the CMR to the perched groundwater chemistry. The sampling program was concluded in 2011. Despite exceedances of MCLs for lead and arsenic, exceedances of SMCLs for sulfate, total dissolved solids (TDS), iron, and manganese, and an exceedance of OWQS for zinc, a 2012 report concluded that metal concentrations in the groundwater had not increased since the construction and operation of the repository began in 2010 (CH2M HILL, 2012c and Table 3).

Three rural residential yards were remediated under the OU4 Phase 1 RA in 2010. Approximately 3,556 tons of soils containing lead concentrations that exceed the remediation goal of 500 mg/kg were excavated from these three yards and transported to the CMR (CH2M HILL, 2011a).

The smelter site remediation was completed in November 2011. Approximately, 10,881 tons of source material, 11,402 tons of TZ soils, and 20,606 tons of debris were excavated or removed from the smelter site and transported from the smelter site to the CMR for disposal (CH2M HILL, 2012a).

Marketable chat sales are ongoing and chat piles and bases can be purchased at the following website http://projects.ch2m.com/TCOU4chat/. To date, 309,787 tons of chat and developmental rock have been sold to nearby chat processors (Table 8). All chat purchased must be used in accordance with the Chat Rule, as provided in the OU4 ROD.

Multiple chat piles and chat bases from several distal groups have been excavated and transported to the CMR. Below is a list of all Distal Groups that have had RA construction activities implemented (*see* Figure 3 for the locations of the distal areas).

- Distal 1 North construction activities began in October 2009 and were completed in October 2011. Six chat bases, three chat piles, and six mine shafts make up Distal 1 North. Approximately, 74,014 tons of source material, 1,000 tons of debris, and 95,022 tons of TZ soils were disposed at the CMR or consolidated into mine shafts (CH2M HILL, 2012a).
- Distal 1 South construction activities were began in October 2009 and were completed in December 2010. One chat base, three chat piles, five mine shafts, and eight cased borings

make up Distal 1 South. Approximately, 16,307 tons of source material, 25 tons of debris, and 13,412 tons of TZ soils were excavated from the property and disposed at the CMR or consolidated into mine shafts. Approximately 3,042 tons of source materials were disposed at CB223 (CH2M HILL, 2011a).

- Distal 2 RA construction activities began in December 2009 and were completed in June 2011. Five chat bases, numerous chat piles, 25 mine shafts, and 20 cased borings make up Distal 2. Approximately 292,933 tons of source material, 205,239 tons of TZ soils, and 16,383 tons of debris were excavated from the property and disposed at the CMR or consolidated into mine shafts. Approximately 4,435 tons of TZ soils were disposed at the Hockerville subsidence, and approximately 20,583 tons of source material were disposed at CB223 (CH2M HILL, 2012a).
- Distal 3 RA construction activities began in October 2009 and were completed in August 2011. Four chat bases, two chat piles, 14 mine shafts, and 12 cased borings make up Distal 3. Approximately 259,787 tons of source material, 305 tons of debris, and 5,375 tons of TZ soils were excavated from the property and disposed at the CMR. Approximately 21,283 tons of source materials were disposed at CB223. However, not all chat bases were entirely removed. It was determined that after remediation, the area around CB220 would become a low lying area recharged by mine pool discharge. In addition, remediation was limited at CB214, CB217, and CB215 due to sediment and erosion purposes associated with Beaver Creek (CH2M HILL, 2012a).
- Distal 4 RA construction activities began in August 2011. However, site restoration and final inspection have yet to be completed. One chat base, seven chat piles, one fine tailings pond, 16 mine shafts, and 10 cased borings make up Distal 4. Approximately, 110,836 tons of source material, 921 tons of debris, and 1,260 tons of TZ soils) were taken to the CMR or consolidated in mine shafts. In addition, CP091 was covered and capped in place.
- Distal 5 RA construction activities began in September 2011 and were complete in September 2015. Two chat bases, two chat piles, six mine shafts, and 13 cased borings make up Distal 5. Approximately 89,101 tons of source material, 17,273 tons of debris, and 17,490 tons of TZ soils were excavated and disposed at the CMR or consolidated in on-site mine shafts.
- Distal 6 RA construction activities began in February 2012 and were complete in September 2015. Two chat bases, two chat piles, 17 mine shafts, and 14 cased borings make up Distal 6. Approximately 51,289 tons of source material, 1,718 tons of debris, and 17,504 tons of TZ soils were excavated and disposed at the CMR or consolidated into on-site mine shafts. Subsidence feature CB011N-PIT took on 14,983 tons of material and was covered in place with soils from Distal 5.
- Distal 7 North RA construction activities began in July 2013 and were completed in September 2014. Five chat bases, four chat piles, 30 mine shafts, and 25 cased borings make up Distal 7 North. Approximately 114,189 tons of source material, 15,455 tons of debris, and 49,749 tons of TZ soils were excavated and disposed at the CMR or consolidated into on-site mine shafts. An estimated 55 acres were remediated on Distal 7 North (CH2M HILL, 2015).

- Distal 7 South RA construction activities began in July 2013 and were completed in September 2014. Two chat bases, one chat piles, four mine shafts, two cased borings, and one subsidence feature make up Distal 7 South. Approximately 55,815 tons of source materials, 3,308 tons of debris, and 713 tons of TZ soils were excavated and disposed at the CMR or consolidated into on-site mine shafts and subsidence features. An estimated 14 acres were remediated on Distal 7 South (CH2M HILL, 2015).
- Distal 8 RA construction activities began in December 2013 and are currently ongoing. Distal 8 is also known as the "Catholic 40" and consists of one chat base, four cased borings, and 2 mine shafts. Approximately, 107,000 tons of source material was excavated and disposed at the CMR or consolidated into on-site mine shafts (pers. comm, Craig Kreman). EPA has begun a pilot project whereby, in lieu of extensive excavation of contaminated soils, EPA is adding soil amendments high in phosphates to bind metals in soil, making them less bioavailable. This pilot project will inform EPA as to whether to continue excavation of contaminated TZ soil. It is hoped that more topsoil may be preserved by adding phosphate-containing soil amendments. In addition to preserving topsoil, an objective of the pilot study is to reduce metals bioavailability to acceptable levels while decreasing the volume of TZ soils being excavated and disposed at the Central Mill Repository (EPA, 2014d).
- Distal 6A RA construction activities began in December 2014 and are currently ongoing. Two chat bases, one chat pile, and two cased borings make up Distal 6A. To date, 82,284 tons of source material have been excavated and disposed at the 605 Hole. Soil amendments are being used to remediate TZ soils as part of a pilot project as explained above (ODEQ, 2015b and ODEQ, 2015c).

In addition to the CMR, some chat bases and chat piles have been consolidated in subsidence features. Below is a list of all subsidence features that have received material generated through RA construction activities since the last five-year review period:

- CB143/CB146/CB147 Group RA construction activities began in June 2011 and were complete in September 2015. CB143/CB146/CB147 consisted of three chat bases, nine mine shafts, 10 cased borings and four subsidence features (Subsidence 1, subsidence 2, CB150, and CB143). An estimated 60,936 tons of source material and TZ soils were consolidated into mine shafts or subsidence features. Subsidence features 1 and 2 were completely filled by September 2011, however, CB150 was not completely backfilled. CB143 accepted an estimate 40,977 tons of material and was capped with on-site borrow material. Approximately 11,741 tons of source materials, 4,894 tons of debris, and 5,308 tons of TZ soils were excavated and disposed at the CMR
- The Hockerville subsidence feature began accepting RA construction related waste in in 2011 and was filled by 2012. This subsidence feature was filled with an estimated 60,351 tons construction and demolition debris (CH2M HILL, 2012b).
- CB223 Group RA construction activities began in November 2009 and were completed in November 2011. CB223 Group consisted of a chat base and subsidence feature. At the completion of the construction activities, approximately 112,280 tons of on-site material (chat and TZ soils) and 44,908 tons of off-site material (from Distal 1, 2 and 3) had been

placed into the subsidence feature. Cover installation and final inspection was completed in 2011 (CH2M HILL, 2012).

- 605 Hole subsidence feature is being used to consolidate source material from Distal 6A. Future Distal projects will use the 605 Hole until it is completely backfilled.

Table 10: Childhood Blood Levels

Childhood Blood Levels for Ottawa County, Oklahoma and Oklahoma 2007 – 2013[1-4]					
Year	Ottawa County Total Tested	Tar Creek Total Tested	Ottawa County % ≥ 5 µg/dL	Tar Creek % ≥ 5 µg/dL	State of Oklahoma % ≥ 5 µg/dL
2007	438	107	10.7%	12.1%	9.1%
2008	330	82	10.9%	13.4%	6.5%
2009	500	107	18.4%	19.6%	6.5%
2010	825	191	10.2%	13.6%	4.5%
2011	700	149	9.9%	9.4%	4.4%
2012	755	165	5.7%	7.9%	3.4%
2013	692	141	2.0%	2.8%	2.5%

Notes:

1 Blood lead results were obtained from convenience sampling of children ages six months to six years of age residing in Oklahoma reported to the Oklahoma Childhood Lead Poisoning Prevention Program, Oklahoma State Department of Health. Blood lead test results were rounded to whole numbers for data analysis in accordance with guidance from the Centers for Disease Control and Prevention (CDC).

2 As of July 2012, capillary blood lead test results >5 µg/dL were confirmed with a venous blood lead test in accordance with CDC and state case management guidelines. From January to June, 2012, capillary blood lead test results from 5 – 9 µg/dL were not confirmed by a venous blood lead test. Therefore, the total number of children between the range 5 – 9 µg/dL for CY 2012 could potentially include false positive results which would overstate the number of blood lead levels in this range.

3 Number of Blood Lead Levels: These tests represent the highest venous blood lead test for an individual child. In absence of a venous blood lead test, the highest capillary blood lead test for an individual child is reported during the calendar year. Blood lead test results in the ranges 5-9 µg/dL and >10 µg/dL include children with capillary blood lead tests without a venous confirmation blood lead test. One child, who resided in multiple zip codes in Ottawa County during the year with multiple elevated blood lead levels, was counted as elevated in more than one zip code area but was not duplicated in the annual data for children screened in Ottawa County.

4 Tar Creek Zip Codes include Commerce (74339), Cardin (74355), North Miami (74358), Picher (74360), and Quapaw (74363)

3.5 Activities Conducted at the Site by Other Governmental Agencies Since the Fourth Five-Year Review

Various other Federal, Tribal, State, and local agencies are also performing work at the Tar Creek Superfund Site to address various environmental, health, and safety risks associated with the site. The following paragraphs describe the activities these various agencies are conducting, outside of the EPA's Superfund work, at the Tar Creek Superfund Site.

The University of Oklahoma (OU) continues to operate a passive treatment system (completed in 2008) to treat acid mine discharges at the Mayer Ranch in Commerce. The Mayer Ranch passive treatment system has improved surface water quality in Tar Creek downstream of the treatment system by addressing approximately 20% of the contaminant mass loading from the mine water discharges (Nairn, 2012). Given the success, feasibility, and cost effectiveness of treating acid mine water discharge with passive treatment, OU and ODEQ have partnered to construct an additional passive treatment system in Commerce. The new passive treatment system is located in southeast Commerce. The area originally contained two distinct mining related ponds. In 2006, the Oklahoma Conservation Commission filled the two ponds with chat and related debris without installing any sort of water control. Shortly after closure of the features, mine drainage started appearing in several areas as seepage surfaces. The proposed Southeast Commerce passive treatment system (SCPTS) project is planned to address the contaminated mine drainage that discharges from upwelling caused by the filling of the subsidence features (Nairn et al. 2014). Construction of the SCPTS is planned for the summer of 2015.

The U.S. Fish and Wildlife Service (USFWS) completed the TSMD Transition Zone Assessment Study in March 2013, intended to provide the information needed to determine the extent of soil degradation from historic mining operations in the TSMD (FWS, 2013). The USFWS also participated with Kansas State University (KSU) on its study into the health effects of mining waste on migrating Canada Geese (*Branta Canadensis*). The USFWS and KSU study documented elevated lead concentrations in liver and brain tissues and elevated pancreatic zinc concentrations in Canada Geese. The authors conclude that Canada Geese at mine waste–contaminated sites at the TSMD consistently suffer adverse health effects associated with lead and zinc exposure (van der Merwe et al. 2011). The USFWS also participated with the Tar Creek Trustee Council on completing the Restoration and Compensation Determination Plan (RCDP) for Grand Lake (TCTC, 2014).

The Quapaw Tribe Environmental Office (QTEO) has been collecting water quality data since 2002 on streams and rivers within the TSMD. The Quapaw Tribe Water Monitoring Program continues to monitor surface water bodies including Tar Creek, Spring River, and Beaver Creek. This program is a designed to assess the ambient water quality conditions of surface waters within the Quapaw lands and sampling is conducted monthly. The QTEO also collects continuous water quality data at the Beaver Creek Gauging Station in the Tribal Pow-Wow Grounds. Additionally, the tribe has initiated a Bio-assessment Monitoring Program that focuses primarily on Beaver Creek and Garret Creek (QTEO, 2013). The QTEO also operate under a management assistance cooperative agreement and a remedial response cooperative agreement both with EPA. Through the remedial response agreement, the QTEO contracted the Quapaw

Services Authority (QSA) to lead the first tribal lead cleanup of a Superfund site in the nation at Distal 8, also known as the "Catholic 40" (*see* Figure 3). In addition, the Quapaw Tribe of Oklahoma (QTO) has also entered into an Interagency Agency agreement with the State of Oklahoma, to undertake the cleanup of Distal 6A (Figure 3). Both cleanup projects are currently ongoing (OK and QTO, 2014).

The Six Treaty Tribes of Oklahoma (Cherokee Nation, Eastern Shawnee Tribe of Oklahoma, Miami Tribe of Oklahoma, Ottawa Tribe of Oklahoma, Seneca-Cayuga Tribe of Oklahoma, and the Wyandotte Nation of Oklahoma) have published two reports focusing on heavy metal contamination in the TSMD. The *Assessment of Heavy Metals in the Clay Fraction of Sediments Downstream of the Tar Creek Superfund Site in Northeast Oklahoma* focuses on the extent to which contamination of fluvial sediment has occurred within the lands of the Six Treaty Tribes of Oklahoma and the level of contamination within the floodplain sediments of the Grand Lake watershed (TEMS, 2012). The *Analysis of Heavy Metals in Culturally Significant Plants within the Grand Lake Watershed of Northeastern Oklahoma* focuses on the lead, zinc, and cadmium concentrations in culturally significant plants and identifies an exposure pathway from contaminated soils to the culturally significant plants (TEMS, 2014). Both studies were conducted because Tribal members who gather wild plants from floodplain habitats in the TSMD are concerned with potential health hazards posed by exposure to heavy metals from mining waste.

Since the Record of Decision in 1997, the Ottawa County Health Department (OCHD) has worked closely with the Oklahoma Department of Environmental Quality (ODEQ) to provide community-wide education on prevention of childhood lead poisoning, and to provide blood lead monitoring of children in residential areas throughout Ottawa County. With funding from EPA, the OCHD provides childhood lead poisoning prevention education through community and tribal health fairs, Head Start and child care programs, community organizations and events, and the major county health department programs serving children. Enhanced efforts are made by staff to identify and offer blood lead screening to children served in the major programs offered in the county health department.

Monitoring and follow-up of children with elevated blood lead levels in Ottawa County is carried out by the OCHD in conjunction with the Oklahoma Childhood Lead Poisoning Prevention Program (OCLPPP) of the Oklahoma State Department of Health. Children with elevated blood lead levels receive follow-up screening, education, and, as indicated, home environmental investigations to determine the source of lead exposure in accordance with the guidelines of the Centers for Disease Control and Prevention (OSDH, 2015).

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Appendix C: Notices to the Public of Five-Year Review

Tar Creek Superfund Site
Public Notice
Oklahoma Department of Environmental Quality Begins 5th Five Year Review of Site Remedy
November 2014

The Oklahoma Department of Environmental Quality (DEQ) and United States Environmental Protection Agency (EPA) Region 6 is beginning the fifth Five-Year Review of the remedy, for the Tar Creek Superfund Site (Site) in Ottawa County, Oklahoma in November 2014. The review will evaluate whether the remedy continues to be protective of human health and the environment, and will document the methods, findings, and conclusions of the Five-Year Review in a report. The report will be available to the public in September 2015. The approximate 40-square mile Site is a former lead and zinc mining area located in the Tri-State Mining District. The cities' of Cardin, Commerce, North Miami, Picher, and Quapaw, as well as rural areas in northern Ottawa County, are located within the Site boundaries. Elevated levels of lead, zinc, and cadmium exist in the mining waste and affect the soils, ground water, surface water, and sediments of the Site.

The Site is divided into Operable Units (OU). The Record of Decision (ROD) for OU1 was signed in 1984 to address surface water and ground water discharges of acid mine water to Tar Creek and the Roubidoux aquifer. The ROD for OU2 was signed in 1997 to address contaminated soils in residential yards and high access areas. OU3 does not have a ROD, but abandoned mining chemicals were addressed under a removal action in 2000. The ROD for OU4 was signed in 2008 to address mining waste contamination in rural residential yards and ground water wells. Investigations into sediments and surface waters for OU5 are still on going and a ROD has yet to be signed.

Previous Five-Year Review reports are available on the internet and in the information repository located at the Miami Public Library. Information about the Tar Creek Superfund Site including EPA contact information is available at *http://www.epa.gov/Region6/6sf/oklahoma/tar_creek/index.htm*

DEQ will be conducting interviews as part of the Five-Year Review. If you wish to be interviewed, have any questions, or need further information, please contact:

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[Published in the Miami News-Record – December 11, 2014]

Proof of Publication

Ottawa County, State of Oklahoma

Tar Creek Superfund

Affidavit of Publication
STATE OF OKLAHOMA, OTTAWA COUNTY OF OKLAHOMA:

I, Cheryl Franklin, of lawful age, being duly sworn, upon oath deposes and says that she is the Authorized Agent of The Miami News Record of Miami, Oklahoma, located at 14 1st Ave. N.W, Miami, Oklahoma 74354, a daily newspaper of general circulation in Ottawa County, printed in the English language, and published continuously and uninterruptedly published in said county for a period of one hundred and four (104) weeks consecutively prior to the first publication of the said notice.

That said newspaper is in the city of Miami, Ottawa County, Oklahoma, a Daily newspaper qualified to publish legal notices, advertisements and publications as provided in Section 106 of Title 25, Oklahoma Statutes 1971, as amended, and complies with all other requirements of the laws of Oklahoma with reference to legal publications.

That the attached notice is a true copy thereof and was published in the regular edition of said newspaper for 1 time(s), the first publication thereof being made as aforesaid on the December 11, 2014.

Cheryl Franklin — Publisher

Subscribed and sworn to before me this December 12, 2014

Kathleen F. Merrill — Notary Public
My commission expires: 08-25-2016

Publication Cost: $57.30

Acct #: **20900703**

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Remittance Address:
Miami News Record
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Appendix D: Interviews Forms

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date: 2/4/15**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
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Name: David Cates	**Title:** Professional Engineer	**Organization:** ODEQ
Email: david.cates@deq.ok.gov	**Phone:** (405) 702-5124	**Address:** 707 N. Robinson, Oklahoma City, OK 73101

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   The work since 2010 entailed remedial actions for OU2 and OU4 and after action monitoring for OU1. The work on OU2 residential cleanups has progressed to include many of the outskirt towns in Ottawa County. This work is thought to be successful due to the lack of complaints. The work on OU4 has been frustrating with cost overruns due to inadequate site characterization and increased project scope due to removal of large amounts of transition zone soils, unfinished work, landowner complaints, reluctance to change remedial procedures to address our concerns, and more, all resulting in the state refusing to provide any additional matching funds. This action has resulted positive changes including use of soil amendments for metals sequestration instead of stripping off the top soil. After Action monitoring has been successful in regard to sampling of the Roubidoux wells but lack of adequate funding has resulted in some wells not getting plugged.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   The residential remediation has been successful and more and more of the community have asked for their yards to be sampled. The opposite is true for the OU4 non-residential work where unfinished work and less productive land due to removal of transitional zone soils (when other options existed) has led to property owners refusing to sign access agreements.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

The down-stream tribes are concerned with continued leaching of metals and contaminated sediments into Tar Creek that flows into areas of their jurisdiction. They are also opposed to injection of fine tailings into the mine workings for fear of contaminating the Roubidoux drinking water aquifer. The Quapaw Tribe and the State would like to have more control (meaningful involvement) in future OU4 work.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   The OU4 stakeholders (the EPA, State, and Quapaw Tribe) meet monthly for conference calls to discuss ongoing work. These meetings were more of a reporting about ongoing work and less about obtaining meaningful Stakeholder input of what should be done. These meetings were more frequent when more work was being conducted. The ODEQ conducts annual O&M for the Douthat diversion dike and annual monitoring of a select group of Roubidoux wells in the area. This activity was also more frequent previously. As a result of EPA closing OU1, the scope will be reduced but periodic monitoring of a few Roubidoux wells will be continued under a modified state O&M plan.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   I am not aware of any emergency responses since the last FYR. There was a tornado in Quapaw in 2014 but am not sure of the response. There was a tornado in Picher in 2008 and flooding in Miami in 2007 that involved responses.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   I feel well informed about the Tar Creek activities but not so much for the Region 7 activities. Progress is slow at Tar Creek mainly due to the immense size of the site but other factors play a role too, like obtaining property access on both fee land and restricted Native American lands. Also the many complications related to performing Superfund remediation on the restricted lands has resulted in slow progress. Also, complaints from land owners about the work defects seem to take a long time to resolve.

7. **Do you know of opportunities to optimize the operation, maintenance, or sampling efforts at the site related to OU1, and have such changes been adopted?**

   All opportunities to optimize the O&M and After Action Monitoring (sampling) have been adopted and implemented. Non-incremental funding of the well plugging project would have helped to better implement this phase of work.

8. **Are you aware of any problems or difficulties encountered since the conclusion of the fourth five-year review period (September 2010) which may have impacted progress or resulted in a change in O&M procedures for the Roubidoux Monitoring Program and the Admiralty diversion dike, conducted under OU1? Please describe changes and impacts.**

   EPA intends to close out OU1. As a result ODEQ will amend the O&M plan to include the periodic sampling of several Roubidoux wells at the Tar Creek site. If abandoned Roubidoux wells are discovered in the future as a result of ongoing OU4 remediation, ODEQ will request funding from EPA under a cooperative agreement to evaluate and plug the wells.

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

   With the success of the Mayer Ranch Passive Treatment System (PTS), it is thought that mine water discharges should be addressed with similar systems to curtail the input of metals loading to Tar Creek and other site streams. The ODEQ has entered into an interagency agreement that will provide state funding to the University of Oklahoma to develop a conceptual plan for a passive treatment system at the Southeast Commerce site; to hire a design–build contractor to construct the PTS; and to conduct monitoring of the system. Other mine water discharges that need to be addressed are at Douthat on Tar Creek and at 50 Road on Beaver Creek. The runoff and leachate from chat piles along Tar Creek needs to be addressed as well.

10. **A recommendation from the fourth five-year review report was that EPA should complete an evaluation of current surface water and sediment data for Tar Creek to verify that no unacceptable risks to human health and the environment exist in Tar Creek. To your knowledge, has this been completed? Please Explain.**

    No. A human health risk assessment for surface water and sediment in Tar Creek has not yet been undertaken by EPA.

11. **A recommendation from the fourth five-year review report was for ODEQ to undertake field work to determine whether the 19 wells found in literature actually exist, and evaluate whether plugging any wells found is warranted or feasible. To your knowledge, has this been completed? How many wells did ODEQ plug since the conclusion of the last five-year review period (September 2010)?**

    The ODEQ has begun the deep well evaluation task but this has not been completed. Two wells were found and evaluated for plugging. Many of the wells are on restricted lands for which the ODEQ does not have access. It is thought that many of these have actually been plugged in the 1930s as part of a flood control project in the Tri-State Mining District funded by the Public Works Administration and managed by the USGS. However, information on the identity of the 18 wells plugged in this program has been

exceedingly difficult to obtain. In the last After Action Monitoring report it was recommended that the Quapaw Tribe take over the plugging of wells on restricted lands. The two wells that ODEQ found on unrestricted property are the Tulsa Mine Well and Netta-White well. The ODEQ plugged one of these (the Tulsa Mine Well at the Atlas Chat pile) and the two powerhouse piezometers, but lacked adequate funding to include additional wells in the contract. It is the opinion of ODEQ that the Netta-White well has been plugged previously by Eagle-Picher and further plugging operations are not necessary. The ODEQ has requested additional funding to complete plugging of wells on unrestricted lands (e.g. the Quapaw #5 and Quapaw#2).

12. **Are you aware of any incidents, complaints, or situations, in which citizens are consuming or have consumed contaminated groundwater from either the Boone or Roubidoux aquifers since the conclusion of the fourth five-year review period (September 2010)?**

I am not aware of any such incidences. However, the backup well for the Town of Quapaw (Quapaw #2) has very poor water quality in terms of greater than secondary MCLs for iron, sulfate, and TDS. As soon as the Town of Quapaw gets an alternate source for their backup supply, this well should be plugged since it represents a source of potential contamination of the Roubidoux aquifer. The Town has explored many options to replace their backup well and the latest option is a new well being drilled by the water district a few miles east of Quapaw. As required in the last Five-year review, institutional controls in the form of new restrictions (i.e., testing requirements) were placed into the Appendix H of the Oklahoma Water Resources Board (OWRB) to protect people from exposure to contaminated water from the Boone aquifer at the Tar Creek site. A supplemental / explanatory fact sheet was also placed on the ODEQ website.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Dennis Datin	**Title:** Professional Engineer	**Organization:** ODEQ
Email: dennis.datin@deq.ok.gov	**Phone:** (405) 702-5125	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   The work for OU2 has gone very well with a large number of properties cleaned up with a minimal number of complaints. For OU4, the work has produced some good results at certain locations but has caused some problems with a few individual property owners. There is discussion related to removal of transition zone soils versus only removing the visible chat. This is being addressed at the current time. There was some problems with getting vegetation established which is due to some rocky solid and very dry weather. At least four or five sites needed to be revisited with additional work being done.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Effects on the surrounding community have been good for the economy and providing work for people who reside in this area. A negative effect has been with a lot of truck driving over the county roads which eventually cause them to be torn up and the county has had to fix them. Also, there has been some trouble in getting access to some sites that need cleanup.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   They are worried about the effect on the roads, with the increase in traffic. Some individuals downstream of the site worry about the effects of the water quality downstream especially from the injection of fines into the Boone aquifer.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   There have been many meetings with EPA and others. The purpose was check on the status of the remediation and resolves any problems that have or might arrive.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   There have been 2 or 3 wrecks between hauling trucks and other vehicle's at the site.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   I have been informed through meetings, emails, working with the RPM's and visits to the site.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   This has been discussed with EPA, the tribes and others with the Remedial Action Optimization Report being the result. Some of the changes that should be made are not to remove the transition zone soils, redo the remedial action objectives for cadmium and zinc and have more presence at the site of government personnel.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   No

9. **Are you aware of any problems or difficulties encountered since the conclusion of the fourth five-year review period (September 2010) which have impacted progress of the Remedial Action for OU2? Please describe changes and impacts.**

   What hinders the work is when someone whose property needs to be remediated either did not turn it in or refused access during the time that EPA was doing the residential remediation.

10. Do you know of opportunities to optimize the operation, maintenance, or sampling efforts at the site related to OU2, and have such changes been adopted?

No

11. Do you have any comments, suggestions, or recommendations regarding the site?
As stated above, the optimization report has some of the recommendations. I will relist three of them here. This has been discussed with EPA, the tribes and others with the Remedial Action Optimization Report being the result. Some of the changes that should be made are not to remove the transition zone soils, redo the remedial action objectives for cadmium and zinc and have more presence at the site of government personnel.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Kelly Dixon	**Title:** LPD Division Director	**Organization:** ODEQ
Email: Kelly.dixon@deq.ok.gov	**Phone:** (405) 702-5151	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   A lot of money was spent on OUR 4 during this time. Work was completed on some parcels but there were so many parcels open at once that not all of them were completed. A comparison of the actual costs v the estimated costs in the ROD reveals that the work conducted during this period was much more expensive than anticipated. It is not clear if this was due to changed site conditions, inefficiencies, contract mechanisms or all of the above. I am pleased with the efforts and some of the recommendations of the optimization board to pause and work more cooperatively with all stakeholders on future work. John Meyer with R6 especially has been helpful in articulating and helping to affect some of these changes.

   R6, especially Bob Sullivan, has worked hard to complete OU2 and made a lot of progress. I appreciate the new direction of turning OU2 over to the state to manage in the long term and am hopeful that this will continue to provide avenues to removing risk to residents of Ottawa County.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Since I do not live there, I do not know. However, I believe that the continued cleanup of the chat and soils are reducing risks to people and the environment and that the continued cleanup of distal areas will have a positive impact on residents and landowners as it will allow them to return land back to productive use.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   Property owners where cleanup was started but not finished were unhappy. I believe there is a plan in place to finish those properties. I am hopeful going forward that work will be conducted in a more measured manner, where timely and complete cleanups can occur rather than starting many and not being able to complete them.

4. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   No

5. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   Yes and no. The state has not felt as it if has been treated as a true partner in the OU4 process. Despite routine phone calls, we feel as if our voices are not heard, and more than once have been out of the loop on work in progress. We are hopeful that the new approach to the site will address these concerns and keep us engaged in a meaningful way.

6. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   Contract oversight and cost control were an issue for OU4 during this period. Unless EPA fundamentally changes its approach to contract oversight and cost control, it is not clear that this situation will improve on the projects that it manages. It would be helpful to have an EPA RPM on-site and responsible for cost control and decisions in a similar manner that OSCs are utilized on projects.

7. **Do you have any comments, suggestions, or recommendations regarding the site?**

   I believe that EPA has worked hard to address issues at the site. The concerns expressed here are not insurmountable and do not reflect lack motivation by staff; I think it is just that the normal way of contracting, contract management and coordination is much more complex on this site and needs to be managed differently. Since the buyout has been completed, the immediate risk to residents has been mitigated. This allows time for all stakeholders to slow down and be more thoughtful about how, where and when work is performed and may lend itself to better coordination with natural resource trustees on restoration projects. It is imperative that the state be treated as a partner on these projects and we are looking forward to taking the lead on some of the projects.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date: 1/29/15**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Rafael Casanova	**Title:** Environmental Scientist	**Organization:** EPA Region 6
Email: casanova.rafael@epa.gov	**Phone: 214-665-7437**	**Address:** 1445 Ross Avenue, Suite 1200; Dallas, TX 75202-2733

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   The remedial actions conducted since the fourth FYR have significantly reduced the blood-Pb levels at the Site.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Site operations have had a positive environmental impact on the surrounding communities.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.** For OU 4, there are community concerns regarding the removal of transition zone soils.

4. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   I am not aware of an events, incidents, or activities at the site which required emergency responses.

5. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   Yes, we are well informed about site activities.

6. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   The EPA is currently addressing the remedial actions concerning transition zone soils.

7. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   I have not been associated with any complaints or other incidents related to the Site and requiring a response from the office.

8. **The optimization report produced for OU4 included several priorities, one of which was to "Leverage potential synergies with project team structure, roles, and responsibilities". Is there any strategy in place to implement this priority?**

   The EPA is currently considering the recommendations provided in the Optimization Report.

9. **Are you aware of any problems or difficulties encountered since the conclusion of the fourth five-year review period (September 2010) which have impacted progress of the Remedial Action for OU4? Please describe changes and impacts.**

   I have not been involved with any problems or difficulties associated with OU 4 since the conclusion of the fourth FYR Report.

10. **A recommendation from the fourth five-year review report was that EPA should complete an evaluation of current surface water and sediment data for Tar Creek to verify that no unacceptable risks to human health and the environment exist in Tar Creek. To you knowledge, has this been completed? Please Explain.**

    It is my understanding that the remedial investigation for Operable Unit 5 has not been initiated.

11. Are you aware of any incidents, complaints, or situations, in which citizens are consuming or have consumed contaminated groundwater from either the Boone or Roubidoux aquifers since the conclusion of the fourth five-year review period (September 2010)?

I am not aware of any incidents, complaints, or situations in which citizens are consuming contaminated ground water since the conclusion of the Fourth FYR Report.

12. Do you have any comments, suggestions, or recommendations regarding the site?

The use of soil amendments for addressing the transition zone soils will need to be evaluated over a period of several years to determine if they are functioning as intended.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Rebecca Jim	**Title:** Executive Director	**Organization:** LEAD Agency
Email: rjim@neok.com	**Phone:** 918-542-9399	**Address:** 223 A. St. S.E., Miami, OK 19289 South 4403 Dr., Vinita, OK

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

First of all, we are still disappointed that nothing has been done about Tar Creek itself. Toxic heavy metals continue to wash into the creek and flow downstream through our communities, into the Neosho River and settle into the sediments of Grand and Hudson Lakes as well as contaminate the fish rendering our water bodies unable to meet their primary Beneficial Use of Fishable. We are grateful for the work that has been done and understand the financial limits of funding and the need to sell the chat rather than remediate the piles. We feel human health and the environment would be better protected if funds were spent on preventing site runoff into the communities major water bodies and diversion of mine water flows before clearing of chat bases. The continued cleanup of yards is also very much appreciated by the communities and LEAD Agency. Our main concern is exposure impacts to human health and environment. The issues above carry importance to us and the community.
We are extremely supportive of the EPA for awarding the Quapaw Tribe contracts to provide cleanup of tribal lands and hope their efforts will be rewarded with continued work on the site.

2. **From your perspective, what effects have site operations had on the surrounding community?**

Clearing waste piles and contaminated soil from agriculture lands is important and appreciated by community, but it needs to be left useable for agricultural purposes or for further uses that would be safe for human health. Removing the families from the

Picher/Cardin area for subsidence risk protected people and allows chat loaded truck traffic to run through a much less populated area, and as such is more protective which is much appreciated. Hiring of local workers is also a boon to the area economy and helps put a good view on the Superfund effort. The Superfund Jobs Training Initiative was a powerful experience for those who both tried out, but especially for those who completed the training. It is hopeful that additional residents will have the opportunity to benefit from future trainings.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   Our concerns focus on communication with the EPA and State which we feel is very slim up until very recently. OU4 especially, has been a vague process for LEAD and we have been in the dark nearly all the way so far. If we didn't host our annual conference we would not know much at all. Despite our constant pleading, we are not given regular updates nor can we even have our contact information as a citizen organization contact consistently placed on public updates and handouts published by the EPA and state. Citizens are not informed that they can contact us to stay informed or to join our group to work more directly with the site. We are the only Superfund Site where the local community group is left out.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   We conduct regular site visits and guided tours for universities, both local and around the country, area and state-wide schools, teachers, scientists, journalists from around the country and world and many others throughout the year, year after year. We try to communicate with EPA when they are in the area however we rarely know that they are here because we are not contacted before coming or while they are here usually. If we see something unusual or we have questions about what we see we call EPA or state to try and get answers or tell them what we see.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   All unusual sightings are called in. None have required emergency response.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   No, we don't for reasons mentioned above. As a former TAG recipient and the only community group organized to address the site, we feel we should be treated like such. We have stated many times we would like a TAG grant for OU4 but have been met with

disinterest and no official response. We are grateful for the updates that are provided at our annual conference and will continue to provide EPA all the time they require to inform the public during our event.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   See above. We would like to see better off-site management. We are extremely interested in the continuation of OU2, the yard clean-up of lead contaminated yards in Ottawa County, since only one fourth of the properties in the county have been tested thus far, we hope that the hand over from EPA to the Oklahoma Department of Environmental Quality will be smooth and that funding will continue for the cleanup of yards, until it has been determined ALL have been remediated that require it. We would be glad to assist in promoting citizen participation.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   Complaints have to do with Tar Creek itself and the fact that nothing has changed and people wondering if the fish are safe and if swimming is safe in Grand Lake, etc. With orange water pouring through our communities it gives us worry and knowing the chat runoff is un-abated.

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

   Nothing additional.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:** January 21, 2015
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK 73101
Individual Contacted:		
Name: Nancy John	**Title:** Environmental Director	**Organization:** Cherokee Nation
Email: nancy-john@cherokee.org	**Phone: 918-453-5102**	**Address:** PO Box 948 Tahlequah, OK 74465

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   The work seems to be progressing. Chat piles are smaller than in the past.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Most of the OU2 yard waste identification and clean ups have been completed. There is documented evidence of lower blood lead levels in the community.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   Yes. There is an untreated mine-water outflow adjacent to US Highway 69, also known as historic Route 66, and the Commerce High School athletic fields. There are no signs or fencing around the mine water. The untreated mine water outflow is scheduled (when funded) to be part of a passive mine water treatment wetland south of US Highway 69, also known as historic Route 66. These children, this community, and Route 66 visitors are concerns for this location.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   Yes. There have been weekly, bi-weekly, then monthly conference calls for OU4 through the period. The purpose of the calls is to keep all 'stakeholders' informed about the

activities occurring at the site. There have been a few tours of the site with EPA representatives during this period.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   No.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   Yes.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   No.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   No.

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

   See number 3 above.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Kristi Laughlin	**Title:** Environmental Specialist	**Organization:** Eastern Shawnee Tribe of Oklahoma
Email: klaughlin@estoo.net	**Phone:** 918-666-5151x1041	**Address:** 10080 S. Bluejacket Rd. Wyandotte, OK 74370

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   OU4 seemed to be more tedious than was previously planned. State participation in activities has been beneficial, and I'm pleased with the work from the Quapaw Tribe.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Site operations have provided jobs in the community, but there has been elevated dust and traffic from the trucks hauling to the repository. There have been some traffic accidents too.

   Cleanup of the site is comparable to the land of the surrounding community, which has mostly been farmland. Cleanup so that the landowner can use the land is beneficial realizing that some restrictions must be in place.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   Not at this time.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   No routine site visits are done by this office. We do participate in tours when offered by EPA to look at the work that is being done. More meetings and tours would be beneficial.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   We have not responded to any incidences.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   More information sharing would be beneficial.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   Not at this time.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   Not at this time.

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

   Not at this time.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date: 12/22/14**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Christen Lee	**Title: Environmental Director**	**Organization: Wyandotte Nation**
Email: clee@wyandotte-nation.org	**Phone: 918-678-6341**	**Address: 64790 E Hwy 60 Wyandotte, OK 74370**

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   Overall, it seems much more daunting in its scale than everyone realized (OU4). I am pleased so far with ODEQ's participation and the work the Quapaw Tribe has done.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Some issues with traffic and dust.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   The idea of multiple repositories, and the main one being in the flood plain.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   Only with EPA personal- set up as stakeholder meetings. More often would be beneficial.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   None

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   More stakeholder site meetings would be helpful.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   More information sharing with other stakeholders, public meetings.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   Not from our office

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

   We would like to see post environmental site monitoring i.e. Water, air…

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date: January 22, 2015**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Ursula Lennox	**Title:** Remedial Project Manager	**Organization:** EPA Region (6SF-RL)
Email: lennox.ursula@epa.gov	**Phone: 214-665-6743**	**Address:** 1445 Ross Avenue, Dallas, TX 75202

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   Significant progress continues to be made at the site since the 4th 5-Year Review Report. EPA has concluded the remedial action activities at Operable Unit 1 (OU1 – surface water/ground water) and have transitioned this OU to the State; in tandem with the efforts of ODEQ and the County Health Department, and the remediation of over 2 thousand residential properties (OU2), the blood lead level of children is below the National average; the voluntary buyout of the towns of Picher, Cardin, and Hockerville, have greatly reduced the chances of exposure, and, with the threat of exposure greatly reduced, the remedy for Operable Unit 4, that addresses mine and mill waste, can be performed over a longer period.

   Region 6 negotiated a $2.6 million cooperative agreement with the Quapaw Tribe Environmental Office to conduct the remediation of a 40 acre parcel of tribal land known as the 'Catholic 40' within the Tar Creek Superfund Site. This was the first time that a Tribe is carrying out a Superfund Remedial Action in the U.S.

   EPA is also working with EPA-HQs' Optimization Team and the stakeholders involved with OU4 to prioritize contaminated areas in flood zones, near waterways, and in riparian areas. Measures are also being evaluated in determining the best approach to address transition zone soils.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Land contaminated with mine and mill waste, is now remediated and with proper maintenance, this remediated land provides additional acreage landowners will eventually utilize for agriculture and/or grazing. For land containing marketable chat, EPA facilitated chat sales between the property owner and purchaser, and transported the material to the designated location. Property owners were kept abreast throughout of the entire process and provided the appropriate documentation and fact sheets related to the response action and what to expect. These remedial actions benefited the land owners and surrounding community, because it removes the risk of exposure and protects human health and the environment.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   EPA has not received any community concerns. However, some property owners where work was performed were concerned with the removal of top soil during the remedial action. The top soil needed to be removed because it was contaminated.

4. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   No.

5. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   Absolutely. The project managers participate in weekly and monthly calls with stakeholders to discuss and hear the status on site activities; EPA and ODEQ Management conducts monthly calls to discuss the status/challenges/plan of actions related to Superfund sites in Oklahoma; EPA and other stakeholders present power point presentations at the annual Tar Creek conference that is hosted by the L.E.A.D. agency each year; EPA conducts availability sessions for the public in order to seek answers to questions they may have related to site activities, etc.

6. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   Yes. It is important that all stakeholders stay abreast on site developments, to minimize delays in various response actions.

7. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   Yes. When work stopped on unrestricted properties in April 2013, EPA received several complaints from property owners and received several inquiries from elected officials. EPA met with the property owners and elected officials and outlined a plan of action and implemented it. The majority of those involved were satisfied with the end result.

8. **The optimization report produced for OU4 included several priorities, one of which was to "Leverage potential synergies with project team structure, roles, and responsibilities". Is there any strategy in place to implement this priority?**

   Yes. The approach has been presented to ODEQ, the Quapaw Tribe of Oklahoma, EPA's Contractor, and the Stakeholders that are involved on this project. The approach is dynamic and will be refined as discussions between the stakeholders and the EPA-HQ's Optimization Team continue.

9. **Are you aware of any problems or difficulties encountered since the conclusion of the fourth five-year review period (September 2010) which have impacted progress of the Remedial Action for OU4? Please describe changes and impacts.**

   Though challenges have continuously evolved throughout the implementation of the remedial action for OU4, progress continues to be achieved. Some of the challenges encountered included securing access agreements on restricted properties, encountered greater volumes of waste material and transition zones soils than what was projected in the OU4 ROD, encountering shallow bedrock during the remedial action, and securing state funds to complete site work.

10. **A recommendation from the fourth five-year review report was that EPA should complete an evaluation of current surface water and sediment data for Tar Creek to verify that no unacceptable risks to human health and the environment exist in Tar Creek. To you knowledge, has this been completed? Please Explain.**

    It is my understanding that Regions 6, 7, and the States are coordinating this effort.

11. **Are you aware of any incidents, complaints, or situations, in which citizens are consuming or have consumed contaminated groundwater from either the Boone or Roubidoux aquifers since the conclusion of the fourth five-year review period (September 2010)?**

    I have not received any complaints from citizens related to this question.

12. Do you have any comments, suggestions, or recommendations regarding the site?

It is important to keep all stakeholders, property owners, and the public informed on work that is being performed; make sure property owners are aware of their role related to ensuring the implemented remedy maintains its effectiveness; and utilize an access agreement that allows an area to be both assessed and remediated.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Larry Tippit	**Title: Environmental Specialist**	**Organization: Peoria Tribe of Indians of Oklahoma**
Email: ltippit@peoriatribe.com	**Phone: 918-540-2535 ex. 17**	**Address: 118 S. Eight tribes Trail Miami, OK. 74354**

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   Much of the EPA remediation work has been performed in a hap-hazard manner with little thought to future effects to the environment or area residents. As in OU4 with the chat fine injections into water-filled underground mine caverns, and chat filling of open pits, shafts, and subsidence's, most of which are water filled and directly connected with the underlying water table (Boone aquifer), higher levels of contamination and hydraulic pressures from the fill will ultimately increase the area and scope of contamination. Also the distinct probability of cross contamination of the Rubidoux aquifer is increased. At least two Tribal members' drinking water wells have become heavy metal contaminated, and at least two noticeable contaminated seeps have been documented on Spring River at a point just below where mine shafts and open pits were chat filled.

   The EPA Chat Repository for chat removal borders and is uphill from already contaminated Tar Creek, and the leachate drains for that repository are in the Tar Creek flood plain.

   Work contracted by EPA to "qualified" contractors has been at times sub-contracted to unqualified contractors. The results have been that sub-contractors were either under paid, not paid, or did not effectively accomplish contracted jobs. Remediation funding was not judiciously used, and time and money were not used effectively.
   Funding provided for the Picher Buy-Out and the actual buy-out did not seem to correlate.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   From my perspective, many people/families directly impacted have been unimpressed or dissatisfied with remediation efforts and results. Some others have been made greedy, trying to take advantage of funding provisions for cleanup / buy-out / remediation.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   Probably the biggest concerns that I am aware of is the threat and/or possibility of the cross contamination of the Rubidoux aquifer source of drinking water, and the contamination of Spring River and Grand Lake, as fishing and recreation resources.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   The Peoria Tribe Environmental Department regularly takes water samples from Spring River, Tar Creek and other tributaries in our tribal jurisdiction. We have also taken extensive pore water samples this past year on Spring River. The purpose is to determine levels of contaminants in those water sources, and with the pore water sampling, to track the movement of contaminants from the Kansas / Oklahoma state line to Grand Lake. We have also sampled mussel tissue and mussel shells from Spring River to determine heavy metal contamination. Consistently, we have found high levels of zinc concentrations in the water samples, and zinc toxicity in mussel tissue and zinc concentrations in mussel shells.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   No.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   Not always. EPA Dallas Region 6 not always forthcoming with their plans. They do hold monthly stakeholders conference calls which we try to monitor, but because of our work load and schedule we are not always a party to those calls. Sometimes they make adjustments to their activities without informing all the stakeholders. Sometimes they are not transparent in all their activities.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

The Peoria Tribe has written numerous letters concerning issues we have had with Region 6 activities. Sometimes we have received a reply, but more times, have not. Our letters/correspondence/opinions, even tribal needs, seem to be of no concern or value to the EPA Regions.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

One specific contact was of a tribal member whose drinking water well became lead contaminated. The individual had a new well drilled and it too was contaminated. He contacted the Peoria Environmental Department, Wyandotte Environmental Department, Quapaw Environmental Department, and Indian Health Services. The Peoria Environmental Department contacted an EPA official and was told to either get the individual's home on a rural water district, or furnish his household bottled water. The Peoria Environmental Department does not know what actions the other Tribal Environmental Departments took. EPA acknowledged no responsibility / liability or further concern, nor did any further investigation. The individual resided within the Peoria Tribal jurisdiction, but was a member of a different tribe. The location of his dwelling is near the northeast Oklahoma / Missouri State line, and south west of the Newton / Jasper Counties, MO. Superfund site and remediation activities. Remediation actions there consisted of filling open, water filled pit mines and subsidences. Those features were in direct connection with the Boone Aquifer which flows toward the southwest, into Oklahoma.

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

The Peoria Environmental Department suggestion:
Instead of hauling chat to repositories or underground dumping, start paving all roads from the OU4 site outward. Chat can safely be encapsulated in pavement and roadbeds. Using the existing chat in pavement would (1) eliminated the aboveground chat in a safe method; (2) provide work for paving crews which would in turn help the economic situation in the poorer Ottawa County; (3) lessen the cost of road building, because nearby building material would be cheaper and wouldn't have to be hauled so far; (4) increase the land values adjacent to paved roads; (5) protect the ground water because no more contaminants are being dumped into it, and there would be no more leachate from chat piles ; (6) improve ground water quality, because the recharge of the aquifer would serve to dilute the existing contamination.

Southwest Missouri is seeking a water supply source for the city of Joplin, MO. and other communities in the area. If a viable and economical means of removing heavy metal contaminants from the existing mine pool in the Picher area, a water treatment facility

could pump water from that existing mine pool, treat the water, and pipeline it to the Joplin area. This would not only supply water to the Southwest Missouri area, but as water was pumped from the mine pool, natural recharge would serve to dilute the contamination therein, thereby consistently reducing the contaminant load of the extracted water, and the cost associated with the water treatment. Building a pipeline, water treatment plant, and operating and maintaining the infrastructure would also provide employment and boost the economic situation in Northeastern Oklahoma.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Heather Webb	**Title: Environmental Director**	**Organization: Miami Tribe of OK**
Email: hwebb@miamination.com	**Phone: 918-541-1373**	**Address: PO Box 1326 Miami, OK 74355**

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   I have been employed in the Miami Tribe Environmental Department since August 2011. The Tar Creek Superfund Site is directly east of our tribal jurisdictional lands. Since I've started, there has been little or no communication with EPA regarding the site, except for a few meetings with Ursula Lennox. We had to invite ourselves to participate on the OU4 conference calls in December and January. So I have had to play a lot of catch-up. BUT, still glad we are now being included in the informational calls. Hopefully, I will be able to give an impression on the 6th Five-year review.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   The only thing I am extremely concerned with is the water coming from the repository that eventually flows into Tar Creek. Hopefully this will be addressed and fixed soon. We are trying to keep the contamination out of the creeks, not make it worse via route of the solution. Any contamination in the creeks is going to affect the community and the communities that have waterways south that TAR Creek flows into.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   We speak for our tribal communities. They know about the Superfund site but chose to ignore the effects. We are their voice and hopefully our concerns are being addressed as

the overall communities concerns. They don't have the background and environmental education so they leave those priorities to the department to address.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   We had one meeting with Ursula a while back and she went over some of what they were doing. But that was before the Quapaw tribe was involved in the remediation. The other tribes wanted information so she scheduled a meeting with all of us in a trailer close to the site. Since then, we invited ourselves to be on the OU4 conference calls. We had to invite ourselves because Ursula didn't seem to want us involved.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   No.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   Well no. It's EPA's idea that the contamination doesn't exist outside the superfund site, so the neighboring tribes have not been involved in information sharing about the site. This needs to change. Just being able to be in on the OU4 conference calls would be a great way for us to keep informed.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   None at this time. Besides doing something about the water coming from the repository.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   We have not heard about anything.

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

   Fix the water from the repository. Include downstream tribes in information sharing calls.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Suzanne Dunn	**Title:** Biologist	**Organization:** USFWS
Email: Suzanne_dunn@fws.gov	**Phone: 918.382.4521**	**Address:** 9014 E 21st Street Tulsa, OK 74129

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five-year review period (September 2010)?**

   The first thing that comes to mind is that EPA should do the cleanup in an orderly manner. The cleanup of properties should start near the OK/KS boarder and progress south from there, or some other logical progression. I understand the need to work with landowners to gain access; however, my impression is that if a landowner won't grant EPA access, then that property is "skipped". This leaves an island of contamination that exposes wildlife to risk and can re-contaminate other areas that have been cleaned up.

   In addition, EPA has reduced sampling efforts so they won't detect where the contaminants have come to be located. The transition zones around the chat piles are known to extend out a great distance, up to 600 ft. in some areas and on average 164 ft. in pasture and 175 ft. in wooded areas (FWS 2013). Reduced sampling efforts during the removal phase are irresponsible and allows for potentially high levels of contamination to be left on site.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   I do not live in the community directly impacted by the site, but I work with many who do live in the area. Comments about reduced home values and reduced use of the natural resources have been discussed.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   The majority of the complaints I heard were related to OU2 clean up around the homes. In general, people seem content with the OU4 administration on site with some complaints about the heavy trucks on roads and fugitive dust.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

   Yes, the FWS has conducted numerous studies at the site. The final reports are located at http://www.fws.gov/southwest/es/oklahoma/nrdar.htm

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five-year review period (September 2010)? If so, please give details.**

   No

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five-year review period (September 2010)?**

   Yes, EPA and ODEQ have provided progress reports at meetings and via phone and/or e-mail whenever asked.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   I suggest that EPA Region 6 work closely with EPA Region 7. I have been told that the two regions are working together; however, it is not apparent given the progress at the Treece site and the lack of progress immediately across the state line at the Tar Creek site. This is also true for the current and future work for OU5. Region 7 is on schedule to have a ROD for sediments by 2015. Region 6 will not confirm if they will adopt Region 7s ROD or if they are going to do their own. If Region 6 does their own ROD, this would waste taxpayer funds and possibly result in different clean up levels between the Regions.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   No

9. Do you have any comments, suggestions, or recommendations regarding the site?

I reiterate my comment from question 7. EPA Regions 6 and 7 should work in tandem with each other to have a uniform cleanup and reduce costs.

INTERVIEW RECORD		
Site Name: Tar Creek Superfund Site		**EPA ID #** OKD980629844
Location: Ottawa County, OK		**Date:**
Contact Made By:		
Name: Brian Stanila	**Title:** EPS III	**Organization:** ODEQ
Email: brian.stanila@deq.ok.gov	**Phone:** (405) 702-5138	**Address:** 707 N. Robinson, Oklahoma City, OK, 73101
Individual Contacted:		
Name: Ramie Tirres	**Title:** Program Grant consultant	**Organization:** Ottawa County Health Department
Email: remedios@health.ok.gov	**Phone:** 918-540-2481 ext.210	**Address:** 1930 N. Elm Street Miami, OK 74354

QUESTIONS

1. **What is your overall impression of the work conducted on site since the conclusion of the fourth five year review period (September 2010)?**

   The work done has reduced the blood lead levels of children in Ottawa County. Remediation of residential properties, community education and screening has had a great impact in the community. There is still much more work to be done to continue to bring the children's blood lead levels down.

2. **From your perspective, what effects have site operations had on the surrounding community?**

   Positive effect. Children's blood lead levels have dropped. People in the area have increased knowledge of the lead problems through education, health fairs and screening. The community is very much concerned regarding soil contamination (health impact in planting a garden) and also the consumption of fish due the amount of lead levels.

3. **Are you aware of any community concerns regarding the site or its operation and administration? If so, please give details.**

   The community is still very much concerned with soil contamination, lead poisoning and in some cases increased lead levels in young children.

4. **Have there been routine communications or activities (site visits, inspections, reporting, etc.) conducted by your office regarding the site? In general, please describe the purpose and results.**

Ottawa County Health Department has conducted ongoing community lead poisoning prevention health educational activities, childhood lead poisoning prevention education and blood screening activities and follow-up case management and monitoring of children with elevated blood lead levels.

5. **Are you aware of any events, incidents, or activities at the site that has required emergency responses from your office since the conclusion of the last five year review period (September 2010)? If so, please give details.**

   The town of Quapaw was hit by a tornado in 2014. Ottawa County Health Department sent our Medical Emergency Response team.

6. **Do you feel well informed about the site's activities and progress since the conclusion of the fourth five year review period (September 2010)?**

   The yearly Tar Creek Conference is very informative as well as some newspaper articles.

7. **Do you have any comments, suggestions, or recommendations regarding the site's management and operation?**

   The Last Chance Yard Cleanup offered to the community by EPA has encouraged our local residents to participate. This effort needs to be continued so more of our community can participate in order to bring the children's blood lead levels down as well as to continue educating and bringing awareness to our community of the lead problem.

8. **Have there been any complaints, violations, or other incidents related to the site requiring a response by your office? If so, please give details of the events and results of the responses.**

   A child was tested for lead at the Health Dept. and the result was high. Parents were very much concerned. With the help of LEAD Agency, Inc., a home visit was made to check for lead in the paint. DEQ came out to check the yard and water. The home was an older home and has been repainted so no lead was detected inside.

9. **Do you have any comments, suggestions, or recommendations regarding the site?**

   It would be good to continue blood lead screening and monitoring children with elevated blood lead levels. Continuing community outreach and education is important to keep the blood levels of children down.

Appendix E: Site Inspection Checklist

I. FIVE-YEAR REVIEW SITE INSPECTION CHECKLIST	
Site Name: Tar Creek Superfund Site	**Date of Inspection:** January 14-16, 2015
Location and Region: Ottawa County, Oklahoma (Region 6)	**EPA ID:** OKD980629844
Agency leading the five-year review: Oklahoma Department of Environmental Quality (ODEQ)	**Weather/temperature:** TBD

Remedy Includes: (Check all that apply)

- ☒ Landfill cover/containment
- ☒ Access controls
- ☒ Institutional controls
- ☐ Groundwater pump-and-treatment
- ☒ Surface water collection and treatment
- ☒ Other- ground water monitoring, surface water diversion, excavation and relocation

Attachments: ☒ Inspection team roster attached ☒ Site map attached to report

II. INTERVIEWS (Check all that apply)

2. O&M

Interviewed: ☒ by e-mail ☐ at office ☐ by phone Email.

Problems, suggestions: ☒ Reports attached in Attachment 3

3. Local regulatory authorities and response agencies (i.e.; State and Tribal offices, emergency response office, police department, office of public health or environmental health, zoning office, recorder of deeds, or other city and county offices, etc.). Fill in all that apply.

Agency: Oklahoma Department of Environmental Quality

Contact: Dennis Datin and David Cates

☒ Reports attached in Attachment X

Agency: Environmental Protection Agency

Contact: Bob Sullivan, Rafael Casanova, and Katrina Coltrain

☒ Reports attached in Attachment X

Agency: Members of Oklahoma Trustee Council

☒ Reports attached in Attachment X

4. Other interviews (optional):

Rebecca Jim (LEAD Agency)

III. ON-SITE DOCUMENTS & RECORDS VERIFIED (Check all that apply)

1. O&M Documents

☐ O&M manual (long term monitoring plan)	☐ Readily available	☐ Up to date	☒ N/A
☐ As-built drawings	☐ Readily available	☐ Up to date	☒ N/A
☐ Maintenance logs	☐ Readily available	☐ Up to date	☒ N/A

Remarks: There are no on-site facilities and therefore no records are maintained at the Site. Records documents are maintained at EPA and ODEQ.

2. Site-Specific Health and Safety Plan	☐ Readily available	☒ Up to date	☐ N/A
☐ Contingency plan/emergency response plan	☐ Readily available	☒ Up to date	☐ N/A

Remarks: All projects operate under general health and safety plans.

3. O&M and OSHA Training Records	☐ Readily available	☐ Up to date	☒ N/A

Remarks:_____

4. Permits and Service Agreements

☐ Air discharge permit	☐ Readily available	☐ Up to date	☒ N/A
☐ Effluent discharge	☐ Readily available	☐ Up to date	☒ N/A
☐ Waste disposal, POTW	☐ Readily available	☐ Up to date	☒ N/A
☐ Other permits _____	☐ Readily available	☐ Up to date	☒ N/A

Remarks:_____

5. Gas Generation Records ☐ Readily available ☐ Up to date ☒ N/A

6. Settlement Monument Records	☐ Readily available	☐ Up to date	☒ N/A
7. Groundwater Monitoring Records	☒ Readily available	☒ Up to date	☐ N/A

There are five After Action Monitoring Reports that document annual Roubidoux sampling events.

8. Leachate Extraction Records	☐ Readily available	☐ Up to date	☒ N/A

9. Discharge Compliance Records

☐ Air ☐ Readily available ☐ Up to date ☒ N/A

☐ Water (effluent) ☐ Readily available ☐ Up to date ☒ N/A

Remarks:

10. Daily Access/Security Logs ☐ Readily available ☐ Up to date ☒ N/A

IV. O&M COSTS

1. O&M Organization

☐ State in-house ☐ Contractor for State ☐ PRP in-house

☐ Contractor for PRP ☒ Other: Memorandum of Agreement between EPA and ODEQ

2. O&M Cost Records –

☐ Readily available ☐ Up to date ☐ Funding mechanism/agreement in place

☐ Original O&M cost estimate____ ☒Breakdown attached

Total annual State cost by year for OU1 O&M

Date	Date	Total Cost	
From 2009	to 2010	$0	- ☐ Breakdown attached
From 2010	to 2011	$0	- ☐ Breakdown attached
From 2011	to 2012	$0	- ☐ Breakdown attached
From 2012	to 2013	$1,157.68	☐ Breakdown attached
From 2013	to 2014	$64.32	☐ Breakdown attached

3. Unanticipated or Unusually High O&M Costs During Review Period

None

V. ACCESS AND INSTITUTIONAL CONTROLS ☒ Applicable ☐ N/A

A. Fencing

1. Fencing damaged ☐ Location shown on site map ☐ Gates secured ☒ N/A

Remarks: CMR gates secured

B. Other Access Restrictions

1. Signs and other security measures ☐ Location shown on site map ☒ N/A

Remarks: CMR signs posted

C. Institutional Controls

1. Implementation and enforcement

Site conditions imply institutional controls not properly implemented	☐ Yes	☐ No	☒ N/A
Site conditions imply institutional controls not being fully enforced	☐ Yes	☐ No	☒ N/A

There are deed notices placed on LICRAT buyout homes and contaminated soil repositories.

Type of monitoring (e.g., self-reporting, drive by): General site visits

Frequency: multiple times per year

Responsible party/agency: EPA/ODEQ

Contact: not applicable

Reporting is up-to-date	☐ Yes	☐ No	☒ N/A
Reports are verified by the lead agency	☐ Yes	☐ No	☒ N/A
Specific requirements in deed or decision documents have been met	☒ Yes	☐ No	☐ N/A
Violations have been reported	☐ Yes	☐ No	☒ N/A

Other problems or suggestions: ☐ Report attached

2. Adequacy ☒ Institutional controls are adequate ☐ Institutional controls are inadequate ☐ N/A

Remarks:

D. General

1. Vandalism/trespassing ☐ Location shown on site map ☐ No vandalism evident

Remarks: While vandalism related to the Site remedy is generally not present, nuisance behavior persists. This behavior includes illegal dumping and trespassing onto chat piles and remediated areas. For example, it is clear that the use of ATV vehicles is present on a filled subsidence in Hockerville.

2. Land use changes on-site ☐ N/A ☒ Land use changes evident

Remarks: Most land use on the Site is rural-residential and agricultural. However, there are mixed areas of residential/commercial. Land use has changed at the Site due to removal and remedial activities. Below is a brief summary of general land use change at the Site.

The LICRAT has voluntarily relocated all of the residents of Picher, OK, and Treece, KS. Homes of former residents have been demolished and disposed. Treece, KS was purchased by the Quapaw Tribe in 2013. Intended land use is agricultural.

Chat piles and contaminated soils were removed from rural-residential properties. Remediated properties were vegetated and have agricultural use. Contaminated soils and chat were placed in repositories constructed from subsidence holes, old mill ponds, and chat bases. Repositories have limited agricultural use and have deed notices filed on them.

3. Land use changes off-site ☒ N/A
Remarks:

VI. GENERAL SITE CONDITIONS

A. Roads ☒ Applicable ☐ N/A

Roads damaged ☐ Location shown on site map ☒ Roads adequate ☐ N/A
Remarks: Roads are publicly owned and maintained.

B. Other Site Conditions ☒ Applicable ☐ N/A

Remarks:
OU2 Repository (Adams) – Fenced and behind locked gate. Good vegetative growth present on site.

OU2 Repository (Stateline) – Fenced and behind locked gate. Good vegetative growth. Owned by Quapaw Tribe.

OU4 Repository- Fenced and behind locked gate. No final cap established and no vegetative growth.

VII. LANDFILL COVERS ☐ Applicable ☒ N/A

A. Landfill Surface

1. Settlement (Low spots) ☐ Location shown on site map ☐ Settlement not evident
Areal extent _____ Depth _____
Remarks:

2. Cracks ☐ Location shown on site map ☐ Cracking not evident
Lengths _____ Widths _____ Depths _____
Remarks:

3. Erosion ☐ Location shown on site map ☐ Erosion not evident
Areal extent _____ Depth _____
Remarks:

4. Holes ☐ Holes evident ☐ Holes not evident
Areal extent _____ Depth _____
Remarks:____

5. Vegetative Cover ☐ Grass ☐ Cover properly established ☐ No signs of stress
☐ Trees/Shrubs (indicate size and locations on a diagram)
Remarks:

6. Alternative Cover (armored rock, concrete, etc.) ☐ N/A
Remarks: _____

7. Bulges ☐ Location shown on site map ☐ Bulges not evident
Areal extent _____ Depth _____
Remarks: _____

8. Wet Areas/Water Damage ☐ Wet areas/water damage not evident

☐ Wet areas	☐ Location shown on site map	☐ Areal extent _____
☐ Ponding	☐ Location shown on site map	☐ Areal extent _____
☐ Seeps	☐ Location shown on site map	☐ Areal extent _____
☐ Soft subgrade	☐ Location shown on site map	☐ Areal extent _____

Remarks:_____

9. Slope Instability ☐ Slides ☐ Location shown on site map
☐ No evidence of slope instability Areal extent _____
Remarks:_____

B. Benches ☐ Applicable ☐ N/A
(Horizontally constructed mounds of earth placed across a steep landfill side slope to interrupt the slope in order to slow down the velocity of surface runoff and intercept and convey the runoff to a lined channel.)

1. Flows Bypass Bench ☐ Location shown on site map ☐ N/A or okay
Remarks: _____

2. Bench Breached ☐ Location shown on site map ☐ N/A or okay
Remarks: _____

3. **Bench Overtopped** ☐ Location shown on site map ☐ N/A or okay
Remarks: _____

C. **Letdown Channels** ☐ Applicable ☐ N/A

1. **Settlement** ☐ Location shown on site map ☐ No evidence of settlement
Remarks: _____

2. **Material Degradation** ☐ Location shown on site map ☐ No evidence of degradation
Material type _____ Areal extent _____
Remarks:

3. **Erosion** ☐ Location shown on site map ☐ No evidence of erosion
Areal extent _____ Depth _____
Remarks: _____

4. **Undercutting** ☐ Location shown on site map ☐ No evidence of undercutting
Areal extent _____ Depth _____
Remarks:

5. **Obstructions** Type _____
☐ No obstructions ☐ Location shown on site map
Areal extent _____ Size _____
Remarks:

6. **Excessive Vegetative Growth** Type _____
☐ No evidence of excessive growth ☐ Vegetation in channels does not obstruct flow
☐ Location shown on site map Areal extent _____
Remarks: _____

D. **Cover Penetrations** ☐ Applicable ☐ N/A

1. **Gas Vents** ☐ Active ☐ Passive
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
Remarks:

2. **Gas Monitoring Probes**
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☒ N/A
Remarks:

3. **Monitoring Wells** (within surface area of landfill)
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A
Remarks: _____

4. Leachate Extraction Wells

☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ Evidence of leakage at penetration ☐ Needs O&M ☐ N/A

Remarks: _____

5. Settlement Monuments ☐ Located ☐ Routinely surveyed ☐ N/A

Remarks: _____

E. Gas Collection and Treatment ☐ Applicable ☐ N/A

1. Gas Treatment Facilities

☐ Flaring ☐ Thermal destruction ☐ Collection for reuse
☐ Good condition ☐ Needs O&M

Remarks: _____

2. Gas Collection Wells, Manifolds, and Piping ☐ Good condition ☐ Needs O&M

Remarks: _____

3. Gas Monitoring Facilities (e.g., gas monitoring of adjacent homes or buildings)

☐ Good condition ☐ Needs O&M ☐ N/A

Remarks: _____

F. Cover Drainage Layer ☐ Applicable ☐ N/A

1. Outlet Pipes Inspected ☐ Functioning ☐ N/A

Remarks: _____

2. Outlet Rock Inspected ☐ Functioning ☐ N/A

Remarks: _____

G. Detention/Sedimentation Ponds ☐ Applicable ☐ N/A

1. Siltation Areal extent _____ Size _____

☐ N/A ☐ Siltation not evident

Remarks: _____

2. Erosion Areal extent _____ Depth _____

☐ Erosion not evident

Remarks: _____

3. Outlet Works ☐ Functioning ☐ N/A

Remarks: _____

4. Dam ☐ Functioning ☐ N/A
Remarks: _____

H. Retaining Walls ☐ Applicable ☐ N/A

1. Deformations ☐ Location shown on site map ☐ Deformation not evident
Horizontal displacement _____ Vertical displacement _____
Rotational displacement _____
Remarks:

2. Degradation ☐ Location shown on site map ☐ Degradation not evident
Remarks:

I. Perimeter Ditches/Off-Site Discharge ☐ Applicable ☐ N/A

1. Siltation ☐ Location shown on site map ☐ Siltation not evident
Areal extent _____ Depth _____
Remarks: _____

2. Vegetative Growth ☐ Location shown on site map ☐ N/A
☐ Vegetation does not impede flow
Areal extent _____ Type _____
Remarks: _____

3. Erosion ☐ Location shown on site map ☐ Erosion not evident
Areal extent _____ Depth _____
Remarks:

4. Discharge Structure ☐ Functioning ☐ N/A
Remarks: _____

VIII. VERTICAL BARRIER WALLS ☐ Applicable ☒ N/A

1. Settlement ☐ Location shown on site map ☐ Settlement not evident
Areal extent _____ Depth _____
Remarks:

2. Performance Monitoring Type of monitoring _____
☐ Performance not monitored Frequency _____ ☐ Evidence of breaching
Head differential _____
Remarks: _____

IX. GROUNDWATER/SURFACE WATER REMEDIES ☒ Applicable ☐ N/A

A. Groundwater Extraction Wells, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Pumps, Wellhead Plumbing, and Electrical

☒ Good condition ☐ All required wells located ☐ Needs O&M ☐ N/A

Remarks: Groundwater/ Surface water remedy at the Site is the Meyer Ranch Passive Treatment System (PTS). The PTS consists of an initial oxidation pond and then a series of wetland/surface flow ponds, vertical flow bio-reactors, re-aeration ponds, horizontal flow limestone beds, and a polishing pond/wetland. The goal of the PTS is to eliminate heavy metal contamination from the groundwater discharges to surface water. The PTS has successfully done this at a low cost.

Flow into the oxidation pond is artesian. Wind and solar power are used in re-aeration ponds.

2. Extraction System Pipelines, Valves, Valve Boxes, and Other Appurtenances

☒ Good condition ☐ Needs O&M

Remarks: _____

3. Spare Parts and Equipment

☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: _____

B. Surface Water Collection Structures, Pumps, and Pipelines ☒ Applicable ☐ N/A

1. Collection Structures, Pumps, and Electrical

☒ Good condition ☐ Needs O&M

Remarks: Series of wetland/surface flow ponds, re-aeration ponds, and vertical flow bio-reactors are present as part of the surface water treatment train.

2. Surface Water Collection System Pipelines, Valves, Valve Boxes, and Other Appurtenances

☒ Good condition ☐ Needs O&M

Remarks: Presumed to be in good condition but are not visible.

3. Spare Parts and Equipment

☒ Readily available ☒ Good condition ☐ Requires upgrade ☐ Needs to be provided

Remarks: Operations agreement with City of Commerce. PTS is regularly inspected by Commerce.

C. Treatment System ☒ **Applicable** ☐ **N/A**

1. Treatment Train (Check components that apply)

☒ **Metals removal** ☐ **Oil/water separation** ☒ **Bioremediation**

☐ **Air stripping** ☐ **Carbon absorbers**

☐ **Filters**

☒ **Additive (e.g., chelation agent, flocculent) pH management**

☒ **Others** **Passive aeration system**

☒ **Good condition** ☐ **Needs O&M**

☒ **Sampling ports properly marked and functional**

☐ **Sampling/maintenance log displayed and up to date**

☐ **Equipment properly identified**
☐ **Quantity of groundwater treated annually**
☐ **Quantity of surface water treated annually**

Remarks: Metals removal occurs in oxidation pond, vertical flow bio-reactors, re-aeration ponds, and limestone beds. Additive occurs vertical flow bio-reactors.

2. Electrical Enclosures and Panels (Properly rated and functional)
☐ **N/A** ☒ **Good condition** ☐ **Needs O&M**

Remarks: Most electrical equipment run by solar panels and windmill.

3. Tanks, Vaults, Storage Vessels
☐ **N/A** ☒ **Good condition** ☒ **Proper secondary containment** ☐ **Needs O&M**

Remarks:

4. Discharge Structure and Appurtenances
☐ N/A ☒ Good condition ☐ Needs O&M

Remarks: Outflow pipe from wetland pond. Approximately 8" in diameter.

5. Treatment Building(s)
☒ N/A ☐ Good condition (esp. roof and doorways) ☐ Needs repair
☐ Chemicals and equipment properly stored

Remarks:

6. Monitoring Wells (Pump-and-treatment remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs O&M ☒ N/A

Remarks:

D. Monitored Natural Attenuation ☐ Applicable ☒ N/A

1. Monitoring Wells (Natural attenuation remedy)
☐ Properly secured/locked ☐ Functioning ☐ Routinely sampled ☐ Good condition
☐ All required wells located ☐ Needs O&M ☐ N/A

Remarks:

X. OTHER REMEDIES

If there are remedies applied at the site that are not covered above, attach an inspection sheet describing the physical nature and condition of any facility associated with the remedy. An example would be soil vapor extraction.

OU1

The OU1 ROD described three remedy elements; (1) Plug abandoned wells completed in the Roubidoux aquifer, (2) construct surface water diversion and diking structures around three major inflow areas to prevent surface water inflow into the abandoned mines, and (3) implement a surface water and groundwater monitoring program to assess the Roubidoux aquifer. The OU1 remedy included construction of three surface water diversion structures and channel improvements to route surface water flow around collapse features. Two such features are located in Treece, Kansas, Cherokee County Superfund Site (EPA Region 7). The other is located in Oklahoma near the Douthat Bridge on E40 Road. At the Douthat Bridge Site, the Remedy included building diversion structures for surface water and plugging abandoned wells completed in the Roubidoux. The diversion dike prevents Lytle Creek from entering nearby subsidences and the channel re-routes Lytle Creek to an upper reach of Tar Creek. The Roubidoux Groundwater Monitoring Program has sampled approximately 13 wells completed in the Roubidoux aquifer and the results of which are documented in After Action Monitoring Reports (2010-2013).

OU2

The OU2 ROD addresses soils in residential yards and high activity areas (HAAs) contaminated with lead. Contaminated soils from residential yards and HAAs were deposited at two repositories

OU4

The OU4 remedy addresses the chat piles, chat bases, tailings ponds, in-stream and near-stream chat, rural residences not addressed under OU2, smelter wastes, and transition zone soils near source materials and smelter wastes. The remedial action is planned to occur over the next 30 years. In addition, LICRAT and TRA have voluntarily bought out impacted residents of Picher, Cardin, and Hockerville, OK, and Treece, KS. The goal of the program is to remove people from the site and thereby reduce the risk from exposure to site-related contaminants.

XI. OVERALL OBSERVATIONS

A. Implementation of the Remedy

Describe issues and observations relating to whether the remedy is effective and functioning as designed. Begin with a brief statement of what the remedy is to accomplish (i.e., to contain contaminant plume, minimize infiltration and gas emission, etc.).

OU1

The OU1 ROD described three remedy elements; (1) Plug abandoned wells completed in the Roubidoux aquifer, (2) construct surface water diversion and diking structures around three major inflow areas to prevent surface water inflow into the abandoned mines, and (3) implement a surface water and groundwater monitoring program to assess the Roubidoux aquifer. The Douthat Bridge Site was visited during the Site Inspection. The stream channel improvements that divert Lytle Creek to an upper reach of Tar Creek appeared to be functioning as designed. There were no signs that the stream was eroding the channel. Rip-rap was present along the cut-banks of the channel. The dike was in good condition and there was no evidence of erosion, slides, burrows, or sloughing. Five wells (Tulsa Mine, Powerhouse well, Quapaw #5, Quapaw #2, and Picher #5) that enter the Roubidoux aquifer were visited during the Site Inspection. Tulsa Mine and Powerhouse well are scheduled to be plugged in January 2015. Plugging these wells is imperative to protect the Roubidoux aquifer from Boone aquifer contamination. The three additional wells are municipal water supply wells. After action monitoring documents that Quapaw #5 exceeds indicator parameter criteria for determining impacted wells. Quapaw #2 is a backup well for Quapaw and while it does not exceed MCLs it has shown historical exceedances of indicator parameters and has a connection to the Roubidoux. ODEQ would like to plug these two wells sometime in the future, but clearly would have to get approval from the City of Quapaw. The Roubidoux Groundwater Monitoring Program has sampled approximately 13 wells completed in the Roubidoux aquifer and the results of which are documented in After Action Monitoring Reports (2010-2013).

OU2

The OU2 ROD addresses soils in residential yards and high activity areas (HAAs) contaminated with lead. Contaminated soils from residential yards and HAAs were deposited at two repositories. Both OU2 repositories were secured by a locked gate and barbed wire fence. Although the Site Inspection occurred during winter, it was apparent that the repositories are well vegetated. Remediation of residential yards for OU2 is completed in the towns of Afton, Cardin, Commerce, Fairland, Miami, Narcissa, North Miami, Peoria, Picher, Quapaw, and Wyandotte. Drive-by inspections of remediated properties were conducted in Quapaw, Commerce, and Miami. Remediated properties included yards, driveways, and alleyways. Yards that were inspected appeared to be in good condition and had vegetation. Driveways and alleyways that were inspected also appeared in good condition and were easily identified from the presence of fresh limestone. Existing data on blood lead levels in children at the site have demonstrated that the OU2 remediation has been effective.

OU4

The OU4 ROD addresses source materials, smelter wastes, rural residential yard contamination, transition zone soil contamination, and contamination in water drawn from rural residential wells. The voluntary buyout being conducted under OU4 was completed in 2011. Residents of Picher, Cardin and Hockerville, OK and Treece, KS were relocated through the LICRAT and TRA programs. The final house demolition from the LICRAT buyout was completed in 2014. Source material from rural residential yard cleanups were placed in the OU4 repository located on E 40 Rd. The OU4 repository was visited during the site inspection. The OU4 repository was behind a locked gate and fence. Chat washing/sale operations (Sooner Pile and Atlas Pile) were visited during the site inspection. Several distal properties were visited during the site inspection. Remedial action was

occurring during the site inspection at distal 8 (Catholic 40) and distal 6A. During the site inspection, source material was still being hauled from distal 6A to a subsidence on 605 Rd. Distal 8 was being seeded during the site inspection. Distal 6 (CP104), Distal 7 North, and Distal 1 North were visited. Distal 6 and Distal 1 North had good vegetative growth present. However, Distal 7 North had sparse vegetation and according to the Quapaw Tribe source material was left near the stream that runs through the property. The 605 subsidence that is acting as the repository for Distal 6A and Distal 8 were visited during the site inspection. At the time of the inspection, 72,000 tons had been placed into the repository. The county owned Hockerville subsidence was visited and has the potential of for accepting source material from other distal properties. A former subsidence filled with construction and demolition waste was visited. This repository had obvious cap settling and it was clear that ATV's had been driving over the repository cap. Additional soil needs to be placed on the settling cap.

B. Adequacy of O&M

OU1

The only O&M procedures involve inspections and maintenance of the diversion dikes at Douthat Bridge. O&M at this location is conducted by the ODEQ and are documented in an O&M Report. Based on the Site Inspection and recent O&M inspection, the O&M at the Admiralty site is adequate.

Groundwater monitoring is being conducted as part of the Long-Term Monitoring program. This monitoring is related to the protection of the drinking water supply at the site. Monitoring of the groundwater used as the primary drinking water supply at the site shows no exceedances of primary drinking water standards (health-based standards). Exceedances of secondary (non-health based) standards do occur in some wells.

OU2

Yards, driveways, alleyways, and HAAs where remedial activities have taken place all appear to be in good condition and are well maintained. Approximately 19 properties may still need to be assessed. EPA has transferred the site lead of this remedial action to ODEQ.

OU4

Remedy is on-going. O&M is not applicable at this point.

C. Early Indicators of Potential Remedy Failure

It is imperative that the Roubidoux aquifer remain protected from the Boone aquifer. To continue these efforts additional wells may need plugging. ODEQ should work to continue to identify well and mine shafts that may allow connection between the Boone and Roubidoux aquifers. Those that are identified need to be plugged.

D. Opportunities for Optimization

Opportunities for optimization have been outlined in the OU4 Optimization Report.

INSPECTION TEAM ROSTER

Name	Organization	Title
Brian Stanila	ODEQ	Environmental Programs Specialist
David Cates	ODEQ	Professional Engineer/Project Manager
Amy Brittain	ODEQ	Environmental Programs Manager
Rafael Casanova	EPA	Remedial Project Manager

Appendix F: Site Inspection Photographs

Photo 1: Mayer Ranch Passive Treatment System (MRPTS) Oxidation Pond

Photo 2: MRPTS Outflow into Oxidation Pond

Photo 3: MRPTS Surface Flow Wetland Pond

Photo 4: MRPTS Wind- and Solar-powered Machinery

Photo 5: MRPTS Re-aeration Pond

Photo 6: MRPTS Horizontal-flow Limestone Bed

Photo 7: MRPTS Polishing Basin

Photo 8: Outflow of Polishing Basin from MRPTS

Photo 9: Southeast Commerce Soil Remediation Project

Photo 10: Vegetative Cover on South Repository; Central Mill Repository in Background

Photo 11: Entrance to Central Mill Repository (photo taken from top of repository)

Photo 12: Roads on Central Mill Repository

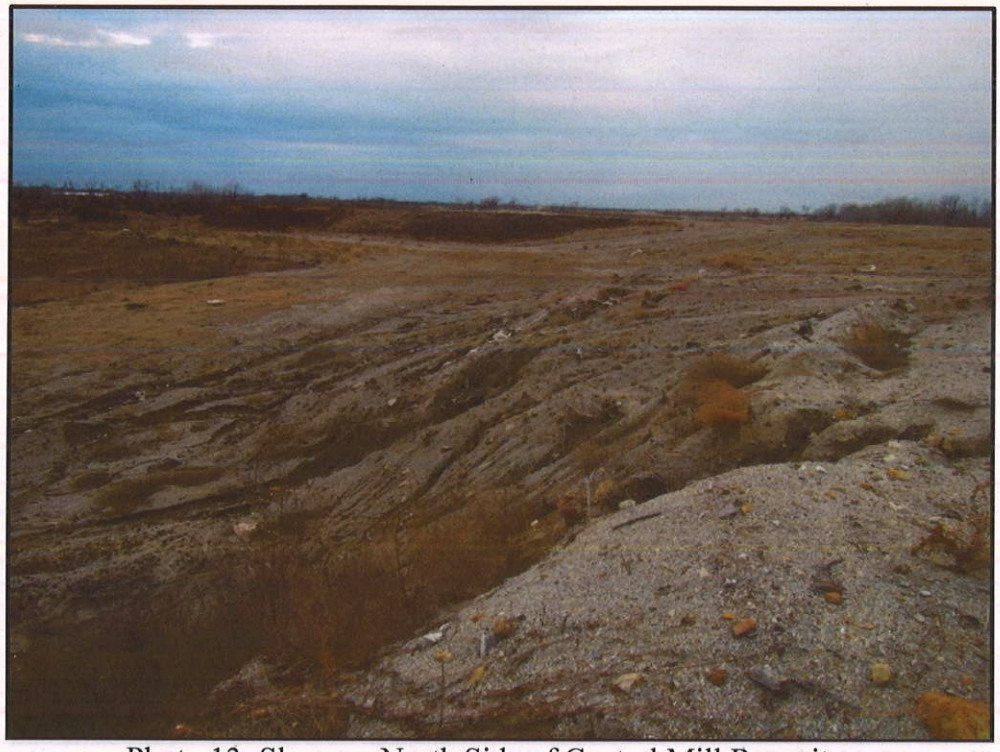

Photo 13: Slope on North Side of Central Mill Repository

Photo 14: Collapsed Rolled Silt Fence on Northern Side of Central Mill Repository

Photo 15: North Slope of Central Mill Repository (photo taken facing south)

Photo 16: Eastern Slope of Central Mill Repository (photo taken facing south)

Photo 17: Erosion of Northeastern Side of Central Mill Repository

Photo 18: Roubidoux Monitoring Well Picher #5

Photo 19: Location of Filled Mine Shaft at Admiralty Mine Site

Photo 20: Portion of Diversion and Dike Structures at Admiralty Mine Site

Photo 21: Rip-rap of Diversion Channel at Admiralty Mine Site

Photo 22: Diversion Channel at Admiralty Mine Site

Photo 23: Confluence of Diversion Channel and Tar Creek

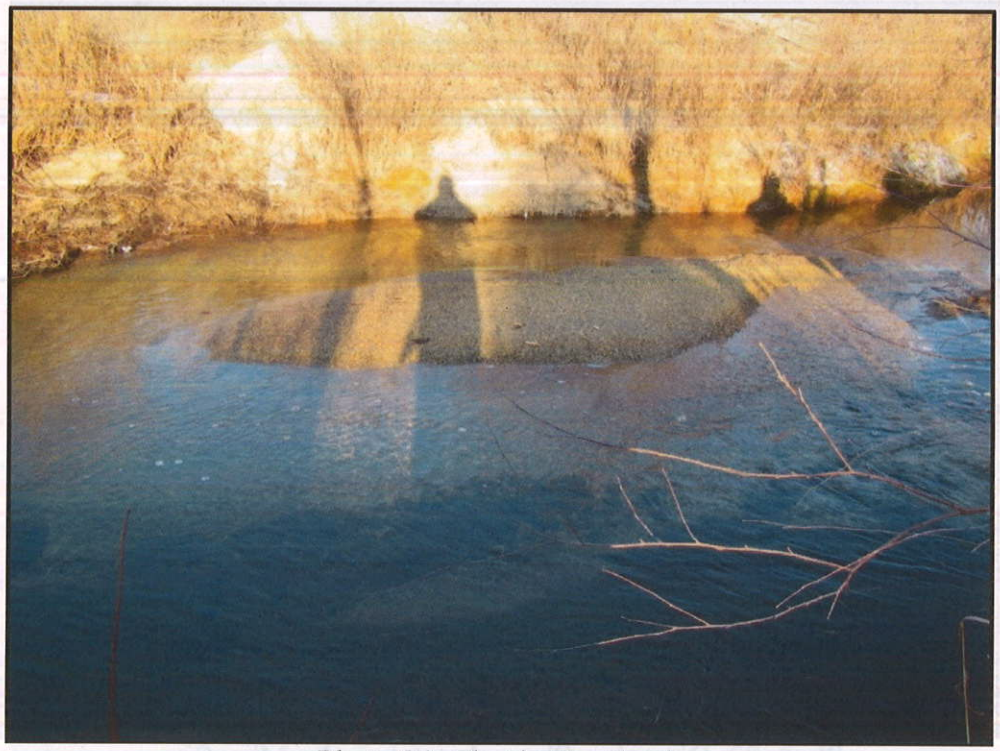

Photo 24: Chat in Tar Creek

Photo 25: Flooded Collapsed Mine Feature at Admiralty Mine Site

Photo 26: Tar Creek at Douthat Bridge (photo taken facing upstream)

Photo 27: Former Lytle Creek at Douthat Bridge (photo taken facing upstream)

Photo 28: Chat in Tar Creek at Douthat Bridge (photo taken facing upstream)

Photo 29: Tar Creek at Douthat Bridge (photo taken facing downstream)

Photo 30: Powerhouse Well in January 2015 (well plugged in February 2015)

Photo 31: Tar Creek at Stateline Road between Oklahoma and Kansas

Photo 32: OU2 Repository Formerly Owned by Picher Development Authority; Property Currently Owned by Quapaw Tribe

Photo 33: OU2 Repository Formerly Owned by Picher Development Authority; Property Currently Owned by Quapaw Tribe

Photo 34: MW-1 at Sooner Pile, Location of Chat Injection Pilot Study

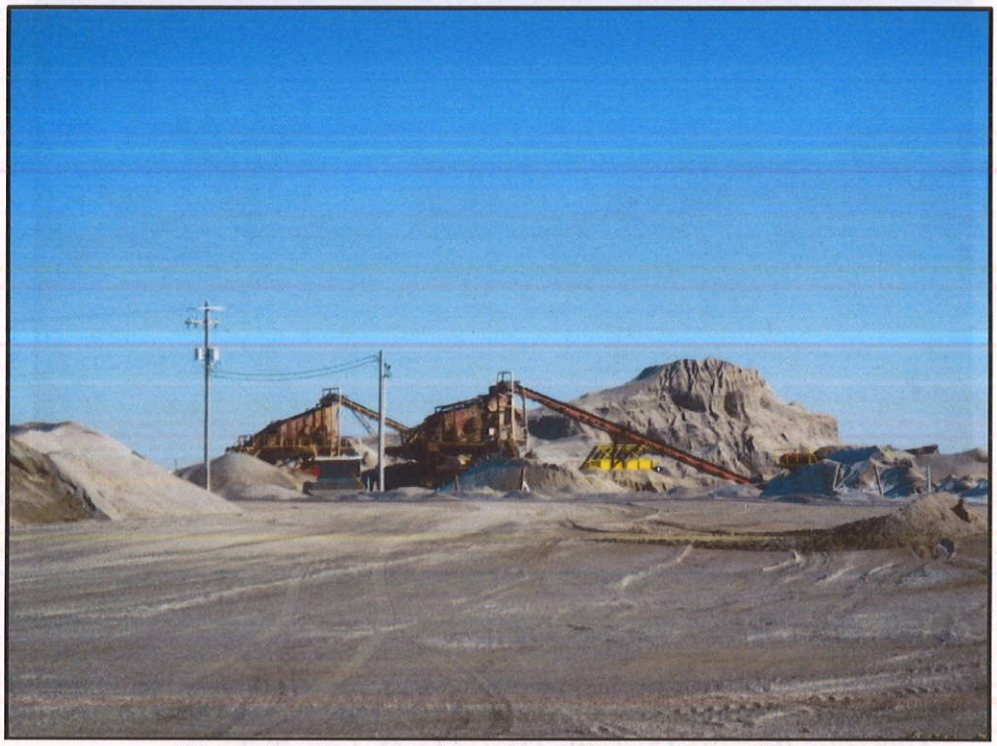

Photo 35: Chat Washing Operation at Sooner Pile

Photo 36: Tulsa Mine Well at Atlas Chat Pile
(well was plugged in February 2015)

Photo 37: Distal 8 Remediation (Catholic 40)

Photo 38: Soil Amendments Placed on Catholic 40 Site

Photo 39: Chat Hauling from Distal 6A

Photo 40: Excavation of Chat from Distal 6A

Photo 41: Catholic 40 Remediation

Photo 42: Soil Amendment Placement on Catholic 40

Photo 43: Distal 6 (CP104) Final Remediation

Photo 44: Distal 7 North; Vegetation Has Yet to Become Established

Photo 45: Distal 1 Final Remediation

Photo 46: "605" Hole

Photo 47: County Subsidence Near 605 Road

Photo 48: Hockerville Subsidence; Settling and Vandalism Present

Photo 49: Hockerville Subsidence; Settling and Vandalism Present

Photo 50: Overview of Picher from Semple Pile

Photo 51: Alleyway Adjacent to Washington Elementary School; No Chat Present

Photo 52: Limestone Alleyway Adjacent to Washington Elementary School

Photo 53: High-access Area, Limestone Church Parking Lot

Photo 54: Driveway Replacement Near Washington Elementary School

Photo 55: Alleyway Near Roosevelt Elementary School

Photo 56: Driveway Near Roosevelt Elementary School

Photo 57: Alleyway Near Roosevelt Elementary School

Photo 58: Alleyway Near Roosevelt Elementary School

Photo 59: Armory Near Riverview Park; Chat Parking Lot has been Replaced with Limestone

Photo 60: Driveway Replacement at 504 5th NE Road

Photo 61: Yard Replacement in Commerce Under OU2

Photo 62: Yard Replacement in Commerce Under OU2

Photo 63: Yard Replacement in Commerce Under OU2

Photo 64: Yard Replacement in Commerce Under OU2

Photo 65: Yard Replacement in Commerce Under OU2