FREEPORT-McMoRan

Sierrita Operations
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August 15, 2019

Electronic Mail and Hand Delivery

Ms. Joey Pace, Project Manager
Arizona Department of Environmental Quality
Voluntary Remediation Program
1110 W. Washington St.
Phoenix, AZ 85007

Re: Voluntary Remediation Program – VRP Site Code: 100073-03
Freeport-McMoRan Sierrita Inc., Green Valley, AZ
Revised Baseline Human Health Risk Assessment (August 2019)

Dear Ms. Pace:

Enclosed you will find the Revised Baseline Human Health Risk Assessment (BHHRA) for Freeport-McMoRan Sierrita Inc. (Sierrita) as part of the Arizona Department of Environmental Quality's (ADEQ's) Voluntary Remediation Program (VRP). This BHHRA was prepared in accordance with the VRP BHHRA Work Plan (Arcadis 2015) approved by ADEQ, and focuses solely on potential impacts associated with exposure to constituents of potential concern (COPCs; site-related constituents) detected in soil and sediment in the following two specific exposure areas (EAs):

- Former Continuous Liquid Extraction and Regeneration (CLEAR) Plant EA, which is composed of the following subareas:
  - Former CLEAR Plant
  - Former E Pond
  - Former Evaporation Pond
  - Old D Pond
- Former Esperanza Mill EA, which is composed of the following subareas:
  - Former Esperanza Mill
  - Former C Pond and C Pond Spoils
  - Former Laydown Yard
  - Former Raffinate Pond.

A revised BHHRA was originally submitted to ADEQ in November 2018. ADEQ provided additional comments in a letter to Sierrita dated March 5, 2019 and titled, *Re: Review of 2018 Revised Baseline Human Health Risk Assessment*, and recommendations in a memo from The Fehling Group, LLC to Joey Pace, ADEQ, dated May 20, 2019 and titled, *Re: Commentary on the Voluntary Remediation Program, Baseline Human Health Risk Assessment. Site Code 100073-03. Sierrita Mine, Green Valley, Arizona. June 7, 2016, Revised November 2018.* Responses to these comments and recommendations were discussed with ADEQ and their consultants during a meeting on March 12, 2019 and a conference call on June 19, 2019. During the March 12, 2019 meeting, all comments from the March 5, 2019 letter were resolved except for a comment about the lack of background data comparisons to support the inclusion or exclusion of radionuclides as COPCs in the BHHRA. The May 20, 2019 memo provided detailed Site and background data evaluations (with which Sierrita generally agrees based on independent data evaluations) and recommendations regarding the use of background radionuclide data in the risk assessment. This revised BHHRA reflects the resolution with regard to the background radionuclide data, which was reached during the June 19, 2019 conference call.

Recommendations for next steps in the May 20, 2019 memo included three options. Option 1 suggested a review of the background laboratory analytical reports be performed to determine why the Ra-226 concentrations are greater than those for uranium isotopes (U-238 and U-234). Sierrita therefore conducted a review of the laboratory analytical methods and data validation reports included in the *Background Soil Assessment Report* (Arcadis 2018) and did not find any issues with the background soil sample analyses. Option 2 suggested a new background study be conducted, while Option 3 recommended a path forward incorporating the existing background soil data in the BHHRA. Option 3 suggested that Sierrita assume the U-238 and U-234 are representative of background conditions, assume the background soil data are in secular equilibrium, ignore the Ra-226 background soil sample results, and use the U-238 and U-234 data as a surrogate for Ra-226 and other radionuclides in the decay series. Sierrita chose to finalize the BHHRA in accordance with Option 3.

Statistical comparisons of the Site and background radionuclide data, as presented in the May 20, 2019 memo, support the inclusion of all sampled radionuclides as COPCs in the BHHRA. Also, in response to ADEQ comments, the contribution of all radionuclides in each naturally-occurring decay series was included in the radiological risk calculations in this revised BHHRA.

Background excess lifetime cancer risks (ELCRs) and noncancer hazard indices (HIs) were estimated to measure the incremental impacts posed by the Site. This was done to provide a comparison of the Site to background and to assist with risk management decisions. Incremental ELCRs/HIs were calculated as the total Site ELCRs/HIs based on mean exposure point concentrations (EPCs) minus background ELCRs/HIs based on mean EPCs. Consistent with Option 3 in the May 20, 2019 memo, the Ra-226 background soil sample results were not used due to the question raised about the laboratory quality of these data. Instead, the U-238 and U-234 results were used as surrogate EPCs for all members of the uranium decay series.

Based on the conclusions of the BHHRA and upon approval of the BHHRA results by the ADEQ, Sierrita intends to request an unconditional No Further Action for the two areas described above.

Please do not hesitate to contact me at (520) 393-2347 if you have any questions regarding this submittal. Thank you for your assistance and cooperation with our efforts to address environmental issues at this Site.

Sincerely,

William Hart

William Hart
Sr. Environmental Specialist
Freeport-McMoRan Sierrita Inc.

Copy:
David Gosen, Freeport-McMoRan Inc.
Katy Brantingham, Arcadis

Enclosure:
Voluntary Remediation Program Baseline Human Health Risk Assessment, Sierrita Mine, Green Valley, Arizona (Revised August 2019)

References:

Arcadis. 2018. Background Soil Assessment Report. Voluntary Remediation Program – VRP Site Code: 100073-03 Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. October.

ARCADIS Design & Consultancy for natural and built assets

Freeport-McMoRan Sierrita Inc.

VOLUNTARY REMEDIATION PROGRAM

BASELINE HUMAN HEALTH RISK ASSESSMENT

Site Code: 100073-03

Sierrita Mine

Green Valley, Arizona

June 7, 2016,
Revised November 2018,
Revised August 2019

BASELINE HUMAN HEALTH RISK ASSESSMENT

Sierrita Mine

Green Valley, Arizona

Anne Thatcher
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Prepared for:

Freeport-McMoRan Sierrita, Inc.

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AZ001233.0018

Date:

June 7, 2016,
Revised November 2018,
Revised August 2019

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ACRONYMS AND ABBREVIATIONS

ABS_{GI}	gastrointestinal absorption factor
ACF	area correction factor
ADD	average daily dose
ADEQ	Arizona Department of Environmental Quality
ADHS	Arizona Department of Health Services
AES	atomic emission spectroscopy
ALM	Adult Lead Model
APP	Aquifer Protection Permit
A.R.S.	Arizona Revised Statutes
Arcadis	Arcadis U.S., Inc.
ATSDR	Agency for Toxic Substances and Disease Registry
BC	Brown and Caldwell
bgs	below ground surface
BHHRA	baseline human health risk assessment
CalEPA	California Environmental Protection Agency
CDC	United States Department of Health and Human Services' Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CLEAR	Continuous Liquid Extraction and Regeneration
cm^2	square centimeters
COI	constituent of interest
COPC	constituent of potential concern
cRfC	chronic reference concentration
cRfD	chronic reference dose
CSM	conceptual site model
CVAA	cold vapor atomic absorption
DEUR	declaration of environmental use restriction
EA	exposure area
EC	exposure concentration
ED	exposure duration

ELCR	excess lifetime cancer risk
ELMA	Errol L. Montgomery and Associates
EPC	exposure point concentration
°F	degrees Fahrenheit
FCX	Freeport-McMoRan Copper and Gold, Inc.
Ft	feet
ft amsl	feet above mean sea level
GPL	groundwater protection levels
GSF	gamma shielding factor
HI	hazard index
HQ	hazard quotient
ICP	inductively coupled plasma
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
kg	kilogram(s)
kg/mg	kilogram(s) per milligram
LADD	lifetime average daily dose
LCS/LCSD	laboratory control sample/laboratory control sample duplicate
m^3/kg	cubic meter(s) per kilogram
mg/kg	milligram(s) per kilogram
mg/kg-day	milligram(s) per kilogram per day
mg/m^3	milligram(s) per cubic meter
MRL	minimal risk level
MS	mass spectrometry
MS/MSD	matrix spike/matrix spike duplicate
ND	not detected
nr-SRL	non-residential soil remediation level
NFA	no further action
OEHHA	Office of Environmental Health Hazard Assessment
OSF	oral slope factor
PbB	blood lead

pCi/g	picoCuries per gram
PEF	particle emission factor
PPRTV	Provisional Peer-Reviewed Toxicity Value
PRG	Preliminary Remediation Goal
QAPP	Quality Assurance Project Plan
QC	quality control
Ra-226	radium-226
Ra-228	radium-228
RAGS	Risk Assessment Guidance for Superfund
RBA	relative bioavailability
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure
RPD	relative percent difference
r-SRL	residential soil remediation level
SAP	Sampling and Analysis Plan
Sierrita	Freeport-McMoRan Sierrita, Inc.
Site	Freeport-McMoRan Sierrita Copper Mine, Green Valley, Arizona
SPLP	synthetic precipitation leaching procedure
SRE	Screening Risk Evaluation
sRfC	subchronic reference concentration
sRfD	subchronic reference dose
SRL	Arizona Soil Remediation Level
SSCR	Soil and Sediment Characterization Report
STI	Sierrita Tailings Impoundment
Th-232	thorium-232
U-235	uranium-235
U-238	uranium-238
UCL	upper confidence limit of the mean concentration
URS	URS Corporation
USC	Upper Santa Cruz

USEPA	United States Environmental Protection Agency
µg/dL	micrograms per deciliter
µg/m^3	micrograms per cubic meter
VRP	Voluntary Remediation Program
XRF	x-ray fluorescence

EXECUTIVE SUMMARY

Arcadis U.S., Inc. (Arcadis) has prepared this Baseline Human Health Risk Assessment (BHHRA) on behalf of Freeport-McMoRan Sierrita Inc. (Sierrita) for the Freeport-McMoRan Sierrita Copper Mine, Green Valley, Arizona (the Site) as part of the Arizona Department of Environmental Quality's (ADEQ's) Voluntary Remediation Program (VRP). The results of the BHHRA will be used in the risk management decision making process for the Site, and the outcome of the BHHRA will be in compliance with risk-based remedial goals of Arizona Revised Statutes (A.R.S.) §49-175(B).

This BHHRA was prepared in accordance with the VRP BHHRA Work Plan (Arcadis 2015a) approved by ADEQ, and in accordance with the letter entitled *Summary and Response Intentions for Comments on the Baseline Human Health Risk Assessment, Freeport Sierrita Inc., 6200 W. Duvall Mine Rd., Green Valley, Arizona, VRP Site Code: 100073-03* submitted to ADEQ on December 19, 2017. This letter summarized the ADEQ's August 18, 2016 comments to the BHHRA dated June 7, 2016. This letter also documented Sierrita's intent to respond or not respond to each comment in the revised BHHRA report, which was submitted to ADEQ in November 2018.

The BHHRA was most recently revised to address additional comments provided by ADEQ in a letter to Sierrita dated March 5, 2019 and titled, *Re: Review of 2018 Revised Baseline Human Health Risk Assessment*, and recommendations provided in a memo from The Fehling Group, LLC to Joey Pace, ADEQ, dated May 20, 2019 and titled, *Re: Commentary on the Voluntary Remediation Program, Baseline Human Health Risk Assessment. Site Code 100073-03. Sierrita Mine, Green Valley, Arizona. June 7, 2016, Revised November 2018*. Responses to these comments and recommendations were discussed with ADEQ and their consultants during a meeting held on March 12, 2019 and a conference call on June 19, 2019. During the March 12, 2019 meeting, all comments from the March 5, 2019 letter were resolved except for a comment about the lack of background data comparisons to support the inclusion or exclusion of radionuclides as constituents of potential concern (COPCs; site-related constituents) in the BHHRA. The May 20, 2019 memo provided detailed Site and background data evaluations (with which Sierrita generally agrees based on independent data evaluations) and recommendations regarding the use of background radionuclide data in the risk assessment. This revised BHHRA reflects the resolution with regard to the background data, which was reached during the June 19, 2019 conference call.

The BHHRA focuses solely on potential impacts associated with exposure to constituents of potential concern detected in soil and sediment in the following two specific exposure areas (EAs):

- Former Continuous Liquid Extraction and Regeneration (CLEAR) Plant EA, which is composed of the following subareas:
  - Former CLEAR Plant
  - Former E Pond
  - Former Evaporation Pond
  - Old D Pond
- Former Esperanza Mill EA, which is composed of the following subareas:

- Former Esperanza Mill
- Former C Pond and C Pond Spoils
- Former Laydown Yard
- Former Raffinate Pond.

The former Rhenium Ponds area was historically investigated for environmental impacts, however in a meeting with ADEQ on September 30, 2016, Sierrita requested the removal of the ponds from the VRP since the facilities are part of an active aquifer protection permitted facility. Therefore, the former Rhenium Ponds were not evaluated in this BHHRA.

The objective of the BHHRA is to determine whether there are any potential human health risks associated with current and hypothetical future land uses within the above listed EAs. As described in the Final VRP Soil and Sediment Characterization Report (SSCR; URS Corporation [URS] 2012), the subareas comprising these EAs were identified as the focus of VRP site investigations because they are:

- Facilities that ceased operation and/or were closed prior to implementation of Sierrita's Aquifer Protection Permit (APP) No. P-101679.
- Selected operations exempt from regulation under the APP.
- Operations identified as "to be closed" under the APP.
- Active operations with the potential to release mining-related constituents to groundwater.
- Areas with the potential to have uranium impacts to groundwater.

This BHHRA was prepared consistent with United States Environmental Protection Agency (USEPA) and ADEQ risk assessment guidelines.

Site Background

Sierrita operates an open pit mine and mineral concentration facility located in Pima County, approximately 6 miles northwest of Green Valley, Arizona. Green Valley lies approximately 25 miles south of Tucson, Arizona. The mine produces copper products and co-products of molybdenum and rhenium. Sierrita operations include conventional crushing and flotation followed by differential flotation, leaching and roasting of molybdenum disulfide, rhenium recovery, molybdenum disulfide production and packaging, molybdenum trioxide production and packaging, leach stockpiles, and solution extraction/electrowinning facilities. The mine is capable of producing up to 250 million pounds of copper and 25 million pounds of molybdenum annually.

Human Receptors and Exposure Routes

Consistent with USEPA and ADEQ risk assessment guidelines, soil and sediment data were used to estimate excess lifetime cancer risks (ELCRs) and noncancer hazards (in the form of hazard indices [HIs]) to human receptors currently or in the future. In accordance with the ADEQ-approved BHHRA Work Plan, the BHHRA does not address the potential for exposure to site-related constituents in groundwater or surface water, as groundwater is not currently being used for potable purposes at the Site, nor is it expected to be a potable water source in the future. The basin fill aquifer is the main source of

groundwater to water wells in Green Valley (ELMA 2001). The basin fill aquifer occurs east of Demetrie Wash and is not present in the Sierrita pit or plant areas and therefore is not expected to be impacted via the leaching pathway. Surface water drainage features/washes are typically dry at the Site, only containing stormwater for short durations during precipitation events.

The following human receptors were evaluated, as applicable, at each EA:

- Current/future outdoor commercial/industrial worker.
- Hypothetical future construction worker.
- Hypothetical future adolescent trespasser.

Sample depth interval specific datasets were used to evaluate potential receptor exposures at each EA. Shallow soil/sediment datasets (0 to 0.5 feet below ground surface [bgs] or 0 to 2 feet bgs) were used to evaluate potential exposures of outdoor commercial/industrial workers and adolescent trespassers. A shallow and deep soil/sediment dataset (0 to 15 ft bgs) was used to evaluate potential exposures of construction workers, as well as for exposure of future outdoor commercial/industrial workers and adolescent trespassers based on the assumption of a hypothetical future development scenario where soil/sediment up to 15 ft bgs may be excavated and redistributed across the surface of each EA.

The Site is an active open pit mine and mineral concentration facility and, although it is highly unlikely it will ever be redeveloped for residential use, hypothetical future resident receptors were also evaluated for both EAs specifically to address potential unrestricted future land use for the property. In accordance with A.R.S. §R49-152(B,C) (as cited in the ADEQ-approved BHHRA Work Plan), the hypothetical future resident evaluation is the basis for determining whether a “declaration of environmental use restriction” is required for commercial/industrial land use, or whether unrestricted land use may be suitable for the Site. Details and results of the hypothetical future resident evaluation for both EAs are presented in Appendix F.

As part of this BHHRA, potentially complete exposure routes were evaluated for on-site receptors, including incidental soil/sediment ingestion, dermal contact with soil/sediment, and inhalation of fugitive dust particulates. External exposure to ionizing radiation was also evaluated.

USEPA and ADEQ recommended default parameters were used to evaluate reasonable maximum exposure (RME) for each of the receptor scenarios, consistent with regulatory guidance. In addition, a separate evaluation of potential outdoor commercial/industrial worker exposures was conducted using site-specific parameters. The site-specific parameters are based on actual worker activities at the Sierrita mine and are considered more representative of potential exposures under the current and foreseeable future land uses at each EA than are the default RME assumptions.

Key Findings

The key findings of this BHHRA are provided below. The results of the ELCR and HI calculations for each EA are summarized in the following table.

Former CLEAR Plant Exposure Area		
	Shallow Soil/Sediment	Shallow and Deep Soil/Sediment
Current Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.3	--
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 8×10^{-5}; HI=0.3	--
Future Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.2	ELCR = 2×10^{-4}; HI=0.2
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 8×10^{-5}; HI=0.2	ELCR = 9×10^{-5}; HI=0.2
Hypothetical Construction Worker	--	ELCR = 8×10^{-6}; HI=0.6
Hypothetical Adolescent Trespasser	ELCR = 2×10^{-6}; HI=0.04	ELCR = 2×10^{-6}; HI=0.03
Former Esperanza Mill Exposure Area		
	Shallow Soil/Sediment	Shallow and Deep Soil/Sediment
Current Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.3	--
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 9×10^{-5}; HI=0.3	--
Future Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.3	ELCR = 2×10^{-4}; HI=0.2
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 9×10^{-5}; HI=0.3	ELCR = 8×10^{-5}; HI=0.2
Hypothetical Construction Worker	--	ELCR = 8×10^{-6}; HI=0.9
Hypothetical Adolescent Trespasser	ELCR = 2×10^{-6}; HI=0.07	ELCR = 2×10^{-6}; HI=0.05

Note:

-- Not applicable.

RME Reasonable maximum exposure.

Lead was identified as a COPC for the former CLEAR Plant and former Esperanza Mill EAs and was evaluated using the USEPA Adult Lead Model (ALM). Based on the ALM, exposure to lead in

soil/sediment at the former CLEAR Plant EA or the former Esperanza Mill EA is not likely to result in adverse health effects in current/future outdoor commercial/industrial workers, future trespassers, or future construction workers.

The calculated ELCRs based on RME parameters for the current/future outdoor commercial/industrial worker at the former CLEAR Plant EA and the former Esperanza Mill EA are 2×10^{-4}, which is slightly above the Arizona Administrative Code (R18-7-206) and USEPA target cancer risk range of 1×10^{-6} to 1×10^{-4}. The ELCRs based on RME parameters for the hypothetical future trespasser and construction worker receptors are within the target cancer risk range. The cumulative HIs are less than the target of 1 for both EAs.

The calculated ELCRs based on site-specific parameters for the current/future outdoor commercial/industrial workers at the former CLEAR Plant EA and former Esperanza Mill EA are lower than the RME based ELCRs and are within the target cancer risk range. The cumulative HIs based on site-specific parameters for the current/future outdoor commercial/industrial workers are less than the target of 1 for both EAs.

The ELCRs for receptors at the former CLEAR Plant EA and former Esperanza Mill EA are attributable to arsenic and radionuclides (primarily radium-226 [Ra-226] and thorium-232 [Th-232]) in soil/sediment. The calculated cancer risk from radionuclides at the former CLEAR Plant EA and former Esperanza Mill EA accounts for between 85% (adolescent trespasser) and 99% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards for receptors at the former CLEAR Plant EA are attributable to arsenic and copper in soil/sediment, and at the former Esperanza Mill EA are due to arsenic and molybdenum in soil/sediment.

Because COPCs are present in background areas, people who may visit the Site may also visit other areas where the same COPCs are present. In accordance with USEPA guidance (2002), background ELCRs and HIs were estimated to measure the incremental impacts posed by the Site. This is done to provide a comparison of the Site to nearby areas and to assist with risk management decisions. Total risks/HIs are those associated with the Site data. Background risks/HIs are those associated with exposures of the same receptors to metal concentrations and radionuclide activity at locations other than the Site. The only difference between the total risks/HIs and the background risks/HIs are the concentrations/activities of the COPCs. Incremental risks/HIs are total risks/HIs minus background risks/HIs.

In general, background radiological risks are similar to Site risks for the former CLEAR Plant EA and former Esperanza Mill EA. After taking into account background impacts, incremental risks for all receptor groups who may be exposed to Site media are below or within the USEPA target risk range of 1×10^{-6} to 1×10^{-4}. Furthermore, all incremental ELCRs and HIs for metals are below or on the low end of the thresholds for cancer and noncancer effects. This indicates that adverse effects to human health are not expected. These conclusions are based on a robust dataset and a scientifically defensible process that can support risk management decisions for this Site.

1 INTRODUCTION

Arcadis U.S., Inc. (Arcadis) prepared this Baseline Human Health Risk Assessment (BHHRA) on behalf of Freeport-McMoRan Sierrita Inc. (Sierrita) for the Sierrita Copper Mine, Green Valley, Arizona (the Site; Figure 1-1). Arcadis conducted the BHHRA as part of the Arizona Department of Environmental Quality's (ADEQ's) Voluntary Remediation Program (VRP) to conservatively evaluate whether residual concentrations of Site-related constituents in soil and sediment pose adverse health effects to current and hypothetical future site users in two exposure areas (EAs). The results of the BHHRA will be used in the risk management decision making process for the Site.

The BHHRA was developed based on the results of previous site investigations, evaluation of anticipated site uses (including historical, current, and long-term future land uses), and applicable agency guidance and laws. The risk assessment approach and methodology follow the VRP BHHRA Work Plan (Arcadis 2015a), which was initially submitted to ADEQ on February 28, 2013. ADEQ provided comments on that initial BHHRA Work Plan in a letter dated November 18, 2014. The BHHRA Work Plan was revised; dated April 24, 2015 based on the November 18, 2014 ADEQ comments; and subsequently approved by the ADEQ on May 13, 2015.

This BHHRA was prepared in accordance with the letter entitled *Summary and Response Intentions for Comments on the Baseline Human Health Risk Assessment, Freeport Sierrita Inc., 6200 W. Duvall Mine Rd., Green Valley, Arizona, VRP Site Code: 100073-03* submitted to ADEQ on December 19, 2017. This letter summarized the ADEQ's August 18, 2016 comments to the BHHRA dated June 7, 2016. This letter (provided in Appendix J) also documented Sierrita's intent to respond or not respond to each comment in the revised BHHRA report, which was submitted in November 2018.

The BHHRA was most recently revised to address additional comments provided by ADEQ in a letter to Sierrita dated March 5, 2019 and titled, *Re: Review of 2018 Revised Baseline Human Health Risk Assessment*, and recommendations provided in a memo from The Fehling Group, LLC to Joey Pace, ADEQ, dated May 20, 2019 and titled, *Re: Commentary on the Voluntary Remediation Program, Baseline Human Health Risk Assessment. Site Code 100073-03. Sierrita Mine, Green Valley, Arizona. June 7, 2016, Revised November 2018*. Responses to these comments and recommendations were discussed with ADEQ and their consultants during a meeting held on March 12, 2019 and a conference call on June 19, 2019. During the March 12, 2019 meeting, all comments from the March 5, 2019 letter were resolved except for a comment about the lack of background data comparisons to support the inclusion or exclusion of radionuclides as constituents of potential concern (COPCs; site-related constituents) in the BHHRA. The May 20, 2019 memo provided detailed Site and background data evaluations (with which Sierrita generally agrees based on independent data evaluations) and recommendations regarding the use of background radionuclide data in the risk assessment. This revised BHHRA reflects the resolution with regard to the background data, which was reached during the June 19, 2019 conference call.

In accordance with the Work Plan, the BHHRA relies on soil and sediment data collected during field activities performed from 2004 through 2015. The BHHRA evaluates a current/future on-site outdoor commercial/industrial worker, a future on-site construction worker, and a future on-site trespasser for all identified potentially complete exposure pathways, as described in the human health conceptual site model (CSM; see Section 6).

Although it is highly unlikely that the Site will ever be redeveloped for residential use, hypothetical future resident receptors were also evaluated specifically to address potential unrestricted future land use for the property. Per the Arizona Revised Statutes (A.R.S.)§R49-152(B,C) (as cited in the ADEQ-approved BHHRA Work Plan), the hypothetical future resident evaluation is the basis for determining whether a "declaration of environmental use restriction" is required for commercial/industrial land use, or whether unrestricted land use may be suitable for the Site. Details and results of the hypothetical future resident evaluation are presented in an appendix to this BHHRA.

The BHHRA does not address the potential for exposure to Site-related constituents in groundwater or surface water, as groundwater within the facility is not being withdrawn for potable purposes or other use and is not accessible to third parties for any use, nor is it expected to be a potable water source in the future. The principal hydrogeologic units at the Site include the alluvial aquifer, the basin fill aquifer, and the bedrock hydrostratigraphic unit. The basin fill aquifer is the main source of groundwater to water wells in Green Valley (ELMA 2001) and depth to water ranges from approximately 250 to 425 ft bgs. The basin fill aquifer occurs east of Demetrie Wash and is not present in the Sierrita pit or plant areas and is not threatened by any impacts to groundwater beneath the Site. Surface water-groundwater interactions were described in the VRP Groundwater Investigation Report (Arcadis 2013b). Additionally, groundwater is either captured by the mine dewatering or Sierrita tailings impoundment interceptor well field and reused in the mine processes. Surface water drainage features are typically dry at the Site, only containing stormwater for short durations during precipitation events.

The remainder of this BHHRA is organized as follows:

Section 2 - Site Background. Provides background information about the Site, including site history, existing facilities, regional and site-specific geology, and hydrogeology.

Section 3 - Previous Investigations and Remedial Activities. Describes previous site investigations and summarizes the relevant findings.

Section 4 - Guidance Documents Used to Conduct the BHHRA. Lists the guidance documents used to develop the approach and methods used in the BHHRA.

Section 5 - Data Used to Conduct the BHHRA. Presents the data used to conduct the BHHRA, identifies the specific exposure areas (EAs) evaluated, and discusses the methods used to estimate constituent concentrations to which a human receptor might be exposed.

Section 6 - Exposure Assessment. Describes the basis for evaluation of certain human receptors and potentially complete exposure routes, as well as methods used to estimate route-specific doses.

Section 7 - Toxicity Assessment. Presents the toxicity values used to estimate impacts to human receptors, including information on the sources of toxicity values, as well as specific approaches used to evaluate certain constituents.

Section 8 - Risk Characterization. Discusses specific methods used to evaluate the potential for adverse human health effects, including the estimation of excess lifetime cancer risks (ELCRs) and calculation of noncancer hazard indices (HIs).

Section 9 - Risk Assessment Results. Presents the results of the BHHRA.

Section 10 - Uncertainties Associated with the BHHRA. Summarizes the key assumptions used in this BHHRA and how each may have affected the results.

Section 11 - Summary and Conclusions. Summarizes the outcome of the BHHRA.

Section 12 - References. Lists the literature cited in this report.

This BHHRA is followed by tables and figures. Supporting information is provided in the appendices, as follows:

Appendix A. Soil and Sediment Data Used to Conduct the Baseline Human Health Risk Assessment.

Appendix B. ProUCL 5.1 Input and Output Files.

Appendix C. Excess Lifetime Cancer Risk and Hazard Index Calculations (Chemicals) using 95% UCL EPCs.

Appendix D. Excess Lifetime Cancer Risk Calculations (Radionuclides) using 95% UCL EPCs.

Appendix E. Lead Model Output.

Appendix F. Hypothetical Future Resident Evaluation.

Appendix G. Background Risk Calculations using mean EPCs.

Appendix H. Excess Lifetime Cancer Risk and Hazard Index Calculations (Chemicals) using mean EPCs.

Appendix I. Excess Lifetime Cancer Risk Calculations (Radionuclides) using mean EPCs.

Appendix J. Summary and Response Intentions for Comments on the BHHRA.

2 SITE BACKGROUND

This section describes the site setting and existing facilities, current and historical site operations, regional and site-specific geology, and hydrogeology.

2.1 Site Location and Description

Sierrita operates an open pit mine and mineral concentration facility located in Pima County, approximately 6 miles northwest of Green Valley, Arizona (Figure 1-1). Green Valley lies approximately 25 miles south of Tucson, Arizona. The mine produces copper products and co-products of molybdenum and rhenium. Sierrita operations include conventional crushing and flotation followed by differential flotation, leaching and roasting of molybdenum disulfide, rhenium recovery, molybdenum disulfide production and packaging, molybdenum trioxide production and packaging, leach stockpiles, and solution extraction/electrowinning facilities. The mine is capable of producing up to 250 million pounds of copper and 25 million pounds of molybdenum annually (ADEQ 2011).

Figure 2-1 shows the general features and facilities at the Site. The Sierrita property consists of three open pits (Sierrita-Esperanza pit, a molybdenum satellite pit, and the Ocotillo pit), a 115,000 ton-per-day concentrator, two molybdenum roasting plants, the rhenium plant, an oxide and low-grade sulfide ore stockpile leaching operation, a copper sulfate plant, and associated support facilities and historical facilities, some of which have been closed and reclaimed.

2.2 Environmental Setting

The mine is situated on the southeast flank of the Sierrita Mountain Range, approximately 7 miles northwest of the Santa Cruz River. Elevations at the Site range from approximately 5,000 feet above mean sea level (ft amsl) on the west side of the Site to approximately 3,000 ft amsl on the east side, as shown on Figure 1-1.

The climate is typical for an arid region, with a wide range in daily temperatures and monsoonal type precipitation patterns. The Western Regional Climate Center reports that the average daily maximum temperature at Green Valley is 84 degrees Fahrenheit (°F), while the average daily minimum temperature is 54°F. Average annual precipitation is 10.86 inches. These statistics were based on a reporting period from 1988 through 2012. The monthly average pan evaporation rates range from 3.25 inches in January to 14.9 inches in June (URS 2008a).

More than one third of the annual precipitation occurs during the months of July and August, and these rain events can produce short, intense downpours; strong winds; and flash floods. Groundwater at Sierrita is derived primarily from mountain front recharge, recharge from ephemeral streamflow, and seepage from the Sierrita Tailings Impoundment (STI; Errol L. Montgomery and Associates [ELMA] and Dames and Moore 1994).

The surface water regime of the Site is divided into four major surface water drainage basins, each associated with one of the four major washes that drain the Site: Demetrie, Amargosa, Esperanza, and Tinaja Washes. The locations of the washes are shown on Figure 2-1. An unnamed drainage (Unnamed Wash) connects with the Tinaja Wash south of the Esperanza Wash. Amargosa, Esperanza, and Tinaja Washes discharge into Demetrie Wash, which is an ephemeral tributary to the Santa Cruz River.

2.3 Site History and Facilities Overview

Mining in the area around Green Valley started in the late 1800s (Freeport-McMoRan Copper & Gold Inc. [FCX] 2011b). At the Sierrita mine, underground mining began in 1907, and open-pit mining began in 1957 (FCX 2011a). The existing 4,316-acre Sierrita Tailings Impoundment (APP No. P-101679) has been used as a final tailings repository since the 1970s (FCX 2011b).

This BHHRA focuses on the potential for exposure to constituents in soil and sediment at two facility areas at the Sierrita mine: 1) the former Continuous Liquid Extraction and Regeneration (CLEAR) Plant and 2) the former Esperanza Mill. These two EAs encompass nine subareas identified as the focus of VRP site investigations (URS 2012) because they are:

- Facilities that ceased operation and/or were closed prior to implementation of Sierrita's APP.
- Selected operations exempt from regulation under the APP.
- Operations identified as "to be closed" under the APP.
- Active operations with the potential to release mining-related constituents to groundwater.
- Areas with the potential to have uranium impacts to groundwater.

A brief description of each facility is provided in the sections below. Information provided below was taken from the Final VRP SSCR (URS 2012) and the VRP Groundwater Investigation Report (Arcadis 2013b).

2.3.1 Former CLEAR Plant

The CLEAR Plant was historically located in the north-central portion of the Sierrita property (see Figure 2-1). The former CLEAR Plant produced metallic copper from 1977 to 1983 and was demolished in 1995. Copper was initially leached from copper concentrate slurry, which was produced from sodium and potassium chloride brines and sodium hydroxide and ferric chloride reagents. The leached solution was processed through two mixing reactors and a thickener before producing a pregnant solution. The pregnant solution was circulated in electrolytic tanks, and the resulting precipitated copper was filtered, washed, dried, and stored until sold.

The former CLEAR Plant subarea encompasses approximately 60 acres and includes a number of associated impoundments, including the former E Pond, the former Evaporation Pond, and the Old D Pond. The former E Pond is an inactive, backfilled pond. This pond was an unlined impoundment historically used to contain surface water runoff and possibly process solutions from upset conditions at the former CLEAR Plant. The former Evaporation Pond was a lined impoundment that received spent copper solution containing chloride. The Old D Pond was an unlined pond that reportedly received process solutions from the former CLEAR Plant operation. These solutions were recycled and possibly concentrated various constituents including metals and radionuclides. Runoff from the closed CLEAR Plant and Copper Sulfate areas is now contained in the New D Pond, an APP-permitted non-stormwater impoundment.

The topography of the former CLEAR Plant area generally slopes eastward and is incised by north-south and east-west trending drainages. The western portion is cut into granodiorite bedrock, and the remaining area is covered with fill ranging from a few inches to approximately 25 feet (ft) in thickness. The easternmost portion of the plant area, near Demetrie Wash, is undisturbed and sparsely covered with native vegetation. A large portion of the plant area is covered with gravel or crushed rock, and buried concrete slabs are known to exist below the gravel.

The former CLEAR Plant area is currently used as 1) a training center; 2) an asset recovery yard to store used equipment, machinery, and vehicles; 3) contractor offices and materials storage; 4) a metal fabrication shop; and 5) Sierrita's "Central Accumulation" building, currently used to store environmental sampling supplies and manage hazardous waste. The former CLEAR Plant building is currently used for storage of miscellaneous materials, such as used computers and office equipment, and as a training center. The Crystal Plant is located in the southernmost building, which manufactures copper sulfate pentahydrate, a product that may be sold as fertilizer, pesticide, foot bath, and animal feed.

2.3.1.1 Work Force at the Former CLEAR Plant

Indoor workers (inside at the contractor offices and Crystal Plant) may be present in the former CLEAR Plant area for 8-hour days 5 days a week. Employee training, which takes place indoors at the training center, occurs periodically. Outdoor worker activities, such as storing/retrieving equipment and supplies, typically occur only on an as-needed basis (i.e., less than 8 hours per day).

2.3.2 Former Esperanza Mill

The former Esperanza Mill covers roughly 128 acres in the central portion of the Sierrita property (see Figure 2-1) and includes the former C Pond and C Pond Spoils, former Raffinate Pond, and former Laydown Yard. The former mill processed sulfide ore from 1959 through 1981 (Hydro Geo Chem, Inc. [HGC] 2008) and included a mill, two thickeners, and a raw water pond. Tailings from the mill were conveyed through a pipeline to the Esperanza Tailings Impoundment, located approximately 0.5 mile southeast of the former mill.

The topography of the former mill area slopes gently to the east-southeast. Amargosa Wash borders the mill area to the south, and Demetrie Wash borders the mill area to the east. The Duval Canal Extension trends west-to-east along the north side of the former mill area. The northwestern portion of the area is cut into bedrock with fill extending eastward. A drainage channel extends from near the base of the former thickeners and trends southeast across the former mill area. Numerous work/storage shops, office buildings, and equipment storage areas are located in the northwest portion of the former mill area.

The former C Pond and C Pond Spoils are located within the easternmost portion of the former mill area, near the northwest corner of the confluence of Demetrie and Amargosa Washes. The former C Pond was an unlined pond used to contain surface runoff from the Sierrita Mill, overflow from the old Duval Canal during storm events, and runoff from the Sierrita crusher dust collector area, which had high concentrations of copper. During operations, sediments that accumulated in the former C Pond were periodically dredged, and spoils were placed on the east and west sides of the current Duval Canal Extension (C Pond Spoils). Currently, the former C Pond area is being used by Sierrita for pilot water treatment plants.

The former Raffinate Pond is an inactive, unlined, and backfilled pond located within the central portion of the former Esperanza Mill area. This pond was used in association with a Precipitation Plant (now removed), which was located immediately southeast of the former Esperanza Mill. Its use ended when Raffinate Pond No. 3 was constructed. The former Raffinate Pond collected surface water runoff from the western portion of the former Esperanza Mill and contained some water most of the year. The central portion of the former Raffinate Pond currently supports a cover of vegetation. Granodiorite bedrock outcrops at the surface along the southwest side of the former pond. The north and east sides of the pond are currently bordered by fill material.

The former Laydown Yard is located in the central portion of the former Esperanza Mill area and was used from the 1960s until the mill was demolished in 2005. During that time, the Laydown Yard was used to store equipment, new drums, and salvage materials from decommissioned site facilities. A subcontractor removed and salvaged the drums and other equipment. The former Laydown Yard is currently used by a contractor for their mobile office and a few pieces of mobile equipment.

2.3.2.1 Work Force at the Former Esperanza Mill

Outdoor workers (general labor crew) convene in the former Esperanza Mill area each morning and disperse throughout the Site (which includes other portions of the Sierrita mine facility). A road maintenance crew may potentially work in the area performing grading, paving, and other maintenance duties. These activities occur as needed. Outdoor workers also work in the Laydown Yard, rental yard, or

other outdoor areas. They travel in and out of those areas, as well as indoors and other areas of the Sierrita mine facility, on a daily basis.

2.4 Geology and Hydrogeology

This section summarizes the regional and site-specific geology and hydrogeology, as described in the VRP Groundwater Investigation Report (Arcadis 2013b).

2.4.1 Site Geology

Sierrita is located in the Basin and Range physiographic province, on the west margin of the Santa Cruz Basin and along the east flank of the Sierrita Mountains (ELMA 2001, ELMA and Dames and Moore 1994). The principal geologic/hydrogeologic units at the Site include the alluvial deposits, the basin fill deposits, and the bedrock complex. The lithology of each of the principal geologic units at the Site is described below.

2.4.1.1 Alluvial Deposits

Unconsolidated Quaternary and late Tertiary deposits cover most of the eastern base (the piedmont) of the Sierrita Mountains. The term “piedmont” is used in the Esperanza Mill Quadrangle (Spencer et al. 2003) and refers to the area east of the immediate mine area. The alluvium was deposited by larger streams that originated in the mountains and then was reworked by smaller streams that originate on the piedmont. Alluvial deposits occur as thin, discontinuous deposits throughout the Site, typically within natural drainage channels including Demetrie Wash, Amargosa Wash, Esperanza Wash, and Tinaja Wash. However, there are unconsolidated deposits across the mine site that overlie bedrock; the soil and sediment samples were collected from the unconsolidated deposits (Arcadis 2013b). The deposits consist of coarse-grained, unconsolidated silty sand and gravel of Quaternary age. Based on investigation work from 2001, the thickness of the alluvial deposits ranges from 0 to 30 feet (ELMA 2001).

2.4.1.2 Basin Fill Deposits

At the Site, basin fill deposits occur generally east of Demetrie Wash, trending from the northwest and extending east below the tailings impoundments, and are not present in the Sierrita pit or plant areas. The basin fill deposits are Tertiary to Quaternary in age and consist of poorly consolidated sand, gravel, silt, and clay in varying proportions. The thickness of the basin fill deposits increases to the east up to more than 1,000 feet near the southeast corner of the Sierrita Tailings Impoundment (ELMA 2001).

2.4.1.3 Bedrock Complex

The Sierrita-Esperanza deposit is composed of igneous rocks; the oldest in the area are the Ox Frame Volcanics. The Ox Frame Volcanics were intruded by the Harris Ranch Quartz Monzonite, which was overlain by the Demetrie Volcanics. Later intrusive rocks, including the Ruby Star Granodiorite, intruded the existing volcanic and intrusive rocks and formed a large batholith. The bedrock complex consists of several formations, including the Tinaja Peak Formation, the Pantano Formation, the Tertiary Intrusives,

Ruby Star Granodiorite, Demetrie Volcanics, Harris Ranch Quartz Monzonite, and Ox Frame Volcanics. These formations are discussed in detail in the VRP SSCR and Addendum (URS 2012; Arcadis 2013a).

2.4.1.4 Naturally Occurring Radioactivity in Soils

In Arizona, uranium is often found in minerals associated with porphyry copper deposits (USEPA 1990a, 1999, 2008), and it most commonly occurs in granitic rocks associated with Precambrian outcrops and Laramide intrusives (ADEQ 1989). The porphyry copper deposit at the Sierrita mine is part of the Laramide physiographic province, and in the vicinity of the Sierrita mine, the bedrock units include a variety of silica-rich igneous units (see Arcadis 2013b for a summary of the individual units). In the Sierrita area, there appears to be a band of uranium-bearing minerals that runs across the Sierrita Mountains, and uranium has been found in minerals associated with a number of mines in the region (USEPA 1999).

Quaternary alluvium consists of soils and sediments generated from weathered bedrock material. Alluvial sediments in the Sierrita area are generated through erosion of the exposed bedrock of the Sierrita Mountains. Eroded material is transported downslope by gravity (rock falls and other mass movements) and by rain events, which can transport large quantities of sedimentary materials. These materials are deposited in low-lying and flat areas on the valley floor. Because alluvial sediments are derived from bedrock material, their mineralogical and chemical composition are similar to their bedrock source. In the Sierrita area, gullies, washes, and shallow, low-lying areas accumulate sediment from large geographic stretches of upslope, exposed bedrock from different formations and geologic units, creating sedimentological variability. Because the alluvial sediments are derived from local bedrock, it is expected that they contain comparable levels of metals and radiological materials as is seen in the Ruby Star Granodiorite, Tinaja Peak Formation, and the Harris Ranch Quartz Monzonite.

A background soil assessment (Arcadis 2018) evaluated alluvial and bedrock samples collected from an area identified as representative of background environments near the Site. Ra-226, Ra-228, U-235, and U-238 results from the background soils showed activities in pCi/g that were comparable to those encountered in both the regional bedrock (Ruby Star Granodiorite, Tinaja Peak Formation, and Harris Ranch Quartz Monzonite) and Site EAs (Former CLEAR Plant and Esperanza Mill). Additionally, total uranium concentrations in mg/kg from the background soils also showed concentrations comparable to the Site EAs, and the average background soil total uranium concentration of 2.67 mg/kg fell within the range of natural uranium reported in Arizona by the USGS (ADEQ 1991) of 1.10-3.40 mg/kg uranium (see table below).

Source	Uranium (mg/kg)
Background soils	2.67
USGS Arizona Average	2.1
USGS Arizona Maximum	3.4
USGS Arizona Minimum	1.1

Ra-226, Ra-228 and total uranium concentrations were greater in the bedrock samples than in alluvial samples, showing that the presence of these constituents in alluvial materials is likely due to their provenance as eroded radium- and uranium-bearing bedrock material (Arcadis 2018).

Based on comments provided by ADEQ, an evaluation of secular equilibrium was conducted for the Site and background soil data. The evaluation indicated that the U-238, U-234 and Ra-226 activities from the former CLEAR Plant and former Esperanza Mill areas are in secular equilibrium; however, the background data are not. The background uranium activity ratio (U-234/U-238) averaged 1.0 for all samples collected shallower than two ft bgs; deeper samples were not analyzed for isotopic uranium. ADEQ suggested a review of the background laboratory analytical reports be performed to determine why the background Ra-226 concentrations are greater than those for uranium isotopes (U-238 and U-234). Sierrita therefore conducted a review of the laboratory analytical methods and data validation reports included in the *Background Soil Assessment Report* (Arcadis 2018) and did not find any issues with the background soil sample analyses. Regardless, ADEQ recommended that Sierrita ignore the Ra-226 background soil sample results, and use the U-238 and U-234 data as a surrogate for Ra-226 and other radionuclides in the decay series (see Section 5.7.3).

2.4.2 Site Hydrogeology

Sierrita is located in the Upper Santa Cruz (USC) Basin and Range Lowlands Hydrogeologic Province. The USC Basin is a north-trending alluvial valley drained by the Santa Cruz River (ELMA and Dames and Moore 1994). The Sierrita Mountains are a contributing source of mountain-front recharge to the basin. The Santa Cruz River to the east of the Site is the main surface water drainage. The Santa Cruz River is located approximately 2 miles due east from the eastern boundary of the STI. The principal hydrogeologic units at the Site include the alluvial aquifer, the basin fill aquifer, and the bedrock hydrostratigraphic unit. The hydrogeology of each of the principal units at the Site is described in detail in the Groundwater Investigation Report (Arcadis 2013b).

3 PREVIOUS SITE INVESTIGATIONS

Sierrita submitted an application to enter the Arizona VRP on June 19, 2007 to evaluate certain operations and constituents that are not considered by other regulatory programs, such as the Mitigation Order on Consent, Docket No. P-50-06 and the Sierrita area-wide APP No. P-101679. The characterization goal for the VRP was to assess potential impacts to soil, sediment, and groundwater from historical and active mine operations. The constituents of interest (COIs) for the Site are trace metals and radiological constituents (uranium and radium isotopes). COIs have been identified in previous reports as constituents detected in soil at concentrations higher than non-residential soil remediation levels (nr-SRLs) or groundwater protection levels (GPLs; URS 2012, Arcadis 2013a and 2013b).

As stated in Section 1, the BHHRA relies on soil and sediment data collected during field activities performed from 2004 through 2015. The following documents related to previous site investigations were reviewed to compile and verify the soil and sediment data used to conduct this BHHRA:

- Soil, Surface Water, and Groundwater Sampling in the CLEAR Plant and Esperanza Mill Areas, Prepared for Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. April 2008 (HGC 2008)
- Voluntary Remediation Program Investigation Work Plan (URS 2008a)
- Voluntary Remediation Program Investigation Quality Assurance Project Plan (URS 2008b)
- Voluntary Remediation Program Soil and Sediment Characterization Report, Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. Final. December 2012 (URS 2012)
- Voluntary Remediation Program Former CLEAR Plant Area Soil Excavation and Tier I Screening Risk Evaluation Report, Sierrita Mine, Green Valley, Arizona. January 2013 (Arcadis 2013c)
- Voluntary Remediation Program Addendum to the Soil and Sediment Characterization Report, Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. August 2013 (Arcadis 2013a)
- Voluntary Remediation Program Groundwater Investigation Report, Sierrita Mine, Green Valley, Arizona. December 2013 (Arcadis 2013b)
- Voluntary Remediation Program Data Gaps Work Plan, Sierrita Mine, Green Valley, Arizona. June 2015 (Arcadis 2015b)
- Former CLEAR Plant Area Paving Project Soil Excavation and Tier I Screening Risk Evaluation Report, Sierrita Mine, Green Valley, Arizona. July 2015 (Arcadis 2015c)
- Background Soil Assessment Report. Voluntary Remediation Program – VRP Site Code: 100073-03 Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. October (Arcadis 2018)

The remainder of this section briefly summarizes the previous site investigations and relevant findings.

3.1 Soil and Sediment Investigations

3.1.1 HGC 2004 Investigation

From August through October 2004, HGC performed a screening level assessment of environmental conditions in the vicinity of the former CLEAR Plant and former Esperanza Mill. The field investigation included the collection of 54 surface soil samples from 0 to 3 inches below ground surface (bgs) and 39 subsurface soil samples at depths up to 15 feet bgs from 14 backhoe trenches (HGC 2008). Soil samples were initially screened for paste pH (a measure of the potential for soil samples to generate acid solutions), which was used to determine if the sample should be submitted for total metals analysis (HGC 2008). Soil samples were selected for laboratory analysis based on their potential to generate acid, because of an anomalous appearance due to copper or iron oxide mineralization, or to provide comprehensive geospatial coverage (HGC 2008).

In total, 12 surface soil and 24 subsurface soil samples from the former CLEAR Plant area, and 12 surface soil and 12 subsurface soil samples from the former Esperanza Mill area (including the Former C Pond, Former Raffinate Pond and the Former Laydown Yard), were submitted for laboratory analysis of metals and acid-base potential. Detected constituent concentrations were compared to the Arizona Soil Remediation Levels (SRLs) for non-residential land use (Arizona Administrative Code Title 18). The HGC (2008) report indicated that arsenic in soil exceeded the non-residential SRL (nr-SRL) throughout the former CLEAR Plant and former Esperanza Mill areas; however, there was no apparent spatial pattern to arsenic concentrations with respect to historical facilities. Additionally, arsenic concentrations were not necessarily elevated with respect to naturally occurring concentrations in some portions of Arizona and the United States (HGC 2008). Copper was the only other metal detected at concentrations greater than the nr-SRL. The copper concentration in one soil sample was greater than its nr-SRL; this sample was described as being pyritic with a greenish color similar to concentrate.

3.1.2 URS 2008 Investigation

Following the Site's acceptance into the VRP, Sierrita retained URS to prepare and implement a site investigation work plan to characterize soil, sediment, and groundwater at the mine. The investigation activities were conducted by URS, in accordance with the VRP Investigation Work Plan (URS 2008a) and the Addendum to Sampling and Analysis Plan & Quality Assurance Project Plan (SAP & QAPP Addendum; URS 2008b). Both plans were approved by the ADEQ.

The VRP soil and sediment investigation was conducted between June and November 2008 at three general areas and nine subareas: 1) former CLEAR Plant area, including the former plant, former E Pond, former Evaporation Pond, and Old D Pond; 2) former Esperanza Mill area, including the former mill, former C Pond and C Pond Spoils, former Raffinate Pond, and former Laydown Yard; and 3) the STI, which includes the former Rhenium Ponds. The objective of field activities was to assess potential releases of COIs from the specified subareas (URS 2012).

As indicated in the SSCR (URS 2012), the COIs analyzed during the VRP characterization were selected based on a review of groundwater constituents monitored or regulated under Sierrita's APP permit, historical groundwater quality data for the Sierrita mine, and current and historical mining processes and

operations. The soil and sediment COIs include mining-related metals (e.g., antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, nickel, selenium, thallium, and zinc), total uranium, uranium isotopes (uranium-234 [U-234], uranium-235 [U-235], and uranium-238 [U-238]), and radium isotopes (radium-226 [Ra-226] and radium-228 [Ra-228]). Many of the COIs also naturally occur in soils, rock, and groundwater at non-mineralized and mineralized mine sites.

3.1.2.1 Relevant Findings for Metals

URS (2012) presented and evaluated the combined analytical results for metals in soil and sediment samples collected by HGC in 2004 and as part of the VRP investigation in 2008. One hundred fifty four soil samples were analyzed from 52 soil borings advanced to the bedrock surface, and 36 sediment samples were collected and analyzed from 18 locations. Detected constituent concentrations were compared to the Arizona SRLs and Groundwater Protection Levels (GPLs). Non-residential SRLs for the following constituents were exceeded in at least one soil sample at each of these subareas:

- Arsenic, copper, and lead at the former CLEAR Plant
- Arsenic at the Old D Pond
- Arsenic at the former Esperanza Mill
- Arsenic and lead at the former C Pond and C Pond Spoils
- Arsenic and copper at the former Raffinate Pond, and
- Arsenic, lead, and molybdenum at the former Laydown Yard.

As part of the SSCR investigation, the 95 percent upper confidence limit of the mean concentration (95% UCL) was calculated for the above listed constituents using the soil data from each subarea. The 95% UCL concentrations were then also compared to the nr-SRLs. The only COI for which 95% UCLs were still greater than the nr-SRL was arsenic at the former CLEAR plant, former Esperanza Mill, former Raffinate Pond, and former Laydown Yard. The SSCR (URS 2012) recommended that site-specific background concentrations and/or soil remediation standards be developed for arsenic.

Antimony and lead were the only metals detected at concentrations greater than their respective GPLs. Antimony exceeded the GPL in the former CLEAR Plant and former Esperanza Mill subareas. Lead exceeded its GPL in the former CLEAR plant, former C Pond and C Pond Spoils, former Raffinate Pond, and former Laydown Yard (URS 2012). The calculated 95% UCL concentrations were less than corresponding GPLs, except for lead at the former Laydown Yard. However, all detected lead concentrations were less than the alternative GPL (25,556 milligrams per kilogram [mg/kg]) calculated based on site-specific total and synthetic precipitation leaching procedure (SPLP) lead data (URS 2012). No further action was recommended for soil with regard to groundwater protection.

3.1.2.2 Relevant Findings for Radionuclides

Arcadis (2013a) reported the results of the soil and sediment investigation for radionuclides. Uranium and radium isotopes were detected in samples from each subarea. The SSCR Addendum (Arcadis 2013a) did

not include a comparison of detected activities to human health risk-based screening levels but indicated that the presence of radionuclides in subarea soils is consistent with the highly mineralized area. The unconsolidated deposits and parent bedrock complex at the Sierrita mine, which contains Ruby Star Granodiorite as well as quartz monzonite porphyry, contain natural levels of radioactivity. The SSCR Addendum noted that rock core samples collected as part of the groundwater investigation (described below) revealed uranium concentrations up to 19 mg/kg in the granodiorite bedrock and at 35 mg/kg in the monzonite bedrock (Arcadis 2013a). Radium-226 activity in the granodiorite has been measured at concentrations up to 5.8 picoCuries per gram (pCi/g) and in the monzonite at up to 11 pCi/g. The SSCR Addendum deferred further evaluation of the soil and sediment radionuclide data to this BHHRA.

To provide additional information relevant to naturally occurring radionuclides in area soil and sediments, a background soil assessment was conducted as outlined in the approved Background Soil Assessment Work Plan (Arcadis 2017). Details are provided in the 2018 Background Soil Assessment Report (Arcadis 2018) and a brief summary of the study results is provided in Section 3.1.5 of this BHHRA.

3.1.3 Former CLEAR Plant Area Soil Excavation

On May 1 and 2, 2012, Arcadis collected 51 soil samples to support construction of a new training facility building on a 1.3-acre area located north of the former CLEAR Plant building (Arcadis 2013c). Previous investigation in the former CLEAR Plant area had partially defined areas of potential impacts in the surface and subsurface soils. The objectives of the soil excavation sampling were to obtain additional information to support a No Further Action (NFA) determination for soil in the area affected by construction, or to provide analytical data in support of a Declaration of Environmental Use Restriction (DEUR).

Discrete soil samples were collected from the building excavations and parking lot areas to be paved. Based on the previously collected data from the former CLEAR Plant area, the samples were only analyzed for arsenic, copper, and lead. Samples were collected from 0 to 6 inches bgs using either a disposable plastic scoop or a hand auger. Dry soil samples were sieved, field-screened using a handheld x-ray fluorescence (XRF) analyzer, and then packaged for laboratory analysis. Eight of the 51 soil samples were collected from excavated and stockpiled soils, but their analytical results are not relevant, as the materials are not representative of concentrations in residual soils. Thirty-five discrete samples were packaged for laboratory analysis based on XRF results.

Supplemental soil sampling was conducted on May 11 and 21, 2012 in proposed locations that had not been sampled on May 1 and 2, from over-excavated areas where material had since been removed, and from areas where initial soil samples had concentrations above the residential SRL (r-SRL). An additional 38 soil samples were collected using the same methods described above.

Arsenic and lead were detected at concentrations in soil greater than their respective r-SRLs and nr-SRLs. Lead was also detected at concentrations above its GPL. Copper was detected at concentrations greater than its r-SRL but less than the nr-SRL, and there is no GPL available for copper. A Tier 1 Screening Risk Evaluation (SRE) was performed using analytical results from the residual soil samples. The Tier 1 SRE demonstrated that 95% UCL concentrations for all three metals were below the available SRLs and GPLs; therefore, no further action was recommended.

3.1.4 Former CLEAR Plant Area Paving Project

Between May 19 and June 19, 2015, 29 soil samples were collected in support of constructing two paved areas in the former CLEAR Plant area. The paved areas occupy approximately 0.9 acre (0.27 acre and 0.63 acre) located north and southwest of the former CLEAR Plant building, along the western edge of the former CLEAR plant subarea defined in the SSCR (URS 2012).

Two soil samples were collected from a leach field in the southern paving area at 3.5 feet bgs using a hand auger. Eight surface soil samples from the northern paving area and 17 surface soil samples from the southern paving area were collected immediately following the excavation and grading of the areas to be paved. These samples were collected at randomly determined locations within a grid placed over the graded area. Surface soil samples were collected using a disposable plastic scoop and were immediately packaged for laboratory analysis. Two additional discretionary samples were collected from the northern paving area after encountering and excavating visually impacted soils. Grid samples were submitted for laboratory analysis of arsenic, copper, and lead. Approximately ten percent of the 25 grid samples (i.e., 3 samples), the two discretionary soil samples, and the two leach field samples were submitted for analysis of an extended list of metals constituents (antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, thallium, uranium, and zinc).

Arsenic was detected at concentrations in soil greater than its r-SRL and nr-SRL; however, arsenic concentrations in all samples were less than its GPL. Copper was detected at concentrations greater than its r-SRL but less than its nr-SRL, and there is no GPL available for copper. Detected lead concentrations were below both the r-SRL and nr-SRL, but the lead concentration in one sample was above its GPL. A Tier 1 SRE was performed using analytical results from the paving area samples. The Tier 1 SRE demonstrated that 95% UCL concentrations for all three metals were below the available SRLs and GPLs; therefore, no further action was recommended.

3.1.5 Background Soil Assessment

A background soil investigation was conducted in 2018 in accordance with the ADEQ approved work plan (Arcadis 2017). The goal of the assessment was to investigate whether elevated COPC (i.e., antimony, arsenic, copper, lead, molybdenum, U-235/238 and Ra-226/228) concentrations detected in the former CLEAR Plant and former Esperanza Mill areas are naturally derived or from mining/milling, or other anthropogenic sources. The objectives of this work were to 1) assess material from the surface down to the competent bedrock interface, in the unsaturated zone, for variation in concentrations of COPCs with depth and lithology; and 2) link COPC concentrations in soil to regional background trends and/or provide evidence of isolated elevated soil COPC concentrations away from known mining and milling impacts.

This work provided a technical basis for the occurrence of elevated concentrations of COPCs in soil at the Sierrita Mine. The report concluded that the alluvium thickness, depth to bedrock and alluvial materials observed in the background area were comparable to the former CLEAR Plant and former Esperanza Mill areas. Therefore from a geological perspective, the areas sampled in this background assessment represent a good match for comparison.

A total of 52 soil samples were collected from separate depth intervals for the background assessment. All samples were collected from the unsaturated zone as groundwater was not encountered in any of the boreholes. Summary statistics for background soils are provided in the table below.

Constituent	Depth (ft bgs)	Number of Samples	Frequency of Detection	Mean of Detections	Minimum Detection	Maximum Detection
Arsenic (mg/kg)	0-0.5	13	100%	2.3	1.2	4
	0-15	50	100%	1.7	0.48	4.5
Copper (mg/kg)	0-0.5	13	100%	245	53	710
	0-15	50	100%	181	7.6	710
Lead (mg/kg)	0-0.5	13	100%	6.0	4.3	8.7
	0-15	50	100%	4.5	0.78	8.7
Molybdenum (mg/kg)	0-0.5	13	100%	48	1.2	270
	0-15	50	100%	20	0.93	270
Uranium (mg/kg)	0-0.5	13	100%	2.8	0.67	5
	0-15	50	100%	2.8	0.67	8
Radium-226 (pCi/g)	0-0.5	13	100%	2.0	1.27	3.09
	0-15	50	100%	2.3	0.95	9.1
Radium-228 (pCi/g)	0-0.5	13	100%	1.85	1.2	2.84
	0-15	50	100%	1.68	0.97	2.84
Uranium-238 (pCi/g)	0-0.5	13	100%	1.53	0.9	2.54
	0-15	13	100%	1.53	0.9	2.54
Uranium-235 (pCi/g)	0-0.5	13	46%	0.092	0.077	0.111
	0-15	13	46%	0.092	0.077	0.111

As described in Section 2.4.1, based on comments received from ADEQ on March 5, 2019 and May 20, 2019 and resolution reached during the June 19, 2019 conference call, ADEQ requested that the background Ra-226 values not be used herein and recommended that the background uranium isotope results (i.e., U-238 and U-234) be substituted as a surrogate, as further discussed in Section 5.7.1 below.

3.2 Data Gaps Investigation

A revised Data Gaps Work Plan (Arcadis 2015b) was submitted to the ADEQ in June 2015. The objective of the data gaps investigation was to collect the remaining data identified by the ADEQ and Sierrita to complete site characterization for the VRP (Arcadis 2015b). During a meeting on August 3, 2017, the decision was made by ADEQ that the groundwater investigation and sampling work that was identified to be conducted in the Data Gaps Work Plan was no longer required by the VRP.

The Data Gaps Work Plan also proposed that confirmation soil samples be collected from the former CLEAR Plant and former Raffinate Pond, where antimony concentrations in previously collected soil samples exceeded the GPL. Five soil samples were collected from the former CLEAR Plant EA, and two samples from the former Esperanza Mill EA in June 2016. The samples were collected at a depth of 0.25 ft bgs and submitted for laboratory analysis of total antimony and SPLP in order to derive a site-specific GPL for antimony. The range of detected antimony concentrations was 1.8 mg/kg to 120 mg/kg, which is below the Arizona nr-SRL of 410 mg/kg for antimony.

No other soil or sediment sampling was proposed as part of the data gaps investigation. COI concentrations in soil are not expected to significantly vary on a short-term temporal basis; therefore, no temporal data needs were identified for the soil data collection program.

4 GUIDANCE DOCUMENTS USED TO CONDUCT THE BASELINE HUMAN HEALTH RISK ASSESSMENT

The methods and approach for the BHHRA are based primarily on the following (but not limited to) Arizona and USEPA risk assessment guidance documents:

- Deterministic Risk Assessment Guidance (Arizona Department of Health Services [ADHS] 2003)
- Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual, Part A (U.S. Environmental Protection Agency [USEPA] 1989)
- RAGS, Volume 1: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment (USEPA 2004)
- RAGS, Volume I: Human Health Evaluation Manual, Part F, Supplemental Guidance for Inhalation Risk Assessment (USEPA 2009a)
- Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites (USEPA 2002)
- ProUCL Version 5.1. User Guide (USEPA 2015a)
- ProUCL Version 5.1. Technical Guide (USEPA 2015b)
- Guidelines for Exposure Assessment (USEPA 1992)
- Exposure Factors Handbook (USEPA 1997, 2011)
- Guidelines for Carcinogen Risk Assessment (USEPA 2005)
- OSWER Directive 9285.7-53, Human Health Toxicity Values in Superfund Risk Assessments (USEPA 2003a)
- Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors (USEPA 2014a)
- Frequently Asked Questions About Update of Standard Default Exposure Factors (USEPA 2014b)
- Soil Screening Guidance for Radionuclides: Technical Background Document (USEPA 2000)
- Preliminary Remediation Goals for Radionuclides. User's Guide (USEPA 2014c).

5 DATA USED TO CONDUCT THE BASELINE HUMAN HEALTH RISK ASSESSMENT

This section discusses the media considered and evaluated, data used, data usability review performed for the data used, definition of EAs, identification of BHHRA datasets, selection of constituents of potential concern (COPCs) for each EA, and derivation of media-specific exposure point concentrations (EPCs) for each EA.

5.1 Media Considered and Evaluated for the Baseline Human Health Risk Assessment

Based on former site operations, previous environmental investigations have focused on potential impacts to soil, sediment, and groundwater. This BHHRA evaluates the potential for adverse human health effects from exposure to site-related constituents in soil and sediment. The available soil and sediment data were combined into a single dataset, termed “soil/sediment”, because the sediment samples were collected from inactive, backfilled ponds or drainage courses that are dry for most of the year. As a result, the potential for human exposure to soil or sediment is the same.

As discussed in the ADEQ approved BHHRA Work Plan (Arcadis 2015a), the potential for adverse human health effects from exposure to groundwater was not evaluated in this BHHRA because groundwater is not currently being used for potable purposes at the Site, nor is it expected to be used as a potable water source in the future. Additionally, groundwater is either captured by the pit dewatering or Sierrita tailings impoundment interceptor well field and is also monitored under the Arizona Aquifer Protection Permit program.

Similarly, surface water was not evaluated because it occurs in on-site drainages only for short durations after precipitation events and is not currently being used for industrial or potable water purposes. In addition, surface water drainage features are typically avoided during and immediately following storm events due to the potential for flash flooding. Finally, the site-related metals are not volatile and are relatively immobile in soil/sediment.

Based on these site conditions, human receptors may be exposed to site-related metals in on-site soil/sediment and fugitive dust. In addition, as discussed in the SSCR Addendum (Arcadis 2013b), the unconsolidated deposits and parent bedrock complex at the Sierrita mine contain natural levels of radioactivity at concentrations and activities consistent with a highly mineralized area. Radionuclides were detected in on-site soil/sediment samples collected as part of the VRP soil and sediment investigation in 2008. Therefore, human receptors may be exposed to radionuclides in addition to the site-related metals.

In 2018, Arcadis completed a background assessment to investigate whether elevated concentrations of metals and radionuclide activity identified at the Site are naturally derived or from mining/milling, or other anthropogenic sources. The results of the assessment indicate that radionuclide (e.g., Ra-226, Ra-228, U-235, and U-238) activities are comparable to those encountered in both the regional bedrock and Site EAs. Ra-226, Ra-228, and total uranium increase with depth and show higher activities/concentrations in bedrock than in alluvial samples. This reflects their natural origin in bedrock material.

5.2 Available Site Soil and Sediment Data

The following soil and sediment data were used to conduct the BHHRA.

- Total metals data from soil samples collected by HGC in 2004 (HGC 2008)
- Total metals and radionuclide data from soil and sediment samples collected by URS in 2008 (URS 2012; Arcadis 2013a)
- Total metals data from soil samples collected in 2012 to support construction of the new training facility near the former CLEAR Plant building (Arcadis 2013c), with the exception of data from stockpiled soils that have since been removed from the Site
- Total metals data from soil samples collected in 2015 to support construction of two paving areas near the former CLEAR Plant building (Arcadis 2015c).

Table 5-1 provides a summary of the available soil/sediment data, including the number of soil and sediment samples collected during each previous site investigation and their selected analyses. Table 5-1 also provides information on sample collection methods and analytical methods in order to facilitate the data review described below.

5.3 Data Usability

Laboratory analytical data used in this BHHRA were subject to a review to verify the data completeness, accuracy, and ultimately the data usability. The key components of the data review are consistent with USEPA (1989, 1992) risk assessment guidance and include:

- Spatial – to ensure that each EA is adequately characterized and data are representative of potential current and future exposures
- Sample size and density – to ensure that EPCs calculated for an exposure area are sufficiently robust and representative of potential current and future exposures
- Temporal applicability – to ensure that data used in the risk assessment are representative of current conditions
- Overall data quality – ascertained through data verification and/or validation
- Evaluation of data qualifiers – specifically with respect to data rejected by the analytical laboratory or during data validation.

Sierrita evaluated the appropriateness of sample locations, adequacy of site characterization (relative to nature and extent), and comprehensiveness of the data collected to date. As part of the exercise, Sierrita evaluated data needed for the risk assessment, constituents that may drive quantitative calculations of risk (e.g., arsenic), and any potential gaps in the data collected to date as they relate to the ability to complete the BHHRA report. Potential data gaps include bioavailability data to assist with the analysis of arsenic. As stated in Section 3.2, concentrations of metals and radionuclides in soil are not expected to significantly vary on a short-term basis; therefore, no temporal data needs were identified for the soil data collection program.

The selection of sample locations contributes to representativeness of the analytical data. Judgmental or biased sampling results in a greater likelihood that analytical data are adequately protective of potential current and future exposures. Most soil and sediment sample locations were chosen based on professional judgment and were biased toward areas identified as potential sources of site-related COIs. Soil samples submitted for laboratory analysis by HGC in 2004 were selected based on their potential to generate acid solutions. In 2008, URS collected judgmental soil samples based on previous sampling results (e.g., locations where COI concentrations in HGC samples exceeded nr-SRLs). Sediment samples were collected from areas of probable sediment accumulation (URS 2012). In 2013, Arcadis collected confirmation soil samples from areas where analytical results from the initial sampling event to support construction of the new training facility revealed metals concentrations greater than r-SRLs; however, for logistical or safety reasons, no additional excavation of material took place.

Gridded sampling also contributes to representativeness of the analytical data. In 2008, URS collected soil samples at randomly selected grid nodes from a system of 200-square-foot grid units placed over the former CLEAR Plant area and former Esperanza Mill area. Gridded collection of soil samples was conducted by Arcadis in 2013 and 2015 as part of the paving of areas in the CLEAR Plant to ensure adequate spatial coverage and collection of a sufficient number of samples to consider the dataset representative for use in the evaluation of potential current and future exposures.

Table 5-1 contains information on the soil and sediment sampling and analytical methods used during different investigations. A variety of sampling methods has been used, including surficial soil sampling using plastic trowels, disposable plastic scoops, and hand augers; backhoe bucket sample collection; and Macrocore sampling from soil and sediment borings installed using direct-push techniques and Geoprobe® tooling. While sampling methods and selected laboratories have varied, the requested analytical methods for metals have remained the same across different investigations (USEPA Method 6020 inductively coupled plasma-mass spectrometry [ICP-MS] or USEPA Method 6010 inductively coupled plasma-atomic emission spectroscopy [ICP-AES], and USEPA Method 7471A cold vapor atomic absorption [CVAA] for mercury). This contributes to the comparability of data from different site investigations.

Soil samples collected by Arcadis to support construction of the new training facility and associated paving areas in the former CLEAR Plant area were evaluated to assess the quality and reliability of the metals data. Laboratory results were subject to Level II data validation per the USEPA Functional Guidelines for Inorganic Data Review, in accordance with criteria specified in the VRP QAPP (URS 2008b). The Level II data validation included a review of the chain of custody and sample receipt, holding times, method blanks, matrix spike/matrix spike duplicate (MS/MSD) recoveries and relative percent difference (RPD), field duplicate RPD, laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recoveries and RPD, and package completeness. Overall, the results were considered usable, and project data objectives specified in the QAPP were met. Analytical results for two soil samples collected to support construction of the new training facility were qualified “J” (estimated) due to the RPD between field duplicate sample pairs being above acceptable limits. Additionally, copper results for 14 soil samples were qualified “J” (estimated) due to MS/MSD recovery being above acceptable limits. The uranium result in one sample collected for the paving areas project was also qualified due to MS/MSD criteria not being met. No analytical results were rejected as a result of data validation. Data validation summaries are provided in Arcadis 2013a and Arcadis 2015c.

It was assumed that historical data quality assessments (i.e., data validation) performed by previous consultants were accurate, and no additional assessments were completed by Arcadis. HGC (2008) indicates that an internal laboratory QC review was performed on their soil data. URS (2012) describes the 100% data verification and 10% Level II data validation performed for the VRP investigation. A data verification memo and summary table, along with data validation reports, are presented in appendices to the SSCR (URS 2012). Overall, all URS data were determined to be usable, with a proportion of the data qualified per Arizona Data Qualifiers, Revision 3.0, September 20, 2007 (URS 2012).

5.4 Exposure Areas

The specific EAs evaluated in this BHHRA, which are consistent with those assessed by URS in 2011 (URS 2012), are listed below:

- Former CLEAR Plant EA, composed of the following subareas:
  - Former CLEAR Plant
  - Former E Pond
  - Former Evaporation Pond
  - Old D Pond
- Former Esperanza Mill EA, composed of the following subareas:
  - Former Esperanza Mill
  - Former C Pond and C Pond Spoils
  - Former Raffinate Pond
  - Former Laydown Yard.

The former Rhenium Ponds area was historically investigated for environmental impacts; however, in the meeting at ADEQ on September 30, 2016, Sierrita requested the removal of the ponds from the VRP since the facilities are part of an active aquifer protection permitted facility. Therefore, the former Rhenium Ponds were not evaluated in this BHHRA.

Figure 5-1 shows the relative locations of the former CLEAR Plant EA and former Esperanza Mill EA. Figures 5-2 through 5-3 show the locations of soil and sediment (if applicable) samples collected at each subarea.

5.5 Identification of Baseline Human Health Risk Assessment Datasets

The following sections describe how the EA-specific datasets were developed for this BHHRA and the handling of field duplicate sample results. Table 5-2 provides an inventory of the soil and sediment samples for each EA, including location subarea, sample depth, applicable dataset(s), and additional sample descriptor. The analytical results of soil and sediment samples used to conduct the BHHRA are presented in Appendix A.

5.5.1 Depth Interval-Specific Datasets

Soil and sediment samples were also grouped into three separate sample intervals (two shallow intervals and one shallow and deep interval) for this BHHRA as follows:

- The shallow soil/sediment interval (0 to 0.5 feet bgs or 0 to 2 feet bgs) datasets were developed to evaluate potential human exposure assuming the continuation of current activities/operations at the Site (i.e., current scenario). In accordance with the BHHRA Work Plan, only one shallow soil/sediment depth interval was evaluated for each EA. The shallow depth range was selected by calculating the total risk posed by the site-related COPCs for both the 0 to 0.5 feet bgs and 0 to 2 feet bgs soil depth intervals and selecting the shallow depth interval with the highest COPC EPCs.
- The shallow and deep soil/sediment interval (0 to 15 feet bgs) dataset was developed to evaluate hypothetical future human exposure to account for potential excavation and redistribution of soil/sediment during on-site development activities (e.g., construction of commercial/industrial structures [i.e., hypothetical future scenario]). This depth interval was also used to evaluate a hypothetical future unrestricted land use scenario, as addressed in Appendix F. Soil and sediment samples with a top or starting sample depth shallower than the bottom or ending depth of the depth interval defined above were included in the dataset for a specific depth interval. As such, a sample with a top depth of 0 foot bgs was included in all three depth-specific datasets; a sample with a top depth of 0.5 foot bgs, 1 foot bgs, or 1.5 feet bgs was included in all except the 0- to 0.5-foot bgs dataset; and a sample with a top depth of 2 feet bgs or greater was only included in the 0- to 15-foot bgs dataset.

5.5.2 Former CLEAR Plant Shallow Soil/Sediment Datasets

In 2012, discrete soil samples were collected from excavations for a new training facility building and associated parking lot areas within the former CLEAR Plant EA. Additional paved areas occupying approximately 0.9 acre were constructed in 2015. Ninety-two samples were identified as being either currently covered with pavement or a building. Therefore, separate shallow soil/sediment datasets were created for the former CLEAR Plant EA to evaluate current and hypothetical future conditions. The current scenario dataset consists of samples that are currently not covered by pavement or buildings (i.e., the soil is exposed and the potential for exposure to receptors exists). The hypothetical future scenario dataset consists of all samples collected from the CLEAR Plant EA. Table 5-2 presents the samples used in each dataset.

Separate current and future scenario shallow soil/sediment datasets were not required for the former Esperanza Mill EA. Soil samples were not collected from beneath buildings or pavement in these areas.

5.5.3 Handling of Field Duplicate Results

In accordance with the QAPP Addendum prepared for the Site (URS 2008b) and the ADEQ-approved BHHRA Work Plan (Arcadis 2015a), any field duplicate collected as part of site investigations considered in this BHHRA was treated as a quality control (QC) sample and was not used to characterize the Site (i.e., the parent sample result was used regardless of the duplicate result). Therefore, the parent analytical result was considered representative of that sample and constituent. Relative percent

difference between parent and duplicate results have been evaluated in previous reports (URS 2012, Arcadis 2013a,c).

5.6 Selection of Constituents of Potential Concern

The selection of COPCs focuses the BHHRA on the site-related constituents that are most likely to present human health risks. COPCs were selected on an EA-specific basis consistent with the ADEQ-approved BHHRA Work Plan. Constituents detected in at least one soil or sediment sample were considered COPCs unless one of the following criteria was met:

- For metals, the highest detected concentration in soil and sediment was less than the corresponding nr-SRL.
- For radionuclides, the highest reported activity in soil and sediment was less than the corresponding USEPA Preliminary Remediation Goal (PRG; USEPA 2014c), when available.
- The constituent was detected in less than 5 percent of the soil/sediment samples, and no “hotspots” were identified. ADHS (2003) defines hotspots as areas yielding one or more samples that contain constituent concentrations that exceed the relevant SRL by a factor of 10 or more.

Constituents that were not eliminated by the criteria listed above were selected as COPCs for evaluation in this BHHRA for each EA.

Table 5-3 presents the Arizona SRLs and USEPA PRGs used to select COPCs in soil/sediment at the Site. Tables 5-4 through 5-19 provide the results of the COPC selection process for each EA. These tables also provide summary statistics, including the number of detections, number of samples, frequency of detection, minimum and maximum reporting limits and detected concentrations, location of maximum detected concentration, mean detected concentration for each detected constituent, and applicable depth interval (0 to 0.5 foot bgs or 0 to 2 feet bgs and 0 to15 feet bgs). In addition, Tables 5-4 through 5-19 provide the 95% UCL, if calculable, as discussed in Section 5.7 for constituents identified as COPCs. The following COPCs were identified for each EA:

- Former CLEAR Plant EA – arsenic, copper, lead, Ra-226, Ra-228, U-235, and U-238
- Former Esperanza Mill EA – arsenic, lead, molybdenum, Ra-226, Ra-228, U-235, and U-238

5.7 Exposure Point Concentrations

An EPC is the COPC concentration to which a hypothetical receptor might be exposed through potentially complete exposure routes. The sections below describe the basis for the established EPCs in soil/sediment and outdoor air.

5.7.1 Soil/Sediment Exposure Point Concentrations

To estimate exposure to COPCs in soil/sediment, the concentration term in the risk equation was calculated as the average of the concentration that could be contacted at the exposure point or points over the exposure period (USEPA 1989, 1992). The EPC is defined as “the arithmetic average of the concentration that is contacted over the exposure period” (USEPA 1989). The 95% UCL is defined as the value that, when calculated repeatedly for randomly drawn subsets of data, equals or exceeds the true

mean 95% of the time (USEPA 1992). Use of the 95% UCL (as representative of the average concentration) is recommended instead of the maximum concentration because it is highly unlikely that a receptor will be exposed to a single (e.g., maximum) concentration over the entire exposure duration. Rather, a receptor will likely be exposed to a range of concentrations in the EA, from not detected to the maximum concentration, over the entire exposure period. In the event that a UCL exceeds the maximum detected concentration, the maximum concentration was used to represent the EPC.

USEPA recommends caution in the use of UCLs for small datasets (e.g., fewer than four detects or 10 total samples) because the performance of the various methods may not be reliable in these cases (USEPA 2013b). Typically, at least five detected concentrations and 10 total samples are necessary to calculate UCLs on the mean concentration (i.e., 95% UCLs; USEPA 2013a). If sufficient data (i.e., at least eight samples with at least five detected concentrations) were available, a conservatively based 95% UCL was estimated using the USEPA-released statistical software ProUCL Version 5.1 (ProUCL 5.1) (USEPA 2015a, 2015b, 2015c). ProUCL 5.1 employs statistical methods to evaluate both full environmental datasets without not detected (ND) values and datasets with below detection limit or ND values (also known as left-censored datasets) without the use of proxy values. Based on the results of ProUCL analyses, the lesser of the UCL (if calculated) or maximum detected concentration of a COPC was selected as the EPC (USEPA 1989). Where ProUCL 5.1 recommended two or more potential 95% UCLs, the estimate that best represented the data set was selected based on the most appropriate 95% UCL method. The multiple UCL selection process is documented in the BHHRA tables (e.g., see Table 5-24). In the event of insufficient data, the maximum detected concentration was used in place of a 95% UCL. ProUCL output results of COPCs for both EAs are presented in Appendix B.

The contribution of all radionuclides in each naturally-occurring decay series was included in the cancer risk calculations. The 95% UCLs calculated by ProUCL were used as EPCs for the radionuclides for which site-specific data are available, and as surrogate EPCs for all of the subsequent radionuclides in their respective decay series, up to the next radionuclide with site-specific data available. As summarized above in Section 5.6, the radionuclides identified as COPCs for both EAs are Ra-226, Ra-228, U-235, and U-238. U-238 and Ra-226, along with U-234 for which site-specific data are also available, are members of the uranium decay series. Ra-228 is in the thorium decay series, and U-235 is the long-lived parent in the actinium decay series. Therefore, to evaluate cancer risk from exposure to radionuclides in the uranium series, the 95% UCL for U-238 was used for U-238 and its daughters thorium-234 and proactinium-234; the 95% UCL for U-234 was used for U-234 and thorium-230; and the 95% UCL for Ra-226 was used for Ra-226 and all the remaining decay products in the series. For the thorium series, it was assumed the long-lived parent (thorium-232 [Th-232]) is in secular equilibrium with its daughter, Ra-228, and all subsequent radionuclides in the series.

EPCs were initially developed for three soil/sediment depth intervals (two shallow intervals and one shallow and deep interval) for each receptor scenario; however, only two soil depth intervals (one shallow interval and one shallow and deep interval) were evaluated for each EA (see Section 5.5). The rationale for calculating EPCs over multiple depth intervals is to capture the variable sampling depths of the soil dataset, and to meet requirements of A.R.S. § 49-152, which identify up to 15 feet of soil as “surface soil”. Evaluating a 0 to 15 ft bgs depth is consistent with the ADEQ-approved BHHRA Work Plan (Arcadis 2015a). As a conservative measure, only the shallow depth range (either 0 to 0.5 ft bgs or 0 to 2 ft bgs)

with the highest COPC EPCs was selected as the shallow soil depth range used in the BHHRA. The shallow soil depth intervals selected for each EA are presented in Tables 5-20 through 5-24.

In addition, to address ADEQ comment K20 (Appendix H), soil only EPCs were also calculated for the 0 to 15 ft bgs dataset to eliminate any potential bias via the inclusion of the sediment data into a single soil/sediment dataset. As a conservative measure, the two EPCs (one based on the soil and sediment dataset and the other based on the soil only dataset) were compared and the highest EPC for each COPC was selected for the shallow and deep soil/sediment depth interval and used in the BHHRA.

Tables 5-20 through 5-24 present the EPCs for COPCs in soil/sediment for the selected shallow soil/sediment depth intervals and the shallow and deep soil/sediment depth intervals.

5.7.2 Air Exposure Point Concentrations

The inhalation of constituents adsorbed to airborne soil dust particles is a potentially complete exposure pathway for all receptors evaluated in this BHHRA. Potential exposure to COPCs adsorbed to soil particles and released to air from wind erosion or during soil invasive activities was evaluated using particulate emission factors (PEFs). In accordance with the ADEQ-approved BHHRA Work Plan (Arcadis 2015a), a default PEF value was used (ADHS 2003) for all receptors in this BHHRA.

5.7.3 Background Exposure Point Concentrations

The presence of naturally-occurring COPCs was incorporated into the BHHRA through reference area soil sampling and subsequent background EPC calculation. As discussed in Section 3.1.5, a background study was conducted in 2018 to investigate whether COPC concentrations detected in the former CLEAR Plant and former Esperanza Mill areas are naturally derived or from mining/milling, or other anthropogenic sources. The background soil data were used to calculate background risks/HIs in this BHHRA, and incremental risks/HIs were calculated as the total Site risks/HIs minus background risks/HIs. For this exercise, the arithmetic means of detected concentrations were used as the EPCs for both the Site and background datasets.

Background mean concentrations were calculated using the background soil dataset and ProUCL 5.1. Similar to the Site datasets discussed in Section 5.5.1, background datasets for shallow soil intervals (0 to 0.5 feet bgs or 0 to 2 feet bgs) were evaluated. The table below shows a comparison of COPC background mean concentrations for the two shallow soil depth intervals.

Constituent	Arsenic (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Molybdenum (mg/kg)	Ra-226 (pCi/g)	Ra-228 (pCi/g)	U-238 (pCi/g)	U-235 (pCi/g)
0-0.5 ft Interval	2.3	245	6.0	48	2.0	1.9	1.5	0.09
0-2 ft Interval	1.9	210	5.2	32	2.0	1.7	1.4	0.10

The background means for the 0 to 0.5 feet bgs interval are higher than those for the 0 to 2 feet bgs interval for all COPCs except U-235 where the difference is minimal (approximately 11% percent).

Therefore, the means for the 0 to 0.5 feet bgs interval were used as shallow soil EPCs to determine the contribution of background to the total risks and hazards calculated based on the Site EPCs. This interval is consistent with the interval used for the Site EPCs (i.e., 0 to 0.5 ft bgs). ProUCL output results for background soils are presented in Appendix G.

As described in Section 5.7.1, the contribution of all radionuclides in each naturally-occurring decay series was included in the background radiological risk calculations. The mean concentrations calculated by ProUCL were used as EPCs for the radionuclides for which site-specific data are available, and as surrogate EPCs for all of their decay products, up to the next radionuclide with site-specific data available. The exception to this EPC substitution process is that the Ra-226 mean concentrations were not used due to a question raised about the laboratory quality of these data in the May 20, 2019 memo. In this case, only the background mean concentrations for U-238 and U-234 were used as EPCs or surrogate EPCs for all members of the uranium decay series.

6 EXPOSURE ASSESSMENT

Exposure assessment is the process of identifying potential receptors and estimating the type and magnitude of potential human exposure to COPCs at the Site. It includes information regarding the models and parameters necessary to estimate human exposure through ingestion, dermal absorption, inhalation, and other exposure routes evaluated (e.g., external exposure to ionizing radiation). Figure 6-1 presents the human health CSM for the Site and illustrates the potential sources of COPCs in soil/sediment, release and transport mechanisms, potential exposure media, and exposure routes for potential human receptor populations (described in more detail below). The following exposure pathway analysis describes each component of the human health CSM in more detail.

6.1 Exposure Pathway Analysis

An exposure pathway is a mechanism by which receptors may come into contact with site-related COPCs. USEPA (1989) describes a complete exposure pathway in terms of four components:

1. Source and mechanism of COPC release (e.g., discharge of process wastewaters to unlined surface impoundments)
2. Retention or transport medium (e.g., soil or sediment)
3. Receptor at a point of potential exposure to an impacted medium (e.g., outdoor commercial/industrial workers)
4. Complete exposure route (e.g., incidental ingestion) at the point of exposure.

If any of these four components is not present, a potential exposure pathway is considered incomplete and is not evaluated further in this BHHRA. Each of the complete or potentially complete exposure pathways identified in Figure 6-1 was quantitatively evaluated in this BHHRA.

6.1.1 Sources and Mechanisms of COPC Release

The sources and mechanisms of COPC release at the Site are related to processing activities that historically occurred within each EA, which include:

- Historical processes used to refine ore
- Storage of reagents and other solutions
- Accidental spills.

6.1.2 Transport Mechanisms

All of the above listed processes have contributed to deposition of site-related constituents onto surface soils and sediments. Constituents present in the surface may also migrate downward into deeper soils through leaching and to other locations on site through transport of wind-blown dust and surface runoff. The vertical transport of COPCs is driven by precipitation, which occurs during the wet season (mid-June through September), when rapid pulses of water move into the alluvium. Constituent transport in sediment of natural drainage channels at the Site is likewise limited to the wet season and/or significant precipitation events, when flushing occurs (Arcadis 2015a). Finally, constituent concentrations present between 0 and 15 ft bgs may be redistributed during future construction/development activities should they occur at either of the EAs. Inclusion of sediment data in this 0 to 15 ft bgs dataset was evaluated initially as a conservative approach, as future construction/development activities are not likely to occur in the on-site drainage features. However, to address the ADEQ comment (Comment K20; Appendix H) that the inclusion of sediment samples may be influencing the soil/sediment EPCs, soil only EPCs were calculated for the 0 to 15 ft bgs dataset. The following table provides the COPC-specific soil/sediment UCLs and the soil only UCLs, and presents the selected UCL that was used as the EPC for the 0 to 15 ft bgs dataset.

Former Clear Plant EA

COPC	Soil/Sediment All Samples 0-15 ft bgs	Soil Only All Samples 0-15 ft bgs	Selected UCL All Samples 0-15 ft bgs
Antimony	5.11	6.91	6.91
Arsenic	8.86	9.99	9.99
Copper	6495	7390	7390
Lead	183.1	209.3	209.3
Molybdenum	375.6	502.6	502.6
Radium-226	2.41	2.58	2.58
Radium-228	2.42	2.52	2.52
Uranium-234	2.78	3.07	3.07

Former Clear Plant EA

COPC	Soil/Sediment All Samples 0-15 ft bgs	Soil Only All Samples 0-15 ft bgs	Selected UCL All Samples 0-15 ft bgs
Uranium-235	0.16	0.19	0.19
Uranium-238	2.87	3.15	3.15

Former Esperanza Mill EA

COPC	Soil/Sediment All Samples 0-15 ft bgs	Soil Only All Samples 0-15 ft bgs	Selected UCL All Samples 0-15 ft bgs
Antimony	4.64	4.63	4.64
Arsenic	12.63	12.85	12.85
Copper	4658	4603	4658
Lead	132.6	132.2	132.6
Molybdenum	1440	1335	1440
Uranium	5.89	7.17	7.17
Radium-226	2.43	2.42	2.43
Radium-228	2.48	2.51	2.51
Uranium-234	2.69	2.71	2.71
Uranium-235	0.116	0.120	0.120
Uranium-238	2.74	2.76	2.76

As a conservative measure, the higher of the two EPCs (one based on the soil/sediment dataset, and the other based on the soil only dataset) was selected for use in the risk calculations for the hypothetical future scenario.

6.1.3 Potential Receptors

Human receptors evaluated in the BHHRA were chosen based on the current and potential future uses of an EA. Given that the Site is an active mine, the reasonably expected current and future receptors include on-site outdoor commercial/industrial workers, future on-site construction workers, and future on-site trespassers. Further description of each receptor and the basis for selection are discussed below.

6.1.3.1 Current/Future Receptors

The only on-site receptors identified based on the current and most likely future land use of the Site are outdoor commercial/industrial workers, who may be exposed to COPCs present in shallow soil/sediment and particulates in outdoor air when they are storing equipment and supplies at the former CLEAR Plant EA or performing maintenance work and other routine activities at the former Esperanza Mill EA.

As noted earlier in Section 2.3, buildings (used for training and storage) currently exist in the former CLEAR Plant EA. An indoor commercial/industrial worker was not evaluated, primarily because the vapor intrusion pathway (which could contribute significantly to indoor impacts) is incomplete for the two EAs, as only metals are chemical COPCs. Radionuclides, including Ra-226, were also identified as COPCs; therefore, the potential for radon gas generation was considered. Ra-226 activity detected in soil/sediment at the Site is relatively low, with 95% UCLs ranging from 2.41 pCi/g (former CLEAR Plant EA) to 2.43 pCi/g (former Esperanza Mill EA), and may be associated with ambient conditions. These Ra-226 UCLs, which were used as EPCs in this BHHRA, are lower than the 5 pCi/g Ra-226 cleanup criterion established by the USEPA for surface soil at sites with residual radioactive contamination (USEPA 1990b, 40 Code of Federal Regulations [CFR] Part 192). The USEPA criterion of 5 pCi/g was intended to limit gamma radiation exposure and to limit the risk from inhalation of radon decay products in houses built on land containing radioactive tailings. Based on these considerations, the indoor air pathway was not evaluated further.

Because radionuclides are identified as COPCs, potential indoor-related exposures (exposure while in commercial buildings) were evaluated in this BHHRA. If potential impacts estimated for an outdoor commercial/industrial worker (who is expected to be in contact with COPCs in soils/particulates in air throughout the duration of employment) are below agency threshold levels of concern, then it is assumed that impacts will be even lower for an indoor commercial/industrial worker due to the shielding effects of buildings.

6.1.3.2 Hypothetical Future Receptors

Based on the unlikely event that the Site is redeveloped in the future, the following hypothetical future receptors were evaluated:

- Future On-site Outdoor Commercial/Industrial Worker – Future outdoor worker exposure is expected to be the same as that for the current outdoor worker exposure discussed in Section 6.1.3.1.
- Future On-site Construction Worker - A future on-site construction worker was selected because this worker may be exposed to COPCs in the unlikely event that the Site is redeveloped.
- Future On-site Trespasser[1] - A future on-site trespasser was selected because a person could illegally access the property in the future and potentially be exposed to COPCs in soil/sediment. For

[1] Trespassing is not a viable current exposure scenario, considering the Sierrita mine is privately owned and operated. Access to the Site is strictly controlled, and the Site is not accessible to the public. Under these conditions, a current trespasser exposure scenario is not realistic or practical for making risk management decisions. However, for the former CLEAR Plant EA, trespasser exposure was also evaluated using the current (exposed soil/sediment) dataset in the event that someone could access the Site prior to redevelopment (pavement and vacant buildings remain on site).

the purpose of the BHHRA, it is anticipated that, if chronic trespassing were to occur at the Site in the future, it would more likely involve an adolescent aged individual rather than an adult. Therefore, an adolescent trespasser was evaluated under a hypothetical future exposure scenario.

6.1.4 Potentially Complete Exposure Routes

Potential receptors may be exposed to COPCs in soil/sediment through the following exposure routes:

- Incidental ingestion
- Dermal contact
- External exposure (i.e., ionizing radiation)
- Inhalation of particulates (e.g., alpha particles or wind-blown dust particles).

6.2 Exposure Parameters

6.2.1 Reasonable Maximum Exposure

Consistent with ADHS (2003) guidance, potential human receptors were evaluated under reasonable maximum exposure (RME) scenarios based on an appropriate combination of central tendency and upper-bound exposure parameters. The RME evaluation results in risk estimates that exceed central tendency exposure scenarios in all cases. The “high end” exposure estimate or RME is defined as the highest exposure that is reasonably expected to occur at a site but that is still within the range of possibility (USEPA 1989). Such a focus on RME scenarios provides an additional measure of health protectiveness.

Human health exposure parameters for each receptor evaluated in this BHHRA are presented in Table 6-1. The RME parameters provided in this table reflect ADHS- and USEPA-recommended values for chronic and subchronic exposures.

6.2.2 Site-Specific Exposure

Table 6-1 also presents site-specific parameters that were used in a separate evaluation of potential outdoor commercial/industrial worker exposures. The site-specific parameters consider actual worker activities and are more representative of potential exposures under the current and foreseeable future land uses at each EA than are the RME parameters.

Typically, outdoor workers do not spend an entire 8-hour workday within the former CLEAR Plant EA or former Esperanza Mill EA. Instead, they travel in and out of these EAs, as well as indoors and other areas of the Sierrita mine facility, throughout the day. An exposure time of 4 hours per day was therefore used in the site-specific evaluation of potential outdoor worker exposures at the former CLEAR Plant EA and former Esperanza Mill EA. All other exposure parameters were the same as used for the RME evaluation.

6.3 Dose (Intake) Estimation

For incidental ingestion and dermal contact with soil/sediment, when evaluating exposure to potential carcinogens, lifetime average daily doses (LADDs) were calculated by averaging exposure over an expected 78-year lifespan. When evaluating exposure to noncarcinogens, doses were estimated as average daily doses (ADDs), calculated as the average exposure for the time the receptor is assumed to be exposed to the COPC. Radionuclide exposures were calculated using the USEPA approach (USEPA 2000; 2014c). Exposures were calculated using the equations recommended by USEPA (1989, 2004) for the potentially complete routes identified in the CSM (Figure 6-1) using the exposure parameters summarized in Table 6-1.

The following sections describe the methods and inputs used to calculate LADDs for carcinogenic COPCs and ADDs for noncarcinogenic COPCs.

6.3.1 Carcinogenic Effects from Chemical COPCs

For chemical constituents with potential carcinogenic effects, the LADD is an estimate of potential daily intake over the course of a lifetime. In accordance with USEPA (1989), the LADD is calculated by averaging the assumed exposure during the receptor's entire lifetime (assumed to be 78 years). For incidental ingestion and dermal exposure, the LADD for each constituent via each route of exposure is multiplied by the oral slope factor (OSF; adjusted by the gastrointestinal absorbance factor [ABS_{GI}] for dermal exposures) to estimate the incremental lifetime cancer risk due to exposure to that constituent via that route of exposure. Consistent with USEPA RAGS Part F (2009a) an inhalation exposure concentration (EC) in place of an LADD was calculated to evaluate inhalation of fugitive dust particles in outdoor air.

6.3.2 Noncarcinogenic Effects from Chemical COPCs

The ADD is an estimate of a receptor's potential daily intake from incidental ingestion and dermal contact with constituents in soil with potential noncarcinogenic effects. The ADD does not represent a true average because the assumptions used to derive it do not represent “averages.” In fact, they overestimate the average exposure. According to USEPA (1989), the ADD should be calculated by averaging over the period of time for which the receptor is assumed to be exposed (averaging time = exposure duration [ED] for potential noncarcinogenic risk), not the lifetime. For incidental ingestion and dermal contact with soil exposure routes, the ADD for each constituent via each route of exposure is compared to the respective chronic reference dose (cRfD; adjusted by the ABS_{GI} for dermal exposures) to estimate the potential hazard quotient (HQ) due to exposure to that constituent via that route of exposure. Consistent with USEPA RAGS Part F (2009), an EC, in place of an ADD, was calculated to evaluate inhalation of fugitive dust particles.

If the ED is less than 7 years of a person’s lifetime (i.e., for the hypothetical future construction worker), the ADD or EC represents a subchronic exposure, and subchronic toxicity values were used in place of chronic toxicity values (USEPA 1989).

The following sections present the equations used for chemical COPC dose calculations in this BHHRA for both on-Site and background soils.

6.3.3 Dose Equations

6.3.3.1 Incidental Ingestion of Soil

The doses of chemical COPCs associated with incidental ingestion of soil were calculated as follows:

Equation 6-1:

$$\text{Dose} = \frac{C_{soil} \times CF \times IR_s \times EF \times ED \times RBA}{AT_n \text{ or } AT_c \times BW}$$

Where:

Dose	= ADD or LADD (milligrams per kilogram per day [mg/kg day])
C_{soil}	= COPC EPC in soil (mg/kg)
CF	= conversion factor (1×10^{-6} kilograms per milligram [kg/mg])
IR_s	= soil ingestion rate (milligrams per day)
EF	= exposure frequency (days per year)
ED	= exposure duration (years)
RBA	= relative bioavailability.
AT_n	= averaging time for noncarcinogens (days; ED (years) × 365 days per year)
AT_c	= averaging time for carcinogens (days; lifetime (78 years) × 365 days per year)
BW	= body weight (kilograms [kg])

6.3.3.2 Dermal Contact with Soil

Absorbed doses of chemical COPCs associated with dermal contact with soil were calculated as follows:

Equation 6 2:

$$\text{Dose} = \frac{C_{soil} \times CF \times SSA \times SAR \times ABS_d \times EF \times ED}{AT_n \text{ or } AT_c \times BW}$$

Where:

Dose	= ADD or LADD (mg/kg day)
C_{soil}	= COPC EPC in soil (mg/kg)
CF	= conversion factor (1×10^{-6} kg/mg)
SSA	= exposed skin surface area (square centimeters [cm^2])
SAR	= soil-to-skin adherence rate (milligrams per cm^2 per day)
ABS_d	= dermal absorption factor (unitless; Table 6-2)
EF	= exposure frequency (days per year)
ED	= exposure duration (years)
AT_n	= averaging time for noncarcinogens (days; ED (years) × 365 days per year)
AT_c	= averaging time for carcinogens (days; lifetime (78 years) × 365 days per year)
BW	= body weight (kg)

6.3.3.3 Inhalation of Fugitive Dust Particles

Doses associated with the inhalation of chemical COPCs associated with fugitive dust particles from outdoor air were calculated as follows:

Equation 6-3:

and:

$$EC = \frac{C_{ambient\_air} \times ET \times EF \times ED}{AT_n \text{ or } AT_c}$$

Equation 6-4:

$$C_{ambient\_air} = \frac{C_{soil}}{PEF}$$

Where:

EC	= exposure concentration (milligrams per cubic meter [mg/m^3])
$C_{ambient\_air}$	= COPC EPC in ambient air (mg/m^3)
ET	= exposure time (hours per day)
EF	= exposure frequency (days per year)
ED	= exposure duration (years)
AT_c	= averaging time for carcinogens (hours; lifetime [78 years] × 365 days per year × 24 hours per day)
AT_n	= averaging time for noncarcinogens (hours; ED [years] × 365 days per year × 24 hours per day)
C_{soil}	= COPC EPC in soil (mg/kg)
PEF	= particulate emission factor (cubic meter(s) per kilogram [m^3/kg])

Toxicity values used, along with the chemical COPC doses estimated above, are discussed in Section 7.

6.3.3.4 Bioavailability of Metals

Oral bioavailability reflects the amount of a constituent absorbed into the body following ingestion. The typical assumption when calculating risks to humans is that oral bioavailability is 100%. In the case of lead and arsenic, however, numerous studies that have measured site-specific oral bioavailability indicate that, especially for mine-related materials, the relative bioavailability of lead and arsenic is often much lower than 100% (e.g., Bradham et al. 2011; Drexler and Brattin 2007; USEPA 2010; Casteel et al. 1997; Freeman et al. 1993).

In this BHHRA, bioavailability of all COPCs, with the exception of lead and arsenic, was conservatively set at 100%. The USEPA model used to evaluate lead exposures assumes 30% oral bioavailability (USEPA 2003c). The arsenic oral dose from exposure through incidental ingestion of soil was adjusted using a relative bioavailability (RBA) factor of 0.4 (or 40 percent). This 40 percent RBA is the 'most likely' RBA value from a triangular distribution developed as part of the ADEQ-approved Ajo/Bisbee risk assessment conducted by Brown and Caldwell (BC) (BC 2009). The dataset used to develop that distribution consisted of reported *in vivo* studies on 35 samples from 15 separate sites, including mining

and smelting sites (Damian Applied Toxicology LLC, 2015). The same arsenic RBA was subsequently applied in an ADEQ-approved risk assessment for a similar site in Douglas, Arizona (BC 2013), and in the ADEQ-approved risk assessment to support the development of soil remediation levels at the former United Verde copper smelter near Clarkdale, Arizona (Damian Applied Toxicology LLC, 2015). Based on the similarity in constituents of interest and type of activities at these sites (i.e., potential exposure to arsenic [and other metals] in soils at former mining/smelting facilities), the RBA value of 40 percent is considered appropriate for the evaluation of arsenic exposure at the Sierrita mine as well.

6.3.4 Carcinogenic Effects from Radionuclide COPCs

Unlike chemicals, radionuclide exposure is typically expressed in units of activity (e.g., picoCuries) per unit of the exposure medium, rather than mass per unit. Only the carcinogenic effects of radionuclides are considered. Dose equations are provided in the following sections for the exposure pathways evaluated in this BHHRA: direct ingestion of soil, inhalation of fugitive dusts, and external exposure to penetrating radiation (i.e., gamma radiation and X-rays). Dermal absorption is considered an insignificant exposure pathway for radionuclides and generally is not evaluated (USEPA 2000). Radioactive half-lives and decay constants required for calculating radionuclide exposure doses are from the USEPA PRG Summary Table (USEPA 2014c). For external radiation exposure, required parameters include an area correction factor (ACF) and gamma shielding factor (GSF), which were developed using USEPA guidance (USEPA 2000).

The following sections present the equations used for radionuclide COPC dose calculations in this BHHRA for both on-Site and background soils.

6.3.4.1 Incidental Ingestion of Soil

The doses of radionuclide COPCs associated with incidental ingestion of soil were calculated as follows:

Equation 6-6:

$$\text{Dose (pCi)} = \frac{\text{EC} \times \text{IR}_s \times \text{EF} \times \text{ED} \times [1 - exp(-\lambda \times \text{ED})]}{(\text{CF} \times \text{ED} \times \lambda)}$$

Where:

Dose = dose due to internal exposure (pCi)

EC = exposure concentration (pCi/g)

IR_s = ingestion rate of soil (mg/day)

EF = exposure frequency (days/year)

ED = exposure duration (years)

CF = units conversion factor of 10^3 (g/kg)

λ = decay constant (1/year)

The fraction intake of impacted soil from the Site and background for the ingestion of radionuclides in soil was set at 1 to account for 100 percent of soil exposure coming from either the Site or background areas.

6.3.4.2 Inhalation of Fugitive Dust Particles

Doses associated with the inhalation of radionuclide COPCs associated with fugitive dust particles from outdoor air were calculated as follows:

Equation 6-7:

$$\text{Dose (pCi)} = \frac{\text{EC} \times \text{CF} \times \text{InhR} \times \text{ET} \times \text{CF} \times \text{EF} \times \text{ED} \times [1 - exp(-\lambda \times \text{ED})]}{(\text{PEF} \times \text{ED} \times \lambda)}$$

Where:

Dose = dose due to internal exposure (pCi)

EC = exposure concentration (pCi/g)

CF = units conversion factor of 10^3 (g/kg)

λ = decay constant (1/year)

CF = conversion factor (0.042 days /hr)

EF = exposure frequency (days/year)

ED = exposure duration (years)

ET = exposure time (hrs/day)

InhR = inhalation rate (m^3/day)

PEF = Particulate emission factor (m^3/kg)

6.3.4.3 External Exposure

Doses associated with external exposure to radionuclide COPCs were calculated as follows:

Equation 6-8:

$$\text{Dose (pCi)} = \frac{\text{EC} \times \text{ACF} \times [(\text{ET}_o \times \text{CF} \times \text{GSF}_o) + (\text{ET}_i \times \text{CF} \times \text{GSF}_i)] \times \text{EF} \times \text{ED} \times [1 - exp(-\lambda \times \text{ED})}{365 \text{ days/year} \times \text{ED} \times \lambda}$$

Where:

Dose = dose due to external exposure (pCi)

EC = exposure concentration (pCi/g)

ACF = area correction factor for source area (unitless)

λ = decay constant (1/year)

CF = conversion factor (0.042 days /hr)

EF = exposure frequency (days/year)

ED = exposure duration (years)

ET_o = exposure time, outdoor (hrs/day)

ET_i = exposure time, indoor (hrs/day)

GSF_o = gamma shielding factor, outdoor (unitless)

GSF_i = gamma shielding factor, indoor (unitless)

Toxicity values used, along with the radionuclide COPC doses estimated above, are discussed in Section 7.

6.3.5 Lead Exposure

USEPA's Adult Lead Methodology and Adult Lead Model (USEPA 2003b, 2003c, 2009b) were used to evaluate the potential for adverse health effects from exposure to lead in soil and sediment at the Site.

Exposure to lead is typically evaluated in terms of the increase in blood lead (PbB) concentrations following exposure. The United States Department of Health and Human Services' Centers for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry (ATSDR) have designated, and the USEPA has adopted, 10 micrograms per deciliter (µg/dL) as a PbB concentration of concern to protect sensitive populations (e.g., neonates, infants, and children). This PbB level of concern is the basis of the USEPA Regional Screening Levels of 400 and 800 mg/kg for a typical residential and commercial/industrial exposure, respectively (USEPA 2019). CDC released an updated endpoint for blood lead of 5 µg/dL; however, USEPA has not yet adopted it for use in risk assessment. The USEPA's stated goal for lead is that children have no more than a 5% probability of exceeding a PbB concentration of 10 µg/dL. As such, this level is assumed to also provide protection for adults.

For adult workers exposed to lead, the ALM was used to predict PbB concentrations and estimate the probability that target PbB concentrations are exceeded. The ALM may also be used to evaluate exposure to lead for the hypothetical future adolescent trespasser by modifying exposure parameter values (e.g., exposure frequency, soil ingestion rate) input to the model. With the ALM, concern is for a fetus that may be carried by an exposed pregnant female, with the assumption that the results apply to both exposed females and males as well. Default estimates were used for the statistical measures of PbB, including the 95th percentile PbB concentration in fetus, fetal/maternal PbB ratio ($R_{fetal/maternal}$), biokinetic slope factor, geometric standard deviation on the population mean PbB concentration (GSD_i), and baseline PbB concentration. Default values were also used for exposure parameters such as the lead absorption fraction and averaging time.

USEPA-recommended methods and standard parameters were used (e.g., arithmetic mean as the EPC) to run the ALM.

7 TOXICITY ASSESSMENT

The USEPA derives numerical toxicity values for use in risk assessments. Because the impacts associated with exposure to carcinogens are assessed differently than the hazards associated with exposure to noncarcinogens, the toxicity values for carcinogenic health effects and for noncarcinogenic health effects are derived using different assumptions and methods. This section discusses toxicity values used to assess potential carcinogenic risk and noncarcinogenic hazards for this BHHRA. Tables 7-1 and 7-2 present the toxicity values used to evaluate carcinogenic and noncarcinogenic effects for the oral, dermal, and inhalation exposure routes for chemical COPCs, and the slope factors used to evaluate carcinogenic effects for oral, inhalation, and external exposure routes for radionuclide COPCs.

7.1 Toxicity Values for Carcinogenic Chemicals

The current approach to carcinogenic risk assessment used by USEPA (2005) and other United States regulatory agencies assumes, without confirmatory studies, that exposure to any carcinogen poses a finite probability, however small, of producing a carcinogenic response. OSFs are used in this BHHRA to estimate potential cancer risk and represent the upper-bound probability of carcinogenic response per unit daily intake of a substance throughout a lifetime. OSFs are used to assess risks associated with oral and dermal exposures. Inhalation unit risks (IURs) are used in this BHHRA to estimate potential cancer risk and represent the upper-bound probability of carcinogenic response per unit (1 micrograms per cubic meter [µg/m^3] in air) of a substance throughout a lifetime. OSFs and IURs were used in this BHHRA to assess the ELCR for each receptor and were selected from the following sources (listed in order of priority):

- USEPA Integrated Risk Information System (IRIS; USEPA 2015b)
- USEPA Provisional Peer-Reviewed Toxicity Values (PPRTVs; USEPA 2015d)
- California Environmental Protection Agency (CalEPA) Unit Risk and Cancer Potency Factors (Office of Environmental Health Hazard Assessment [OEHHA] 2009)
- USEPA Health Effects Assessment Summary Tables (USEPA 2015e).

7.2 Toxicity Values for Noncarcinogenic Chemicals

Noncarcinogenic toxicity values (reference doses [RfDs] and reference concentrations [RfCs]) are applied in this BHHRA to estimate the potential noncancer hazards associated with chemical exposure. In contrast to the default non-threshold assumption used to assess carcinogenic risk, noncarcinogenic effects are assumed by most regulatory agencies, including USEPA, to exhibit a biological or toxicological threshold below which adverse effects are not expected.

Following USEPA (1989, 2015c) guidance, cRfDs are used in this BHHRA to assess potential noncarcinogenic hazards for receptors with EDs greater than 7 years. RfDs are used to assess hazards associated with oral and dermal exposures. Chronic reference concentrations (cRfCs) for inhalation are used in this BHHRA to assess potential noncarcinogenic hazards by the inhalation exposure route. Subchronic reference doses (sRfDs) are used in this BHHRA to assess potential noncarcinogenic hazards for adult receptors with EDs less than 7 years (e.g., hypothetical future construction worker), and subchronic reference concentrations (sRfCs) are used to assess potential inhalation noncarcinogenic hazards. Whenever an sRfD or sRfC was unavailable, then (in order of preference) either intermediate minimal risk levels (MRLs)[2] developed by the ATSDR (ATSDR 2014) or the cRfD or cRfC was used. Therefore, for some COPCs the subchronic toxicity values are the same as for the chronic toxicity values (e.g., molybdenum).

Chronic and subchronic noncancer RfDs and RfCs used in this BHHRA were selected consistent with USEPA's (2003a) recommended hierarchy as follows:

[2] The intermediate MRLs were developed for exposure ranging from 15 to 364 days. In this BHHRA, intermediate MRLs were only used for hypothetical future construction workers, for which the ED was 1 year and the EF was 250 days per year.

- Tier 1 – USEPA's (2015b) IRIS
- Tier 2 – USEPA's (2015d) PPRTVs
- Tier 3 – other USEPA and non-USEPA toxicity values (e.g., CalEPA [2015], ATSDR [2014], USEPA's Health Effects Assessment Summary Tables [USEPA 2015e]).

7.3 Toxicity Values for Radionuclides

USEPA classifies all radionuclides as "Group A" or known human carcinogens, based on their property of emitting ionizing radiation and on the extensive weight of evidence provided by epidemiological studies of radiogenic cancers in humans (USEPA 2001; 2014c). Human health risks are evaluated based on the radiotoxicity, rather than on the chemical toxicity, of each radionuclide present (an exception is uranium, where both radiotoxicity and chemical toxicity are normally evaluated; USEPA 2001). Cancer slope factors for radionuclides were obtained from the USEPA PRG Summary Table (USEPA 2014c). As seen in Table 7-2, "Adult Only Soil Ingestion" slope factors were used to evaluate trespasser and worker exposure. "Soil Ingestion" slope factors are lifetime values appropriate for evaluating hypothetical future residential exposure at the Site.

8 RISK CHARACTERIZATION

Risk characterization integrates the exposure assessment and toxicity information. The cancer risk and/or noncancer hazard was calculated for each COPC and for each medium and potentially complete exposure route.

To assist with risk management decisions, ELCRs and HIs were calculated using EPCs based on 95% UCL concentrations, and then both total and background ELCRs and HIs were estimated using EPCs based on arithmetic mean concentrations to determine incremental impacts associated with exposure to COPCs at the former CLEAR Plant and former Esperanza Mill areas. All results were compared to ADEQ allowable risk and hazard thresholds, which are described below.

8.1 Excess Lifetime Cancer Risks

An ELCR was calculated for each constituent identified by ADHS (AAC Title 18 Chapter 7 Appendix B) or USEPA as a potential carcinogen.

The ELCR for incidental ingestion and dermal contact with soil was estimated as shown in the following equation:

Equation 8-1a (metals): $ELCR = CSF \times LADD$

Equation 8-1b (radionuclides, oral only): $ELCRo = CSFo \times Dose$

Equation 8-2 was used to determine the ELCR associated with inhalation of fugitive dust particles in ambient air:

Equation 8-2a (metals): $ELCR = IUR \times EC$

Equation 8-2b (radionuclides): $ELCR = CSFi \times Dose$

Equation 8-3 was used to determine the ELCR associated with external exposure of radionuclides:

Equation 8-3 (radionuclides): $ELCR = CSFe \times Dose$

The total ELCR was calculated by summing the risk for each carcinogen over all exposure media and exposure routes. The cumulative ELCR for each receptor was compared to the target risk range (i.e., 1×10^{-6} to 1×10^{-4}) established by the Arizona Administrative Code (R18-7-206) and USEPA (1990b) for excess lifetime cancer risks.

8.2 Noncancer Hazards

An HQ was calculated for all chemical COPCs. The HQ is the ratio of the estimated dose from exposure to a constituent in a particular medium to the dose that is not expected to result in adverse noncancer health effects.

The HQ for incidental ingestion and dermal contact is:

Equation 8-4: $$HQ = \frac{ADD}{RfD}$$

Equation 8-5 was used to determine the HQ for inhalation exposures to fugitive dust particles in ambient air:

Equation 8-5: $$HQ = \frac{EC}{RfC}$$

The total HI was calculated by summing the HQs for each noncarcinogen over all exposure media and exposure routes. If the HI exceeds a value of 1, the possibility exists for a noncarcinogenic hazard. The HI is not a mathematical prediction of the severity or incidence of the effects, but rather indicates that a hazard may exist. ADHS (2003) and USEPA (1989) recommend that the total HI not exceed a value of 1. If the resulting total HI is greater than 1, it may be recalculated by summing only HQs for constituents with a similar mechanism of action or toxic endpoints (USEPA 1989).

9 RISK CHARACTERIZATION RESULTS

This section presents the estimated ELCRs and HIs from COPCs in soil/sediment for each receptor at the two EAs evaluated in this BHHRA. The results for each EA are presented in Tables 9-1 and 9-2. Exposure and receptor-specific estimated ELCR and HI tables are presented in Appendix C (Excess Lifetime Cancer Risk and Hazard Index Calculations [Chemicals] using 95% UCLs) and Appendix D (Excess Lifetime Cancer Risk Calculations [Radionuclides] using 95% UCLs). The results are also discussed in Section 9.1.

Because COPCs are present in background areas, people who may visit the Site may also visit other areas where the same COPCs are present. In accordance with USEPA guidance (2002), background ELCRs and HIs were estimated to measure the incremental impacts posed by the Site. This is done to provide a comparison of the Site to nearby areas and to assist with risk management decisions. Total risks/HIs are those associated with the Site data. Background risks/HIs are those associated with

exposures of the same receptors to metal concentrations and radionuclide activity at locations other than the Site. The only difference between the total risks/HIs and the background risks/HIs are the concentrations/activities of the COPCs. Incremental risks/HIs are total risks/HIs minus background risks/HIs. The arithmetic means of detected concentrations were used as the EPCs for both the Site and background datasets to provide an estimate of the central tendency for incremental risks/HIs. Exposure and receptor-specific background ELCR and HI calculations are presented in Appendix G (Background Risk Calculations using Mean EPCs), Appendix H (Excess Lifetime Cancer Risk and Hazard Index Calculations [Chemicals] using Mean EPCs) and Appendix I (Excess Lifetime Cancer Risk Calculations [Radionuclides] using Mean EPCs). Background and incremental risks and HIs are presented in Tables 9-3 (former CLEAR Plant EA) and 9-4 (former Esperanza Mill EA).

Results of the ALM used to evaluate the potential for adverse health effects from exposure to lead are presented in Appendix E and summarized in Section 9.2.

9.1 ELCR and HI Results for Current and Future Scenarios

This section presents the results of the BHHRA by EA under the current and future scenarios.

ELCR and HI results are summarized in the following table:

Former CLEAR Plant Exposure Area		
	Shallow Soil/Sediment	Shallow and Deep Soil/Sediment
Current Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.3	--
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 8×10^{-5}; HI=0.3	--
Future Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.2	ELCR = 2×10^{-4}; HI=0.2
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 8×10^{-5}; HI=0.2	ELCR = 9×10^{-5}; HI=0.2
Hypothetical Construction Worker	--	ELCR = 8×10^{-6}; HI=0.6
Hypothetical Adolescent Trespasser	ELCR = 2×10^{-6}; HI=0.04	ELCR = 2×10^{-6}; HI=0.03
Former Esperanza Mill Exposure Area		
	Shallow Soil/Sediment	Shallow and Deep Soil/Sediment
Current Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.3	--
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 9×10^{-5}; HI=0.3	--

Future Scenario		
RME Outdoor Commercial/Industrial Worker	ELCR = 2×10^{-4}; HI=0.3	ELCR = 2×10^{-4}; HI=0.2
Site-Specific Outdoor Commercial/Industrial Worker	ELCR = 9×10^{-5}; HI=0.3	ELCR = 8×10^{-5}; HI=0.2
Hypothetical Construction Worker	--	ELCR = 8×10^{-6}; HI=0.9
Hypothetical Adolescent Trespasser	ELCR = 2×10^{-6}; HI=0.07	ELCR = 2×10^{-6}; HI=0.05

Notes:

-- Not applicable.

RME Reasonable maximum exposure.

9.1.1 Current/Future Scenario – Shallow Soil/Sediment Exposures

9.1.1.1 Former CLEAR Plant EA

- The cumulative ELCR for the RME outdoor commercial/industrial worker is 2×10^{-4}, which is slightly above the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The ELCR is attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in shallow soil/sediment, with the cancer risk from radionuclides accounting for 95% of the total ELCR. The cumulative HI for the RME outdoor commercial/industrial worker is 0.3, which is below the target HI (1) for noncancer effects. The noncancer hazard is due to arsenic and copper in shallow soil/sediment.
- The cumulative ELCR for the site-specific outdoor commercial/industrial worker is 8×10^{-5}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The ELCR is attributable to arsenic and radionuclides, with the cancer risk from radionuclides accounting for 91% of the total ELCR. The cumulative HI for the site-specific outdoor commercial/industrial worker is 0.3, which is below the target HI (1) for noncancer effects.

9.1.1.2 Former Esperanza Mill EA

- The cumulative ELCR for the RME outdoor commercial/industrial worker is 2×10^{-4}, which is slightly above the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The ELCR is attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in shallow soil/sediment, with the cancer risk from radionuclides accounting for 97% of the total ELCR. The cumulative HI for the RME outdoor commercial/industrial worker is 0.3, which is below the target HI (1) for noncancer effects. The noncancer hazard is due to arsenic and molybdenum in shallow soil/sediment.
- The cumulative ELCR for the site-specific outdoor commercial/industrial worker is 9×10^{-5}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The ELCR is attributable to arsenic and radionuclides, with the cancer risk from radionuclides accounting for 94% of the total ELCR. The cumulative HI for the site-specific outdoor commercial/industrial worker is 0.3, which is below the target HI (1) for noncancer effects.

9.1.2 Future Scenarios – Shallow Soil/Sediment Exposures

9.1.2.1 Former CLEAR Plant EA

- The cumulative ELCR for the RME outdoor commercial/industrial worker is 2×10^{-4}, which is slightly above the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the RME outdoor commercial/industrial worker is 0.2, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the site-specific outdoor commercial/industrial worker is 8×10^{-5}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the site-specific outdoor commercial/industrial worker is 0.2, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the adolescent trespasser is 2×10^{-6}, which is at the lower end of the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the adolescent trespasser is 0.04, which is below the target HI (1) for noncancer effects.
- A second future scenario was evaluated for the trespasser using the current scenario shallow soil/sediment dataset (i.e., exposed soil/sediment) in the event that an adolescent trespasser could access the former CLEAR Plant EA while vacant prior to redevelopment (current pavement and buildings remain). For this scenario, the cumulative ELCR for the adolescent trespasser is 2×10^{-6}, which is at the lower end of the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the adolescent trespasser is 0.06, which is below the target HI (1) for noncancer effects.

The ELCRs for the outdoor commercial/industrial worker and adolescent trespasser are attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in shallow soil/sediment. The calculated cancer risk from radionuclides accounts for between 92% (adolescent trespasser) and 98% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards for all receptors are due to arsenic and copper in shallow soil/sediment.

9.1.2.2 Former Esperanza Mill EA

- The cumulative ELCR for the RME outdoor commercial/industrial worker is 2×10^{-4}, which is slightly above the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the RME outdoor commercial/industrial worker is 0.3, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the site-specific outdoor commercial/industrial worker is 9×10^{-5}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the site-specific outdoor commercial/industrial worker is 0.3, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the adolescent trespasser is 2×10^{-6}, which is at the lower end of the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the adolescent trespasser is 0.07, which is below the target HI (1) for noncancer effects.

The ELCRs for all three receptors are attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in shallow soil/sediment. The calculated cancer risk from radionuclides accounts for between 85% (adolescent trespasser) and 97% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards are due to arsenic and molybdenum in shallow soil/sediment.

9.1.3 Future Scenarios – Shallow and Deep Soil/Sediment Exposures

9.1.3.1 Former CLEAR Plant EA

- The cumulative ELCR for the RME outdoor commercial/industrial worker is 2×10^{-4}, which is slightly above the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the RME outdoor commercial/industrial worker is 0.2, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the site-specific outdoor commercial/industrial worker is 9×10^{-5}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the site-specific outdoor commercial/industrial worker is 0.2, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the adolescent trespasser is 2×10^{-6}, which is at the lower end of the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the outdoor commercial/industrial worker is 0.03 which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the construction worker is 8×10^{-6}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the construction worker is 0.6, which is below the target HI (1) for noncancer effects.

The ELCRs for all receptors are attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in shallow and deep soil/sediment. The calculated cancer risk from radionuclides accounts for between 92% (adolescent trespasser) and 99% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards are due to arsenic and copper in shallow and deep soil/sediment.

9.1.3.2 Former Esperanza Mill EA

- The cumulative ELCR for the RME outdoor commercial/industrial worker is 2×10^{-4}, which is slightly above the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the RME outdoor commercial/industrial worker is 0.2, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the site-specific outdoor commercial/industrial worker is 8×10^{-5}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the site-specific outdoor commercial/industrial worker is 0.2, which is below the target HI (1) for noncancer effects.
- The cumulative ELCR for the adolescent trespasser is 2×10^{-6}, which is at the lower end of the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the adolescent trespasser is 0.05, which is below the target HI (1) for noncancer effects.

- The cumulative ELCR for the construction worker is 8×10^{-6}, which is within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks. The cumulative HI for the construction worker is 0.9, which is below the target HI (1) for noncancer effects.

The ELCRs for all receptors are attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in shallow and deep soil/sediment. The calculated cancer risk from radionuclides accounts for between 89% (adolescent trespasser) and 98% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards are due to arsenic and molybdenum in shallow and deep soil/sediment.

9.1.4 Summary of ELCRs and HIs

The calculated ELCRs based on RME parameters for the current/future outdoor commercial/industrial worker are 2×10^{-4}, which is slightly above the Arizona Administrative Code (R18-7-206) and USEPA target cancer risk range of 1×10^{-6} to 1×10^{-4}. The ELCRs based on RME parameters for the hypothetical future trespasser and construction worker receptors are within the target cancer risk range. The cumulative HIs are less than the target of 1 for both EAs.

The calculated ELCRs based on site-specific parameters for the current/future outdoor commercial/industrial workers at the former CLEAR Plant EA and former Esperanza Mill EA are lower than the RME based ELCRs and are within the target cancer risk range. The cumulative HIs based on site-specific parameters for the current/future outdoor commercial/industrial workers are less than the target of 1 for both EAs.

The ELCRs for receptors at the former CLEAR Plant EA and former Esperanza Mill EA are attributable to arsenic and radionuclides in soil/sediment. The calculated cancer risk from radionuclides at the former CLEAR Plant EA and former Esperanza Mill EA accounts for between 85% (adolescent trespasser) and 99% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards for receptors at the former CLEAR Plant EA are attributable to arsenic and copper in soil/sediment, and at the former Esperanza Mill EA are due to arsenic and molybdenum in soil/sediment.

As discussed previously, metals and radionuclides are naturally present in soils in and around Sierrita Mine, and therefore cancer risks and non-cancer hazards based on background concentrations and activity were also estimated. Background and incremental ELCRs and HIs associated with exposure to metals and radionuclides in soils are summarized in Tables 9-3 and 9-4 for the former CLEAR Plant and former Esperanza Mill EA, respectively. The incremental ELCRs for receptors at both EAs are less than or within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks, and the incremental HIs are below the target HI (1) for noncancer effects.

9.2 Lead Exposure Evaluation

Lead was identified as a COPC in soil and sediment at the former CLEAR Plant and former Esperanza Mill EAs. USEPA's ALM (USEPA 2003b, 2003c, 2009b) was used to evaluate the potential for adverse health effects from exposure to lead in soil and sediment. The ALM worksheets are provided in Appendix E. The tables below summarize the results of the lead evaluation by EA using RME parameters for all receptors under the current and future scenarios.

9.2.1 Current/Future Scenario – Shallow Soil Exposures

Former CLEAR Plant EA

Exposure Medium	Receptor Population	EPC_{Pb} (mg/kg)	$PbB_{adult,central}$ (µg/dL)	$PbB_{fetal,0.95}$ (µg/dL)	Probability PbB_{fetal}>10µg/dL (%)
Shallow Soil/Sediment (0-0.5 ft bgs)	Outdoor Commercial/ Industrial Worker	87	0.9	2.0	0.0007

Former Esperanza Mill EA

Exposure Medium	Receptor Population	EPC_{Pb} (mg/kg)	$PbB_{adult,central}$ (µg/dL)	$PbB_{fetal,0.95}$ (µg/dL)	Probability PbB_{fetal}>10µg/dL (%)
Shallow Soil/Sediment (0-2 ft bgs)	Outdoor Commercial/ Industrial Worker	116	0.9	2.2	0.001

9.2.2 Future Scenario – Shallow Soil Exposures

Former CLEAR Plant

Exposure Medium	Receptor Population	EPC_{Pb} (mg/kg)	$PbB_{adult,central}$ (µg/dL)	$PbB_{fetal,0.95}$ (µg/dL)	Probability PbB_{fetal}>10µg/dL (%)
Shallow Soil/Sediment (0-0.5 ft bgs), All sample locations	Outdoor Commercial/ Industrial Worker	136	1.0	2.4	0.002
Shallow Soil/Sediment (0-0.5 ft bgs), All sample locations	Adolescent Trespasser	136	0.6	1.5	0.00007
Shallow Soil/Sediment (0-0.5 ft bgs), Exposed sample locations only	Adolescent Trespasser	87	0.6	1.5	0.00005

Former Esperanza Mill

Exposure Medium	Receptor Population	EPC_{Pb} (mg/kg)	$PbB_{adult,central}$ (µg/dL)	$PbB_{fetal,0.95}$ (µg/dL)	Probability PbB_{fetal}>10µg/dL (%)
Shallow Soil/Sediment (0-2 ft bgs)	Adolescent Trespasser	116	0.6	1.5	0.00006

9.2.3 Future Scenario – Shallow and Deep Soil Exposures

Former CLEAR Plant

Exposure Medium	Receptor Population	EPC_{Pb} (mg/kg)	$PbB_{adult,central}$ (µg/dL)	$PbB_{fetal,0.95}$ (µg/dL)	Probability PbB_{fetal}>10µg/dL (%)
Shallow and Deep Soil/Sediment (0-15 feet bgs)	Outdoor Commercial/ Industrial Worker	113.5	0.9	2.2	0.001
	Adolescent Trespasser	113.5	0.6	1.5	0.00006
	Construction Worker	113.5	1.8	4.3	0.1

Former Esperanza Mill

Exposure Medium	Receptor Population	EPC_{Pb} (mg/kg)	$PbB_{adult,central}$ (µg/dL)	$PbB_{fetal,0.95}$ (µg/dL)	Probability PbB_{fetal}>10µg/dL (%)
Shallow and Deep Soil/Sediment (0-15 feet bgs)	Outdoor Commercial/ Industrial Worker	117	0.9	2.2	0.001
	Adolescent Trespasser	117	0.6	1.5	0.00006
	Construction Worker	117	1.9	4.4	0.1

9.2.4 Summary of Lead Evaluation

Based on the results of the ALM, exposure to lead in soil/sediment at the former CLEAR Plant and former Esperanza Mill EAs are not likely to result in adverse health effects in current/future outdoor commercial/industrial workers, future trespassers, or future construction workers.

10 UNCERTAINTIES ASSOCIATED WITH THE BASELINE HUMAN HEALTH RISK ASSESSMENT

This section discusses uncertainties associated with the BHHRA. The BHHRA was conducted to evaluate the potential for adverse health effects associated with exposure to COPCs at the Site. To this end, the assumptions used in this BHHRA reflect estimates based on upper-bound exposure (or RME) estimates. Because standard default assumptions for the potential receptors were used, the risk estimates and HIs calculated for the BHHRA are not absolute and are conservative overestimates of true risks. This section discusses key uncertainties associated with conducting the BHHRA and the potential impacts on the outcome.

10.1 Sampling and Analysis

The selection of COPCs was based upon the results of the sampling and analytical program established for the Site. The factors that contribute to uncertainties associated with the identification of COPCs are inherent in the data collection and data evaluation processes, including appropriate sample locations, adequate sample quantities, laboratory analyses, data validation, and treatment of validated sample results.

A comparison of maximum detected concentrations to ADEQ nr-SRLs for chemicals and highest reported activity to USEPA PRGs for radionuclides was conducted. Constituents with maximum concentrations below their respective screening levels were not carried through the assessment. It is unlikely that this screening would have excluded constituents that would be of concern, based on the conservative exposure assumptions and toxicity criteria that are the basis of the screening levels. Although following this methodology does not provide a quantitative risk estimate for all constituents, it focuses the assessment on the constituents accounting for the greatest potential for risk, and the overall cumulative risk estimates would not be expected to be greater than these conservative screening values.

10.2 Receptors Evaluated and Potentially Complete Exposure Routes

Arcadis conducted a comprehensive assessment of potential human receptors that are likely to be present at the Site. Based on potential use scenarios and future plans for the Site, other possible receptors are unlikely to be more potentially exposed to site-related COPCs than the receptors evaluated in this BHHRA. Exposure pathways considered complete were evaluated for these receptors.

10.3 Exposure Assumptions and Intake/Dose Models

The exposure assessment relied on several different exposure intake assumptions, many of which were based on statistical analyses of human populations. An RME is the “highest exposure that is reasonably expected to occur at the Site” (USEPA 1989). In some cases, EPCs were based on maximum detected concentrations, which will result in an overestimate of the ELCR and/or HI.

To address ADEQ comment K20 (Appendix H), soil only EPCs were calculated for the 0 to 15 ft bgs dataset to eliminate any potential bias via the inclusion of the sediment data into a single soil/sediment dataset. As a conservative measure, the two EPCs (one based on the soil and sediment dataset and the other based on the soil only dataset) were compared and the highest EPC for each COPC was selected

for the shallow and deep soil/sediment depth interval and used in the BHHRA. Using the soil only EPCs may result in an overestimate of ELCRs and/or HIs since the sediment samples were collected from intermittent drainage swales that are typically dry and would not limit or prevent potential future exposure.

The evaluation of both site-specific and RME scenarios reduces the amount of uncertainty associated with the BHHRA, as the BHHRA provides a range of potential exposures based on a more realistic exposure and a high-end (maximum) exposure. For the site-specific scenario, the exposure time for workers was adjusted to a more reasonable 4 hours per day as they do not spend an entire 8-hour workday within the former CLEAR Plant EA or former Esperanza Mill EA. However, there is uncertainty associated with this exposure time since workdays for individual workers vary, and therefore this site-specific ET may over or under estimate the ELCR and/or HI.

10.4 Toxicity Assessment: Constituents of Potential Concern without Toxicity Values

RfCs are not available for some of the COPCs identified (i.e., copper, lead and molybdenum). Because USEPA (2009, 2015f) no longer allows extrapolating oral toxicity values to inhalation toxicity values, HQs for the inhalation exposure route could not be estimated for these COPCs. The inability to estimate inhalation HQs for COPCs lacking RfCs is likely to result in an underestimate of the HI.

It is important to note that toxicity values used to conduct this BHHRA were derived using methods that are designed to overestimate toxicity, resulting in an overestimate of ELCRs and/or HIs.

11 SUMMARY AND CONCLUSIONS

11.1 Summary

This BHHRA was conducted to evaluate potential risks to human health under current and future exposure scenarios. Available data were reviewed, and it was determined that potential receptors may be exposed to constituents present in soil/sediment at the Site. Two EAs (former CLEAR Plant and former Esperanza Mill) based on current and potential future scenarios were identified, datasets for each EA were compiled, and COPCs were selected:

- Former CLEAR Plant EA – arsenic, copper, lead, Ra-226, Ra-228, U-235, and U-238
- Former Esperanza Mill EA – arsenic, lead, molybdenum, Ra-226, Ra-228, U-235, and U-238

Following COPC selection, EPCs were calculated. An exposure evaluation was completed, and specific receptors and potentially complete exposure pathways and routes were evaluated.

Potential cancer risks and noncancer hazards were characterized by estimated ELCRs and HIs for the potentially complete exposure routes for current and future receptors. Lead was evaluated separately using the ALM. Results are discussed below.

11.1.1 Cancer Risk and Noncancer Hazard Summary

Tables 9-1 and 9-2 summarize the ELCRs and HIs for each of the receptors evaluated at the Site in this BHHRA. The risks and hazards shown in Tables 9-1 and 9-2 are cumulative for each exposure scenario, summed across all COPCs and exposure routes.

The calculated ELCRs based on RME parameters for the current and future outdoor commercial/industrial worker at the former CLEAR Plant EA and the former Esperanza Mill EA are 2×10^{-4}, which is slightly above the Arizona Administrative Code (R18-7-206) and USEPA target risk range of 1×10^{-6} to 1×10^{-4}. The ELCRs based on RME parameters for the hypothetical future trespasser and construction worker receptors are within the target cancer risk range. The cumulative HIs are less than the target of 1 for both EAs.

The calculated ELCRs based on site-specific parameters for the current/future outdoor commercial/industrial workers at the former CLEAR Plant EA and former Esperanza Mill EA are lower than the RME based ELCRs and are within the target cancer risk range. The cumulative HIs based on site-specific parameters for the current/future outdoor commercial/industrial workers are less than the target of 1 for both EAs.

The ELCRs for receptors at the former CLEAR Plant EA and former Esperanza Mill EA are attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in soil/sediment. The calculated cancer risk from radionuclides at the former CLEAR Plant EA and former Esperanza Mill EA accounts for between 85% (adolescent trespasser) and 99% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards for receptors at the former CLEAR Plant EA are attributable to arsenic and copper and at the former Esperanza Mill EA are due to arsenic and molybdenum in soil/sediment.

In accordance with USEPA guidance (2002a), background ELCRs and HIs were also estimated to evaluate the incremental impacts from metals and radionuclides posed by the Site. This is done to provide a comparison of the Site to nearby areas and to assist with risk management decisions. Total risks/HIs are those associated with the Site data. Background risks/HIs are those associated with exposures of the same receptors to metal concentrations and radionuclide activity at locations other than the Site. The only difference between the total risks/HIs and the background risks/HIs are the concentrations/activities of the COPCs. Incremental risks/HIs are total risks/HIs minus background risks/HIs.

In general, background radiological risks are similar to Site risks for both EAs. Once background impacts are accounted for, incremental risks from radionuclides for all receptor groups who may be exposed to Site soils are negligible or on the low end of the USEPA target risk range of 1×10^{-6} to 1×10^{-4} . Furthermore, all incremental ELCRs and HIs for metals are below or on the low end of the thresholds for cancer and noncancer effects.

11.1.2 Lead Evaluation Summary

Lead was identified as a COPC for the former CLEAR Plant and former Esperanza Mill EAs. Based on the results of the ALM, exposure to lead in soil/sediment at the former CLEAR Plant and former

Esperanza Mill EAs is not likely to result in adverse health effects in current/future outdoor commercial/industrial workers, future trespassers, or future construction workers.

11.2 Conclusions

Potential cancer risks calculated in this BHHRA based on RME parameters for the current/future scenario (i.e., outdoor commercial/industrial workers) at both EAs are slightly above the target cancer risk range (1×10^{-6} to 1×10^{-4}) established by the USEPA and the Arizona Administrative Code (R18-7-206). Cancer risks based on RME parameters for the hypothetical future trespassers and construction workers at both EAs are within the target cancer risk range, and the cumulative HIs are less than the target HI of 1.

Potential cancer risks calculated in this BHHRA based on site-specific parameters for the current/future outdoor commercial/industrial workers at both EAs are lower than the RME based ELCRs and are within the target ELCR range for cancer risks (1×10^{-6} to 1×10^{-4}). The cumulative HIs based on site-specific parameters for the current/future outdoor commercial/industrial workers are less than the target HI of 1 for both EAs.

The ELCRs are attributable to arsenic and radionuclides (primarily Ra-226 and Th-232) in soil/sediment, with radionuclides contributing between 85% (adolescent trespasser) and 99% (outdoor commercial/industrial worker) of the total calculated receptor-specific ELCR. The noncancer hazards are attributable to arsenic, copper, and molybdenum in soil/sediment.

Trace metals, including arsenic, copper, and molybdenum, as well as radionuclides, are naturally present in soils in this part of Arizona. To estimate the contribution of background metal concentrations and radionuclide activity to the Site cancer risks and non-cancer hazards, background ELCRs and HIs for all receptors were calculated based on mean EPCs and subtracted from Site ELCRs and HIs, also calculated based on mean EPCs. The incremental ELCRs for receptors at both EAs are less than or within the target risk range (1×10^{-6} to 1×10^{-4}) for excess lifetime cancer risks, and the incremental HIs are below the target HI (1) for noncancer effects.

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TABLES

Table 5-1
Summary of Available Soil and Sediment Data for Metals and Radionuclides
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Report Reference	Sampling Period	Investigation Area	No. / Type Samples [1]	No. Locations	Sample Depths	Sampling Methods	Sieved?	Laboratory	Analysis and Analytical Method	
HGC (2008)	August - October 2004	Former CLEAR Plant	12 Surficial Soil	12 locations	0-0.25 ft bgs	plastic trowel	All soil samples were sieved to <2mm by HGC prior to sample analysis.	ACZ Laboratories, Steamboat Springs, CO	Metals via or Mercury via	EPA Method 6020 ICP-MS EPA Method 6010B ICP-AES EPA Method 7471A CVAA
			17 Subsurface Soil	8 trench locations	≤ 6 ft bgs	plastic trowel				
			7 Subsurface Soil		> 6 and ≤ 15 ft bgs	backhoe bucket				
		Former Esperanza Mill	9 Surficial Soil	9 locations	0-0.25 ft bgs	plastic trowel				
			5 Subsurface Soil	2 trench locations	≤ 6 ft bgs	plastic trowel				
			1 Subsurface Soil		> 6 and ≤ 15 ft bgs	backhoe bucket				
		Former C Pond	1 Surficial Soil	1 location	0-0.25 ft bgs	plastic trowel				
			1 Subsurface Soil	1 trench location	≤ 6 ft bgs	plastic trowel				
			1 Subsurface Soil		> 6 and ≤ 15 ft bgs	backhoe bucket				
		Former Raffinate Pond	1 Surficial Soil	1 location	0-0.25 ft bgs	plastic trowel				
			3 Subsurface Soil	1 trench location	≤ 6 ft bgs	plastic trowel				
			1 Subsurface Soil		> 6 and ≤ 15 ft bgs	backhoe bucket				
		Former Laydown Yard	1 Surficial Soil	1 location	0-0.25 ft bgs	plastic trowel				
URS (2012); ARCADIS (2013a)	June - November 2008	Former CLEAR Plant	27 Gridded Soil	10 locations	up to 17 ft bgs	Soil and sediment borings installed using direct push techniques and Geoprobe tooling. Samples were collected using disposable acetate liners within a Macro-core sampler. Samples from the Former Raffinate Pond were collected using stainless steel hand auger, due to Geoprobe access issues.	No	ACZ Laboratories, Steamboat Springs, CO	Metals via or Mercury via Lead via and Chromium +6 via	EPA Method 6020 ICP-MS EPA Method 6010B ICP-AES EPA Method 7471A CVAA EPA Method 1312 SPLP EPA Method 6020 ICP-MS EPA Method 7196A (colorimetric)
			15 Biased Soil	4 locations	up to 20 ft bgs					
			20 Sediment	10 locations	0-1.5, 1.5-3.0 ft bgs					
		Former E Pond	5 Biased Soil	2 locations	up to 7 ft bgs					
		Former Evaporation Pond	6 Biased Soil	2 locations	up to 7 ft bgs					
		Old D Pond	7 Biased Soil	3 locations	up to 7 ft bgs					
			12 Sediment	6 locations	0-1.5, 1.5-3.0 ft bgs					
		Former Esperanza Mill	26 Gridded Soil	9 locations	up to 11 ft bgs			Paragon Analytics, Inc., Fort Collins, CO	Isotopic uranium Radium-226 via Radium-228 via and	ASTM Method D3972 (alpha spectroscopy) EPA Method 903.1 (radon emanation) EPA Method 9320/904.0M (gas flow proportional counting) EPA Method 901.1M
			2 Biased Soil	1 location	0-1.0, 1.0-3.0 ft bgs					
		Former C Pond and C Pond Spoils	3 Gridded Soil	1 location	up to 5.5 ft bgs					
			36 Biased Soil	11 locations	up to 17 ft bgs					
		Former Raffinate Pond	12 Biased Soil	5 locations	up to 7 ft bgs					
			4 Sediment	2 locations	0-1.5, 1.5-3.0 ft bgs					
		Former Laydown Yard	15 Biased Soil	4 locations	up to 16 ft bgs					
ARCADIS (2013c)	May 2012	Former CLEAR Plant Soil excavation for new training facility building	35 Initial Soil (count does not include excavated samples)	43 locations	6 inches bgs	Disposable plastic scoop; Samples from the parking lot area and building pad were collected with hand auger.	No. 12 mesh sieve was used to remove large rocks and debris from dry soil samples.	SVL Analytical, Inc., Kellogg, ID	Arsenic, copper, and lead	Field screened using portable handheld XRF analyzer; EPA Method 6010B
			38 Confirmation Soil	38 locations	6 inches bgs					
ARCADIS (2015c)	May - June 2015	Former CLEAR Plant Paving Areas	25 Gridded Samples	25 locations	6 inches bgs	Disposable plastic scoop	No	SVL Analytical, Inc., Kellogg, ID	Select metals via or Mercury via	EPA Method 6010B ICP-AES EPA Method 6020A ICP-MS EPA Method 7471 CVAA
			2 Biased Samples	2 locations	6 inches bgs	Disposable plastic scoop				
			2 Biased Samples	2 locations	3.5 ft bgs	Hand auger				

Notes
[1] Sample counts do not include field duplicates or excavated samples.

CVAA = cold-vapor atomic absorption.
EPA = United States Environmental Protection Agency.
ft bgs = feet below ground surface.
ICP-AES = inductively coupled plasma-atomic emission spectroscopy.
ICP-MS = inductively coupled plasma-mass spectroscopy.
mm = millimeters.
SPLP = synthetic precipitation leaching procedure.

Table 5-2
Inventory of Soil and Sediment Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Exposure Area	Location SubArea	Sample ID	Alternative ID for Figures	Medium	Sample Date	Metals Analysis	Radionuclide Analysis	Depth (ft bgs)	Applicable Data Set(s)	Sample Descriptor [a]
Former CLEAR Plant	Former CLEAR Plant	CP-1 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-2 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-3 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-5 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-7 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-9 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-13 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-14 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-15 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-16 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-19 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-21 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-1-18IN 100404	--	Soil	10/4/2004	✓	--	1.5	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-1-2 100404	--	Soil	10/4/2004	✓	--	2	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-1-4 100404	--	Soil	10/4/2004	✓	--	4	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-1-8 100404	--	Soil	10/4/2004	✓	--	8	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-2-10 100404	--	Soil	10/4/2004	✓	--	10	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-2-2 100404	--	Soil	10/4/2004	✓	--	2	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-2-7 100404	--	Soil	10/4/2004	✓	--	7	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-2-B-6 100404	--	Soil	10/4/2004	✓	--	6	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-2-7BL 100404	--	Soil	10/4/2004	✓	--	7	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-2-C-6 100404	--	Soil	10/4/2004	✓	--	6	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-4-1.5C 100404	--	Soil	10/4/2004	✓	--	1.5	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-4-14 100404	--	Soil	10/4/2004	✓	--	14	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-4-18IN 100404	--	Soil	10/4/2004	✓	--	1.5	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-4-2.5 100404	--	Soil	10/4/2004	✓	--	2.5	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-5-1.5 100404	--	Soil	10/4/2004	✓	--	1.5	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-5-3 100404	--	Soil	10/4/2004	✓	--	3	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-5-6 100404	--	Soil	10/4/2004	✓	--	6	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-6-2 100404	--	Soil	10/4/2004	✓	--	2	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-6-4 100404	--	Soil	10/4/2004	✓	--	4	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-6-6 100404	--	Soil	10/4/2004	✓	--	6	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-T-3-6 100504	--	Soil	10/5/2004	✓	--	0.5	0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-T-3-8 100504	--	Soil	10/5/2004	✓	--	8	0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-T-3-8IN 100504	--	Soil	10/5/2004	✓	--	0.75	0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-JS-02-0-1_07112008	--	Soil	7/11/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-JS-02-1-3_07112008	--	Soil	7/11/2008	✓	✓	1-3	0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-M04-0-1_07112008	--	Soil	7/11/2008	✓	sample jar broken	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-M04-1-2.5_07112008	--	Soil	7/11/2008	✓	✓	1-2.5	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-M04-5-5.4_07112008	--	Soil	7/11/2008	✓	✓	5-5.4	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-M06-0-1_07112008	--	Soil	7/11/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-M06-1-3_07112008	--	Soil	7/11/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-N08-0-1_07112008	--	Soil	7/11/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-N08-10-11_07112008	--	Soil	7/11/2008	✓	sample jar broken	10-11	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-N08-1-3_07112008	--	Soil	7/11/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-N08-5-7_07112008	--	Soil	7/11/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-O03-0-1_07112008	--	Soil	7/11/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-O03-1-3_07112008	--	Soil	7/11/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-O09-0-1_07112008	--	Soil	7/11/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-O09-10-12_07112008	--	Soil	7/11/2008	✓	✓	10-12	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-O09-1-3_07112008	--	Soil	7/11/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-O09-5-7_07112008	--	Soil	7/11/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-03-0-1_07142008	--	Soil	7/14/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-03-1-3_07142008	--	Soil	7/14/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-03-5-7_07142008	--	Soil	7/14/2008	✓	✓	5-7	0-15	exposed at surface

Table 5-2
Inventory of Soil and Sediment Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Exposure Area	Location SubArea	Sample ID	Alternative ID for Figures	Medium	Sample Date	Metals Analysis	Radionuclide Analysis	Depth (ft bgs)	Applicable Data Set(s)	Sample Descriptor [a]
Former CLEAR Plant	Former CLEAR Plant	CP-JS-01-0-1_07152008	--	Soil	7/15/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-01-10-12_07152008	--	Soil	7/15/2008	✓	✓	10-12	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-01-1-3_07152008	--	Soil	7/15/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-01-5-7_07152008	--	Soil	7/15/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P04-0-1_07152008	--	Soil	7/15/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P04-1-3_07152008	--	Soil	7/15/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P05-0-1_07152008	--	Soil	7/15/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P05-1-3_07152008	--	Soil	7/15/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-01-0-1.5_07162008	--	Sediment	7/16/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-01-1.5-3.0_07162008	--	Sediment	7/16/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-02-0-1.5_07162008	--	Sediment	7/16/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-02-1.5-3.0_07162008	--	Sediment	7/16/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-03-0-1.5_07162008	--	Sediment	7/16/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-03-1.5-3.0_07162008	--	Sediment	7/16/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-05-0-1.5_07162008	--	Sediment	7/16/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-05-1.5-3.0_07162008	--	Sediment	7/16/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-06-0-1.5_07162008	--	Sediment	7/16/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-06-1.5-3.0_07162008	--	Sediment	7/16/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-04-0-1.5_07172008	--	Sediment	7/17/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-04-1.5-3.0_07172008	--	Sediment	7/17/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P07-0-1_07172008	--	Soil	7/17/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P07-1-3_07172008	--	Soil	7/17/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P07-5-7_07172008	--	Soil	7/17/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-07-0-1.5_07232008	--	Sediment	7/23/2008	✓	sample jar broken	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-07-1.5-3.0_07232008	--	Sediment	7/23/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P12-0-1_07232008	--	Soil	7/23/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-P12-1-3_07232008	--	Soil	7/23/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-Q09-0-1_07232008	--	Soil	7/23/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-Q09-1-3_07232008	--	Soil	7/23/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-08-0-1.5_07282008	--	Sediment	7/28/2008	✓	sample jar broken	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-08-1.5-3.0_07282008	--	Sediment	7/28/2008	✓	sample jar broken	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-09-0-1.5_07282008	--	Sediment	7/28/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-09-1.5-3.0_07282008	--	Sediment	7/28/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-10-0-1.5_07282008	--	Sediment	7/28/2008	✓	sample jar broken	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-SD-10-1.5-3.0_07282008	--	Sediment	7/28/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-04-0-1_08272008	--	Soil	8/27/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-04-10-12_08272008	--	Soil	8/27/2008	✓	✓	10-12	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-04-1-3_08272008	--	Soil	8/27/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CP-JS-04-5-7_08272008		Soil	8/27/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Former CLEAR Plant	CPS-SWW-D2.5-01_20120501	24	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-D3-01_20120501	6	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-D4-02_20120501	3	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWE-D1.5-01_20120501	5	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWW-D2-01_20120501	4	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-D5-06_20120501	39	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D2.5-01_20120501	38	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D2.5-02_20120501	33	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D2.5-03_20120501	30	Soil	5/1/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-D3-01_20120502	14	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-D3-02_20120502	13	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-D3-03_20120502	19	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-D3-04_20120502	20	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-SWE-D1.5-01_20120502	16	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-SWE-D1.5-02_20120502	21	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-SWW-D1.5-02_20120502	18	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed

Table 5-2
Inventory of Soil and Sediment Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Exposure Area	Location SubArea	Sample ID	Alternative ID for Figures	Medium	Sample Date	Metals Analysis	Radionuclide Analysis	Depth (ft bgs)	Applicable Data Set(s)	Sample Descriptor [a]
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWE-D1.5-02_20120502	--	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWE-D2.5-02_20120502	--	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-D4-05_20120502	1	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AE-S-01_20120502	64	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AE-S-02_20120502	65	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AE-S-03_20120502	66	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AE-S-04_20120502	67	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AN-S-01_20120502	59	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AN-S-02_20120502	60	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AN-S-03_20120502	61	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AN-S-04_20120502	62	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AW-S-01_20120502	69	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AW-S-02_20120502	70	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AW-S-03_20120502	71	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AW-S-04_20120502	72	Soil	5/2/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWE-D2.5-01_20120502	40	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D4-04_20120502	28	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	RCP-16-D2.5-01_20120502	56	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	RCP-T-3-D0.5-01_20120502	57	Soil	5/2/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPB-S-02_20120511	51	Soil	5/11/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPB-S-03_20120511	52	Soil	5/11/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPB-S-04_20120511	53	Soil	5/11/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPB-S-05_20120511	54	Soil	5/11/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPB-S-06_20120511	55	Soil	5/11/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-D2-06_20120511	23	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-D3-05_20120511	15	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-SWE-D1.5-03_20120511	17	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-SWW-D1-04_20120511	22	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AE-SWW-D2-03_20120511	12	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-D2-05_20120511	7	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWE-D0.5-04_20120511	9	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWE-D2.5-03_20120511	2	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWW-D0.75-04_20120511	10	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AW-SWW-D1-03_20120511	8	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AE-S-05_20120511	68	Soil	5/11/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPP-AN-S-05_20120511	63	Soil	5/11/2012	✓	--	6 inches bgs (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWN-D2-01_20120511	27	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWN-D2-02_20120511	29	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWN-D2-03_20120511	31	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWN-D2-04_20120511	36	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWN-D3.5-05_20120511	35	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D2.5-07_20120511	34	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D2-05_20120511	37	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D4.5-06_20120511	32	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWS-D4.5-08_20120511	26	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPS-SWW-D2.5-02_20120511	25	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-D1-01_20120511	50	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWN-D0.5-05_20120511	49	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWN-D1.5-02_20120511	43	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWN-D1.5-04_20120511	47	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWN-D1-01_20120511	41	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWN-D1-03_20120511	45	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWS-D0.5-02_20120511	44	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWS-D0.5-03_20120511	46	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWS-D0.5-04_20120511	48	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed

Table 5-2
Inventory of Soil and Sediment Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Exposure Area	Location SubArea	Sample ID	Alternative ID for Figures	Medium	Sample Date	Metals Analysis	Radionuclide Analysis	Depth (ft bgs)	Applicable Data Set(s)	Sample Descriptor [a]
Former CLEAR Plant	Former CLEAR Plant	RCP-T-3-D0.5-02_20120511	58	Soil	5/11/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CPF-AN-SWS-D0.5-05_20120521	42	Soil	5/21/2012	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-01_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-02_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-03_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-04_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-05_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-06_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-07_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-08_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-09_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-NPA-S-10_20150528	--	Soil	5/28/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-1_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-2_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-3_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-4_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-5_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-6_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-7_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-8_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-9_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-10_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-11_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-12_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-13_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-14_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-15_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-16_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-S-17_20150609	--	Soil	6/9/2015	✓	--	surface (0)	0-0.5, 0-2, 0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-SL-E-D3.5-01	--	Soil	6/19/2015	✓	--	3.5	0-15	paved/developed
Former CLEAR Plant	Former CLEAR Plant	CP-SPA-SL-W-D3.5-01	--	Soil	6/19/2015	✓	--	3.5	0-15	paved/developed
Former CLEAR Plant	Former E Pond	E-JS-01-0-1_07142008	--	Soil	7/14/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former E Pond	E-JS-01-1-3_07142008	--	Soil	7/14/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former E Pond	E-JS-01-5-7_07142008	--	Soil	7/14/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Former E Pond	E-JS-02-0-1_07142008	--	Soil	7/14/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former E Pond	E-JS-02-1-3_07142008	--	Soil	7/14/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former Evaporation Pond	EV-JS-01-0-1_07142008	--	Soil	7/14/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former Evaporation Pond	EV-JS-01-1-3_07142008	--	Soil	7/14/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former Evaporation Pond	EV-JS-01-5-7_07142008	--	Soil	7/14/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Former Evaporation Pond	EV-JS-02-0-1_07142008	--	Soil	7/14/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Former Evaporation Pond	EV-JS-02-1-3_07142008	--	Soil	7/14/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Former Evaporation Pond	EV-JS-02-5-7_07142008	--	Soil	7/14/2008	✓	✓	5-7	0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-01-0-1.5_07282008	--	Sediment	7/28/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-01-1.5-3.0_07282008	--	Sediment	7/28/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-02-0-1.5_07282008	--	Sediment	7/28/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-02-1.5-3.0_07282008	--	Sediment	7/28/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-03-0-1.5_07282008	--	Sediment	7/28/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-03-1.5-3.0_07282008	--	Sediment	7/28/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-04-0-1.5_07282008	--	Sediment	7/28/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-04-1.5-3.0_07282008	--	Sediment	7/28/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-JS-01-0-1_07292008	--	Soil	7/29/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-JS-01-1-3_07292008	--	Soil	7/29/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-JS-02-0-1_07292008	--	Soil	7/29/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-JS-02-1-3_07292008	--	Soil	7/29/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-JS-02-5-7_07292008	--	Soil	7/29/2008	✓	✓	5-7	0-15	exposed at surface

Table 5-2
Inventory of Soil and Sediment Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Exposure Area	Location SubArea	Sample ID	Alternative ID for Figures	Medium	Sample Date	Metals Analysis	Radionuclide Analysis	Depth (ft bgs)	Applicable Data Set(s)	Sample Descriptor [a]
Former CLEAR Plant	Old D Pond	OD-SD-05-0-1.5_07292008	--	Sediment	7/29/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-05-1.5-3.0_07292008	--	Sediment	7/29/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-06-0-1.5_07292008	--	Sediment	7/29/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-SD-06-1.5-3.0_07292008	--	Sediment	7/29/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-JS-03-0-1_08272008	--	Soil	8/27/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former CLEAR Plant	Old D Pond	OD-JS-03-1-3_08272008	--	Soil	8/27/2008	✓	no radionuclide data	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	EM-26 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	EM-T-4-10 100504	--	Soil	10/5/2004	✓	--	10	0-15	exposed at surface
Former Esperanza Mill	Former C Pond	EM-T-4-6 100504	--	Soil	10/5/2004	✓	--	6	0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-01-0-1_08012008	--	Soil	8/1/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-01-1-3_08012008	--	Soil	8/1/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-02-0-1_08012008	--	Soil	8/1/2008	✓	sample jar broken	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-02-1-3_08012008	--	Soil	8/1/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-02-5-7_08012008	--	Soil	8/1/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-03-0-1_08042008	--	Soil	8/4/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-03-10-12_08042008	--	Soil	8/4/2008	✓	✓	10-12	0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-03-1-3_08042008	--	Soil	8/4/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-03-5-7_08042008	--	Soil	8/4/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-04-0-1_08052008	--	Soil	8/5/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-04-10-12_08052008	--	Soil	8/5/2008	✓	✓	10-12	0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-04-1-3_08052008	--	Soil	8/5/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-04-5-7_08052008	--	Soil	8/5/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-05-0-1_08052008	--	Soil	8/5/2008	✓	no radionuclide data	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond	C-JS-05-1-3_08052008	--	Soil	8/5/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-01-0-1_08042008	--	Soil	8/4/2008	✓	sample jar broken	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-01-10-12_08042008	--	Soil	8/4/2008	✓	✓	10-12	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-01-1-3_08042008	--	Soil	8/4/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-01-5-7_08042008	--	Soil	8/4/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-02-0-1_08042008	--	Soil	8/4/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-02-10-11_08042008	--	Soil	8/4/2008	✓	✓	10-11	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-02-1-3_08042008	--	Soil	8/4/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-02-5-7_08042008	--	Soil	8/4/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-03-0-1_08052008	--	Soil	8/5/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-03-10-12_08052008	--	Soil	8/5/2008	✓	✓	10-12	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-03-1-3_08052008	--	Soil	8/5/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-03-5-7_08052008	--	Soil	8/5/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	EM-U25-0-1_08062008	--	Soil	8/6/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	EM-U25-1-3_08062008	--	Soil	8/6/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	EM-U25-5-5.5_08062008	--	Soil	8/6/2008	✓	✓	5-5.5	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-04-0-1_08062008	--	Soil	8/6/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-04-1-3_08062008	--	Soil	8/6/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-04-5-7_08062008	--	Soil	8/6/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-05-0-1_08272008	--	Soil	8/27/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-05-1-3_08272008	--	Soil	8/27/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-06-0-1_08272008	--	Soil	8/27/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former C Pond Spoils	CS-JS-06-1-3_08272008	--	Soil	8/27/2008	✓	no radionuclide data	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-3 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-4 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-5 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-10 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-13 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-14 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-17 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-18 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-21 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface

Table 5-2
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Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Exposure Area	Location SubArea	Sample ID	Alternative ID for Figures	Medium	Sample Date	Metals Analysis	Radionuclide Analysis	Depth (ft bgs)	Applicable Data Set(s)	Sample Descriptor [a]
Former Esperanza Mill	Former Esperanza Mill	EM-T-2-2 100504	--	Soil	10/5/2004	✓	--	2	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-T-2-2.5 100504	--	Soil	10/5/2004	✓	--	2.5	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-T-2-B-18 100504	--	Soil	10/5/2004	✓	--	1.5	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-T-3-12 100504	--	Soil	10/5/2004	✓	--	12	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-T-3-4 100504	--	Soil	10/5/2004	✓	--	4	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-T-3-6 100504	--	Soil	10/5/2004	✓	--	6	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-C22-0-1_07292008	--	Soil	7/29/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-C22-1-3_07292008	--	Soil	7/29/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-C22-5-7_07292008	--	Soil	7/29/2008	✓	sample jar broken	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-E24-0-1_07292008	--	Soil	7/29/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-E24-1-3_07292008	--	Soil	7/29/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-E24-5-7_07292008	--	Soil	7/29/2008	✓	sample jar broken	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-H22-0-1_07302008	--	Soil	7/30/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-H22-1-3_07302008	--	Soil	7/30/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-H22-5-7_07312008	--	Soil	7/31/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-K24-0-1_07312008	--	Soil	7/31/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-K24-1-3_07312008	--	Soil	7/31/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-K24-5-7_07312008	--	Soil	7/31/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-JS-01-0-1_08012008	--	Soil	8/1/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-JS-01-1-3_08012008	--	Soil	8/1/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-M26-0-1_08012008	--	Soil	8/1/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-M26-1-3_08012008	--	Soil	8/1/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-M26-5-7_08012008	--	Soil	8/1/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-N29-0-1_08062008	--	Soil	8/6/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-N29-1-3_08062008	--	Soil	8/6/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-X26-0-1_08062008	--	Soil	8/6/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-X26-1-3_08062008	--	Soil	8/6/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-X26-5-7_08062008	--	Soil	8/6/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-G27-0-1_08072008	--	Soil	8/7/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-G27-1-3_08072008	--	Soil	8/7/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-P24-0-1_08072008	--	Soil	8/7/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-P24-10-11_08072008	--	Soil	8/7/2008	✓	✓	10-11	0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-P24-1-3_08072008	--	Soil	8/7/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Esperanza Mill	EM-P24-5-7_08072008	--	Soil	8/7/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-20 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-02-0-1_08012008	--	Soil	8/1/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-02-1-3_08012008	--	Soil	8/1/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-08-0-1_08122008	--	Soil	8/12/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-08-10-12_08122008	--	Soil	8/12/2008	✓	✓	10-12	0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-08-1-3_08122008	--	Soil	8/12/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-08-5-7_08122008	--	Soil	8/12/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-06-0-1_08132008	--	Soil	8/13/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-06-10-11_08132008	--	Soil	8/13/2008	✓	✓	10-11	0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-06-1-3_08132008	--	Soil	8/13/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-06-5-7_08132008	--	Soil	8/13/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-07-0-1_08132008	--	Soil	8/13/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-07-10-12_08132008	--	Soil	8/13/2008	✓	✓	10-12	0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-07-1-3_08132008	--	Soil	8/13/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Laydown Yard	EM-JS-07-5-7_08132008	--	Soil	8/13/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	EM-9 081304	--	Soil	8/13/2004	✓	--	0-0.25	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	EM-T-1-1.5 100504	--	Soil	10/5/2004	✓	--	1.5	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	EM-T-1-13 100504	--	Soil	10/5/2004	✓	--	13	0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	EM-T-1-2 100504	--	Soil	10/5/2004	✓	--	2	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	EM-T-1-6 100504	--	Soil	10/5/2004	✓	--	6	0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-01-0-1_08072008	--	Soil	8/7/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface

Table 5-2
Inventory of Soil and Sediment Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Exposure Area	Location SubArea	Sample ID	Alternative ID for Figures	Medium	Sample Date	Metals Analysis	Radionuclide Analysis	Depth (ft bgs)	Applicable Data Set(s)	Sample Descriptor [a]
Former Esperanza Mill	Former Raffinate Pond	RA-JS-01-1-3_08072008	--	Soil	8/7/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-01-5-7_08072008	--	Soil	8/7/2008	✓	✓	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-03-0-1_08072008	--	Soil	8/7/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-03-1-3_08072008	--	Soil	8/7/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-04-0-1_08072008	--	Soil	8/7/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-04-1-2.5_08072008	--	Soil	8/7/2008	✓	✓	1-2.5	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-05-0-1_08072008	--	Soil	8/7/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-05-1-3_08072008	--	Soil	8/7/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-02-0-1_08112008	--	Soil	8/11/2008	✓	✓	0-1	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-02-1-3_08112008	--	Soil	8/11/2008	✓	✓	1-3	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-JS-02-5-7_08112008	--	Soil	8/11/2008	✓	no radionuclide data	5-7	0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-SD-01-0-1.5_08112008	--	Sediment	8/11/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-SD-01-1.5-3.0_08112008	--	Sediment	8/11/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-SD-02-0-1.5_08112008	--	Sediment	8/11/2008	✓	✓	0-1.5	0-0.5, 0-2, 0-15	exposed at surface
Former Esperanza Mill	Former Raffinate Pond	RA-SD-02-1.5-3.0_08112008	--	Sediment	8/11/2008	✓	✓	1.5-3.0	0-2, 0-15	exposed at surface

Notes
Sample inventory does not include field duplicates or excavated samples.
[a] Descriptor of "exposed at surface" indentifies samples used to evaluate current conditions. All samples, including those with descriptor "paved/developed", are used to evaluate hypothetical future exposure scenarios.
The future scenario assumes areas currently covered with pavement or buildings are no longer covered after hypothetical future redevelopment.
BHHRA = Baseline Human Health Risk Assessment.
ft bgs = feet below ground surface.
N/A - Not available.

Table 5-3
Soil Screening Levels Used to Select Constituents of Potential Concern
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]		CASRN	Constituent Class [b]	Selected Soil Screening Level [c,d]	
				(mg/kg) or (pCi/g)	Surrogate
Inorganics					
Antimony		7440-36-0	nc	4.10E+02	–
Arsenic		7440-38-2	ca, nc	1.00E+01	–
Barium		7440-39-3	nc	1.70E+05	–
Beryllium		7440-41-7	ca, nc	1.90E+03	–
Cadmium		7440-43-9	ca, nc	5.10E+02	–
Chromium		7440-47-3	nc	1.00E+06	Chromium III
Cobalt		7440-48-4	ca, nc	1.30E+04	–
Copper		7440-50-8	nc	4.10E+04	–
Lead		7439-92-1	ca, nc	8.00E+02	–
Manganese		7439-96-5	nc	3.20E+04	–
Mercury		7487-94-7	nc	3.10E+02	–
Molybdenum		7439-98-7	nc	5.10E+03	–
Nickel		7440-02-0	nc	2.00E+04	–
Selenium		7782-49-2	nc	5.10E+03	–
Thallium		7440-28-0	nc	6.70E+01	–
Uranium		7440-61-1	nc	2.00E+02	–
Zinc		7440-66-6	nc	3.10E+05	–
Radionuclides					
Radium-226	+D	Ra-226	–	2.10E-02	–
Radium-228	+D	Ra-228	–	1.30E-01	–
Uranium-234		U-234	–	2.80E+01	–
Uranium-235	+D	U-235	–	3.00E-01	–
Uranium-238	+D	U-238	–	1.40E+00	–

Notes:
[a] All detected constituents are presented.
[b] Constituent Class: "ca" indicates carcinogenic effects; "nc" indicates noncarcinogenic effects.
[c] The selected screening levels for inorganic constituents are the ADEQ's Non-Residential Soil Remediation Levels (nrSRLs). 2007. Available online at: http://apps.azsos.gov/public_services/Title_18/18-07.pdf.
[d] Screening levels for radiological constituents are the USEPA's Preliminary Remediation Goals (PRGs) for Radionuclides (USEPA 2014c). PRGs for the composite worker were used. Available online at: epa- prgs.ornl.gov/radionuclides/.

"+D" (plus daughters) indicates branches in the decay chain.
Ra-226: Rn-222, Po-218, Pb-214+At-218, Bi-214, Po-214+Tl-210
Ra-228: Ac-228
U-235: Th-231
U-238: Th234, Pa-234m+Pa234

–: not available or not applicable.
ADEQ: Arizona Department of Environmental Quality.
CASRN: Chemical Abstracts Service Registry Number.
mg/kg: milligram(s) per kilogram.
pCi/g: picoCurie(s) per gram.
USEPA: United States Environmental Protection Agency.

Table 5-4
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
	No. of Detects / No. of Samples	(%)	Min (mg/kg)	Max (mg/kg)	Min (mg/kg)	Max (mg/kg)		(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics												
Antimony	32 / 46	70	1.00E+00	1.00E+00	2.00E-01	6.60E+01	CP-2 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	46 / 46	100	–	–	1.10E+00	1.66E+02	CP-2 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	36 / 36	100	–	–	6.71E+01	6.54E+02	CP-JS-01-0-1_07152008(7/15/2008)	1.70E+05	–	no	no	BSL
Beryllium	43 / 46	94	1.00E+00	1.00E+00	1.10E-01	1.30E+00	CP-JS-01-0-1_07152008(7/15/2008)	1.90E+03	–	no	no	BSL
Cadmium	16 / 46	35	2.00E+00	2.00E+00	4.80E-01	2.49E+01	CP-9 081304(8/13/2004)	5.10E+02	–	no	no	BSL
Chromium	46 / 46	100	–	–	3.00E+00	5.80E+01	CP-5 081304(8/13/2004)	1.00E+06	Chromium III	no	no	BSL
Cobalt	41 / 41	100	–	–	4.00E+00	7.60E+01	CP-1 081304(8/13/2004)	1.30E+04	–	no	no	BSL
Copper	46 / 46	100	–	–	2.07E+02	5.93E+04	CP-9 081304(8/13/2004)	4.10E+04	–	no	**YES**	ASL
Lead	46 / 46	100	–	–	4.00E+00	1.82E+03	CP-2 081304(8/13/2004)	8.00E+02	–	no	**YES**	ASL
Manganese	46 / 46	100	–	–	7.10E+01	5.87E+02	CP-9 081304(8/13/2004)	3.20E+04	–	no	no	BSL
Mercury	9 / 46	20	4.00E-02	2.00E-01	5.00E-02	6.20E-01	CP-2 081304(8/13/2004)	3.10E+02	–	no	no	BSL
Molybdenum	46 / 46	100	–	–	1.50E+01	3.02E+03	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Nickel	46 / 46	100	–	–	3.00E+00	6.40E+01	CP-5 081304(8/13/2004)	2.00E+04	–	no	no	BSL
Selenium	45 / 46	98	6.70E-01	6.70E-01	2.30E-01	5.00E+01	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	46 / 46	100	–	–	1.00E-01	5.20E+00	CP-2 081304(8/13/2004)	6.70E+01	–	no	no	BSL
Uranium	36 / 36	100	–	–	1.45E+00	7.57E+00	OD-SD-03-0-1.5_07282008(7/28/2008)	2.00E+02	–	no	no	BSL
Zinc	46 / 46	100	–	–	2.60E+01	6.21E+03	CP-9 081304(8/13/2004)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-5
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
				Min - Max		Min - Max						
	No. of Detects	No. of Samples	(%)	(pCi/g)		(pCi/g)			(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides												
Radium-226	31	/ 32	97	8.40E-01	8.40E-01	4.30E-01	3.50E+00	OD-JS-02-0-1_07292008(7/29/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	32	/ 32	100	–	–	1.20E+00	7.60E+00	CP-O09-0-1_07112008(7/11/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	32	/ 32	100	–	–	9.80E-01	3.90E+00	OD-SD-05-0-1.5_07292008(7/29/2008)	2.80E+01	no	no	BSL
Uranium-235	23	/ 32	72	3.90E-02	1.90E-01	6.30E-02	3.10E-01	OD-SD-03-0-1.5_07282008(7/28/2008)	3.00E-01	no	**YES**	ASL
Uranium-238	32	/ 32	100	–	–	1.10E+00	4.00E+00	EV-JS-01-0-1_07142008(7/14/2008), OD-SD-03-0-1.5_07282008(7/28/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-6
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 2 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
				Min - Max		Min - Max							
	No. of Detects	No. of Samples	(%)	(mg/kg)		(mg/kg)			(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics													
Antimony	47	/ 86	55	1.00E+00	- 2.00E+00	2.00E-01	- 6.60E+01	CP-2 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	89	/ 89	100	–	- –	7.00E-01	- 1.66E+02	CP-2 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	72	/ 72	100	–	- –	4.11E+01	- 6.54E+02	CP-JS-01-0-1_07152008(7/15/2008)	1.70E+05	–	no	no	BSL
Beryllium	79	/ 89	89	1.00E+00	- 1.00E+00	1.10E-01	- 1.30E+00	CP-JS-01-0-1_07152008(7/15/2008)	1.90E+03	–	no	no	BSL
Cadmium	23	/ 86	27	2.00E+00	- 2.00E+00	4.80E-01	- 2.49E+01	CP-9 081304(8/13/2004)	5.10E+02	–	no	no	BSL
Chromium	86	/ 86	100	–	- –	2.00E+00	- 4.70E+02	CP-T-4-18IN 100404(10/4/2004)	1.00E+06	Chromium III	no	no	BSL
Cobalt	77	/ 77	100	–	- –	3.00E+00	- 7.60E+01	CP-1 081304(8/13/2004)	1.30E+04	–	no	no	BSL
Copper	89	/ 89	100	–	- –	2.70E+01	- 5.93E+04	CP-9 081304(8/13/2004)	4.10E+04	–	no	**YES**	ASL
Lead	89	/ 89	100	–	- –	1.20E+00	- 1.82E+03	CP-2 081304(8/13/2004)	8.00E+02	–	no	**YES**	ASL
Manganese	86	/ 86	100	–	- –	7.10E+01	- 7.59E+02	CP-T-4-18IN 100404(10/4/2004)	3.20E+04	–	no	no	BSL
Mercury	13	/ 86	15	4.00E-02	- 2.00E-01	4.00E-02	- 6.20E-01	CP-2 081304(8/13/2004)	3.10E+02	–	no	no	BSL
Molybdenum	89	/ 89	100	–	- –	2.00E+00	- 3.02E+03	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Nickel	86	/ 86	100	–	- –	2.00E+00	- 7.00E+01	CP-T-4-18IN 100404(10/4/2004)	2.00E+04	–	no	no	BSL
Selenium	81	/ 86	94	3.00E-01	- 6.70E-01	7.00E-02	- 5.00E+01	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	82	/ 86	95	1.00E-01	- 3.00E-01	1.00E-01	- 5.20E+00	CP-2 081304(8/13/2004)	6.70E+01	–	no	no	BSL
Uranium	72	/ 72	100	–	- –	1.30E+00	- 1.03E+01	OD-SD-05-1.5-3.0_07292008(7/29/2008)	2.00E+02	–	no	no	BSL
Zinc	86	/ 86	100	–	- –	2.60E+01	- 6.21E+03	CP-9 081304(8/13/2004)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (HTSPT) (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency. Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-7
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 2 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
	Min - Max					Min - Max						
	No. of Detects	No. of Sample	(%)	(pCi/g)	(pCi/g)	(pCi/g)	(pCi/g)		(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides												
Radium-226	65	66	99	8.40E-01	8.40E-01	4.30E-01	4.80E+00	CP-P07-1-3_07172008(7/17/2008), E-JS-02-1-3_07142008(7/14/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	66	66	100	–	–	1.20E+00	7.60E+00	CP-O09-0-1_07112008(7/11/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	66	66	100	–	–	8.80E-01	4.60E+00	E-JS-02-1-3_07142008(7/14/2008)	2.80E+01	no	no	BSL
Uranium-235	48	66	73	3.90E-02	2.30E-01	2.00E-02	3.10E-01	E-JS-02-1-3_07142008(7/14/2008), OD-SD-03-0-1.5_07282008(7/28/2008)	3.00E-01	no	**YES**	ASL
Uranium-238	66	66	100	–	–	8.40E-01	4.90E+00	E-JS-02-1-3_07142008(7/14/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-8
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
	No. of Detects / No. of Samples	(%)	Min - Max (mg/kg)		Min - Max (mg/kg)			(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics													
Antimony	36 / 54	67	1.00E+00 - 2.00E+00		2.00E-01 - 6.60E+01		CP-2 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	139 / 149	93	2.50E+00 - 2.50E+00		1.10E+00 - 1.66E+02		CP-2 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	42 / 42	100	– - –		3.68E+01 - 6.54E+02		CP-JS-01-0-1_07152008(7/15/2008)	1.70E+05	–	no	no	BSL
Beryllium	51 / 54	94	1.00E+00 - 1.00E+00		1.10E-01 - 1.30E+00		CP-JS-01-0-1_07152008(7/15/2008)	1.90E+03	–	no	no	BSL
Cadmium	21 / 54	39	2.00E-01 - 2.00E+00		4.30E-01 - 2.49E+01		CP-9 081304(8/13/2004)	5.10E+02	–	no	no	BSL
Chromium	54 / 54	100	– - –		3.00E+00 - 5.80E+01		CP-5 081304(8/13/2004)	1.00E+06	Chromium III	no	no	BSL
Cobalt	47 / 47	100	– - –		4.00E+00 - 7.60E+01		CP-1 081304(8/13/2004)	1.30E+04	–	no	no	BSL
Copper	149 / 149	100	– - –		1.33E+02 - 1.09E+05		CP-16 081304(8/13/2004)	4.10E+04	–	no	**YES**	ASL
Lead	149 / 149	100	– - –		2.70E+00 - 3.22E+03		CPS-SWN-D2-01_20120511(5/11/2012)	8.00E+02	–	no	**YES**	ASL
Manganese	53 / 54	98	4.00E-01 - 4.00E-01		7.10E+01 - 5.87E+02		CP-9 081304(8/13/2004)	3.20E+04	–	no	no	BSL
Mercury	13 / 54	24	3.30E-02 - 2.00E-01		3.70E-02 - 6.20E-01		CP-2 081304(8/13/2004)	3.10E+02	–	no	no	BSL
Molybdenum	54 / 54	100	– - –		1.36E+01 - 3.02E+03		CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Nickel	54 / 54	100	– - –		2.00E+00 - 6.40E+01		CP-5 081304(8/13/2004)	2.00E+04	–	no	no	BSL
Selenium	48 / 54	89	6.70E-01 - 4.00E+00		2.30E-01 - 5.00E+01		CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	49 / 54	91	1.50E+00 - 1.50E+00		1.00E-01 - 5.20E+00		CP-2 081304(8/13/2004)	6.70E+01	–	no	no	BSL
Uranium	42 / 42	100	– - –		1.32E+00 - 7.57E+00		OD-SD-03-0-1.5_07282008(7/28/2008)	2.00E+02	–	no	no	BSL
Zinc	54 / 54	100	– - –		2.60E+01 - 6.21E+03		CP-9 081304(8/13/2004)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-9
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits			Detected Concentrations			Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
				Min	-	Max	Min	-	Max					
	No. of Detects	No. of Samples	(%)	(pCi/g)		(pCi/g)	(pCi/g)		(pCi/g)		(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides														
Radium-226	32	/ 33	97	8.40E-01	-	8.40E-01	4.30E-01	-	3.50E+00	OD-JS-02-0-1_07292008(7/29/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	33	/ 33	100	–	-	–	1.20E+00	-	7.60E+00	CP-O09-0-1_07112008(7/11/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	33	/ 33	100	–	-	–	9.80E-01	-	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	2.80E+01	no	no	BSL
Uranium-235	24	/ 33	73	3.90E-02	-	1.90E-01	6.30E-02	-	7.40E-01	CP-JS-02-0-1_07112008(7/11/2008)	3.00E-01	no	**YES**	ASL
Uranium-238	33	/ 33	100	–	-	–	1.10E+00	-	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-10
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 2 ft bgs), All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
	No. of Detects / No. of Samples	(%)	Min (mg/kg)	Max (mg/kg)	Min (mg/kg)	Max (mg/kg)		(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics												
Antimony	53 / 96	55	1.00E+00	2.00E+00	2.00E-01	6.60E+01	CP-2 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	185 / 195	95	2.50E+00	2.50E+00	7.00E-01	1.66E+02	CP-2 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	79 / 79	100	–	–	3.68E+01	6.54E+02	CP-JS-01-0-1_07152008(7/15/2008)	1.70E+05	–	no	no	BSL
Beryllium	90 / 100	90	1.00E+00	1.00E+00	1.10E-01	1.40E+00	CP-T-3-6 100504(10/5/2004)	1.90E+03	–	no	no	BSL
Cadmium	29 / 96	30	2.00E-01	2.00E+00	4.30E-01	2.49E+01	CP-9 081304(8/13/2004)	5.10E+02	–	no	no	BSL
Chromium	96 / 96	100	–	–	2.00E+00	4.70E+02	CP-T-4-18IN 100404(10/4/2004)	1.00E+06	Chromium III	no	no	BSL
Cobalt	84 / 84	100	–	–	3.00E+00	7.60E+01	CP-1 081304(8/13/2004)	1.30E+04	–	no	no	BSL
Copper	195 / 195	100	–	–	2.70E+01	1.09E+05	CP-16 081304(8/13/2004)	4.10E+04	–	no	**YES**	ASL
Lead	195 / 195	100	–	–	1.20E+00	3.22E+03	CPS-SWN-D2-01_20120511(5/11/2012)	8.00E+02	–	no	**YES**	ASL
Manganese	95 / 96	99	4.00E-01	4.00E-01	7.10E+01	7.59E+02	CP-T-4-18IN 100404(10/4/2004)	3.20E+04	–	no	no	BSL
Mercury	17 / 96	18	3.30E-02	2.00E-01	3.70E-02	6.20E-01	CP-2 081304(8/13/2004)	3.10E+02	–	no	no	BSL
Molybdenum	100 / 100	100	–	–	2.00E+00	3.02E+03	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Nickel	96 / 96	100	–	–	2.00E+00	7.00E+01	CP-T-4-18IN 100404(10/4/2004)	2.00E+04	–	no	no	BSL
Selenium	86 / 96	90	3.00E-01	4.00E+00	7.00E-02	5.00E+01	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	86 / 96	90	1.00E-01	1.50E+00	1.00E-01	5.20E+00	CP-2 081304(8/13/2004)	6.70E+01	–	no	no	BSL
Uranium	79 / 79	100	–	–	9.30E-01	1.03E+01	OD-SD-05-1.5-3.0_07292008(7/29/2008)	2.00E+02	–	no	no	BSL
Zinc	96 / 96	100	–	–	2.60E+01	6.21E+03	CP-9 081304(8/13/2004)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (HTSPT) (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency. Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-11
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former CLEAR Plant - Shallow Soil/Sediment (0 to 2 ft bgs), All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits			Detected Concentrations			Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
				Min	-	Max	Min	-	Max					
	No. of Detects	No. of Samples	(%)	(pCi/g)		(pCi/g)	(pCi/g)		(pCi/g)		(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides														
Radium-226	67	/ 68	99	8.40E-01	-	8.40E-01	4.30E-01	-	4.80E+00	CP-P07-1-3_07172008(7/17/2008), E-JS-02-1-3_07142008(7/14/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	68	/ 68	100	–	-	–	1.20E+00	-	7.60E+00	CP-O09-0-1_07112008(7/11/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	68	/ 68	100	–	-	–	8.40E-01	-	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	2.80E+01	no	no	BSL
Uranium-235	50	/ 68	74	3.90E-02	-	2.30E-01	2.00E-02	-	7.40E-01	CP-JS-02-0-1_07112008(7/11/2008)	3.00E-01	no	**YES**	ASL
Uranium-238	68	/ 68	100	–	-	–	8.40E-01	-	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-12
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
	No. of Detects / No. of Samples		(%)	Min (mg/kg)	Max (mg/kg)	Min (mg/kg)	Max (mg/kg)		(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics													
Antimony	62 / 116		53	1.00E+00	2.00E+00	2.00E-01	6.60E+01	CP-2 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	216 / 226		96	2.50E+00	2.50E+00	7.00E-01	1.66E+02	CP-2 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	96 / 96		100	–	–	3.68E+01	6.54E+02	CP-JS-01-0-1_07152008(7/15/2008)	1.70E+05	–	no	no	BSL
Beryllium	118 / 131		90	1.00E+00	5.00E+00	1.10E-01	1.40E+00	CP-T-3-6 100504(10/5/2004)	1.90E+03	–	no	no	BSL
Cadmium	36 / 116		31	2.00E-01	8.00E+00	4.20E-01	2.49E+01	CP-9 081304(8/13/2004)	5.10E+02	–	no	no	BSL
Chromium	116 / 116		100	–	–	2.00E+00	4.70E+02	CP-T-4-18IN 100404(10/4/2004)	1.00E+06	Chromium III	no	no	BSL
Cobalt	101 / 101		100	–	–	3.00E+00	7.60E+01	CP-1 081304(8/13/2004)	1.30E+04	–	no	no	BSL
Copper	226 / 226		100	–	–	2.70E+01	1.09E+05	CP-16 081304(8/13/2004)	4.10E+04	–	no	**YES**	ASL
Lead	226 / 226		100	–	–	1.20E+00	3.22E+03	CPS-SWN-D2-01_20120511(5/11/2012)	8.00E+02	–	no	**YES**	ASL
Manganese	115 / 116		99	4.00E-01	4.00E-01	7.10E+01	1.24E+03	CP-JS-01-10-12_07152008(7/15/2008)	3.20E+04	–	no	no	BSL
Mercury	21 / 116		18	3.30E-02	2.00E-01	3.70E-02	6.20E-01	CP-2 081304(8/13/2004)	3.10E+02	–	no	no	BSL
Molybdenum	131 / 131		100	–	–	2.00E+00	3.02E+03	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Nickel	116 / 116		100	–	–	2.00E+00	7.00E+01	CP-T-4-18IN 100404(10/4/2004)	2.00E+04	–	no	no	BSL
Selenium	104 / 116		90	3.00E-01	4.00E+00	7.00E-02	5.00E+01	CP-2 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	104 / 116		90	1.00E-01	1.50E+00	1.00E-01	5.20E+00	CP-2 081304(8/13/2004)	6.70E+01	–	no	no	BSL
Uranium	96 / 96		100	–	–	9.30E-01	1.60E+01	CP-JS-04-5-7_08272008(8/27/2008)	2.00E+02	–	no	no	BSL
Zinc	116 / 116		100	–	–	2.60E+01	6.21E+03	CP-9 081304(8/13/2004)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (HTSPT) (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency. Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-13
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits			Detected Concentrations			Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
				Min	-	Max	Min	-	Max					
	No. of Detects	No. of Samples	(%)	(pCi/g)		(pCi/g)	(pCi/g)		(pCi/g)		(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides														
Radium-226	80	/ 82	98	4.00E-01	-	8.40E-01	4.30E-01	-	5.30E+00	CP-JS-03-5-7_07142008(7/14/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	82	/ 82	100	–	-	–	1.20E+00	-	7.60E+00	CP-O09-0-1_07112008(7/11/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	82	/ 82	100	–	-	–	8.40E-01	-	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	2.80E+01	no	no	BSL
Uranium-235	63	/ 82	77	3.90E-02	-	2.30E-01	2.00E-02	-	7.40E-01	CP-JS-02-0-1_07112008(7/11/2008)	3.00E-01	no	**YES**	ASL
Uranium-238	82	/ 82	100	–	-	–	8.40E-01	-	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-14
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
	No. of Detects	No. of Samples	(%)	Min (mg/kg)	Max (mg/kg)	Min (mg/kg)	Max (mg/kg)		(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics													
Antimony	40	45	89	1.00E+00	1.00E+00	2.00E-01	6.90E+01	EM-17 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	42	45	93	1.01E+01	3.54E+01	1.40E+00	1.01E+02	EM-17 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	33	33	100	–	–	4.50E+01	2.94E+02	CS-JS-05-0-1_08272008(8/27/2008)	1.70E+05	–	no	no	BSL
Beryllium	40	45	89	1.00E+00	5.00E+00	1.70E-01	2.36E+00	EM-26 081304(8/13/2004)	1.90E+03	–	no	no	BSL
Cadmium	20	45	44	2.00E+00	2.00E+00	3.20E-01	5.65E+00	EM-3 081304(8/13/2004)	5.10E+02	–	no	no	BSL
Chromium	45	45	100	–	–	2.00E+00	2.30E+01	C-JS-04-0-1_08052008(8/5/2008)	1.00E+06	Chromium III	no	no	BSL
Cobalt	36	37	97	5.00E+00	5.00E+00	3.00E+00	1.90E+01	EM-JS-07-0-1_08132008(8/13/2008)	1.30E+04	–	no	no	BSL
Copper	45	45	100	–	–	1.13E+02	3.02E+04	RA-JS-02-0-1_08112008(8/11/2008)	4.10E+04	–	no	no	BSL
Lead	45	45	100	–	–	4.99E+00	4.77E+02	C-JS-05-0-1_08052008(8/5/2008)	8.00E+02	–	no	no	BSL
Manganese	45	45	100	–	–	3.00E+01	9.28E+02	EM-26 081304(8/13/2004)	3.20E+04	–	no	no	BSL
Mercury	17	45	38	4.00E-02	2.00E-01	4.00E-02	3.60E-01	RA-JS-02-0-1_08112008(8/11/2008)	3.10E+02	–	no	no	BSL
Molybdenum	45	45	100	–	–	7.00E+00	6.83E+03	EM-JS-07-0-1_08132008(8/13/2008)	5.10E+03	–	no	**YES**	ASL
Nickel	39	45	87	1.00E+00	5.00E+00	2.00E+00	2.50E+01	EM-4 081304(8/13/2004)	2.00E+04	–	no	no	BSL
Selenium	36	45	80	4.10E-01	1.11E+01	9.00E-02	9.40E+00	EM-3 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	38	44	86	1.80E-01	3.00E-01	7.00E-02	8.90E-01	EM-14 081304(8/13/2004)	6.70E+01	–	no	no	BSL
Uranium	33	33	100	–	–	1.96E+00	1.10E+01	CS-JS-03-0-1_08052008(8/5/2008)	2.00E+02	–	no	no	BSL
Zinc	44	44	100	–	–	2.50E+01	8.24E+02	EM-3 081304(8/13/2004)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-15
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits			Detected Concentrations			Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
				Min	-	Max	Min	-	Max					
	No. of Detects	No. of Samples	(%)	(pCi/g)		(pCi/g)	(pCi/g)		(pCi/g)		(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides														
Radium-226	30 /	30	100	–	-	–	5.40E-01	-	5.80E+00	RA-JS-03-0-1_08072008(8/7/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	28 /	30	93.3	2.40E+00	-	2.50E+00	1.40E+00	-	3.70E+00	EM-JS-02-0-1_08012008(8/1/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	30 /	30	100	–	-	–	1.00E+00	-	3.70E+00	RA-JS-05-0-1_08072008(8/7/2008)	2.80E+01	no	no	BSL
Uranium-235	21 /	30	70	5.20E-02	-	1.10E-01	5.50E-02	-	2.00E-01	RA-JS-05-0-1_08072008(8/7/2008)	3.00E-01	no	no	BSL
Uranium-238	30 /	30	100	–	-	–	9.20E-01	-	3.50E+00	RA-JS-05-0-1_08072008(8/7/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-16
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former Esperanza Mill - Shallow Soil/Sediment (0 to 2 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
	No. of Detects	No. of Samples	(%)	Min (mg/kg)	Max (mg/kg)	Min (mg/kg)	Max (mg/kg)		(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics													
Antimony	64	80	80	1.00E+00	1.00E+00	2.00E-01	6.90E+01	EM-17 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	76	82	93	1.01E+01	8.97E+01	1.00E+00	1.01E+02	EM-17 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	66	66	100	–	–	4.02E+01	2.94E+02	CS-JS-05-0-1_08272008(8/27/2008)	1.70E+05	–	no	no	BSL
Beryllium	71	82	87	1.00E+00	5.00E+00	1.70E-01	2.36E+00	EM-26 081304(8/13/2004)	1.90E+03	–	no	no	BSL
Cadmium	33	80	41	2.00E+00	2.00E+00	3.20E-01	5.65E+00	EM-3 081304(8/13/2004)	5.10E+02	–	no	no	BSL
Chromium	80	80	100	–	–	2.00E+00	3.70E+01	CS-JS-01-1-3_08042008(8/4/2008)	1.00E+06	Chromium III	no	no	BSL
Cobalt	69	70	99	5.00E+00	5.00E+00	1.00E+00	2.20E+01	RA-JS-02-1-3_08112008(8/11/2008)	1.30E+04	–	no	no	BSL
Copper	82	82	100	–	–	6.20E+01	3.02E+04	RA-JS-02-0-1_08112008(8/11/2008)	4.10E+04	–	no	no	BSL
Lead	82	82	100	–	–	2.81E+00	3.74E+03	C-JS-05-1-3_08052008(8/5/2008)	8.00E+02	–	no	**YES**	ASL
Manganese	80	80	100	–	–	3.00E+01	9.28E+02	EM-26 081304(8/13/2004)	3.20E+04	–	no	no	BSL
Mercury	24	80	30	4.00E-02	2.00E-01	4.00E-02	3.60E-01	RA-JS-02-0-1_08112008(8/11/2008)	3.10E+02	–	no	no	BSL
Molybdenum	81	82	99	5.00E+00	5.00E+00	3.00E+00	6.83E+03	EM-JS-07-0-1_08132008(8/13/2008)	5.10E+03	–	no	**YES**	ASL
Nickel	71	80	89	1.00E+00	5.00E+00	2.00E+00	2.50E+01	EM-4 081304(8/13/2004)	2.00E+04	–	no	no	BSL
Selenium	66	80	83	2.60E-01	1.11E+01	5.00E-02	9.40E+00	EM-3 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	67	78	86	1.20E-01	3.00E-01	7.00E-02	8.90E-01	EM-14 081304(8/13/2004)	6.70E+01	–	no	no	BSL
Uranium	66	66	100	–	–	1.17E+00	1.34E+01	RA-JS-01-1-3_08072008(8/7/2008)	2.00E+02	–	no	no	BSL
Zinc	78	78	100	–	–	2.50E+01	8.24E+02	EM-3 081304(8/13/2004)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (HTSPT) (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency. Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-17
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former Esperanza Mill - Shallow Soil/Sediment (0 to 2 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits			Detected Concentrations			Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
				Min	-	Max	Min	-	Max					
	No. of Detects	No. of Samples	(%)	(pCi/g)		(pCi/g)	(pCi/g)		(pCi/g)		(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides														
Radium-226	62	/ 62	100	–	-	–	5.40E-01	-	5.80E+00	RA-JS-03-0-1_08072008(8/7/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	59	/ 62	95.2	2.00E+00	-	2.50E+00	1.00E+00	-	8.90E+00	RA-JS-02-1-3_08112008(8/11/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	62	/ 62	100	–	-	–	8.50E-01	-	6.60E+00	CS-JS-05-1-3_08272008(8/27/2008)	2.80E+01	no	no	BSL
Uranium-235	45	/ 62	72.6	4.20E-02	-	2.00E-01	4.20E-02	-	3.40E-01	CS-JS-05-1-3_08272008(8/27/2008)	3.00E-01	no	**YES**	ASL
Uranium-238	62	/ 62	100	–	-	–	9.00E-01	-	6.60E+00	CS-JS-05-1-3_08272008(8/27/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-18
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Non-Residential Screening Level [b]		Is Maximum Concentration > 10x nrSRL?	Is Constituent a COPC? [c]	
	No. of Detects / No. of Samples	(%)	Min (mg/kg)	Max (mg/kg)	Min (mg/kg)	Max (mg/kg)		(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics												
Antimony	86 / 114	75	2.00E-01	1.00E+00	2.00E-01	6.90E+01	EM-17 081304(8/13/2004)	4.10E+02	–	no	no	BSL
Arsenic	112 / 119	94	1.01E+01	8.97E+01	1.00E+00	1.01E+02	EM-17 081304(8/13/2004)	1.00E+01	–	YES	**YES**	ASL
Barium	95 / 95	100	–	–	3.92E+01	3.66E+02	CS-JS-02-5-7_08042008(8/4/2008)	1.70E+05	–	no	no	BSL
Beryllium	107 / 119	90	1.00E+00	5.00E+00	1.70E-01	6.20E+00	RA-JS-02-5-7_08112008(8/11/2008)	1.90E+03	–	no	no	BSL
Cadmium	51 / 114	45	2.00E+00	2.00E+00	2.60E-01	8.30E+00	CS-JS-02-10-11_08042008(8/4/2008)	5.10E+02	–	no	no	BSL
Chromium	114 / 114	100	–	–	2.00E+00	1.93E+02	EM-JS-08-10-12_08122008(8/12/2008)	1.00E+06	Chromium III	no	no	BSL
Chromium VI	1 / 5	20	4.00E+00	9.00E+00	4.00E+00	4.00E+00	EM-JS-08-10-12_08122008(8/12/2008)	6.50E+01	–	no	no	BSL
Cobalt	98 / 99	99	5.00E+00	5.00E+00	1.00E+00	4.20E+01	EM-JS-08-5-7_08122008(8/12/2008)	1.30E+04	–	no	no	BSL
Copper	119 / 119	100	–	–	6.20E+01	3.02E+04	RA-JS-02-0-1_08112008(8/11/2008)	4.10E+04	–	no	no	BSL
Lead	119 / 119	100	–	–	2.81E+00	3.74E+03	C-JS-05-1-3_08052008(8/5/2008)	8.00E+02	–	no	**YES**	ASL
Manganese	114 / 114	100	–	–	3.00E+01	9.32E+02	EM-JS-08-5-7_08122008(8/12/2008)	3.20E+04	–	no	no	BSL
Mercury	35 / 114	31	4.00E-02	2.00E-01	4.00E-02	6.00E-01	EM-JS-08-5-7_08122008(8/12/2008)	3.10E+02	–	no	no	BSL
Molybdenum	118 / 119	99	5.00E+00	5.00E+00	3.00E+00	6.83E+03	EM-JS-07-0-1_08132008(8/13/2008)	5.10E+03	–	no	**YES**	ASL
Nickel	103 / 114	90	1.00E+00	5.00E+00	2.00E+00	3.30E+01	EM-JS-08-5-7_08122008(8/12/2008)	2.00E+04	–	no	no	BSL
Selenium	93 / 114	82	1.90E-01	1.11E+01	5.00E-02	9.40E+00	EM-3 081304(8/13/2004)	5.10E+03	–	no	no	BSL
Thallium	98 / 111	88	1.20E-01	3.00E-01	7.00E-02	1.10E+00	EM-T-2-2.5 100504(10/5/2004)	6.70E+01	–	no	no	BSL
Uranium	95 / 95	100	–	–	1.17E+00	2.99E+01	RA-JS-02-5-7_08112008(8/11/2008)	2.00E+02	–	no	no	BSL
Zinc	111 / 111	100	–	–	2.50E+01	3.63E+03	CS-JS-02-10-11_08042008(8/4/2008)	3.10E+05	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (HTSPT) (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency. Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
nrSRL: non-residential Soil Remediation Level.

Table 5-19
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits			Detected Concentrations			Sample Identification of Maximum Concentration (Sample Date)	Composite Worker PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
				Min	-	Max	Min	-	Max					
	No. of Detects	No. of Samples	(%)	(pCi/g)		(pCi/g)	(pCi/g)		(pCi/g)		(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides														
Radium-226	88	/ 88	100	–	-	–	5.40E-01	-	5.80E+00	RA-JS-03-0-1_08072008(8/7/2008)	2.10E-02	YES	**YES**	ASL
Radium-228	85	/ 88	96.6	2.00E+00	-	2.50E+00	1.00E+00	-	8.90E+00	RA-JS-02-1-3_08112008(8/11/2008)	1.30E-01	YES	**YES**	ASL
Uranium-234	88	/ 88	100	–	-	–	8.50E-01	-	1.20E+01	EM-JS-08-10-12_08122008(8/12/2008)	2.80E+01	no	no	BSL
Uranium-235	68	/ 88	77.3	4.20E-02	-	2.00E-01	4.20E-02	-	5.70E-01	EM-JS-08-10-12_08122008(8/12/2008)	3.00E-01	no	**YES**	ASL
Uranium-238	88	/ 88	100	–	-	–	9.00E-01	-	1.20E+01	EM-JS-08-10-12_08122008(8/12/2008)	1.40E+00	no	**YES**	ASL

Notes:
[a] Only detected constituents are presented.
[b] Refer to Table 5-3 for screening level selection.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
%: percent.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Table 5-20
Summary of Exposure Point Concentrations (Chemicals) for Soil/Sediment:
Former CLEAR Plant, Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

COPC	CASRN	COPC? [a]	Exposure Point Concentrations [b]
		Shallow Soil/Sediment (0 to 0.5 ft bgs)	Shallow Soil/Sediment (0 to 0.5 ft bgs) (mg/kg)
Inorganics			
Antimony	7440-36-0	no	–
Arsenic	7440-38-2	**YES**	3.01E+01
Barium	7440-39-3	no	–
Beryllium	7440-41-7	no	–
Cadmium	7440-43-9	no	–
Chromium	7440-47-3	no	–
Cobalt	7440-48-4	no	–
Copper	7440-50-8	**YES**	1.23E+04
Lead	7439-92-1	**YES**	2.67E+02
Manganese	7439-96-5	no	–
Mercury	7487-94-7	no	–
Molybdenum	7439-98-7	no	–
Nickel	7440-02-0	no	–
Selenium	7782-49-2	no	–
Thallium	7440-28-0	no	–
Uranium	7440-61-1	no	–
Zinc	7440-66-6	no	–

Notes:
[a] Constituent of potential concern (COPC), as determined in Table 5-4.
[b] The exposure point concentrations (EPCs) are presented for compounds selected as COPCs. EPCs are the upper confidence limit on the mean concentration (UCL) and were calculated using ProUCL (5.1).

–: not applicable.
CASRN: Chemical Abstracts Service Registry Number.
ft bgs: feet below ground surface.
mg/kg: milligram(s) per kilogram.

Table 5-21
Summary of Exposure Point Concentrations (Radionuclides) for Soil/Sediment:
Former CLEAR Plant, Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	COPC? [a]	Exposure Point Concentrations [b]
	Shallow Soil/Sediment (0-0.5 ft bgs)	Shallow Soil/Sediment (0-0.5 ft bgs) (pCi/g)
Radionuclides		
Radium-226	**YES**	2.15E+00
Radium-228	**YES**	2.66E+00
Uranium-234	no	2.46E+00
Uranium-235	**YES**	1.46E-01
Uranium-238	**YES**	2.57E+00

Notes:
[a] Constituent of potential concern (COPC), as determined in Table 5-5.
[b] The exposure point concentrations (EPCs) are the upper confidence limit on the mean concentration (UCL) or the maximum concentration where data are insufficient to calculate a UCL (i.e., less than 8 samples or less than 5 detects). The UCLs were calculated using ProUCL (5.1). The UCL used is the 95UCL recommended by ProUCL (5.1).

--: not detected or not applicable.
ft bgs: feet below ground surface.
pCi/g: picoCurie(s) per gram.

Table 5-22
Summary of Exposure Point Concentrations (Chemicals) for Soil/Sediment:
Former CLEAR Plant, All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

COPC	CASRN	COPC? [a]		Exposure Point Concentrations [b]		
		Shallow Soil/Sediment (0 to 0.5 ft bgs)	Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Shallow Soil/Sediment (0 to 0.5 ft bgs) (mg/kg)	Shallow and Deep Soil/Sediment (0 to 15 ft bgs) (mg/kg)	
Inorganics						
Antimony	7440-36-0	no	no	–	–	
Arsenic	7440-38-2	**YES**	**YES**	9.58E+00	9.99E+00	soil
Barium	7440-39-3	no	no	–	–	
Beryllium	7440-41-7	no	no	–	–	
Cadmium	7440-43-9	no	no	–	–	
Chromium	7440-47-3	no	no	–	–	
Cobalt	7440-48-4	no	no	–	–	
Copper	7440-50-8	**YES**	**YES**	7.96E+03	7.39E+03	soil
Lead	7439-92-1	**YES**	**YES**	2.58E+02	2.09E+02	soil
Manganese	7439-96-5	no	no	–	–	
Mercury	7487-94-7	no	no	–	–	
Molybdenum	7439-98-7	no	no	–	–	
Nickel	7440-02-0	no	no	–	–	
Selenium	7782-49-2	no	no	–	–	
Thallium	7440-28-0	no	no	–	–	
Uranium	7440-61-1	no	no	–	–	
Zinc	7440-66-6	no	no	–	–	

Notes:
[a] Constituent of potential concern (COPC), as determined in Tables 5-8 and 5-12.
[b] The exposure point concentrations (EPCs) are presented for compounds selected as COPCs. EPCs are the upper confidence limit on the mean concentration (UCL) and were calculated using ProUCL (5.1).

–: not applicable.
CASRN: Chemical Abstracts Service Registry Number.
ft bgs: feet below ground surface.
mg/kg: milligram(s) per kilogram.

Table 5-23
Summary of Exposure Point Concentrations (Chemicals) for Soil/Sediment:
Former Esperanza Mill
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

COPC	CASRN	COPC? [a]		Exposure Point Concentrations [b]		
		Shallow Soil/Sediment (0 to 0.5 ft bgs)	Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Shallow Soil/Sediment (0 to 0.5 ft bgs) (mg/kg)	Shallow and Deep Soil/Sediment (0 to 15 ft bgs) (mg/kg)	
Inorganics						
Antimony	7440-36-0	no	no	–	–	
Arsenic	7440-38-2	**YES**	**YES**	1.93E+01	1.29E+01	soil only
Barium	7440-39-3	no	no	–	–	
Beryllium	7440-41-7	no	no	–	–	
Cadmium	7440-43-9	no	no	–	–	
Chromium	7440-47-3	no	no	–	–	
Chromium VI	18540-29-9	no	no	–	–	
Cobalt	7440-48-4	no	no	–	–	
Copper	7440-50-8	no	no	–	–	
Lead	7439-92-1	no	**YES**	–	1.33E+02	soil + sed
Manganese	7439-96-5	no	no	–	–	
Mercury	7487-94-7	no	no	–	–	
Molybdenum	7439-98-7	**YES**	**YES**	1.85E+03	1.44E+03	soil + sed
Nickel	7440-02-0	no	no	–	–	
Selenium	7782-49-2	no	no	–	–	
Thallium	7440-28-0	no	no	–	–	
Uranium	7440-61-1	no	no	–	–	
Zinc	7440-66-6	no	no	–	–	

Notes:
[a] Constituent of potential concern (COPC), as determined in Tables 5-14 and 5-18.
[b] The exposure point concentrations (EPCs) are presented for compounds selected as COPCs. EPCs are the upper confidence limit on the mean concentration (UCL) and were calculated using ProUCL (5.1).

–: not applicable.
CASRN: Chemical Abstracts Service Registry Number.
ft bgs: feet below ground surface.
mg/kg: milligram(s) per kilogram.

Table 5-24
Summary of Exposure Point Concentrations (Radionuclides):
All Exposure Areas
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	COPC? [a]				Exposure Point Concentrations [b]					
	Former CLEAR Plant, All Samples		Former Esperanza Mill		Former CLEAR Plant, All Samples			Former Esperanza Mill		
	Shallow Soil/Sediment (0-0.5 ft bgs)	Shallow and Deep Soil/Sediment (0-15 ft bgs)	Shallow Soil/Sediment (0-0.5 ft bgs)	Shallow and Deep Soil/Sediment (0-15 ft bgs)	Shallow Soil/Sediment, Exposed and Covered Samples (0-0.5 ft bgs) (pCi/g)	Shallow and Deep Soil/Sediment (0-15 ft bgs) (pCi/g)		Shallow Soil/Sediment (0-0.5 ft bgs) (pCi/g)	Shallow and Deep Soil/Sediment (0-15 ft bgs) (pCi/g)	
Radionuclides										
Radium-226	**YES**	**YES**	**YES**	**YES**	2.18E+00	2.58E+00	soil	2.60E+00	2.43E+00	soil+sed
Radium-228	**YES**	**YES**	**YES**	**YES**	2.63E+00	2.52E+00	soil	2.19E+00	2.51E+00	soil
Uranium-234	no	no	no	no	3.08E+00	3.07E+00	soil	2.12E+00	2.71E+00	soil
Uranium-235	**YES**	**YES**	no	**YES**	1.92E-01	1.85E-01	soil	1.12E-01	1.20E-01	soil
Uranium-238	**YES**	**YES**	**YES**	**YES**	3.17E+00	3.15E+00	soil	2.10E+00	2.76E+00	soil

Notes:
[a] Constituent of potential concern (COPC), as determined in Tables 5-9, 5-13, 5-15 and 5-19.
[b] The exposure point concentrations (EPCs) are the upper confidence limit on the mean concentration (UCL) or the maximum concentration where data are insufficient to calculate a UCL (i.e., less than 8 samples or less than 5 detects). The UCLs were calculated using ProUCL (5.1). The UCL used is the 95UCL recommended by ProUCL (5.1). Where multiple 95UCLs are recommended, the following decision logic was used:

- Where 95% KM Adjusted or Approximate Gamma UCL and 95% GROS Adjusted or Approximate Gamma UCL are recommended, the KM Gamma UCL was used because the GROS Gamma UCL is more vulnerable to the effects of outliers.
- Where 95% Student's-t UCL and 95% Modified-t UCL are recommended, the 95% Student's-t UCL was used because Student's-t is a simpler model with similar results.
- Where 95% Student's-t UCL, 95% Modified-t UCL, and 95% H-UCL are recommended, the 95% Student's-t UCL was used because the H-UCL can often be inflated and the Student's-t is a simpler model than Modified-t.
- Where 95% KM (t) UCL, 95% KM (BCA) UCL, and KM H-UCL are recommended, the 95% KM (BCA) UCL was used because H-UCL can often be inflated and the BCA is more accurate and is consistent with the area-weighting approach.
- Where 95% KM (t) UCL and KM H-UCL are recommended, the 95% KM (t) UCL was used because the H-UCL can often be inflated.

ft bgs: feet below ground surface.
pCi/g: picoCurie(s) per gram.

Table 6-1
Human Health Exposure Parameters
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Parameter	Symbol	Units	Commercial/Industrial Outdoor Worker – Adult					Adolescent Trespasser (6 to 16 years)		Construction Worker – Adult	
			EPA and Arizona Recommended		Site-Specific Factors			EPA and Arizona Recommended		EPA and Arizona Recommended	
			All Exposure Areas		CLEAR Plant	Esperanza Mill		All Exposure Areas		All Exposure Areas	
General Factors											
Averaging Time (cancer)	ATc	days	28,470	[1]	28,470	28,470	[1]	28,470	[1]	28,470	[1]
Averaging Time (noncancer)	ATnc	days	9,125	[2]	9,125	9,125	[2]	3,650	[2]	365	[2]
Body Weight	BW	kg	80	[3]	80	80	[3]	44	[4]	80	[3]
Exposure Frequency	EF	days/year	225	[5]	225	225	[22]	52	[6]	250	[7]
Exposure Duration	ED	years	25	[8]	25	25	[8]	10	[6]	1	[9]
Inhalation											
Exposure Time	ET	hours/day	4	[10]	4	4	[22]	1	[6]	8	[10]
Exposure Time, indoor	ET_i	hours/day	0		0	0		0		0	
Exposure Time, outdoor	ET_o	hours/day	8	[10]	4	4	[22]	1	[6]	8	[10]
Conversion Factor	CF	day/hour	0.042		0.042	0.042		0.042		0.042	
Particulate Emission Factor	PEF	m^3/kg	1.396E +09	[11]	1.396E +09	1.396E +09	[11]	1.396E +09	[11]	1.396E +09	[11]
Inhalation Rate	InhR	m^3/day	60	[12]	60	60	[12]	13.6	[13]	60	[12]
Age-Adjusted Inhalation Rate	$InhR_{adj}$	m^3/day	–		–	–		–		–	
Soil - Ingestion (Oral)											
Incidental Soil Ingestion Rate	IRs	mg/day	100	[14]	100	100	[14]	50	[15]	330	[16]
Age-Adjusted Soil Ingestion Rate	IR_{adj}	mg/day	–		–	–		–		–	
Soil - Dermal Contact											
Exposed Skin Surface Area	SA	cm^2	6,125	[17]	6,125	6,125	[17]	4,400	[18]	6,125	[17]
Soil-to-Skin Adherence Rate	SAR	$mg/cm^2/day$	0.15	[19]	0.15	0.15	[19]	0.07	[20]	0.3	[21]

Table 6-1
Human Health Exposure Parameters
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Notes:

[1] The averaging time for assessing cancer risk is the average expected lifespan of 78 years (Table 18-1, USEPA 2011) expressed in days.

[2] The averaging time for evaluating non-cancer health effects is the exposure duration expressed in days (e.g., 25 years x 365 days/year = 9,125 days) (USEPA 1989).

[3] Mean recommended body weight for adults (Table 8-1, USEPA 2011).

[4] Mean recommended body weight for adolescents, ages 6-16 (Table 8-1, USEPA 2011).

[5] Standard default occupational exposure frequency for an outdoor worker (ADHS 2003).

[6] Professional Judgment: Assumes trespassing occurs one day per week, for one hour at a time. Also assumes trespasser age is 6 to 16 years.

[7] Standard default occupational exposure frequency for a construction worker (ADHS 2003).

[8] Standard default occupational exposure duration for an outdoor worker (ADHS 2003; ADEQ 2002).

[9] Standard default occupational exposure duration for a construction worker (ADHS 2003).

[10] Professional Judgment: Based on a typical 8-hour workday.

[11] Standard default particulate emission factor (ADHS 2003; ADEQ 2002).

[12] Recommended default exposure parameter (USEPA 2015g).

[13] Based on an age-weighted average of mean inhalation rates for combined males and females, ages 6 to <16 (Table 6-1, USEPA 2011).

[14] Standard default soil ingestion rate for an adult (ADEQ 2002).

[15] Recommended central tendency soil and dust ingestion rate for an adult (Table 5-1, USEPA 2011). There is no upper percentile soil and dust ingestion rate for an adult available in Table 5-1 (USEPA, 2011).

[16] Standard default occupational soil ingestion rate for a construction worker (ADHS 2003).

[17] Based on an age-weighted average of 95th percentile total skin surface areas for combined males and females, ages 18 to 60 (2.45 m^2 or 24,500 cm^2) (Table 7-9; USEPA 2011). The exposed skin surface area was assumed to be 25% of the total skin surface area (ADEQ, 2002); 24,500 cm^2 x 0.25 = 6,125 cm^2.

[18] Assumes that a receptor 6 to 16 years old is wearing a short-sleeved shirt, shorts, and shoes; therefore, the SA is the time-weighted average of the surface area for the hands, forearms, and lower legs (USEPA 2011).

[19] Average of recommended values for mean solids adherence to skin for adult hands (0.1595 mg/cm^2) and feet (0.1393 mg/cm^2), during "activities with soil" (Table 7-4, USEPA 2011).

[20] The soil-to-skin adherence factor for the adolescent trespasser is based on the geometric mean adherence factor for gardeners (USEPA 2004).

[21] Standard default soil adherence factor for a construction worker (ADHS 2003).

[22] Site-specific exposure parameters are based on typical outdoor worker activities and conditions at each of the two exposure areas.

References:

Arizona Department of Environmental Quality. 2002. Appendix P, Table 1: Standard Default Factors. UST Program Release Reporting and Corrective Action Guidance. Accessed online: http://www.azdeq.gov/environ/waste/ust/lust/rbca/appp.pdf

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U.S. Environmental Protection Agency. 1989. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A). EPA/540/1-89/002. Office of Emergency and Remedial Response, USEPA, Washington, DC. (December)

U.S. Environmental Protection Agency. 2011. Exposure Factors Handbook 2011 Edition (Final). EPA/600/R-09/052F. National Center for Environmental Assessment, Office of Research and Development, USEPA, Washington, DC. (September)

U.S. Environmental Protection Agency. 2015g. Preliminary Remediation Goals for Radionuclides, User's Guide. Accessed online: http://epa-prgs.ornl.gov/radionuclides/prg_guide.html.

ADEQ: Arizona Department of Environmental Quality.
ADHS: Arizona Department of Health Services.
cm^2: square centimeter(s).
kg: kilogram(s).
m^2: square meter(s).
m^3: cubic meter(s).
mg: milligram(s).
USEPA: United States Environmental Protection Agency.

Table 6-2
Dermal Absorption Parameters
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	ABSd [b] (Unitless)
Inorganics	
Arsenic	0.03
Cobalt	0
Copper	0
Lead	0

Notes:
[a] Only constituents of potential concern are presented.
[b] Dermal absorption efficiency for uptake of constituents from a soil matrix (unitless) (USEPA 2004).

ABSd: dermal absorption efficiency.

Table 7-1
Human Health Toxicity Values for Chemical COPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	ABS_{GI} [b]	Oral RfD [c]				Dermal RfD [d]		Inhalation RfC [c]				Oral CSF [c]		Dermal CSF [d]	Inhalation Unit Risk [c]	
		Subchronic		Chronic		Subchronic	Chronic	Subchronic		Chronic						
		(mg/kg/day)	[ref]	(mg/kg/day)	[ref]	(mg/kg/day)	(mg/kg/day)	(mg/m^3)	[ref]	(mg/m^3)	[ref]	$(mg/kg/day)^{-1}$	[ref]	$(mg/kg/day)^{-1}$	$(mg/m^3)^{-1}$	[ref]
Inorganics																
Arsenic	1	3.0E-04	c	3.0E-04	I	3.0E-04	3.0E-04	1.5E-05	c	1.5E-05	C	1.5E+00	I	1.5E+00	4.3E+00	I
Copper	1	4.0E-02	c	4.0E-02	H	4.0E-02	4.0E-02	NA		NA		NA		NA	NA	
Lead [e]	1	NA		NA		NA	NA	NA		NA		NA		NA	NA	
Molybdenum	1	5.0E-03	H	5.0E-03	I	5.0E-03	5.0E-03	NA		NA		NA		NA	NA	

Notes:

[a] Only constituents of potential concern are presented.

[b] ABS_{GI} - Gastrointestinal absorption fraction (USEPA 2004).

[c] Toxicity values were selected from the following hierarchy of sources:
(1) USEPA Integrated Risk Information System (I) (USEPA 2015b).
(2) USEPA Provisional Peer Reviewed Toxicity Values (P) (USEPA 2015d).
(3) Agency for Toxic Substances and Disease Registry (A) (ATSDR 2014).
(4) USEPA Health Effects Summary Tables (H). (USEPA 2015e).
(5) California Environmental Protection Agency Toxicity Criteria Database (C). (CalEPA 2015).

[d] RfD (dermal) = RfD (oral) × ABS_{GI}.
CSF (dermal) = CSF (oral) / ABS_{GI}.

[e] The potential for adverse effects from exposure to lead is evaluated using USEPA lead models.

c: The chronic value is used if no subchronic value is available.
CSF: cancer slope factor.
mg/kg/day: milligram(s) per kilogram per day.
$(mg/kg/day)^{-1}$: inverse of milligram(s) per kilogram per day.
mg/m^3: milligram(s) per cubic meter.
$(mg/m^3)^{-1}$: inverse of milligram(s) per cubic meter.
NA: not available or applicable.
RfC: reference concentration.
RfD: reference dose.
USEPA: United States Environmental Protection Agency.

Table 7-2
Radionuclide Physical Constants and Carcinogenicity Slope Factors
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	Radioactive Half-Life [a]	Decay Constant (λ) [a]	Slope Factors [a]				ACFs [c]		GSFi [d]	GSFo [e]
			Soil Ingestion [b]	Adult Only Soil Ingestion [b]	Inhalation	External Exposure	CP	EM		
	yr	yr^{-1}	risk/pCi	risk/pCi	risk/pCi	risk-yr/pCi-g				
Radionuclides										
Uranium-238 +D [f]	4.47E+09	1.55E-10	1.97E-10	5.62E-11	2.37E-08	1.19E-07	1.0	1.0	0.4	1.0
Uranium-234	2.45E+05	2.82E-06	1.48E-10	5.11E-11	2.80E-08	2.53E-10	1.0	1.0	0.4	1.0
Thorium-230	7.54E+04	9.19E-06	1.66E-10	7.73E-11	3.40E-08	8.45E-10	1.0	1.0	0.4	1.0
Radium-226 +D [f]	1.60E+03	4.33E-04	6.77E-10	2.95E-10	2.82E-08	8.37E-06	1.0	1.0	0.4	1.0
Lead-210	2.22E+01	3.12E-02	1.72E-09	5.99E-10	1.60E-08	1.48E-09	1.0	1.0	0.4	1.0
Bismuth-210	1.37E-02	5.05E+01	2.40E-11	3.74E-12	4.60E-10	2.77E-09	1.0	1.0	0.4	1.0
Polonium-210	3.79E-01	1.83E+00	3.27E-09	1.44E-09	1.50E-08	4.51E-11	1.0	1.0	0.4	1.0
Thorium-232 +D [f]	1.41E+10	4.93E-11	2.17E-09	7.55E-10	8.70E-08	4.04E-06	1.0	1.0	0.4	1.0
Thorium-228	1.91E+00	3.63E-01	2.43E-10	6.40E-11	1.30E-07	5.64E-09	1.0	1.0	0.4	1.0
Radium-224 +D [f]	1.00E-02	6.91E+01	4.26E-10	8.47E-11	1.10E-08	4.19E-08	1.0	1.0	0.4	1.0
Lead-212	1.21E-03	5.71E+02	6.33E-11	1.31E-11	6.40E-10	4.96E-07	1.0	1.0	0.4	1.0
Bismuth-212 +D [f]	1.15E-04	6.02E+03	1.68E-12	4.44E-13	8.40E-11	4.96E-07	1.0	1.0	0.4	1.0
Thallium-208	5.81E-06	1.19E+05	NA	NA	NA	1.75E-05	1.0	1.0	0.4	1.0
Uranium-235 +D [f]	7.04E+08	9.84E-10	1.54E-10	5.00E-11	2.50E-08	5.76E-07	1.0	1.0	0.4	1.0
Protactinium-231	3.28E+04	2.12E-05	2.98E-10	1.54E-10	7.60E-08	1.27E-07	1.0	1.0	0.4	1.0
Actinium-227	2.18E+01	3.18E-02	2.90E-10	2.01E-10	1.50E-07	1.98E-10	1.0	1.0	0.4	1.0
Francium-223	4.19E-05	1.66E+04	1.69E-11	4.88E-12	4.10E-11	1.35E-07	1.0	1.0	0.4	1.0
Astatine-219	1.78E-06	3.90E+05	NA	NA	NA	NA	1.0	1.0	0.4	1.0
Bismuth-215	1.45E-05	4.79E+04	NA	NA	NA	1.08E-06	1.0	1.0	0.4	1.0
Thorium-227	5.12E-02	1.35E+01	1.29E-10	2.06E-11	3.50E-08	4.45E-07	1.0	1.0	0.4	1.0
Radium-223 +D [f]	3.13E-02	2.21E+01	5.99E-10	1.23E-10	2.90E-08	6.91E-07	1.0	1.0	0.4	1.0
Lead-211	6.87E-05	1.01E+04	9.55E-13	2.63E-13	4.00E-11	2.91E-07	1.0	1.0	0.4	1.0
Astatine-215	3.17E-12	2.19E+11	NA	NA	NA	7.08E-10	1.0	1.0	0.4	1.0
Bismuth-211	4.07E-06	1.70E+05	NA	NA	NA	1.90E-07	1.0	1.0	0.4	1.0
Thallium-207	9.08E-06	7.64E+04	NA	NA	NA	1.59E-08	1.0	1.0	0.4	1.0
Polonium-211	1.64E-08	4.24E+07	NA	NA	NA	3.76E-08	1.0	1.0	0.4	1.0

Notes:

[a] Radioactive half-lives, decay constants and slope factors are from the USEPA Preliminary Remediation Goal (PRG) Summary Table (USEPA 2014c).

[b] "Adult Only Soil Ingestion" slope factors are used to evaluate worker and trespasser exposures. "Soil Ingestion" slope factors are lifetime values and are appropriate for evaluating residential exposure.

[c] Isotope-specific ACFs for source area size from Appendix B of Bellamy et al. 2014 (http://epa-prgs.ornl.gov/radionuclides/ACF_FINAL_APPENDIX.pdf), based on the following calculated exposure areas:
Former CLEAR Plant Area: 226,499 m^2 (ground plane, infinite source area)
Former Esperanza Mill Area: 521,523 m^2 (ground plane, infinite source area)

[d] Gamma shielding factor for indoor exposure (USEPA 2000).

[e] Assumes no gamma shielding when individual is outdoors.

[f] Slope factors account for contributions to risks from ingrowth of the following short-lived radioactive decay products (radioactive half-lives less than or equal to 6 months), with a decay chain extending to, but not including, the next principal or stable radionuclide out to 100 years (+D). This method assumes secular equilibrium (equal activity concentrations) with the parent radionuclide in the environment in the absence of empirical data.
"+" indicates branches in the decay chain.
U-238: Th234, Pa-234m+Pa234
Ra-226: Rn-222, Po-218, Pb-214+At-218, Bi-214, Po-214+Tl-210
Th-232: Ra-228, Ac-228
Ra-224: Rn-220, Po-216
Bi-212: Po-212
U-235: Th-231
Ra-223: Rn-219, Po-215

ACF: area correction factor.
CP: Former CLEAR Plant Area.
EM: Former Esperanza Mill Area.
GSFi: Gamma shielding factor, indoor.
GSFo: Gamma shielding factor, outdoor.
NA: not available.
risk/pCi: Risk per picoCurie.
risk-yr/pCi-g: Risk per year per picoCurie per gram soil.
yr: year

Table 9-1
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on 95% UCLs:
Former CLEAR Plant Exposure Area
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

		Former CLEAR Plant Exposure Area			
		TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX	
Human Receptors	Exposure Type (Table Reference)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Current/Future Scenario					
RME Outdoor Commercial/Industrial Worker - Exposed Samples Only	Chemical (Table C-1)	8E-06		0.3	
	Radiological (Table D-1)	2E-04		–	
	Receptor Total	2E-04		0.3	
Site-Specific Outdoor Commercial/Industrial Worker - Exposed Samples Only	Chemical (Table C-2)	8E-06		0.3	
	Radiological (Table D-2)	8E-05		–	
	Receptor Total	8E-05		0.3	
Hypothetical Future Scenario					
RME Outdoor Commercial/Industrial Worker - All Samples	Chemical (Tables C-4 and C-7)	2E-06	3E-06	0.2	0.2
	Radiological (Tables D-4 and D-7)	2E-04	2E-04	–	–
	Receptor Total	2E-04	2E-04	0.2	0.2
Site-Specific Outdoor Commercial/Industrial Worker - All Samples	Chemical (Tables C-5 and C-8)	2E-06	3E-06	0.2	0.2
	Radiological (Tables D-5 and D-8)	8E-05	9E-05	–	–
	Receptor Total	8E-05	9E-05	0.2	0.2
Hypothetical Construction Worker	Chemical (Table C-10)		3E-07		0.6
	Radiological (Table D-10)		8E-06		–
	Receptor Total		8E-06		0.6
Hypothetical Adolescent Trespasser	Chemical (Tables C-6 and C-9)	2E-07	2E-07	0.04	0.03
	Radiological (Tables D-6 and D-9)	2E-06	2E-06	–	–
	Receptor Total	2E-06	2E-06	0.04	0.03

Notes:
The current/future scenario evaluated for the Former CLEAR Plant Exposure Area is based on shallow soil and sediment data from the sample locations that are currently exposed at the surface.
The hypothetical future scenarios evaluated for the Former CLEAR Plant Exposure Area are based on soil and sediment data from sample locations that are currently exposed at the surface and from sample locations that are currently covered (i.e., paved or developed) at the surface. This assumes that the currently covered soils will become exposed in the future.

– : not applicable.
95% UCL: 95 percent upper confidence limit of the mean concentration.
ft bgs: feet below ground surface.

Table 9-2
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on 95% UCLs:
Former Esperanza Mill Exposure Area
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

		Former Esperanza Mill Exposure Area			
		TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX	
Human Receptors	Exposure Type (Table Reference)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Current Scenario					
RME Outdoor Commercial/Industrial Worker	Chemical (Table C-11)	5E-06		0.3	
	Radiological (Table D-11)	2E-04		–	
	Receptor Total	2E-04		0.3	
Site-Specific Outdoor Commercial/Industrial Worker	Chemical (Table C-12)	5E-06		0.3	
	Radiological (Table D-12)	8E-05		–	
	Receptor Total	9E-05		0.3	
Future Scenario					
RME Outdoor Commercial/Industrial Worker	Chemical (Tables C-11 and C-14)	5E-06	3E-06	0.3	0.2
	Radiological (Tables D-11 and D-14)	2E-04	2E-04	–	–
	Receptor Total	2E-04	2E-04	0.3	0.2
Site-Specific Outdoor Commercial/Industrial Worker	Chemical (Tables C-12 and C-15)	5E-06	3E-06	0.3	0.2
	Radiological (Tables D-12 and D-15)	8E-05	8E-05	–	–
	Receptor Total	9E-05	8E-05	0.3	0.2
Hypothetical Construction Worker	Chemical (Table C-17)		4E-07		0.9
	Radiological (Table D-17)		8E-06		–
	Receptor Total		8E-06		0.9
Hypothetical Adolescent Trespasser	Chemical (Tables C-13 and C-16)	4E-07	2E-07	0.07	0.05
	Radiological (Tables D-13 and D-16)	2E-06	2E-06	–	–
	Receptor Total	2E-06	2E-06	0.07	0.05

Notes:
– : not applicable.
95% UCL: 95 percent upper confidence limit of the mean concentration.
ft bgs: feet below ground surface.

Table 9-3
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on Mean EPCs:
Former CLEAR Plant Exposure Area, Background, and Incremental Cancer Risks and Hazard Indices
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

	Former CLEAR Plant Exposure Area					Background					Incremental				
		TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX			TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX			TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX	
Human Receptors	Exposure Type (Table Reference)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Exposure Type (Table Reference)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Exposure Type	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Current/Future Scenario															
RME Outdoor Commercial/Industrial Worker - Exposed Samples Only	Chemical (Table H-1)	3E-06		0.1		Chemical (Table G-1)	6E-07		0.009		Chemical	2E-06		0.09	
	Radiological (Table I-1)	1E-04		–		Radiological (Table G-17)	1E-04		–		Radiological	3E-05		–	
	Receptor Total	1E-04		0.1		Receptor Total	1E-04		0.009		Receptor Total	3E-05		0.09	
Site-Specific Outdoor Commercial/Industrial Worker - Exposed Samples Only	Chemical (Table H-2)	3E-06		0.1		Chemical (Table G-2)	6E-07		0.009		Chemical	2E-06		0.09	
	Radiological (Table I-2)	7E-05		–		Radiological (Table G-18)	5E-05		–		Radiological	1E-05		–	
	Receptor Total	7E-05		0.1		Receptor Total	5E-05		0.009		Receptor Total	2E-05		0.09	
Hypothetical Future Scenario															
RME Outdoor Commercial/Industrial Worker - All Samples	Chemical (Tables H-4 and H-7)	2E-06	2E-06	0.09	0.09	Chemical (Tables G-1 and G-4)	6E-07	4E-07	0.009	0.006	Chemical	2E-06	2E-06	0.08	0.08
	Radiological (Tables I-4 and I-7)	1E-04	2E-04	–	–	Radiological (Tables G-17 and G-23)	1E-04	1E-04	–	–	Radiological	3E-05	5E-05	–	–
	Receptor Total	1E-04	2E-04	0.09	0.09	Receptor Total	1E-04	1E-04	0.009	0.006	Receptor Total	3E-05	5E-05	0.08	0.08
Site-Specific Outdoor Commercial/Industrial Worker - All Samples	Chemical (Tables H-5 and H-8)	2E-06	2E-06	0.09	0.09	Chemical (Tables G-2 and G-5)	6E-07	4E-07	0.009	0.006	Chemical	2E-06	2E-06	0.08	0.08
	Radiological (Tables I-5 and I-8)	7E-05	8E-05	–	–	Radiological (Tables G-18 and G-24)	5E-05	5E-05	–	–	Radiological	2E-05	3E-05	–	–
	Receptor Total	7E-05	8E-05	0.09	0.09	Receptor Total	5E-05	5E-05	0.009	0.006	Receptor Total	2E-05	3E-05	0.08	0.08
Hypothetical Construction Worker	Chemical (Table H-10)		3E-07		0.3	Chemical (Table G-7)		5E-08		0.02	Chemical		2E-07		0.3
	Radiological (Table I-10)		7E-06		–	Radiological (Table G-26)		5E-06		–	Radiological		2E-06		–
	Receptor Total		7E-06		0.3	Receptor Total		5E-06		0.02	Receptor Total		3E-06		0.3
Hypothetical Adolescent Trespasser	Chemical (Tables H-6 and H-9)	2E-07	2E-07	0.02	0.02	Chemical (Tables G-3 and G-6)	4E-08	3E-08	0.002	0.001	Chemical	1E-07	1E-07	0.02	0.02
	Radiological (Tables I-6 and I-9)	2E-06	2E-06	–	–	Radiological (Tables G-19 and G-25)	1E-06	1E-06	–	–	Radiological	4E-07	6E-07	–	–
	Receptor Total	2E-06	2E-06	0.02	0.02	Receptor Total	1E-06	1E-06	0.002	0.001	Receptor Total	5E-07	8E-07	0.02	0.02

Notes:
The current/future scenario evaluated for the Former CLEAR Plant Exposure Area is based on shallow soil and sediment data from the sample locations that are currently exposed at the surface.
The hypothetical future scenarios evaluated for the Former CLEAR Plant Exposure Area are based on soil and sediment data from sample locations that are currently exposed at the surface and from sample locations that are currently covered (i.e., paved or developed) at the surface. This assumes that the currently covered soils will become exposed in the future.

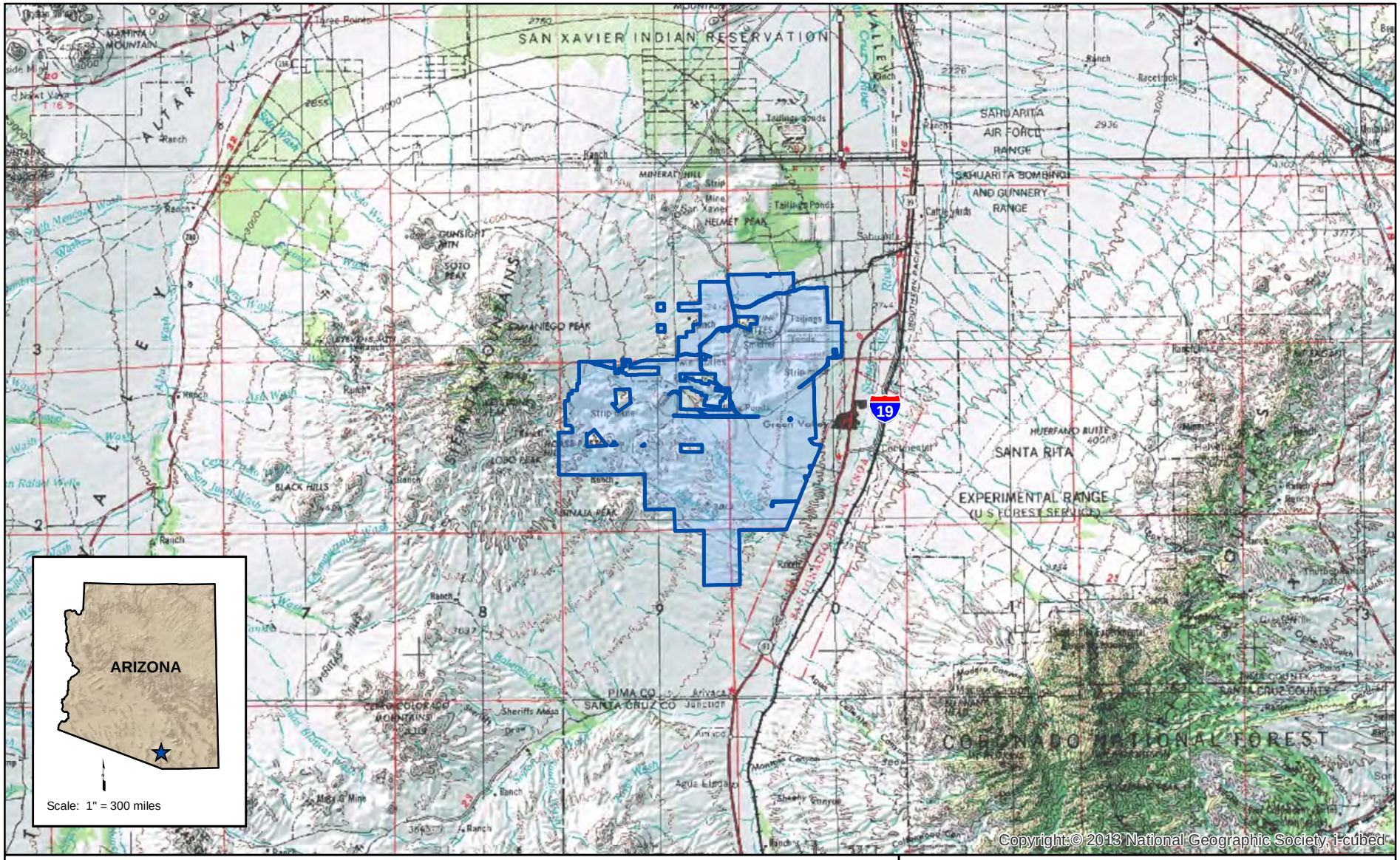
– : not applicable.
EPC: exposure point concentration.
ft bgs: feet below ground surface.

Table 9-4
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on Mean EPCs:
Former Esperanza Mill Exposure Area, Background, and Incremental Cancer Risks and Hazard Indices
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

	Former Esperanza Mill Exposure Area					Background					Incremental				
		TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX			TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX			TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX	
Human Receptors	Exposure Type (Table Reference)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Exposure Type (Table Reference)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Exposure Type	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow Soil/Sediment (0 to 0.5 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Current Scenario															
RME Outdoor Commercial/Industrial Worker	Chemical (Table H-11)	2E-06		0.1		Chemical (Table G-8)	6E-07		0.01		Chemical	2E-06		0.09	
	Radiological (Table I-11)	1E-04		–		Radiological (Table G-20)	1E-04		–		Radiological	4E-05		–	
	Receptor Total	1E-04		0.1		Receptor Total	1E-04		0.01		Receptor Total	4E-05		0.09	
Site-Specific Outdoor Commercial/Industrial Worker	Chemical (Table H-12)	2E-06		0.1		Chemical (Table G-9)	6E-07		0.01		Chemical	2E-06		0.09	
	Radiological (Table I-12)	7E-05		–		Radiological (Table G-21)	5E-05		–		Radiological	2E-05		–	
	Receptor Total	7E-05		0.1		Receptor Total	5E-05		0.01		Receptor Total	2E-05		0.09	
Future Scenario															
RME Outdoor Commercial/Industrial Worker	Chemical (Tables H-11 and H-14)	2E-06	2E-06	0.1	0.1	Chemical (Tables G-8 and G-11)	6E-07	4E-07	0.01	0.006	Chemical	2E-06	2E-06	0.09	0.09
	Radiological (Tables I-11 and I-14)	1E-04	1E-04	–	–	Radiological (Tables G-20 and G-23)	1E-04	1E-04	–	–	Radiological	4E-05	5E-05	–	–
	Receptor Total	1E-04	2E-04	0.1	0.1	Receptor Total	1E-04	1E-04	0.01	0.006	Receptor Total	4E-05	5E-05	0.09	0.09
Site-Specific Outdoor Commercial/Industrial Worker	Chemical (Tables H-12 and H-15)	2E-06	2E-06	0.1	0.1	Chemical (Tables G-9 and G-12)	6E-07	4E-07	0.01	0.006	Chemical	2E-06	2E-06	0.09	0.09
	Radiological (Tables I-12 and I-15)	7E-05	8E-05	–	–	Radiological (Tables G-21 and G-24)	5E-05	5E-05	–	–	Radiological	2E-05	2E-05	–	–
	Receptor Total	7E-05	8E-05	0.1	0.1	Receptor Total	5E-05	5E-05	0.01	0.006	Receptor Total	2E-05	3E-05	0.09	0.09
Hypothetical Construction Worker	Chemical (Table H-17)		2E-07		0.4	Chemical (Table G-14)		5E-08		0.02	Chemical		2E-07		0.4
	Radiological (Table I-17)		7E-06		–	Radiological (Table G-26)		5E-06		–	Radiological		2E-06		–
	Receptor Total		7E-06		0.4	Receptor Total		5E-06		0.02	Receptor Total		2E-06		0.4
Hypothetical Adolescent Trespasser	Chemical (Tables H-13 and H-16)	2E-07	1E-07	0.03	0.02	Chemical (Tables G-10 and G-13)	4E-08	3E-08	0.002	0.001	Chemical	1E-07	1E-07	0.03	0.02
	Radiological (Tables I-13 and I-16)	2E-06	2E-06	–	–	Radiological (Tables G-22 and G-25)	1E-06	1E-06	–	–	Radiological	4E-07	6E-07	–	–
	Receptor Total	2E-06	2E-06	0.03	0.02	Receptor Total	1E-06	1E-06	0.002	0.001	Receptor Total	6E-07	7E-07	0.03	0.02

Notes:
– : not applicable.
EPC: exposure point concentration.
ft bgs: feet below ground surface.

FIGURES



LEGEND

Approximate property boundary

NOTES

· Topographic map source: ESRI USA Topo Maps.

N

0 2.5 5 Miles

Scale: 1" = 5 mi

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

BASELINE HUMAN HEALTH RISK ASSESSMENT

SITE LOCATION MAP

ARCADIS

FIGURE
1-1

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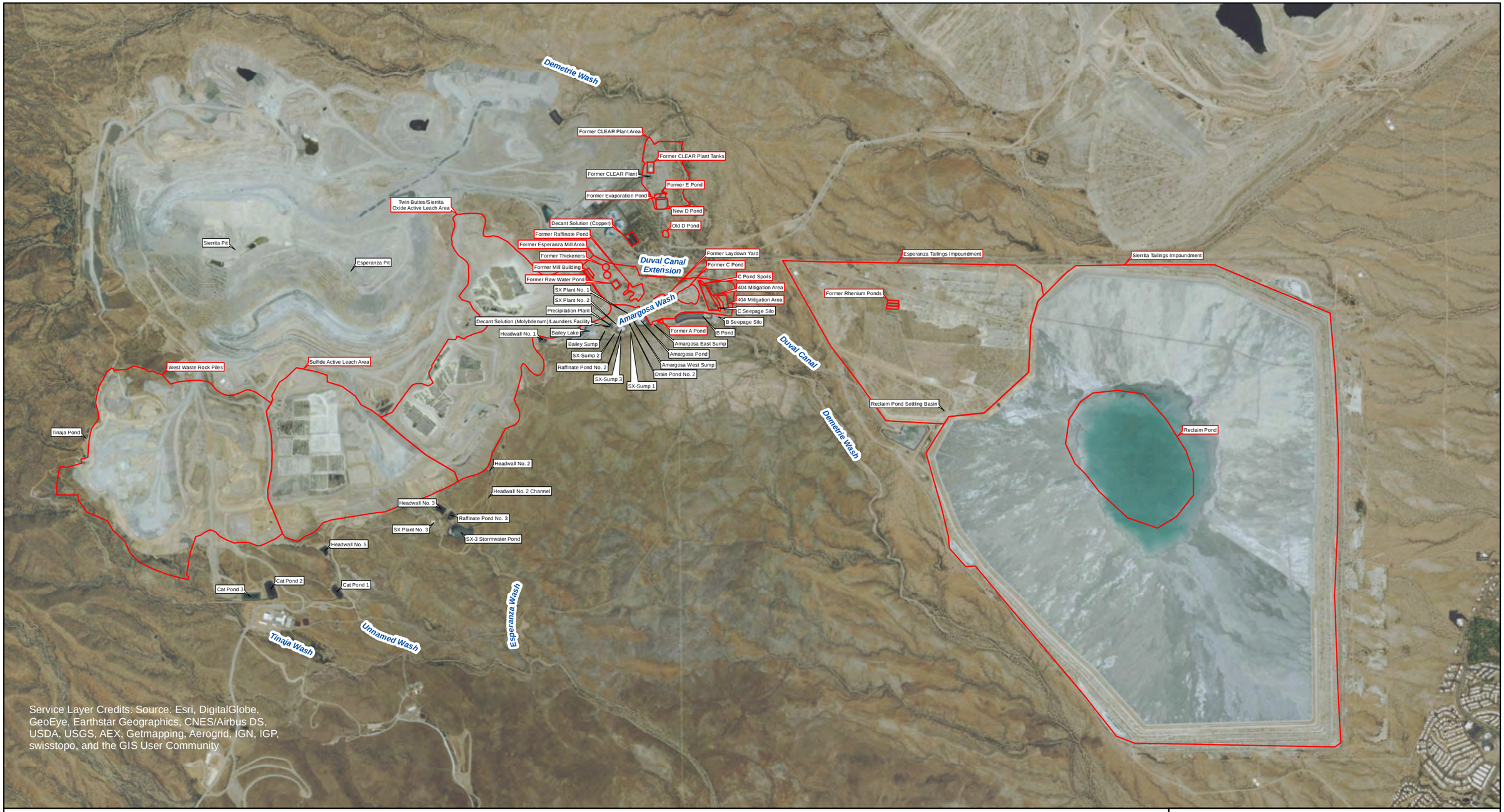


Document Path: W:\GISPROJECTS_ENV\Sierrita\GIS\ArcMap_MXD\2015\BHHRA\Fig 2-1 SiteFeaturesMap.mxd

LEGEND

SITE FEATURE

N

0 1,500 3,000 Feet

Scale: 1" = 3,000'

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

BASELINE HUMAN HEALTH RISK ASSESSMENT

SITE FEATURES MAP

ARCADIS

FIGURE
2-1

LEGEND

- FOOTPRINT* OF FORMER CLEAR PLANT AREA
- FOOTPRINT* OF FORMER ESPERANZA MILL AREA

* These footprints of former site features are according to the Final Voluntary Remediation Program - Soil and Sediment Characterization Report, URS Corporation, March 2011, Freeport-McMoran Sierrita Inc.

N

0 1,250 2,500 Feet

Scale: 1 inch = 2500 feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

BASELINE HUMAN HEALTH RISK ASSESSMENT

EXPOSURE AREAS EVALUATED IN THE BASELINE HUMAN HEALTH RISK ASSESSMENT

ARCADIS

FIGURE
5-1

Path: Z:\GISProjects_ENV\Sierrita\GIS\ArcMap_MXD\2015\BHHRA\Fig 5-1 ExposureAreasEval.mxd Date Saved: 10/30/2018 3:13:44 PM Author: J.Chen @ Boulder, CO

LEGEND

- SURFACE SOIL SAMPLE (2004/2008)
- TRENCH LOCATION (2004/2008)
- JUDGMENTAL SAMPLING LOCATION (2004/2008)
- GRID SAMPLING LOCATION (2004/2008)
- SEDIMENT SAMPLING LOCATION (2004/2008)
- SOIL SAMPLING LOCATION (2012)
- PAVING SAMPLING LOCATION (2015)
- FORMER CLEAR PLANT AREA
- FORMER EVAPORATION POND
- FORMER E POND

NOTES

LOCATIONS WHOSE SYMBOLS HAVE A WHITE POLYGON (/ /) AT THEIR CENTER HAVE EXPOSED SOIL AT THE SURFACE; ALL OTHER LOCATIONS ARE PAVED/DEVELOPED.

N

0 150 300 600 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

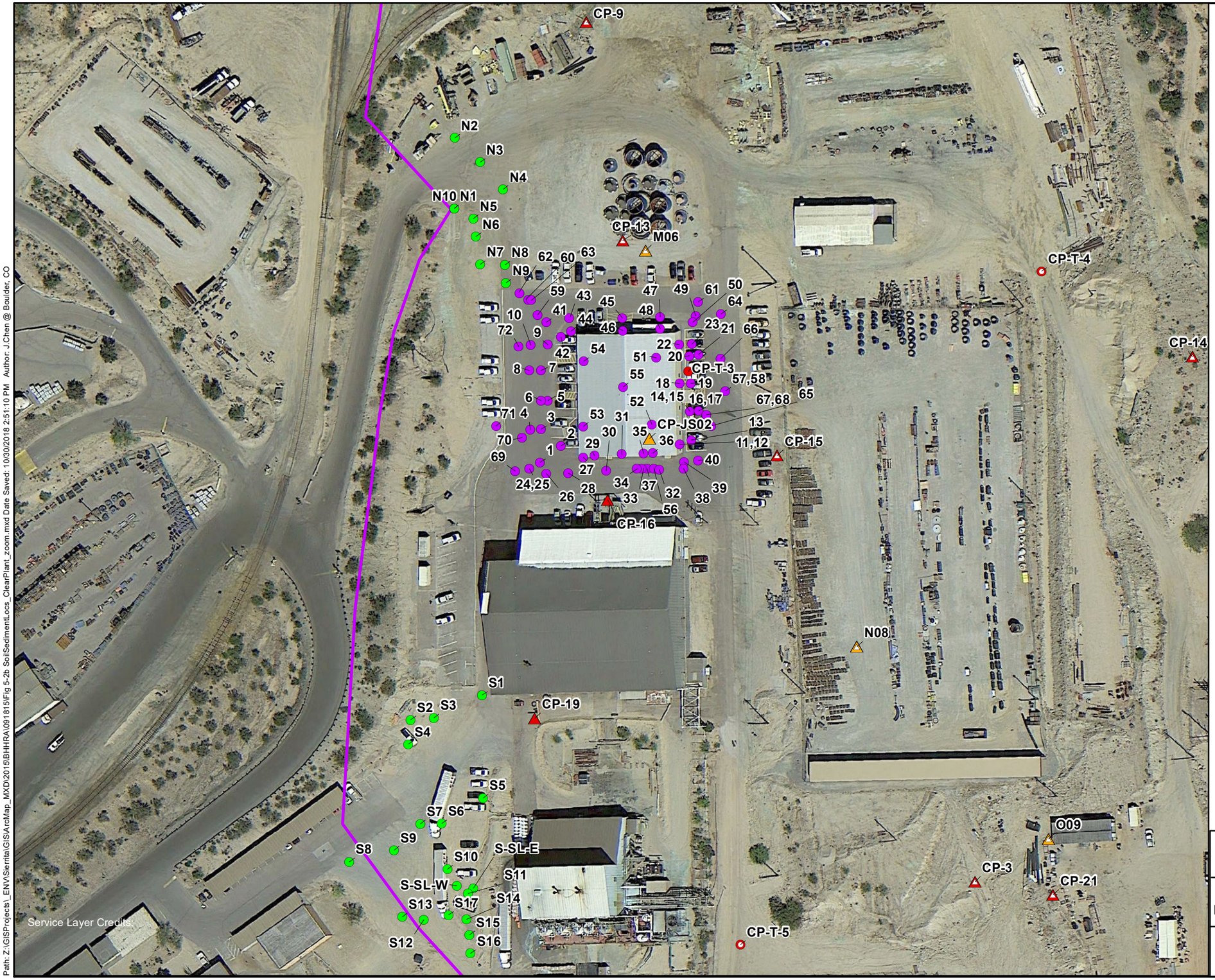
BASELINE HUMAN HEALTH RISK ASSESSMENT

SOIL AND SEDIMENT SAMPLE LOCATIONS IN THE FORMER CLEAR PLANT EXPOSURE AREA

ARCADIS

FIGURE
5-2a

Path: Z:\GISProjects_ENV\Sierrita\GIS\ArcMap_MXD\2015\BHHRA\091815\Fig 5-2a SoilSedimentLocs_ClearPlant.mxd Date Saved: 10/30/2018 3:26:53 PM Author: J.Chen @ Boulder, CO



LEGEND

- SURFACE SOIL SAMPLE (2004/2008)
- TRENCH LOCATION (2004/2008)
- GRID SAMPLING LOCATION (2004/2008)
- SOIL SAMPLING LOCATION (2012)
- PAVING SAMPLING LOCATION (2015)
- FORMER CLEAR PLANT AREA

NOTES

LOCATIONS WHOSE SYMBOLS HAVE A WHITE POLYGON (△ / ○ / □) AT THEIR CENTER HAVE EXPOSED SOIL AT THE SURFACE; ALL OTHER LOCATIONS ARE PAVED/DEVELOPED.

N

0 50 100 200 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

BASELINE HUMAN HEALTH RISK ASSESSMENT

SOIL AND SEDIMENT SAMPLE LOCATIONS IN THE FORMER CLEAR PLANT EXPOSURE AREA

ARCADIS

FIGURE
5-2b

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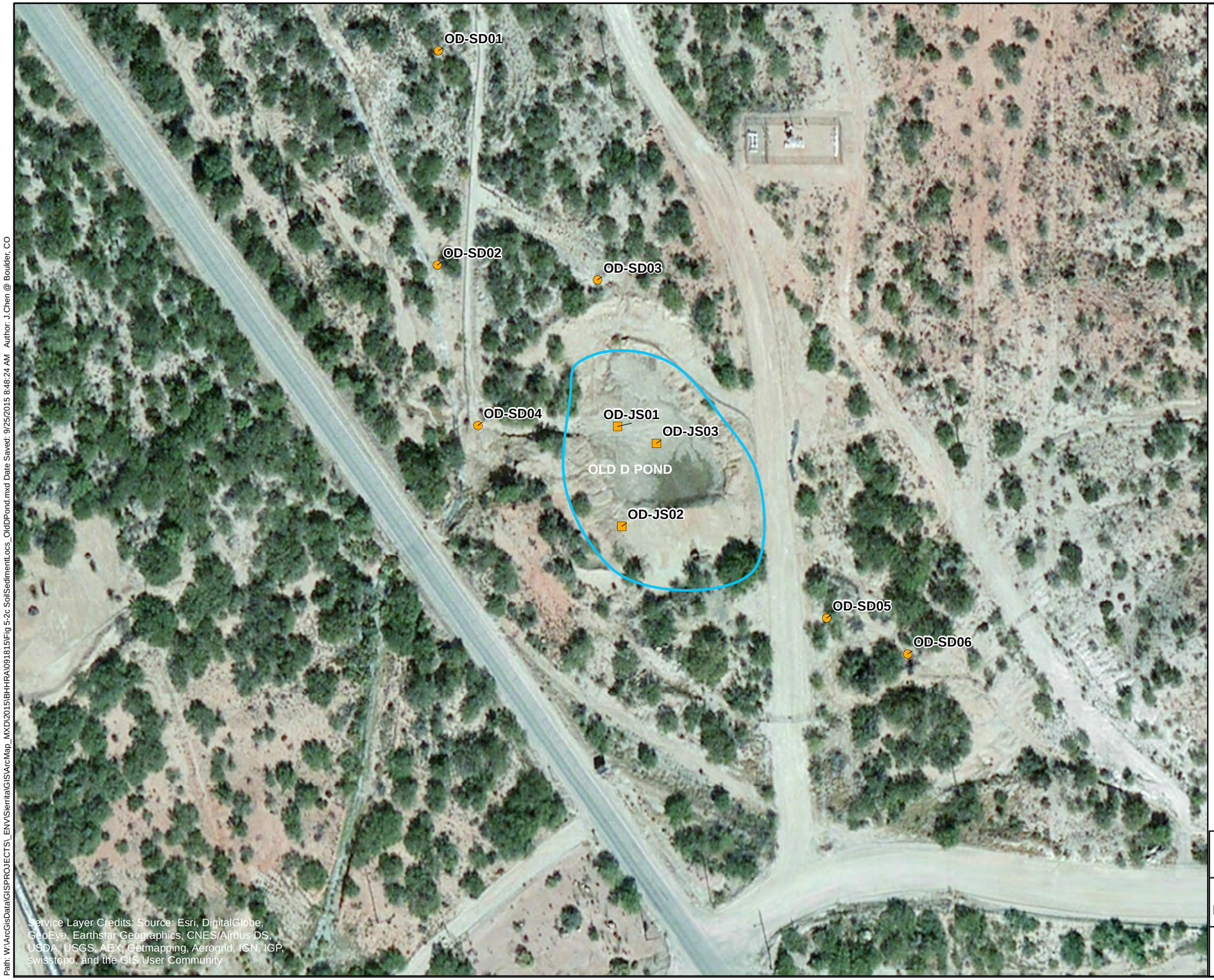

LEGEND

- JUDGMENTAL SAMPLING LOCATION (2004/2008)
- SEDIMENT SAMPLING LOCATION (2004/2008)
- OLD D POND

N

0 50 100 200 Feet

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

BASELINE HUMAN HEALTH RISK ASSESSMENT

SOIL AND SEDIMENT SAMPLE LOCATIONS IN THE FORMER CLEAR PLANT EXPOSURE AREA

ARCADIS

FIGURE
5-2c

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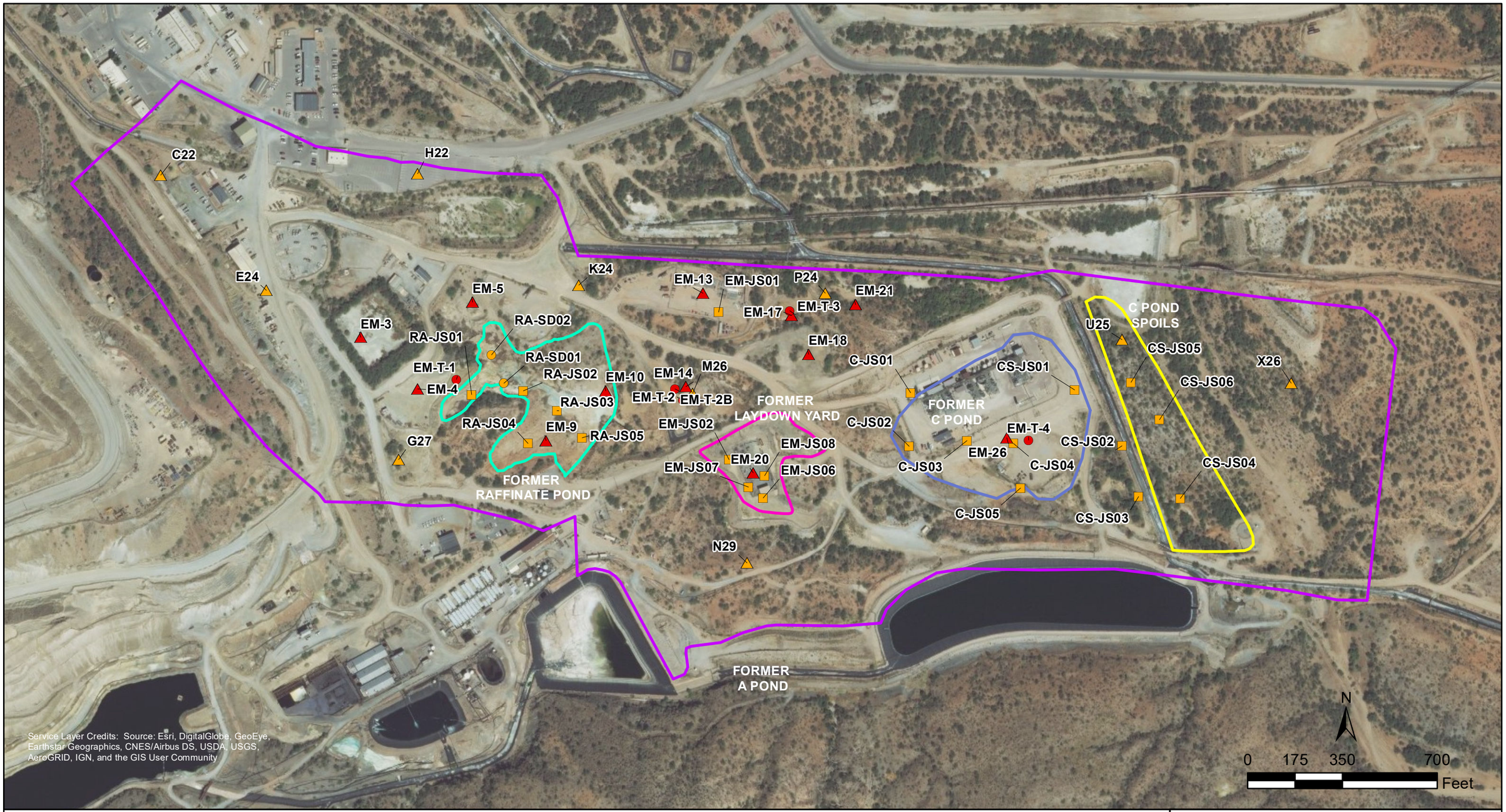


LEGEND

- SURFACE SOIL SAMPLE (2004/2008)
- TRENCH LOCATION (2004/2008)
- JUDGMENTAL SAMPLING LOCATION (2004/2008)
- GRID SAMPLING LOCATION (2004/2008)
- SEDIMENT SAMPLING LOCATION (2004/2008)
- C POND SPOILS
- FORMER C POND
- FORMER ESPERANZA MILL AREA
- FORMER LAYDOWN YARD
- FORMER RAFFINATE POND

FREEPORT-MCMORAN SIERRITA INC.
GREEN VALLEY, ARIZONA

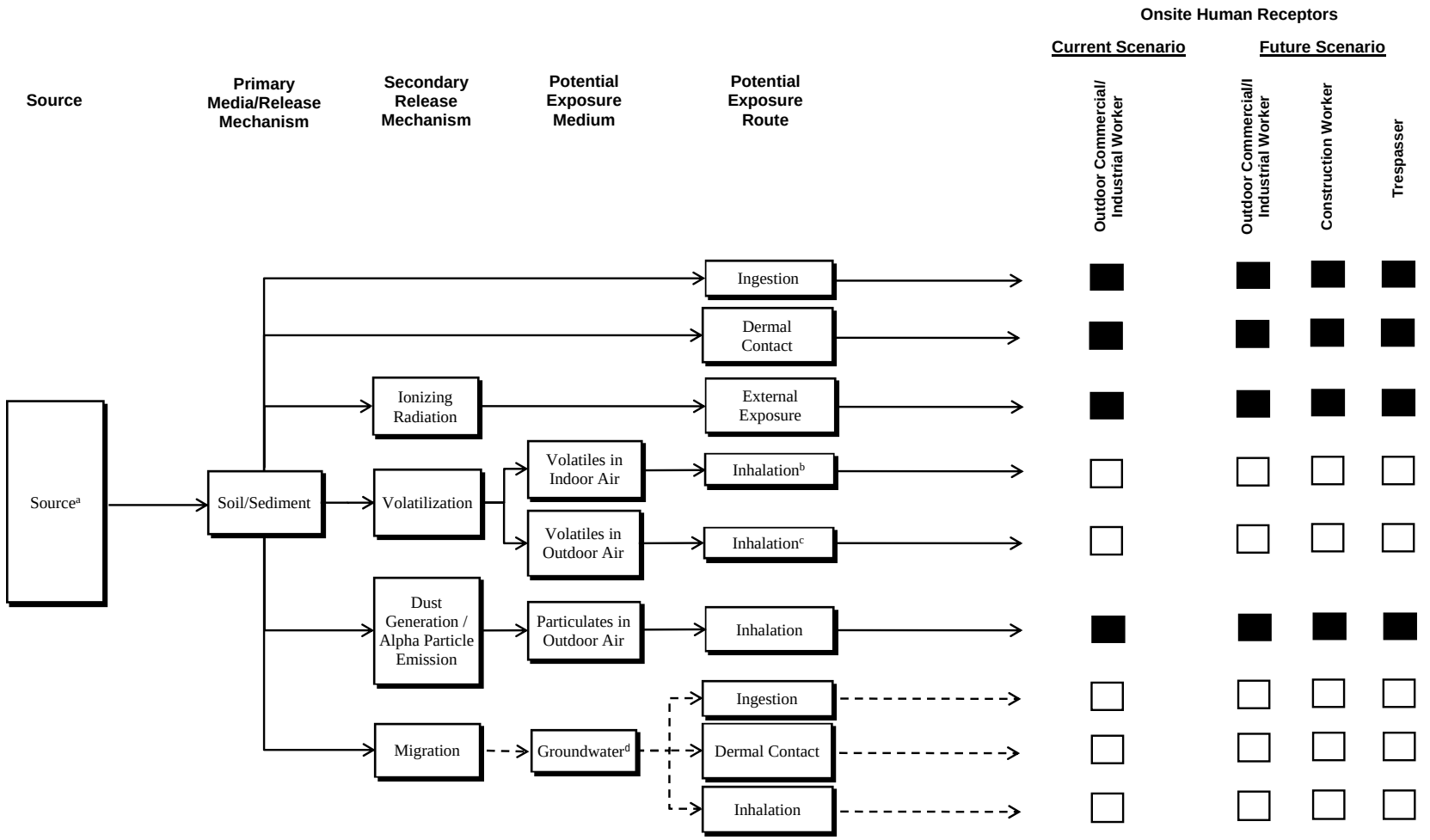
BASELINE HUMAN HEALTH RISK ASSESSMENT

SOIL AND SEDIMENT SAMPLE LOCATIONS IN THE FORMER ESPERANZA MILL EXPOSURE AREA

ARCADIS

FIGURE
5-3

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: CMHICKMA LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISProjects_ENV\Sierrita\GIS\ArcMap_MXD\2015\BHRA\091815\Fig 5-3 SoilSedimentLocs_FormerEsperanzaMill.mxd



Notes:

a. Source is related to current and historical activities including: a) excavation; b) hauling and dumping of overburden; c) historic processes to refine ore; d) storage of reagents and other solutions; d) accidental spills.

b. This exposure pathway is incomplete for metals, which are not volatile. Radionuclides were identified as constituents of potential concern, and the potential for radon gas generation was considered. However, the radium 226 (Ra-226) exposure point concentrations (EPCs) used in this risk assessment are considerably lower than the 5 pCi/g cleanup criterion established by the United States Environmental Protection Agency (USEPA) for surface soil at sites with residual radioactive contamination (40 CFR Part 192). The USEPA criterion was intended to limit gamma radiation exposure and to limit the risk from inhalation of radon decay products in houses built on land containing radioactive tailings. Based on these considerations, the indoor air pathway is considered incomplete.

c. This exposure pathway is incomplete for metals, which are not volatile. The potential for outdoor inhalation exposure to radon is negligible, considering mixing with ambient air would occur. In addition, the Ra-226 EPCs used in this risk assessment are considerably lower than the 5 pCi/g cleanup criterion established by the USEPA for surface soil at sites with residual radioactive contamination. Based on these considerations, the outdoor air pathway is considered incomplete.

d. Groundwater is not used at the facility nor does it discharge to the surface at any of the three exposure areas. For this reason, it is not an exposure medium for this risk assessment.

Explanation:

- - → Transport pathway incomplete; → Transport pathway complete

☐ Exposure pathway is incomplete.

■ Exposure pathway is complete or potentially complete and is quantitatively evaluated in the risk assessment.

BASELINE HUMAN HEALTH RISK ASSESSMENT
FREEPORT-MCMORAN SIERRITA
SIERRITA MINE, GREEN VALLEY, ARIZONA

HUMAN HEALTH CONCEPTUAL SITE MODEL

ARCADIS Design & Consultancy for natural and built assets

FIGURE
6-1

APPENDIX A

Soil and Sediment Data Used to Conduct the Baseline Human Health Risk Assessment

Appendix A, Table A-1
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-01		CP-02		CP-03		CP-05		CP-07		CP-09		CP-13		CP-14		CP-15	
		Sample ID	CP-1 081304		CP-2 081304		CP-3 081304		CP-5 081304		CP-7 081304		CP-9 081304		CP-13 081304		CP-14 081304		CP-15 081304	
		Sample Date	8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004	
		Sample Depth (feet bgs)	0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	52		66		4.5		2.0		4.5		10.3		0.6		0.3		1.9	
Arsenic	7440-38-2	mg/kg	105		166		16.30		17.10		31.30		40.10		5.44		4.63		13.70	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	0.38		0.11		0.27		0.58		0.52		0.51		1.08		0.44		0.51	
Cadmium	7440-43-9	mg/kg	3		4		3.23		4.5		5.01		24.9		0.48		1.01		7.38	
Chromium	7440-47-3	mg/kg	42		35		21		58		9		20		12		6		22	
Cobalt	7440-48-4	mg/kg	76		40		37		20		NA		20		NA		NA		NA	
Copper	7440-50-8	mg/kg	45600		9020		21700		6220		20000		59300		1090		2080		8260	
Lead	7439-92-1	mg/kg	638		1820		51.70		141		152		200		15.4		12.70		116	
Manganese	7439-96-5	mg/kg	156		71		317		332		295		587		177		464		335	
Mercury	7439-97-6	mg/kg	< 0.04	U	0.62		0.07		0.12		0.32		0.18		< 0.05	U	< 0.04	U	0.11	
Molybdenum	7439-98-7	mg/kg	1440		3020		1900		522		2820		2290		273		369		456	
Nickel	7440-02-0	mg/kg	38		17		26		64		7		23		7		8		14	
Selenium	7782-49-2	mg/kg	40		50		13.4		4		10.3		16.1		0.7		0.9		3.2	
Thallium	7440-28-0	mg/kg	0.7		5.2		0.35		0.46		0.23		0.23		0.31		0.23		0.17	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	34		300		143		793		451		6210		76		118		730	

Appendix A, Table A-1
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-16		CP-19		CP-21		CPB-S-02		CPB-S-03		CPB-S-04		CPB-S-05		CPB-S-06		CPF-AE-D2-06	
		Sample ID	CP-16 081304		CP-19 081304		CP-21 081304		CPB-S-02_20120511		CPB-S-03_20120511		CPB-S-04_20120511		CPB-S-05_20120511		CPB-S-06_20120511		CPF-AE-D2-06_20120511	
		Sample Date	8/13/2004		8/13/2004		8/13/2004		5/11/2012		5/11/2012		5/11/2012		5/11/2012		5/11/2012		5/11/2012	
		Sample Depth (feet bgs)	0-0.25		0-0.25		0-0.25		0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	11		1.6		0.4		NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	34.90		9.10		4.81		17.1		6.9		3.7		17.5		4		11.1	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	0.39		0.42		0.46		NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	21.2		5.95		1.26		NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	17		7		7		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	109000		23800		2360		2340		1700		1140		1640		2160		2360	
Lead	7439-92-1	mg/kg	950		45.00		25.10		132		17.7		13.3		174		34.2		73.3	
Manganese	7439-96-5	mg/kg	384		273		377		NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	0.37		0.11		< 0.04	U	NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	1980		2430		446		NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	31		12		9		NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	12		28.4		1.0		NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	0.4		0.21		0.21		NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	4400		658		134		NA		NA		NA		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
			Location ID	CPF-AE-D3-01		CPF-AE-D3-02		CPF-AE-D3-03		CPF-AE-D3-04		CPF-AE-D3-05		CPF-AE-SWE-D1.5-01		CPF-AE-SWE-D1.5-02	
			Sample ID	CPF-AE-D3-01_20120502		CPF-AE-D3-02_20120502		CPF-AE-D3-03_20120502		CPF-AE-D3-04_20120502		CPF-AE-D3-05_20120511		CPF-AE-SWE-D1.5-01_20120502		CPF-AE-SWE-D1.5-02_20120502	
			Sample Date	5/2/2012		5/2/2012		5/2/2012		5/2/2012		5/11/2012		5/2/2012		5/2/2012	
			Sample Depth (feet bgs)	0		0		0		0		0		0		0	
Analyte	CASRN	Units		Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg		10.9		7.6		9.3		8.1		12.2		12.7		9.9	
Barium	7440-39-3	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg		2330		1840		1860		2860		1680		2500		1490	
Lead	7439-92-1	mg/kg		56		127		38.3		19.3		36.9		94		12.5	
Manganese	7439-96-5	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg		NA		NA		NA		NA		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPF-AE-SWE-D1.5-03		CPF-AE-SWW-D1.5-02		CPF-AE-SWW-D1-04		CPF-AE-SWW-D2-03		CPF-AN-D1-01		CPF-AN-SWN-D0.5-05	
		Sample ID	CPF-AE-SWE-D1.5-03_20120511		CPF-AE-SWW-D1.5-02_20120502		CPF-AE-SWW-D1-04_20120511		CPF-AE-SWW-D2-03_20120511		CPF-AN-D1-01_20120511		CPF-AN-SWN-D0.5-05_20120511	
		Sample Date	5/11/2012		5/2/2012		5/11/2012		5/11/2012		5/11/2012		5/11/2012	
		Sample Depth (feet bgs)	0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	9.5		8.7		12		8.1		10.1		9.9	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	3060		1800		4070		2540		4910		4090	
Lead	7439-92-1	mg/kg	35.6		45.7		279		93.7		236		105	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPF-AN-SWN-D1.5-02		CPF-AN-SWN-D1.5-04		CPF-AN-SWN-D1-01		CPF-AN-SWN-D1-03		CPF-AN-SWS-D0.5-02		CPF-AN-SWS-D0.5-03	
		Sample ID	CPF-AN-SWN-D1.5-02_20120511		CPF-AN-SWN-D1.5-04_20120511		CPF-AN-SWN-D1-01_20120511		CPF-AN-SWN-D1-03_20120511		CPF-AN-SWS-D0.5-02_20120511		CPF-AN-SWS-D0.5-03_20120511	
		Sample Date	5/11/2012		5/11/2012		5/11/2012		5/11/2012		5/11/2012		5/11/2012	
		Sample Depth (feet bgs)	0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	9.8		8.7		6.1		10.7		6.3		18	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	4570		3490		1910		3800		2470		3810	
Lead	7439-92-1	mg/kg	453		466		171		473		279		470	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPF-AN-SWS-D0.5-04		CPF-AN-SWS-D0.5-05		CPF-AW-D2-05		CPF-AW-D3-01		CPF-AW-D4-02		CPF-AW-D4-05		CPF-AW-SWE-D0.5-04	
		Sample ID	CPF-AN-SWS-D0.5-04_20120511		CPF-AN-SWS-D0.5-05_20120521		CPF-AW-D2-05_20120511		CPF-AW-D3-01_20120501		CPF-AW-D4-02_20120501		CPF-AW-D4-05_20120502		CPF-AW-SWE-D0.5-04_20120511	
		Sample Date	5/11/2012		5/21/2012		5/11/2012		5/1/2012		5/1/2012		5/2/2012		5/11/2012	
		Sample Depth (feet bgs)	0		0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA				NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	21.7		6.3		9.8		2.6		< 2.5	U	< 2.5	U	15	
Barium	7440-39-3	mg/kg	NA				NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA				NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA				NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA				NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA				NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	4390		3760		1040		313		248		924		8970	
Lead	7439-92-1	mg/kg	379		578		12.3		11.5		11.7		63.1		1140	
Manganese	7439-96-5	mg/kg	NA				NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA				NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA				NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA				NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA				NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA				NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA				NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA				NA		NA		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPF-AW-SWE-D1.5-01		CPF-AW-SWE-D1.5-02		CPF-AW-SWE-D2.5-02		CPF-AW-SWE-D2.5-03		CPF-AW-SWW-D0.75-04		CPF-AW-SWW-D1-03	
		Sample ID	CPF-AW-SWE-D1.5-01_20120501		CPF-AW-SWE-D1.5-02_20120502		CPF-AW-SWE-D2.5-02_20120502		CPF-AW-SWE-D2.5-03_20120511		CPF-AW-SWW-D0.75-04_20120511		CPF-AW-SWW-D1-03_20120511	
		Sample Date	5/1/2012		5/2/2012		5/2/2012		5/11/2012		5/11/2012		5/11/2012	
		Sample Depth (feet bgs)	0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	3		9.9		10.3		2.6		6.9		7.6	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	360		1490		3040		423		4610		1290	
Lead	7439-92-1	mg/kg	18.7		12.5		459		37.5		622		120	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPF-AW-SWW-D2-01		CP-JS01		CP-JS01		CP-JS01		CP-JS01		CP-JS02		CP-JS02	
		Sample ID	CPF-AW-SWW-D2-01_20120501		CP-JS-01-0-1_07152008		CP-JS-01-10-12_07152008		CP-JS-01-1-3_07152008		CP-JS-01-5-7_07152008		CP-JS-02-0-1_07112008		CP-JS-02-1-3_07112008	
		Sample Date	5/1/2012		7/15/2008		7/15/2008		7/15/2008		7/15/2008		7/11/2008		7/11/2008	
		Sample Depth (feet bgs)	0		0-1		10-12		1-3		5-7		0-1		1-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		0.4		0.7		0.4	J	5.9		1		0.2	
Arsenic	7440-38-2	mg/kg	3.5		7.3		28.1		12.3		32.8		6.3		2.8	
Barium	7440-39-3	mg/kg	NA		654		159		336		130		36.8		77.4	
Beryllium	7440-41-7	mg/kg	NA		1.3		< 5	U	0.8		0.7		0.8		0.8	
Cadmium	7440-43-9	mg/kg	NA		< 2	U	< 8	U	< 2	U	< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	NA		8		3		7		7		3		7	
Cobalt	7440-48-4	mg/kg	NA		8		18		12		12		12		5	
Copper	7440-50-8	mg/kg	779		1390		506		781		822		2690		174	
Lead	7439-92-1	mg/kg	39.9		5.93		8.98		7.4		44.3		39.7		7.39	
Manganese	7439-96-5	mg/kg	NA		297		1240		379		482		345		122	
Mercury	7439-97-6	mg/kg	NA		0.06		< 0.2	U	< 0.2	U	< 0.2	U	0.07		< 0.2	U
Molybdenum	7439-98-7	mg/kg	NA		15		200		53		34		618		27	
Nickel	7440-02-0	mg/kg	NA		8		14		8		7		2		4	
Selenium	7782-49-2	mg/kg	NA		0.28		1.68		0.69		0.24		3.15		0.17	
Thallium	7440-28-0	mg/kg	NA		0.3		0.36		< 0.3	U	0.39		0.12		< 0.3	U
Uranium	7440-61-1	mg/kg	NA		2.36		7.77		4.29		5.11		6.34		0.93	
Zinc	7440-66-6	mg/kg	NA		45		65		39		42		114		34	

Appendix A, Table A-1
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-JS03		CP-JS03		CP-JS03		CP-JS04		CP-JS04		CP-JS04		CP-JS04		CPP-AE-S-01	
		Sample ID	CP-JS-03-0-1_07142008		CP-JS-03-1-3_07142008		CP-JS-03-5-7_07142008		CP-JS-04-0-1_08272008		CP-JS-04-10-12_08272008		CP-JS-04-1-3_08272008		CP-JS-04-5-7_08272008		CPP-AE-S-01_20120502	
		Sample Date	7/14/2008		7/14/2008		7/14/2008		8/27/2008		8/27/2008		8/27/2008		8/27/2008		5/2/2012	
		Sample Depth (feet bgs)	0-1		1-3		5-7		0-1		10-12		1-3		5-7		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	< 1	UJ	< 1	U	0.4		< 1	U	0.2		0.4		NA	
Arsenic	7440-38-2	mg/kg	3.3		2		2		4.5		2.3		1.6		8.7		5.9	
Barium	7440-39-3	mg/kg	164	J	189		205		165	J	106		172		183		NA	
Beryllium	7440-41-7	mg/kg	0.3		0.2		0.4		0.5		0.4		0.4		0.4		NA	
Cadmium	7440-43-9	mg/kg	0.7		< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	NA	
Chromium	7440-47-3	mg/kg	7		9		8		5	J	5		5	J	5		NA	
Cobalt	7440-48-4	mg/kg	11		12		11		13		9		12		11		NA	
Copper	7440-50-8	mg/kg	1700		888		1680		1710		1080		684		1400		2850	
Lead	7439-92-1	mg/kg	24.5		13		5.98		14.3		5.36		4.55		10.9		21.8	
Manganese	7439-96-5	mg/kg	456		456		496		396		347		469		343		NA	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	NA	
Molybdenum	7439-98-7	mg/kg	75	J	20		26		223		34		24		202		NA	
Nickel	7440-02-0	mg/kg	15		15		13		8		7		8		7		NA	
Selenium	7782-49-2	mg/kg	< 0.67	U	< 0.31	U	0.44		1.26		0.56		0.26	J	0.76		NA	
Thallium	7440-28-0	mg/kg	0.29		0.22		0.49		0.35		0.26		0.28	J	0.36		NA	
Uranium	7440-61-1	mg/kg	4.29		3.96		5.27		4.96		8.72		5.03	J	16		NA	
Zinc	7440-66-6	mg/kg	158		129		78		82		71		77		63		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPP-AE-S-02		CPP-AE-S-03		CPP-AE-S-04		CPP-AE-S-05		CPP-AN-S-01		CPP-AN-S-02		CPP-AN-S-03		CPP-AN-S-04	
		Sample ID	CPP-AE-S-02_20120502		CPP-AE-S-03_20120502		CPP-AE-S-04_20120502		CPP-AE-S-05_20120511		CPP-AN-S-01_20120502		CPP-AN-S-02_20120502		CPP-AN-S-03_20120502		CPP-AN-S-04_20120502	
		Sample Date	5/2/2012		5/2/2012		5/2/2012		5/11/2012		5/2/2012		5/2/2012		5/2/2012		5/2/2012	
		Sample Depth (feet bgs)	0		0		0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	4.2		9.3		10.1		16.3		3.5		< 2.5	U	6.9		< 2.5	U
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	1410		1890		3310		2090		987		4550		2090		133	
Lead	7439-92-1	mg/kg	64.8		45.9		73.9		37.4		48.8		8.98		65.2		5.1	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPP-AN-S-05		CPP-AW-S-01		CPP-AW-S-02		CPP-AW-S-03		CPP-AW-S-04		CP-SD01		CP-SD01	
		Sample ID	CPP-AN-S-05_20120511		CPP-AW-S-01_20120502		CPP-AW-S-02_20120502		CPP-AW-S-03_20120502		CPP-AW-S-04_20120502		CP-SD-01-0-1.5_07162008		CP-SD-01-1.5-3.0_07162008	
		Sample Date	5/11/2012		5/2/2012		5/2/2012		5/2/2012		5/2/2012		7/16/2008		7/16/2008	
		Sample Depth (feet bgs)	0		0		0		0		0		0-1.5		1.5-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		< 1	U	< 1	U
Arsenic	7440-38-2	mg/kg	2.6		2.5		4.5		2.6		11.1		2.1		1	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		145		140	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		0.4		0.4	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		6		6	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		10		9	
Copper	7440-50-8	mg/kg	264		679		1520		217		1190		979		253	
Lead	7439-92-1	mg/kg	9.25		9.98		65.6		11.9		22.3		5.49		1.72	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		342		314	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		121		4	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		8		8	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		0.37		0.08	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		0.23		0.25	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		4.04		2.34	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		49		30	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-SD02		CP-SD02		CP-SD03		CP-SD03		CP-SD04		CP-SD04		CP-SD05	
		Sample ID	CP-SD-02-0-1.5_07162008		CP-SD-02-1.5-3.0_07162008		CP-SD-03-0-1.5_07162008		CP-SD-03-1.5-3.0_07162008		CP-SD-04-0-1.5_07172008		CP-SD-04-1.5-3.0_07172008		CP-SD-05-0-1.5_07162008	
		Sample Date	7/16/2008		7/16/2008		7/16/2008		7/16/2008		7/17/2008		7/17/2008		7/16/2008	
		Sample Depth (feet bgs)	0-1.5		1.5-3		0-1.5		1.5-3		0-1.5		1.5-3		0-1.5	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U
Arsenic	7440-38-2	mg/kg	1.1		1.5		2.9		1.9		1.8		1		5.4	
Barium	7440-39-3	mg/kg	117		41.1		95.3		112		166		170		123	
Beryllium	7440-41-7	mg/kg	< 1	U	0.3		0.7		0.5		0.6		0.4		0.6	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	3		2		5		4		7		7		6	
Cobalt	7440-48-4	mg/kg	6		3		7		7		11		11		11	
Copper	7440-50-8	mg/kg	451		780		995		335		1180		512		561	
Lead	7439-92-1	mg/kg	4		3.78		9.49		5.32		4.25		2.14		8.74	
Manganese	7439-96-5	mg/kg	207		148		257		302		403		448		343	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	32		18		114		44		40		7		126	
Nickel	7440-02-0	mg/kg	6		2		5		6		10		10		7	
Selenium	7782-49-2	mg/kg	0.31		0.21		0.36		0.2		0.36		0.12		0.51	
Thallium	7440-28-0	mg/kg	0.18		< 0.3	U	0.13		0.14		0.43		0.35		0.13	
Uranium	7440-61-1	mg/kg	2.5		2.82		4.05		3.86		4.05		4.76		3.61	
Zinc	7440-66-6	mg/kg	31		30		48		34		57		46		43	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-SD05		CP-SD06		CP-SD06		CP-SD07		CP-SD07		CP-SD08		CP-SD08	
		Sample ID	CP-SD-05-1.5-3.0_07162008		CP-SD-06-0-1.5_07162008		CP-SD-06-1.5-3.0_07162008		CP-SD-07-0-1.5_07232008		CP-SD-07-1.5-3.0_07232008		CP-SD-08-0-1.5_07282008		CP-SD-08-1.5-3.0_07282008	
		Sample Date	7/16/2008		7/16/2008		7/16/2008		7/23/2008		7/23/2008		7/28/2008		7/28/2008	
		Sample Depth (feet bgs)	1.5-3		0-1.5		1.5-3		0-1.5		1.5-3		0-1.5		1.5-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	< 1	U	< 1	U	0.2		0.2		0.2		< 1	U
Arsenic	7440-38-2	mg/kg	3.6		3.7		4		2.9		0.8		2		1.2	
Barium	7440-39-3	mg/kg	181		177		174		136		166		135		164	
Beryllium	7440-41-7	mg/kg	0.5		0.7		0.5		0.9		0.5		0.5		0.5	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	6		6		6		14		9		12		11	
Cobalt	7440-48-4	mg/kg	11		17		11		9		11		10		11	
Copper	7440-50-8	mg/kg	283		976		729		439		180		599		142	
Lead	7439-92-1	mg/kg	4.91		4.17		3.75		7.05		2.49		6.87		3.69	
Manganese	7439-96-5	mg/kg	359		447		375		298		344		283		300	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	24		43		37		42		2		86		9	
Nickel	7440-02-0	mg/kg	8		10		8		33		31		31		27	
Selenium	7782-49-2	mg/kg	0.31		0.46		0.26		0.34		< 0.3	U	0.27		0.09	
Thallium	7440-28-0	mg/kg	0.17		0.29		0.28		0.27		0.3		0.25		0.33	
Uranium	7440-61-1	mg/kg	2.86		5.54		3.81		3.45		2.19		5.96		3.99	
Zinc	7440-66-6	mg/kg	42		86		39		45		47		50		52	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-SD09		CP-SD09		CP-SD10		CP-SD10		CPS-D5-06		CPS-SWE-D2.5-01		CPS-SWN-D2-01	
		Sample ID	CP-SD-09-0-1.5_07282008		CP-SD-09-1.5-3.0_07282008		CP-SD-10-0-1.5_07282008		CP-SD-10-1.5-3.0_07282008		CPS-D5-06_20120501		CPS-SWE-D2.5-01_20120502		CPS-SWN-D2-01_20120511	
		Sample Date	7/28/2008		7/28/2008		7/28/2008		7/28/2008		5/1/2012		5/2/2012		5/11/2012	
		Sample Depth (feet bgs)	0-1.5		1.5-3		0-1.5		1.5-3		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.3		< 1	U	0.2		< 1	U	NA		NA		NA	
Arsenic	7440-38-2	mg/kg	1.9		0.7		3.6		1.2		5.5		5.6		19.3	
Barium	7440-39-3	mg/kg	139		131		161		193		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	0.4		0.2		0.5		0.4		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	NA		NA		NA	
Chromium	7440-47-3	mg/kg	11		11		11		13		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	10		9		9		12		NA		NA		NA	
Copper	7440-50-8	mg/kg	1100		380		570		269		2670		2220		4350	
Lead	7439-92-1	mg/kg	11.3		26.6		6.23		1.81		176		258		3220	
Manganese	7439-96-5	mg/kg	312		239		278		332		NA		NA		NA	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	157		25		84		3		NA		NA		NA	
Nickel	7440-02-0	mg/kg	29		28		29		31		NA		NA		NA	
Selenium	7782-49-2	mg/kg	0.3		< 0.3	U	0.34		< 0.3	U	NA		NA		NA	
Thallium	7440-28-0	mg/kg	0.21		0.25		0.25		0.32		NA		NA		NA	
Uranium	7440-61-1	mg/kg	2.44		2.46		4.13		4.41		NA		NA		NA	
Zinc	7440-66-6	mg/kg	75		52		47		53		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPS-SWN-D2-02		CPS-SWN-D2-03		CPS-SWN-D2-04		CPS-SWN-D3.5-05		CPS-SWS-D2.5-01		CPS-SWS-D2.5-02		CPS-SWS-D2.5-03	
		Sample ID	CPS-SWN-D2-02_20120511		CPS-SWN-D2-03_20120511		CPS-SWN-D2-04_20120511		CPS-SWN-D3.5-05_20120511		CPS-SWS-D2.5-01_20120501		CPS-SWS-D2.5-02_20120501		CPS-SWS-D2.5-03_20120501	
		Sample Date	5/11/2012		5/11/2012		5/11/2012		5/11/2012		5/1/2012		5/1/2012		5/1/2012	
		Sample Depth (feet bgs)	0		0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	3.1		11.9		3.2		13.1		12		9.7		4.1	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	261		4150		1350		4560		2210		7560		914	
Lead	7439-92-1	mg/kg	13		617		29.5		643		208		503		32.4	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		NA		NA	

Appendix A, Table A-1
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CPS-SWS-D2.5-07		CPS-SWS-D2-05		CPS-SWS-D4.5-06		CPS-SWS-D4.5-08		CPS-SWS-D4-04		CPS-SWW-D2.5-01		CPS-SWW-D2.5-02	
		Sample ID	CPS-SWS-D2.5-07_20120511		CPS-SWS-D2-05_20120511		CPS-SWS-D4.5-06_20120511		CPS-SWS-D4.5-08_20120511		CPS-SWS-D4-04_20120502		CPS-SWW-D2.5-01_20120501		CPS-SWW-D2.5-02_20120511	
		Sample Date	5/11/2012		5/11/2012		5/11/2012		5/11/2012		5/2/2012		5/1/2012		5/11/2012	
		Sample Depth (feet bgs)	0		0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Arsenic	7440-38-2	mg/kg	5		6.7		14.3		3.2		< 2.5	U	12.3		< 2.5	U
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	1580		3220		2200		451		287		3250		248	
Lead	7439-92-1	mg/kg	20.6		34		97.2		20.3		6.99		126		9.3	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		NA		NA	

Appendix A, Table A-1
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-T01		CP-T01		CP-T01		CP-T01		CP-T02		CP-T02		CP-T02		CP-T02B		CP-T02BL		CP-T02C	
		Sample ID	CP-T-1-18IN 100404		CP-T-1-2 100404		CP-T-1-4 100404		CP-T-1-8 100404		CP-T-2-10 100404		CP-T-2-2 100404		CP-T-2-7 100404		CP-T-2-B-6 100404		CP-T-2-7BL 100404		CP-T-2-C-6 100404	
		Sample Date	10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004	
		Sample Depth (feet bgs)	1.5		2		4		8		10		2		7		6		7		6	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.8		NA		NA		NA		NA		NA		NA		1.4		7.6		2.1	
Arsenic	7440-38-2	mg/kg	18.1		8.64		14.30		4.20		5.43		3.60		5.63		11.80		37.1		14.8	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	0.7		0.82		1.29		0.52		0.63		0.63		0.58		0.35		0.2		0.3	
Cadmium	7440-43-9	mg/kg	8.9		NA		NA		NA		NA		NA		NA		2.75		2.2		1.5	
Chromium	7440-47-3	mg/kg	25		NA		NA		NA		NA		NA		NA		10		9		9	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	40100		2520		4390		1200		2850		765		2160		2600		1470		1950	
Lead	7439-92-1	mg/kg	77.1		21.70		37.20		12.70		44.70		12.50		39.80		62.40		270		293	
Manganese	7439-96-5	mg/kg	347		NA		NA		NA		NA		NA		NA		569		157		197	
Mercury	7439-97-6	mg/kg	0.06		NA		NA		NA		NA		NA		NA		0.05		< 0.05	U	< 0.04	U
Molybdenum	7439-98-7	mg/kg	377		368		182		114		99		38		135		625		535		331	
Nickel	7440-02-0	mg/kg	37		NA		NA		NA		NA		NA		NA		9		4		6	
Selenium	7782-49-2	mg/kg	2.1		NA		NA		NA		NA		NA		NA		2.5		8.1		3.9	
Thallium	7440-28-0	mg/kg	1		NA		NA		NA		NA		NA		NA		0.32		0.2		0.3	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	1270		NA		NA		NA		NA		NA		NA		127		43		92	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-T03		CP-T03		CP-T03		CP-T04		CP-T04		CP-T04		CP-T04		CP-T05		CP-T05		CP-T05	
		Sample ID	CP-T-3-6 100504		CP-T-3-8 100504		CP-T-3-8IN 100504		CP-T-4-1.5C 100404		CP-T-4-14 100404		CP-T-4-18IN 100404		CP-T-4-2.5 100404		CP-T-5-1.5 100404		CP-T-5-3 100404		CP-T-5-6 100404	
		Sample Date	10/5/2004		10/5/2004		10/5/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004		10/4/2004	
		Sample Depth (feet bgs)	0.5		8		0.75		1.5		14		1.5		2.5		1.5		3		6	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		1.2		0.5		NA		0.4		NA		0.4		NA		NA	
Arsenic	7440-38-2	mg/kg	5.60		26.9		20.90		4.88		10.40		1.1		16.40		4.70		4.14		5.27	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	1.40		0.5		0.48		0.28		0.45		1		0.41		0.23		0.57		0.44	
Cadmium	7440-43-9	mg/kg	NA		NA		1.07		1.74		NA		18.1		NA		0.62		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		7		24		NA		470		NA		9		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	4750		14100		978		2790		1570		57300		998		839		1050		746	
Lead	7439-92-1	mg/kg	31.10		488		6.03		14.40		3.66		4.1		7.26		13.90		12.40		3.98	
Manganese	7439-96-5	mg/kg	NA		NA		379		244		NA		759		NA		235		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		< 0.04	U	< 0.04	U	NA		< 0.04	U	NA		< 0.04	U	NA		NA	
Molybdenum	7439-98-7	mg/kg	62		615		264		347		91		60		330		115		95		60	
Nickel	7440-02-0	mg/kg	NA		NA		9		11		NA		70		NA		4		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		0.6		2.6		NA		3.7		NA		0.8		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		0.37		0.34		NA		< 0.1	U	NA		0.18		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		47		153		NA		4900		NA		57		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-T06		CP-T06		CP-T06		M04		M04		M04		M06		M06	
		Sample ID	CP-T-6-2 100404		CP-T-6-4 100404		CP-T-6-6 100404		CP-M04-0-1_07112008		CP-M04-1-2.5_07112008		CP-M04-5-5.4_07112008		CP-M06-0-1_07112008		CP-M06-1-3_07112008	
		Sample Date	10/4/2004		10/4/2004		10/4/2004		7/11/2008		7/11/2008		7/11/2008		7/11/2008		7/11/2008	
		Sample Depth (feet bgs)	2		4		6		0-1		1-2.5		5-5.4		0-1		1-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		2.3		1.1		< 1	U	< 1	U	0.2	
Arsenic	7440-38-2	mg/kg	5.38		4.75		3.96		12.6		7.5		1.5		2.6		3	
Barium	7440-39-3	mg/kg	NA		NA		NA		130		142		197		67.1		92.4	
Beryllium	7440-41-7	mg/kg	0.60		0.60		0.51		0.5		0.4		0.5		0.5		0.7	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		0.7		0.6		< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	NA		NA		NA		9		26		6		6		7	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		9		5		11		4		4	
Copper	7440-50-8	mg/kg	1900		2150		1410		9390		3900		1720		207		200	
Lead	7439-92-1	mg/kg	29.20		45.00		28.10		48.1		48.1		6.55		7.76		8.17	
Manganese	7439-96-5	mg/kg	NA		NA		NA		333		319		374		159		157	
Mercury	7439-97-6	mg/kg	NA		NA		NA		0.15		0.16		< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	76		143		52		704		206		48		23		14	
Nickel	7440-02-0	mg/kg	NA		NA		NA		7		7		7		3		4	
Selenium	7782-49-2	mg/kg	NA		NA		NA		3.09		1.29		0.87		0.23		0.35	
Thallium	7440-28-0	mg/kg	NA		NA		NA		0.24		0.12		0.41		0.11		0.14	
Uranium	7440-61-1	mg/kg	NA		NA		NA		5.55		3.01		9.05		1.45		1.35	
Zinc	7440-66-6	mg/kg	NA		NA		NA		272		212		45		26		27	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	N08		N08		N08		N08		O03		O03		O09		O09	
		Sample ID	CP-N08-0-1_07112008		CP-N08-10-11_07112008		CP-N08-1-3_07112008		CP-N08-5-7_07112008		CP-O03-0-1_07112008		CP-O03-1-3_07112008		CP-O09-0-1_07112008		CP-O09-10-12_07112008	
		Sample Date	7/11/2008		7/11/2008		7/11/2008		7/11/2008		7/11/2008		7/11/2008		7/11/2008		7/11/2008	
		Sample Depth (feet bgs)	0-1		10-11		1-3		5-7		0-1		1-3		0-1		10-12	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	UJ	2.9		0.6		0.5		< 1	U	< 1	U	< 1	U	0.4	
Arsenic	7440-38-2	mg/kg	4.1		41.9		7.5		7.7		2.3		1.2		3.5		3.7	
Barium	7440-39-3	mg/kg	169		213		188	J	186		251		212		142		155	
Beryllium	7440-41-7	mg/kg	0.4		0.6		0.4	J	0.4		0.5		< 1	U	0.5		0.4	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	UJ	< 2	U	< 2	U	< 2	U	< 2	U	1.1	
Chromium	7440-47-3	mg/kg	5		14		7	J	11		8		5		5		25	
Cobalt	7440-48-4	mg/kg	11		9		12	J	11		14		13		11		11	
Copper	7440-50-8	mg/kg	1070		1190		2420		1100		1700		298		913		1670	
Lead	7439-92-1	mg/kg	10.1		9.66		16.3		9.56		5.35		1.72		11.2		46.1	
Manganese	7439-96-5	mg/kg	504		271		294		365		386		440		469		343	
Mercury	7439-97-6	mg/kg	< 0.2	U	0.1		0.04		< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	27		106		149	J	77		102		2		69		73	
Nickel	7440-02-0	mg/kg	8		9		9	J	9		11		11		8		11	
Selenium	7782-49-2	mg/kg	0.42		1.58		0.85		0.54		0.45		0.81		0.39		0.84	
Thallium	7440-28-0	mg/kg	0.27		0.34		0.53		0.41		0.4		0.31		0.32		0.31	
Uranium	7440-61-1	mg/kg	4.77		9.05		8.99		9.35		4.91		7.25		4.91		3.45	
Zinc	7440-66-6	mg/kg	94		73		161	J	66		119		77		106		123	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	O09		O09		P04		P04		P05		P05		P07		P07	
		Sample ID	CP-O09-1-3_07112008		CP-O09-5-7_07112008		CP-P04-0-1_07152008		CP-P04-1-3_07152008		CP-P05-0-1_07152008		CP-P05-1-3_07152008		CP-P07-0-1_07172008		CP-P07-1-3_07172008	
		Sample Date	7/11/2008		7/11/2008		7/15/2008		7/15/2008		7/15/2008		7/15/2008		7/17/2008		7/17/2008	
		Sample Depth (feet bgs)	1-3		5-7		0-1		1-3		0-1		1-3		0-1		1-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U	< 1	U
Arsenic	7440-38-2	mg/kg	3.4		2.6		1.6		1		1.6		1.1		1.5		1.1	
Barium	7440-39-3	mg/kg	187		158		206		154		115		197		99.5		80.4	
Beryllium	7440-41-7	mg/kg	0.5		0.4		0.4		< 1	U	0.4		0.4		0.4		0.3	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	7		12		8		3		5		4		6		5	
Cobalt	7440-48-4	mg/kg	13		9		7		8		9		7		8		7	
Copper	7440-50-8	mg/kg	1500		2480		626		518		973		289		538		210	
Lead	7439-92-1	mg/kg	26.7		18.6		4.87		1.2		7.41		2.05		9.36		3.38	
Manganese	7439-96-5	mg/kg	442		317		275		295		330		307		293		276	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	43		36		33		4		72		3		26		31	
Nickel	7440-02-0	mg/kg	10		9		7		6		7		6		7		6	
Selenium	7782-49-2	mg/kg	0.45		0.39		0.48		0.07		0.34		0.07		0.36		0.24	
Thallium	7440-28-0	mg/kg	0.35		0.29		0.37		0.29		0.22		0.22		0.15		0.14	
Uranium	7440-61-1	mg/kg	5.66		3.4		3.77		2.41		4.75		3.16		3.24		3.79	
Zinc	7440-66-6	mg/kg	146		78		34		39		55		29		44		39	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	P07		P12		P12		Q09		Q09		RCP-16-D2.5-01		RCP-T-3-D0.5-01		RCP-T-3-D0.5-02	
		Sample ID	CP-P07-5-7_07172008		CP-P12-0-1_07232008		CP-P12-1-3_07232008		CP-Q09-0-1_07232008		CP-Q09-1-3_07232008		RCP-16-D2.5-01_20120502		RCP-T-3-D0.5-01_20120502		RCP-T-3-D0.5-02_20120511	
		Sample Date	7/17/2008		7/23/2008		7/23/2008		7/23/2008		7/23/2008		5/2/2012		5/2/2012		5/11/2012	
		Sample Depth (feet bgs)	5-7		0-1		1-3		0-1		1-3		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	0.9		0.3		0.3	J	< 1	U	NA		NA		NA	
Arsenic	7440-38-2	mg/kg	1.4		5.5		3.4		2.3		1.5		< 2.5	U	18.1		7.3	
Barium	7440-39-3	mg/kg	101		81.4		49.9		120		247		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	< 1	U	0.7		0.8		0.6		0.3		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	NA		NA		NA	
Chromium	7440-47-3	mg/kg	13		13		10		12		7		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	8		6		3		8		5		NA		NA		NA	
Copper	7440-50-8	mg/kg	333		1680		337		724		499		1250		3610		2910	
Lead	7439-92-1	mg/kg	3.79		39		7.98		4.61		3.19		139		65.1		39.3	
Manganese	7439-96-5	mg/kg	283		167		85		202		170		NA		NA		NA	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	53		239		9		123		8		NA		NA		NA	
Nickel	7440-02-0	mg/kg	8		31		31		29		22		NA		NA		NA	
Selenium	7782-49-2	mg/kg	0.5		1.48		0.19		0.35		0.14		NA		NA		NA	
Thallium	7440-28-0	mg/kg	0.16		0.26		0.18		0.26		0.49		NA		NA		NA	
Uranium	7440-61-1	mg/kg	4.03		3.15		1.3		2.21		2.67		NA		NA		NA	
Zinc	7440-66-6	mg/kg	88		96		27		44		30		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-NPA-S-01		CP-NPA-S-02		CP-NPA-S-03		CP-NPA-S-04		CP-NPA-S-05		CP-NPA-S-06		CP-NPA-S-07		CP-NPA-S-08	
		Sample ID	CP-NPA-S-01_20150528		CP-NPA-S-02_20150528		CP-NPA-S-03_20150528		CP-NPA-S-04_20150528		CP-NPA-S-05_20150528		CP-NPA-S-06_20150528		CP-NPA-S-07_20150528		CP-NPA-S-08_20150528	
		Sample Date	5/28/2015		5/28/2015		5/28/2015		5/28/2015		5/28/2015		5/28/2015		5/28/2015		5/28/2015	
		Sample Depth (feet bgs)	0		0		0		0		0		0		0		0	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 2	U	NA		NA		NA		< 2	U	NA		NA		NA	
Arsenic	7440-38-2	mg/kg	< 2.5	U	5.1		7.9		7.3		< 2.5	U	18.9		23.6		2.9	
Barium	7440-39-3	mg/kg	115		NA		NA		NA		68.9		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	0.42		NA		NA		NA		0.44		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	0.43		NA		NA		NA		< 0.2	U	NA		NA		NA	
Chromium	7440-47-3	mg/kg	4.52		NA		NA		NA		3.45		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	7.46		NA		NA		NA		5.64		NA		NA		NA	
Copper	7440-50-8	mg/kg	1580		2550		12800		4730		764		4810		3200		618	
Lead	7439-92-1	mg/kg	3.9		19.8		69		41.6		5.8		97		57		20.6	
Manganese	7439-96-5	mg/kg	< 0.4	U	NA		NA		NA		231		NA		NA		NA	
Mercury	7439-97-6	mg/kg	< 0.033	U	NA		NA		NA		< 0.033	U	NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	13.6		NA		NA		NA		26.6		NA		NA		NA	
Nickel	7440-02-0	mg/kg	8.53		NA		NA		NA		4.88		NA		NA		NA	
Selenium	7782-49-2	mg/kg	< 4	U	NA		NA		NA		< 4	U	NA		NA		NA	
Thallium	7440-28-0	mg/kg	< 1.5	U	NA		NA		NA		< 1.5	U	NA		NA		NA	
Uranium	7440-61-1	mg/kg	2.64		NA		NA		NA		1.32		NA		NA		NA	
Zinc	7440-66-6	mg/kg	187		NA		NA		NA		67.3		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-NPA-S-09		CP-NPA-S-10		CP-SPA-SL-E		CP-SPA-SL-W		CP-SPA-S-01		CP-SPA-S-02		CP-SPA-S-03		CP-SPA-S-04	
		Sample ID	CP-NPA-S-09_20150528		CP-NPA-S-10_20150528		CP-SPA-SL-E-D3.5-01		CP-SPA-SL-W-D3.5-01		CP-SPA-S-01_20150609		CP-SPA-S-02_20150609		CP-SPA-S-03_20150609		CP-SPA-S-04_20150609	
		Sample Date	5/28/2015		5/28/2015		5/19/2015		5/19/2015		6/9/2015		6/9/2015		6/9/2015		6/9/2015	
		Sample Depth (feet bgs)	0		0		3.5		3.5		0-0.25		0-0.25		0-0.25		0-0.25	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		5.1		< 2	U	< 2	U	NA		NA		< 2.0	U	NA	
Arsenic	7440-38-2	mg/kg	3.8		10.3		4.1		18.7		10.3		3.8		6.2		12	
Barium	7440-39-3	mg/kg	NA		51.8		136		167		NA		NA		134		NA	
Beryllium	7440-41-7	mg/kg	NA		0.38		0.42		0.48		NA		NA		0.45		NA	
Cadmium	7440-43-9	mg/kg	NA		0.98		0.42		1.04		NA		NA		0.43		NA	
Chromium	7440-47-3	mg/kg	NA		3.12		8.35		21.5		NA		NA		6.63		NA	
Cobalt	7440-48-4	mg/kg	NA		8.4		5.72		5.38		NA		NA		7.67		NA	
Copper	7440-50-8	mg/kg	1290		5090		2100		1310		1050		2310		823		2340	
Lead	7439-92-1	mg/kg	23.9		80.7		17.3		22.6		6.2		311		4.2		33.1	
Manganese	7439-96-5	mg/kg	NA		168		220		235		NA		NA		292		NA	
Mercury	7439-97-6	mg/kg	NA		0.037		0.052		0.137		NA		NA		< 0.033	U	NA	
Molybdenum	7439-98-7	mg/kg	NA		366		157		263		NA		NA		216		NA	
Nickel	7440-02-0	mg/kg	NA		6.53		8.73		14.3		NA		NA		7.44		NA	
Selenium	7782-49-2	mg/kg	NA		< 4	U	< 4	U	< 4	U	NA		NA		< 4.0	U	NA	
Thallium	7440-28-0	mg/kg	NA		< 1.5	U	< 1.5	U	< 1.5	U	NA		NA		< 1.5	U	NA	
Uranium	7440-61-1	mg/kg	NA		2.33		4.16		6.28		NA		NA		7.25		NA	
Zinc	7440-66-6	mg/kg	NA		249		57.8		78.9		NA		NA		35.2		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant	
		Location ID	CP-SPA-S-05		CP-SPA-S-06		CP-SPA-S-07		CP-SPA-S-08		CP-SPA-S-09		CP-SPA-S-10		CP-SPA-S-11		CP-SPA-S-12	
		Sample ID	CP-SPA-S-05_20150609		CP-SPA-S-06_20150609		CP-SPA-S-07_20150609		CP-SPA-S-08_20150609		CP-SPA-S-09_20150609		CP-SPA-S-10_20150609		CP-SPA-S-11_20150609		CP-SPA-S-12_20150609	
		Sample Date	6/9/2015		6/9/2015		6/9/2015		6/9/2015		6/9/2015		6/9/2015		6/9/2015		6/9/2015	
		Sample Depth (feet bgs)	0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		< 2.0	U	NA		NA		NA	
Arsenic	7440-38-2	mg/kg	6.1		4.5		6.4		2.5		3.1		5.6		3.7		3.1	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		318		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		0.41		NA		NA		NA	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		< 0.20	U	NA		NA		NA	
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		7.53		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		13.1		NA		NA		NA	
Copper	7440-50-8	mg/kg	2490		1420		1770		943		922		1770		1920		1500	
Lead	7439-92-1	mg/kg	35.1		14.2		20.5		4.6		2.7		16		15.5		12.2	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		306		NA		NA		NA	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		< 0.033	U	NA		NA		NA	
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		47.7		NA		NA		NA	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		10.4		NA		NA		NA	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		< 4.0	U	NA		NA		NA	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		< 1.5	U	NA		NA		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		2.72		NA		NA		NA	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		39.1		NA		NA		NA	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former CLEAR Plant		Former E Pond		Former E Pond		Former E Pond	
		Location ID	CP-SPA-S-13		CP-SPA-S-14		CP-SPA-S-15		CP-SPA-S-16		CP-SPA-S-17		E-JS01		E-JS01		E-JS01	
		Sample ID	CP-SPA-S-13_20150609		CP-SPA-S-14_20150609		CP-SPA-S-15_20150609		CP-SPA-S-16_20150609		CP-SPA-S-17_20150609		E-JS-01-0-1_07142008		E-JS-01-1-3_07142008		E-JS-01-5-7_07142008	
		Sample Date	6/9/2015		6/9/2015		6/9/2015		6/9/2015		6/9/2015		7/14/2008		7/14/2008		7/14/2008	
		Sample Depth (feet bgs)	0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-1		1-3		5-7	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	NA		NA		NA		NA		NA		0.3		0.2		< 1	U
Arsenic	7440-38-2	mg/kg	11.1		5.6		8.9		< 2.5	U	4.8		2.9		2.5		2	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		146		122		203	
Beryllium	7440-41-7	mg/kg	NA		NA		NA		NA		NA		< 1	U	< 1	U	0.3	
Cadmium	7440-43-9	mg/kg	NA		NA		NA		NA		NA		0.8		< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	NA		NA		NA		NA		NA		5		3		4	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		NA		10		8		6	
Copper	7440-50-8	mg/kg	767		2970		2820		515		1710		2650		1810		1510	
Lead	7439-92-1	mg/kg	4.2		17.4		40.1		4.9		17.7		22.9		19.1		6.62	
Manganese	7439-96-5	mg/kg	NA		NA		NA		NA		NA		369		327		182	
Mercury	7439-97-6	mg/kg	NA		NA		NA		NA		NA		< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	NA		NA		NA		NA		NA		104		79		246	
Nickel	7440-02-0	mg/kg	NA		NA		NA		NA		NA		11		10		9	
Selenium	7782-49-2	mg/kg	NA		NA		NA		NA		NA		0.78		0.59		0.42	
Thallium	7440-28-0	mg/kg	NA		NA		NA		NA		NA		0.17		0.13		0.12	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		3.11		3.04		2.9	
Zinc	7440-66-6	mg/kg	NA		NA		NA		NA		NA		197		165		134	

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
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Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former E Pond		Former E Pond		Former Evaporation Pond		Former Evaporation Pond		Former Evaporation Pond		Former Evaporation Pond		Former Evaporation Pond		Former Evaporation Pond	
		Location ID	E-JS02		E-JS02		EV-JS01		EV-JS01		EV-JS01		EV-JS02		EV-JS02		EV-JS02	
		Sample ID	E-JS-02-0-1_07142008		E-JS-02-1-3_07142008		EV-JS-01-0-1_07142008		EV-JS-01-1-3_07142008		EV-JS-01-5-7_07142008		EV-JS-02-0-1_07142008		EV-JS-02-1-3_07142008		EV-JS-02-5-7_07142008	
		Sample Date	7/14/2008		7/14/2008		7/14/2008		7/14/2008		7/14/2008		7/14/2008		7/14/2008		7/14/2008	
		Sample Depth (feet bgs)	0-1		1-3		0-1		1-3		5-7		0-1		1-3		5-7	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.3		< 1	U	1.1		0.4		< 1	U	0.3		< 1	U	< 1	U
Arsenic	7440-38-2	mg/kg	3		4		9.9		5.7		5.5		2.8		1.1		3.5	
Barium	7440-39-3	mg/kg	183		75.1		122		213		169		105		96.2		142	
Beryllium	7440-41-7	mg/kg	0.3		0.5		0.2		0.4		0.6		0.2		< 1	U	< 1	U
Cadmium	7440-43-9	mg/kg	0.5		< 2	U	0.6		1.6		6		< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	7		6		6		9		7		4		7		20	
Cobalt	7440-48-4	mg/kg	10		8		7		15		12		9		10		9	
Copper	7440-50-8	mg/kg	1160		1290		3380		5440		1550		2020		583		890	
Lead	7439-92-1	mg/kg	83.5		10.2		196		73.8		12		19.1		1.59		11.3	
Manganese	7439-96-5	mg/kg	408		719		208		402		342		330		357		394	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	138		98		547		258		77		67		11		37	
Nickel	7440-02-0	mg/kg	15		12		11		18		14		14		13		17	
Selenium	7782-49-2	mg/kg	0.57		0.67		3.43		1.85		1.69		0.47		1.02		0.46	
Thallium	7440-28-0	mg/kg	0.21		< 0.3	U	0.4		0.44		0.1		0.1		0.12		0.14	
Uranium	7440-61-1	mg/kg	3.62		9.68		4.26		7.05		8.51		2.87		4.14		5.53	
Zinc	7440-66-6	mg/kg	98		87		100		224		407		124		54		77	

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Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Old D Pond		Old D Pond		Old D Pond		Old D Pond		Old D Pond		Old D Pond		Old D Pond		Old D Pond	
		Location ID	OD-JS01		OD-JS01		OD-JS02		OD-JS02		OD-JS02		OD-JS03		OD-JS03		OD-SD01	
		Sample ID	OD-JS-01-0-1_07292008		OD-JS-01-1-3_07292008		OD-JS-02-0-1_07292008		OD-JS-02-1-3_07292008		OD-JS-02-5-7_07292008		OD-JS-03-0-1_08272008		OD-JS-03-1-3_08272008		OD-SD-01-0-1.5_07282008	
		Sample Date	7/29/2008		7/29/2008		7/29/2008		7/29/2008		7/29/2008		8/27/2008		8/27/2008		7/28/2008	
		Sample Depth (feet bgs)	0-1		1-3		0-1		1-3		5-7		0-1		1-3		0-1.5	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.3		< 1	U	0.4		< 1	U	< 1	U	0.6		0.4		0.3	
Arsenic	7440-38-2	mg/kg	3.6		1.8		3.4		1.4		0.8		10.6		6.4		2	
Barium	7440-39-3	mg/kg	121		149		96.8		170		139		118		114		184	
Beryllium	7440-41-7	mg/kg	0.3		< 1	U	< 1	U	0.5		0.5		0.3		< 1	U	0.4	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	15		9		8		9		9		8		5		13	
Cobalt	7440-48-4	mg/kg	9		10		7		13		11		8		6		11	
Copper	7440-50-8	mg/kg	1770		121		1840		1310		110		1470		1510		361	
Lead	7439-92-1	mg/kg	17.7		2.1		13.8		4.43		2.12		19.3		10.6		5.32	
Manganese	7439-96-5	mg/kg	231		328		250		391		378		236		203		332	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	95		8		304		9		8		97		74		87	
Nickel	7440-02-0	mg/kg	6		7		6		9		9		7		6		30	
Selenium	7782-49-2	mg/kg	1.1		0.11		1.44		0.11		0.71		0.85		0.72		0.23	
Thallium	7440-28-0	mg/kg	0.25		0.28		0.28		0.32		0.35		0.23		0.23		0.29	
Uranium	7440-61-1	mg/kg	5.3		2.54		2.92		3.68		7.34		4.32		3.31		3.11	
Zinc	7440-66-6	mg/kg	99		42		83		89		45		111		71		51	

Appendix A, Table A-1
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Old D Pond		Old D Pond		Old D Pond		Old D Pond		Old D Pond		Old D Pond		Old D Pond	
		Location ID	OD-SD01		OD-SD02		OD-SD02		OD-SD03		OD-SD03		OD-SD04		OD-SD04	
		Sample ID	OD-SD-01-1.5-3.0_07282008		OD-SD-02-0-1.5_07282008		OD-SD-02-1.5-3.0_07282008		OD-SD-03-0-1.5_07282008		OD-SD-03-1.5-3.0_07282008		OD-SD-04-0-1.5_07282008		OD-SD-04-1.5-3.0_07282008	
		Sample Date	7/28/2008		7/28/2008		7/28/2008		7/28/2008		7/28/2008		7/28/2008		7/28/2008	
		Sample Depth (feet bgs)	1.5-3		0-1.5		1.5-3		0-1.5		1.5-3		0-1.5		1.5-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	0.2		< 1	U	0.3		< 2	U	0.3		< 1	U
Arsenic	7440-38-2	mg/kg	1.2		2.2		0.9		2.7		2.8		3.1		2.1	
Barium	7440-39-3	mg/kg	185		173		173		158		87.9	J	118		133	
Beryllium	7440-41-7	mg/kg	< 1	U	0.5		0.2		0.4		0.3		0.4		0.3	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	0.5		< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	14		13		9		18		13		11		9	
Cobalt	7440-48-4	mg/kg	10		12		9		11		8		11		9	
Copper	7440-50-8	mg/kg	125		376		27		2350		4390		1640		671	
Lead	7439-92-1	mg/kg	2.59		7.63		1.89		46.7		253		8.86		2.2	
Manganese	7439-96-5	mg/kg	346		390		320		316		173		262		258	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	0.05		< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	6		107		3		100		145		128		25	
Nickel	7440-02-0	mg/kg	29		32		26		31		30		29		27	
Selenium	7782-49-2	mg/kg	0.08		0.42		0.07		0.41		0.4		0.53		0.19	
Thallium	7440-28-0	mg/kg	0.28		0.3		0.32		0.28		0.2		0.3		0.26	
Uranium	7440-61-1	mg/kg	7.42		4.66		3.37		7.57		7.8		4.25		2.18	
Zinc	7440-66-6	mg/kg	43		60		41		147		201		68		48	

Appendix A, Table A-1
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Old D Pond		Old D Pond		Old D Pond		Old D Pond	
		Location ID	OD-SD05		OD-SD05		OD-SD06		OD-SD06	
		Sample ID	OD-SD-05-0-1.5_07292008		OD-SD-05-1.5-3.0_07292008		OD-SD-06-0-1.5_07292008		OD-SD-06-1.5-3.0_07292008	
		Sample Date	7/29/2008		7/29/2008		7/29/2008		7/29/2008	
		Sample Depth (feet bgs)	0-1.5		1.5-3		0-1.5		1.5-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.8		0.3		0.5		< 1	U
Arsenic	7440-38-2	mg/kg	6.2		4.6		5.3		3.2	
Barium	7440-39-3	mg/kg	141	J	169		109		122	
Beryllium	7440-41-7	mg/kg	0.6		0.5		0.5		0.5	
Cadmium	7440-43-9	mg/kg	1.1		< 2	U	< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	22		13		13		12	
Cobalt	7440-48-4	mg/kg	13		12		11		14	
Copper	7440-50-8	mg/kg	3960		916		2590		1130	
Lead	7439-92-1	mg/kg	102		35.3		29.3		7.26	
Manganese	7439-96-5	mg/kg	365		402		334		552	
Mercury	7439-97-6	mg/kg	0.05		< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	230		63		115		9	
Nickel	7440-02-0	mg/kg	8		7		7		11	
Selenium	7782-49-2	mg/kg	1.04		0.47		1.04		0.23	
Thallium	7440-28-0	mg/kg	0.39		0.28		0.3		0.23	
Uranium	7440-61-1	mg/kg	5.57		10.3		4.33		6.42	
Zinc	7440-66-6	mg/kg	179		105		198		218	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

	Location Subarea		Esperanza Mill		Esperanza Mill		Esperanza Mill		Raffinate Pond		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Laydown Yard	
	Location ID		EM-03		EM-04		EM-05		EM-09		EM-10		EM-13		EM-14		EM-17		EM-18		EM-20	
	Sample ID		EM-3 081304		EM-4 081304		EM-5 081304		EM-9 081304		EM-10 081304		EM-13 081304		EM-14 081304		EM-17 081304		EM-18 081304		EM-20 081304	
	Sample Date		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004		8/13/2004	
	Sample Depth (feet bgs)		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25		0-0.25	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	4.7		0.9		0.3		0.6		0.6		0.3		0.4		69		0.7		2.0	
Arsenic	7440-38-2	mg/kg	34.80		10.80		3.62		5.01		9.52		4.23		11.80		101		10.40		13.70	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	1		0.55		0.37		0.44		0.93		0.72		0.26		0.33		0.48		0.55	
Cadmium	7440-43-9	mg/kg	5.65		2.55		0.59		0.57		1.78		0.83		0.85		2.8		2.31		2.39	
Chromium	7440-47-3	mg/kg	6		10		7		8		10		8		14		3		8		17	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		12		NA		< 5	U	3		NA		NA	
Copper	7440-50-8	mg/kg	11600		8360		1880		522		814		668		409		2330		3560		4710	
Lead	7439-92-1	mg/kg	133		61.9		12.00		38.10		54.50		12.7		8.87		80.7		54.80		87.8	
Manganese	7439-96-5	mg/kg	715		657		323		340		538		172		30		75.5		173		405	
Mercury	7439-97-6	mg/kg	0.14		0.08		< 0.04	U	< 0.04	U	< 0.04	U	< 0.05	U	< 0.05	U	0.3		0.04		0.07	
Molybdenum	7439-98-7	mg/kg	1570		630		122		230		239		2640		471		1690		1470		6500	
Nickel	7440-02-0	mg/kg	11		25		8		5		8		8		< 5	U	< 1	U	4		14	
Selenium	7782-49-2	mg/kg	9.4		1.5		< 0.5	U	< 0.5	U	0.7		< 0.5	U	1.0		< 5	U	2.9		5.5	
Thallium	7440-28-0	mg/kg	0.17		0.15		0.27		NA		0.22		0.27		0.89		< 0.3	U	0.19		0.2	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	824		443		195		NA		256		64		29		77		67		234	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Esperanza Mill		C Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill	
		Location ID	EM-21		EM-26		EM-T01		EM-T01		EM-T01		EM-T01		EM-T02		EM-T02		EM-T02B		EM-T03	
		Sample ID	EM-21 081304		EM-26 081304		EM-T-1-1.5 100504		EM-T-1-13 100504		EM-T-1-2 100504		EM-T-1-6 100504		EM-T-2-2 100504		EM-T-2-2.5 100504		EM-T-2-B-18 100504		EM-T-3-12 100504	
		Sample Date	8/13/2004		8/13/2004		10/5/2004		10/5/2004		10/5/2004		10/5/2004		10/5/2004		10/5/2004		10/5/2004		10/5/2004	
		Sample Depth (feet bgs)	0-0.25		0-0.25		1.5		13		2		6		2		2.5		1.5		12	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.5		2.5		1.4		NA		NA		0.5		NA		< 0.2	U	0.3		NA	
Arsenic	7440-38-2	mg/kg	4.09		23.00		28.30		1.35		23.00		5.49		3.58		5.3		6.4		3.52	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Beryllium	7440-41-7	mg/kg	0.17		2.36		0.41		0.69		0.82		0.85		0.51		0.7		0.9		1.43	
Cadmium	7440-43-9	mg/kg	0.32		1.99		1.3		NA		NA		0.26		NA		3.6		0.5		NA	
Chromium	7440-47-3	mg/kg	2		15		9		NA		NA		12		NA		36		33		NA	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	4		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Copper	7440-50-8	mg/kg	514		5220		2200		159		9850		1700		533		1170		1400		733	
Lead	7439-92-1	mg/kg	8.79		127		60.90		65.90		63.60		36.50		17.20		19.0		17.5		12.40	
Manganese	7439-96-5	mg/kg	110		928		151		NA		NA		146		NA		31		198		NA	
Mercury	7439-97-6	mg/kg	< 0.04	U	0.18		< 0.05	U	NA		NA		0.06		NA		< 0.05	U	< 0.04	U	NA	
Molybdenum	7439-98-7	mg/kg	151		936		305		3		229		24		16		1050		103		20	
Nickel	7440-02-0	mg/kg	< 1	U	20		6		NA		NA		9		NA		< 5	U	< 5	U	NA	
Selenium	7782-49-2	mg/kg	1.5		2.2		3.76		NA		NA		0.41		NA		0.9		2.2		NA	
Thallium	7440-28-0	mg/kg	0.07		0.4		NA		NA		NA		NA		NA		1.1		0.2		NA	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Zinc	7440-66-6	mg/kg	25		429		NA		NA		NA		NA		NA		40		169		NA	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Esperanza Mill		Esperanza Mill		C Pond		C Pond		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill	
		Location ID	EM-T03		EM-T03		EM-T04		EM-T04		EM-JS01		EM-JS01		C22		C22		C22	
		Sample ID	EM-T-3-4 100504		EM-T-3-6 100504		EM-T-4-10 100504		EM-T-4-6 100504		EM-JS-01-0-1_08012008		EM-JS-01-1-3_08012008		EM-C22-0-1_07292008		EM-C22-1-3_07292008		EM-C22-5-7_07292008	
		Sample Date	10/5/2004		10/5/2004		10/5/2004		10/5/2004		8/1/2008		8/1/2008		7/29/2008		7/29/2008		7/29/2008	
		Sample Depth (feet bgs)	4		6		10		6		0-1		1-3		0-1		1-3		5-7	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	3.1		2.0		NA		0.7		0.5		< 1	U	2		0.5		< 1	U
Arsenic	7440-38-2	mg/kg	38.8		4.70		2.66		6.77		4.3		3.1		13.9		5.1		2.2	
Barium	7440-39-3	mg/kg	NA		NA		NA		NA		103		228		82.7		161		234	
Beryllium	7440-41-7	mg/kg	0.9		1.03		0.76		0.76		0.6		0.8		0.5		0.5		0.5	
Cadmium	7440-43-9	mg/kg	1.6		1.37		NA		2.83		< 2	U	0.8		0.8		< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	90		8		NA		7		7		11		19		13		10	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	NA		NA		NA		NA		8		10		16		13		14	
Copper	7440-50-8	mg/kg	1850		1270		643		2020		840		543		5480		1120		739	
Lead	7439-92-1	mg/kg	43.8		10.80		21.60		64.30		24		9.8		85.2		12.1		5.13	
Manganese	7439-96-5	mg/kg	212		593		NA		250		238		388		323		378		370	
Mercury	7439-97-6	mg/kg	< 0.05	U	< 0.04	U	NA		0.05		< 0.2	U	< 0.2	U	0.2		< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	260		21		88		550		143		8		4800		270		5	
Nickel	7440-02-0	mg/kg	< 5	U	8		NA		6		7		13		5		9		8	
Selenium	7782-49-2	mg/kg	0.9		0.31		NA		2.27		0.46		0.12		7.25		0.28		0.15	
Thallium	7440-28-0	mg/kg	0.2		0.16		NA		0.21		< 0.28	U	< 0.26	U	0.21		0.25		0.26	
Uranium	7440-61-1	mg/kg	NA		NA		NA		NA		2.9		3.64		4.74		3.37		2.45	
Zinc	7440-66-6	mg/kg	111		209		NA		104		88		187		332		122		85	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill	
		Location ID	E24		E24		E24		G27		G27		H22		H22		H22	
		Sample ID	EM-E24-0-1_07292008		EM-E24-1-3_07292008		EM-E24-5-7_07292008		EM-G27-0-1_08072008		EM-G27-1-3_08072008		EM-H22-0-1_07302008		EM-H22-1-3_07302008		EM-H22-5-7_07312008	
		Sample Date	7/29/2008		7/29/2008		7/29/2008		8/7/2008		8/7/2008		7/30/2008		7/30/2008		7/31/2008	
		Sample Depth (feet bgs)	0-1		1-3		5-7		0-1		1-3		0-1		1-3		5-7	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.6		1		0.2		0.3		< 1	UJ	3.7		0.4		< 1	U
Arsenic	7440-38-2	mg/kg	5		7.6		2.2		3.5		1.2		11.7		3.7		1.1	
Barium	7440-39-3	mg/kg	149		116		198		81.2		126		115	J	70.4		199	
Beryllium	7440-41-7	mg/kg	0.8		0.9		0.6		0.5		0.4		0.5		0.3		0.5	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	1.6		1		1.7	
Chromium	7440-47-3	mg/kg	10		11		12		6		4		8		5		6	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	9		10		14		7		11		10		5		14	
Copper	7440-50-8	mg/kg	2270		2470		364		2750		933		10000		2330		1740	
Lead	7439-92-1	mg/kg	26.5		47.9		13.1		30.9		3.92		91.3		15		3.75	
Manganese	7439-96-5	mg/kg	364		369		434		233		399		294		188		594	
Mercury	7439-97-6	mg/kg	0.04		< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	0.05		< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	234		362		57		403		3		821		118		10	
Nickel	7440-02-0	mg/kg	2		3		10		5		7		7		7		14	
Selenium	7782-49-2	mg/kg	1.65		2.42		0.32		0.8		0.07		4.53		1.07		0.06	
Thallium	7440-28-0	mg/kg	0.18		0.22		0.38		0.2		0.29		0.42		0.24		0.51	
Uranium	7440-61-1	mg/kg	4.05		5.32		4.07		2.8		3.7		3.34		2.3		3.75	
Zinc	7440-66-6	mg/kg	132		159		68		90		57		293		181		464	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill	
		Location ID	K24		K24		K24		M26		M26		M26		N29		N29	
		Sample ID	EM-K24-0-1_07312008		EM-K24-1-3_07312008		EM-K24-5-7_07312008		EM-M26-0-1_08012008		EM-M26-1-3_08012008		EM-M26-5-7_08012008		EM-N29-0-1_08062008		EM-N29-1-3_08062008	
		Sample Date	7/31/2008		7/31/2008		7/31/2008		8/1/2008		8/1/2008		8/1/2008		8/6/2008		8/6/2008	
		Sample Depth (feet bgs)	0-1		1-3		5-7		0-1		1-3		5-7		0-1		1-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	0.2		< 1	U	< 1	U	0.3		0.2		0.4		0.6	
Arsenic	7440-38-2	mg/kg	3		2.5		2.4		2.6		3.7		4.6		5.2		7.5	
Barium	7440-39-3	mg/kg	78.7		79.4		152		126		48.4		67.5		56		65.9	
Beryllium	7440-41-7	mg/kg	0.8		0.6		0.6		< 1	U	0.4		0.7		0.9		1.1	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	0.5		< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	7		8		6		7		8		10		9		6	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	8		5		8		5		4		6		6		17	
Copper	7440-50-8	mg/kg	629		530		486		358		469		536		495		805	
Lead	7439-92-1	mg/kg	15.9		13.1		12.3		21.9		20.3		19.5		25.8		41.8	
Manganese	7439-96-5	mg/kg	175		124		241		146		109		144		194		429	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	66		19		24		66		23		44		124		94	
Nickel	7440-02-0	mg/kg	6		6		7		5		5		7		3		3	
Selenium	7782-49-2	mg/kg	0.52		0.21		0.27		0.35		0.28		0.16		0.5		0.79	
Thallium	7440-28-0	mg/kg	0.28		0.26		0.25		< 0.18	U	< 0.16	U	< 0.19	U	0.13		0.13	
Uranium	7440-61-1	mg/kg	2.5		3.16		2.89		3.13		5.3		5.57		1.96		2.7	
Zinc	7440-66-6	mg/kg	46		47		45		57		97		142		78		59	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		Esperanza Mill		C Pond	
			Location ID		P24		P24		P24		P24		X26		X26		X26		C-JS01	
			Sample ID		EM-P24-0-1_08072008		EM-P24-10-11_08072008		EM-P24-1-3_08072008		EM-P24-5-7_08072008		EM-X26-0-1_08062008		EM-X26-1-3_08062008		EM-X26-5-7_08062008		C-JS-01-0-1_08012008	
			Sample Date		8/7/2008		8/7/2008		8/7/2008		8/7/2008		8/6/2008		8/6/2008		8/6/2008		8/1/2008	
			Sample Depth (feet bgs)		0-1		10-11		1-3		5-7		0-1		1-3		5-7		0-1	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	< 1	U	< 1	U	< 1	U	0.4		< 1	U	0.5		0.4			
Arsenic	7440-38-2	mg/kg	2.3		2.1		2.6		2.3		3.2		1.7		4.5		5.3			
Barium	7440-39-3	mg/kg	104		132		79.9		86.5		94.8		52.8		101		79.2			
Beryllium	7440-41-7	mg/kg	0.7		0.9		0.5		0.4		0.6		0.2		0.5		0.6			
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U		
Chromium	7440-47-3	mg/kg	5		3		6		8		6		5		5		9			
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA			
Cobalt	7440-48-4	mg/kg	10		8		5		6		10		7		7		7			
Copper	7440-50-8	mg/kg	719		348		483		540		1390		424		1030		677			
Lead	7439-92-1	mg/kg	15		104		14.6		24.6		12.8		6.02		75.2		56.6			
Manganese	7439-96-5	mg/kg	379		293		146		230		356		199		232		338			
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	0.06		< 0.2	U		
Molybdenum	7439-98-7	mg/kg	60		9		260		106		154		51		307		135			
Nickel	7440-02-0	mg/kg	7		8		4		5		5		3		5		7			
Selenium	7782-49-2	mg/kg	0.36		0.14		0.48		0.27		0.52		0.27		0.63		0.33			
Thallium	7440-28-0	mg/kg	0.24		0.28		0.17		0.16		0.3		0.14		0.24		< 0.19	U		
Uranium	7440-61-1	mg/kg	4.54		6.46		5.44		3.97		3.78		2.38		5.86		3.39			
Zinc	7440-66-6	mg/kg	82		550		64		89		67		37		77		149			

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	C Pond		C Pond		C Pond		C Pond		C Pond		C Pond		C Pond		C Pond	
		Location ID	C-JS01		C-JS02		C-JS02		C-JS02		C-JS03		C-JS03		C-JS03		C-JS03	
		Sample ID	C-JS-01-1-3_08012008		C-JS-02-0-1_08012008		C-JS-02-1-3_08012008		C-JS-02-5-7_08012008		C-JS-03-0-1_08042008		C-JS-03-10-12_08042008		C-JS-03-1-3_08042008		C-JS-03-5-7_08042008	
		Sample Date	8/1/2008		8/1/2008		8/1/2008		8/1/2008		8/4/2008		8/4/2008		8/4/2008		8/4/2008	
		Sample Depth (feet bgs)	1-3		0-1		1-3		5-7		0-1		10-12		1-3		5-7	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.5		0.2		< 1	U	< 1	UJ	0.5		< 1	U	< 1	U	< 1	U
Arsenic	7440-38-2	mg/kg	4.5		3.4		1.8		1.6		6.6		2.2		3.3		2.7	
Barium	7440-39-3	mg/kg	136		116		64.9		143		82.5		85.8		136		88.1	
Beryllium	7440-41-7	mg/kg	0.7		1.3		0.5		0.7		1.4		0.7		0.7		0.6	
Cadmium	7440-43-9	mg/kg	0.6		1.7		< 2	U	1		< 2	U	< 2	U	0.7		< 2	U
Chromium	7440-47-3	mg/kg	8		8		6		4		11		8		8		12	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	8		14		5		9		12		4		8		6	
Copper	7440-50-8	mg/kg	763		794		399		442		1020		365		485		371	
Lead	7439-92-1	mg/kg	46.3		30.5		10		37.3	J	74.8		89.3		53.2		45.9	
Manganese	7439-96-5	mg/kg	329		551		170		373		573		211		351		256	
Mercury	7439-97-6	mg/kg	0.04		< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	194		99		18		5		199		7		37		18	
Nickel	7440-02-0	mg/kg	6		9		6		7		10		4		6		6	
Selenium	7782-49-2	mg/kg	0.4		0.39		0.18		0.07		< 0.69	U	< 0.41	U	< 0.29	U	< 0.23	U
Thallium	7440-28-0	mg/kg	< 0.18	U	< 0.19	U	< 0.12	U	< 0.19	U	0.2		0.18		0.22		0.15	
Uranium	7440-61-1	mg/kg	4.1		4.64		4.34		9.38		6.11		13		3.7		3.15	
Zinc	7440-66-6	mg/kg	188		362		180		1070		256		178		442		255	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	C Pond		C Pond		C Pond		C Pond		C Pond		C Pond		C Pond Spoils		C Pond Spoils	
		Location ID	C-JS04		C-JS04		C-JS04		C-JS04		C-JS05		C-JS05		CS-JS01		CS-JS01	
		Sample ID	C-JS-04-0-1_08052008		C-JS-04-10-12_08052008		C-JS-04-1-3_08052008		C-JS-04-5-7_08052008		C-JS-05-0-1_08052008		C-JS-05-1-3_08052008		CS-JS-01-0-1_08042008		CS-JS-01-10-12_08042008	
		Sample Date	8/5/2008		8/5/2008		8/5/2008		8/5/2008		8/5/2008		8/5/2008		8/4/2008		8/4/2008	
		Sample Depth (feet bgs)	0-1		10-12		1-3		5-7		0-1		1-3		0-1		10-12	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.4		0.7		< 1	U	< 1	U	0.2	J	0.3		0.5		1	
Arsenic	7440-38-2	mg/kg	8.9		4.7		1.4		2.3		4.2		11.2		8.7		5.8	
Barium	7440-39-3	mg/kg	73		88.1		137		152		120		104	J	82.3		123	
Beryllium	7440-41-7	mg/kg	1.2		0.4		0.5		0.6		0.9		< 1	U	0.6		0.7	
Cadmium	7440-43-9	mg/kg	< 2	U	2.1		< 2	U	< 2	U	1.2		0.6		< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	23		9		6		11		16		3		14		9	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		< 4	U	NA	
Cobalt	7440-48-4	mg/kg	12		11		7		11		10		1		7		12	
Copper	7440-50-8	mg/kg	671		2780		491		420		481		185		423		4580	
Lead	7439-92-1	mg/kg	44.4		41.4		15.1		56.1		477		3740		65.1		47.9	
Manganese	7439-96-5	mg/kg	664		187		333		388		838		78.1	J	386		392	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	98		537		16		38		74		18		142		735	
Nickel	7440-02-0	mg/kg	11		6		6		8		7		< 5	U	6		5	
Selenium	7782-49-2	mg/kg	0.3		2.39		0.15		0.26		< 1	U	< 5	U	< 0.62	U	< 3.37	U
Thallium	7440-28-0	mg/kg	0.18		0.22		0.28		0.27		0.18		0.62		0.22		0.27	
Uranium	7440-61-1	mg/kg	4.05		7.23		3.28		3.23		5.66		4.19		3.67		6.9	
Zinc	7440-66-6	mg/kg	245		135		45		106		315		156	J	124		150	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils	
			Location ID		CS-JS01		CS-JS01		CS-JS02		CS-JS02		CS-JS02		CS-JS02		CS-JS03	
			Sample ID		CS-JS-01-1-3_08042008		CS-JS-01-5-7_08042008		CS-JS-02-0-1_08042008		CS-JS-02-10-11_08042008		CS-JS-02-1-3_08042008		CS-JS-02-5-7_08042008		CS-JS-03-0-1_08052008	
			Sample Date		8/4/2008		8/4/2008		8/4/2008		8/4/2008		8/4/2008		8/4/2008		8/5/2008	
			Sample Depth (feet bgs)		1-3		5-7		0-1		10-11		1-3		5-7		0-1	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	0.3		0.3		0.7	J	0.2		< 1	U	0.3			
Arsenic	7440-38-2	mg/kg	2.2		3.6		4		5.3		3.3		1.6		3.8			
Barium	7440-39-3	mg/kg	121		146		157		138		85.6		366		95.4			
Beryllium	7440-41-7	mg/kg	0.6		0.7		0.6		0.6		0.7		0.5		0.4			
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	8.3		< 2	U	< 2	U	< 2	U		
Chromium	7440-47-3	mg/kg	37		5		8		5		7		5		8			
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA			
Cobalt	7440-48-4	mg/kg	8		10		9		12		7		11		17			
Copper	7440-50-8	mg/kg	432		602		640		448		448		131		562			
Lead	7439-92-1	mg/kg	90.5		343		126		376		25.7		20.3		57.2			
Manganese	7439-96-5	mg/kg	546		486		348		717		269		430		279			
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U		
Molybdenum	7439-98-7	mg/kg	54		134		81		15		28		5		51			
Nickel	7440-02-0	mg/kg	6		5		6		8		5		9		5			
Selenium	7782-49-2	mg/kg	< 0.26	U	< 0.48	U	< 0.41	U	< 0.24	U	< 0.32	U	< 0.19	U	0.28			
Thallium	7440-28-0	mg/kg	0.2		0.23		0.32		0.4		0.26		0.38		0.17			
Uranium	7440-61-1	mg/kg	4.66		6.09		3.77		7.77		3.28		3		11			
Zinc	7440-66-6	mg/kg	172		302		218		3630		269		1140		129			

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils	
		Location ID	CS-JS03		CS-JS03		CS-JS03		CS-JS04		CS-JS04		CS-JS04		CS-JS05		CS-JS05	
		Sample ID	CS-JS-03-10-12_08052008		CS-JS-03-1-3_08052008		CS-JS-03-5-7_08052008		CS-JS-04-0-1_08062008		CS-JS-04-1-3_08062008		CS-JS-04-5-7_08062008		CS-JS-05-0-1_08272008		CS-JS-05-1-3_08272008	
		Sample Date	8/5/2008		8/5/2008		8/5/2008		8/6/2008		8/6/2008		8/6/2008		8/27/2008		8/27/2008	
		Sample Depth (feet bgs)	10-12		1-3		5-7		0-1		1-3		5-7		0-1		1-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.3		0.3		0.2		0.4		0.6	J	< 1	U	0.2		0.5	
Arsenic	7440-38-2	mg/kg	3.3		3.5		2.9		3.2		4.3		1.6		3.9		14.6	
Barium	7440-39-3	mg/kg	201		123		142		111		101		216		294		103	
Beryllium	7440-41-7	mg/kg	0.4		0.6		0.6		0.4		0.4		0.6		0.5		0.6	
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	1.4		< 2	U	1.7	
Chromium	7440-47-3	mg/kg	8		8		13		7		17		6		5		4	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	11		8		10		8		8		14		12		6	
Copper	7440-50-8	mg/kg	641		802		770		557		658		425		116		148	
Lead	7439-92-1	mg/kg	71.4		48.8		88.7		131		18.2		16.3		38.1		280	
Manganese	7439-96-5	mg/kg	371		273		478		375		209		495		515		538	
Mercury	7439-97-6	mg/kg	0.04		< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U
Molybdenum	7439-98-7	mg/kg	98		66		46		281		822		8		19		17	
Nickel	7440-02-0	mg/kg	9		6		10		6		5		9		11		6	
Selenium	7782-49-2	mg/kg	0.34		0.37		0.3		0.49		0.88		0.1		0.16		0.39	
Thallium	7440-28-0	mg/kg	0.35		0.23		0.31		0.31		0.19		0.4		0.36		0.17	
Uranium	7440-61-1	mg/kg	3		3.24		3.01		2.94		3.42		3.29		5.08		8.01	
Zinc	7440-66-6	mg/kg	456		154		217		207		76		451		134		502	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea		C Pond Spoils		C Pond Spoils		C Pond Spoils		C Pond Spoils		Laydown Yard		Laydown Yard	
			Location ID		CS-JS06		CS-JS06		U25		U25		EM-JS02		EM-JS02	
			Sample ID		CS-JS-06-0-1_08272008		CS-JS-06-1-3_08272008		EM-U25-0-1_08062008		EM-U25-1-3_08062008		EM-U25-5-5.5_08062008		EM-JS-02-0-1_08012008		EM-JS-02-1-3_08012008	
			Sample Date		8/27/2008		8/27/2008		8/6/2008		8/6/2008		8/6/2008		8/1/2008		8/1/2008	
			Sample Depth (feet bgs)		0-1		1-3		0-1		1-3		5-5.5		0-1		1-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.2		0.2	J	0.4		0.4		0.3		0.4		< 1	U
Arsenic	7440-38-2	mg/kg	1.6		1.2		3.2		4.6		8.6		5.1		3.4	
Barium	7440-39-3	mg/kg	213		168		265		156		88.7		115		89.6	
Beryllium	7440-41-7	mg/kg	0.4		0.5		0.6		0.7		0.6		0.7		0.5	
Cadmium	7440-43-9	mg/kg	< 2	U	1		0.6		< 2	U	0.6		0.9		1.5	
Chromium	7440-47-3	mg/kg	5		5		7		8		7		7		5	
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA	
Cobalt	7440-48-4	mg/kg	16		11		10		11		9		9		6	
Copper	7440-50-8	mg/kg	175		149		728		1210		204		2160		722	
Lead	7439-92-1	mg/kg	30.5		3.5		100		136		433		187		576	
Manganese	7439-96-5	mg/kg	501		373		398		366		693		566		684	
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	< 0.2	U	0.05		0.11		< 0.2	U
Molybdenum	7439-98-7	mg/kg	7		3		113		292		57		382		8	
Nickel	7440-02-0	mg/kg	12		9		7		7		6		9		5	
Selenium	7782-49-2	mg/kg	0.14		0.13		0.32		0.72		0.26		0.55		0.23	
Thallium	7440-28-0	mg/kg	0.49		0.5		0.25		0.23		0.15		< 0.22	U	< 0.17	U
Uranium	7440-61-1	mg/kg	3.15		2.88		3.65		3.89		14.1		6.85		10.2	
Zinc	7440-66-6	mg/kg	168		257		234		233		971		531		640	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea	Laydown Yard		Laydown Yard		Laydown Yard		Laydown Yard		Laydown Yard		Laydown Yard		Laydown Yard	
			Location ID	EM-JS06		EM-JS06		EM-JS06		EM-JS06		EM-JS07		EM-JS07		EM-JS07	
			Sample ID	EM-JS-06-0-1_08132008		EM-JS-06-10-11_08132008		EM-JS-06-1-3_08132008		EM-JS-06-5-7_08132008		EM-JS-07-0-1_08132008		EM-JS-07-10-12_08132008		EM-JS-07-1-3_08132008	
			Sample Date	8/13/2008		8/13/2008		8/13/2008		8/13/2008		8/13/2008		8/13/2008		8/13/2008	
			Sample Depth (feet bgs)	0-1		10-11		1-3		5-7		0-1		10-12		1-3	
Analyte	CASRN	Units		Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg		1.5		2.1		1		0.9		1.4		2.6		2.3	
Arsenic	7440-38-2	mg/kg		10.3		15.8		6.5		8.1		11.7		16.1		10.7	
Barium	7440-39-3	mg/kg		45		142		40.2		39.2		96.2		62.6		77.8	
Beryllium	7440-41-7	mg/kg		0.7		0.9		0.4		0.5		0.2		0.5		0.7	
Cadmium	7440-43-9	mg/kg		< 2	U	1		< 2	U	< 2	U	0.6		2		0.7	
Chromium	7440-47-3	mg/kg		9		22		6		14		12		36		13	
Chromium VI	18540-29-9	mg/kg		NA		NA		NA		NA		NA		< 4	U	NA	
Cobalt	7440-48-4	mg/kg		18		16		14		17		19		25		17	
Copper	7440-50-8	mg/kg		4090		5870		1900		2650		3770		5150		4840	
Lead	7439-92-1	mg/kg		86.1		93.3		33.5		157		96.4		147		151	
Manganese	7439-96-5	mg/kg		448		579		288		371		382		645		556	
Mercury	7439-97-6	mg/kg		0.06		0.05		< 0.2	U	< 0.2	U	0.09		0.23		0.05	
Molybdenum	7439-98-7	mg/kg		1180		481		472		309		6830		5610		1000	
Nickel	7440-02-0	mg/kg		4		19		2		4		< 5	U	16		10	
Selenium	7782-49-2	mg/kg		3.01		1.85		2.58		2.53		3.68		3.96		2.77	
Thallium	7440-28-0	mg/kg		0.21		0.25		0.19		0.21		0.27		0.26		0.21	
Uranium	7440-61-1	mg/kg		6.63		18.1		4.13		5.12		6.01		9.21		8.97	
Zinc	7440-66-6	mg/kg		161		283		53		110		122		393		238	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea		Laydown Yard		Laydown Yard		Laydown Yard		Laydown Yard		Laydown Yard		Raffinate Pond		Raffinate Pond	
			Location ID		EM-JS07		EM-JS08		EM-JS08		EM-JS08		EM-JS08		RA-JS01		RA-JS01	
			Sample ID		EM-JS-07-5-7_08132008		EM-JS-08-0-1_08122008		EM-JS-08-10-12_08122008		EM-JS-08-1-3_08122008		EM-JS-08-5-7_08122008		RA-JS-01-0-1_08072008		RA-JS-01-1-3_08072008	
			Sample Date		8/13/2008		8/12/2008		8/12/2008		8/12/2008		8/12/2008		8/7/2008		8/7/2008	
			Sample Depth (feet bgs)		5-7		0-1		10-12		1-3		5-7		0-1		1-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	1.2		1.1		2	J	0.4		13.6		0.6		0.8	
Arsenic	7440-38-2	mg/kg	9.1		11.9	J	16		7.7	J	64.8	J	9.7		16.8	
Barium	7440-39-3	mg/kg	75.8		55.7		77.6		47.3		150		67.3		99.1	
Beryllium	7440-41-7	mg/kg	0.7		< 1	U	0.9		< 1	U	< 1	U	0.9		2.1	
Cadmium	7440-43-9	mg/kg	0.9		< 2	U	5.3		< 2	U	5		< 2	U	< 2	U
Chromium	7440-47-3	mg/kg	10		5		193		2		36	J	5		8	
Chromium VI	18540-29-9	mg/kg	NA		NA		4	R	NA		< 9	U	NA		NA	
Cobalt	7440-48-4	mg/kg	17		4		23		5		42		7		13	
Copper	7440-50-8	mg/kg	3840		2040		4120		1800		26800		3550		4020	
Lead	7439-92-1	mg/kg	144		57		303		152		999		64.7		120	
Manganese	7439-96-5	mg/kg	590		166		683		190		932		401		566	
Mercury	7439-97-6	mg/kg	0.07		0.08		0.4		0.09		0.6		0.07		0.08	
Molybdenum	7439-98-7	mg/kg	343		1240		2220		315		6470		955		767	
Nickel	7440-02-0	mg/kg	11		< 5	U	29		< 5	U	33		4		7	
Selenium	7782-49-2	mg/kg	2.13		3.24		2.86		3.38		7.85		1.9		2.17	
Thallium	7440-28-0	mg/kg	0.26		0.12		0.17		0.2		0.22		0.22		0.28	
Uranium	7440-61-1	mg/kg	6.49		2.41		7.78		1.17		5.2		4.42		13.4	
Zinc	7440-66-6	mg/kg	274		39		741		39		1550		133		173	

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond	
			Location ID		RA-JS01		RA-JS02		RA-JS02		RA-JS02		RA-JS03		RA-JS03		RA-JS04	
			Sample ID		RA-JS-01-5-7_08072008		RA-JS-02-0-1_08112008		RA-JS-02-1-3_08112008		RA-JS-02-5-7_08112008		RA-JS-03-0-1_08072008		RA-JS-03-1-3_08072008		RA-JS-04-0-1_08072008	
			Sample Date		8/7/2008		8/11/2008		8/11/2008		8/11/2008		8/7/2008		8/7/2008		8/7/2008	
			Sample Depth (feet bgs)		5-7		0-1		1-3		5-7		0-1		1-3		0-1	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	0.9		8		17.4		9.6		< 1	U	< 1	U	< 1	U		
Arsenic	7440-38-2	mg/kg	13.5		< 35.4	U	< 89.7	U	< 60	U	1.7		1.1		1.4			
Barium	7440-39-3	mg/kg	83.7		74.1		68.9		78.1		163		127		121			
Beryllium	7440-41-7	mg/kg	0.8		< 5	U	< 5	U	6.2		0.3		< 1	U	< 1	U		
Cadmium	7440-43-9	mg/kg	< 2	U	1.5		2.5		1.8		< 2	U	< 2	U	< 2	U		
Chromium	7440-47-3	mg/kg	6		10		18		35		5		4		4			
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		< 8	UJ	NA		NA		NA			
Cobalt	7440-48-4	mg/kg	16		17		22		26		7		6		6			
Copper	7440-50-8	mg/kg	7520		30200		27800		19600		113		62		201			
Lead	7439-92-1	mg/kg	78.6		137		349		199		4.99		2.81		10.8			
Manganese	7439-96-5	mg/kg	276		384		327		382		239		228		232			
Mercury	7439-97-6	mg/kg	< 0.2	U	0.36		0.28		0.32		< 0.2	U	< 0.2	U	< 0.2	U		
Molybdenum	7439-98-7	mg/kg	525		1430		3430		1950		26		12		13			
Nickel	7440-02-0	mg/kg	7		2		2		8		6		6		5			
Selenium	7782-49-2	mg/kg	2.43		< 11.1	U	< 9.76	U	< 6.25	U	0.13		0.05		0.09			
Thallium	7440-28-0	mg/kg	0.19		0.35		0.36		0.39		0.32		0.26		0.34			
Uranium	7440-61-1	mg/kg	6.59		5.63		8.62		29.9		3.7		3.33		2.75			
Zinc	7440-66-6	mg/kg	125		281		466		629		75		63		60			

Appendix A, Table A-2
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond		Raffinate Pond	
			Location ID		RA-JS04		RA-JS05		RA-JS05		RA-SD01		RA-SD01		RA-SD02		RA-SD02	
			Sample ID		RA-JS-04-1-2.5_08072008		RA-JS-05-0-1_08072008		RA-JS-05-1-3_08072008		RA-SD-01-0-1.5_08112008		RA-SD-01-1.5-3.0_08112008		RA-SD-02-0-1.5_08112008		RA-SD-02-1.5-3.0_08112008	
			Sample Date		8/7/2008		8/7/2008		8/7/2008		8/11/2008		8/11/2008		8/11/2008		8/11/2008	
			Sample Depth (feet bgs)		1-2.5		0-1		1-3		0-1.5		1.5-3		0-1.5		1.5-3	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	0.4		0.6		1.3		4		5.8		7.4			
Arsenic	7440-38-2	mg/kg	1		5.2		3.1		< 10.1	U	< 24.7	U	< 32.4	U	< 39.1	U		
Barium	7440-39-3	mg/kg	98.9		52.2		53.5		73.1		81.7		52.4		57.4			
Beryllium	7440-41-7	mg/kg	< 1	U	0.4		< 1	U	0.7		0.7		< 1	U	0.5			
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	0.8		< 2	U	< 2	U		
Chromium	7440-47-3	mg/kg	3		2		2		11		14		7		8			
Chromium VI	18540-29-9	mg/kg	NA		NA		NA		NA		NA		NA		NA			
Cobalt	7440-48-4	mg/kg	5		4		5		6		10		4		5			
Copper	7440-50-8	mg/kg	136		380		284		7630		6960		4210		4180			
Lead	7439-92-1	mg/kg	3		24.5		8.63		86.9		114		106		91.3			
Manganese	7439-96-5	mg/kg	220		169		210		277		226		108		181			
Mercury	7439-97-6	mg/kg	< 0.2	U	< 0.2	U	< 0.2	U	0.09		0.11		0.13		0.13			
Molybdenum	7439-98-7	mg/kg	< 5	U	157		25		998		1590		530		1000			
Nickel	7440-02-0	mg/kg	4		3		3		2		2		< 5	U	2			
Selenium	7782-49-2	mg/kg	0.06		0.33		0.15		2.61		3.46		3.13		3.02			
Thallium	7440-28-0	mg/kg	0.22		0.14		0.15		0.2		0.31		0.18		0.25			
Uranium	7440-61-1	mg/kg	3.4		6.88		8.31		7.72		10.9		2.12		3.98			
Zinc	7440-66-6	mg/kg	51		82		87		91		186		51		77			

Appendix A, Table A-3
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Rhenium Ponds - Metals
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

			Location Subarea		Rhenium Ponds		Rhenium Ponds		Rhenium Ponds		Rhenium Ponds		Rhenium Ponds		Rhenium Ponds		Rhenium Ponds		Rhenium Ponds	
			Location ID		RP-JS01		RP-JS01		RP-JS01		RP-JS01		RP-JS02		RP-JS02		RP-JS02		RP-JS02	
			Sample ID		RP-JS-01-0-1_08122008		RP-JS-01-10-12_08122008		RP-JS-01-1-3_08122008		RP-JS-01-5-7_08122008		RP-JS-02-0-1_08122008		RP-JS-02-10-12_08122008		RP-JS-02-1-3_08122008		RP-JS-02-5-7_08122008	
			Sample Date		8/12/2008		8/12/2008		8/12/2008		8/12/2008		8/12/2008		8/12/2008		8/12/2008		8/12/2008	
			Sample Depth (feet bgs)		0-1		10-12		1-3		5-7		0-1		10-12		1-3		5-7	
Analyte	CASRN	Units	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual	Result	Qual
Antimony	7440-36-0	mg/kg	< 1	U	< 1	U	< 1	U	< 1	U	0.2		0.3		< 1	U	< 1	U		
Arsenic	7440-38-2	mg/kg	3.5	J	2.6	J	3.1	J	1.9	J	3.5	J	3.3	J	3.5	J	5.2	J		
Barium	7440-39-3	mg/kg	127		50.8		46.1		49		303		50.9		47.3		188			
Beryllium	7440-41-7	mg/kg	0.6		0.3		0.2		< 1	U	1.6		0.5		< 1	U	0.8			
Cadmium	7440-43-9	mg/kg	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U	< 2	U		
Chromium	7440-47-3	mg/kg	4		2		4		2		7		2		3		4			
Cobalt	7440-48-4	mg/kg	5		5		5		5		10		16		2		10			
Copper	7440-50-8	mg/kg	124		466		183		137		63		323		74		123			
Lead	7439-92-1	mg/kg	11.4		9.69		12.7		6.43		10.8		14.5		8.5		7.69			
Manganese	7439-96-5	mg/kg	271		207		244		231		975		713		160		1250			
Mercury	7439-97-6	mg/kg	0.07		0.06		< 0.2	U	< 0.2	U	0.04		0.07		< 0.2	U	< 0.2	U		
Molybdenum	7439-98-7	mg/kg	51		126		86		33		6		93		121		32			
Nickel	7440-02-0	mg/kg	2		2		2		2		6		5		< 5	U	4			
Selenium	7782-49-2	mg/kg	0.91		1.04		0.8		0.6		0.34		0.93		0.74		0.7			
Thallium	7440-28-0	mg/kg	0.15		0.09		0.13		0.08		0.25		0.12		0.11		0.17			
Uranium	7440-61-1	mg/kg	2.64		2.25		2.44		1.26		2.11		9.12		1.07		2.12			
Zinc	7440-66-6	mg/kg	40		48		43		36		51		139		23		71			

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	CP-JS01				CP-JS01				CP-JS01				CP-JS01				CP-JS02				CP-JS02			
		Sample ID	CP-JS-01-0-1_07152008				CP-JS-01-10-12_07152008				CP-JS-01-1-3_07152008				CP-JS-01-5-7_07152008				CP-JS-02-0-1_07112008				CP-JS-02-1-3_07112008			
		Sample Date	7/15/2008				7/15/2008				7/15/2008				7/15/2008				7/11/2008				7/11/2008			
		Sample Depth (feet bgs)	0-1				10-12				1-3				5-7				0-1				1-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	0.64		0.59	0.44	2.4		0.33	0.71	2		0.37	0.54	2.8		0.6	0.49	2.9		0.46	0.8	1.1	J	0.42	0.28
Radium-228	15262-20-1	pCi/g	4.2		2.7	1.9	2.5		0.96	0.68	2.1	J	0.98	0.64	1.7	J	0.77	0.57	1.9	J	1.6	0.85	1.5	J	1.1	0.63
Uranium-234	13966-29-5	pCi/g	1.3		0.034	0.27	2.8		0.047	0.52	2.4		0.073	0.47	2		0.043	0.39	12		0.017	2	0.84		0.034	0.19
Uranium-235	15117-96-1	pCi/g	< 0.039	U	0.039	0.039	0.11		0.047	0.059	0.19		0.053	0.084	0.2		0.034	0.079	0.74		0.046	0.19	0.081		0.033	0.048
Uranium-238	ARC-U238	pCi/g	1.3		0.034	0.28	3		0.058	0.55	2.7		0.06	0.52	2.1		0.029	0.4	12		0.017	2	1		0.028	0.22

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	CP-JS03				CP-JS03				CP-JS03				CP-JS04				CP-JS04				CP-JS04			
		Sample ID	CP-JS-03-0-1_07142008				CP-JS-03-1-3_07142008				CP-JS-03-5-7_07142008				CP-JS-04-0-1_08272008				CP-JS-04-10-12_08272008				CP-JS-04-1-3_08272008			
		Sample Date	7/14/2008				7/14/2008				7/14/2008				8/27/2008				8/27/2008				8/27/2008			
		Sample Depth (feet bgs)	0-1				1-3				5-7				0-1				10-12				1-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.5		0.38	0.66	2.1		0.35	0.6	5.3		0.35	1.2	2.6		0.38	0.69	0.88	J	0.52	0.43	2.4		0.51	0.41
Radium-228	15262-20-1	pCi/g	2.3		0.87	0.61	2.3	J	0.89	0.64	2	J	0.74	0.52	2.3		0.99	0.62	1.8	J	0.66	0.57	1.7		1.1	0.53
Uranium-234	13966-29-5	pCi/g	2.6		0.036	0.49	2.3		0.027	0.42	3.6		0.03	0.65	3		0.051	0.55	2.9		0.11	0.52	2.3		0.073	0.45
Uranium-235	15117-96-1	pCi/g	0.11		0.048	0.059	0.072		0.032	0.044	0.2		0.042	0.081	0.081		0.076	0.059	0.19		0.052	0.078	0.14		0.086	0.083
Uranium-238	ARC-U238	pCi/g	2.7		0.036	0.5	2.2		0.033	0.42	3.6		0.036	0.64	2.6		0.058	0.48	3.1		0.077	0.55	2.2		0.052	0.45

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	CP-JS04				CP-SD01				CP-SD01				CP-SD02				CP-SD02				CP-SD03			
		Sample ID	CP-JS-04-5-7_08272008				CP-SD-01-0-1.5_07162008				CP-SD-01-1.5-3.0_07162008				CP-SD-02-0-1.5_07162008				CP-SD-02-1.5-3.0_07162008				CP-SD-03-0-1.5_07162008			
		Sample Date	8/27/2008				7/16/2008				7/16/2008				7/16/2008				7/16/2008				7/16/2008			
		Sample Depth (feet bgs)	5-7				0-1.5				1.5-3				0-1.5				1.5-3				0-1.5			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	5	J	0.62	0.75	2.1		0.41	0.61	2.2		0.42	0.39	1.5		0.54	0.34	1.5		0.35	0.47	2.8		0.094	0.79
Radium-228	15262-20-1	pCi/g	2.4	J	1.1	0.67	1.5		0.96	0.5	2.4		0.78	0.57	1.4	J	1	0.58	1.5		0.95	0.66	1.5	J	1	0.61
Uranium-234	13966-29-5	pCi/g	6.4		0.087	1.1	1.5		0.031	0.32	2.2		0.03	0.42	1.9		0.014	0.37	1.2		0.046	0.27	0.98		0.049	0.23
Uranium-235	15117-96-1	pCi/g	0.27		0.085	0.11	0.11		0.036	0.058	0.14		0.042	0.067	0.092		0.033	0.051	0.043		0.023	0.039	0.075		0.053	0.051
Uranium-238	ARC-U238	pCi/g	6.3		0.11	1.1	1.5		0.016	0.31	2.2		0.03	0.42	1.8		0.028	0.36	1.2		0.046	0.27	1.1		0.04	0.25

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	CP-SD03				CP-SD04				CP-SD04				CP-SD05				CP-SD05				CP-SD06			
		Sample ID	CP-SD-03-1.5-3.0_07162008				CP-SD-04-0-1.5_07172008				CP-SD-04-1.5-3.0_07172008				CP-SD-05-0-1.5_07162008				CP-SD-05-1.5-3.0_07162008				CP-SD-06-0-1.5_07162008			
		Sample Date	7/16/2008				7/17/2008				7/17/2008				7/16/2008				7/16/2008				7/16/2008			
		Sample Depth (feet bgs)	1.5-3				0-1.5				1.5-3				0-1.5				1.5-3				0-1.5			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.3		0.45	0.42	0.77		0.065	0.31	1.4		0.46	0.49	2.7		0.54	0.46	2.3		0.06	0.61	2.7		0.49	0.44
Radium-228	15262-20-1	pCi/g	1.8	J	0.78	0.59	2.7		1.6	0.81	2.3	J	1.5	0.84	2		1	0.56	2.1		0.96	0.62	2.1		0.91	0.59
Uranium-234	13966-29-5	pCi/g	1.8		0.13	0.42	1.9		0.059	0.42	1.4		0.031	0.29	2.1		0.05	0.4	2.3		0.1	0.49	1.7		0.037	0.34
Uranium-235	15117-96-1	pCi/g	< 0.097	U	0.097	0.08	0.097		0.069	0.075	0.11		0.036	0.058	0.15		0.035	0.068	0.098		0.038	0.076	0.095		0.039	0.052
Uranium-238	ARC-U238	pCi/g	1.9		0.031	0.42	2.1		0.041	0.46	1.3		0.031	0.27	2		0.04	0.39	1.9		0.11	0.44	1.9		0.028	0.37

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	CP-SD06				CP-SD07				CP-SD09				CP-SD09				CP-SD10				M04			
		Sample ID	CP-SD-06-1.5-3.0_07162008				CP-SD-07-1.5-3.0_07232008				CP-SD-09-0-1.5_07282008				CP-SD-09-1.5-3.0_07282008				CP-SD-10-1.5-3.0_07282008				CP-M04-1-2.5_07112008			
		Sample Date	7/16/2008				7/23/2008				7/28/2008				7/28/2008				7/28/2008				7/11/2008			
		Sample Depth (feet bgs)	1.5-3				1.5-3				0-1.5				1.5-3				1.5-3				1-2.5			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	3		0.51	0.49	2.1		0.45	0.38	3		0.26	0.76	1.6		0.42	0.55	0.61		0.58	0.4	2.3		0.56	0.42
Radium-228	15262-20-1	pCi/g	2.6		0.92	0.65	2.5		0.83	0.6	2		1	0.59	1.4		0.79	0.45	2.2	J	0.93	0.66	1.5	J	1.1	0.6
Uranium-234	13966-29-5	pCi/g	1.7		0.034	0.34	2		0.034	0.39	2.1		0.041	0.4	1.7		0.051	0.34	1.2		0.079	0.27	1.9		0.067	0.37
Uranium-235	15117-96-1	pCi/g	0.11		0.034	0.056	< 0.12	U	0.12	0.067	0.098		0.043	0.055	0.072		0.035	0.046	< 0.054	U	0.054	0.045	0.069		0.049	0.047
Uranium-238	ARC-U238	pCi/g	1.9		0.029	0.36	2.2		0.051	0.44	2.4		0.03	0.46	1.7		0.041	0.34	1.4		0.063	0.3	1.8		0.055	0.35

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	M04				M06				M06				N08				N08				N08			
		Sample ID	CP-M04-5-5.4_07112008				CP-M06-0-1_07112008				CP-M06-1-3_07112008				CP-N08-0-1_07112008				CP-N08-1-3_07112008				CP-N08-5-7_07112008			
		Sample Date	7/11/2008				7/11/2008				7/11/2008				7/11/2008				7/11/2008				7/11/2008			
		Sample Depth (feet bgs)	5-5.4				0-1				1-3				0-1				1-3				5-7			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	4		0.57	0.61	1.3	J	0.47	0.29	1		0.52	0.28	1.5		0.42	0.31	4.1		0.47	0.94	2.3		0.35	0.59
Radium-228	15262-20-1	pCi/g	2.5	J	1.1	0.72	1.2	J	0.9	0.45	1.6	J	1.2	0.64	1.6		0.72	0.47	3	J	0.96	0.8	2.4	J	1.2	0.78
Uranium-234	13966-29-5	pCi/g	3.8		0.034	0.68	1.1		0.065	0.24	0.88		0.034	0.2	1.5		0.043	0.32	3.9		0.05	0.7	4		0.058	0.72
Uranium-235	15117-96-1	pCi/g	0.2		0.017	0.079	0.063		0.056	0.046	0.056		0.034	0.04	0.089		0.037	0.053	0.2		0.036	0.082	0.18		0.038	0.079
Uranium-238	ARC-U238	pCi/g	3.8		0.034	0.68	1.1		0.047	0.23	1		0.034	0.22	1.8		0.047	0.36	4		0.042	0.71	4.3		0.044	0.78

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	O03				O03				O09				O09				O09				O09			
		Sample ID	CP-O03-0-1_07112008				CP-O03-1-3_07112008				CP-O09-0-1_07112008				CP-O09-10-12_07112008				CP-O09-1-3_07112008				CP-O09-5-7_07112008			
		Sample Date	7/11/2008				7/11/2008				7/11/2008				7/11/2008				7/11/2008				7/11/2008			
		Sample Depth (feet bgs)	0-1				1-3				0-1				10-12				1-3				5-7			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.1		0.44	0.38	3.3		0.5	0.52	1.4		0.29	0.42	< 0.4	U	0.4	0.3	1.2		0.44	0.44	1.7		0.42	0.54
Radium-228	15262-20-1	pCi/g	2		0.9	0.52	2.4		0.83	0.61	7.6	J	3.4	2.9	1.9	J	1.1	0.67	2.1		1	0.64	2.2	J	1.4	0.77
Uranium-234	13966-29-5	pCi/g	2.5		0.072	0.49	3.1		0.072	0.56	2.7		0.054	0.51	1.8		0.05	0.37	2		0.051	0.4	1.9		0.066	0.38
Uranium-235	15117-96-1	pCi/g	0.14		0.043	0.069	0.23		0.044	0.085	0.21		0.038	0.086	0.1		0.019	0.057	0.17	J	0.019	0.075	0.16		0.044	0.074
Uranium-238	ARC-U238	pCi/g	2.7		0.075	0.52	3.1		0.053	0.56	2.8		0.043	0.53	1.9		0.042	0.38	2		0.057	0.4	1.9		0.016	0.37

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant			
		Location ID	P04				P04				P05				P05				P07				P07			
		Sample ID	CP-P04-0-1_07152008				CP-P04-1-3_07152008				CP-P05-0-1_07152008				CP-P05-1-3_07152008				CP-P07-0-1_07172008				CP-P07-1-3_07172008			
		Sample Date	7/15/2008				7/15/2008				7/15/2008				7/15/2008				7/17/2008				7/17/2008			
		Sample Depth (feet bgs)	0-1				1-3				0-1				1-3				0-1				1-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1.9		0.47	0.58	1.8		0.44	0.35	1.2		0.28	0.38	2.2		0.41	0.39	2.8		0.3	0.69	4.8		0.71	1.2
Radium-228	15262-20-1	pCi/g	2.5	J	0.88	0.7	2.1		0.91	0.57	2.5		0.94	0.63	1.9		0.72	0.52	2.8	J	0.9	0.69	2.8	J	1.3	0.78
Uranium-234	13966-29-5	pCi/g	2.5		0.016	0.48	2.3		0.055	0.45	2.9		0.038	0.54	2.5		0.045	0.47	2.2		0.11	0.49	2.4		0.1	0.52
Uranium-235	15117-96-1	pCi/g	0.17		0.019	0.075	0.19		0.049	0.084	0.27		0.045	0.1	0.22		0.036	0.085	0.21		0.04	0.12	0.19		0.04	0.11
Uranium-238	ARC-U238	pCi/g	2.5		0.047	0.47	1.9		0.062	0.39	3		0.032	0.57	2.6		0.041	0.48	2.9		0.079	0.62	2.6		0.089	0.56

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former CLEAR Plant				Former E Pond			
		Location ID	P07				P12				P12				Q09				Q09				E-JS01			
		Sample ID	CP-P07-5-7_07172008				CP-P12-0-1_07232008				CP-P12-1-3_07232008				CP-Q09-0-1_07232008				CP-Q09-1-3_07232008				E-JS-01-0-1_07142008			
		Sample Date	7/17/2008				7/23/2008				7/23/2008				7/23/2008				7/23/2008				7/14/2008			
		Sample Depth (feet bgs)	5-7				0-1				1-3				0-1				1-3				0-1			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1.3		0.33	0.44	1.5		0.055	0.43	1.9		0.58	0.65	< 0.84	U	0.84	0.54	1.9		0.44	0.35	1.3	J	0.24	0.44
Radium-228	15262-20-1	pCi/g	3.5		2.8	1.8	1.6	J	1.1	0.62	1.9	J	1	0.67	2	J	1.2	0.66	1.8	J	0.69	0.54	1.4		0.88	0.5
Uranium-234	13966-29-5	pCi/g	1.9		0.1	0.36	1.6		0.083	0.39	0.91		0.049	0.21	1.7		0.095	0.4	1.2		0.036	0.26	1.8		0.06	0.35
Uranium-235	15117-96-1	pCi/g	< 0.074	U	0.074	0.068	< 0.19	U	0.19	0.11	0.041		0.019	0.034	0.14		0.099	0.09	0.02		0.018	0.025	0.097		0.051	0.055
Uranium-238	ARC-U238	pCi/g	1.8		0.11	0.35	1.7		0.061	0.39	0.84		0.055	0.2	1.5		0.12	0.37	1.2		0.036	0.25	1.6		0.058	0.33

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former E Pond				Former E Pond				Former E Pond				Former E Pond				Former Evaporation Pond				Former Evaporation Pond			
		Location ID	E-JS01				E-JS01				E-JS02				E-JS02				EV-JS01				EV-JS01			
		Sample ID	E-JS-01-1-3_07142008				E-JS-01-5-7_07142008				E-JS-02-0-1_07142008				E-JS-02-1-3_07142008				EV-JS-01-0-1_07142008				EV-JS-01-1-3_07142008			
		Sample Date	7/14/2008				7/14/2008				7/14/2008				7/14/2008				7/14/2008				7/14/2008			
		Sample Depth (feet bgs)	1-3				5-7				0-1				1-3				0-1				1-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1.6		0.5	0.54	2		0.41	0.61	1.8		0.063	0.52	4.8		0.42	1.1	0.44		0.17	0.23	3		0.33	0.85
Radium-228	15262-20-1	pCi/g	3.5		2.5	1.7	2.2	J	1.2	0.66	2.7		1	0.71	2		1	0.63	1.9	J	0.88	0.59	3.8		2.5	1.7
Uranium-234	13966-29-5	pCi/g	2.1		0.088	0.43	2.3		0.09	0.47	2.2		0.029	0.41	4.6		0.046	0.83	3.8		0.051	0.68	2.4		0.048	0.46
Uranium-235	15117-96-1	pCi/g	0.092		0.074	0.062	0.072		0.063	0.055	0.12		0.018	0.061	0.31		0.019	0.1	0.27		0.019	0.098	0.13		0.035	0.063
Uranium-238	ARC-U238	pCi/g	2.5		0.044	0.48	2.5		0.048	0.51	2.3		0.015	0.44	4.9		0.037	0.87	4		0.051	0.72	2.6		0.04	0.48

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Former Evaporation Pond				Former Evaporation Pond				Former Evaporation Pond				Former Evaporation Pond				Old D Pond				Old D Pond			
		Location ID	EV-JS01				EV-JS02				EV-JS02				EV-JS02				OD-JS01				OD-JS01			
		Sample ID	EV-JS-01-5-7_07142008				EV-JS-02-0-1_07142008				EV-JS-02-1-3_07142008				EV-JS-02-5-7_07142008				OD-JS-01-0-1_07292008				OD-JS-01-1-3_07292008			
		Sample Date	7/14/2008				7/14/2008				7/14/2008				7/14/2008				7/29/2008				7/29/2008			
		Sample Depth (feet bgs)	5-7				0-1				1-3				5-7				0-1				1-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	5.2		0.64	0.76	0.43		0.35	0.3	2.5		0.47	0.43	2.6	J	0.59	0.48	3.1		0.41	0.91	1.5		0.37	0.46
Radium-228	15262-20-1	pCi/g	2.5		1	0.69	1.5	J	0.84	0.56	1.6		0.77	0.51	1.9	J	0.95	0.58	1.8	J	0.99	0.66	2.1	J	1.1	0.71
Uranium-234	13966-29-5	pCi/g	6.1		0.031	1.1	2		0.037	0.39	2.7		0.047	0.51	2		0.016	0.39	2.8		0.033	0.52	2.3		0.05	0.47
Uranium-235	15117-96-1	pCi/g	0.4		0.036	0.16	0.15		0.044	0.07	0.21		0.041	0.087	0.069		0.038	0.047	< 0.11	U	0.11	0.057	0.17		0.049	0.084
Uranium-238	ARC-U238	pCi/g	6.6		0.071	1.2	2		0.046	0.4	2.6		0.042	0.5	2.3		0.032	0.45	2.9		0.014	0.52	2		0.062	0.42

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Old D Pond				Old D Pond				Old D Pond				Old D Pond				Old D Pond				Old D Pond			
		Location ID	OD-JS02				OD-JS02				OD-JS02				OD-JS03				OD-SD01				OD-SD01			
		Sample ID	OD-JS-02-0-1_07292008				OD-JS-02-1-3_07292008				OD-JS-02-5-7_07292008				OD-JS-03-0-1_08272008				OD-SD-01-0-1.5_07282008				OD-SD-01-1.5-3.0_07282008			
		Sample Date	7/29/2008				7/29/2008				7/29/2008				8/27/2008				7/28/2008				7/28/2008			
		Sample Depth (feet bgs)	0-1				1-3				5-7				0-1				0-1.5				1.5-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	3.5		0.79	1.1	3.3		0.22	0.79	2.2		0.42	0.6	2.3		0.52	0.42	2		0.4	0.59	1.6		0.31	0.5
Radium-228	15262-20-1	pCi/g	1.2	J	0.67	0.46	2.6		1	0.69	3.5	J	1.3	0.84	1.7		1.1	0.54	2.6		1.1	0.68	1.8		1	0.57
Uranium-234	13966-29-5	pCi/g	1.8		0.015	0.36	2.5		0.036	0.47	2.7	J	0.026	0.57	3		0.037	0.53	1.9		0.029	0.37	1.8		0.039	0.35
Uranium-235	15117-96-1	pCi/g	< 0.052	U	0.052	0.038	< 0.079	U	0.079	0.049	0.12	J	0.083	0.084	0.16		0.044	0.072	< 0.099	U	0.099	0.055	< 0.091	U	0.091	0.051
Uranium-238	ARC-U238	pCi/g	2.1		0.015	0.4	2.4		0.016	0.46	3	J	0.1	0.63	3		0.053	0.54	2.2		0.035	0.42	1.9		0.029	0.38

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Old D Pond				Old D Pond				Old D Pond				Old D Pond				Old D Pond				Old D Pond			
		Location ID	OD-SD02				OD-SD02				OD-SD03				OD-SD03				OD-SD04				OD-SD04			
		Sample ID	OD-SD-02-0-1.5_07282008				OD-SD-02-1.5-3.0_07282008				OD-SD-03-0-1.5_07282008				OD-SD-03-1.5-3.0_07282008				OD-SD-04-0-1.5_07282008				OD-SD-04-1.5-3.0_07282008			
		Sample Date	7/28/2008				7/28/2008				7/28/2008				7/28/2008				7/28/2008				7/28/2008			
		Sample Depth (feet bgs)	0-1.5				1.5-3				0-1.5				1.5-3				0-1.5				1.5-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1.9		0.58	0.61	2.5		0.69	0.83	2.9		0.25	0.7	2.2		0.49	0.42	2.6		0.39	0.66	2.6		0.22	0.63
Radium-228	15262-20-1	pCi/g	2.7		0.85	0.62	2.3		0.79	0.56	3		0.88	0.65	2		1.1	0.59	2.1		1.1	0.63	1.6	J	0.81	0.56
Uranium-234	13966-29-5	pCi/g	1.7		0.16	0.35	1.7		0.05	0.34	3.7		0.11	0.72	4.5		0.038	0.8	2.5		0.05	0.49	1.6		0.054	0.34
Uranium-235	15117-96-1	pCi/g	< 0.06	U	0.06	0.058	< 0.11	U	0.11	0.059	0.31		0.097	0.14	< 0.23	U	0.23	0.089	< 0.18	U	0.18	0.079	< 0.1	U	0.1	0.059
Uranium-238	ARC-U238	pCi/g	1.9		0.1	0.38	1.8		0.042	0.36	4		0.12	0.77	4.8		0.042	0.85	2.6		0.05	0.49	1.6		0.066	0.34

Appendix A, Table A-4
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former CLEAR Plant - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Old D Pond				Old D Pond				Old D Pond				Old D Pond			
		Location ID	OD-SD05				OD-SD05				OD-SD06				OD-SD06			
		Sample ID	OD-SD-05-0-1.5_07292008				OD-SD-05-1.5-3.0_07292008				OD-SD-06-0-1.5_07292008				OD-SD-06-1.5-3.0_07292008			
		Sample Date	7/29/2008				7/29/2008				7/29/2008				7/29/2008			
		Sample Depth (feet bgs)	0-1.5				1.5-3				0-1.5				1.5-3			
Analyte	CAS	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.1		0.39	0.68	1.5		0.77	0.68	0.64		0.18	0.29	2.6		0.54	0.45
Radium-228	15262-20-1	pCi/g	2.9		1	0.72	3.2	J	1.2	0.77	3.2	J	0.96	0.77	2		0.88	0.57
Uranium-234	13966-29-5	pCi/g	3.9		0.054	0.7	3.1		0.049	0.6	2.7		0.039	0.5	4.4		0.016	0.79
Uranium-235	15117-96-1	pCi/g	< 0.18	U	0.18	0.079	0.23		0.043	0.096	< 0.18	U	0.18	0.075	< 0.23	U	0.23	0.088
Uranium-238	ARC-U238	pCi/g	3.7		0.061	0.67	3		0.019	0.59	3.1		0.015	0.56	4.5		0.037	0.8

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill			
Location ID			EM-JS01				EM-JS01				C22				C22				E24				E24			
Sample ID			EM-JS-01-0-1_08012008				EM-JS-01-1-3_08012008				EM-C22-0-1_07292008				EM-C22-1-3_07292008				EM-E24-0-1_07292008				EM-E24-1-3_07292008			
Sample Date			8/1/2008				8/1/2008				7/29/2008				7/29/2008				7/29/2008				7/29/2008			
Sample Depth (feet bgs)			0-1				1-3				0-1				1-3				0-1				1-3			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.7	J	0.55	0.48	1.6	J	0.32	0.5	2.4		0.2	0.61	1.6		0.76	0.73	0.54		0.2	0.25	2.1		0.47	0.68
Radium-228	15262-20-1	pCi/g	1.8	J	1.2	0.6	2.8	J	1.2	0.84	1.4		1.1	0.52	2.4	J	1	0.66	1.7		1.2	0.6	1.3	J	1	0.56
Uranium-234	13966-29-5	pCi/g	1.6		0.079	0.32	2.9		0.053	0.55	2.2		0.045	0.42	2.3		0.052	0.48	1.8		0.053	0.35	1.9		0.057	0.41
Uranium-235	15117-96-1	pCi/g	0.079		0.047	0.05	0.11		0.042	0.058	< 0.11	U	0.11	0.059	0.12		0.061	0.073	< 0.086	U	0.086	0.052	< 0.11	U	0.11	0.074
Uranium-238	ARC-U238	pCi/g	1.7		0.058	0.35	2.9		0.044	0.54	1.9		0.052	0.37	2.4		0.064	0.5	1.7		0.037	0.35	1.8		0.065	0.41

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill			
Location ID			G27				G27				H22				H22				H22				K24			
Sample ID			EM-G27-0-1_08072008				EM-G27-1-3_08072008				EM-H22-0-1_07302008				EM-H22-1-3_07302008				EM-H22-5-7_07312008				EM-K24-0-1_07312008			
Sample Date			8/7/2008				8/7/2008				7/30/2008				7/30/2008				7/31/2008				7/31/2008			
Sample Depth (feet bgs)			0-1				1-3				0-1				1-3				5-7				0-1			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.1		0.87	0.83	2		0.56	0.69	1.8	J	0.53	0.38	1.6		0.42	0.55	2.4		0.43	0.41	1.8		0.47	0.35
Radium-228	15262-20-1	pCi/g	2.3	J	0.95	0.77	2.2	J	1.6	0.9	2	J	0.9	0.6	1	J	0.82	0.63	1.3	J	0.89	0.54	1.7	J	0.84	0.57
Uranium-234	13966-29-5	pCi/g	2.8		0.052	0.54	1.6		0.043	0.32	1.9		0.045	0.37	1.5		0.062	0.31	2.7		0.051	0.51	1.7		0.052	0.34
Uranium-235	15117-96-1	pCi/g	0.18		0.052	0.078	0.074		0.045	0.049	0.096		0.049	0.056	< 0.055	U	0.055	0.044	0.13		0.018	0.064	0.12		0.052	0.063
Uranium-238	ARC-U238	pCi/g	2.7		0.052	0.51	1.7		0.016	0.34	1.9		0.037	0.39	1.3		0.05	0.28	2.6		0.036	0.49	1.7		0.039	0.34

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill			
Location ID			K24				K24				M26				M26				M26				N29			
Sample ID			EM-K24-1-3_07312008				EM-K24-5-7_07312008				EM-M26-0-1_08012008				EM-M26-1-3_08012008				EM-M26-5-7_08012008				EM-N29-0-1_08062008			
Sample Date			7/31/2008				7/31/2008				8/1/2008				8/1/2008				8/1/2008				8/6/2008			
Sample Depth (feet bgs)			1-3				5-7				0-1				1-3				5-7				0-1			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2		0.45	0.37	2.2		0.41	0.39	2.5		0.43	0.68	1.6		0.35	0.5	2.7	J	0.58	0.49	0.79		0.32	0.34
Radium-228	15262-20-1	pCi/g	2	J	0.74	0.57	2.3		0.7	0.59	2.2	J	1.1	0.83	1.7	J	0.96	0.56	2.9	J	1	0.79	1.5		1	0.48
Uranium-234	13966-29-5	pCi/g	1.4		0.041	0.29	1.7		0.046	0.35	1.7		0.054	0.35	2.4		0.045	0.46	2.7		0.029	0.51	1.4		0.084	0.29
Uranium-235	15117-96-1	pCi/g	0.081		0.018	0.049	< 0.049	U	0.049	0.041	0.11		0.058	0.064	0.13		0.036	0.063	0.25		0.034	0.09	0.056		0.05	0.043
Uranium-238	ARC-U238	pCi/g	1.3		0.052	0.28	1.6		0.037	0.32	1.7		0.054	0.36	2.5		0.045	0.48	2.9		0.035	0.54	1.4		0.061	0.29

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill				Esperanza Mill			
Location ID			N29				P24				P24				P24				P24				X26			
Sample ID			EM-N29-1-3_08062008				EM-P24-0-1_08072008				EM-P24-10-11_08072008				EM-P24-1-3_08072008				EM-P24-5-7_08072008				EM-X26-0-1_08062008			
Sample Date			8/6/2008				8/7/2008				8/7/2008				8/7/2008				8/7/2008				8/6/2008			
Sample Depth (feet bgs)			1-3				0-1				10-11				1-3				5-7				0-1			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2		0.29	0.58	2.4		0.53	0.42	2.8		0.41	0.75	1.8		0.2	0.55	2.6		0.23	0.73	3.5		0.37	0.91
Radium-228	15262-20-1	pCi/g	1.7	J	1.4	0.75	1.9		0.97	0.56	3	J	1	0.78	2.1		0.87	0.6	2		0.87	0.58	1.8	J	0.94	0.67
Uranium-234	13966-29-5	pCi/g	1.2		0.048	0.27	2.2		0.03	0.43	2		0.048	0.38	3.3		0.043	0.57	2.1		0.042	0.41	1.7		0.046	0.33
Uranium-235	15117-96-1	pCi/g	0.078		0.038	0.05	< 0.078	U	0.078	0.048	0.12		0.062	0.064	0.14		0.04	0.066	< 0.12	U	0.12	0.059	0.063		0.05	0.044
Uranium-238	ARC-U238	pCi/g	1.3		0.039	0.28	2.1		0.036	0.41	2.2		0.053	0.41	3.4		0.036	0.6	2.2		0.015	0.42	1.8		0.049	0.35

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Esperanza Mill				Esperanza Mill				C Pond				C Pond				C Pond				C Pond			
Location ID			X26				X26				C-JS01				C-JS01				C-JS02				C-JS02			
Sample ID			EM-X26-1-3_08062008				EM-X26-5-7_08062008				C-JS-01-0-1_08012008				C-JS-01-1-3_08012008				C-JS-02-1-3_08012008				C-JS-02-5-7_08012008			
Sample Date			8/6/2008				8/6/2008				8/1/2008				8/1/2008				8/1/2008				8/1/2008			
Sample Depth (feet bgs)			1-3				5-7				0-1				1-3				1-3				5-7			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	0.72		0.63	0.47	1.1		0.072	0.38	1.5		0.48	0.53	2.1		0.29	0.62	2.3	J	0.42	0.41	4		0.46	0.98
Radium-228	15262-20-1	pCi/g	< 2	U	2	1.4	2.2		1.1	0.69	2.1	J	1.1	0.77	2.2	J	1.1	0.69	1.8	J	0.94	0.56	5.2	J	1.3	1.2
Uranium-234	13966-29-5	pCi/g	0.85		0.061	0.2	2.1		0.11	0.49	1.6		0.032	0.32	1.8		0.03	0.36	2.6		0.036	0.49	3.3		0.029	0.62
Uranium-235	15117-96-1	pCi/g	0.059		0.052	0.044	0.084		0.083	0.072	0.092		0.019	0.053	0.11		0.018	0.058	0.088		0.018	0.051	0.2		0.047	0.082
Uranium-238	ARC-U238	pCi/g	0.9		0.041	0.21	2.2		0.087	0.5	1.5		0.016	0.31	1.7		0.03	0.34	2.6		0.03	0.5	4		0.035	0.72

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			C Pond				C Pond				C Pond				C Pond				C Pond				C Pond			
Location ID			C-JS03				C-JS03				C-JS03				C-JS03				C-JS04				C-JS04			
Sample ID			C-JS-03-0-1_08042008				C-JS-03-10-12_08042008				C-JS-03-1-3_08042008				C-JS-03-5-7_08042008				C-JS-04-0-1_08052008				C-JS-04-10-12_08052008			
Sample Date			8/4/2008				8/4/2008				8/4/2008				8/4/2008				8/5/2008				8/5/2008			
Sample Depth (feet bgs)			0-1				10-12				1-3				5-7				0-1				10-12			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1.9		0.39	0.61	2.2	J	0.7	0.45	0.91		0.073	0.35	2.6		0.29	0.65	0.82		0.18	0.33	3.1		0.86	1
Radium-228	15262-20-1	pCi/g	1.8	J	1.2	0.8	2.7	J	0.99	0.74	1.9	J	1.1	0.69	2.1	J	1.1	0.66	< 2.4	U	2.4	1.5	2.3	J	1.2	0.77
Uranium-234	13966-29-5	pCi/g	1.9		0.045	0.38	3.6		0.032	0.67	1.9		0.046	0.37	1.9		0.029	0.38	1.6		0.045	0.33	3		0.034	0.55
Uranium-235	15117-96-1	pCi/g	0.12		0.018	0.059	0.21		0.019	0.084	0.14		0.041	0.066	0.1		0.018	0.055	0.071		0.043	0.047	0.15		0.033	0.067
Uranium-238	ARC-U238	pCi/g	1.9		0.036	0.38	3.5		0.032	0.66	2		0.034	0.39	2.1		0.015	0.41	1.5		0.041	0.31	3.1		0.038	0.56

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			C Pond				C Pond				C Pond				C Pond Spoils				C Pond Spoils				C Pond Spoils			
Location ID			C-JS04				C-JS04				C-JS05				CS-JS01				CS-JS01				CS-JS01			
Sample ID			C-JS-04-1-3_08052008				C-JS-04-5-7_08052008				C-JS-05-1-3_08052008				CS-JS-01-10-12_08042008				CS-JS-01-1-3_08042008				CS-JS-01-5-7_08042008			
Sample Date			8/5/2008				8/5/2008				8/5/2008				8/4/2008				8/4/2008				8/4/2008			
Sample Depth (feet bgs)			1-3				5-7				1-3				10-12				1-3				5-7			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.6		0.53	0.85	1.4		0.55	0.62	5	J	0.34	1.1	1.9		0.61	0.64	1.8	J	0.28	0.53	3.6		0.45	0.92
Radium-228	15262-20-1	pCi/g	2.6		1	0.73	2.4		0.73	0.64	4.6		2.7	2	2.7	J	0.98	0.77	2	J	1.5	0.79	3.4	J	1.1	0.91
Uranium-234	13966-29-5	pCi/g	1.9		0.056	0.38	1.5		0.038	0.3	2.2		0.055	0.44	2.2		0.042	0.42	2.2		0.031	0.43	2.1		0.049	0.43
Uranium-235	15117-96-1	pCi/g	0.19		0.061	0.084	0.092		0.033	0.051	0.085	J	0.038	0.052	0.087		0.034	0.05	< 0.042	U	0.042	0.038	0.14		0.053	0.071
Uranium-238	ARC-U238	pCi/g	2.1		0.064	0.42	1.6		0.028	0.32	2.1		0.048	0.42	2.4		0.039	0.46	2		0.037	0.39	2.1		0.04	0.41

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils			
Location ID			CS-JS02				CS-JS02				CS-JS02				CS-JS02				CS-JS03				CS-JS03			
Sample ID			CS-JS-02-0-1_08042008				CS-JS-02-10-11_08042008				CS-JS-02-1-3_08042008				CS-JS-02-5-7_08042008				CS-JS-03-0-1_08052008				CS-JS-03-10-12_08052008			
Sample Date			8/4/2008				8/4/2008				8/4/2008				8/4/2008				8/5/2008				8/5/2008			
Sample Depth (feet bgs)			0-1				10-11				1-3				5-7				0-1				10-12			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	2.2		0.33	0.62	3.7		0.33	0.93	1.9		0.39	0.6	1.7		0.61	0.38	2.3		0.45	0.65	2.7	J	0.51	0.46
Radium-228	15262-20-1	pCi/g	2.2	J	0.94	0.74	2.2		0.94	0.64	1.9		0.73	0.53	2.1	J	0.77	0.63	2		1	0.64	2.6		0.99	0.66
Uranium-234	13966-29-5	pCi/g	1.6		0.042	0.32	2.5		0.015	0.48	2.4		0.066	0.45	1.6		0.039	0.34	1.5		0.042	0.31	1.7		0.037	0.35
Uranium-235	15117-96-1	pCi/g	< 0.056	U	0.056	0.046	0.093		0.018	0.052	0.11		0.054	0.059	0.098		0.046	0.058	0.077		0.049	0.05	0.11		0.043	0.058
Uranium-238	ARC-U238	pCi/g	1.8		0.037	0.37	2.7		0.03	0.51	2.5		0.056	0.47	1.9		0.049	0.38	1.8		0.031	0.37	1.8		0.046	0.36

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils			
Location ID			CS-JS03				CS-JS03				CS-JS04				CS-JS04				CS-JS04				CS-JS05			
Sample ID			CS-JS-03-1-3_08052008				CS-JS-03-5-7_08052008				CS-JS-04-0-1_08062008				CS-JS-04-1-3_08062008				CS-JS-04-5-7_08062008				CS-JS-05-0-1_08272008			
Sample Date			8/5/2008				8/5/2008				8/6/2008				8/6/2008				8/6/2008				8/27/2008			
Sample Depth (feet bgs)			1-3				5-7				0-1				1-3				5-7				0-1			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	0.92		0.76	0.54	1.9		0.67	0.69	0.89		0.75	0.55	1.7		0.5	0.56	1.5		0.31	0.51	2.1		0.44	0.37
Radium-228	15262-20-1	pCi/g	1.7	J	1	0.62	1.9		1.4	0.67	2.6		0.82	0.65	2.4	J	0.81	0.71	2		1.2	0.62	2.4	J	0.69	0.64
Uranium-234	13966-29-5	pCi/g	1.5		0.098	0.35	1.3		0.016	0.27	1.8		0.027	0.35	1.7		0.027	0.34	1.4		0.091	0.35	3.3		0.042	0.62
Uranium-235	15117-96-1	pCi/g	0.12		0.083	0.081	0.071		0.043	0.047	0.14		0.016	0.063	0.096		0.032	0.051	0.088		0.087	0.075	0.19		0.044	0.08
Uranium-238	ARC-U238	pCi/g	1.5		0.063	0.36	1.4		0.037	0.29	1.8		0.027	0.35	1.8		0.033	0.35	1.8		0.032	0.41	3.3		0.016	0.62

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils				C Pond Spoils				Laydown Yard			
Location ID			CS-JS05				CS-JS06				U25				U25				U25				EM-JS02			
Sample ID			CS-JS-05-1-3_08272008				CS-JS-06-0-1_08272008				EM-U25-0-1_08062008				EM-U25-1-3_08062008				EM-U25-5-5.5_08062008				EM-JS-02-0-1_08012008			
Sample Date			8/27/2008				8/27/2008				8/6/2008				8/6/2008				8/6/2008				8/1/2008			
Sample Depth (feet bgs)			1-3				0-1				0-1				1-3				5-5.5				0-1			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	4.6		0.5	1.2	1.7		0.39	0.33	0.67	J	0.3	0.31	1.6		0.38	0.52	5.1		0.63	0.74	3		0.31	0.74
Radium-228	15262-20-1	pCi/g	2.6	J	0.91	0.61	1.5	J	0.65	0.44	2	J	0.92	0.7	2.1	J	1.1	0.69	3.5		1.3	0.78	3.7	J	1.5	0.96
Uranium-234	13966-29-5	pCi/g	6.6		0.032	1.2	1.5		0.046	0.31	2.1		0.046	0.4	1.7		0.072	0.35	5.4		0.07	1	2.1		0.043	0.41
Uranium-235	15117-96-1	pCi/g	0.34		0.02	0.11	0.096		0.019	0.054	0.13		0.019	0.062	0.11		0.045	0.065	0.26		0.051	0.11	0.13		0.034	0.062
Uranium-238	ARC-U238	pCi/g	6.6		0.044	1.2	1.6		0.046	0.33	2.2		0.037	0.42	1.8		0.052	0.37	6.1		0.052	1.1	2.5		0.043	0.47

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Laydown Yard				Laydown Yard				Laydown Yard				Laydown Yard				Laydown Yard				Laydown Yard			
Location ID			EM-JS02				EM-JS06				EM-JS06				EM-JS06				EM-JS06				EM-JS07			
Sample ID			EM-JS-02-1-3_08012008				EM-JS-06-0-1_08132008				EM-JS-06-10-11_08132008				EM-JS-06-1-3_08132008				EM-JS-06-5-7_08132008				EM-JS-07-0-1_08132008			
Sample Date			8/1/2008				8/13/2008				8/13/2008				8/13/2008				8/13/2008				8/13/2008			
Sample Depth (feet bgs)			1-3				0-1				10-11				1-3				5-7				0-1			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	3		0.44	0.81	2.9		0.53	0.49	1.4	J	0.21	0.38	1.3	J	0.28	0.4	1.8	J	0.44	0.54	4.6		0.29	1.1
Radium-228	15262-20-1	pCi/g	4		2.3	1.7	2.1	J	0.86	0.63	4.6	J	1.4	1.2	1.5		0.8	0.49	1.9	J	0.93	0.67	1.9		0.92	0.58
Uranium-234	13966-29-5	pCi/g	4.5		0.046	0.82	1.9		0.031	0.39	4.4		0.016	0.79	5.5		0.015	0.96	2.4		0.039	0.47	2.8		0.065	0.51
Uranium-235	15117-96-1	pCi/g	0.2		0.021	0.085	0.094		0.036	0.054	0.19		0.049	0.079	0.23		0.018	0.086	0.086		0.019	0.052	0.19		0.064	0.084
Uranium-238	ARC-U238	pCi/g	4.4		0.058	0.81	1.9		0.037	0.38	5		0.037	0.89	5.5		0.035	0.96	2		0.017	0.41	2.5		0.054	0.47

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Laydown Yard				Laydown Yard				Laydown Yard				Laydown Yard				Laydown Yard				Laydown Yard			
Location ID			EM-JS07				EM-JS07				EM-JS07				EM-JS08				EM-JS08				EM-JS08			
Sample ID			EM-JS-07-10-12_08132008				EM-JS-07-1-3_08132008				EM-JS-07-5-7_08132008				EM-JS-08-0-1_08122008				EM-JS-08-10-12_08122008				EM-JS-08-1-3_08122008			
Sample Date			8/13/2008				8/13/2008				8/13/2008				8/12/2008				8/12/2008				8/12/2008			
Sample Depth (feet bgs)			10-12				1-3				5-7				0-1				10-12				1-3			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1.4	J	0.4	0.49	2	J	0.25	0.59	2.3	J	0.36	0.6	1.9		0.43	0.61	3.4	J	0.27	0.86	2.9	J	0.52	0.49
Radium-228	15262-20-1	pCi/g	1.8	J	0.99	0.66	1.6	J	0.99	0.62	2.1	J	1.2	0.78	1.6	J	0.87	0.63	1.8	J	0.96	0.75	1.1	J	0.71	0.6
Uranium-234	13966-29-5	pCi/g	3.6		0.045	0.68	3.2		0.016	0.59	2.8		0.038	0.52	1.2		0.034	0.25	12		0.095	2.1	0.93		0.026	0.18
Uranium-235	15117-96-1	pCi/g	0.12		0.052	0.068	0.16		0.037	0.073	0.14		0.037	0.068	0.055		0.049	0.042	0.57		0.068	0.17	0.042		0.031	0.029
Uranium-238	ARC-U238	pCi/g	3.3		0.037	0.64	3.7		0.031	0.67	2.7		0.032	0.51	1.2		0.072	0.25	12		0.044	2.1	0.97		0.021	0.19

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Laydown Yard				Raffinate Pond				Raffinate Pond				Raffinate Pond				Raffinate Pond				Raffinate Pond			
Location ID			EM-JS08				RA-JS01				RA-JS01				RA-JS01				RA-JS02				RA-JS02			
Sample ID			EM-JS-08-5-7_08122008				RA-JS-01-0-1_08072008				RA-JS-01-1-3_08072008				RA-JS-01-5-7_08072008				RA-JS-02-0-1_08112008				RA-JS-02-1-3_08112008			
Sample Date			8/12/2008				8/7/2008				8/7/2008				8/7/2008				8/11/2008				8/11/2008			
Sample Depth (feet bgs)			5-7				0-1				1-3				5-7				0-1				1-3			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1	J	0.34	0.41	1.4		0.66	0.61	2.1		0.2	0.61	0.9		0.24	0.39	3.4	J	0.85	0.62	1.5		0.35	0.55
Radium-228	15262-20-1	pCi/g	2.5	J	1.1	0.76	< 2.5	U	2.5	1.5	1.9	J	1.4	0.84	1.7	J	1.2	0.64	2	J	1.5	0.75	8.9		2.7	3.1
Uranium-234	13966-29-5	pCi/g	2.8		0.069	0.54	1.6		0.044	0.32	2.9		0.025	0.56	3.3		0.059	0.59	2		0.051	0.4	3.8		0.048	0.7
Uranium-235	15117-96-1	pCi/g	0.22		0.051	0.094	< 0.087	U	0.087	0.052	0.21		0.086	0.11	< 0.16	U	0.16	0.071	< 0.082	U	0.082	0.053	0.19		0.051	0.081
Uranium-238	ARC-U238	pCi/g	2.8		0.058	0.54	1.6		0.053	0.32	3.2		0.073	0.62	3.4		0.039	0.61	2.1		0.034	0.43	3.8		0.063	0.7

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Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Raffinate Pond				Raffinate Pond				Raffinate Pond				Raffinate Pond				Raffinate Pond				Raffinate Pond			
Location ID			RA-JS03				RA-JS03				RA-JS04				RA-JS04				RA-JS05				RA-JS05			
Sample ID			RA-JS-03-0-1_08072008				RA-JS-03-1-3_08072008				RA-JS-04-0-1_08072008				RA-JS-04-1-2.5_08072008				RA-JS-05-0-1_08072008				RA-JS-05-1-3_08072008			
Sample Date			8/7/2008				8/7/2008				8/7/2008				8/7/2008				8/7/2008				8/7/2008			
Sample Depth (feet bgs)			0-1				1-3				0-1				1-2.5				0-1				1-3			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	5.8		0.82	1.5	0.84		0.43	0.36	2.7		0.56	0.47	2.7		0.46	0.8	1.8		0.49	0.65	3.8		0.44	0.95
Radium-228	15262-20-1	pCi/g	2.9	J	1.4	0.88	2.2	J	1.1	0.73	2.4		0.97	0.64	2.6		0.87	0.67	2.6	J	1.5	0.83	3.1		1.5	0.84
Uranium-234	13966-29-5	pCi/g	1.8		0.029	0.32	1.8		0.035	0.35	1.5		0.041	0.3	2		0.039	0.39	3.7		0.015	0.63	3.7		0.027	0.66
Uranium-235	15117-96-1	pCi/g	0.092		0.0092	0.038	< 0.1	U	0.1	0.056	< 0.079	U	0.079	0.049	< 0.083	U	0.083	0.049	0.2		0.052	0.082	< 0.12	U	0.12	0.056
Uranium-238	ARC-U238	pCi/g	1.8		0.0078	0.31	1.9		0.03	0.38	1.6		0.03	0.32	2		0.039	0.39	3.5		0.036	0.6	3.5		0.027	0.62

Appendix A, Table A-5
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Esperanza Mill - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Location Subarea			Raffinate Pond				Raffinate Pond				Raffinate Pond				Raffinate Pond			
Location ID			RA-SD01				RA-SD01				RA-SD02				RA-SD02			
Sample ID			RA-SD-01-0-1.5_08112008				RA-SD-01-1.5-3.0_08112008				RA-SD-02-0-1.5_08112008				RA-SD-02-1.5-3.0_08112008			
Sample Date			8/11/2008				8/11/2008				8/11/2008				8/11/2008			
Sample Depth (feet bgs)			0-1.5				1.5-3				0-1.5				1.5-3			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	3	J	0.47	0.49	3.1	J	0.54	0.52	2.5	J	0.59	0.47	2	J	0.65	0.44
Radium-228	15262-20-1	pCi/g	1.6	J	0.91	0.6	2.4	J	1.2	0.65	1.6	J	1	0.65	1.1	J	1.1	0.6
Uranium-234	13966-29-5	pCi/g	2.3		0.047	0.44	4.2		0.05	0.75	1		0.043	0.22	1.3		0.058	0.28
Uranium-235	15117-96-1	pCi/g	< 0.091	U	0.091	0.052	< 0.2	U	0.2	0.083	< 0.052	U	0.052	0.038	< 0.06	U	0.06	0.043
Uranium-238	ARC-U238	pCi/g	2.3		0.036	0.44	3.9		0.047	0.71	0.92		0.035	0.21	1.2		0.042	0.25

Appendix A, Table A-6
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Former Rhenium Ponds - Radionuclides
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

		Location Subarea	Rhenium Ponds				Rhenium Ponds				Rhenium Ponds				Rhenium Ponds				Rhenium Ponds				Rhenium Ponds				Rhenium Ponds			
		Location ID	RP-JS01				RP-JS01				RP-JS01				RP-JS01				RP-JS02				RP-JS02				RP-JS02			
		Sample ID	RP-JS-01-0-1_08122008				RP-JS-01-10-12_08122008				RP-JS-01-1-3_08122008				RP-JS-01-5-7_08122008				RP-JS-02-10-12_08122008				RP-JS-02-1-3_08122008				RP-JS-02-5-7_08122008			
		Sample Date	8/12/2008				8/12/2008				8/12/2008				8/12/2008				8/12/2008				8/12/2008				8/12/2008			
		Sample Depth (feet bgs)	0-1				10-12				1-3				5-7				10-12				1-3				5-7			
Analyte	CASRN	Units	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU	Result	Qual	MDC	TPU
Radium-226	13982-63-3	pCi/g	1.9		0.49	0.65	2.8	J	0.69	0.53	2.6	J	0.55	0.47	1.6		0.32	0.54	2.5	J	0.49	0.45	2.6		0.43	0.79	1.5		0.65	0.69
Radium-228	15262-20-1	pCi/g	1.4	J	1.1	0.53	1.9	J	1.3	0.77	1.6	J	1.2	0.64	0.82	J	0.77	0.4	1.6	J	1.2	0.66	1.7	J	1	0.74	1.5	J	1.2	0.71
Uranium-234	13966-29-5	pCi/g	1.3		0.043	0.28	1.2		0.016	0.21	1.4		0.041	0.29	0.7		0.063	0.19	3.1		0.054	0.56	1		0.033	0.19	1.3		0.084	0.27
Uranium-235	15117-96-1	pCi/g	< 0.18	U	0.18	0.077	0.057		0.0081	0.027	< 0.084	U	0.084	0.051	< 0.042	U	0.042	0.044	< 0.11	U	0.11	0.058	0.046		0.0096	0.027	< 0.075	U	0.075	0.049
Uranium-238	ARC-U238	pCi/g	1.2		0.032	0.26	1.2		0.0069	0.21	1.2		0.016	0.26	0.8		0.057	0.21	3.2		0.044	0.59	0.94		0.03	0.18	1.4		0.06	0.28

Appendix A, Table A-7
Soil and Sediment Data used to Conduct the Baseline Human Health Risk Assessment
Notes for All Appendix A Tables
Baseline Human Health Risk Assessment
Sierrita Mine, Green Valley, Arizona

Notes

Sources of data presented in this appendix include:

ARCADIS. 2013a. Addendum to the Soil and Sediment Characterization Report. Prepared for Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. August 2013.
ARCADIS. 2013c. Voluntary Remediation Program Former CLEAR Plant Area Soil Excavation and Tier I Screening Risk Evaluation Report. Prepared for Sierrita Mine, Green Valley, Arizona.
ARCADIS. 2015c. Former CLEAR Plant Area Paving Project Soil Excavation and Tier I Screening Risk Evaluation Report. Prepared for Sierrita Mine, Green Valley, Arizona. July 2015.
HGC. 2008. Soil, Surface Water, and Groundwater Sampling in the CLEAR Plant and Esperanza Mill Areas, Prepared for Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. April 2008.
URS. 2012. Voluntary Remediation Program Soil and Sediment Characterization Report, Freeport-McMoRan Sierrita Inc., Green Valley, Arizona. Final. December 2012.

For samples collected in 2004, please see Appendix C of HGC 2008 for additional data qualifiers and associated definitions.

Acronyms and Abbreviations

bgs = below ground surface.
CASRN = Chemical Abstracts Service Registry Number.
MDL = method detection limit.
mg/kg = milligram(s) per kilogram.
NA = not available.
pCi/g = picoCurie(s) per gram.
PQL = practical quantitation limit.
Qual = qualifier.
TPU = total propagated uncertainty.

Qualifier Definitions

J = Analyte concentration detected at a value between MDL and PQL.
U = Analyte was analyzed for but was not detected at the indicated MDL.

APPENDIX B

ProUCL 5.1 Input and Output Files (ProUCL input files are provided electronically on CD)

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (antimony)

General Statistics

Total Number of Observations	116	Number of Distinct Observations	26
Number of Detects	62	Number of Non-Detects	54
Number of Distinct Detects	26	Number of Distinct Non-Detects	2
Minimum Detect	0.2	Minimum Non-Detect	1
Maximum Detect	66	Maximum Non-Detect	2
Variance Detects	112	Percent Non-Detects	46.55%
Mean Detects	3.255	SD Detects	10.58
Median Detects	0.4	CV Detects	3.251
Skewness Detects	5.184	Kurtosis Detects	27.35
Mean of Logged Detects	-0.275	SD of Logged Detects	1.344

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.311	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.386	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.924	KM Standard Error of Mean	0.731
KM SD	7.807	95% KM (BCA) UCL	3.38
95% KM (t) UCL	3.137	95% KM (Percentile Bootstrap) UCL	3.272
95% KM (z) UCL	3.127	95% KM Bootstrap t UCL	7.074
90% KM Chebyshev UCL	4.117	95% KM Chebyshev UCL	5.111
97.5% KM Chebyshev UCL	6.489	99% KM Chebyshev UCL	9.198

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.091	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.829	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.261	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.12	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.445	k star (bias corrected MLE)	0.434
Theta hat (MLE)	7.322	Theta star (bias corrected MLE)	7.503
nu hat (MLE)	55.12	nu star (bias corrected)	53.79
Mean (detects)	3.255		

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.983
Maximum	66	Median	0.3
SD	7.865	CV	3.967
k hat (MLE)	0.291	k star (bias corrected MLE)	0.289
Theta hat (MLE)	6.814	Theta star (bias corrected MLE)	6.856
nu hat (MLE)	67.51	nu star (bias corrected)	67.09
Adjusted Level of Significance (β)	0.0479		
Approximate Chi Square Value (67.09, α)	49.24	Adjusted Chi Square Value (67.09, β)	49.05
95% Gamma Approximate UCL (use when n>=50)	2.702	95% Gamma Adjusted UCL (use when n<50)	2.712

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.924	SD (KM)	7.807
Variance (KM)	60.95	SE of Mean (KM)	0.731
k hat (KM)	0.0608	k star (KM)	0.0649
nu hat (KM)	14.1	nu star (KM)	15.07
theta hat (KM)	31.67	theta star (KM)	29.63
80% gamma percentile (KM)	0.574	90% gamma percentile (KM)	3.9
95% gamma percentile (KM)	10.95	99% gamma percentile (KM)	37.51

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (15.07, α)	7.308	Adjusted Chi Square Value (15.07, β)	7.24
95% Gamma Approximate KM-UCL (use when n>=50)	3.968	95% Gamma Adjusted KM-UCL (use when n<50)	4.005

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.831	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.0443E-9	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.199	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.992	Mean in Log Scale	-0.57
SD in Original Scale	7.831	SD in Log Scale	1.176
95% t UCL (assumes normality of ROS data)	3.198	95% Percentile Bootstrap UCL	3.453
95% BCA Bootstrap UCL	4.047	95% Bootstrap t UCL	6.866
95% H-UCL (Log ROS)	1.467		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.624	KM Geo Mean	0.536
KM SD (logged)	1.085	95% Critical H Value (KM-Log)	2.299
KM Standard Error of Mean (logged)	0.109	95% H-UCL (KM -Log)	1.218
KM SD (logged)	1.085	95% Critical H Value (KM-Log)	2.299
KM Standard Error of Mean (logged)	0.109		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.003	Mean in Log Scale	-0.428
SD in Original Scale	7.826	SD in Log Scale	1.005
95% t UCL (Assumes normality)	3.207	95% H-Stat UCL	1.331

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	5.111

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	226	Number of Distinct Observations	117
Number of Detects	216	Number of Non-Detects	10
Number of Distinct Detects	117	Number of Distinct Non-Detects	1
Minimum Detect	0.7	Minimum Non-Detect	2.5
Maximum Detect	166	Maximum Non-Detect	2.5
Variance Detects	211.1	Percent Non-Detects	4.425%
Mean Detects	8.617	SD Detects	14.53
Median Detects	5.285	CV Detects	1.686
Skewness Detects	7.555	Kurtosis Detects	72.55
Mean of Logged Detects	1.662	SD of Logged Detects	0.925

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.439	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.293	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0607	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	8.303	KM Standard Error of Mean	0.95
KM SD	14.25	95% KM (BCA) UCL	9.982
95% KM (t) UCL	9.872	95% KM (Percentile Bootstrap) UCL	9.933
95% KM (z) UCL	9.865	95% KM Bootstrap t UCL	11.02
90% KM Chebyshev UCL	11.15	95% KM Chebyshev UCL	12.44
97.5% KM Chebyshev UCL	14.24	99% KM Chebyshev UCL	17.75

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.37	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.78	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.105	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0634	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	1.154	k star (bias corrected MLE)	1.141
Theta hat (MLE)	7.466	Theta star (bias corrected MLE)	7.551
nu hat (MLE)	498.6	nu star (bias corrected)	493
Mean (detects)	8.617		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	8.236
Maximum	166	Median	4.805
SD	14.31	CV	1.738
k hat (MLE)	0.817	k star (bias corrected MLE)	0.809
Theta hat (MLE)	10.08	Theta star (bias corrected MLE)	10.18
nu hat (MLE)	369.4	nu star (bias corrected)	365.8
Adjusted Level of Significance (β)	0.0489		
Approximate Chi Square Value (365.81, α)	322.5	Adjusted Chi Square Value (365.81, β)	322.2
95% Gamma Approximate UCL (use when n>=50)	9.343	95% Gamma Adjusted UCL (use when n<50)	9.35

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	8.303	SD (KM)	14.25
Variance (KM)	203	SE of Mean (KM)	0.95
k hat (KM)	0.34	k star (KM)	0.338
nu hat (KM)	153.5	nu star (KM)	152.8
theta hat (KM)	24.45	theta star (KM)	24.56
80% gamma percentile (KM)	13.07	90% gamma percentile (KM)	24.1
95% gamma percentile (KM)	36.53	99% gamma percentile (KM)	68.35

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (152.82, α)	125.2	Adjusted Chi Square Value (152.82, β)	125.1
95% Gamma Approximate KM-UCL (use when n>=50)	10.13	95% Gamma Adjusted KM-UCL (use when n<50)	10.14

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.98	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.31	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0366	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0607	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	8.302	Mean in Log Scale	1.604
SD in Original Scale	14.28	SD in Log Scale	0.946
95% t UCL (assumes normality of ROS data)	9.871	95% Percentile Bootstrap UCL	9.994
95% BCA Bootstrap UCL	10.45	95% Bootstrap t UCL	11
95% H-UCL (Log ROS)	8.885		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.604	KM Geo Mean	4.975
KM SD (logged)	0.943	95% Critical H Value (KM-Log)	2.103
KM Standard Error of Mean (logged)	0.0631	95% H-UCL (KM -Log)	8.857
KM SD (logged)	0.943	95% Critical H Value (KM-Log)	2.103
KM Standard Error of Mean (logged)	0.0631		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	8.291	Mean in Log Scale	1.598
SD in Original Scale	14.28	SD in Log Scale	0.951
95% t UCL (Assumes normality)	9.86	95% H-Stat UCL	8.886

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	8.857

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	226	Number of Distinct Observations	196
		Number of Missing Observations	0
Minimum	27	Mean	3589
Maximum	109000	Median	1560
SD	10024	Std. Error of Mean	666.8
Coefficient of Variation	2.793	Skewness	7.302

Normal GOF Test

Shapiro Wilk Test Statistic	0.313	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.368	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0594	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4690	95% Adjusted-CLT UCL (Chen-1995)	5032
		95% Modified-t UCL (Johnson-1978)	4744

Gamma GOF Test

A-D Test Statistic	13.69	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.803	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.191	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0634	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.684	k star (bias corrected MLE)	0.678
Theta hat (MLE)	5244	Theta star (bias corrected MLE)	5291
nu hat (MLE)	309.3	nu star (bias corrected)	306.6
MLE Mean (bias corrected)	3589	MLE Sd (bias corrected)	4357
		Approximate Chi Square Value (0.05)	267
Adjusted Level of Significance	0.0489	Adjusted Chi Square Value	266.8

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4120	95% Adjusted Gamma UCL (use when n<50)	4124

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0106	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.072	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0594	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.296	Mean of logged Data	7.3
Maximum of Logged Data	11.6	SD of logged Data	1.165

Assuming Lognormal Distribution

95% H-UCL	3486	90% Chebyshev (MVUE) UCL	3765
95% Chebyshev (MVUE) UCL	4156	97.5% Chebyshev (MVUE) UCL	4699
99% Chebyshev (MVUE) UCL	5764		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	4685	95% Jackknife UCL	4690
95% Standard Bootstrap UCL	4666	95% Bootstrap-t UCL	5371
95% Hall's Bootstrap UCL	5407	95% Percentile Bootstrap UCL	4836
95% BCA Bootstrap UCL	5029		
90% Chebyshev(Mean, Sd) UCL	5589	95% Chebyshev(Mean, Sd) UCL	6495
97.5% Chebyshev(Mean, Sd) UCL	7753	99% Chebyshev(Mean, Sd) UCL	10223

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	6495

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	226	Number of Distinct Observations	208
		Number of Missing Observations	0
Minimum	1.2	Mean	100.2
Maximum	3220	Median	19.2
SD	286	Std. Error of Mean	19.02
Coefficient of Variation	2.855	Skewness	7.327

Normal GOF Test

Shapiro Wilk Test Statistic	0.371	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.365	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0594	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	131.6	95% Adjusted-CLT UCL (Chen-1995)	141.4
		95% Modified-t UCL (Johnson-1978)	133.1

Gamma GOF Test

A-D Test Statistic	13.72	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.832	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.198	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0645	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.453	k star (bias corrected MLE)	0.45
Theta hat (MLE)	220.9	Theta star (bias corrected MLE)	222.4
nu hat (MLE)	204.9	nu star (bias corrected)	203.6
MLE Mean (bias corrected)	100.2	MLE Sd (bias corrected)	149.3
		Approximate Chi Square Value (0.05)	171.5
Adjusted Level of Significance	0.0489	Adjusted Chi Square Value	171.4

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	118.9	95% Adjusted Gamma UCL (use when n<50)	119

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.956	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	6.1565E-6	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0717	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0594	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	3.184
Maximum of Logged Data	8.077	SD of logged Data	1.567

Assuming Lognormal Distribution

95% H-UCL	109.3	90% Chebyshev (MVUE) UCL	118.6
95% Chebyshev (MVUE) UCL	135.4	97.5% Chebyshev (MVUE) UCL	158.7
99% Chebyshev (MVUE) UCL	204.5		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	131.5	95% Jackknife UCL	131.6
95% Standard Bootstrap UCL	131.6	95% Bootstrap-t UCL	146.4
95% Hall's Bootstrap UCL	261.7	95% Percentile Bootstrap UCL	132.8
95% BCA Bootstrap UCL	147.3		
90% Chebyshev(Mean, Sd) UCL	157.2	95% Chebyshev(Mean, Sd) UCL	183.1
97.5% Chebyshev(Mean, Sd) UCL	219	99% Chebyshev(Mean, Sd) UCL	289.5

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	183.1

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (molybdenum)

General Statistics

Total Number of Observations	131	Number of Distinct Observations	108
		Number of Missing Observations	0
Minimum	2	Mean	246.4
Maximum	3020	Median	84
SD	518.7	Std. Error of Mean	45.32
Coefficient of Variation	2.105	Skewness	3.829

Normal GOF Test

Shapiro Wilk Test Statistic	0.468	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.319	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0778	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	321.4	95% Adjusted-CLT UCL (Chen-1995)	337.1
		95% Modified-t UCL (Johnson-1978)	324

Gamma GOF Test

A-D Test Statistic	4.367	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.815	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.154	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0859	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.542	k star (bias corrected MLE)	0.535
Theta hat (MLE)	454.3	Theta star (bias corrected MLE)	460.5
nu hat (MLE)	142.1	nu star (bias corrected)	140.2
MLE Mean (bias corrected)	246.4	MLE Sd (bias corrected)	336.8
		Approximate Chi Square Value (0.05)	113.8
Adjusted Level of Significance	0.0482	Adjusted Chi Square Value	113.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	303.4	95% Adjusted Gamma UCL (use when n<50)	304.1

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.145	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0495	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0778	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 9:47:19 AM
From File	**Former CLEAR Plant_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal Statistics

Minimum of Logged Data	0.693	Mean of logged Data	4.35
Maximum of Logged Data	8.013	SD of logged Data	1.552

Assuming Lognormal Distribution

95% H-UCL	375.6	90% Chebyshev (MVUE) UCL	400
95% Chebyshev (MVUE) UCL	466.4	97.5% Chebyshev (MVUE) UCL	558.6
99% Chebyshev (MVUE) UCL	739.7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	320.9	95% Jackknife UCL	321.4
95% Standard Bootstrap UCL	319.2	95% Bootstrap-t UCL	343.5
95% Hall's Bootstrap UCL	333.1	95% Percentile Bootstrap UCL	321.8
95% BCA Bootstrap UCL	346.9		
90% Chebyshev(Mean, Sd) UCL	382.3	95% Chebyshev(Mean, Sd) UCL	443.9
97.5% Chebyshev(Mean, Sd) UCL	529.4	99% Chebyshev(Mean, Sd) UCL	697.3

Suggested UCL to Use

95% H-UCL	375.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (antimony)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	26
Number of Detects	50	Number of Non-Detects	34
Number of Distinct Detects	26	Number of Distinct Non-Detects	2
Minimum Detect	0.2	Minimum Non-Detect	1
Maximum Detect	66	Maximum Non-Detect	2
Variance Detects	136.8	Percent Non-Detects	40.48%
Mean Detects	3.96	SD Detects	11.7
Median Detects	0.6	CV Detects	2.954
Skewness Detects	4.635	Kurtosis Detects	21.64
Mean of Logged Detects	-0.0417	SD of Logged Detects	1.385

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.344	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.374	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.125	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.533	KM Standard Error of Mean	1.003
KM SD	9.1	95% KM (BCA) UCL	4.44
95% KM (t) UCL	4.202	95% KM (Percentile Bootstrap) UCL	4.326
95% KM (z) UCL	4.183	95% KM Bootstrap t UCL	9.822
90% KM Chebyshev UCL	5.542	95% KM Chebyshev UCL	6.906
97.5% KM Chebyshev UCL	8.798	99% KM Chebyshev UCL	12.51

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	5.736	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.825	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.24	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.133	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.455	k star (bias corrected MLE)	0.441
Theta hat (MLE)	8.709	Theta star (bias corrected MLE)	8.985
nu hat (MLE)	45.47	nu star (bias corrected)	44.07
Mean (detects)	3.96		

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	2.491
Maximum	66	Median	0.4
SD	9.177	CV	3.684
k hat (MLE)	0.288	k star (bias corrected MLE)	0.285
Theta hat (MLE)	8.66	Theta star (bias corrected MLE)	8.731
nu hat (MLE)	48.32	nu star (bias corrected)	47.93
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (47.93, α)	33.04	Adjusted Chi Square Value (47.93, β)	32.83
95% Gamma Approximate UCL (use when n>=50)	3.614	95% Gamma Adjusted UCL (use when n<50)	3.637

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.533	SD (KM)	9.1
Variance (KM)	82.81	SE of Mean (KM)	1.003
k hat (KM)	0.0775	k star (KM)	0.0826
nu hat (KM)	13.01	nu star (KM)	13.88
theta hat (KM)	32.7	theta star (KM)	30.65
80% gamma percentile (KM)	1.282	90% gamma percentile (KM)	6.126
95% gamma percentile (KM)	14.75	99% gamma percentile (KM)	44.17

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (13.88, α)	6.491	Adjusted Chi Square Value (13.88, β)	6.403
95% Gamma Approximate KM-UCL (use when n>=50)	5.417	95% Gamma Adjusted KM-UCL (use when n<50)	5.492

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.86	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.176	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.125	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.591	Mean in Log Scale	-0.362
SD in Original Scale	9.144	SD in Log Scale	1.248
95% t UCL (assumes normality of ROS data)	4.251	95% Percentile Bootstrap UCL	4.348
95% BCA Bootstrap UCL	5.082	95% Bootstrap t UCL	9.734
95% H-UCL (Log ROS)	2.134		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.401	KM Geo Mean	0.67
KM SD (logged)	1.175	95% Critical H Value (KM-Log)	2.409
KM Standard Error of Mean (logged)	0.136	95% H-UCL (KM -Log)	1.822
KM SD (logged)	1.175	95% Critical H Value (KM-Log)	2.409
KM Standard Error of Mean (logged)	0.136		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	2.595	Mean in Log Scale	-0.256
SD in Original Scale	9.141	SD in Log Scale	1.109
95% t UCL (Assumes normality)	4.254	95% H-Stat UCL	1.904

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	6.906

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	194	Number of Distinct Observations	108
Number of Detects	184	Number of Non-Detects	10
Number of Distinct Detects	108	Number of Distinct Non-Detects	1
Minimum Detect	0.8	Minimum Non-Detect	2.5
Maximum Detect	166	Maximum Non-Detect	2.5
Variance Detects	240	Percent Non-Detects	5.155%
Mean Detects	9.678	SD Detects	15.49
Median Detects	6	CV Detects	1.601
Skewness Detects	7.138	Kurtosis Detects	63.95
Mean of Logged Detects	1.819	SD of Logged Detects	0.882

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.448	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.283	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0657	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.259	KM Standard Error of Mean	1.091
KM SD	15.15	95% KM (BCA) UCL	11.1
95% KM (t) UCL	11.06	95% KM (Percentile Bootstrap) UCL	11.16
95% KM (z) UCL	11.05	95% KM Bootstrap t UCL	12.58
90% KM Chebyshev UCL	12.53	95% KM Chebyshev UCL	14.01
97.5% KM Chebyshev UCL	16.07	99% KM Chebyshev UCL	20.11

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.791	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.777	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.103	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0694	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	1.248	k star (bias corrected MLE)	1.232
Theta hat (MLE)	7.753	Theta star (bias corrected MLE)	7.858
nu hat (MLE)	459.4	nu star (bias corrected)	453.2
Mean (detects)	9.678		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	9.179
Maximum	166	Median	5.6
SD	15.24	CV	1.66
k hat (MLE)	0.812	k star (bias corrected MLE)	0.803
Theta hat (MLE)	11.31	Theta star (bias corrected MLE)	11.43
nu hat (MLE)	315	nu star (bias corrected)	311.5
Adjusted Level of Significance (β)	0.0488		
Approximate Chi Square Value (311.49, α)	271.6	Adjusted Chi Square Value (311.49, β)	271.3
95% Gamma Approximate UCL (use when n>=50)	10.53	95% Gamma Adjusted UCL (use when n<50)	10.54

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.259	SD (KM)	15.15
Variance (KM)	229.7	SE of Mean (KM)	1.091
k hat (KM)	0.373	k star (KM)	0.371
nu hat (KM)	144.8	nu star (KM)	143.9
theta hat (KM)	24.8	theta star (KM)	24.96
80% gamma percentile (KM)	14.8	90% gamma percentile (KM)	26.49
95% gamma percentile (KM)	39.48	99% gamma percentile (KM)	72.4

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (143.93, α)	117.2	Adjusted Chi Square Value (143.93, β)	117
95% Gamma Approximate KM-UCL (use when n>=50)	11.37	95% Gamma Adjusted KM-UCL (use when n<50)	11.39

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.982	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.471	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0377	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0657	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.257	Mean in Log Scale	1.744
SD in Original Scale	15.19	SD in Log Scale	0.919
95% t UCL (assumes normality of ROS data)	11.06	95% Percentile Bootstrap UCL	11.16
95% BCA Bootstrap UCL	11.87	95% Bootstrap t UCL	12.4
95% H-UCL (Log ROS)	10.03		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.745	KM Geo Mean	5.728
KM SD (logged)	0.915	95% Critical H Value (KM-Log)	2.101
KM Standard Error of Mean (logged)	0.0661	95% H-UCL (KM -Log)	9.993
KM SD (logged)	0.915	95% Critical H Value (KM-Log)	2.101
KM Standard Error of Mean (logged)	0.0661		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	9.243	Mean in Log Scale	1.736
SD in Original Scale	15.2	SD in Log Scale	0.929
95% t UCL (Assumes normality)	11.05	95% H-Stat UCL	10.06

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	9.993

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	194	Number of Distinct Observations	168
		Number of Missing Observations	0
Minimum	110	Mean	4025
Maximum	109000	Median	1705
SD	10753	Std. Error of Mean	772
Coefficient of Variation	2.672	Skewness	6.787

Normal GOF Test

Shapiro Wilk Test Statistic	0.327	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.374	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.064	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	5301	95% Adjusted-CLT UCL (Chen-1995)	5697
		95% Modified-t UCL (Johnson-1978)	5363

Gamma GOF Test

A-D Test Statistic	13.6	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.8	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.205	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.068	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.71	k star (bias corrected MLE)	0.703
Theta hat (MLE)	5665	Theta star (bias corrected MLE)	5726
nu hat (MLE)	275.7	nu star (bias corrected)	272.7
MLE Mean (bias corrected)	4025	MLE Sd (bias corrected)	4800
		Approximate Chi Square Value (0.05)	235.5
Adjusted Level of Significance	0.0488	Adjusted Chi Square Value	235.2

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4661	95% Adjusted Gamma UCL (use when n<50)	4666

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.951	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	3.8258E-6	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0824	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.064	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.7	Mean of logged Data	7.451
Maximum of Logged Data	11.6	SD of logged Data	1.116

Assuming Lognormal Distribution

95% H-UCL	3854	90% Chebyshev (MVUE) UCL	4157
95% Chebyshev (MVUE) UCL	4594	97.5% Chebyshev (MVUE) UCL	5200
99% Chebyshev (MVUE) UCL	6390		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	5295	95% Jackknife UCL	5301
95% Standard Bootstrap UCL	5323	95% Bootstrap-t UCL	6156
95% Hall's Bootstrap UCL	6080	95% Percentile Bootstrap UCL	5367
95% BCA Bootstrap UCL	5900		
90% Chebyshev(Mean, Sd) UCL	6341	95% Chebyshev(Mean, Sd) UCL	7390
97.5% Chebyshev(Mean, Sd) UCL	8846	99% Chebyshev(Mean, Sd) UCL	11706

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	7390

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	194	Number of Distinct Observations	180
		Number of Missing Observations	0
Minimum	1.2	Mean	113.5
Maximum	3220	Median	22.45
SD	306.2	Std. Error of Mean	21.98
Coefficient of Variation	2.699	Skewness	6.843

Normal GOF Test

Shapiro Wilk Test Statistic	0.39	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.357	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.064	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	149.8	95% Adjusted-CLT UCL (Chen-1995)	161.2
		95% Modified-t UCL (Johnson-1978)	151.6

Gamma GOF Test

A-D Test Statistic	11.29	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.827	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.198	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0692	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.475	k star (bias corrected MLE)	0.471
Theta hat (MLE)	238.7	Theta star (bias corrected MLE)	240.7
nu hat (MLE)	184.4	nu star (bias corrected)	182.9
MLE Mean (bias corrected)	113.5	MLE Sd (bias corrected)	165.3
		Approximate Chi Square Value (0.05)	152.6
Adjusted Level of Significance	0.0488	Adjusted Chi Square Value	152.4

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	136	95% Adjusted Gamma UCL (use when n<50)	136.2

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.962	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	8.5239E-4	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0771	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.064	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	3.385
Maximum of Logged Data	8.077	SD of logged Data	1.535

Assuming Lognormal Distribution

95% H-UCL	129	90% Chebyshev (MVUE) UCL	139.4
95% Chebyshev (MVUE) UCL	159.7	97.5% Chebyshev (MVUE) UCL	187.9
99% Chebyshev (MVUE) UCL	243.3		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	149.6	95% Jackknife UCL	149.8
95% Standard Bootstrap UCL	148.5	95% Bootstrap-t UCL	176.5
95% Hall's Bootstrap UCL	272.2	95% Percentile Bootstrap UCL	149.7
95% BCA Bootstrap UCL	165.2		
90% Chebyshev(Mean, Sd) UCL	179.4	95% Chebyshev(Mean, Sd) UCL	209.3
97.5% Chebyshev(Mean, Sd) UCL	250.8	99% Chebyshev(Mean, Sd) UCL	332.2

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	209.3

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (molybdenum)

General Statistics

Total Number of Observations	99	Number of Distinct Observations	89
		Number of Missing Observations	0
Minimum	2	Mean	305.4
Maximum	3020	Median	97
SD	584.3	Std. Error of Mean	58.73
Coefficient of Variation	1.913	Skewness	3.273

Normal GOF Test

Shapiro Wilk Test Statistic	0.517	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.302	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0893	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	403	95% Adjusted-CLT UCL (Chen-1995)	422.7
		95% Modified-t UCL (Johnson-1978)	406.2

Gamma GOF Test

A-D Test Statistic	3.189	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.813	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.14	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0947	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.563	k star (bias corrected MLE)	0.552
Theta hat (MLE)	542.8	Theta star (bias corrected MLE)	552.9
nu hat (MLE)	111.4	nu star (bias corrected)	109.4
MLE Mean (bias corrected)	305.4	MLE Sd (bias corrected)	411
		Approximate Chi Square Value (0.05)	86.23
Adjusted Level of Significance	0.0476	Adjusted Chi Square Value	85.93

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:20:47 AM
From File	**Former CLEAR Plant_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	387.4	95% Adjusted Gamma UCL (use when n<50)	388.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.979	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.493	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0424	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0893	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.693	Mean of logged Data	4.613
Maximum of Logged Data	8.013	SD of logged Data	1.529

Assuming Lognormal Distribution

95% H-UCL	502.6	90% Chebyshev (MVUE) UCL	520.4
95% Chebyshev (MVUE) UCL	612.8	97.5% Chebyshev (MVUE) UCL	741
99% Chebyshev (MVUE) UCL	992.7		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	402	95% Jackknife UCL	403
95% Standard Bootstrap UCL	399.9	95% Bootstrap-t UCL	438
95% Hall's Bootstrap UCL	421.1	95% Percentile Bootstrap UCL	403.5
95% BCA Bootstrap UCL	426.6		
90% Chebyshev(Mean, Sd) UCL	481.6	95% Chebyshev(Mean, Sd) UCL	561.4
97.5% Chebyshev(Mean, Sd) UCL	672.2	99% Chebyshev(Mean, Sd) UCL	889.7

Suggested UCL to Use

95% H-UCL	502.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:53:36 PM
From File	**Former CLEAR Plant_Metals_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	89	Number of Distinct Observations	59
		Number of Missing Observations	0
Minimum	0.7	Mean	7.75
Maximum	166	Median	3.1
SD	20.89	Std. Error of Mean	2.214
Coefficient of Variation	2.695	Skewness	6.276

Normal GOF Test

Shapiro Wilk Test Statistic	0.318	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.368	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0941	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	11.43	95% Adjusted-CLT UCL (Chen-1995)	12.97
		95% Modified-t UCL (Johnson-1978)	11.68

Gamma GOF Test

A-D Test Statistic	7.778	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.794	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.239	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0986	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.742	k star (bias corrected MLE)	0.724
Theta hat (MLE)	10.44	Theta star (bias corrected MLE)	10.7
nu hat (MLE)	132.1	nu star (bias corrected)	129
MLE Mean (bias corrected)	7.75	MLE Sd (bias corrected)	9.105
		Approximate Chi Square Value (0.05)	103.7
Adjusted Level of Significance	0.0473	Adjusted Chi Square Value	103.4

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:53:36 PM
From File	**Former CLEAR Plant_Metals_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	9.636	95% Adjusted Gamma UCL (use when n<50)	9.67

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.913	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	1.8861E-6	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.108	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0941	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.357	Mean of logged Data	1.24
Maximum of Logged Data	5.112	SD of logged Data	1.004

Assuming Lognormal Distribution

95% H-UCL	7.278	90% Chebyshev (MVUE) UCL	7.845
95% Chebyshev (MVUE) UCL	8.828	97.5% Chebyshev (MVUE) UCL	10.19
99% Chebyshev (MVUE) UCL	12.87		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	11.39	95% Jackknife UCL	11.43
95% Standard Bootstrap UCL	11.31	95% Bootstrap-t UCL	18.89
95% Hall's Bootstrap UCL	26.35	95% Percentile Bootstrap UCL	11.77
95% BCA Bootstrap UCL	13.41		
90% Chebyshev(Mean, Sd) UCL	14.39	95% Chebyshev(Mean, Sd) UCL	17.4
97.5% Chebyshev(Mean, Sd) UCL	21.58	99% Chebyshev(Mean, Sd) UCL	29.78

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	17.4

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:53:36 PM
From File	**Former CLEAR Plant_Metals_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	89	Number of Distinct Observations	88
		Number of Missing Observations	0
Minimum	27	Mean	4198
Maximum	59300	Median	1070
SD	10805	Std. Error of Mean	1145
Coefficient of Variation	2.574	Skewness	4.066

Normal GOF Test

Shapiro Wilk Test Statistic	0.388	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.383	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0941	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6102	95% Adjusted-CLT UCL (Chen-1995)	6609
		95% Modified-t UCL (Johnson-1978)	6184

Gamma GOF Test

A-D Test Statistic	7.845	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.818	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.248	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.1	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.503	k star (bias corrected MLE)	0.494
Theta hat (MLE)	8339	Theta star (bias corrected MLE)	8499
nu hat (MLE)	89.6	nu star (bias corrected)	87.91
MLE Mean (bias corrected)	4198	MLE Sd (bias corrected)	5973
		Approximate Chi Square Value (0.05)	67.3
Adjusted Level of Significance	0.0473	Adjusted Chi Square Value	67

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:53:36 PM
From File	**Former CLEAR Plant_Metals_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5484	95% Adjusted Gamma UCL (use when n<50)	5508

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00829	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.103	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0941	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.296	Mean of logged Data	7.082
Maximum of Logged Data	10.99	SD of logged Data	1.392

Assuming Lognormal Distribution

95% H-UCL	4648	90% Chebyshev (MVUE) UCL	4889
95% Chebyshev (MVUE) UCL	5713	97.5% Chebyshev (MVUE) UCL	6856
99% Chebyshev (MVUE) UCL	9102		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	6081	95% Jackknife UCL	6102
95% Standard Bootstrap UCL	6069	95% Bootstrap-t UCL	7237
95% Hall's Bootstrap UCL	6409	95% Percentile Bootstrap UCL	6154
95% BCA Bootstrap UCL	6617		
90% Chebyshev(Mean, Sd) UCL	7634	95% Chebyshev(Mean, Sd) UCL	9190
97.5% Chebyshev(Mean, Sd) UCL	11350	99% Chebyshev(Mean, Sd) UCL	15593

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	9190

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:53:36 PM
From File	**Former CLEAR Plant_Metals_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	89	Number of Distinct Observations	85
		Number of Missing Observations	0
Minimum	1.2	Mean	53.94
Maximum	1820	Median	9.49
SD	205.3	Std. Error of Mean	21.77
Coefficient of Variation	3.807	Skewness	7.675

Normal GOF Test

Shapiro Wilk Test Statistic	0.264	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.399	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0941	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	90.13	95% Adjusted-CLT UCL (Chen-1995)	108.7
		95% Modified-t UCL (Johnson-1978)	93.08

Gamma GOF Test

A-D Test Statistic	8.175	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.834	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.237	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.101	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.439	k star (bias corrected MLE)	0.431
Theta hat (MLE)	123	Theta star (bias corrected MLE)	125.1
nu hat (MLE)	78.07	nu star (bias corrected)	76.78
MLE Mean (bias corrected)	53.94	MLE Sd (bias corrected)	82.14
		Approximate Chi Square Value (0.05)	57.59
Adjusted Level of Significance	0.0473	Adjusted Chi Square Value	57.32

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:53:36 PM
From File	**Former CLEAR Plant_Metals_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	71.91	95% Adjusted Gamma UCL (use when n<50)	72.25

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.94	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	6.3981E-4	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0963	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0941	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	2.51
Maximum of Logged Data	7.507	SD of logged Data	1.422

Assuming Lognormal Distribution

95% H-UCL	50.83	90% Chebyshev (MVUE) UCL	53.27
95% Chebyshev (MVUE) UCL	62.42	97.5% Chebyshev (MVUE) UCL	75.11
99% Chebyshev (MVUE) UCL	100		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	89.75	95% Jackknife UCL	90.13
95% Standard Bootstrap UCL	90.15	95% Bootstrap-t UCL	197.6
95% Hall's Bootstrap UCL	224.4	95% Percentile Bootstrap UCL	93.56
95% BCA Bootstrap UCL	127.7		
90% Chebyshev(Mean, Sd) UCL	119.2	95% Chebyshev(Mean, Sd) UCL	148.8
97.5% Chebyshev(Mean, Sd) UCL	189.9	99% Chebyshev(Mean, Sd) UCL	270.5

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	148.8

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:51:37 PM
From File	**Former CLEAR Plant_Metals_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	195	Number of Distinct Observations	100
Number of Detects	185	Number of Non-Detects	10
Number of Distinct Detects	100	Number of Distinct Non-Detects	1
Minimum Detect	0.7	Minimum Non-Detect	2.5
Maximum Detect	166	Maximum Non-Detect	2.5
Variance Detects	224.9	Percent Non-Detects	5.128%
Mean Detects	8.264	SD Detects	15
Median Detects	5.1	CV Detects	1.815
Skewness Detects	7.971	Kurtosis Detects	75.61
Mean of Logged Detects	1.628	SD of Logged Detects	0.902

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.389	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.307	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0656	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.917	KM Standard Error of Mean	1.052
KM SD	14.64	95% KM (BCA) UCL	9.934
95% KM (t) UCL	9.655	95% KM (Percentile Bootstrap) UCL	9.89
95% KM (z) UCL	9.647	95% KM Bootstrap t UCL	11.58
90% KM Chebyshev UCL	11.07	95% KM Chebyshev UCL	12.5
97.5% KM Chebyshev UCL	14.48	99% KM Chebyshev UCL	18.38

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.937	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.779	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0955	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0692	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:51:37 PM
From File	**Former CLEAR Plant_Metals_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	1.171	k star (bias corrected MLE)	1.155
Theta hat (MLE)	7.058	Theta star (bias corrected MLE)	7.152
nu hat (MLE)	433.2	nu star (bias corrected)	427.5
Mean (detects)	8.264		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	7.841
Maximum	166	Median	4.7
SD	14.72	CV	1.877
k hat (MLE)	0.791	k star (bias corrected MLE)	0.782
Theta hat (MLE)	9.912	Theta star (bias corrected MLE)	10.02
nu hat (MLE)	308.5	nu star (bias corrected)	305.1
Adjusted Level of Significance (β)	0.0488		
Approximate Chi Square Value (305.08, α)	265.6	Adjusted Chi Square Value (305.08, β)	265.4
95% Gamma Approximate UCL (use when n>=50)	9.006	95% Gamma Adjusted UCL (use when n<50)	9.015

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.917	SD (KM)	14.64
Variance (KM)	214.5	SE of Mean (KM)	1.052
k hat (KM)	0.292	k star (KM)	0.291
nu hat (KM)	114	nu star (KM)	113.6
theta hat (KM)	27.09	theta star (KM)	27.19
80% gamma percentile (KM)	12.05	90% gamma percentile (KM)	23.43
95% gamma percentile (KM)	36.56	99% gamma percentile (KM)	70.82

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (113.56, α)	89.96	Adjusted Chi Square Value (113.56, β)	89.8
95% Gamma Approximate KM-UCL (use when n>=50)	9.994	95% Gamma Adjusted KM-UCL (use when n<50)	10.01

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.977	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.19	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0383	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0656	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:51:37 PM
From File	**Former CLEAR Plant_Metals_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.917	Mean in Log Scale	1.562
SD in Original Scale	14.68	SD in Log Scale	0.926
95% t UCL (assumes normality of ROS data)	9.655	95% Percentile Bootstrap UCL	9.807
95% BCA Bootstrap UCL	10.52	95% Bootstrap t UCL	11.67
95% H-UCL (Log ROS)	8.429		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.562	KM Geo Mean	4.769
KM SD (logged)	0.923	95% Critical H Value (KM-Log)	2.109
KM Standard Error of Mean (logged)	0.0666	95% H-UCL (KM -Log)	8.401
KM SD (logged)	0.923	95% Critical H Value (KM-Log)	2.109
KM Standard Error of Mean (logged)	0.0666		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	7.905	Mean in Log Scale	1.556
SD in Original Scale	14.69	SD in Log Scale	0.932
95% t UCL (Assumes normality)	9.643	95% H-Stat UCL	8.427

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	8.401

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:51:37 PM
From File	**Former CLEAR Plant_Metals_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	195	Number of Distinct Observations	176
		Number of Missing Observations	0
Minimum	27	Mean	3851
Maximum	109000	Median	1640
SD	10731	Std. Error of Mean	768.4
Coefficient of Variation	2.786	Skewness	6.837

Normal GOF Test

Shapiro Wilk Test Statistic	0.323	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.374	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0639	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5121	95% Adjusted-CLT UCL (Chen-1995)	5517
		95% Modified-t UCL (Johnson-1978)	5184

Gamma GOF Test

A-D Test Statistic	11.63	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.806	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.182	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.068	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.646	k star (bias corrected MLE)	0.639
Theta hat (MLE)	5961	Theta star (bias corrected MLE)	6022
nu hat (MLE)	251.9	nu star (bias corrected)	249.4
MLE Mean (bias corrected)	3851	MLE Sd (bias corrected)	4816
		Approximate Chi Square Value (0.05)	213.8
Adjusted Level of Significance	0.0488	Adjusted Chi Square Value	213.6

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4491	95% Adjusted Gamma UCL (use when n<50)	4497

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:51:37 PM
From File	**Former CLEAR Plant_Metals_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	0.0531	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0764	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0639	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.296	Mean of logged Data	7.31
Maximum of Logged Data	11.6	SD of logged Data	1.214

Assuming Lognormal Distribution

95% H-UCL	3839	90% Chebyshev (MVUE) UCL	4150
95% Chebyshev (MVUE) UCL	4625	97.5% Chebyshev (MVUE) UCL	5284
99% Chebyshev (MVUE) UCL	6579		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5115	95% Jackknife UCL	5121
95% Standard Bootstrap UCL	5101	95% Bootstrap-t UCL	6058
95% Hall's Bootstrap UCL	5845	95% Percentile Bootstrap UCL	5135
95% BCA Bootstrap UCL	5665		
90% Chebyshev(Mean, Sd) UCL	6156	95% Chebyshev(Mean, Sd) UCL	7201
97.5% Chebyshev(Mean, Sd) UCL	8650	99% Chebyshev(Mean, Sd) UCL	11497

Suggested UCL to Use

95% H-UCL	3839

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:51:37 PM
From File	**Former CLEAR Plant_Metals_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	195	Number of Distinct Observations	182
		Number of Missing Observations	0
Minimum	1.2	Mean	107.9
Maximum	3220	Median	20.3
SD	304.5	Std. Error of Mean	21.8
Coefficient of Variation	2.821	Skewness	6.965

Normal GOF Test

Shapiro Wilk Test Statistic	0.378	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.363	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0639	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	144	95% Adjusted-CLT UCL (Chen-1995)	155.4
		95% Modified-t UCL (Johnson-1978)	145.8

Gamma GOF Test

A-D Test Statistic	11.18	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.834	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.187	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0692	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.446	k star (bias corrected MLE)	0.443
Theta hat (MLE)	242	Theta star (bias corrected MLE)	243.9
nu hat (MLE)	174	nu star (bias corrected)	172.6
MLE Mean (bias corrected)	107.9	MLE Sd (bias corrected)	162.2
		Approximate Chi Square Value (0.05)	143.2
Adjusted Level of Significance	0.0488	Adjusted Chi Square Value	143

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	130.1	95% Adjusted Gamma UCL (use when n<50)	130.3

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:51:37 PM
From File	**Former CLEAR Plant_Metals_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk P Value	2.7069E-4	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0693	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.0639	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	3.232
Maximum of Logged Data	8.077	SD of logged Data	1.602

Assuming Lognormal Distribution

95% H-UCL	125.6	90% Chebyshev (MVUE) UCL	135.4
95% Chebyshev (MVUE) UCL	155.9	97.5% Chebyshev (MVUE) UCL	184.4
99% Chebyshev (MVUE) UCL	240.5		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	143.8	95% Jackknife UCL	144
95% Standard Bootstrap UCL	143.7	95% Bootstrap-t UCL	165.8
95% Hall's Bootstrap UCL	299.6	95% Percentile Bootstrap UCL	147
95% BCA Bootstrap UCL	159.7		
90% Chebyshev(Mean, Sd) UCL	173.4	95% Chebyshev(Mean, Sd) UCL	203
97.5% Chebyshev(Mean, Sd) UCL	244.1	99% Chebyshev(Mean, Sd) UCL	324.9

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	203

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:00:32 AM
From File	**Former CLEAR Plant_Metals_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	40
		Number of Missing Observations	0
Minimum	1.1	Mean	11.79
Maximum	166	Median	3.55
SD	28.43	Std. Error of Mean	4.191
Coefficient of Variation	2.412	Skewness	4.534

Normal GOF Test

Shapiro Wilk Test Statistic	0.383	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.353	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	18.83	95% Adjusted-CLT UCL (Chen-1995)	21.68
		95% Modified-t UCL (Johnson-1978)	19.29

Gamma GOF Test

A-D Test Statistic	5.401	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.797	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.291	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.136	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.675	k star (bias corrected MLE)	0.646
Theta hat (MLE)	17.45	Theta star (bias corrected MLE)	18.25
nu hat (MLE)	62.14	nu star (bias corrected)	59.42
MLE Mean (bias corrected)	11.79	MLE Sd (bias corrected)	14.67
		Approximate Chi Square Value (0.05)	42.7
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	42.24

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:00:32 AM
From File	**Former CLEAR Plant_Metals_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	16.4	95% Adjusted Gamma UCL (use when n<50)	16.58

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.856	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.188	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	1.568
Maximum of Logged Data	5.112	SD of logged Data	1.066

Assuming Lognormal Distribution

95% H-UCL	12.39	90% Chebyshev (MVUE) UCL	12.98
95% Chebyshev (MVUE) UCL	15.09	97.5% Chebyshev (MVUE) UCL	18.03
99% Chebyshev (MVUE) UCL	23.79		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	18.68	95% Jackknife UCL	18.83
95% Standard Bootstrap UCL	18.65	95% Bootstrap-t UCL	36.9
95% Hall's Bootstrap UCL	45.7	95% Percentile Bootstrap UCL	19.12
95% BCA Bootstrap UCL	22.95		
90% Chebyshev(Mean, Sd) UCL	24.36	95% Chebyshev(Mean, Sd) UCL	30.06
97.5% Chebyshev(Mean, Sd) UCL	37.96	99% Chebyshev(Mean, Sd) UCL	53.49

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	30.06

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:00:32 AM
From File	**Former CLEAR Plant_Metals_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	45
		Number of Missing Observations	0
Minimum	207	Mean	5036
Maximum	59300	Median	1555
SD	11230	Std. Error of Mean	1656
Coefficient of Variation	2.23	Skewness	3.814

Normal GOF Test

Shapiro Wilk Test Statistic	0.444	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.367	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	7817	95% Adjusted-CLT UCL (Chen-1995)	8755
		95% Modified-t UCL (Johnson-1978)	7972

Gamma GOF Test

A-D Test Statistic	4.364	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.805	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.282	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.137	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.596	k star (bias corrected MLE)	0.572
Theta hat (MLE)	8444	Theta star (bias corrected MLE)	8805
nu hat (MLE)	54.87	nu star (bias corrected)	52.62
MLE Mean (bias corrected)	5036	MLE Sd (bias corrected)	6659
		Approximate Chi Square Value (0.05)	36.96
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	36.53

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:00:32 AM
From File	**Former CLEAR Plant_Metals_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	7171	95% Adjusted Gamma UCL (use when n<50)	7254

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.158	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.333	Mean of logged Data	7.487
Maximum of Logged Data	10.99	SD of logged Data	1.242

Assuming Lognormal Distribution

95% H-UCL	6248	90% Chebyshev (MVUE) UCL	6318
95% Chebyshev (MVUE) UCL	7480	97.5% Chebyshev (MVUE) UCL	9092
99% Chebyshev (MVUE) UCL	12258		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	7760	95% Jackknife UCL	7817
95% Standard Bootstrap UCL	7774	95% Bootstrap-t UCL	11856
95% Hall's Bootstrap UCL	16980	95% Percentile Bootstrap UCL	7944
95% BCA Bootstrap UCL	9118		
90% Chebyshev(Mean, Sd) UCL	10004	95% Chebyshev(Mean, Sd) UCL	12254
97.5% Chebyshev(Mean, Sd) UCL	15377	99% Chebyshev(Mean, Sd) UCL	21512

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	12254

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:00:32 AM
From File	**Former CLEAR Plant_Metals_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	46	Number of Distinct Observations	46
		Number of Missing Observations	0
Minimum	4	Mean	87.05
Maximum	1820	Median	13.25
SD	280.4	Std. Error of Mean	41.34
Coefficient of Variation	3.221	Skewness	5.649

Normal GOF Test

Shapiro Wilk Test Statistic	0.318	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.384	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.129	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	156.5	95% Adjusted-CLT UCL (Chen-1995)	191.8
		95% Modified-t UCL (Johnson-1978)	162.2

Gamma GOF Test

A-D Test Statistic	4.937	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.828	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.258	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.139	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.441	k star (bias corrected MLE)	0.427
Theta hat (MLE)	197.3	Theta star (bias corrected MLE)	203.9
nu hat (MLE)	40.58	nu star (bias corrected)	39.27
MLE Mean (bias corrected)	87.05	MLE Sd (bias corrected)	133.2
		Approximate Chi Square Value (0.05)	25.92
Adjusted Level of Significance	0.0448	Adjusted Chi Square Value	25.56

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:00:32 AM
From File	**Former CLEAR Plant_Metals_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	131.9	95% Adjusted Gamma UCL (use when n<50)	133.7

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.881	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.945	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.141	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.129	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.386	Mean of logged Data	2.998
Maximum of Logged Data	7.507	SD of logged Data	1.418

Assuming Lognormal Distribution

95% H-UCL	99.18	90% Chebyshev (MVUE) UCL	95.19
95% Chebyshev (MVUE) UCL	114.5	97.5% Chebyshev (MVUE) UCL	141.3
99% Chebyshev (MVUE) UCL	194		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	155	95% Jackknife UCL	156.5
95% Standard Bootstrap UCL	155.4	95% Bootstrap-t UCL	429.5
95% Hall's Bootstrap UCL	414.5	95% Percentile Bootstrap UCL	164
95% BCA Bootstrap UCL	219.8		
90% Chebyshev(Mean, Sd) UCL	211.1	95% Chebyshev(Mean, Sd) UCL	267.2
97.5% Chebyshev(Mean, Sd) UCL	345.2	99% Chebyshev(Mean, Sd) UCL	498.4

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	267.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:03:08 AM
From File	**Former CLEAR Plant_Metals_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	149	Number of Distinct Observations	86
Number of Detects	139	Number of Non-Detects	10
Number of Distinct Detects	86	Number of Distinct Non-Detects	1
Minimum Detect	1.1	Minimum Non-Detect	2.5
Maximum Detect	166	Maximum Non-Detect	2.5
Variance Detects	285.5	Percent Non-Detects	6.711%
Mean Detects	9.726	SD Detects	16.9
Median Detects	6.2	CV Detects	1.737
Skewness Detects	7.202	Kurtosis Detects	60.1
Mean of Logged Detects	1.85	SD of Logged Detects	0.806

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.387	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.306	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0755	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.199	KM Standard Error of Mean	1.347
KM SD	16.38	95% KM (BCA) UCL	11.49
95% KM (t) UCL	11.43	95% KM (Percentile Bootstrap) UCL	11.65
95% KM (z) UCL	11.41	95% KM Bootstrap t UCL	14.7
90% KM Chebyshev UCL	13.24	95% KM Chebyshev UCL	15.07
97.5% KM Chebyshev UCL	17.61	99% KM Chebyshev UCL	22.6

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.481	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.775	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.128	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0812	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	1.317	k star (bias corrected MLE)	1.294
Theta hat (MLE)	7.384	Theta star (bias corrected MLE)	7.519
nu hat (MLE)	366.2	nu star (bias corrected)	359.6
Mean (detects)	9.726		

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:03:08 AM
From File	**Former CLEAR Plant_Metals_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	9.074
Maximum	166	Median	5.6
SD	16.5	CV	1.818
k hat (MLE)	0.758	k star (bias corrected MLE)	0.747
Theta hat (MLE)	11.98	Theta star (bias corrected MLE)	12.15
nu hat (MLE)	225.8	nu star (bias corrected)	222.5
Adjusted Level of Significance (β)	0.0484		
Approximate Chi Square Value (222.54, α)	189	Adjusted Chi Square Value (222.54, β)	188.7
95% Gamma Approximate UCL (use when n>=50)	10.68	95% Gamma Adjusted UCL (use when n<50)	10.7

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.199	SD (KM)	16.38
Variance (KM)	268.3	SE of Mean (KM)	1.347
k hat (KM)	0.315	k star (KM)	0.313
nu hat (KM)	93.98	nu star (KM)	93.42
theta hat (KM)	29.17	theta star (KM)	29.34
80% gamma percentile (KM)	14.25	90% gamma percentile (KM)	26.98
95% gamma percentile (KM)	41.49	99% gamma percentile (KM)	78.98

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (93.42, α)	72.13	Adjusted Chi Square Value (93.42, β)	71.95
95% Gamma Approximate KM-UCL (use when n>=50)	11.91	95% Gamma Adjusted KM-UCL (use when n<50)	11.94

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.963	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0109	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.062	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0755	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:03:08 AM
From File	**Former CLEAR Plant_Metals_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.181	Mean in Log Scale	1.754
SD in Original Scale	16.44	SD in Log Scale	0.86
95% t UCL (assumes normality of ROS data)	11.41	95% Percentile Bootstrap UCL	11.47
95% BCA Bootstrap UCL	12.54	95% Bootstrap t UCL	14.5
95% H-UCL (Log ROS)	9.688		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.766	KM Geo Mean	5.847
KM SD (logged)	0.838	95% Critical H Value (KM-Log)	2.064
KM Standard Error of Mean (logged)	0.0692	95% H-UCL (KM -Log)	9.575
KM SD (logged)	0.838	95% Critical H Value (KM-Log)	2.064
KM Standard Error of Mean (logged)	0.0692		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	9.158	Mean in Log Scale	1.74
SD in Original Scale	16.46	SD in Log Scale	0.879
95% t UCL (Assumes normality)	11.39	95% H-Stat UCL	9.762

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	9.575

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:03:08 AM
From File	**Former CLEAR Plant_Metals_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	149	Number of Distinct Observations	133
		Number of Missing Observations	0
Minimum	133	Mean	4048
Maximum	109000	Median	1800
SD	10957	Std. Error of Mean	897.6
Coefficient of Variation	2.707	Skewness	7.355

Normal GOF Test

Shapiro Wilk Test Statistic	0.312	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.375	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.073	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5533	95% Adjusted-CLT UCL (Chen-1995)	6102
		95% Modified-t UCL (Johnson-1978)	5624

Gamma GOF Test

A-D Test Statistic	9.627	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.795	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.195	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0798	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.752	k star (bias corrected MLE)	0.742
Theta hat (MLE)	5381	Theta star (bias corrected MLE)	5458
nu hat (MLE)	224.2	nu star (bias corrected)	221
MLE Mean (bias corrected)	4048	MLE Sd (bias corrected)	4700
		Approximate Chi Square Value (0.05)	187.6
Adjusted Level of Significance	0.0484	Adjusted Chi Square Value	187.3

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:03:08 AM
From File	**Former CLEAR Plant_Metals_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4769	95% Adjusted Gamma UCL (use when n<50)	4776

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00284	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0838	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.073	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.89	Mean of logged Data	7.51
Maximum of Logged Data	11.6	SD of logged Data	1.07

Assuming Lognormal Distribution

95% H-UCL	3953	90% Chebyshev (MVUE) UCL	4262
95% Chebyshev (MVUE) UCL	4735	97.5% Chebyshev (MVUE) UCL	5391
99% Chebyshev (MVUE) UCL	6680		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	5524	95% Jackknife UCL	5533
95% Standard Bootstrap UCL	5523	95% Bootstrap-t UCL	7362
95% Hall's Bootstrap UCL	10725	95% Percentile Bootstrap UCL	5534
95% BCA Bootstrap UCL	6224		
90% Chebyshev(Mean, Sd) UCL	6741	95% Chebyshev(Mean, Sd) UCL	7960
97.5% Chebyshev(Mean, Sd) UCL	9653	99% Chebyshev(Mean, Sd) UCL	12979

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	7960

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:03:08 AM
From File	**Former CLEAR Plant_Metals_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	149	Number of Distinct Observations	142
		Number of Missing Observations	0
Minimum	2.7	Mean	135.6
Maximum	3220	Median	33.1
SD	343.2	Std. Error of Mean	28.12
Coefficient of Variation	2.531	Skewness	6.157

Normal GOF Test

Shapiro Wilk Test Statistic	0.416	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.349	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.073	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	182.2	95% Adjusted-CLT UCL (Chen-1995)	197
		95% Modified-t UCL (Johnson-1978)	184.5

Gamma GOF Test

A-D Test Statistic	8.091	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.822	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.182	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0814	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.489	k star (bias corrected MLE)	0.484
Theta hat (MLE)	277.1	Theta star (bias corrected MLE)	280.2
nu hat (MLE)	145.8	nu star (bias corrected)	144.2
MLE Mean (bias corrected)	135.6	MLE Sd (bias corrected)	194.9
		Approximate Chi Square Value (0.05)	117.5
Adjusted Level of Significance	0.0484	Adjusted Chi Square Value	117.3

ProUCL 5.1 Former CLEAR Plant Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:03:08 AM
From File	**Former CLEAR Plant_Metals_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	166.5	95% Adjusted Gamma UCL (use when n<50)	166.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	3.3820E-5	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0855	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.073	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.993	Mean of logged Data	3.608
Maximum of Logged Data	8.077	SD of logged Data	1.519

Assuming Lognormal Distribution

95% H-UCL	164.5	90% Chebyshev (MVUE) UCL	175.9
95% Chebyshev (MVUE) UCL	203.4	97.5% Chebyshev (MVUE) UCL	241.7
99% Chebyshev (MVUE) UCL	316.8		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	181.9	95% Jackknife UCL	182.2
95% Standard Bootstrap UCL	181.9	95% Bootstrap-t UCL	219.3
95% Hall's Bootstrap UCL	373.6	95% Percentile Bootstrap UCL	187.4
95% BCA Bootstrap UCL	204.2		
90% Chebyshev(Mean, Sd) UCL	220	95% Chebyshev(Mean, Sd) UCL	258.2
97.5% Chebyshev(Mean, Sd) UCL	311.2	99% Chebyshev(Mean, Sd) UCL	415.4

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	258.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	38
Number of Detects	80	Number of Non-Detects	2
Number of Distinct Detects	36	Number of Distinct Non-Detects	2
Minimum Detect	0.43	Minimum Non-Detect	0.4
Maximum Detect	5.3	Maximum Non-Detect	0.84
Variance Detects	1.116	Percent Non-Detects	2.439%
Mean Detects	2.243	SD Detects	1.056
Median Detects	2.15	CV Detects	0.471
Skewness Detects	0.939	Kurtosis Detects	1.249
Mean of Logged Detects	0.689	SD of Logged Detects	0.52

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.925	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	9.3872E-5	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.105	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.2	KM Standard Error of Mean	0.119
KM SD	1.072	95% KM (BCA) UCL	2.38
95% KM (t) UCL	2.398	95% KM (Percentile Bootstrap) UCL	2.396
95% KM (z) UCL	2.396	95% KM Bootstrap t UCL	2.416
90% KM Chebyshev UCL	2.557	95% KM Chebyshev UCL	2.719
97.5% KM Chebyshev UCL	2.944	99% KM Chebyshev UCL	3.385

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.678	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.756	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0805	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.1	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.371	k star (bias corrected MLE)	4.215
Theta hat (MLE)	0.513	Theta star (bias corrected MLE)	0.532
nu hat (MLE)	699.3	nu star (bias corrected)	674.5
Mean (detects)	2.243		

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.364	Mean	2.201
Maximum	5.3	Median	2.1
SD	1.076	CV	0.489
k hat (MLE)	3.915	k star (bias corrected MLE)	3.78
Theta hat (MLE)	0.562	Theta star (bias corrected MLE)	0.582
nu hat (MLE)	642	nu star (bias corrected)	619.9
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (619.89, α)	563.1	Adjusted Chi Square Value (619.89, β)	562.2
95% Gamma Approximate UCL (use when n>=50)	2.423	95% Gamma Adjusted UCL (use when n<50)	2.427

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.2	SD (KM)	1.072
Variance (KM)	1.149	SE of Mean (KM)	0.119
k hat (KM)	4.209	k star (KM)	4.064
nu hat (KM)	690.3	nu star (KM)	666.4
theta hat (KM)	0.523	theta star (KM)	0.541
80% gamma percentile (KM)	3.027	90% gamma percentile (KM)	3.662
95% gamma percentile (KM)	4.246	99% gamma percentile (KM)	5.492

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (666.42, α)	607.5	Adjusted Chi Square Value (666.42, β)	606.5
95% Gamma Approximate KM-UCL (use when n>=50)	2.413	95% Gamma Adjusted KM-UCL (use when n<50)	2.417

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.941	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.00189	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0991	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.204	Mean in Log Scale	0.661
SD in Original Scale	1.073	SD in Log Scale	0.545
95% t UCL (assumes normality of ROS data)	2.401	95% Percentile Bootstrap UCL	2.408
95% BCA Bootstrap UCL	2.414	95% Bootstrap t UCL	2.421
95% H-UCL (Log ROS)	2.515		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.654	KM Geo Mean	1.922
KM SD (logged)	0.558	95% Critical H Value (KM-Log)	1.879
KM Standard Error of Mean (logged)	0.0621	95% H-UCL (KM -Log)	2.524
KM SD (logged)	0.558	95% Critical H Value (KM-Log)	1.879
KM Standard Error of Mean (logged)	0.0621		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.195	Mean in Log Scale	0.642
SD in Original Scale	1.086	SD in Log Scale	0.597
95% t UCL (Assumes normality)	2.395	95% H-Stat UCL	2.577

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	2.413	95% GROS Approximate Gamma UCL	2.423

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	1.2	Mean	2.261
Maximum	7.6	Median	2.1
SD	0.847	Std. Error of Mean	0.0935
Coefficient of Variation	0.375	Skewness	3.385

Normal GOF Test

Shapiro Wilk Test Statistic	0.764	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.098	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.417	95% Adjusted-CLT UCL (Chen-1995)	2.452
		95% Modified-t UCL (Johnson-1978)	2.422

Gamma GOF Test

A-D Test Statistic	1.163	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.101	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0986	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.32	k star (bias corrected MLE)	9.948
Theta hat (MLE)	0.219	Theta star (bias corrected MLE)	0.227
nu hat (MLE)	1692	nu star (bias corrected)	1632
MLE Mean (bias corrected)	2.261	MLE Sd (bias corrected)	0.717
		Approximate Chi Square Value (0.05)	1539
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	1537

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.397	95% Adjusted Gamma UCL (use when n<50)	2.4

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0264	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0816	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.098	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	0.767
Maximum of Logged Data	2.028	SD of logged Data	0.299

Assuming Lognormal Distribution

95% H-UCL	2.384	90% Chebyshev (MVUE) UCL	2.476
95% Chebyshev (MVUE) UCL	2.579	97.5% Chebyshev (MVUE) UCL	2.722
99% Chebyshev (MVUE) UCL	3.002		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.415	95% Jackknife UCL	2.417
95% Standard Bootstrap UCL	2.412	95% Bootstrap-t UCL	2.461
95% Hall's Bootstrap UCL	2.57	95% Percentile Bootstrap UCL	2.43
95% BCA Bootstrap UCL	2.446		
90% Chebyshev(Mean, Sd) UCL	2.542	95% Chebyshev(Mean, Sd) UCL	2.669
97.5% Chebyshev(Mean, Sd) UCL	2.845	99% Chebyshev(Mean, Sd) UCL	3.192

Suggested UCL to Use

95% Student's-t UCL	2.417	or 95% Modified-t UCL	2.422
or 95% H-UCL	2.384		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-234)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	36
		Number of Missing Observations	0
Minimum	0.84	Mean	2.511
Maximum	12	Median	2.2
SD	1.486	Std. Error of Mean	0.164
Coefficient of Variation	0.592	Skewness	3.703

Normal GOF Test

Shapiro Wilk Test Statistic	0.712	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.193	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.098	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.784	95% Adjusted-CLT UCL (Chen-1995)	2.853
		95% Modified-t UCL (Johnson-1978)	2.795

Gamma GOF Test

A-D Test Statistic	1.62	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.125	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0989	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.675	k star (bias corrected MLE)	4.512
Theta hat (MLE)	0.537	Theta star (bias corrected MLE)	0.557
nu hat (MLE)	766.7	nu star (bias corrected)	740
MLE Mean (bias corrected)	2.511	MLE Sd (bias corrected)	1.182
		Approximate Chi Square Value (0.05)	677.8
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	676.8

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.741	95% Adjusted Gamma UCL (use when n<50)	2.745

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.967	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.133	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0956	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.098	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.174	Mean of logged Data	0.81
Maximum of Logged Data	2.485	SD of logged Data	0.448

Assuming Lognormal Distribution

95% H-UCL	2.719	90% Chebyshev (MVUE) UCL	2.865
95% Chebyshev (MVUE) UCL	3.039	97.5% Chebyshev (MVUE) UCL	3.281
99% Chebyshev (MVUE) UCL	3.755		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.781	95% Jackknife UCL	2.784
95% Standard Bootstrap UCL	2.783	95% Bootstrap-t UCL	2.879
95% Hall's Bootstrap UCL	3.057	95% Percentile Bootstrap UCL	2.792
95% BCA Bootstrap UCL	2.869		
90% Chebyshev(Mean, Sd) UCL	3.003	95% Chebyshev(Mean, Sd) UCL	3.226
97.5% Chebyshev(Mean, Sd) UCL	3.536	99% Chebyshev(Mean, Sd) UCL	4.143

Suggested UCL to Use

95% Student's-t UCL	2.784	or 95% Modified-t UCL	2.795
or 95% H-UCL	2.719		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	40
Number of Detects	63	Number of Non-Detects	19
Number of Distinct Detects	32	Number of Distinct Non-Detects	15
Minimum Detect	0.02	Minimum Non-Detect	0.039
Maximum Detect	0.74	Maximum Non-Detect	0.23
Variance Detects	0.0111	Percent Non-Detects	23.17%
Mean Detects	0.157	SD Detects	0.105
Median Detects	0.14	CV Detects	0.671
Skewness Detects	2.991	Kurtosis Detects	14.37
Mean of Logged Detects	-2.021	SD of Logged Detects	0.592

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.779	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	1.426E-12	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.15	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.136	KM Standard Error of Mean	0.0114
KM SD	0.101	95% KM (BCA) UCL	0.157
95% KM (t) UCL	0.155	95% KM (Percentile Bootstrap) UCL	0.157
95% KM (z) UCL	0.155	95% KM Bootstrap t UCL	0.16
90% KM Chebyshev UCL	0.17	95% KM Chebyshev UCL	0.186
97.5% KM Chebyshev UCL	0.208	99% KM Chebyshev UCL	0.25

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.484	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.758	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0829	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.113	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.096	k star (bias corrected MLE)	2.959
Theta hat (MLE)	0.0508	Theta star (bias corrected MLE)	0.0531
nu hat (MLE)	390.1	nu star (bias corrected)	372.8
Mean (detects)	0.157		

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.133
Maximum	0.74	Median	0.11
SD	0.104	CV	0.778
k hat (MLE)	1.98	k star (bias corrected MLE)	1.916
Theta hat (MLE)	0.0673	Theta star (bias corrected MLE)	0.0695
nu hat (MLE)	324.7	nu star (bias corrected)	314.2
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (314.15, α)	274.1	Adjusted Chi Square Value (314.15, β)	273.4
95% Gamma Approximate UCL (use when n>=50)	0.153	95% Gamma Adjusted UCL (use when n<50)	0.153

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.136	SD (KM)	0.101
Variance (KM)	0.0103	SE of Mean (KM)	0.0114
k hat (KM)	1.805	k star (KM)	1.747
nu hat (KM)	296	nu star (KM)	286.5
theta hat (KM)	0.0754	theta star (KM)	0.0779
80% gamma percentile (KM)	0.207	90% gamma percentile (KM)	0.273
95% gamma percentile (KM)	0.337	99% gamma percentile (KM)	0.48

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (286.53, α)	248.3	Adjusted Chi Square Value (286.53, β)	247.7
95% Gamma Approximate KM-UCL (use when n>=50)	0.157	95% Gamma Adjusted KM-UCL (use when n<50)	0.158

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.987	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.906	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0649	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.111	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.136	Mean in Log Scale	-2.19
SD in Original Scale	0.1	SD in Log Scale	0.627
95% t UCL (assumes normality of ROS data)	0.155	95% Percentile Bootstrap UCL	0.156
95% BCA Bootstrap UCL	0.159	95% Bootstrap t UCL	0.16
95% H-UCL (Log ROS)	0.156		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.228	KM Geo Mean	0.108
KM SD (logged)	0.714	95% Critical H Value (KM-Log)	2.009
KM Standard Error of Mean (logged)	0.0869	95% H-UCL (KM -Log)	0.163
KM SD (logged)	0.714	95% Critical H Value (KM-Log)	2.009
KM Standard Error of Mean (logged)	0.0869		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.135	Mean in Log Scale	-2.234
SD in Original Scale	0.102	SD in Log Scale	0.694
95% t UCL (Assumes normality)	0.153	95% H-Stat UCL	0.159

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.157	95% GROS Approximate Gamma UCL	0.153

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	34
		Number of Missing Observations	0
Minimum	0.84	Mean	2.591
Maximum	12	Median	2.2
SD	1.509	Std. Error of Mean	0.167
Coefficient of Variation	0.582	Skewness	3.51

Normal GOF Test

Shapiro Wilk Test Statistic	0.727	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.098	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.868	95% Adjusted-CLT UCL (Chen-1995)	2.934
		95% Modified-t UCL (Johnson-1978)	2.879

Gamma GOF Test

A-D Test Statistic	1.487	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.131	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0989	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.712	k star (bias corrected MLE)	4.548
Theta hat (MLE)	0.55	Theta star (bias corrected MLE)	0.57
nu hat (MLE)	772.8	nu star (bias corrected)	745.8
MLE Mean (bias corrected)	2.591	MLE Sd (bias corrected)	1.215
		Approximate Chi Square Value (0.05)	683.5
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	682.4

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:08:59 AM
From File	**Former CLEAR Plant_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.827	95% Adjusted Gamma UCL (use when n<50)	2.832

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.972	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.256	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.098	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.174	Mean of logged Data	0.842
Maximum of Logged Data	2.485	SD of logged Data	0.446

Assuming Lognormal Distribution

95% H-UCL	2.806	90% Chebyshev (MVUE) UCL	2.956
95% Chebyshev (MVUE) UCL	3.136	97.5% Chebyshev (MVUE) UCL	3.384
99% Chebyshev (MVUE) UCL	3.872		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.865	95% Jackknife UCL	2.868
95% Standard Bootstrap UCL	2.865	95% Bootstrap-t UCL	2.957
95% Hall's Bootstrap UCL	3.1	95% Percentile Bootstrap UCL	2.873
95% BCA Bootstrap UCL	2.952		
90% Chebyshev(Mean, Sd) UCL	3.091	95% Chebyshev(Mean, Sd) UCL	3.317
97.5% Chebyshev(Mean, Sd) UCL	3.631	99% Chebyshev(Mean, Sd) UCL	4.249

Suggested UCL to Use

95% Student's-t UCL	2.868	or 95% Modified-t UCL	2.879
or 95% H-UCL	2.806		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	35
Number of Detects	52	Number of Non-Detects	2
Number of Distinct Detects	33	Number of Distinct Non-Detects	2
Minimum Detect	0.43	Minimum Non-Detect	0.4
Maximum Detect	5.3	Maximum Non-Detect	0.84
Variance Detects	1.452	Percent Non-Detects	3.704%
Mean Detects	2.34	SD Detects	1.205
Median Detects	2.15	CV Detects	0.515
Skewness Detects	0.884	Kurtosis Detects	0.403
Mean of Logged Detects	0.711	SD of Logged Detects	0.563

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.921	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.00192	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.126	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.122	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.27	KM Standard Error of Mean	0.168
KM SD	1.225	95% KM (BCA) UCL	2.544
95% KM (t) UCL	2.552	95% KM (Percentile Bootstrap) UCL	2.549
95% KM (z) UCL	2.547	95% KM Bootstrap t UCL	2.578
90% KM Chebyshev UCL	2.775	95% KM Chebyshev UCL	3.004
97.5% KM Chebyshev UCL	3.321	99% KM Chebyshev UCL	3.945

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.278	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0639	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.124	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	3.743	k star (bias corrected MLE)	3.54
Theta hat (MLE)	0.625	Theta star (bias corrected MLE)	0.661
nu hat (MLE)	389.2	nu star (bias corrected)	368.1
Mean (detects)	2.34		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.269	Mean	2.269
Maximum	5.3	Median	2.1
SD	1.238	CV	0.546
k hat (MLE)	3.101	k star (bias corrected MLE)	2.941
Theta hat (MLE)	0.732	Theta star (bias corrected MLE)	0.771
nu hat (MLE)	334.9	nu star (bias corrected)	317.6
Adjusted Level of Significance (β)	0.0456		
Approximate Chi Square Value (317.65, α)	277.4	Adjusted Chi Square Value (317.65, β)	276.3
95% Gamma Approximate UCL (use when n>=50)	2.599	95% Gamma Adjusted UCL (use when n<50)	2.608

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.27	SD (KM)	1.225
Variance (KM)	1.501	SE of Mean (KM)	0.168
k hat (KM)	3.432	k star (KM)	3.254
nu hat (KM)	370.7	nu star (KM)	351.4
theta hat (KM)	0.661	theta star (KM)	0.698
80% gamma percentile (KM)	3.206	90% gamma percentile (KM)	3.957
95% gamma percentile (KM)	4.655	99% gamma percentile (KM)	6.16

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (351.44, α)	309	Adjusted Chi Square Value (351.44, β)	307.9
95% Gamma Approximate KM-UCL (use when n>=50)	2.582	95% Gamma Adjusted KM-UCL (use when n<50)	2.591

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.953	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0733	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0866	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.122	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.275	Mean in Log Scale	0.664
SD in Original Scale	1.229	SD in Log Scale	0.603
95% t UCL (assumes normality of ROS data)	2.555	95% Percentile Bootstrap UCL	2.556
95% BCA Bootstrap UCL	2.558	95% Bootstrap t UCL	2.585
95% H-UCL (Log ROS)	2.74		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.653	KM Geo Mean	1.922
KM SD (logged)	0.621	95% Critical H Value (KM-Log)	1.967
KM Standard Error of Mean (logged)	0.0854	95% H-UCL (KM -Log)	2.756
KM SD (logged)	0.621	95% Critical H Value (KM-Log)	1.967
KM Standard Error of Mean (logged)	0.0854		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.265	Mean in Log Scale	0.639
SD in Original Scale	1.244	SD in Log Scale	0.669
95% t UCL (Assumes normality)	2.548	95% H-Stat UCL	2.849

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	2.582	95% GROS Approximate Gamma UCL	2.599

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	1.2	Mean	2.296
Maximum	7.6	Median	2.1
SD	0.973	Std. Error of Mean	0.132
Coefficient of Variation	0.424	Skewness	3.355

Normal GOF Test

Shapiro Wilk Test Statistic	0.723	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	7.974E-13	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.213	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.12	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.518	95% Adjusted-CLT UCL (Chen-1995)	2.579
		95% Modified-t UCL (Johnson-1978)	2.528

Gamma GOF Test

A-D Test Statistic	1.415	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.153	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.121	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.603	k star (bias corrected MLE)	8.137
Theta hat (MLE)	0.267	Theta star (bias corrected MLE)	0.282
nu hat (MLE)	929.1	nu star (bias corrected)	878.8
MLE Mean (bias corrected)	2.296	MLE Sd (bias corrected)	0.805
		Approximate Chi Square Value (0.05)	811
Adjusted Level of Significance	0.0456	Adjusted Chi Square Value	809.3

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.488	95% Adjusted Gamma UCL (use when n<50)	2.494

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.936	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00944	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.124	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.12	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	0.772
Maximum of Logged Data	2.028	SD of logged Data	0.324

Assuming Lognormal Distribution

95% H-UCL	2.462	90% Chebyshev (MVUE) UCL	2.586
95% Chebyshev (MVUE) UCL	2.726	97.5% Chebyshev (MVUE) UCL	2.919
99% Chebyshev (MVUE) UCL	3.299		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2.514	95% Jackknife UCL	2.518
95% Standard Bootstrap UCL	2.511	95% Bootstrap-t UCL	2.634
95% Hall's Bootstrap UCL	2.921	95% Percentile Bootstrap UCL	2.528
95% BCA Bootstrap UCL	2.581		
90% Chebyshev(Mean, Sd) UCL	2.694	95% Chebyshev(Mean, Sd) UCL	2.873
97.5% Chebyshev(Mean, Sd) UCL	3.123	99% Chebyshev(Mean, Sd) UCL	3.614

Suggested UCL to Use

95% Student's-t UCL	2.518	or 95% Modified-t UCL	2.528

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-234)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	31
		Number of Missing Observations	0
Minimum	0.84	Mean	2.68
Maximum	12	Median	2.35
SD	1.688	Std. Error of Mean	0.23
Coefficient of Variation	0.63	Skewness	3.584

Normal GOF Test

Shapiro Wilk Test Statistic	0.684	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.021E-14	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.24	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.12	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.065	95% Adjusted-CLT UCL (Chen-1995)	3.178
		95% Modified-t UCL (Johnson-1978)	3.083

Gamma GOF Test

A-D Test Statistic	1.575	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.16	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.121	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.235	k star (bias corrected MLE)	4.012
Theta hat (MLE)	0.633	Theta star (bias corrected MLE)	0.668
nu hat (MLE)	457.3	nu star (bias corrected)	433.3
MLE Mean (bias corrected)	2.68	MLE Sd (bias corrected)	1.338
		Approximate Chi Square Value (0.05)	386
Adjusted Level of Significance	0.0456	Adjusted Chi Square Value	384.8

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.008	95% Adjusted Gamma UCL (use when n<50)	3.018

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0438	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.124	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.12	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.174	Mean of logged Data	0.863
Maximum of Logged Data	2.485	SD of logged Data	0.473

Assuming Lognormal Distribution

95% H-UCL	2.994	90% Chebyshev (MVUE) UCL	3.18
95% Chebyshev (MVUE) UCL	3.422	97.5% Chebyshev (MVUE) UCL	3.758
99% Chebyshev (MVUE) UCL	4.418		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	3.058	95% Jackknife UCL	3.065
95% Standard Bootstrap UCL	3.064	95% Bootstrap-t UCL	3.293
95% Hall's Bootstrap UCL	4.826	95% Percentile Bootstrap UCL	3.058
95% BCA Bootstrap UCL	3.191		
90% Chebyshev(Mean, Sd) UCL	3.369	95% Chebyshev(Mean, Sd) UCL	3.681
97.5% Chebyshev(Mean, Sd) UCL	4.114	99% Chebyshev(Mean, Sd) UCL	4.965

Suggested UCL to Use

95% Student's-t UCL	3.065	or 95% Modified-t UCL	3.083

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	32
Number of Detects	48	Number of Non-Detects	6
Number of Distinct Detects	28	Number of Distinct Non-Detects	6
Minimum Detect	0.02	Minimum Non-Detect	0.039
Maximum Detect	0.74	Maximum Non-Detect	0.19
Variance Detects	0.0128	Percent Non-Detects	11.11%
Mean Detects	0.168	SD Detects	0.113
Median Detects	0.16	CV Detects	0.673
Skewness Detects	2.921	Kurtosis Detects	13.31
Mean of Logged Detects	-1.96	SD of Logged Detects	0.617

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.772	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.155	KM Standard Error of Mean	0.0155
KM SD	0.112	95% KM (BCA) UCL	0.183
95% KM (t) UCL	0.181	95% KM (Percentile Bootstrap) UCL	0.183
95% KM (z) UCL	0.181	95% KM Bootstrap t UCL	0.19
90% KM Chebyshev UCL	0.202	95% KM Chebyshev UCL	0.223
97.5% KM Chebyshev UCL	0.252	99% KM Chebyshev UCL	0.31

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.545	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.757	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.111	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.129	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	2.978	k star (bias corrected MLE)	2.806
Theta hat (MLE)	0.0565	Theta star (bias corrected MLE)	0.0599
nu hat (MLE)	285.9	nu star (bias corrected)	269.4
Mean (detects)	0.168		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.154
Maximum	0.74	Median	0.14
SD	0.114	CV	0.742
k hat (MLE)	2.121	k star (bias corrected MLE)	2.015
Theta hat (MLE)	0.0727	Theta star (bias corrected MLE)	0.0765
nu hat (MLE)	229	nu star (bias corrected)	217.6
Adjusted Level of Significance (β)	0.0456		
Approximate Chi Square Value (217.65, α)	184.5	Adjusted Chi Square Value (217.65, β)	183.7
95% Gamma Approximate UCL (use when n>=50)	0.182	95% Gamma Adjusted UCL (use when n<50)	0.183

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.155	SD (KM)	0.112
Variance (KM)	0.0126	SE of Mean (KM)	0.0155
k hat (KM)	1.908	k star (KM)	1.814
nu hat (KM)	206.1	nu star (KM)	196
theta hat (KM)	0.0814	theta star (KM)	0.0856
80% gamma percentile (KM)	0.235	90% gamma percentile (KM)	0.309
95% gamma percentile (KM)	0.38	99% gamma percentile (KM)	0.538

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (195.96, α)	164.6	Adjusted Chi Square Value (195.96, β)	163.8
95% Gamma Approximate KM-UCL (use when n>=50)	0.185	95% Gamma Adjusted KM-UCL (use when n<50)	0.186

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.103	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.127	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.156	Mean in Log Scale	-2.063
SD in Original Scale	0.112	SD in Log Scale	0.66
95% t UCL (assumes normality of ROS data)	0.182	95% Percentile Bootstrap UCL	0.184
95% BCA Bootstrap UCL	0.189	95% Bootstrap t UCL	0.19
95% H-UCL (Log ROS)	0.189		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.096	KM Geo Mean	0.123
KM SD (logged)	0.728	95% Critical H Value (KM-Log)	2.055
KM Standard Error of Mean (logged)	0.103	95% H-UCL (KM -Log)	0.197
KM SD (logged)	0.728	95% Critical H Value (KM-Log)	2.055
KM Standard Error of Mean (logged)	0.103		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.155	Mean in Log Scale	-2.101
SD in Original Scale	0.114	SD in Log Scale	0.727
95% t UCL (Assumes normality)	0.18	95% H-Stat UCL	0.196

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.185	95% GROS Approximate Gamma UCL	0.182

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	54	Number of Distinct Observations	30
		Number of Missing Observations	0
Minimum	0.84	Mean	2.756
Maximum	12	Median	2.5
SD	1.712	Std. Error of Mean	0.233
Coefficient of Variation	0.621	Skewness	3.395

Normal GOF Test

Shapiro Wilk Test Statistic	0.704	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.316E-13	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.254	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.12	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.146	95% Adjusted-CLT UCL (Chen-1995)	3.255
		95% Modified-t UCL (Johnson-1978)	3.164

Gamma GOF Test

A-D Test Statistic	1.348	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.175	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.121	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.228	k star (bias corrected MLE)	4.005
Theta hat (MLE)	0.652	Theta star (bias corrected MLE)	0.688
nu hat (MLE)	456.6	nu star (bias corrected)	432.6
MLE Mean (bias corrected)	2.756	MLE Sd (bias corrected)	1.377
		Approximate Chi Square Value (0.05)	385.4
Adjusted Level of Significance	0.0456	Adjusted Chi Square Value	384.2

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:12:59 AM
From File	**Former CLEAR Plant_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.094	95% Adjusted Gamma UCL (use when n<50)	3.104

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.96	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.139	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.14	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.12	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.174	Mean of logged Data	0.891
Maximum of Logged Data	2.485	SD of logged Data	0.475

Assuming Lognormal Distribution

95% H-UCL	3.082	90% Chebyshev (MVUE) UCL	3.274
95% Chebyshev (MVUE) UCL	3.525	97.5% Chebyshev (MVUE) UCL	3.872
99% Chebyshev (MVUE) UCL	4.554		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.14	95% Jackknife UCL	3.146
95% Standard Bootstrap UCL	3.145	95% Bootstrap-t UCL	3.338
95% Hall's Bootstrap UCL	4.96	95% Percentile Bootstrap UCL	3.16
95% BCA Bootstrap UCL	3.234		
90% Chebyshev(Mean, Sd) UCL	3.455	95% Chebyshev(Mean, Sd) UCL	3.772
97.5% Chebyshev(Mean, Sd) UCL	4.211	99% Chebyshev(Mean, Sd) UCL	5.074

Suggested UCL to Use

95% Student's-t UCL	3.146	or 95% Modified-t UCL	3.164
or 95% H-UCL	3.082		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	66	Number of Distinct Observations	30
Number of Detects	65	Number of Non-Detects	1
Number of Distinct Detects	29	Number of Distinct Non-Detects	1
Minimum Detect	0.43	Minimum Non-Detect	0.84
Maximum Detect	4.8	Maximum Non-Detect	0.84
Variance Detects	0.829	Percent Non-Detects	1.515%
Mean Detects	2.119	SD Detects	0.911
Median Detects	2.1	CV Detects	0.43
Skewness Detects	0.614	Kurtosis Detects	1.095
Mean of Logged Detects	0.643	SD of Logged Detects	0.506

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.957	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.0623	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0679	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.11	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.096	KM Standard Error of Mean	0.114
KM SD	0.916	95% KM (BCA) UCL	2.269
95% KM (t) UCL	2.285	95% KM (Percentile Bootstrap) UCL	2.286
95% KM (z) UCL	2.283	95% KM Bootstrap t UCL	2.3
90% KM Chebyshev UCL	2.437	95% KM Chebyshev UCL	2.591
97.5% KM Chebyshev UCL	2.806	99% KM Chebyshev UCL	3.227

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.801	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0987	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.111	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.798	k star (bias corrected MLE)	4.587
Theta hat (MLE)	0.442	Theta star (bias corrected MLE)	0.462
nu hat (MLE)	623.7	nu star (bias corrected)	596.3
Mean (detects)	2.119		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.43	Mean	2.1
Maximum	4.8	Median	2.1
SD	0.917	CV	0.437
k hat (MLE)	4.664	k star (bias corrected MLE)	4.462
Theta hat (MLE)	0.45	Theta star (bias corrected MLE)	0.471
nu hat (MLE)	615.6	nu star (bias corrected)	588.9
Adjusted Level of Significance (β)	0.0464		
Approximate Chi Square Value (588.95, α)	533.7	Adjusted Chi Square Value (588.95, β)	532.5
95% Gamma Approximate UCL (use when n>=50)	2.317	95% Gamma Adjusted UCL (use when n<50)	2.322

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.096	SD (KM)	0.916
Variance (KM)	0.839	SE of Mean (KM)	0.114
k hat (KM)	5.232	k star (KM)	5.004
nu hat (KM)	690.6	nu star (KM)	660.6
theta hat (KM)	0.401	theta star (KM)	0.419
80% gamma percentile (KM)	2.817	90% gamma percentile (KM)	3.35
95% gamma percentile (KM)	3.836	99% gamma percentile (KM)	4.863

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (660.56, α)	601.9	Adjusted Chi Square Value (660.56, β)	600.7
95% Gamma Approximate KM-UCL (use when n>=50)	2.3	95% Gamma Adjusted KM-UCL (use when n<50)	2.305

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.917	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.9803E-4	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.13	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.11	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.099	Mean in Log Scale	0.63
SD in Original Scale	0.918	SD in Log Scale	0.513
95% t UCL (assumes normality of ROS data)	2.288	95% Percentile Bootstrap UCL	2.286
95% BCA Bootstrap UCL	2.291	95% Bootstrap t UCL	2.302
95% H-UCL (Log ROS)	2.413		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.625	KM Geo Mean	1.868
KM SD (logged)	0.52	95% Critical H Value (KM-Log)	1.879
KM Standard Error of Mean (logged)	0.0646	95% H-UCL (KM -Log)	2.414
KM SD (logged)	0.52	95% Critical H Value (KM-Log)	1.879
KM Standard Error of Mean (logged)	0.0646		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.093	Mean in Log Scale	0.62
SD in Original Scale	0.928	SD in Log Scale	0.535
95% t UCL (Assumes normality)	2.284	95% H-Stat UCL	2.433

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.285

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	66	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	1.2	Mean	2.258
Maximum	7.6	Median	2.1
SD	0.905	Std. Error of Mean	0.111
Coefficient of Variation	0.401	Skewness	3.425

Normal GOF Test

Shapiro Wilk Test Statistic	0.744	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.109E-15	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.148	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.109	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.443	95% Adjusted-CLT UCL (Chen-1995)	2.491
		95% Modified-t UCL (Johnson-1978)	2.451

Gamma GOF Test

A-D Test Statistic	1.072	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.119	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.11	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.303	k star (bias corrected MLE)	8.89
Theta hat (MLE)	0.243	Theta star (bias corrected MLE)	0.254
nu hat (MLE)	1228	nu star (bias corrected)	1174
MLE Mean (bias corrected)	2.258	MLE Sd (bias corrected)	0.757
		Approximate Chi Square Value (0.05)	1095
Adjusted Level of Significance	0.0464	Adjusted Chi Square Value	1093

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.419	95% Adjusted Gamma UCL (use when n<50)	2.423

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0218	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0982	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.109	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	0.76
Maximum of Logged Data	2.028	SD of logged Data	0.314

Assuming Lognormal Distribution

95% H-UCL	2.404	90% Chebyshev (MVUE) UCL	2.509
95% Chebyshev (MVUE) UCL	2.629	97.5% Chebyshev (MVUE) UCL	2.795
99% Chebyshev (MVUE) UCL	3.123		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.441	95% Jackknife UCL	2.443
95% Standard Bootstrap UCL	2.442	95% Bootstrap-t UCL	2.526
95% Hall's Bootstrap UCL	2.706	95% Percentile Bootstrap UCL	2.452
95% BCA Bootstrap UCL	2.521		
90% Chebyshev(Mean, Sd) UCL	2.592	95% Chebyshev(Mean, Sd) UCL	2.743
97.5% Chebyshev(Mean, Sd) UCL	2.953	99% Chebyshev(Mean, Sd) UCL	3.366

Suggested UCL to Use

95% Student's-t UCL	2.443	or 95% Modified-t UCL	2.451
or 95% H-UCL	2.404		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	66	Number of Distinct Observations	37
Number of Detects	48	Number of Non-Detects	18
Number of Distinct Detects	28	Number of Distinct Non-Detects	14
Minimum Detect	0.02	Minimum Non-Detect	0.039
Maximum Detect	0.31	Maximum Non-Detect	0.23
Variance Detects	0.00494	Percent Non-Detects	27.27%
Mean Detects	0.142	SD Detects	0.0703
Median Detects	0.135	CV Detects	0.496
Skewness Detects	0.613	Kurtosis Detects	-0.176
Mean of Logged Detects	-2.089	SD of Logged Detects	0.562

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.95	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.133	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.127	Detected Data Not Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.121	KM Standard Error of Mean	0.00926
KM SD	0.0717	95% KM (BCA) UCL	0.137
95% KM (t) UCL	0.137	95% KM (Percentile Bootstrap) UCL	0.137
95% KM (z) UCL	0.136	95% KM Bootstrap t UCL	0.137
90% KM Chebyshev UCL	0.149	95% KM Chebyshev UCL	0.161
97.5% KM Chebyshev UCL	0.179	99% KM Chebyshev UCL	0.213

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.22	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0773	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.128	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.825	k star (bias corrected MLE)	3.6
Theta hat (MLE)	0.0371	Theta star (bias corrected MLE)	0.0394
nu hat (MLE)	367.2	nu star (bias corrected)	345.6
Mean (detects)	0.142		

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.02	Mean	0.122
Maximum	0.31	Median	0.098
SD	0.07	CV	0.576
k hat (MLE)	3.054	k star (bias corrected MLE)	2.925
Theta hat (MLE)	0.0398	Theta star (bias corrected MLE)	0.0416
nu hat (MLE)	403.1	nu star (bias corrected)	386.1
Adjusted Level of Significance (β)	0.0464		
Approximate Chi Square Value (386.13, α)	341.6	Adjusted Chi Square Value (386.13, β)	340.7
95% Gamma Approximate UCL (use when n>=50)	0.137	95% Gamma Adjusted UCL (use when n<50)	0.138

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.121	SD (KM)	0.0717
Variance (KM)	0.00514	SE of Mean (KM)	0.00926
k hat (KM)	2.851	k star (KM)	2.731
nu hat (KM)	376.3	nu star (KM)	360.5
theta hat (KM)	0.0425	theta star (KM)	0.0443
80% gamma percentile (KM)	0.175	90% gamma percentile (KM)	0.219
95% gamma percentile (KM)	0.261	99% gamma percentile (KM)	0.352

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (360.54, α)	317.5	Adjusted Chi Square Value (360.54, β)	316.6
95% Gamma Approximate KM-UCL (use when n>=50)	0.138	95% Gamma Adjusted KM-UCL (use when n<50)	0.138

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0866	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.127	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.122	Mean in Log Scale	-2.269
SD in Original Scale	0.0695	SD in Log Scale	0.589
95% t UCL (assumes normality of ROS data)	0.136	95% Percentile Bootstrap UCL	0.136
95% BCA Bootstrap UCL	0.137	95% Bootstrap t UCL	0.138
95% H-UCL (Log ROS)	0.142		

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.32	KM Geo Mean	0.0983
KM SD (logged)	0.702	95% Critical H Value (KM-Log)	2.015
KM Standard Error of Mean (logged)	0.0982	95% H-UCL (KM -Log)	0.15
KM SD (logged)	0.702	95% Critical H Value (KM-Log)	2.015
KM Standard Error of Mean (logged)	0.0982		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.12	Mean in Log Scale	-2.316
SD in Original Scale	0.0716	SD in Log Scale	0.665
95% t UCL (Assumes normality)	0.135	95% H-Stat UCL	0.145

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.137

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	66	Number of Distinct Observations	28
		Number of Missing Observations	0
Minimum	0.84	Mean	2.322
Maximum	4.9	Median	2.2
SD	0.884	Std. Error of Mean	0.109
Coefficient of Variation	0.381	Skewness	1.001

Normal GOF Test

Shapiro Wilk Test Statistic	0.923	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	4.2812E-4	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.109	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.503	95% Adjusted-CLT UCL (Chen-1995)	2.515
		95% Modified-t UCL (Johnson-1978)	2.506

Gamma GOF Test

A-D Test Statistic	0.434	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.752	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0698	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.11	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	7.461	k star (bias corrected MLE)	7.132
Theta hat (MLE)	0.311	Theta star (bias corrected MLE)	0.326
nu hat (MLE)	984.8	nu star (bias corrected)	941.4
MLE Mean (bias corrected)	2.322	MLE Sd (bias corrected)	0.869
		Approximate Chi Square Value (0.05)	871.2
Adjusted Level of Significance	0.0464	Adjusted Chi Square Value	869.7

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:57 PM
From File	**Former CLEAR Plant_Rad_Exposed 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.509	95% Adjusted Gamma UCL (use when n<50)	2.513

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.978	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.579	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0827	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.109	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.174	Mean of logged Data	0.774
Maximum of Logged Data	1.589	SD of logged Data	0.375

Assuming Lognormal Distribution

95% H-UCL	2.529	90% Chebyshev (MVUE) UCL	2.655
95% Chebyshev (MVUE) UCL	2.805	97.5% Chebyshev (MVUE) UCL	3.014
99% Chebyshev (MVUE) UCL	3.424		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.501	95% Jackknife UCL	2.503
95% Standard Bootstrap UCL	2.501	95% Bootstrap-t UCL	2.518
95% Hall's Bootstrap UCL	2.533	95% Percentile Bootstrap UCL	2.501
95% BCA Bootstrap UCL	2.517		
90% Chebyshev(Mean, Sd) UCL	2.648	95% Chebyshev(Mean, Sd) UCL	2.796
97.5% Chebyshev(Mean, Sd) UCL	3.001	99% Chebyshev(Mean, Sd) UCL	3.405

Suggested UCL to Use

95% Approximate Gamma UCL	2.509

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	31
Number of Detects	67	Number of Non-Detects	1
Number of Distinct Detects	30	Number of Distinct Non-Detects	1
Minimum Detect	0.43	Minimum Non-Detect	0.84
Maximum Detect	4.8	Maximum Non-Detect	0.84
Variance Detects	0.829	Percent Non-Detects	1.471%
Mean Detects	2.115	SD Detects	0.911
Median Detects	2.1	CV Detects	0.43
Skewness Detects	0.595	Kurtosis Detects	1.006
Mean of Logged Detects	0.641	SD of Logged Detects	0.505

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.96	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0.075	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0615	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.108	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.093	KM Standard Error of Mean	0.112
KM SD	0.916	95% KM (BCA) UCL	2.286
95% KM (t) UCL	2.28	95% KM (Percentile Bootstrap) UCL	2.28
95% KM (z) UCL	2.277	95% KM Bootstrap t UCL	2.285
90% KM Chebyshev UCL	2.429	95% KM Chebyshev UCL	2.581
97.5% KM Chebyshev UCL	2.792	99% KM Chebyshev UCL	3.207

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.74	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0964	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.109	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	4.789	k star (bias corrected MLE)	4.584
Theta hat (MLE)	0.442	Theta star (bias corrected MLE)	0.461
nu hat (MLE)	641.7	nu star (bias corrected)	614.3
Mean (detects)	2.115		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.43	Mean	2.096
Maximum	4.8	Median	2.1
SD	0.917	CV	0.437
k hat (MLE)	4.656	k star (bias corrected MLE)	4.46
Theta hat (MLE)	0.45	Theta star (bias corrected MLE)	0.47
nu hat (MLE)	633.2	nu star (bias corrected)	606.6
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (606.57, α)	550.4	Adjusted Chi Square Value (606.57, β)	549.3
95% Gamma Approximate UCL (use when n>=50)	2.31	95% Gamma Adjusted UCL (use when n<50)	2.315

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.093	SD (KM)	0.916
Variance (KM)	0.839	SE of Mean (KM)	0.112
k hat (KM)	5.222	k star (KM)	5.001
nu hat (KM)	710.2	nu star (KM)	680.2
theta hat (KM)	0.401	theta star (KM)	0.418
80% gamma percentile (KM)	2.813	90% gamma percentile (KM)	3.346
95% gamma percentile (KM)	3.831	99% gamma percentile (KM)	4.857

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (680.16, α)	620.6	Adjusted Chi Square Value (680.16, β)	619.4
95% Gamma Approximate KM-UCL (use when n>=50)	2.294	95% Gamma Adjusted KM-UCL (use when n<50)	2.298

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.922	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	3.1283E-4	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.127	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.108	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.096	Mean in Log Scale	0.629
SD in Original Scale	0.918	SD in Log Scale	0.512
95% t UCL (assumes normality of ROS data)	2.282	95% Percentile Bootstrap UCL	2.282
95% BCA Bootstrap UCL	2.277	95% Bootstrap t UCL	2.288
95% H-UCL (Log ROS)	2.404		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.624	KM Geo Mean	1.866
KM SD (logged)	0.519	95% Critical H Value (KM-Log)	1.881
KM Standard Error of Mean (logged)	0.0635	95% H-UCL (KM -Log)	2.405
KM SD (logged)	0.519	95% Critical H Value (KM-Log)	1.881
KM Standard Error of Mean (logged)	0.0635		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.09	Mean in Log Scale	0.619
SD in Original Scale	0.927	SD in Log Scale	0.534
95% t UCL (Assumes normality)	2.278	95% H-Stat UCL	2.423

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.28

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	23
		Number of Missing Observations	0
Minimum	1.2	Mean	2.241
Maximum	7.6	Median	2.1
SD	0.897	Std. Error of Mean	0.109
Coefficient of Variation	0.4	Skewness	3.455

Normal GOF Test

Shapiro Wilk Test Statistic	0.742	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	4.441E-16	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.151	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.423	95% Adjusted-CLT UCL (Chen-1995)	2.469
		95% Modified-t UCL (Johnson-1978)	2.43

Gamma GOF Test

A-D Test Statistic	1.138	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.123	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.108	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.362	k star (bias corrected MLE)	8.959
Theta hat (MLE)	0.239	Theta star (bias corrected MLE)	0.25
nu hat (MLE)	1273	nu star (bias corrected)	1218
MLE Mean (bias corrected)	2.241	MLE Sd (bias corrected)	0.749
		Approximate Chi Square Value (0.05)	1138
Adjusted Level of Significance	0.0465	Adjusted Chi Square Value	1137

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.399	95% Adjusted Gamma UCL (use when n<50)	2.402

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.948	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0147	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.102	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.107	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	0.753
Maximum of Logged Data	2.028	SD of logged Data	0.312

Assuming Lognormal Distribution

95% H-UCL	2.383	90% Chebyshev (MVUE) UCL	2.485
95% Chebyshev (MVUE) UCL	2.602	97.5% Chebyshev (MVUE) UCL	2.764
99% Chebyshev (MVUE) UCL	3.083		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.42	95% Jackknife UCL	2.423
95% Standard Bootstrap UCL	2.418	95% Bootstrap-t UCL	2.493
95% Hall's Bootstrap UCL	2.64	95% Percentile Bootstrap UCL	2.437
95% BCA Bootstrap UCL	2.478		
90% Chebyshev(Mean, Sd) UCL	2.568	95% Chebyshev(Mean, Sd) UCL	2.715
97.5% Chebyshev(Mean, Sd) UCL	2.921	99% Chebyshev(Mean, Sd) UCL	3.324

Suggested UCL to Use

95% Student's-t UCL	2.423	or 95% Modified-t UCL	2.43
or 95% H-UCL	2.383		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	38
Number of Detects	50	Number of Non-Detects	18
Number of Distinct Detects	29	Number of Distinct Non-Detects	14
Minimum Detect	0.02	Minimum Non-Detect	0.039
Maximum Detect	0.74	Maximum Non-Detect	0.23
Variance Detects	0.012	Percent Non-Detects	26.47%
Mean Detects	0.153	SD Detects	0.11
Median Detects	0.135	CV Detects	0.718
Skewness Detects	3.305	Kurtosis Detects	16.33
Mean of Logged Detects	-2.062	SD of Logged Detects	0.61

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.738	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.14	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.125	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.13	KM Standard Error of Mean	0.0128
KM SD	0.103	95% KM (BCA) UCL	0.153
95% KM (t) UCL	0.151	95% KM (Percentile Bootstrap) UCL	0.152
95% KM (z) UCL	0.151	95% KM Bootstrap t UCL	0.158
90% KM Chebyshev UCL	0.168	95% KM Chebyshev UCL	0.186
97.5% KM Chebyshev UCL	0.21	99% KM Chebyshev UCL	0.257

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.456	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.758	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0882	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.126	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.902	k star (bias corrected MLE)	2.741
Theta hat (MLE)	0.0526	Theta star (bias corrected MLE)	0.0557
nu hat (MLE)	290.2	nu star (bias corrected)	274.1
Mean (detects)	0.153		

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.126
Maximum	0.74	Median	0.098
SD	0.105	CV	0.836
k hat (MLE)	1.816	k star (bias corrected MLE)	1.745
Theta hat (MLE)	0.0694	Theta star (bias corrected MLE)	0.0722
nu hat (MLE)	246.9	nu star (bias corrected)	237.4
Adjusted Level of Significance (β)	0.0465		
Approximate Chi Square Value (237.36, α)	202.7	Adjusted Chi Square Value (237.36, β)	202
95% Gamma Approximate UCL (use when n>=50)	0.148	95% Gamma Adjusted UCL (use when n<50)	0.148

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.13	SD (KM)	0.103
Variance (KM)	0.0106	SE of Mean (KM)	0.0128
k hat (KM)	1.593	k star (KM)	1.532
nu hat (KM)	216.6	nu star (KM)	208.4
theta hat (KM)	0.0814	theta star (KM)	0.0846
80% gamma percentile (KM)	0.2	90% gamma percentile (KM)	0.269
95% gamma percentile (KM)	0.335	99% gamma percentile (KM)	0.486

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (208.41, α)	176	Adjusted Chi Square Value (208.41, β)	175.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.154	95% Gamma Adjusted KM-UCL (use when n<50)	0.154

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.984	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.947	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0657	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.125	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.13	Mean in Log Scale	-2.252
SD in Original Scale	0.102	SD in Log Scale	0.639
95% t UCL (assumes normality of ROS data)	0.15	95% Percentile Bootstrap UCL	0.152
95% BCA Bootstrap UCL	0.156	95% Bootstrap t UCL	0.158
95% H-UCL (Log ROS)	0.15		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.291	KM Geo Mean	0.101
KM SD (logged)	0.731	95% Critical H Value (KM-Log)	2.042
KM Standard Error of Mean (logged)	0.0992	95% H-UCL (KM -Log)	0.159
KM SD (logged)	0.731	95% Critical H Value (KM-Log)	2.042
KM Standard Error of Mean (logged)	0.0992		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.128	Mean in Log Scale	-2.289
SD in Original Scale	0.103	SD in Log Scale	0.699
95% t UCL (Assumes normality)	0.149	95% H-Stat UCL	0.154

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Approximate Gamma UCL	0.154	95% GROS Approximate Gamma UCL	0.148

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	68	Number of Distinct Observations	29
		Number of Missing Observations	0
Minimum	0.84	Mean	2.445
Maximum	12	Median	2.2
SD	1.472	Std. Error of Mean	0.179
Coefficient of Variation	0.602	Skewness	4.31

Normal GOF Test

Shapiro Wilk Test Statistic	0.663	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.21	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.742	95% Adjusted-CLT UCL (Chen-1995)	2.838
		95% Modified-t UCL (Johnson-1978)	2.758

Gamma GOF Test

A-D Test Statistic	1.273	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.126	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.108	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.864	k star (bias corrected MLE)	4.659
Theta hat (MLE)	0.503	Theta star (bias corrected MLE)	0.525
nu hat (MLE)	661.5	nu star (bias corrected)	633.6
MLE Mean (bias corrected)	2.445	MLE Sd (bias corrected)	1.133
		Approximate Chi Square Value (0.05)	576.3
Adjusted Level of Significance	0.0465	Adjusted Chi Square Value	575.1

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:55:00 PM
From File	**Former CLEAR Plant_Rad_All 0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.688	95% Adjusted Gamma UCL (use when n<50)	2.694

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.129	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0969	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.107	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.174	Mean of logged Data	0.788
Maximum of Logged Data	2.485	SD of logged Data	0.435

Assuming Lognormal Distribution

95% H-UCL	2.662	90% Chebyshev (MVUE) UCL	2.809
95% Chebyshev (MVUE) UCL	2.989	97.5% Chebyshev (MVUE) UCL	3.239
99% Chebyshev (MVUE) UCL	3.729		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.738	95% Jackknife UCL	2.742
95% Standard Bootstrap UCL	2.728	95% Bootstrap-t UCL	2.892
95% Hall's Bootstrap UCL	4.122	95% Percentile Bootstrap UCL	2.747
95% BCA Bootstrap UCL	2.812		
90% Chebyshev(Mean, Sd) UCL	2.98	95% Chebyshev(Mean, Sd) UCL	3.223
97.5% Chebyshev(Mean, Sd) UCL	3.56	99% Chebyshev(Mean, Sd) UCL	4.221

Suggested UCL to Use

95% Student's-t UCL	2.742	or 95% Modified-t UCL	2.758
or 95% H-UCL	2.662		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	22
Number of Detects	31	Number of Non-Detects	1
Number of Distinct Detects	21	Number of Distinct Non-Detects	1
Minimum Detect	0.43	Minimum Non-Detect	0.84
Maximum Detect	3.5	Maximum Non-Detect	0.84
Variance Detects	0.713	Percent Non-Detects	3.125%
Mean Detects	1.936	SD Detects	0.844
Median Detects	2	CV Detects	0.436
Skewness Detects	-0.208	Kurtosis Detects	-0.865
Mean of Logged Detects	0.532	SD of Logged Detects	0.572

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.958	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.929	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.156	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.894	KM Standard Error of Mean	0.153
KM SD	0.851	95% KM (BCA) UCL	2.133
95% KM (t) UCL	2.153	95% KM (Percentile Bootstrap) UCL	2.133
95% KM (z) UCL	2.146	95% KM Bootstrap t UCL	2.149
90% KM Chebyshev UCL	2.353	95% KM Chebyshev UCL	2.561
97.5% KM Chebyshev UCL	2.849	99% KM Chebyshev UCL	3.416

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.878	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.75	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.132	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.158	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	4.038	k star (bias corrected MLE)	3.668
Theta hat (MLE)	0.48	Theta star (bias corrected MLE)	0.528
nu hat (MLE)	250.3	nu star (bias corrected)	227.4
Mean (detects)	1.936		

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.43	Mean	1.903
Maximum	3.5	Median	1.95
SD	0.851	CV	0.447
k hat (MLE)	3.943	k star (bias corrected MLE)	3.594
Theta hat (MLE)	0.483	Theta star (bias corrected MLE)	0.53
nu hat (MLE)	252.4	nu star (bias corrected)	230
Adjusted Level of Significance (β)	0.0416		
Approximate Chi Square Value (230.04, α)	195.9	Adjusted Chi Square Value (230.04, β)	194.3
95% Gamma Approximate UCL (use when n>=50)	2.235	95% Gamma Adjusted UCL (use when n<50)	2.254

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.894	SD (KM)	0.851
Variance (KM)	0.724	SE of Mean (KM)	0.153
k hat (KM)	4.951	k star (KM)	4.508
nu hat (KM)	316.9	nu star (KM)	288.5
theta hat (KM)	0.383	theta star (KM)	0.42
80% gamma percentile (KM)	2.576	90% gamma percentile (KM)	3.089
95% gamma percentile (KM)	3.559	99% gamma percentile (KM)	4.556

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (288.49, α)	250.2	Adjusted Chi Square Value (288.49, β)	248.2
95% Gamma Approximate KM-UCL (use when n>=50)	2.184	95% Gamma Adjusted KM-UCL (use when n<50)	2.201

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.874	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.929	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.156	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.899	Mean in Log Scale	0.507
SD in Original Scale	0.856	SD in Log Scale	0.58
95% t UCL (assumes normality of ROS data)	2.156	95% Percentile Bootstrap UCL	2.137
95% BCA Bootstrap UCL	2.126	95% Bootstrap t UCL	2.149
95% H-UCL (Log ROS)	2.418		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.498	KM Geo Mean	1.645
KM SD (logged)	0.587	95% Critical H Value (KM-Log)	2.003
KM Standard Error of Mean (logged)	0.106	95% H-UCL (KM -Log)	2.413
KM SD (logged)	0.587	95% Critical H Value (KM-Log)	2.003
KM Standard Error of Mean (logged)	0.106		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.889	Mean in Log Scale	0.488
SD in Original Scale	0.873	SD in Log Scale	0.614
95% t UCL (Assumes normality)	2.15	95% H-Stat UCL	2.461

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.153

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	1.2	Mean	2.328
Maximum	7.6	Median	2.05
SD	1.169	Std. Error of Mean	0.207
Coefficient of Variation	0.502	Skewness	3.162

Normal GOF Test

Shapiro Wilk Test Statistic	0.701	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.679	95% Adjusted-CLT UCL (Chen-1995)	2.792
		95% Modified-t UCL (Johnson-1978)	2.698

Gamma GOF Test

A-D Test Statistic	0.849	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.119	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.156	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.368	k star (bias corrected MLE)	5.792
Theta hat (MLE)	0.366	Theta star (bias corrected MLE)	0.402
nu hat (MLE)	407.5	nu star (bias corrected)	370.7
MLE Mean (bias corrected)	2.328	MLE Sd (bias corrected)	0.967
		Approximate Chi Square Value (0.05)	327
Adjusted Level of Significance	0.0416	Adjusted Chi Square Value	324.9

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.639	95% Adjusted Gamma UCL (use when n<50)	2.656

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.929	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.93	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0953	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.154	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	0.764
Maximum of Logged Data	2.028	SD of logged Data	0.379

Assuming Lognormal Distribution

95% H-UCL	2.617	90% Chebyshev (MVUE) UCL	2.777
95% Chebyshev (MVUE) UCL	2.993	97.5% Chebyshev (MVUE) UCL	3.291
99% Chebyshev (MVUE) UCL	3.878		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.668	95% Jackknife UCL	2.679
95% Standard Bootstrap UCL	2.663	95% Bootstrap-t UCL	2.923
95% Hall's Bootstrap UCL	4.356	95% Percentile Bootstrap UCL	2.684
95% BCA Bootstrap UCL	2.825		
90% Chebyshev(Mean, Sd) UCL	2.948	95% Chebyshev(Mean, Sd) UCL	3.229
97.5% Chebyshev(Mean, Sd) UCL	3.619	99% Chebyshev(Mean, Sd) UCL	4.385

Suggested UCL to Use

95% Adjusted Gamma UCL	2.656

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-234)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	20
		Number of Missing Observations	0
Minimum	0.98	Mean	2.237
Maximum	3.9	Median	2.1
SD	0.74	Std. Error of Mean	0.131
Coefficient of Variation	0.331	Skewness	0.604

Normal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.114	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.459	95% Adjusted-CLT UCL (Chen-1995)	2.467
		95% Modified-t UCL (Johnson-1978)	2.461

Gamma GOF Test

A-D Test Statistic	0.223	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0857	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.155	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.518	k star (bias corrected MLE)	8.646
Theta hat (MLE)	0.235	Theta star (bias corrected MLE)	0.259
nu hat (MLE)	609.1	nu star (bias corrected)	553.4
MLE Mean (bias corrected)	2.237	MLE Sd (bias corrected)	0.761
		Approximate Chi Square Value (0.05)	499.8
Adjusted Level of Significance	0.0416	Adjusted Chi Square Value	497.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.477	95% Adjusted Gamma UCL (use when n<50)	2.49

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.977	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0941	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.154	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.0202	Mean of logged Data	0.752
Maximum of Logged Data	1.361	SD of logged Data	0.336

Assuming Lognormal Distribution

95% H-UCL	2.504	90% Chebyshev (MVUE) UCL	2.647
95% Chebyshev (MVUE) UCL	2.832	97.5% Chebyshev (MVUE) UCL	3.088
99% Chebyshev (MVUE) UCL	3.592		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.452	95% Jackknife UCL	2.459
95% Standard Bootstrap UCL	2.446	95% Bootstrap-t UCL	2.486
95% Hall's Bootstrap UCL	2.46	95% Percentile Bootstrap UCL	2.44
95% BCA Bootstrap UCL	2.466		
90% Chebyshev(Mean, Sd) UCL	2.629	95% Chebyshev(Mean, Sd) UCL	2.807
97.5% Chebyshev(Mean, Sd) UCL	3.054	99% Chebyshev(Mean, Sd) UCL	3.538

Suggested UCL to Use

95% Student's-t UCL	2.459

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	23
Number of Detects	23	Number of Non-Detects	9
Number of Distinct Detects	17	Number of Distinct Non-Detects	7
Minimum Detect	0.063	Minimum Non-Detect	0.039
Maximum Detect	0.31	Maximum Non-Detect	0.19
Variance Detects	0.00463	Percent Non-Detects	28.13%
Mean Detects	0.144	SD Detects	0.0681
Median Detects	0.12	CV Detects	0.473
Skewness Detects	1.154	Kurtosis Detects	0.523
Mean of Logged Detects	-2.034	SD of Logged Detects	0.436

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.871	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.168	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.124	KM Standard Error of Mean	0.0126
KM SD	0.0676	95% KM (BCA) UCL	0.146
95% KM (t) UCL	0.146	95% KM (Percentile Bootstrap) UCL	0.146
95% KM (z) UCL	0.145	95% KM Bootstrap t UCL	0.148
90% KM Chebyshev UCL	0.162	95% KM Chebyshev UCL	0.179
97.5% KM Chebyshev UCL	0.203	99% KM Chebyshev UCL	0.249

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.613	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.746	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.152	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.182	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	5.423	k star (bias corrected MLE)	4.745
Theta hat (MLE)	0.0265	Theta star (bias corrected MLE)	0.0303
nu hat (MLE)	249.5	nu star (bias corrected)	218.3
Mean (detects)	0.144		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0261	Mean	0.123
Maximum	0.31	Median	0.099
SD	0.0697	CV	0.569
k hat (MLE)	3.188	k star (bias corrected MLE)	2.91
Theta hat (MLE)	0.0385	Theta star (bias corrected MLE)	0.0421
nu hat (MLE)	204	nu star (bias corrected)	186.3
Adjusted Level of Significance (β)	0.0416		
Approximate Chi Square Value (186.25, α)	155.7	Adjusted Chi Square Value (186.25, β)	154.2
95% Gamma Approximate UCL (use when n>=50)	0.147	95% Gamma Adjusted UCL (use when n<50)	0.148

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.124	SD (KM)	0.0676
Variance (KM)	0.00458	SE of Mean (KM)	0.0126
k hat (KM)	3.372	k star (KM)	3.077
nu hat (KM)	215.8	nu star (KM)	196.9
theta hat (KM)	0.0368	theta star (KM)	0.0404
80% gamma percentile (KM)	0.177	90% gamma percentile (KM)	0.219
95% gamma percentile (KM)	0.259	99% gamma percentile (KM)	0.345

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (196.94, α)	165.5	Adjusted Chi Square Value (196.94, β)	163.9
95% Gamma Approximate KM-UCL (use when n>=50)	0.148	95% Gamma Adjusted KM-UCL (use when n<50)	0.149

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.914	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.137	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.18	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.125	Mean in Log Scale	-2.194
SD in Original Scale	0.0662	SD in Log Scale	0.485
95% t UCL (assumes normality of ROS data)	0.145	95% Percentile Bootstrap UCL	0.146
95% BCA Bootstrap UCL	0.147	95% Bootstrap t UCL	0.149
95% H-UCL (Log ROS)	0.148		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.23	KM Geo Mean	0.108
KM SD (logged)	0.549	95% Critical H Value (KM-Log)	1.971
KM Standard Error of Mean (logged)	0.106	95% H-UCL (KM -Log)	0.152
KM SD (logged)	0.549	95% Critical H Value (KM-Log)	1.971
KM Standard Error of Mean (logged)	0.106		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.12	Mean in Log Scale	-2.293
SD in Original Scale	0.0706	SD in Log Scale	0.639
95% t UCL (Assumes normality)	0.142	95% H-Stat UCL	0.157

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.146

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	32	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	1.1	Mean	2.338
Maximum	4	Median	2.25
SD	0.761	Std. Error of Mean	0.134
Coefficient of Variation	0.325	Skewness	0.47

Normal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.0913	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.565	95% Adjusted-CLT UCL (Chen-1995)	2.571
		95% Modified-t UCL (Johnson-1978)	2.567

Gamma GOF Test

A-D Test Statistic	0.186	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.747	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0772	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.155	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.59	k star (bias corrected MLE)	8.712
Theta hat (MLE)	0.244	Theta star (bias corrected MLE)	0.268
nu hat (MLE)	613.8	nu star (bias corrected)	557.5
MLE Mean (bias corrected)	2.338	MLE Sd (bias corrected)	0.792
		Approximate Chi Square Value (0.05)	503.8
Adjusted Level of Significance	0.0416	Adjusted Chi Square Value	501.1

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:02:22 AM
From File	**Former CLEAR Plant_Rad_Exposed 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.587	95% Adjusted Gamma UCL (use when n<50)	2.601

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.97	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.93	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0884	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.154	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.796
Maximum of Logged Data	1.386	SD of logged Data	0.337

Assuming Lognormal Distribution

95% H-UCL	2.619	90% Chebyshev (MVUE) UCL	2.769
95% Chebyshev (MVUE) UCL	2.962	97.5% Chebyshev (MVUE) UCL	3.23
99% Chebyshev (MVUE) UCL	3.758		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.559	95% Jackknife UCL	2.565
95% Standard Bootstrap UCL	2.555	95% Bootstrap-t UCL	2.579
95% Hall's Bootstrap UCL	2.576	95% Percentile Bootstrap UCL	2.566
95% BCA Bootstrap UCL	2.588		
90% Chebyshev(Mean, Sd) UCL	2.741	95% Chebyshev(Mean, Sd) UCL	2.924
97.5% Chebyshev(Mean, Sd) UCL	3.177	99% Chebyshev(Mean, Sd) UCL	3.675

Suggested UCL to Use

95% Student's-t UCL	2.565

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	33	Number of Distinct Observations	22
Number of Detects	32	Number of Non-Detects	1
Number of Distinct Detects	21	Number of Distinct Non-Detects	1
Minimum Detect	0.43	Minimum Non-Detect	0.84
Maximum Detect	3.5	Maximum Non-Detect	0.84
Variance Detects	0.719	Percent Non-Detects	3.03%
Mean Detects	1.966	SD Detects	0.848
Median Detects	2.05	CV Detects	0.431
Skewness Detects	-0.262	Kurtosis Detects	-0.889
Mean of Logged Detects	0.548	SD of Logged Detects	0.57

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.93	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.116	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.154	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.924	KM Standard Error of Mean	0.151
KM SD	0.856	95% KM (BCA) UCL	2.173
95% KM (t) UCL	2.181	95% KM (Percentile Bootstrap) UCL	2.156
95% KM (z) UCL	2.173	95% KM Bootstrap t UCL	2.172
90% KM Chebyshev UCL	2.379	95% KM Chebyshev UCL	2.584
97.5% KM Chebyshev UCL	2.87	99% KM Chebyshev UCL	3.431

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.978	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.751	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.133	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.156	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	4.075	k star (bias corrected MLE)	3.713
Theta hat (MLE)	0.483	Theta star (bias corrected MLE)	0.529
nu hat (MLE)	260.8	nu star (bias corrected)	237.7
Mean (detects)	1.966		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.43	Mean	1.934
Maximum	3.5	Median	2
SD	0.854	CV	0.442
k hat (MLE)	3.986	k star (bias corrected MLE)	3.644
Theta hat (MLE)	0.485	Theta star (bias corrected MLE)	0.531
nu hat (MLE)	263.1	nu star (bias corrected)	240.5
Adjusted Level of Significance (β)	0.0419		
Approximate Chi Square Value (240.48, α)	205.6	Adjusted Chi Square Value (240.48, β)	203.9
95% Gamma Approximate UCL (use when n>=50)	2.263	95% Gamma Adjusted UCL (use when n<50)	2.281

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.924	SD (KM)	0.856
Variance (KM)	0.732	SE of Mean (KM)	0.151
k hat (KM)	5.057	k star (KM)	4.618
nu hat (KM)	333.8	nu star (KM)	304.8
theta hat (KM)	0.381	theta star (KM)	0.417
80% gamma percentile (KM)	2.61	90% gamma percentile (KM)	3.124
95% gamma percentile (KM)	3.594	99% gamma percentile (KM)	4.591

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (304.77, α)	265.3	Adjusted Chi Square Value (304.77, β)	263.4
95% Gamma Approximate KM-UCL (use when n>=50)	2.21	95% Gamma Adjusted KM-UCL (use when n<50)	2.226

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.867	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.93	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.159	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.154	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.93	Mean in Log Scale	0.524
SD in Original Scale	0.86	SD in Log Scale	0.579
95% t UCL (assumes normality of ROS data)	2.184	95% Percentile Bootstrap UCL	2.165
95% BCA Bootstrap UCL	2.155	95% Bootstrap t UCL	2.182
95% H-UCL (Log ROS)	2.45		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.515	KM Geo Mean	1.673
KM SD (logged)	0.586	95% Critical H Value (KM-Log)	2.007
KM Standard Error of Mean (logged)	0.104	95% H-UCL (KM -Log)	2.446
KM SD (logged)	0.586	95% Critical H Value (KM-Log)	2.007
KM Standard Error of Mean (logged)	0.104		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	1.919	Mean in Log Scale	0.506
SD in Original Scale	0.877	SD in Log Scale	0.613
95% t UCL (Assumes normality)	2.178	95% H-Stat UCL	2.493

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.181

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	33	Number of Distinct Observations	19
		Number of Missing Observations	0
Minimum	1.2	Mean	2.315
Maximum	7.6	Median	2
SD	1.153	Std. Error of Mean	0.201
Coefficient of Variation	0.498	Skewness	3.221

Normal GOF Test

Shapiro Wilk Test Statistic	0.697	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.931	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.187	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.655	95% Adjusted-CLT UCL (Chen-1995)	2.766
		95% Modified-t UCL (Johnson-1978)	2.674

Gamma GOF Test

A-D Test Statistic	0.891	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.748	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.121	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.153	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	6.515	k star (bias corrected MLE)	5.943
Theta hat (MLE)	0.355	Theta star (bias corrected MLE)	0.39
nu hat (MLE)	430	nu star (bias corrected)	392.3
MLE Mean (bias corrected)	2.315	MLE Sd (bias corrected)	0.95
		Approximate Chi Square Value (0.05)	347.3
Adjusted Level of Significance	0.0419	Adjusted Chi Square Value	345.2

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.614	95% Adjusted Gamma UCL (use when n<50)	2.631

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.927	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.931	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0959	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.182	Mean of logged Data	0.761
Maximum of Logged Data	2.028	SD of logged Data	0.374

Assuming Lognormal Distribution

95% H-UCL	2.592	90% Chebyshev (MVUE) UCL	2.748
95% Chebyshev (MVUE) UCL	2.956	97.5% Chebyshev (MVUE) UCL	3.244
99% Chebyshev (MVUE) UCL	3.81		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.645	95% Jackknife UCL	2.655
95% Standard Bootstrap UCL	2.637	95% Bootstrap-t UCL	2.906
95% Hall's Bootstrap UCL	4.253	95% Percentile Bootstrap UCL	2.658
95% BCA Bootstrap UCL	2.794		
90% Chebyshev(Mean, Sd) UCL	2.917	95% Chebyshev(Mean, Sd) UCL	3.19
97.5% Chebyshev(Mean, Sd) UCL	3.569	99% Chebyshev(Mean, Sd) UCL	4.313

Suggested UCL to Use

95% Adjusted Gamma UCL	2.631

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-234)

General Statistics

Total Number of Observations	33	Number of Distinct Observations	21
		Number of Missing Observations	0
Minimum	0.98	Mean	2.533
Maximum	12	Median	2.1
SD	1.849	Std. Error of Mean	0.322
Coefficient of Variation	0.73	Skewness	4.42

Normal GOF Test

Shapiro Wilk Test Statistic	0.537	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.931	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.279	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.078	95% Adjusted-CLT UCL (Chen-1995)	3.327
		95% Modified-t UCL (Johnson-1978)	3.119

Gamma GOF Test

A-D Test Statistic	1.501	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.751	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.181	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.154	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.155	k star (bias corrected MLE)	3.797
Theta hat (MLE)	0.61	Theta star (bias corrected MLE)	0.667
nu hat (MLE)	274.2	nu star (bias corrected)	250.6
MLE Mean (bias corrected)	2.533	MLE Sd (bias corrected)	1.3
		Approximate Chi Square Value (0.05)	215
Adjusted Level of Significance	0.0419	Adjusted Chi Square Value	213.3

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.953	95% Adjusted Gamma UCL (use when n<50)	2.976

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.901	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.931	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.134	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal Statistics

Minimum of Logged Data	-0.0202	Mean of logged Data	0.804
Maximum of Logged Data	2.485	SD of logged Data	0.448

Assuming Lognormal Distribution

95% H-UCL	2.871	90% Chebyshev (MVUE) UCL	3.059
95% Chebyshev (MVUE) UCL	3.33	97.5% Chebyshev (MVUE) UCL	3.705
99% Chebyshev (MVUE) UCL	4.443		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.062	95% Jackknife UCL	3.078
95% Standard Bootstrap UCL	3.049	95% Bootstrap-t UCL	3.725
95% Hall's Bootstrap UCL	5.252	95% Percentile Bootstrap UCL	3.138
95% BCA Bootstrap UCL	3.469		
90% Chebyshev(Mean, Sd) UCL	3.498	95% Chebyshev(Mean, Sd) UCL	3.936
97.5% Chebyshev(Mean, Sd) UCL	4.543	99% Chebyshev(Mean, Sd) UCL	5.735

Suggested UCL to Use

95% Student's-t UCL	3.078	or 95% Modified-t UCL	3.119
or 95% H-UCL	2.871		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	33	Number of Distinct Observations	24
Number of Detects	24	Number of Non-Detects	9
Number of Distinct Detects	18	Number of Distinct Non-Detects	7
Minimum Detect	0.063	Minimum Non-Detect	0.039
Maximum Detect	0.74	Maximum Non-Detect	0.19
Variance Detects	0.0192	Percent Non-Detects	27.27%
Mean Detects	0.169	SD Detects	0.139
Median Detects	0.13	CV Detects	0.823
Skewness Detects	3.303	Kurtosis Detects	12.99
Mean of Logged Detects	-1.962	SD of Logged Detects	0.554

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.624	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.916	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.246	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.177	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.143	KM Standard Error of Mean	0.0224
KM SD	0.125	95% KM (BCA) UCL	0.192
95% KM (t) UCL	0.181	95% KM (Percentile Bootstrap) UCL	0.183
95% KM (z) UCL	0.18	95% KM Bootstrap t UCL	0.211
90% KM Chebyshev UCL	0.21	95% KM Chebyshev UCL	0.24
97.5% KM Chebyshev UCL	0.283	99% KM Chebyshev UCL	0.366

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.135	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.167	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.179	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	2.901	k star (bias corrected MLE)	2.566
Theta hat (MLE)	0.0581	Theta star (bias corrected MLE)	0.0657
nu hat (MLE)	139.2	nu star (bias corrected)	123.2
Mean (detects)	0.169		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.136
Maximum	0.74	Median	0.098
SD	0.131	CV	0.961
k hat (MLE)	1.517	k star (bias corrected MLE)	1.4
Theta hat (MLE)	0.0899	Theta star (bias corrected MLE)	0.0975
nu hat (MLE)	100.2	nu star (bias corrected)	92.38
Adjusted Level of Significance (β)	0.0419		
Approximate Chi Square Value (92.38, α)	71.21	Adjusted Chi Square Value (92.38, β)	70.26
95% Gamma Approximate UCL (use when n>=50)	0.177	95% Gamma Adjusted UCL (use when n<50)	0.179

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.143	SD (KM)	0.125
Variance (KM)	0.0156	SE of Mean (KM)	0.0224
k hat (KM)	1.311	k star (KM)	1.212
nu hat (KM)	86.5	nu star (KM)	79.97
theta hat (KM)	0.109	theta star (KM)	0.118
80% gamma percentile (KM)	0.226	90% gamma percentile (KM)	0.314
95% gamma percentile (KM)	0.4	99% gamma percentile (KM)	0.598

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (79.97, α)	60.36	Adjusted Chi Square Value (79.97, β)	59.49
95% Gamma Approximate KM-UCL (use when n>=50)	0.189	95% Gamma Adjusted KM-UCL (use when n<50)	0.192

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.916	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.129	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.177	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.143	Mean in Log Scale	-2.157
SD in Original Scale	0.126	SD in Log Scale	0.61
95% t UCL (assumes normality of ROS data)	0.18	95% Percentile Bootstrap UCL	0.186
95% BCA Bootstrap UCL	0.204	95% Bootstrap t UCL	0.215
95% H-UCL (Log ROS)	0.173		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.172	KM Geo Mean	0.114
KM SD (logged)	0.633	95% Critical H Value (KM-Log)	2.049
KM Standard Error of Mean (logged)	0.118	95% H-UCL (KM -Log)	0.175
KM SD (logged)	0.633	95% Critical H Value (KM-Log)	2.049
KM Standard Error of Mean (logged)	0.118		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.139	Mean in Log Scale	-2.232
SD in Original Scale	0.128	SD in Log Scale	0.718
95% t UCL (Assumes normality)	0.177	95% H-Stat UCL	0.182

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.192	95% GROS Adjusted Gamma UCL	0.179

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test

When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	33	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	1.1	Mean	2.63
Maximum	12	Median	2.3
SD	1.841	Std. Error of Mean	0.32
Coefficient of Variation	0.7	Skewness	4.328

Normal GOF Test

Shapiro Wilk Test Statistic	0.553	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.931	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.278	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.152	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.173	95% Adjusted-CLT UCL (Chen-1995)	3.416
		95% Modified-t UCL (Johnson-1978)	3.213

Gamma GOF Test

A-D Test Statistic	1.319	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.184	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.154	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.33	k star (bias corrected MLE)	3.957
Theta hat (MLE)	0.607	Theta star (bias corrected MLE)	0.665
nu hat (MLE)	285.8	nu star (bias corrected)	261.2
MLE Mean (bias corrected)	2.63	MLE Sd (bias corrected)	1.322
		Approximate Chi Square Value (0.05)	224.7
Adjusted Level of Significance	0.0419	Adjusted Chi Square Value	223

ProUCL 5.1 Former CLEAR Plant Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:04:52 AM
From File	**Former CLEAR Plant_Rad_All 0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.057	95% Adjusted Gamma UCL (use when n<50)	3.08

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.906	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.931	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.139	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.152	Data appear Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.0953	Mean of logged Data	0.847
Maximum of Logged Data	2.485	SD of logged Data	0.443

Assuming Lognormal Distribution

95% H-UCL	2.985	90% Chebyshev (MVUE) UCL	3.18
95% Chebyshev (MVUE) UCL	3.459	97.5% Chebyshev (MVUE) UCL	3.845
99% Chebyshev (MVUE) UCL	4.605		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.157	95% Jackknife UCL	3.173
95% Standard Bootstrap UCL	3.158	95% Bootstrap-t UCL	3.758
95% Hall's Bootstrap UCL	5.391	95% Percentile Bootstrap UCL	3.236
95% BCA Bootstrap UCL	3.542		
90% Chebyshev(Mean, Sd) UCL	3.592	95% Chebyshev(Mean, Sd) UCL	4.027
97.5% Chebyshev(Mean, Sd) UCL	4.632	99% Chebyshev(Mean, Sd) UCL	5.819

Suggested UCL to Use

95% Student's-t UCL	3.173	or 95% Modified-t UCL	3.213
or 95% H-UCL	2.985		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (antimony)

General Statistics

Total Number of Observations	114	Number of Distinct Observations	30
Number of Detects	86	Number of Non-Detects	28
Number of Distinct Detects	30	Number of Distinct Non-Detects	2
Minimum Detect	0.2	Minimum Non-Detect	0.2
Maximum Detect	69	Maximum Non-Detect	1
Variance Detects	60.64	Percent Non-Detects	24.56%
Mean Detects	2.327	SD Detects	7.787
Median Detects	0.55	CV Detects	3.347
Skewness Detects	7.692	Kurtosis Detects	64.99
Mean of Logged Detects	-0.259	SD of Logged Detects	1.171

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.281	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.392	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0957	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.86	KM Standard Error of Mean	0.638
KM SD	6.774	95% KM (BCA) UCL	3.223
95% KM (t) UCL	2.918	95% KM (Percentile Bootstrap) UCL	3.065
95% KM (z) UCL	2.91	95% KM Bootstrap t UCL	5.141
90% KM Chebyshev UCL	3.775	95% KM Chebyshev UCL	4.642
97.5% KM Chebyshev UCL	5.846	99% KM Chebyshev UCL	8.211

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	8.997	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.812	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.245	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.102	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	0.565	k star (bias corrected MLE)	0.553
Theta hat (MLE)	4.119	Theta star (bias corrected MLE)	4.209
nu hat (MLE)	97.15	nu star (bias corrected)	95.09
Mean (detects)	2.327		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.841
Maximum	69	Median	0.5
SD	6.817	CV	3.702
k hat (MLE)	0.403	k star (bias corrected MLE)	0.398
Theta hat (MLE)	4.574	Theta star (bias corrected MLE)	4.629
nu hat (MLE)	91.79	nu star (bias corrected)	90.71
Adjusted Level of Significance (β)	0.0479		
Approximate Chi Square Value (90.71, α)	69.75	Adjusted Chi Square Value (90.71, β)	69.51
95% Gamma Approximate UCL (use when n>=50)	2.395	95% Gamma Adjusted UCL (use when n<50)	2.403

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.86	SD (KM)	6.774
Variance (KM)	45.89	SE of Mean (KM)	0.638
k hat (KM)	0.0754	k star (KM)	0.0792
nu hat (KM)	17.18	nu star (KM)	18.06
theta hat (KM)	24.68	theta star (KM)	23.47
80% gamma percentile (KM)	0.869	90% gamma percentile (KM)	4.383
95% gamma percentile (KM)	10.81	99% gamma percentile (KM)	33.09

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (18.06, α)	9.437	Adjusted Chi Square Value (18.06, β)	9.357
95% Gamma Approximate KM-UCL (use when n>=50)	3.56	95% Gamma Adjusted KM-UCL (use when n<50)	3.59

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.877	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.2831E-9	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0957	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.881	Mean in Log Scale	-0.433
SD in Original Scale	6.802	SD in Log Scale	1.142
95% t UCL (assumes normality of ROS data)	2.937	95% Percentile Bootstrap UCL	2.989
95% BCA Bootstrap UCL	3.705	95% Bootstrap t UCL	4.971
95% H-UCL (Log ROS)	1.604		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.43	KM Geo Mean	0.65
KM SD (logged)	1.078	95% Critical H Value (KM-Log)	2.291
KM Standard Error of Mean (logged)	0.104	95% H-UCL (KM -Log)	1.467
KM SD (logged)	1.078	95% Critical H Value (KM-Log)	2.291
KM Standard Error of Mean (logged)	0.104		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.875	Mean in Log Scale	-0.38
SD in Original Scale	6.801	SD in Log Scale	1.048
95% t UCL (Assumes normality)	2.931	95% H-Stat UCL	1.48

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	4.642

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	119	Number of Distinct Observations	88
Number of Detects	112	Number of Non-Detects	7
Number of Distinct Detects	81	Number of Distinct Non-Detects	7
Minimum Detect	1	Minimum Non-Detect	10.1
Maximum Detect	101	Maximum Non-Detect	89.7
Variance Detects	150.7	Percent Non-Detects	5.882%
Mean Detects	7.913	SD Detects	12.27
Median Detects	4.3	CV Detects	1.551
Skewness Detects	5.204	Kurtosis Detects	33.51
Mean of Logged Detects	1.588	SD of Logged Detects	0.882

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.498	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.287	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.084	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.8	KM Standard Error of Mean	1.108
KM SD	11.95	95% KM (BCA) UCL	9.884
95% KM (t) UCL	9.637	95% KM (Percentile Bootstrap) UCL	9.853
95% KM (z) UCL	9.623	95% KM Bootstrap t UCL	10.7
90% KM Chebyshev UCL	11.12	95% KM Chebyshev UCL	12.63
97.5% KM Chebyshev UCL	14.72	99% KM Chebyshev UCL	18.83

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.217	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.778	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0886	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	1.18	k star (bias corrected MLE)	1.154
Theta hat (MLE)	6.705	Theta star (bias corrected MLE)	6.854
nu hat (MLE)	264.3	nu star (bias corrected)	258.6
Mean (detects)	7.913		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1	Mean	7.698
Maximum	101	Median	4.426
SD	11.94	CV	1.551
k hat (MLE)	1.223	k star (bias corrected MLE)	1.197
Theta hat (MLE)	6.297	Theta star (bias corrected MLE)	6.429
nu hat (MLE)	291	nu star (bias corrected)	285
Adjusted Level of Significance (β)	0.048		
Approximate Chi Square Value (284.98, α)	246.9	Adjusted Chi Square Value (284.98, β)	246.4
95% Gamma Approximate UCL (use when n>=50)	8.886	95% Gamma Adjusted UCL (use when n<50)	8.902

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.8	SD (KM)	11.95
Variance (KM)	142.8	SE of Mean (KM)	1.108
k hat (KM)	0.426	k star (KM)	0.421
nu hat (KM)	101.4	nu star (KM)	100.2
theta hat (KM)	18.3	theta star (KM)	18.52
80% gamma percentile (KM)	12.66	90% gamma percentile (KM)	21.83
95% gamma percentile (KM)	31.84	99% gamma percentile (KM)	56.87

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (100.21, α)	78.12	Adjusted Chi Square Value (100.21, β)	77.88
95% Gamma Approximate KM-UCL (use when n>=50)	10.01	95% Gamma Adjusted KM-UCL (use when n<50)	10.04

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.959	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0108	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.084	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.718	Mean in Log Scale	1.584
SD in Original Scale	11.93	SD in Log Scale	0.856
95% t UCL (assumes normality of ROS data)	9.531	95% Percentile Bootstrap UCL	9.659
95% BCA Bootstrap UCL	10.3	95% Bootstrap t UCL	10.8
95% H-UCL (Log ROS)	8.293		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.582	KM Geo Mean	4.864
KM SD (logged)	0.872	95% Critical H Value (KM-Log)	2.108
KM Standard Error of Mean (logged)	0.0821	95% H-UCL (KM -Log)	8.424
KM SD (logged)	0.872	95% Critical H Value (KM-Log)	2.108
KM Standard Error of Mean (logged)	0.0821		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	8.672	Mean in Log Scale	1.663
SD in Original Scale	12.63	SD in Log Scale	0.919
95% t UCL (Assumes normality)	10.59	95% H-Stat UCL	9.651

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	12.63

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	119	Number of Distinct Observations	117
		Number of Missing Observations	0
Minimum	62	Mean	2662
Maximum	30200	Median	763
SD	4996	Std. Error of Mean	458
Coefficient of Variation	1.877	Skewness	3.944

Normal GOF Test

Shapiro Wilk Test Statistic	0.506	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.301	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0816	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3421	95% Adjusted-CLT UCL (Chen-1995)	3592
		95% Modified-t UCL (Johnson-1978)	3448

Gamma GOF Test

A-D Test Statistic	5.502	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.802	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.196	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0883	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.674	k star (bias corrected MLE)	0.662
Theta hat (MLE)	3951	Theta star (bias corrected MLE)	4019
nu hat (MLE)	160.3	nu star (bias corrected)	157.6
MLE Mean (bias corrected)	2662	MLE Sd (bias corrected)	3271
		Approximate Chi Square Value (0.05)	129.6
Adjusted Level of Significance	0.048	Adjusted Chi Square Value	129.3

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3237	95% Adjusted Gamma UCL (use when n<50)	3245

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00477	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.134	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0816	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.127	Mean of logged Data	6.985
Maximum of Logged Data	10.32	SD of logged Data	1.277

Assuming Lognormal Distribution

95% H-UCL	3273	90% Chebyshev (MVUE) UCL	3517
95% Chebyshev (MVUE) UCL	4018	97.5% Chebyshev (MVUE) UCL	4714
99% Chebyshev (MVUE) UCL	6080		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	3415	95% Jackknife UCL	3421
95% Standard Bootstrap UCL	3427	95% Bootstrap-t UCL	3716
95% Hall's Bootstrap UCL	3631	95% Percentile Bootstrap UCL	3471
95% BCA Bootstrap UCL	3528		
90% Chebyshev(Mean, Sd) UCL	4036	95% Chebyshev(Mean, Sd) UCL	4658
97.5% Chebyshev(Mean, Sd) UCL	5522	99% Chebyshev(Mean, Sd) UCL	7219

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	4658

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	119	Number of Distinct Observations	111
		Number of Missing Observations	0
Minimum	2.81	Mean	116.4
Maximum	3740	Median	47.9
SD	359.2	Std. Error of Mean	32.93
Coefficient of Variation	3.086	Skewness	9.005

Normal GOF Test

Shapiro Wilk Test Statistic	0.28	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.376	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0816	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	171	95% Adjusted-CLT UCL (Chen-1995)	199.6
		95% Modified-t UCL (Johnson-1978)	175.5

Gamma GOF Test

A-D Test Statistic	4.764	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.806	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.155	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0886	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.636	k star (bias corrected MLE)	0.626
Theta hat (MLE)	182.9	Theta star (bias corrected MLE)	186
nu hat (MLE)	151.5	nu star (bias corrected)	149
MLE Mean (bias corrected)	116.4	MLE Sd (bias corrected)	147.2
		Approximate Chi Square Value (0.05)	121.8
Adjusted Level of Significance	0.048	Adjusted Chi Square Value	121.5

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	142.4	95% Adjusted Gamma UCL (use when n<50)	142.8

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.58	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0588	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0816	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.033	Mean of logged Data	3.795
Maximum of Logged Data	8.227	SD of logged Data	1.267

Assuming Lognormal Distribution

95% H-UCL	132.6	90% Chebyshev (MVUE) UCL	142.5
95% Chebyshev (MVUE) UCL	162.7	97.5% Chebyshev (MVUE) UCL	190.7
99% Chebyshev (MVUE) UCL	245.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	170.6	95% Jackknife UCL	171
95% Standard Bootstrap UCL	169.4	95% Bootstrap-t UCL	275.1
95% Hall's Bootstrap UCL	377.1	95% Percentile Bootstrap UCL	178.2
95% BCA Bootstrap UCL	222		
90% Chebyshev(Mean, Sd) UCL	215.2	95% Chebyshev(Mean, Sd) UCL	260
97.5% Chebyshev(Mean, Sd) UCL	322.1	99% Chebyshev(Mean, Sd) UCL	444.1

Suggested UCL to Use

95% H-UCL	132.6

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (molybdenum)

General Statistics

Total Number of Observations	119	Number of Distinct Observations	99
Number of Detects	118	Number of Non-Detects	1
Number of Distinct Detects	99	Number of Distinct Non-Detects	1
Minimum Detect	3	Minimum Non-Detect	5
Maximum Detect	6830	Maximum Non-Detect	5
Variance Detects	1669550	Percent Non-Detects	0.84%
Mean Detects	616.9	SD Detects	1292
Median Detects	134.5	CV Detects	2.095
Skewness Detects	3.51	Kurtosis Detects	12.71
Mean of Logged Detects	4.88	SD of Logged Detects	1.909

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.503	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.317	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0819	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	611.7	KM Standard Error of Mean	118.1
KM SD	1282	95% KM (BCA) UCL	819.6
95% KM (t) UCL	807.5	95% KM (Percentile Bootstrap) UCL	803.4
95% KM (z) UCL	805.9	95% KM Bootstrap t UCL	867.9
90% KM Chebyshev UCL	965.9	95% KM Chebyshev UCL	1126
97.5% KM Chebyshev UCL	1349	99% KM Chebyshev UCL	1786

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.09	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.838	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.125	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0906	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	0.422	k star (bias corrected MLE)	0.417
Theta hat (MLE)	1461	Theta star (bias corrected MLE)	1479
nu hat (MLE)	99.65	nu star (bias corrected)	98.45
Mean (detects)	616.9		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	611.7
Maximum	6830	Median	134
SD	1288	CV	2.105
k hat (MLE)	0.406	k star (bias corrected MLE)	0.402
Theta hat (MLE)	1506	Theta star (bias corrected MLE)	1523
nu hat (MLE)	96.67	nu star (bias corrected)	95.56
Adjusted Level of Significance (β)	0.048		
Approximate Chi Square Value (95.56, α)	74.02	Adjusted Chi Square Value (95.56, β)	73.78
95% Gamma Approximate UCL (use when n>=50)	789.8	95% Gamma Adjusted UCL (use when n<50)	792.3

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	611.7	SD (KM)	1282
Variance (KM)	1644631	SE of Mean (KM)	118.1
k hat (KM)	0.228	k star (KM)	0.227
nu hat (KM)	54.16	nu star (KM)	54.12
theta hat (KM)	2688	theta star (KM)	2690
80% gamma percentile (KM)	856.4	90% gamma percentile (KM)	1846
95% gamma percentile (KM)	3044	99% gamma percentile (KM)	6276

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (54.12, α)	38.22	Adjusted Chi Square Value (54.12, β)	38.06
95% Gamma Approximate KM-UCL (use when n>=50)	866.3	95% Gamma Adjusted KM-UCL (use when n<50)	870

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.964	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0294	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.065	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0819	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	611.7	Mean in Log Scale	4.844
SD in Original Scale	1288	SD in Log Scale	1.94
95% t UCL (assumes normality of ROS data)	807.5	95% Percentile Bootstrap UCL	822.4
95% BCA Bootstrap UCL	867.2	95% Bootstrap t UCL	875.2
95% H-UCL (Log ROS)	1493		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.848	KM Geo Mean	127.5
KM SD (logged)	1.924	95% Critical H Value (KM-Log)	3.242
KM Standard Error of Mean (logged)	0.177	95% H-UCL (KM -Log)	1440
KM SD (logged)	1.924	95% Critical H Value (KM-Log)	3.242
KM Standard Error of Mean (logged)	0.177		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	611.7	Mean in Log Scale	4.847
SD in Original Scale	1288	SD in Log Scale	1.935
95% t UCL (Assumes normality)	807.5	95% H-Stat UCL	1478

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 1440

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium)

General Statistics

Total Number of Observations	95	Number of Distinct Observations	89
		Number of Missing Observations	0
Minimum	1.17	Mean	5.424
Maximum	29.9	Median	4.07
SD	3.872	Std. Error of Mean	0.397
Coefficient of Variation	0.714	Skewness	3.438

Normal GOF Test

Shapiro Wilk Test Statistic	0.707	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.178	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0911	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6.083	95% Adjusted-CLT UCL (Chen-1995)	6.227
		95% Modified-t UCL (Johnson-1978)	6.107

Gamma GOF Test

A-D Test Statistic	2.629	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.142	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0924	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.356	k star (bias corrected MLE)	3.257
Theta hat (MLE)	1.616	Theta star (bias corrected MLE)	1.665
nu hat (MLE)	637.6	nu star (bias corrected)	618.8
MLE Mean (bias corrected)	5.424	MLE Sd (bias corrected)	3.005
		Approximate Chi Square Value (0.05)	562.1
Adjusted Level of Significance	0.0475	Adjusted Chi Square Value	561.2

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:38:33 AM
From File	**Esperanza Mill_Metals_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.971	95% Adjusted Gamma UCL (use when n<50)	5.98

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0575	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.114	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0911	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.157	Mean of logged Data	1.534
Maximum of Logged Data	3.398	SD of logged Data	0.524

Assuming Lognormal Distribution

95% H-UCL	5.886	90% Chebyshev (MVUE) UCL	6.221
95% Chebyshev (MVUE) UCL	6.632	97.5% Chebyshev (MVUE) UCL	7.204
99% Chebyshev (MVUE) UCL	8.326		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6.077	95% Jackknife UCL	6.083
95% Standard Bootstrap UCL	6.069	95% Bootstrap-t UCL	6.265
95% Hall's Bootstrap UCL	6.519	95% Percentile Bootstrap UCL	6.073
95% BCA Bootstrap UCL	6.22		
90% Chebyshev(Mean, Sd) UCL	6.615	95% Chebyshev(Mean, Sd) UCL	7.155
97.5% Chebyshev(Mean, Sd) UCL	7.904	99% Chebyshev(Mean, Sd) UCL	9.376

Suggested UCL to Use

95% H-UCL	5.886

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (antimony)

General Statistics

Total Number of Observations	110	Number of Distinct Observations	26
Number of Detects	82	Number of Non-Detects	28
Number of Distinct Detects	26	Number of Distinct Non-Detects	2
Minimum Detect	0.2	Minimum Non-Detect	0.2
Maximum Detect	69	Maximum Non-Detect	1
Variance Detects	63.11	Percent Non-Detects	25.45%
Mean Detects	2.215	SD Detects	7.944
Median Detects	0.5	CV Detects	3.587
Skewness Detects	7.651	Kurtosis Detects	63.55
Mean of Logged Detects	-0.338	SD of Logged Detects	1.132

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.261	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.4	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.098	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	1.759	KM Standard Error of Mean	0.658
KM SD	6.862	95% KM (BCA) UCL	3.042
95% KM (t) UCL	2.851	95% KM (Percentile Bootstrap) UCL	2.91
95% KM (z) UCL	2.842	95% KM Bootstrap t UCL	5.371
90% KM Chebyshev UCL	3.734	95% KM Chebyshev UCL	4.629
97.5% KM Chebyshev UCL	5.871	99% KM Chebyshev UCL	8.31

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	9.976	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.813	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.265	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.104	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	0.552	k star (bias corrected MLE)	0.54
Theta hat (MLE)	4.011	Theta star (bias corrected MLE)	4.101
nu hat (MLE)	90.55	nu star (bias corrected)	88.57
Mean (detects)	2.215		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	1.756
Maximum	69	Median	0.424
SD	6.906	CV	3.932
k hat (MLE)	0.399	k star (bias corrected MLE)	0.394
Theta hat (MLE)	4.402	Theta star (bias corrected MLE)	4.456
nu hat (MLE)	87.77	nu star (bias corrected)	86.71
Adjusted Level of Significance (β)	0.0478		
Approximate Chi Square Value (86.71, α)	66.25	Adjusted Chi Square Value (86.71, β)	66.01
95% Gamma Approximate UCL (use when n>=50)	2.299	95% Gamma Adjusted UCL (use when n<50)	2.307

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	1.759	SD (KM)	6.862
Variance (KM)	47.09	SE of Mean (KM)	0.658
k hat (KM)	0.0657	k star (KM)	0.07
nu hat (KM)	14.46	nu star (KM)	15.4
theta hat (KM)	26.77	theta star (KM)	25.13
80% gamma percentile (KM)	0.63	90% gamma percentile (KM)	3.796
95% gamma percentile (KM)	10.12	99% gamma percentile (KM)	33.15

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (15.40, α)	7.54	Adjusted Chi Square Value (15.40, β)	7.467
95% Gamma Approximate KM-UCL (use when n>=50)	3.593	95% Gamma Adjusted KM-UCL (use when n<50)	3.628

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.859	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.100E-10	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.17	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.098	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	1.78	Mean in Log Scale	-0.497
SD in Original Scale	6.891	SD in Log Scale	1.098
95% t UCL (assumes normality of ROS data)	2.87	95% Percentile Bootstrap UCL	3.032
95% BCA Bootstrap UCL	3.978	95% Bootstrap t UCL	5.778
95% H-UCL (Log ROS)	1.416		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-0.495	KM Geo Mean	0.61
KM SD (logged)	1.034	95% Critical H Value (KM-Log)	2.245
KM Standard Error of Mean (logged)	0.102	95% H-UCL (KM -Log)	1.299
KM SD (logged)	1.034	95% Critical H Value (KM-Log)	2.245
KM Standard Error of Mean (logged)	0.102		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.775	Mean in Log Scale	-0.443
SD in Original Scale	6.89	SD in Log Scale	1.004
95% t UCL (Assumes normality)	2.864	95% H-Stat UCL	1.316

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	4.629

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	115	Number of Distinct Observations	84
Number of Detects	112	Number of Non-Detects	3
Number of Distinct Detects	81	Number of Distinct Non-Detects	3
Minimum Detect	1	Minimum Non-Detect	35.4
Maximum Detect	101	Maximum Non-Detect	89.7
Variance Detects	150.7	Percent Non-Detects	2.609%
Mean Detects	7.913	SD Detects	12.27
Median Detects	4.3	CV Detects	1.551
Skewness Detects	5.204	Kurtosis Detects	33.51
Mean of Logged Detects	1.588	SD of Logged Detects	0.882

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.498	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.287	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.084	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.879	KM Standard Error of Mean	1.14
KM SD	12.11	95% KM (BCA) UCL	9.908
95% KM (t) UCL	9.769	95% KM (Percentile Bootstrap) UCL	9.88
95% KM (z) UCL	9.754	95% KM Bootstrap t UCL	11.2
90% KM Chebyshev UCL	11.3	95% KM Chebyshev UCL	12.85
97.5% KM Chebyshev UCL	15	99% KM Chebyshev UCL	19.22

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	4.217	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.778	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.178	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0886	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	1.18	k star (bias corrected MLE)	1.154
Theta hat (MLE)	6.705	Theta star (bias corrected MLE)	6.854
nu hat (MLE)	264.3	nu star (bias corrected)	258.6
Mean (detects)	7.913		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1	Mean	7.828
Maximum	101	Median	4.5
SD	12.12	CV	1.549
k hat (MLE)	1.202	k star (bias corrected MLE)	1.176
Theta hat (MLE)	6.515	Theta star (bias corrected MLE)	6.656
nu hat (MLE)	276.4	nu star (bias corrected)	270.5
Adjusted Level of Significance (β)	0.0479		
Approximate Chi Square Value (270.49, α)	233.4	Adjusted Chi Square Value (270.49, β)	233
95% Gamma Approximate UCL (use when n>=50)	9.072	95% Gamma Adjusted UCL (use when n<50)	9.089

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.879	SD (KM)	12.11
Variance (KM)	146.7	SE of Mean (KM)	1.14
k hat (KM)	0.423	k star (KM)	0.418
nu hat (KM)	97.31	nu star (KM)	96.11
theta hat (KM)	18.62	theta star (KM)	18.86
80% gamma percentile (KM)	12.78	90% gamma percentile (KM)	22.08
95% gamma percentile (KM)	32.24	99% gamma percentile (KM)	57.69

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (96.11, α)	74.5	Adjusted Chi Square Value (96.11, β)	74.26
95% Gamma Approximate KM-UCL (use when n>=50)	10.17	95% Gamma Adjusted KM-UCL (use when n<50)	10.2

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.959	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0108	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.107	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.084	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.831	Mean in Log Scale	1.588
SD in Original Scale	12.12	SD in Log Scale	0.87
95% t UCL (assumes normality of ROS data)	9.706	95% Percentile Bootstrap UCL	9.834
95% BCA Bootstrap UCL	10.62	95% Bootstrap t UCL	11.13
95% H-UCL (Log ROS)	8.48		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.587	KM Geo Mean	4.889
KM SD (logged)	0.876	95% Critical H Value (KM-Log)	2.108
KM Standard Error of Mean (logged)	0.083	95% H-UCL (KM -Log)	8.531
KM SD (logged)	0.876	95% Critical H Value (KM-Log)	2.108
KM Standard Error of Mean (logged)	0.083		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	8.511	Mean in Log Scale	1.635
SD in Original Scale	12.78	SD in Log Scale	0.917
95% t UCL (Assumes normality)	10.49	95% H-Stat UCL	9.387

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	12.85

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (copper)

General Statistics

Total Number of Observations	115	Number of Distinct Observations	113
		Number of Missing Observations	0
Minimum	62	Mean	2554
Maximum	30200	Median	733
SD	5041	Std. Error of Mean	470
Coefficient of Variation	1.973	Skewness	4.029

Normal GOF Test

Shapiro Wilk Test Statistic	0.482	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.31	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0829	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3334	95% Adjusted-CLT UCL (Chen-1995)	3516
		95% Modified-t UCL (Johnson-1978)	3363

Gamma GOF Test

A-D Test Statistic	6.117	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.803	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.203	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0895	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.664	k star (bias corrected MLE)	0.652
Theta hat (MLE)	3849	Theta star (bias corrected MLE)	3917
nu hat (MLE)	152.6	nu star (bias corrected)	150
MLE Mean (bias corrected)	2554	MLE Sd (bias corrected)	3163
		Approximate Chi Square Value (0.05)	122.7
Adjusted Level of Significance	0.0479	Adjusted Chi Square Value	122.4

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3123	95% Adjusted Gamma UCL (use when n<50)	3131

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00276	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.136	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0829	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.127	Mean of logged Data	6.928
Maximum of Logged Data	10.32	SD of logged Data	1.26

Assuming Lognormal Distribution

95% H-UCL	3023	90% Chebyshev (MVUE) UCL	3251
95% Chebyshev (MVUE) UCL	3714	97.5% Chebyshev (MVUE) UCL	4356
99% Chebyshev (MVUE) UCL	5617		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	3327	95% Jackknife UCL	3334
95% Standard Bootstrap UCL	3333	95% Bootstrap-t UCL	3694
95% Hall's Bootstrap UCL	3536	95% Percentile Bootstrap UCL	3352
95% BCA Bootstrap UCL	3553		
90% Chebyshev(Mean, Sd) UCL	3964	95% Chebyshev(Mean, Sd) UCL	4603
97.5% Chebyshev(Mean, Sd) UCL	5490	99% Chebyshev(Mean, Sd) UCL	7231

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	4603

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (lead)

General Statistics

Total Number of Observations	115	Number of Distinct Observations	108
		Number of Missing Observations	0
Minimum	2.81	Mean	117
Maximum	3740	Median	46.3
SD	365.5	Std. Error of Mean	34.08
Coefficient of Variation	3.124	Skewness	8.853

Normal GOF Test

Shapiro Wilk Test Statistic	0.281	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.377	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0829	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	173.5	95% Adjusted-CLT UCL (Chen-1995)	203.1
		95% Modified-t UCL (Johnson-1978)	178.2

Gamma GOF Test

A-D Test Statistic	4.924	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.808	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.162	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0898	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.618	k star (bias corrected MLE)	0.608
Theta hat (MLE)	189.3	Theta star (bias corrected MLE)	192.6
nu hat (MLE)	142.1	nu star (bias corrected)	139.8
MLE Mean (bias corrected)	117	MLE Sd (bias corrected)	150.1
		Approximate Chi Square Value (0.05)	113.4
Adjusted Level of Significance	0.0479	Adjusted Chi Square Value	113.1

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	144.1	95% Adjusted Gamma UCL (use when n<50)	144.5

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.982	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.605	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0524	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0829	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.033	Mean of logged Data	3.767
Maximum of Logged Data	8.227	SD of logged Data	1.28

Assuming Lognormal Distribution

95% H-UCL	132.2	90% Chebyshev (MVUE) UCL	142.1
95% Chebyshev (MVUE) UCL	162.6	97.5% Chebyshev (MVUE) UCL	191.1
99% Chebyshev (MVUE) UCL	247.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	173.1	95% Jackknife UCL	173.5
95% Standard Bootstrap UCL	171.3	95% Bootstrap-t UCL	283.4
95% Hall's Bootstrap UCL	384.8	95% Percentile Bootstrap UCL	180.5
95% BCA Bootstrap UCL	218.4		
90% Chebyshev(Mean, Sd) UCL	219.2	95% Chebyshev(Mean, Sd) UCL	265.6
97.5% Chebyshev(Mean, Sd) UCL	329.8	99% Chebyshev(Mean, Sd) UCL	456.1

Suggested UCL to Use

95% H-UCL	132.2

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (molybdenum)

General Statistics

Total Number of Observations	115	Number of Distinct Observations	96
Number of Detects	114	Number of Non-Detects	1
Number of Distinct Detects	96	Number of Distinct Non-Detects	1
Minimum Detect	3	Minimum Non-Detect	5
Maximum Detect	6830	Maximum Non-Detect	5
Variance Detects	1717407	Percent Non-Detects	0.87%
Mean Detects	602.4	SD Detects	1310
Median Detects	123	CV Detects	2.175
Skewness Detects	3.516	Kurtosis Detects	12.55
Mean of Logged Detects	4.81	SD of Logged Detects	1.903

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.488	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.324	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0833	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	597.2	KM Standard Error of Mean	121.8
KM SD	1300	95% KM (BCA) UCL	831.4
95% KM (t) UCL	799.2	95% KM (Percentile Bootstrap) UCL	804.7
95% KM (z) UCL	797.5	95% KM Bootstrap t UCL	856.6
90% KM Chebyshev UCL	962.6	95% KM Chebyshev UCL	1128
97.5% KM Chebyshev UCL	1358	99% KM Chebyshev UCL	1809

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	3.601	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.84	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.138	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0918	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.412	k star (bias corrected MLE)	0.407
Theta hat (MLE)	1463	Theta star (bias corrected MLE)	1481
nu hat (MLE)	93.88	nu star (bias corrected)	92.74
Mean (detects)	602.4		

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	597.2
Maximum	6830	Median	122
SD	1306	CV	2.187
k hat (MLE)	0.396	k star (bias corrected MLE)	0.392
Theta hat (MLE)	1508	Theta star (bias corrected MLE)	1525
nu hat (MLE)	91.1	nu star (bias corrected)	90.06
Adjusted Level of Significance (β)	0.0479		
Approximate Chi Square Value (90.06, α)	69.18	Adjusted Chi Square Value (90.06, β)	68.95
95% Gamma Approximate UCL (use when n>=50)	777.4	95% Gamma Adjusted UCL (use when n<50)	780

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	597.2	SD (KM)	1300
Variance (KM)	1690636	SE of Mean (KM)	121.8
k hat (KM)	0.211	k star (KM)	0.211
nu hat (KM)	48.52	nu star (KM)	48.59
theta hat (KM)	2831	theta star (KM)	2827
80% gamma percentile (KM)	808.8	90% gamma percentile (KM)	1806
95% gamma percentile (KM)	3033	99% gamma percentile (KM)	6381

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (48.59, α)	33.59	Adjusted Chi Square Value (48.59, β)	33.43
95% Gamma Approximate KM-UCL (use when n>=50)	863.9	95% Gamma Adjusted KM-UCL (use when n<50)	868

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.965	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.0425	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0645	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0833	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	597.2	Mean in Log Scale	4.774
SD in Original Scale	1306	SD in Log Scale	1.935
95% t UCL (assumes normality of ROS data)	799.1	95% Percentile Bootstrap UCL	803.9
95% BCA Bootstrap UCL	858.3	95% Bootstrap t UCL	871.8
95% H-UCL (Log ROS)	1386		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.778	KM Geo Mean	118.9
KM SD (logged)	1.918	95% Critical H Value (KM-Log)	3.226
KM Standard Error of Mean (logged)	0.18	95% H-UCL (KM -Log)	1335
KM SD (logged)	1.918	95% Critical H Value (KM-Log)	3.226
KM Standard Error of Mean (logged)	0.18		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	597.2	Mean in Log Scale	4.776
SD in Original Scale	1306	SD in Log Scale	1.929
95% t UCL (Assumes normality)	799.2	95% H-Stat UCL	1371

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 1335

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium)

General Statistics

Total Number of Observations	91	Number of Distinct Observations	85
		Number of Missing Observations	0
Minimum	1.17	Mean	5.39
Maximum	29.9	Median	4.07
SD	3.888	Std. Error of Mean	0.408
Coefficient of Variation	0.721	Skewness	3.548

Normal GOF Test

Shapiro Wilk Test Statistic	0.691	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0931	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6.068	95% Adjusted-CLT UCL (Chen-1995)	6.223
		95% Modified-t UCL (Johnson-1978)	6.093

Gamma GOF Test

A-D Test Statistic	2.78	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.758	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0943	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.386	k star (bias corrected MLE)	3.281
Theta hat (MLE)	1.592	Theta star (bias corrected MLE)	1.643
nu hat (MLE)	616.2	nu star (bias corrected)	597.2
MLE Mean (bias corrected)	5.39	MLE Sd (bias corrected)	2.976
		Approximate Chi Square Value (0.05)	541.5
Adjusted Level of Significance	0.0474	Adjusted Chi Square Value	540.7

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 10:48:51 AM
From File	**Esperanza Mill_Metals_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.945	95% Adjusted Gamma UCL (use when n<50)	5.954

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.958	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0234	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.113	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0931	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.157	Mean of logged Data	1.53
Maximum of Logged Data	3.398	SD of logged Data	0.518

Assuming Lognormal Distribution

95% H-UCL	5.845	90% Chebyshev (MVUE) UCL	6.182
95% Chebyshev (MVUE) UCL	6.594	97.5% Chebyshev (MVUE) UCL	7.166
99% Chebyshev (MVUE) UCL	8.29		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	6.061	95% Jackknife UCL	6.068
95% Standard Bootstrap UCL	6.065	95% Bootstrap-t UCL	6.341
95% Hall's Bootstrap UCL	6.486	95% Percentile Bootstrap UCL	6.12
95% BCA Bootstrap UCL	6.237		
90% Chebyshev(Mean, Sd) UCL	6.613	95% Chebyshev(Mean, Sd) UCL	7.167
97.5% Chebyshev(Mean, Sd) UCL	7.936	99% Chebyshev(Mean, Sd) UCL	9.446

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	7.167

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:56:59 PM
From File	**Esperanza Mill_Metals_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	66
Number of Detects	76	Number of Non-Detects	6
Number of Distinct Detects	60	Number of Distinct Non-Detects	6
Minimum Detect	1	Minimum Non-Detect	10.1
Maximum Detect	101	Maximum Non-Detect	89.7
Variance Detects	155.5	Percent Non-Detects	7.317%
Mean Detects	7.982	SD Detects	12.47
Median Detects	4.3	CV Detects	1.562
Skewness Detects	5.896	Kurtosis Detects	42.09
Mean of Logged Detects	1.627	SD of Logged Detects	0.861

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.468	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.288	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.102	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	7.844	KM Standard Error of Mean	1.347
KM SD	12.02	95% KM (BCA) UCL	10.25
95% KM (t) UCL	10.08	95% KM (Percentile Bootstrap) UCL	10.32
95% KM (z) UCL	10.06	95% KM Bootstrap t UCL	12.34
90% KM Chebyshev UCL	11.88	95% KM Chebyshev UCL	13.71
97.5% KM Chebyshev UCL	16.25	99% KM Chebyshev UCL	21.24

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.625	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.776	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.179	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.105	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:56:59 PM
From File	**Esperanza Mill_Metals_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	1.251	k star (bias corrected MLE)	1.21
Theta hat (MLE)	6.383	Theta star (bias corrected MLE)	6.597
nu hat (MLE)	190.1	nu star (bias corrected)	183.9
Mean (detects)	7.982		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1	Mean	7.725
Maximum	101	Median	4.55
SD	12.04	CV	1.558
k hat (MLE)	1.308	k star (bias corrected MLE)	1.268
Theta hat (MLE)	5.907	Theta star (bias corrected MLE)	6.092
nu hat (MLE)	214.5	nu star (bias corrected)	208
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (207.97, α)	175.6	Adjusted Chi Square Value (207.97, β)	175.1
95% Gamma Approximate UCL (use when n>=50)	9.149	95% Gamma Adjusted UCL (use when n<50)	9.176

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	7.844	SD (KM)	12.02
Variance (KM)	144.6	SE of Mean (KM)	1.347
k hat (KM)	0.426	k star (KM)	0.418
nu hat (KM)	69.79	nu star (KM)	68.57
theta hat (KM)	18.43	theta star (KM)	18.76
80% gamma percentile (KM)	12.72	90% gamma percentile (KM)	21.98
95% gamma percentile (KM)	32.09	99% gamma percentile (KM)	57.41

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (68.57, α)	50.51	Adjusted Chi Square Value (68.57, β)	50.23
95% Gamma Approximate KM-UCL (use when n>=50)	10.65	95% Gamma Adjusted KM-UCL (use when n<50)	10.71

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:56:59 PM
From File	**Esperanza Mill_Metals_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.967	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.142	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.113	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.102	Detected Data Not Lognormal at 5% Significance Level

Detected Data appear Approximate Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	7.745	Mean in Log Scale	1.621
SD in Original Scale	12.03	SD in Log Scale	0.829
95% t UCL (assumes normality of ROS data)	9.956	95% Percentile Bootstrap UCL	10.05
95% BCA Bootstrap UCL	11.7	95% Bootstrap t UCL	12.46
95% H-UCL (Log ROS)	8.643		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.619	KM Geo Mean	5.047
KM SD (logged)	0.848	95% Critical H Value (KM-Log)	2.095
KM Standard Error of Mean (logged)	0.0971	95% H-UCL (KM -Log)	8.812
KM SD (logged)	0.848	95% Critical H Value (KM-Log)	2.095
KM Standard Error of Mean (logged)	0.0971		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	8.809	Mean in Log Scale	1.71
SD in Original Scale	12.81	SD in Log Scale	0.898
95% t UCL (Assumes normality)	11.16	95% H-Stat UCL	10.24

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL	8.812

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:56:59 PM
From File	**Esperanza Mill_Metals_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (molybdenum)

General Statistics

Total Number of Observations	82	Number of Distinct Observations	73
Number of Detects	81	Number of Non-Detects	1
Number of Distinct Detects	72	Number of Distinct Non-Detects	1
Minimum Detect	3	Minimum Non-Detect	5
Maximum Detect	6830	Maximum Non-Detect	5
Variance Detects	1542342	Percent Non-Detects	1.22%
Mean Detects	624.8	SD Detects	1242
Median Detects	154	CV Detects	1.988
Skewness Detects	3.621	Kurtosis Detects	14.25
Mean of Logged Detects	5.077	SD of Logged Detects	1.793

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.523	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.308	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	617.2	KM Standard Error of Mean	136.5
KM SD	1229	95% KM (BCA) UCL	835.2
95% KM (t) UCL	844.3	95% KM (Percentile Bootstrap) UCL	851
95% KM (z) UCL	841.7	95% KM Bootstrap t UCL	948.6
90% KM Chebyshev UCL	1027	95% KM Chebyshev UCL	1212
97.5% KM Chebyshev UCL	1470	99% KM Chebyshev UCL	1976

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.862	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.826	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.134	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.105	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:56:59 PM
From File	**Esperanza Mill_Metals_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	0.471	k star (bias corrected MLE)	0.462
Theta hat (MLE)	1325	Theta star (bias corrected MLE)	1352
nu hat (MLE)	76.37	nu star (bias corrected)	74.87
Mean (detects)	624.8		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	617.1
Maximum	6830	Median	152.5
SD	1236	CV	2.003
k hat (MLE)	0.442	k star (bias corrected MLE)	0.434
Theta hat (MLE)	1397	Theta star (bias corrected MLE)	1423
nu hat (MLE)	72.46	nu star (bias corrected)	71.15
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (71.15, α)	52.73	Adjusted Chi Square Value (71.15, β)	52.44
95% Gamma Approximate UCL (use when n>=50)	832.7	95% Gamma Adjusted UCL (use when n<50)	837.2

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	617.2	SD (KM)	1229
Variance (KM)	1509380	SE of Mean (KM)	136.5
k hat (KM)	0.252	k star (KM)	0.251
nu hat (KM)	41.39	nu star (KM)	41.21
theta hat (KM)	2446	theta star (KM)	2456
80% gamma percentile (KM)	897.9	90% gamma percentile (KM)	1852
95% gamma percentile (KM)	2983	99% gamma percentile (KM)	5992

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (41.21, α)	27.49	Adjusted Chi Square Value (41.21, β)	27.29
95% Gamma Approximate KM-UCL (use when n>=50)	925	95% Gamma Adjusted KM-UCL (use when n<50)	931.8

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:56:59 PM
From File	**Esperanza Mill_Metals_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.974	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.33	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.057	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	617.2	Mean in Log Scale	5.029
SD in Original Scale	1236	SD in Log Scale	1.836
95% t UCL (assumes normality of ROS data)	844.3	95% Percentile Bootstrap UCL	866.9
95% BCA Bootstrap UCL	884.3	95% Bootstrap t UCL	951.2
95% H-UCL (Log ROS)	1570		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	5.029	KM Geo Mean	152.8
KM SD (logged)	1.824	95% Critical H Value (KM-Log)	3.145
KM Standard Error of Mean (logged)	0.203	95% H-UCL (KM -Log)	1526
KM SD (logged)	1.824	95% Critical H Value (KM-Log)	3.145
KM Standard Error of Mean (logged)	0.203		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	617.2	Mean in Log Scale	5.027
SD in Original Scale	1236	SD in Log Scale	1.84
95% t UCL (Assumes normality)	844.3	95% H-Stat UCL	1584

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM H-UCL 1526

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:05:44 AM
From File	**Esperanza Mill_Metals_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (arsenic)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	41
Number of Detects	42	Number of Non-Detects	3
Number of Distinct Detects	38	Number of Distinct Non-Detects	3
Minimum Detect	1.4	Minimum Non-Detect	10.1
Maximum Detect	101	Maximum Non-Detect	35.4
Variance Detects	247.4	Percent Non-Detects	6.667%
Mean Detects	9.535	SD Detects	15.73
Median Detects	5.055	CV Detects	1.65
Skewness Detects	5.123	Kurtosis Detects	29.28
Mean of Logged Detects	1.794	SD of Logged Detects	0.835

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.424	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.942	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.321	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	9.306	KM Standard Error of Mean	2.283
KM SD	15.09	95% KM (BCA) UCL	13.88
95% KM (t) UCL	13.14	95% KM (Percentile Bootstrap) UCL	13.36
95% KM (z) UCL	13.06	95% KM Bootstrap t UCL	20.64
90% KM Chebyshev UCL	16.16	95% KM Chebyshev UCL	19.26
97.5% KM Chebyshev UCL	23.57	99% KM Chebyshev UCL	32.03

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.307	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.773	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.204	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.14	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:05:44 AM
From File	**Esperanza Mill_Metals_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	1.224	k star (bias corrected MLE)	1.153
Theta hat (MLE)	7.787	Theta star (bias corrected MLE)	8.271
nu hat (MLE)	102.9	nu star (bias corrected)	96.84
Mean (detects)	9.535		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.4	Mean	9.19
Maximum	101	Median	5.1
SD	15.24	CV	1.659
k hat (MLE)	1.251	k star (bias corrected MLE)	1.183
Theta hat (MLE)	7.343	Theta star (bias corrected MLE)	7.769
nu hat (MLE)	112.6	nu star (bias corrected)	106.5
Adjusted Level of Significance (β)	0.0447		
Approximate Chi Square Value (106.45, α)	83.64	Adjusted Chi Square Value (106.45, β)	82.97
95% Gamma Approximate UCL (use when n>=50)	11.7	95% Gamma Adjusted UCL (use when n<50)	11.79

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	9.306	SD (KM)	15.09
Variance (KM)	227.6	SE of Mean (KM)	2.283
k hat (KM)	0.381	k star (KM)	0.37
nu hat (KM)	34.25	nu star (KM)	33.3
theta hat (KM)	24.46	theta star (KM)	25.15
80% gamma percentile (KM)	14.87	90% gamma percentile (KM)	26.64
95% gamma percentile (KM)	39.72	99% gamma percentile (KM)	72.88

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (33.30, α)	21.1	Adjusted Chi Square Value (33.30, β)	20.78
95% Gamma Approximate KM-UCL (use when n>=50)	14.68	95% Gamma Adjusted KM-UCL (use when n<50)	14.91

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:05:44 AM
From File	**Esperanza Mill_Metals_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.897	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.942	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.155	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.135	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	9.25	Mean in Log Scale	1.784
SD in Original Scale	15.22	SD in Log Scale	0.807
95% t UCL (assumes normality of ROS data)	13.06	95% Percentile Bootstrap UCL	13.39
95% BCA Bootstrap UCL	15.99	95% Bootstrap t UCL	19.63
95% H-UCL (Log ROS)	10.74		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	1.781	KM Geo Mean	5.934
KM SD (logged)	0.815	95% Critical H Value (KM-Log)	2.176
KM Standard Error of Mean (logged)	0.125	95% H-UCL (KM -Log)	10.81
KM SD (logged)	0.815	95% Critical H Value (KM-Log)	2.176
KM Standard Error of Mean (logged)	0.125		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	9.765	Mean in Log Scale	1.836
SD in Original Scale	15.28	SD in Log Scale	0.835
95% t UCL (Assumes normality)	13.59	95% H-Stat UCL	11.72

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (Chebyshev) UCL	19.26

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:05:44 AM
From File	**Esperanza Mill_Metals_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (molybdenum)

General Statistics

Total Number of Observations	45	Number of Distinct Observations	44
		Number of Missing Observations	0
Minimum	7	Mean	856.9
Maximum	6830	Median	230
SD	1534	Std. Error of Mean	228.6
Coefficient of Variation	1.79	Skewness	2.968

Normal GOF Test

Shapiro Wilk Test Statistic	0.564	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.29	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.131	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1241	95% Adjusted-CLT UCL (Chen-1995)	1341
		95% Modified-t UCL (Johnson-1978)	1258

Gamma GOF Test

A-D Test Statistic	1.494	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.809	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.139	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.546	k star (bias corrected MLE)	0.524
Theta hat (MLE)	1570	Theta star (bias corrected MLE)	1634
nu hat (MLE)	49.12	nu star (bias corrected)	47.18
MLE Mean (bias corrected)	856.9	MLE Sd (bias corrected)	1183
		Approximate Chi Square Value (0.05)	32.42
Adjusted Level of Significance	0.0447	Adjusted Chi Square Value	32.01

ProUCL 5.1 Esperanza Mill Metals

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:05:44 AM
From File	**Esperanza Mill_Metals_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1247	95% Adjusted Gamma UCL (use when n<50)	1263

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.976	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.945	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.101	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.131	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.946	Mean of logged Data	5.605
Maximum of Logged Data	8.829	SD of logged Data	1.596

Assuming Lognormal Distribution

95% H-UCL	2059	90% Chebyshev (MVUE) UCL	1792
95% Chebyshev (MVUE) UCL	2190	97.5% Chebyshev (MVUE) UCL	2741
99% Chebyshev (MVUE) UCL	3824		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1233	95% Jackknife UCL	1241
95% Standard Bootstrap UCL	1221	95% Bootstrap-t UCL	1451
95% Hall's Bootstrap UCL	1399	95% Percentile Bootstrap UCL	1241
95% BCA Bootstrap UCL	1322		
90% Chebyshev(Mean, Sd) UCL	1543	95% Chebyshev(Mean, Sd) UCL	1853
97.5% Chebyshev(Mean, Sd) UCL	2285	99% Chebyshev(Mean, Sd) UCL	3132

Suggested UCL to Use

95% Chebyshev (Mean, Sd) UCL	1853

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	88	Number of Distinct Observations	41
		Number of Missing Observations	0
Minimum	0.54	Mean	2.235
Maximum	5.8	Median	2.05
SD	1.037	Std. Error of Mean	0.111
Coefficient of Variation	0.464	Skewness	1.058

Normal GOF Test

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	6.1534E-5	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.109	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0946	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.419	95% Adjusted-CLT UCL (Chen-1995)	2.43
		95% Modified-t UCL (Johnson-1978)	2.421

Gamma GOF Test

A-D Test Statistic	0.463	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0675	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0956	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.827	k star (bias corrected MLE)	4.67
Theta hat (MLE)	0.463	Theta star (bias corrected MLE)	0.479
nu hat (MLE)	849.5	nu star (bias corrected)	821.9
MLE Mean (bias corrected)	2.235	MLE Sd (bias corrected)	1.034
		Approximate Chi Square Value (0.05)	756.4
Adjusted Level of Significance	0.0473	Adjusted Chi Square Value	755.3

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.429	95% Adjusted Gamma UCL (use when n<50)	2.432

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.969	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.158	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0916	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0946	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.616	Mean of logged Data	0.697
Maximum of Logged Data	1.758	SD of logged Data	0.48

Assuming Lognormal Distribution

95% H-UCL	2.476	90% Chebyshev (MVUE) UCL	2.612
95% Chebyshev (MVUE) UCL	2.776	97.5% Chebyshev (MVUE) UCL	3.004
99% Chebyshev (MVUE) UCL	3.452		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.417	95% Jackknife UCL	2.419
95% Standard Bootstrap UCL	2.418	95% Bootstrap-t UCL	2.424
95% Hall's Bootstrap UCL	2.445	95% Percentile Bootstrap UCL	2.419
95% BCA Bootstrap UCL	2.427		
90% Chebyshev(Mean, Sd) UCL	2.567	95% Chebyshev(Mean, Sd) UCL	2.717
97.5% Chebyshev(Mean, Sd) UCL	2.926	99% Chebyshev(Mean, Sd) UCL	3.335

Suggested UCL to Use

95% Approximate Gamma UCL	2.429

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	88	Number of Distinct Observations	28
Number of Detects	85	Number of Non-Detects	3
Number of Distinct Detects	28	Number of Distinct Non-Detects	3
Minimum Detect	1	Minimum Non-Detect	2
Maximum Detect	8.9	Maximum Non-Detect	2.5
Variance Detects	1.074	Percent Non-Detects	3.409%
Mean Detects	2.305	SD Detects	1.036
Median Detects	2.1	CV Detects	0.45
Skewness Detects	3.651	Kurtosis Detects	19.59
Mean of Logged Detects	0.77	SD of Logged Detects	0.338

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.709	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.211	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0962	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.287	KM Standard Error of Mean	0.109
KM SD	1.019	95% KM (BCA) UCL	2.483
95% KM (t) UCL	2.469	95% KM (Percentile Bootstrap) UCL	2.481
95% KM (z) UCL	2.467	95% KM Bootstrap t UCL	2.557
90% KM Chebyshev UCL	2.615	95% KM Chebyshev UCL	2.764
97.5% KM Chebyshev UCL	2.97	99% KM Chebyshev UCL	3.376

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.631	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.753	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.149	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.097	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	7.853	k star (bias corrected MLE)	7.583
Theta hat (MLE)	0.293	Theta star (bias corrected MLE)	0.304
nu hat (MLE)	1335	nu star (bias corrected)	1289
Mean (detects)	2.305		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1	Mean	2.286
Maximum	8.9	Median	2.1
SD	1.024	CV	0.448
k hat (MLE)	7.952	k star (bias corrected MLE)	7.689
Theta hat (MLE)	0.287	Theta star (bias corrected MLE)	0.297
nu hat (MLE)	1400	nu star (bias corrected)	1353
Adjusted Level of Significance (β)	0.0473		
Approximate Chi Square Value (N/A, α)	1269	Adjusted Chi Square Value (N/A, β)	1267
95% Gamma Approximate UCL (use when n>=50)	2.438	95% Gamma Adjusted UCL (use when n<50)	2.44

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.287	SD (KM)	1.019
Variance (KM)	1.037	SE of Mean (KM)	0.109
k hat (KM)	5.043	k star (KM)	4.879
nu hat (KM)	887.6	nu star (KM)	858.7
theta hat (KM)	0.454	theta star (KM)	0.469
80% gamma percentile (KM)	3.083	90% gamma percentile (KM)	3.674
95% gamma percentile (KM)	4.213	99% gamma percentile (KM)	5.353

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (858.68, α)	791.7	Adjusted Chi Square Value (858.68, β)	790.6
95% Gamma Approximate KM-UCL (use when n>=50)	2.481	95% Gamma Adjusted KM-UCL (use when n<50)	2.484

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.94	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	9.4053E-4	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.119	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0962	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.288	Mean in Log Scale	0.764
SD in Original Scale	1.023	SD in Log Scale	0.334
95% t UCL (assumes normality of ROS data)	2.469	95% Percentile Bootstrap UCL	2.473
95% BCA Bootstrap UCL	2.506	95% Bootstrap t UCL	2.546
95% H-UCL (Log ROS)	2.417		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.763	KM Geo Mean	2.145
KM SD (logged)	0.334	95% Critical H Value (KM-Log)	1.758
KM Standard Error of Mean (logged)	0.036	95% H-UCL (KM -Log)	2.415
KM SD (logged)	0.334	95% Critical H Value (KM-Log)	1.758
KM Standard Error of Mean (logged)	0.036		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.265	Mean in Log Scale	0.748
SD in Original Scale	1.04	SD in Log Scale	0.352
95% t UCL (Assumes normality)	2.45	95% H-Stat UCL	2.404

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.469	KM H-UCL	2.415
95% KM (BCA) UCL	2.483		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-234)

General Statistics

Total Number of Observations	88	Number of Distinct Observations	34
		Number of Missing Observations	0
Minimum	0.85	Mean	2.427
Maximum	12	Median	2
SD	1.463	Std. Error of Mean	0.156
Coefficient of Variation	0.603	Skewness	3.785

Normal GOF Test

Shapiro Wilk Test Statistic	0.695	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0946	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.686	95% Adjusted-CLT UCL (Chen-1995)	2.751
		95% Modified-t UCL (Johnson-1978)	2.697

Gamma GOF Test

A-D Test Statistic	2.376	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.147	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0956	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.729	k star (bias corrected MLE)	4.576
Theta hat (MLE)	0.513	Theta star (bias corrected MLE)	0.53
nu hat (MLE)	832.4	nu star (bias corrected)	805.3
MLE Mean (bias corrected)	2.427	MLE Sd (bias corrected)	1.135
		Approximate Chi Square Value (0.05)	740.5
Adjusted Level of Significance	0.0473	Adjusted Chi Square Value	739.5

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.64	95% Adjusted Gamma UCL (use when n<50)	2.643

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.955	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0144	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.115	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0946	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.163	Mean of logged Data	0.777
Maximum of Logged Data	2.485	SD of logged Data	0.436

Assuming Lognormal Distribution

95% H-UCL	2.603	90% Chebyshev (MVUE) UCL	2.736
95% Chebyshev (MVUE) UCL	2.893	97.5% Chebyshev (MVUE) UCL	3.111
99% Chebyshev (MVUE) UCL	3.539		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2.684	95% Jackknife UCL	2.686
95% Standard Bootstrap UCL	2.682	95% Bootstrap-t UCL	2.801
95% Hall's Bootstrap UCL	2.99	95% Percentile Bootstrap UCL	2.696
95% BCA Bootstrap UCL	2.784		
90% Chebyshev(Mean, Sd) UCL	2.895	95% Chebyshev(Mean, Sd) UCL	3.107
97.5% Chebyshev(Mean, Sd) UCL	3.401	99% Chebyshev(Mean, Sd) UCL	3.978

Suggested UCL to Use

95% Student's-t UCL	2.686	or 95% Modified-t UCL	2.697

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	88	Number of Distinct Observations	44
Number of Detects	68	Number of Non-Detects	20
Number of Distinct Detects	38	Number of Distinct Non-Detects	18
Minimum Detect	0.042	Minimum Non-Detect	0.042
Maximum Detect	0.57	Maximum Non-Detect	0.2
Variance Detects	0.00613	Percent Non-Detects	22.73%
Mean Detects	0.135	SD Detects	0.0783
Median Detects	0.115	CV Detects	0.579
Skewness Detects	2.963	Kurtosis Detects	13.59
Mean of Logged Detects	-2.116	SD of Logged Detects	0.462

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.765	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	1.099E-14	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.119	KM Standard Error of Mean	0.00821
KM SD	0.0759	95% KM (BCA) UCL	0.133
95% KM (t) UCL	0.132	95% KM (Percentile Bootstrap) UCL	0.133
95% KM (z) UCL	0.132	95% KM Bootstrap t UCL	0.135
90% KM Chebyshev UCL	0.143	95% KM Chebyshev UCL	0.154
97.5% KM Chebyshev UCL	0.17	99% KM Chebyshev UCL	0.2

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.19	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.13	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.108	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	4.478	k star (bias corrected MLE)	4.29
Theta hat (MLE)	0.0302	Theta star (bias corrected MLE)	0.0315
nu hat (MLE)	609	nu star (bias corrected)	583.5
Mean (detects)	0.135		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.114
Maximum	0.57	Median	0.096
SD	0.0802	CV	0.703
k hat (MLE)	2.273	k star (bias corrected MLE)	2.203
Theta hat (MLE)	0.0502	Theta star (bias corrected MLE)	0.0518
nu hat (MLE)	400	nu star (bias corrected)	387.7
Adjusted Level of Significance (β)	0.0473		
Approximate Chi Square Value (387.66, α)	343	Adjusted Chi Square Value (387.66, β)	342.3
95% Gamma Approximate UCL (use when n>=50)	0.129	95% Gamma Adjusted UCL (use when n<50)	0.129

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.119	SD (KM)	0.0759
Variance (KM)	0.00575	SE of Mean (KM)	0.00821
k hat (KM)	2.444	k star (KM)	2.368
nu hat (KM)	430.1	nu star (KM)	416.8
theta hat (KM)	0.0485	theta star (KM)	0.0501
80% gamma percentile (KM)	0.174	90% gamma percentile (KM)	0.222
95% gamma percentile (KM)	0.267	99% gamma percentile (KM)	0.366

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (416.76, α)	370.4	Adjusted Chi Square Value (416.76, β)	369.7
95% Gamma Approximate KM-UCL (use when n>=50)	0.133	95% Gamma Adjusted KM-UCL (use when n<50)	0.134

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.976	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.461	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0936	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.118	Mean in Log Scale	-2.281
SD in Original Scale	0.076	SD in Log Scale	0.524
95% t UCL (assumes normality of ROS data)	0.132	95% Percentile Bootstrap UCL	0.131
95% BCA Bootstrap UCL	0.134	95% Bootstrap t UCL	0.134
95% H-UCL (Log ROS)	0.13		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.283	KM Geo Mean	0.102
KM SD (logged)	0.534	95% Critical H Value (KM-Log)	1.867
KM Standard Error of Mean (logged)	0.0594	95% H-UCL (KM -Log)	0.131
KM SD (logged)	0.534	95% Critical H Value (KM-Log)	1.867
KM Standard Error of Mean (logged)	0.0594		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.115	Mean in Log Scale	-2.355
SD in Original Scale	0.079	SD in Log Scale	0.63
95% t UCL (Assumes normality)	0.129	95% H-Stat UCL	0.132

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM Student's t	0.116	KM H-UCL	0.131

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	88	Number of Distinct Observations	36
		Number of Missing Observations	0
Minimum	0.9	Mean	2.473
Maximum	12	Median	2.05
SD	1.483	Std. Error of Mean	0.158
Coefficient of Variation	0.6	Skewness	3.662

Normal GOF Test

Shapiro Wilk Test Statistic	0.699	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.189	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0946	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.735	95% Adjusted-CLT UCL (Chen-1995)	2.799
		95% Modified-t UCL (Johnson-1978)	2.746

Gamma GOF Test

A-D Test Statistic	2.494	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.151	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0956	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.721	k star (bias corrected MLE)	4.568
Theta hat (MLE)	0.524	Theta star (bias corrected MLE)	0.541
nu hat (MLE)	830.9	nu star (bias corrected)	803.9
MLE Mean (bias corrected)	2.473	MLE Sd (bias corrected)	1.157
		Approximate Chi Square Value (0.05)	739.1
Adjusted Level of Significance	0.0473	Adjusted Chi Square Value	738.1

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:10:00 AM
From File	**Esperanza Mill_Rad_All (Soil and Sediment) 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.689	95% Adjusted Gamma UCL (use when n<50)	2.693

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.952	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00855	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.12	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0946	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.105	Mean of logged Data	0.796
Maximum of Logged Data	2.485	SD of logged Data	0.437

Assuming Lognormal Distribution

95% H-UCL	2.653	90% Chebyshev (MVUE) UCL	2.789
95% Chebyshev (MVUE) UCL	2.949	97.5% Chebyshev (MVUE) UCL	3.172
99% Chebyshev (MVUE) UCL	3.61		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2.733	95% Jackknife UCL	2.735
95% Standard Bootstrap UCL	2.731	95% Bootstrap-t UCL	2.869
95% Hall's Bootstrap UCL	2.972	95% Percentile Bootstrap UCL	2.742
95% BCA Bootstrap UCL	2.814		
90% Chebyshev(Mean, Sd) UCL	2.947	95% Chebyshev(Mean, Sd) UCL	3.162
97.5% Chebyshev(Mean, Sd) UCL	3.46	99% Chebyshev(Mean, Sd) UCL	4.045

Suggested UCL to Use

95% Student's-t UCL	2.735	or 95% Modified-t UCL	2.746

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	41
		Number of Missing Observations	0
Minimum	0.54	Mean	2.215
Maximum	5.8	Median	2
SD	1.053	Std. Error of Mean	0.115
Coefficient of Variation	0.475	Skewness	1.106

Normal GOF Test

Shapiro Wilk Test Statistic	0.921	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	2.3756E-5	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.115	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0968	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.407	95% Adjusted-CLT UCL (Chen-1995)	2.419
		95% Modified-t UCL (Johnson-1978)	2.409

Gamma GOF Test

A-D Test Statistic	0.482	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.755	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0683	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.0978	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.674	k star (bias corrected MLE)	4.515
Theta hat (MLE)	0.474	Theta star (bias corrected MLE)	0.491
nu hat (MLE)	785.2	nu star (bias corrected)	758.5
MLE Mean (bias corrected)	2.215	MLE Sd (bias corrected)	1.043
		Approximate Chi Square Value (0.05)	695.6
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	694.5

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.416	95% Adjusted Gamma UCL (use when n<50)	2.419

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.971	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.213	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0913	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0968	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.616	Mean of logged Data	0.685
Maximum of Logged Data	1.758	SD of logged Data	0.486

Assuming Lognormal Distribution

95% H-UCL	2.461	90% Chebyshev (MVUE) UCL	2.601
95% Chebyshev (MVUE) UCL	2.77	97.5% Chebyshev (MVUE) UCL	3.004
99% Chebyshev (MVUE) UCL	3.465		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.405	95% Jackknife UCL	2.407
95% Standard Bootstrap UCL	2.41	95% Bootstrap-t UCL	2.421
95% Hall's Bootstrap UCL	2.44	95% Percentile Bootstrap UCL	2.4
95% BCA Bootstrap UCL	2.414		
90% Chebyshev(Mean, Sd) UCL	2.56	95% Chebyshev(Mean, Sd) UCL	2.716
97.5% Chebyshev(Mean, Sd) UCL	2.933	99% Chebyshev(Mean, Sd) UCL	3.359

Suggested UCL to Use

95% Approximate Gamma UCL	2.416

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	28
Number of Detects	81	Number of Non-Detects	3
Number of Distinct Detects	28	Number of Distinct Non-Detects	3
Minimum Detect	1	Minimum Non-Detect	2
Maximum Detect	8.9	Maximum Non-Detect	2.5
Variance Detects	1.096	Percent Non-Detects	3.571%
Mean Detects	2.336	SD Detects	1.047
Median Detects	2.1	CV Detects	0.448
Skewness Detects	3.659	Kurtosis Detects	19.36
Mean of Logged Detects	0.784	SD of Logged Detects	0.334

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.703	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.215	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.317	KM Standard Error of Mean	0.113
KM SD	1.028	95% KM (BCA) UCL	2.511
95% KM (t) UCL	2.505	95% KM (Percentile Bootstrap) UCL	2.516
95% KM (z) UCL	2.503	95% KM Bootstrap t UCL	2.59
90% KM Chebyshev UCL	2.656	95% KM Chebyshev UCL	2.81
97.5% KM Chebyshev UCL	3.023	99% KM Chebyshev UCL	3.442

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.799	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.151	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.0992	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	7.976	k star (bias corrected MLE)	7.689
Theta hat (MLE)	0.293	Theta star (bias corrected MLE)	0.304
nu hat (MLE)	1292	nu star (bias corrected)	1246
Mean (detects)	2.336		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1	Mean	2.315
Maximum	8.9	Median	2.1
SD	1.034	CV	0.447
k hat (MLE)	8.071	k star (bias corrected MLE)	7.791
Theta hat (MLE)	0.287	Theta star (bias corrected MLE)	0.297
nu hat (MLE)	1356	nu star (bias corrected)	1309
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (N/A, α)	1226	Adjusted Chi Square Value (N/A, β)	1225
95% Gamma Approximate UCL (use when n>=50)	2.472	95% Gamma Adjusted UCL (use when n<50)	2.475

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.317	SD (KM)	1.028
Variance (KM)	1.057	SE of Mean (KM)	0.113
k hat (KM)	5.081	k star (KM)	4.907
nu hat (KM)	853.6	nu star (KM)	824.4
theta hat (KM)	0.456	theta star (KM)	0.472
80% gamma percentile (KM)	3.121	90% gamma percentile (KM)	3.718
95% gamma percentile (KM)	4.262	99% gamma percentile (KM)	5.412

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (824.44, α)	758.8	Adjusted Chi Square Value (824.44, β)	757.7
95% Gamma Approximate KM-UCL (use when n>=50)	2.518	95% Gamma Adjusted KM-UCL (use when n<50)	2.521

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.934	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	4.7424E-4	Detected Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.125	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.0985	Detected Data Not Lognormal at 5% Significance Level

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.317	Mean in Log Scale	0.778
SD in Original Scale	1.033	SD in Log Scale	0.33
95% t UCL (assumes normality of ROS data)	2.505	95% Percentile Bootstrap UCL	2.51
95% BCA Bootstrap UCL	2.559	95% Bootstrap t UCL	2.588
95% H-UCL (Log ROS)	2.449		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.777	KM Geo Mean	2.175
KM SD (logged)	0.33	95% Critical H Value (KM-Log)	1.754
KM Standard Error of Mean (logged)	0.0364	95% H-UCL (KM -Log)	2.448
KM SD (logged)	0.33	95% Critical H Value (KM-Log)	1.754
KM Standard Error of Mean (logged)	0.0364		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.293	Mean in Log Scale	0.761
SD in Original Scale	1.052	SD in Log Scale	0.35
95% t UCL (Assumes normality)	2.484	95% H-Stat UCL	2.436

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.505	KM H-UCL	2.448
95% KM (BCA) UCL	2.511		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-234)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	32
		Number of Missing Observations	0
Minimum	0.85	Mean	2.438
Maximum	12	Median	2
SD	1.471	Std. Error of Mean	0.161
Coefficient of Variation	0.603	Skewness	3.876

Normal GOF Test

Shapiro Wilk Test Statistic	0.679	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.195	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.705	95% Adjusted-CLT UCL (Chen-1995)	2.774
		95% Modified-t UCL (Johnson-1978)	2.716

Gamma GOF Test

A-D Test Statistic	2.628	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.158	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0978	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.834	k star (bias corrected MLE)	4.669
Theta hat (MLE)	0.504	Theta star (bias corrected MLE)	0.522
nu hat (MLE)	812.1	nu star (bias corrected)	784.4
MLE Mean (bias corrected)	2.438	MLE Sd (bias corrected)	1.128
		Approximate Chi Square Value (0.05)	720.4
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	719.4

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.654	95% Adjusted Gamma UCL (use when n<50)	2.658

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.946	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00317	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.127	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.163	Mean of logged Data	0.784
Maximum of Logged Data	2.485	SD of logged Data	0.428

Assuming Lognormal Distribution

95% H-UCL	2.613	90% Chebyshev (MVUE) UCL	2.747
95% Chebyshev (MVUE) UCL	2.905	97.5% Chebyshev (MVUE) UCL	3.125
99% Chebyshev (MVUE) UCL	3.556		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2.702	95% Jackknife UCL	2.705
95% Standard Bootstrap UCL	2.698	95% Bootstrap-t UCL	2.843
95% Hall's Bootstrap UCL	3.015	95% Percentile Bootstrap UCL	2.705
95% BCA Bootstrap UCL	2.802		
90% Chebyshev(Mean, Sd) UCL	2.919	95% Chebyshev(Mean, Sd) UCL	3.138
97.5% Chebyshev(Mean, Sd) UCL	3.44	99% Chebyshev(Mean, Sd) UCL	4.035

Suggested UCL to Use

95% Student's-t UCL	2.705	or 95% Modified-t UCL	2.716

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	41
Number of Detects	68	Number of Non-Detects	16
Number of Distinct Detects	38	Number of Distinct Non-Detects	14
Minimum Detect	0.042	Minimum Non-Detect	0.042
Maximum Detect	0.57	Maximum Non-Detect	0.16
Variance Detects	0.00613	Percent Non-Detects	19.05%
Mean Detects	0.135	SD Detects	0.0783
Median Detects	0.115	CV Detects	0.579
Skewness Detects	2.963	Kurtosis Detects	13.59
Mean of Logged Detects	-2.116	SD of Logged Detects	0.462

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.765	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	1.099E-14	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.197	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.121	KM Standard Error of Mean	0.00841
KM SD	0.0761	95% KM (BCA) UCL	0.138
95% KM (t) UCL	0.135	95% KM (Percentile Bootstrap) UCL	0.135
95% KM (z) UCL	0.135	95% KM Bootstrap t UCL	0.14
90% KM Chebyshev UCL	0.147	95% KM Chebyshev UCL	0.158
97.5% KM Chebyshev UCL	0.174	99% KM Chebyshev UCL	0.205

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.19	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.755	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.13	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.108	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	4.478	k star (bias corrected MLE)	4.29
Theta hat (MLE)	0.0302	Theta star (bias corrected MLE)	0.0315
nu hat (MLE)	609	nu star (bias corrected)	583.5
Mean (detects)	0.135		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	0.118
Maximum	0.57	Median	0.097
SD	0.0799	CV	0.679
k hat (MLE)	2.516	k star (bias corrected MLE)	2.434
Theta hat (MLE)	0.0468	Theta star (bias corrected MLE)	0.0484
nu hat (MLE)	422.7	nu star (bias corrected)	409
Adjusted Level of Significance (β)	0.0471		
Approximate Chi Square Value (408.97, α)	363.1	Adjusted Chi Square Value (408.97, β)	362.3
95% Gamma Approximate UCL (use when n>=50)	0.133	95% Gamma Adjusted UCL (use when n<50)	0.133

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.121	SD (KM)	0.0761
Variance (KM)	0.00579	SE of Mean (KM)	0.00841
k hat (KM)	2.547	k star (KM)	2.464
nu hat (KM)	428	nu star (KM)	414
theta hat (KM)	0.0477	theta star (KM)	0.0493
80% gamma percentile (KM)	0.177	90% gamma percentile (KM)	0.225
95% gamma percentile (KM)	0.27	99% gamma percentile (KM)	0.369

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (414.00, α)	367.8	Adjusted Chi Square Value (414.00, β)	367.1
95% Gamma Approximate KM-UCL (use when n>=50)	0.137	95% Gamma Adjusted KM-UCL (use when n<50)	0.137

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.976	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	0.461	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0936	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.107	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.121	Mean in Log Scale	-2.251
SD in Original Scale	0.0765	SD in Log Scale	0.515
95% t UCL (assumes normality of ROS data)	0.135	95% Percentile Bootstrap UCL	0.135
95% BCA Bootstrap UCL	0.138	95% Bootstrap t UCL	0.139
95% H-UCL (Log ROS)	0.133		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.251	KM Geo Mean	0.105
KM SD (logged)	0.519	95% Critical H Value (KM-Log)	1.855
KM Standard Error of Mean (logged)	0.0587	95% H-UCL (KM -Log)	0.134
KM SD (logged)	0.519	95% Critical H Value (KM-Log)	1.855
KM Standard Error of Mean (logged)	0.0587		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.118	Mean in Log Scale	-2.318
SD in Original Scale	0.0793	SD in Log Scale	0.61
95% t UCL (Assumes normality)	0.132	95% H-Stat UCL	0.135

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Lognormal Distributed at 5% Significance Level

Suggested UCL to Use

KM Student's t	0.12	KM H-UCL	0.134

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	84	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	0.9	Mean	2.491
Maximum	12	Median	2.05
SD	1.494	Std. Error of Mean	0.163
Coefficient of Variation	0.6	Skewness	3.732

Normal GOF Test

Shapiro Wilk Test Statistic	0.683	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	0	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.196	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.762	95% Adjusted-CLT UCL (Chen-1995)	2.83
		95% Modified-t UCL (Johnson-1978)	2.773

Gamma GOF Test

A-D Test Statistic	2.858	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.165	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.0978	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.852	k star (bias corrected MLE)	4.687
Theta hat (MLE)	0.513	Theta star (bias corrected MLE)	0.532
nu hat (MLE)	815.1	nu star (bias corrected)	787.4
MLE Mean (bias corrected)	2.491	MLE Sd (bias corrected)	1.151
		Approximate Chi Square Value (0.05)	723.2
Adjusted Level of Significance	0.0471	Adjusted Chi Square Value	722.2

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/18/2018 11:14:15 AM
From File	**Esperanza Mill_Rad_Soil Only 0-15.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.712	95% Adjusted Gamma UCL (use when n<50)	2.716

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.00139	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.136	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.0968	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.105	Mean of logged Data	0.806
Maximum of Logged Data	2.485	SD of logged Data	0.427

Assuming Lognormal Distribution

95% H-UCL	2.669	90% Chebyshev (MVUE) UCL	2.806
95% Chebyshev (MVUE) UCL	2.967	97.5% Chebyshev (MVUE) UCL	3.191
99% Chebyshev (MVUE) UCL	3.63		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2.759	95% Jackknife UCL	2.762
95% Standard Bootstrap UCL	2.758	95% Bootstrap-t UCL	2.876
95% Hall's Bootstrap UCL	3.041	95% Percentile Bootstrap UCL	2.785
95% BCA Bootstrap UCL	2.882		
90% Chebyshev(Mean, Sd) UCL	2.98	95% Chebyshev(Mean, Sd) UCL	3.202
97.5% Chebyshev(Mean, Sd) UCL	3.509	99% Chebyshev(Mean, Sd) UCL	4.113

Suggested UCL to Use

95% Student's-t UCL	2.762	or 95% Modified-t UCL	2.773

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:58:39 PM
From File	**Esperanza Mill_Rad_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	33
		Number of Missing Observations	0
Minimum	0.54	Mean	2.182
Maximum	5.8	Median	2
SD	1.048	Std. Error of Mean	0.133
Coefficient of Variation	0.48	Skewness	1.204

Normal GOF Test

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	1.3494E-4	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.144	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.405	95% Adjusted-CLT UCL (Chen-1995)	2.423
		95% Modified-t UCL (Johnson-1978)	2.408

Gamma GOF Test

A-D Test Statistic	0.718	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.754	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.109	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.113	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.583	k star (bias corrected MLE)	4.372
Theta hat (MLE)	0.476	Theta star (bias corrected MLE)	0.499
nu hat (MLE)	568.3	nu star (bias corrected)	542.2
MLE Mean (bias corrected)	2.182	MLE Sd (bias corrected)	1.044
		Approximate Chi Square Value (0.05)	489.2
Adjusted Level of Significance	0.0461	Adjusted Chi Square Value	488

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:58:39 PM
From File	**Esperanza Mill_Rad_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.419	95% Adjusted Gamma UCL (use when n<50)	2.425

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0691	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.135	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.112	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.616	Mean of logged Data	0.667
Maximum of Logged Data	1.758	SD of logged Data	0.495

Assuming Lognormal Distribution

95% H-UCL	2.478	90% Chebyshev (MVUE) UCL	2.634
95% Chebyshev (MVUE) UCL	2.831	97.5% Chebyshev (MVUE) UCL	3.105
99% Chebyshev (MVUE) UCL	3.643		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.401	95% Jackknife UCL	2.405
95% Standard Bootstrap UCL	2.401	95% Bootstrap-t UCL	2.427
95% Hall's Bootstrap UCL	2.442	95% Percentile Bootstrap UCL	2.393
95% BCA Bootstrap UCL	2.399		
90% Chebyshev(Mean, Sd) UCL	2.582	95% Chebyshev(Mean, Sd) UCL	2.762
97.5% Chebyshev(Mean, Sd) UCL	3.013	99% Chebyshev(Mean, Sd) UCL	3.506

Suggested UCL to Use

95% Approximate Gamma UCL	2.419

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:58:39 PM
From File	**Esperanza Mill_Rad_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	23
Number of Detects	59	Number of Non-Detects	3
Number of Distinct Detects	22	Number of Distinct Non-Detects	3
Minimum Detect	1	Minimum Non-Detect	2
Maximum Detect	8.9	Maximum Non-Detect	2.5
Variance Detects	1.201	Percent Non-Detects	4.839%
Mean Detects	2.215	SD Detects	1.096
Median Detects	2	CV Detects	0.495
Skewness Detects	4.255	Kurtosis Detects	24.08
Mean of Logged Detects	0.725	SD of Logged Detects	0.345

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.634	**Normal GOF Test on Detected Observations Only**
5% Shapiro Wilk P Value	0	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.244	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.115	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.193	KM Standard Error of Mean	0.137
KM SD	1.067	95% KM (BCA) UCL	2.471
95% KM (t) UCL	2.422	95% KM (Percentile Bootstrap) UCL	2.436
95% KM (z) UCL	2.418	95% KM Bootstrap t UCL	2.571
90% KM Chebyshev UCL	2.604	95% KM Chebyshev UCL	2.79
97.5% KM Chebyshev UCL	3.048	99% KM Chebyshev UCL	3.556

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	2.236	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.752	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.167	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.116	Detected Data Not Gamma Distributed at 5% Significance Level

Detected Data Not Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:58:39 PM
From File	**Esperanza Mill_Rad_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	7.292	k star (bias corrected MLE)	6.932
Theta hat (MLE)	0.304	Theta star (bias corrected MLE)	0.32
nu hat (MLE)	860.4	nu star (bias corrected)	818
Mean (detects)	2.215		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1	Mean	2.191
Maximum	8.9	Median	2
SD	1.075	CV	0.49
k hat (MLE)	7.472	k star (bias corrected MLE)	7.121
Theta hat (MLE)	0.293	Theta star (bias corrected MLE)	0.308
nu hat (MLE)	926.6	nu star (bias corrected)	883.1
Adjusted Level of Significance (β)	0.0461		
Approximate Chi Square Value (883.06, α)	815.1	Adjusted Chi Square Value (883.06, β)	813.5
95% Gamma Approximate UCL (use when n>=50)	2.374	95% Gamma Adjusted UCL (use when n<50)	2.378

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.193	SD (KM)	1.067
Variance (KM)	1.138	SE of Mean (KM)	0.137
k hat (KM)	4.227	k star (KM)	4.033
nu hat (KM)	524.1	nu star (KM)	500.1
theta hat (KM)	0.519	theta star (KM)	0.544
80% gamma percentile (KM)	3.021	90% gamma percentile (KM)	3.657
95% gamma percentile (KM)	4.242	99% gamma percentile (KM)	5.491

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (500.07, α)	449.2	Adjusted Chi Square Value (500.07, β)	448.1
95% Gamma Approximate KM-UCL (use when n>=50)	2.441	95% Gamma Adjusted KM-UCL (use when n<50)	2.448

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:58:39 PM
From File	**Esperanza Mill_Rad_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Approximate Test Statistic	0.916	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk P Value	4.2547E-4	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.133	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.115	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.193	Mean in Log Scale	0.718
SD in Original Scale	1.073	SD in Log Scale	0.338
95% t UCL (assumes normality of ROS data)	2.421	95% Percentile Bootstrap UCL	2.44
95% BCA Bootstrap UCL	2.539	95% Bootstrap t UCL	2.589
95% H-UCL (Log ROS)	2.343		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.717	KM Geo Mean	2.047
KM SD (logged)	0.339	95% Critical H Value (KM-Log)	1.771
KM Standard Error of Mean (logged)	0.0437	95% H-UCL (KM -Log)	2.341
KM SD (logged)	0.339	95% Critical H Value (KM-Log)	1.771
KM Standard Error of Mean (logged)	0.0437		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	2.164	Mean in Log Scale	0.697
SD in Original Scale	1.093	SD in Log Scale	0.36
95% t UCL (Assumes normality)	2.396	95% H-Stat UCL	2.325

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.422	KM H-UCL	2.341
95% KM (BCA) UCL	2.471		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:58:39 PM
From File	**Esperanza Mill_Rad_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	62	Number of Distinct Observations	30
		Number of Missing Observations	0
Minimum	0.9	Mean	2.229
Maximum	6.6	Median	1.9
SD	1.047	Std. Error of Mean	0.133
Coefficient of Variation	0.47	Skewness	1.968

Normal GOF Test

Shapiro Wilk Test Statistic	0.824	**Shapiro Wilk GOF Test**
5% Shapiro Wilk P Value	8.442E-10	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.21	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.112	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.451	95% Adjusted-CLT UCL (Chen-1995)	2.483
		95% Modified-t UCL (Johnson-1978)	2.457

Gamma GOF Test

A-D Test Statistic	1.573	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.753	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.164	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.113	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.994	k star (bias corrected MLE)	5.715
Theta hat (MLE)	0.372	Theta star (bias corrected MLE)	0.39
nu hat (MLE)	743.3	nu star (bias corrected)	708.6
MLE Mean (bias corrected)	2.229	MLE Sd (bias corrected)	0.932
		Approximate Chi Square Value (0.05)	647.9
Adjusted Level of Significance	0.0461	Adjusted Chi Square Value	646.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.438	95% Adjusted Gamma UCL (use when n<50)	2.443

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/24/2018 4:58:39 PM
From File	**Esperanza Mill_Rad_0-2.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.959	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk P Value	0.0866	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.135	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.112	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.105	Mean of logged Data	0.716
Maximum of Logged Data	1.887	SD of logged Data	0.402

Assuming Lognormal Distribution

95% H-UCL	2.433	90% Chebyshev (MVUE) UCL	2.565
95% Chebyshev (MVUE) UCL	2.724	97.5% Chebyshev (MVUE) UCL	2.945
99% Chebyshev (MVUE) UCL	3.378		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.448	95% Jackknife UCL	2.451
95% Standard Bootstrap UCL	2.445	95% Bootstrap-t UCL	2.499
95% Hall's Bootstrap UCL	2.51	95% Percentile Bootstrap UCL	2.446
95% BCA Bootstrap UCL	2.473		
90% Chebyshev(Mean, Sd) UCL	2.628	95% Chebyshev(Mean, Sd) UCL	2.809
97.5% Chebyshev(Mean, Sd) UCL	3.06	99% Chebyshev(Mean, Sd) UCL	3.552

Suggested UCL to Use

95% Student's-t UCL	2.451	or 95% Modified-t UCL	2.457
or 95% H-UCL	2.433		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-226)

General Statistics

Total Number of Observations	30	Number of Distinct Observations	22
		Number of Missing Observations	0
Minimum	0.54	Mean	2.254
Maximum	5.8	Median	2.15
SD	1.131	Std. Error of Mean	0.206
Coefficient of Variation	0.502	Skewness	1.101

Normal GOF Test

Shapiro Wilk Test Statistic	0.924	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.121	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Data appear Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.604	95% Adjusted-CLT UCL (Chen-1995)	2.638
		95% Modified-t UCL (Johnson-1978)	2.611

Gamma GOF Test

A-D Test Statistic	0.494	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.75	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.13	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.161	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.979	k star (bias corrected MLE)	3.603
Theta hat (MLE)	0.566	Theta star (bias corrected MLE)	0.625
nu hat (MLE)	238.7	nu star (bias corrected)	216.2
MLE Mean (bias corrected)	2.254	MLE Sd (bias corrected)	1.187
		Approximate Chi Square Value (0.05)	183.2
Adjusted Level of Significance	0.041	Adjusted Chi Square Value	181.4

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.66	95% Adjusted Gamma UCL (use when n<50)	2.686

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.941	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.927	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.166	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.159	Data Not Lognormal at 5% Significance Level	

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.616	Mean of logged Data	0.682
Maximum of Logged Data	1.758	SD of logged Data	0.55

Assuming Lognormal Distribution

95% H-UCL	2.819	90% Chebyshev (MVUE) UCL	3.011
95% Chebyshev (MVUE) UCL	3.339	97.5% Chebyshev (MVUE) UCL	3.795
99% Chebyshev (MVUE) UCL	4.69		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.593	95% Jackknife UCL	2.604
95% Standard Bootstrap UCL	2.583	95% Bootstrap-t UCL	2.673
95% Hall's Bootstrap UCL	2.77	95% Percentile Bootstrap UCL	2.594
95% BCA Bootstrap UCL	2.633		
90% Chebyshev(Mean, Sd) UCL	2.873	95% Chebyshev(Mean, Sd) UCL	3.153
97.5% Chebyshev(Mean, Sd) UCL	3.543	99% Chebyshev(Mean, Sd) UCL	4.307

Suggested UCL to Use

95% Student's-t UCL	2.604

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (radium-228)

General Statistics

Total Number of Observations	30	Number of Distinct Observations	15
Number of Detects	28	Number of Non-Detects	2
Number of Distinct Detects	14	Number of Distinct Non-Detects	2
Minimum Detect	1.4	Minimum Non-Detect	2.4
Maximum Detect	3.7	Maximum Non-Detect	2.5
Variance Detects	0.242	Percent Non-Detects	6.667%
Mean Detects	2.046	SD Detects	0.492
Median Detects	2	CV Detects	0.24
Skewness Detects	1.542	Kurtosis Detects	3.553
Mean of Logged Detects	0.692	SD of Logged Detects	0.219

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.889	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.145	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	2.035	KM Standard Error of Mean	0.089
KM SD	0.474	95% KM (BCA) UCL	2.191
95% KM (t) UCL	2.186	95% KM (Percentile Bootstrap) UCL	2.186
95% KM (z) UCL	2.181	95% KM Bootstrap t UCL	2.224
90% KM Chebyshev UCL	2.302	95% KM Chebyshev UCL	2.423
97.5% KM Chebyshev UCL	2.591	99% KM Chebyshev UCL	2.921

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.407	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.119	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.165	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	20.64	k star (bias corrected MLE)	18.46
Theta hat (MLE)	0.0991	Theta star (bias corrected MLE)	0.111
nu hat (MLE)	1156	nu star (bias corrected)	1033
Mean (detects)	2.046		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	1.4	Mean	2.037
Maximum	3.7	Median	1.96
SD	0.476	CV	0.234
k hat (MLE)	21.94	k star (bias corrected MLE)	19.77
Theta hat (MLE)	0.0928	Theta star (bias corrected MLE)	0.103
nu hat (MLE)	1316	nu star (bias corrected)	1186
Adjusted Level of Significance (β)	0.041		
Approximate Chi Square Value (N/A, α)	1107	Adjusted Chi Square Value (N/A, β)	1103
95% Gamma Approximate UCL (use when n>=50)	2.182	95% Gamma Adjusted UCL (use when n<50)	2.19

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	2.035	SD (KM)	0.474
Variance (KM)	0.224	SE of Mean (KM)	0.089
k hat (KM)	18.46	k star (KM)	16.64
nu hat (KM)	1108	nu star (KM)	998.3
theta hat (KM)	0.11	theta star (KM)	0.122
80% gamma percentile (KM)	2.438	90% gamma percentile (KM)	2.695
95% gamma percentile (KM)	2.919	99% gamma percentile (KM)	3.371

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (998.29, α)	925.9	Adjusted Chi Square Value (998.29, β)	921.9
95% Gamma Approximate KM-UCL (use when n>=50)	2.194	95% Gamma Adjusted KM-UCL (use when n<50)	2.203

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.924	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.104	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.164	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	2.036	Mean in Log Scale	0.688
SD in Original Scale	0.476	SD in Log Scale	0.212
95% t UCL (assumes normality of ROS data)	2.184	95% Percentile Bootstrap UCL	2.181
95% BCA Bootstrap UCL	2.197	95% Bootstrap t UCL	2.236
95% H-UCL (Log ROS)	2.181		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	0.687	KM Geo Mean	1.987
KM SD (logged)	0.212	95% Critical H Value (KM-Log)	1.76
KM Standard Error of Mean (logged)	0.0401	95% H-UCL (KM -Log)	2.178
KM SD (logged)	0.212	95% Critical H Value (KM-Log)	1.76
KM Standard Error of Mean (logged)	0.0401		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	1.992	Mean in Log Scale	0.659
SD in Original Scale	0.518	SD in Log Scale	0.245
95% t UCL (Assumes normality)	2.152	95% H-Stat UCL	2.16

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	2.186

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-234)

General Statistics

Total Number of Observations	30	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	1	Mean	1.927
Maximum	3.7	Median	1.8
SD	0.583	Std. Error of Mean	0.106
Coefficient of Variation	0.303	Skewness	1.459

Normal GOF Test

Shapiro Wilk Test Statistic	0.872	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.185	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.108	95% Adjusted-CLT UCL (Chen-1995)	2.132
		95% Modified-t UCL (Johnson-1978)	2.112

Gamma GOF Test

A-D Test Statistic	0.845	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.15	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.16	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.1	k star (bias corrected MLE)	11.81
Theta hat (MLE)	0.147	Theta star (bias corrected MLE)	0.163
nu hat (MLE)	786.1	nu star (bias corrected)	708.9
MLE Mean (bias corrected)	1.927	MLE Sd (bias corrected)	0.561
		Approximate Chi Square Value (0.05)	648.1
Adjusted Level of Significance	0.041	Adjusted Chi Square Value	644.7

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	2.107	95% Adjusted Gamma UCL (use when n<50)	2.118

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.927	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.131	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.159	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0	Mean of logged Data	0.617
Maximum of Logged Data	1.308	SD of logged Data	0.276

Assuming Lognormal Distribution

95% H-UCL	2.111	90% Chebyshev (MVUE) UCL	2.218
95% Chebyshev (MVUE) UCL	2.352	97.5% Chebyshev (MVUE) UCL	2.537
99% Chebyshev (MVUE) UCL	2.901		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.102	95% Jackknife UCL	2.108
95% Standard Bootstrap UCL	2.102	95% Bootstrap-t UCL	2.159
95% Hall's Bootstrap UCL	2.175	95% Percentile Bootstrap UCL	2.11
95% BCA Bootstrap UCL	2.14		
90% Chebyshev(Mean, Sd) UCL	2.246	95% Chebyshev(Mean, Sd) UCL	2.391
97.5% Chebyshev(Mean, Sd) UCL	2.591	99% Chebyshev(Mean, Sd) UCL	2.986

Suggested UCL to Use

95% Adjusted Gamma UCL	2.118

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-235)

General Statistics

Total Number of Observations	30	Number of Distinct Observations	22
Number of Detects	21	Number of Non-Detects	9
Number of Distinct Detects	16	Number of Distinct Non-Detects	9
Minimum Detect	0.055	Minimum Non-Detect	0.052
Maximum Detect	0.2	Maximum Non-Detect	0.11
Variance Detects	0.00202	Percent Non-Detects	30%
Mean Detects	0.113	SD Detects	0.045
Median Detects	0.096	CV Detects	0.397
Skewness Detects	0.701	Kurtosis Detects	-0.514
Mean of Logged Detects	-2.25	SD of Logged Detects	0.393

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.911	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.174	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0977	KM Standard Error of Mean	0.00838
KM SD	0.0443	95% KM (BCA) UCL	0.112
95% KM (t) UCL	0.112	95% KM (Percentile Bootstrap) UCL	0.112
95% KM (z) UCL	0.111	95% KM Bootstrap t UCL	0.113
90% KM Chebyshev UCL	0.123	95% KM Chebyshev UCL	0.134
97.5% KM Chebyshev UCL	0.15	99% KM Chebyshev UCL	0.181

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.371	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.141	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.19	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Gamma Statistics on Detected Data Only

k hat (MLE)	6.976	k star (bias corrected MLE)	6.011
Theta hat (MLE)	0.0163	Theta star (bias corrected MLE)	0.0189
nu hat (MLE)	293	nu star (bias corrected)	252.5
Mean (detects)	0.113		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0198	Mean	0.0943
Maximum	0.2	Median	0.0855
SD	0.0483	CV	0.513
k hat (MLE)	3.987	k star (bias corrected MLE)	3.611
Theta hat (MLE)	0.0236	Theta star (bias corrected MLE)	0.0261
nu hat (MLE)	239.2	nu star (bias corrected)	216.7
Adjusted Level of Significance (β)	0.041		
Approximate Chi Square Value (216.66, α)	183.6	Adjusted Chi Square Value (216.66, β)	181.8
95% Gamma Approximate UCL (use when n>=50)	0.111	95% Gamma Adjusted UCL (use when n<50)	0.112

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0977	SD (KM)	0.0443
Variance (KM)	0.00196	SE of Mean (KM)	0.00838
k hat (KM)	4.874	k star (KM)	4.409
nu hat (KM)	292.4	nu star (KM)	264.5
theta hat (KM)	0.02	theta star (KM)	0.0222
80% gamma percentile (KM)	0.133	90% gamma percentile (KM)	0.16
95% gamma percentile (KM)	0.185	99% gamma percentile (KM)	0.237

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (264.52, α)	227.9	Adjusted Chi Square Value (264.52, β)	225.9
95% Gamma Approximate KM-UCL (use when n>=50)	0.113	95% Gamma Adjusted KM-UCL (use when n<50)	0.114

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.957	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.908	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.117	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.188	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0964	Mean in Log Scale	-2.441
SD in Original Scale	0.046	SD in Log Scale	0.452
95% t UCL (assumes normality of ROS data)	0.111	95% Percentile Bootstrap UCL	0.11
95% BCA Bootstrap UCL	0.112	95% Bootstrap t UCL	0.114
95% H-UCL (Log ROS)	0.113		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.418	KM Geo Mean	0.0891
KM SD (logged)	0.421	95% Critical H Value (KM-Log)	1.889
KM Standard Error of Mean (logged)	0.081	95% H-UCL (KM -Log)	0.113
KM SD (logged)	0.421	95% Critical H Value (KM-Log)	1.889
KM Standard Error of Mean (logged)	0.081		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0914	Mean in Log Scale	-2.548
SD in Original Scale	0.0508	SD in Log Scale	0.579
95% t UCL (Assumes normality)	0.107	95% H-Stat UCL	0.115

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.112

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.

Recommendations are based upon data size, data distribution, and skewness.

These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).

However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Result (uranium-238)

General Statistics

Total Number of Observations	30	Number of Distinct Observations	15
		Number of Missing Observations	0
Minimum	0.92	Mean	1.931
Maximum	3.5	Median	1.8
SD	0.547	Std. Error of Mean	0.0999
Coefficient of Variation	0.283	Skewness	1.226

Normal GOF Test

Shapiro Wilk Test Statistic	0.895	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.927	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.222	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.159	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.1	95% Adjusted-CLT UCL (Chen-1995)	2.119
		95% Modified-t UCL (Johnson-1978)	2.104

Gamma GOF Test

A-D Test Statistic	0.796	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.188	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.16	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	14.14	k star (bias corrected MLE)	12.75
Theta hat (MLE)	0.136	Theta star (bias corrected MLE)	0.151
nu hat (MLE)	848.7	nu star (bias corrected)	765.1
MLE Mean (bias corrected)	1.931	MLE Sd (bias corrected)	0.541
		Approximate Chi Square Value (0.05)	701.9
Adjusted Level of Significance	0.041	Adjusted Chi Square Value	698.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.104	95% Adjusted Gamma UCL (use when n<50)	2.115

ProUCL 5.1 Esperanza Mill Radionuclides

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/25/2018 10:07:04 AM
From File	**Esperanza Mill_Rad_0-0.5.xls**
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.953	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.927	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.171	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.159	Data Not Lognormal at 5% Significance Level

Data appear Approximate Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.0834	Mean of logged Data	0.622
Maximum of Logged Data	1.253	SD of logged Data	0.27

Assuming Lognormal Distribution

95% H-UCL	2.113	90% Chebyshev (MVUE) UCL	2.219
95% Chebyshev (MVUE) UCL	2.35	97.5% Chebyshev (MVUE) UCL	2.531
99% Chebyshev (MVUE) UCL	2.888		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.095	95% Jackknife UCL	2.1
95% Standard Bootstrap UCL	2.094	95% Bootstrap-t UCL	2.131
95% Hall's Bootstrap UCL	2.143	95% Percentile Bootstrap UCL	2.09
95% BCA Bootstrap UCL	2.12		
90% Chebyshev(Mean, Sd) UCL	2.23	95% Chebyshev(Mean, Sd) UCL	2.366
97.5% Chebyshev(Mean, Sd) UCL	2.555	99% Chebyshev(Mean, Sd) UCL	2.925

Suggested UCL to Use

95% Student's-t UCL	2.1	or 95% Modified-t UCL	2.104
or 95% H-UCL	2.113		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

APPENDIX C

Excess Lifetime Cancer Risk and Hazard Index Calculations (Chemicals) using 95% UCL EPCs

Appendix C, Table C-1 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	3.01E+01	1.40E+09 P	4.5E-06	3.1E-06	6.1E-09	7.5E-06	100%	3.1E-02	2.1E-02	2.9E-04	5.2E-02	18%
Copper	D	1.23E+04	1.40E+09 P	NA	NA	NA	–		2.4E-01	–	NA	2.4E-01	82%
Lead	B2	2.67E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				4E-06	3E-06	6E-09			0.3	0.02	0.0003		
Total						**Total ELCR**	8E-06				**Total HI**	0.3	
						Group A Total ELCR	8E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-2 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	3.01E+01	1.40E+09 P	4.5E-06	3.1E-06	3.0E-09	7.5E-06	100%	3.1E-02	2.1E-02	1.5E-04	5.2E-02	18%
Copper	D	1.23E+04	1.40E+09 P	NA	NA	NA	–		2.4E-01	–	NA	2.4E-01	82%
Lead	B2	2.67E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				4E-06	3E-06	3E-09			0.3	0.02	0.0001		
Total						**Total ELCR**	8E-06				**Total HI**	0.3	
						Group A Total ELCR	8E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-3 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former CLEAR Plant - Shallow Soil (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	3.01E+01	1.40E+09 P	3.7E-07	1.7E-07	7.0E-11	5.5E-07	100%	6.5E-03	3.0E-03	8.5E-06	9.5E-03	16%
Copper	D	1.23E+04	1.40E+09 P	NA	NA	NA	–		5.0E-02	–	NA	5.0E-02	84%
Lead	B2	2.67E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				4E-07	2E-07	7E-11			0.06	0.003	0.000009		
Total						**Total ELCR**	5E-07				**Total HI**	0.06	
						Group A Total ELCR	5E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix C, Table C-4 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk				Percent	Route-Specific Hazard				Percent
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m³/kg)	Oral	Dermal	Inhalation	Total ELCR	Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.58E+00	1.40E+09 P	1.4E-06	9.8E-07	1.9E-09	2.4E-06	100%	9.8E-03	6.8E-03	9.4E-05	1.7E-02	10%
Copper	D	7.96E+03	1.40E+09 P	NA	NA	NA	–		1.5E-01	–	NA	1.5E-01	90%
Lead	B2	2.58E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-06	1E-06	2E-09			0.2	0.007	0.00009		
Total						**Total ELCR**	2E-06				**Total HI**	0.2	
						Group A Total ELCR	2E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-5 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NON-CANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	9.58E+00	1.40E+09	P	1.4E-06	9.8E-07	9.7E-10	2.4E-06	100%	9.8E-03	6.8E-03	4.7E-05	1.7E-02	10%
Copper	D	7.96E+03	1.40E+09	P	NA	NA	NA	–		1.5E-01	–	NA	1.5E-01	90%
Lead	B2	2.58E+02	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
					1E-06	1E-06	1E-09			0.2	0.007	0.00005		
Total							**Total ELCR**	2E-06				**Total HI**	0.2	
							Group A Total ELCR	2E-06						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-6 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.58E+00	1.40E+09 P	1.2E-07	5.5E-08	2.2E-11	1.7E-07	100%	2.1E-03	9.5E-04	2.7E-06	3.0E-03	9%
Copper	D	7.96E+03	1.40E+09 P	NA	NA	NA	–		3.2E-02	–	NA	3.2E-02	91%
Lead	B2	2.58E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-07	6E-08	2E-11			0.03	0.001	0.000003		
Total						**Total ELCR**	2E-07				**Total HI**	0.04	
						Group A Total ELCR	2E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:

[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
- Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
- Group B: Probable Human Carcinogen.
  - B1 - Limited evidence of carcinogenicity in humans.
  - B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
- Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
- Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).

[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix C, Table C-7 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.99E+00	1.40E+09 P	1.5E-06	1.0E-06	2.0E-09	2.5E-06	100%	1.0E-02	7.1E-03	9.8E-05	1.7E-02	11%
Copper	D	7.39E+03	1.40E+09 P	NA	NA	NA	–		1.4E-01	–	NA	1.4E-01	89%
Lead	B2	2.09E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-06	1E-06	2E-09			0.2	0.007	0.0001		
Total						**Total ELCR**	3E-06				**Total HI**	0.2	
						Group A Total ELCR	3E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-8 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.99E+00	1.40E+09 P	1.5E-06	1.0E-06	1.0E-09	2.5E-06	100%	1.0E-02	7.1E-03	4.9E-05	1.7E-02	11%
Copper	D	7.39E+03	1.40E+09 P	NA	NA	NA	–		1.4E-01	–	NA	1.4E-01	89%
Lead	B2	2.09E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-06	1E-06	1E-09			0.2	0.007	0.0001		
Total						**Total ELCR**	3E-06				**Total HI**	0.2	
						Group A Total ELCR	3E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-9 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NON-CANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	9.99E+00	1.40E+09	P	1.2E-07	5.7E-08	2.3E-11	1.8E-07	100%	2.2E-03	1.0E-03	2.8E-06	3.2E-03	10%
Copper	D	7.39E+03	1.40E+09	P	NA	NA	NA	–		3.0E-02	–	NA	3.0E-02	90%
Lead	B2	2.09E+02	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
					1E-07	6E-08	2E-11			0.03	0.001	0.000003		
Total							**Total ELCR**	2E-07				**Total HI**	0.03	
							Group A Total ELCR	2E-07						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)
HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix C, Table C-10 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Construction Worker
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.99E+00	1.40E+09 P	2.2E-07	9.1E-08	9.0E-11	3.1E-07	100%	3.8E-02	1.6E-02	1.1E-04	5.3E-02	9%
Copper	D	7.39E+03	1.40E+09 P	NA	NA	NA	–		5.2E-01	–	NA	5.2E-01	91%
Lead	B2	2.09E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				2E-07	9E-08	9E-11			0.6	0.02	0.0001		
Total						**Total ELCR**	3E-07				**Total HI**	0.6	
						Group A Total ELCR	3E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 330 x 250 x 1 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1 x IUR) / (28470)
HQo = (EPCs x 1 x 330 x 250 x 1 x RBA) / (1,000,000 x 80 x 365 x RfDo)
HQd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1) / (1,000,000 x 80 x 365 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1) / (365 x RfC)

Appendix C, Table C-11 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.93E+01	1.40E+09 P	2.9E-06	2.0E-06	3.9E-09	4.8E-06	100%	2.0E-02	1.4E-02	1.9E-04	3.4E-02	11%
Molybdenum	NA	1.85E+03	1.40E+09 P	NA	NA	NA	–		2.9E-01	–	NA	2.9E-01	89%
				3E-06	2E-06	4E-09			0.3	0.01	0.0002		
Total						**Total ELCR**	5E-06				**Total HI**	0.3	
						Group A Total ELCR	5E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-12 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NON-CANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	1.93E+01	1.40E+09	P	2.9E-06	2.0E-06	2.0E-09	4.8E-06	100%	2.0E-02	1.4E-02	9.4E-05	3.4E-02	11%
Molybdenum	NA	1.85E+03	1.40E+09	P	NA	NA	NA	–		2.9E-01	–	NA	2.9E-01	89%
					3E-06	2E-06	2E-09			0.3	0.01	0.00009		
Total							**Total ELCR**	5E-06				**Total HI**	0.3	
							Group A Total ELCR	5E-06						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-13 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.93E+01	1.40E+09 P	2.4E-07	1.1E-07	4.5E-11	3.5E-07	100%	4.2E-03	1.9E-03	5.5E-06	6.1E-03	9%
Molybdenum	NA	1.85E+03	1.40E+09 P	NA	NA	NA	–		6.0E-02	–	NA	6.0E-02	91%
				2E-07	1E-07	5E-11			0.06	0.002	0.000005		
Total						**Total ELCR**	4E-07				**Total HI**	0.07	
						Group A Total ELCR	4E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)
HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix C, Table C-14 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.29E+01	1.40E+09 P	1.9E-06	1.3E-06	2.6E-09	3.2E-06	100%	1.3E-02	9.1E-03	1.3E-04	2.2E-02	9%
Lead	B2	1.33E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	1.44E+03	1.40E+09 P	NA	NA	NA	–		2.2E-01	–	NA	2.2E-01	91%
				2E-06	1E-06	3E-09			0.2	0.009	0.0001		
Total						**Total ELCR**	3E-06				**Total HI**	0.2	
						Group A Total ELCR	3E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-15 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.29E+01	1.40E+09 P	1.9E-06	1.3E-06	1.3E-09	3.2E-06	100%	1.3E-02	9.1E-03	6.3E-05	2.2E-02	9%
Lead	B2	1.33E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	1.44E+03	1.40E+09 P	NA	NA	NA	–		2.2E-01	–	NA	2.2E-01	91%
				2E-06	1E-06	1E-09			0.20	0.009	0.00006		
Total						**Total ELCR**	3E-06				**Total HI**	0.2	
						Group A Total ELCR	3E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix C, Table C-16 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.29E+01	1.40E+09 P	1.6E-07	7.4E-08	3.0E-11	2.3E-07	100%	2.8E-03	1.3E-03	3.6E-06	4.1E-03	8%
Lead	B2	1.33E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	1.44E+03	1.40E+09 P	NA	NA	NA	–		4.7E-02	–	NA	4.7E-02	93%
				2E-07	7E-08	3E-11			0.05	0.001	0.000004		
Total						**Total ELCR**	2E-07				**Total HI**	0.05	
						Group A Total ELCR	2E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix C, Table C-17 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Construction Worker
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.29E+01	1.40E+09 P	2.8E-07	1.2E-07	1.2E-10	4.0E-07	100%	4.8E-02	2.0E-02	1.4E-04	6.9E-02	8%
Lead	B2	1.33E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	1.44E+03	1.40E+09 P	NA	NA	NA	–		8.1E-01	–	NA	8.1E-01	92%
				3E-07	1E-07	1E-10			0.9	0.02	0.0001		
Total						**Total ELCR**	4E-07				**Total HI**	0.9	
						Group A Total ELCR	4E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 330 x 250 x 1 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1 x IUR) / (28470)

HQo = (EPCs x 1 x 330 x 250 x 1 x RBA) / (1,000,000 x 80 x 365 x RfDo)
HQd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1) / (1,000,000 x 80 x 365 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1) / (365 x RfC)

APPENDIX D

Excess Lifetime Cancer Risk Calculations (Radionuclides) using 95% UCL EPCs

Appendix D, Table D-1 (RME)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.57E+00	1.40E+09	P	8.1E-08	4.9E-09	1.6E-06	1.7E-06	1%
Uranium-234	2.46E+00	1.40E+09	P	7.1E-08	5.5E-09	3.2E-09	7.9E-08	<1%
Thorium-230	2.46E+00	1.40E+09	P	1.1E-07	6.7E-09	1.1E-08	1.2E-07	<1%
Radium-226	2.15E+00	1.40E+09	P	3.6E-07	4.9E-09	9.2E-05	9.2E-05	61%
Lead-210	2.15E+00	1.40E+09	P	5.0E-07	1.9E-09	1.1E-08	5.2E-07	<1%
Bismuth-210	2.15E+00	1.40E+09	P	3.6E-12	6.3E-14	2.4E-11	2.8E-11	<1%
Polonium-210	2.15E+00	1.40E+09	P	3.8E-08	5.7E-11	1.1E-11	3.8E-08	<1%
Thorium-232	2.66E+00	1.40E+09	P	1.1E-06	1.9E-08	5.5E-05	5.6E-05	37%
Thorium-228	2.66E+00	1.40E+09	P	1.1E-08	3.1E-09	8.5E-09	2.2E-08	<1%
Radium-224	2.66E+00	1.40E+09	P	7.3E-11	1.4E-12	3.3E-10	4.1E-10	<1%
Lead-212	2.66E+00	1.40E+09	P	1.4E-12	9.6E-15	4.7E-10	4.8E-10	<1%
Bismuth-212	2.66E+00	1.40E+09	P	4.4E-15	1.2E-16	4.5E-11	4.5E-11	<1%
Thallium-208	2.66E+00	1.40E+09	P	NA	NA	8.0E-11	8.0E-11	<1%
Uranium-235	1.46E-01	1.40E+09	P	4.1E-09	2.9E-10	4.3E-07	4.4E-07	<1%
Protactinium-231	1.46E-01	1.40E+09	P	1.3E-08	8.9E-10	9.5E-08	1.1E-07	<1%
Actinium-227	1.46E-01	1.40E+09	P	1.1E-08	1.2E-09	1.0E-10	1.3E-08	<1%
Francium-223	1.46E-01	1.40E+09	P	9.7E-16	1.2E-18	2.4E-13	2.4E-13	<1%
Astatine-219	1.46E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.46E-01	1.40E+09	P	NA	NA	6.8E-13	6.8E-13	<1%
Thorium-227	1.46E-01	1.40E+09	P	5.0E-12	1.2E-12	9.9E-10	9.9E-10	<1%
Radium-223	1.46E-01	1.40E+09	P	1.8E-11	6.2E-13	9.4E-10	9.6E-10	<1%
Lead-211	1.46E-01	1.40E+09	P	8.6E-17	1.9E-18	8.7E-13	8.7E-13	<1%
Astatine-215	1.46E-01	1.40E+09	P	NA	NA	9.7E-23	9.7E-23	<1%
Bismuth-211	1.46E-01	1.40E+09	P	NA	NA	3.3E-14	3.3E-14	<1%
Thallium-207	1.46E-01	1.40E+09	P	NA	NA	6.2E-15	6.2E-15	<1%
Polonium-211	1.46E-01	1.40E+09	P	NA	NA	2.7E-17	2.7E-17	<1%
				2E-06	5E-08	1E-04		
Total						**Total ELCR**	2E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-2 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.57E+00	1.40E+09	P	8.1E-08	2.4E-09	7.8E-07	8.7E-07	1%
Uranium-234	2.46E+00	1.40E+09	P	7.1E-08	2.8E-09	1.6E-09	7.5E-08	<1%
Thorium-230	2.46E+00	1.40E+09	P	1.1E-07	3.4E-09	5.3E-09	1.2E-07	<1%
Radium-226	2.15E+00	1.40E+09	P	3.6E-07	2.4E-09	4.6E-05	4.6E-05	60%
Lead-210	2.15E+00	1.40E+09	P	5.0E-07	9.6E-10	5.7E-09	5.1E-07	<1%
Bismuth-210	2.15E+00	1.40E+09	P	3.6E-12	3.2E-14	1.2E-11	1.6E-11	<1%
Polonium-210	2.15E+00	1.40E+09	P	3.8E-08	2.8E-11	5.5E-12	3.8E-08	<1%
Thorium-232	2.66E+00	1.40E+09	P	1.1E-06	9.3E-09	2.8E-05	2.9E-05	37%
Thorium-228	2.66E+00	1.40E+09	P	1.1E-08	1.5E-09	4.2E-09	1.6E-08	<1%
Radium-224	2.66E+00	1.40E+09	P	7.3E-11	6.8E-13	1.7E-10	2.4E-10	<1%
Lead-212	2.66E+00	1.40E+09	P	1.4E-12	4.8E-15	2.4E-10	2.4E-10	<1%
Bismuth-212	2.66E+00	1.40E+09	P	4.4E-15	6.0E-17	2.2E-11	2.2E-11	<1%
Thallium-208	2.66E+00	1.40E+09	P	NA	NA	4.0E-11	4.0E-11	<1%
Uranium-235	1.46E-01	1.40E+09	P	4.1E-09	1.5E-10	2.2E-07	2.2E-07	<1%
Protactinium-231	1.46E-01	1.40E+09	P	1.3E-08	4.5E-10	4.8E-08	6.1E-08	<1%
Actinium-227	1.46E-01	1.40E+09	P	1.1E-08	6.1E-10	5.1E-11	1.2E-08	<1%
Francium-223	1.46E-01	1.40E+09	P	9.7E-16	5.8E-19	1.2E-13	1.2E-13	<1%
Astatine-219	1.46E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.46E-01	1.40E+09	P	NA	NA	3.4E-13	3.4E-13	<1%
Thorium-227	1.46E-01	1.40E+09	P	5.0E-12	6.1E-13	4.9E-10	5.0E-10	<1%
Radium-223	1.46E-01	1.40E+09	P	1.8E-11	3.1E-13	4.7E-10	4.9E-10	<1%
Lead-211	1.46E-01	1.40E+09	P	8.6E-17	9.3E-19	4.3E-13	4.3E-13	<1%
Astatine-215	1.46E-01	1.40E+09	P	NA	NA	4.9E-23	4.9E-23	<1%
Bismuth-211	1.46E-01	1.40E+09	P	NA	NA	1.7E-14	1.7E-14	<1%
Thallium-207	1.46E-01	1.40E+09	P	NA	NA	3.1E-15	3.1E-15	<1%
Polonium-211	1.46E-01	1.40E+09	P	NA	NA	1.3E-17	1.3E-17	<1%
				2E-06	2E-08	7E-05		
Total						**Total ELCR**	8E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
$ELCRo = (EPCs \times 100 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFo) / (1{,}000 \times 25 \times \lambda)$
$ELCRi = (EPCs \times 1{,}000 \times 60 \times 8 \times 0.042 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFi) / (1.40E{+}09 \times 25 \times \lambda)$
$ELCRe = (EPCs \times ACF \times [(8 \times 0.042 \times 1) + (0 \times 0.042 \times 0.4)] \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFe) / (365 \times 25 \times \lambda)$

Appendix D, Table D-3 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.57E+00	1.40E+09	P	3.7E-09	1.3E-11	1.8E-08	2.2E-08	1%
Uranium-234	2.46E+00	1.40E+09	P	3.3E-09	1.5E-11	3.7E-11	3.3E-09	<1%
Thorium-230	2.46E+00	1.40E+09	P	4.9E-09	1.8E-11	1.2E-10	5.1E-09	<1%
Radium-226	2.15E+00	1.40E+09	P	1.6E-08	1.3E-11	1.1E-06	1.1E-06	59%
Lead-210	2.15E+00	1.40E+09	P	2.9E-08	6.3E-12	1.6E-10	2.9E-08	2%
Bismuth-210	2.15E+00	1.40E+09	P	4.1E-13	4.2E-16	7.1E-13	1.1E-12	<1%
Polonium-210	2.15E+00	1.40E+09	P	4.4E-09	3.8E-13	3.2E-13	4.4E-09	<1%
Thorium-232	2.66E+00	1.40E+09	P	5.2E-08	4.9E-11	6.4E-07	6.9E-07	37%
Thorium-228	2.66E+00	1.40E+09	P	1.2E-09	2.0E-11	2.4E-10	1.4E-09	<1%
Radium-224	2.66E+00	1.40E+09	P	8.5E-12	9.0E-15	9.6E-12	1.8E-11	<1%
Lead-212	2.66E+00	1.40E+09	P	1.6E-13	6.3E-17	1.4E-11	1.4E-11	<1%
Bismuth-212	2.66E+00	1.40E+09	P	5.1E-16	7.9E-19	1.3E-12	1.3E-12	<1%
Thallium-208	2.66E+00	1.40E+09	P	NA	NA	2.3E-12	2.3E-12	<1%
Uranium-235	1.46E-01	1.40E+09	P	1.9E-10	7.8E-13	5.0E-09	5.2E-09	<1%
Protactinium-231	1.46E-01	1.40E+09	P	5.8E-10	2.4E-12	1.1E-09	1.7E-09	<1%
Actinium-227	1.46E-01	1.40E+09	P	6.5E-10	4.0E-12	1.5E-12	6.6E-10	<1%
Francium-223	1.46E-01	1.40E+09	P	1.1E-16	7.7E-21	7.1E-15	7.2E-15	<1%
Astatine-219	1.46E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.46E-01	1.40E+09	P	NA	NA	2.0E-14	2.0E-14	<1%
Thorium-227	1.46E-01	1.40E+09	P	5.8E-13	8.0E-15	2.9E-11	2.9E-11	<1%
Radium-223	1.46E-01	1.40E+09	P	2.1E-12	4.1E-15	2.7E-11	2.9E-11	<1%
Lead-211	1.46E-01	1.40E+09	P	9.9E-18	1.2E-20	2.5E-14	2.5E-14	<1%
Astatine-215	1.46E-01	1.40E+09	P	NA	NA	2.8E-24	2.8E-24	<1%
Bismuth-211	1.46E-01	1.40E+09	P	NA	NA	9.7E-16	9.7E-16	<1%
Thallium-207	1.46E-01	1.40E+09	P	NA	NA	1.8E-16	1.8E-16	<1%
Polonium-211	1.46E-01	1.40E+09	P	NA	NA	7.7E-19	7.7E-19	<1%
				1E-07	1E-10	2E-06		
Total						**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix D, Table D-4 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	3.17E+00	1.40E+09	P	1.0E-07	6.1E-09	1.9E-06	2.0E-06	1%
Uranium-234	3.08E+00	1.40E+09	P	8.8E-08	6.9E-09	4.0E-09	9.9E-08	<1%
Thorium-230	3.08E+00	1.40E+09	P	1.3E-07	8.4E-09	1.3E-08	1.6E-07	<1%
Radium-226	2.18E+00	1.40E+09	P	3.6E-07	4.9E-09	9.3E-05	9.4E-05	61%
Lead-210	2.18E+00	1.40E+09	P	5.1E-07	2.0E-09	1.2E-08	5.2E-07	<1%
Bismuth-210	2.18E+00	1.40E+09	P	3.6E-12	6.4E-14	2.5E-11	2.8E-11	<1%
Polonium-210	2.18E+00	1.40E+09	P	3.9E-08	5.8E-11	1.1E-11	3.9E-08	<1%
Thorium-232	2.63E+00	1.40E+09	P	1.1E-06	1.8E-08	5.5E-05	5.6E-05	36%
Thorium-228	2.63E+00	1.40E+09	P	1.0E-08	3.0E-09	8.4E-09	2.2E-08	<1%
Radium-224	2.63E+00	1.40E+09	P	7.3E-11	1.4E-12	3.3E-10	4.0E-10	<1%
Lead-212	2.63E+00	1.40E+09	P	1.4E-12	9.5E-15	4.7E-10	4.7E-10	<1%
Bismuth-212	2.63E+00	1.40E+09	P	4.4E-15	1.2E-16	4.5E-11	4.5E-11	<1%
Thallium-208	2.63E+00	1.40E+09	P	NA	NA	7.9E-11	7.9E-11	<1%
Uranium-235	1.92E-01	1.40E+09	P	5.4E-09	3.9E-10	5.7E-07	5.7E-07	<1%
Protactinium-231	1.92E-01	1.40E+09	P	1.7E-08	1.2E-09	1.3E-07	1.4E-07	<1%
Actinium-227	1.92E-01	1.40E+09	P	1.5E-08	1.6E-09	1.3E-10	1.7E-08	<1%
Francium-223	1.92E-01	1.40E+09	P	1.3E-15	1.5E-18	3.2E-13	3.2E-13	<1%
Astatine-219	1.92E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.92E-01	1.40E+09	P	NA	NA	8.9E-13	8.9E-13	<1%
Thorium-227	1.92E-01	1.40E+09	P	6.6E-12	1.6E-12	1.3E-09	1.3E-09	<1%
Radium-223	1.92E-01	1.40E+09	P	2.4E-11	8.1E-13	1.2E-09	1.3E-09	<1%
Lead-211	1.92E-01	1.40E+09	P	1.1E-16	2.5E-18	1.1E-12	1.1E-12	<1%
Astatine-215	1.92E-01	1.40E+09	P	NA	NA	1.3E-22	1.3E-22	<1%
Bismuth-211	1.92E-01	1.40E+09	P	NA	NA	4.4E-14	4.4E-14	<1%
Thallium-207	1.92E-01	1.40E+09	P	NA	NA	8.2E-15	8.2E-15	<1%
Polonium-211	1.92E-01	1.40E+09	P	NA	NA	3.5E-17	3.5E-17	<1%
				2E-06	5E-08	2E-04		
Total						**Total ELCR**	2E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-5 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	3.17E+00	1.40E+09	P	1.0E-07	3.0E-09	9.7E-07	1.1E-06	1%
Uranium-234	3.08E+00	1.40E+09	P	8.8E-08	3.5E-09	2.0E-09	9.4E-08	<1%
Thorium-230	3.08E+00	1.40E+09	P	1.3E-07	4.2E-09	6.7E-09	1.4E-07	<1%
Radium-226	2.18E+00	1.40E+09	P	3.6E-07	2.5E-09	4.7E-05	4.7E-05	60%
Lead-210	2.18E+00	1.40E+09	P	5.1E-07	9.8E-10	5.8E-09	5.2E-07	<1%
Bismuth-210	2.18E+00	1.40E+09	P	3.6E-12	3.2E-14	1.2E-11	1.6E-11	<1%
Polonium-210	2.18E+00	1.40E+09	P	3.9E-08	2.9E-11	5.5E-12	3.9E-08	<1%
Thorium-232	2.63E+00	1.40E+09	P	1.1E-06	9.2E-09	2.7E-05	2.8E-05	37%
Thorium-228	2.63E+00	1.40E+09	P	1.0E-08	1.5E-09	4.2E-09	1.6E-08	<1%
Radium-224	2.63E+00	1.40E+09	P	7.3E-11	6.8E-13	1.6E-10	2.4E-10	<1%
Lead-212	2.63E+00	1.40E+09	P	1.4E-12	4.8E-15	2.3E-10	2.4E-10	<1%
Bismuth-212	2.63E+00	1.40E+09	P	4.4E-15	5.9E-17	2.2E-11	2.2E-11	<1%
Thallium-208	2.63E+00	1.40E+09	P	NA	NA	4.0E-11	4.0E-11	<1%
Uranium-235	1.92E-01	1.40E+09	P	5.4E-09	1.9E-10	2.8E-07	2.9E-07	<1%
Protactinium-231	1.92E-01	1.40E+09	P	1.7E-08	5.9E-10	6.3E-08	8.0E-08	<1%
Actinium-227	1.92E-01	1.40E+09	P	1.5E-08	8.0E-10	6.7E-11	1.6E-08	<1%
Francium-223	1.92E-01	1.40E+09	P	1.3E-15	7.6E-19	1.6E-13	1.6E-13	<1%
Astatine-219	1.92E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.92E-01	1.40E+09	P	NA	NA	4.4E-13	4.4E-13	<1%
Thorium-227	1.92E-01	1.40E+09	P	6.6E-12	8.0E-13	6.5E-10	6.6E-10	<1%
Radium-223	1.92E-01	1.40E+09	P	2.4E-11	4.1E-13	6.2E-10	6.4E-10	<1%
Lead-211	1.92E-01	1.40E+09	P	1.1E-16	1.2E-18	5.7E-13	5.7E-13	<1%
Astatine-215	1.92E-01	1.40E+09	P	NA	NA	6.4E-23	6.4E-23	<1%
Bismuth-211	1.92E-01	1.40E+09	P	NA	NA	2.2E-14	2.2E-14	<1%
Thallium-207	1.92E-01	1.40E+09	P	NA	NA	4.1E-15	4.1E-15	<1%
Polonium-211	1.92E-01	1.40E+09	P	NA	NA	1.7E-17	1.7E-17	<1%
				2E-06	3E-08	8E-05		
Total						**Total ELCR**	8E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-6 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	3.17E+00	1.40E+09	P	4.6E-09	1.6E-11	2.3E-08	2.7E-08	1%
Uranium-234	3.08E+00	1.40E+09	P	4.1E-09	1.8E-11	4.7E-11	4.2E-09	<1%
Thorium-230	3.08E+00	1.40E+09	P	6.2E-09	2.2E-11	1.6E-10	6.4E-09	<1%
Radium-226	2.18E+00	1.40E+09	P	1.7E-08	1.3E-11	1.1E-06	1.1E-06	59%
Lead-210	2.18E+00	1.40E+09	P	2.9E-08	6.4E-12	1.7E-10	2.9E-08	2%
Bismuth-210	2.18E+00	1.40E+09	P	4.2E-13	4.2E-16	7.2E-13	1.1E-12	<1%
Polonium-210	2.18E+00	1.40E+09	P	4.5E-09	3.8E-13	3.2E-13	4.5E-09	<1%
Thorium-232	2.63E+00	1.40E+09	P	5.2E-08	4.9E-11	6.4E-07	6.9E-07	37%
Thorium-228	2.63E+00	1.40E+09	P	1.2E-09	2.0E-11	2.4E-10	1.4E-09	<1%
Radium-224	2.63E+00	1.40E+09	P	8.4E-12	8.9E-15	9.5E-12	1.8E-11	<1%
Lead-212	2.63E+00	1.40E+09	P	1.6E-13	6.3E-17	1.4E-11	1.4E-11	<1%
Bismuth-212	2.63E+00	1.40E+09	P	5.0E-16	7.8E-19	1.3E-12	1.3E-12	<1%
Thallium-208	2.63E+00	1.40E+09	P	NA	NA	2.3E-12	2.3E-12	<1%
Uranium-235	1.92E-01	1.40E+09	P	2.5E-10	1.0E-12	6.6E-09	6.9E-09	<1%
Protactinium-231	1.92E-01	1.40E+09	P	7.7E-10	3.1E-12	1.5E-09	2.2E-09	<1%
Actinium-227	1.92E-01	1.40E+09	P	8.6E-10	5.2E-12	1.9E-12	8.7E-10	<1%
Francium-223	1.92E-01	1.40E+09	P	1.5E-16	1.0E-20	9.3E-15	9.5E-15	<1%
Astatine-219	1.92E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.92E-01	1.40E+09	P	NA	NA	2.6E-14	2.6E-14	<1%
Thorium-227	1.92E-01	1.40E+09	P	7.6E-13	1.1E-14	3.8E-11	3.9E-11	<1%
Radium-223	1.92E-01	1.40E+09	P	2.8E-12	5.4E-15	3.6E-11	3.9E-11	<1%
Lead-211	1.92E-01	1.40E+09	P	1.3E-17	1.6E-20	3.3E-14	3.3E-14	<1%
Astatine-215	1.92E-01	1.40E+09	P	NA	NA	3.7E-24	3.7E-24	<1%
Bismuth-211	1.92E-01	1.40E+09	P	NA	NA	1.3E-15	1.3E-15	<1%
Thallium-207	1.92E-01	1.40E+09	P	NA	NA	2.4E-16	2.4E-16	<1%
Polonium-211	1.92E-01	1.40E+09	P	NA	NA	1.0E-18	1.0E-18	<1%
				1E-07	2E-10	2E-06		
Total						**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix D, Table D-7 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	3.15E+00	soil	1.40E+09	P	9.9E-08	6.0E-09	1.9E-06	2.0E-06	1%
Uranium-234	3.07E+00	soil	1.40E+09	P	8.8E-08	6.9E-09	4.0E-09	9.9E-08	<1%
Thorium-230	3.07E+00	soil	1.40E+09	P	1.3E-07	8.4E-09	1.3E-08	1.5E-07	<1%
Radium-226	2.58E+00	soil	1.40E+09	P	4.3E-07	5.8E-09	1.1E-04	1.1E-04	66%
Lead-210	2.58E+00	soil	1.40E+09	P	6.0E-07	2.3E-09	1.4E-08	6.2E-07	<1%
Bismuth-210	2.58E+00	soil	1.40E+09	P	4.3E-12	7.6E-14	2.9E-11	3.3E-11	<1%
Polonium-210	2.58E+00	soil	1.40E+09	P	4.6E-08	6.8E-11	1.3E-11	4.6E-08	<1%
Thorium-232	2.52E+00	soil	1.40E+09	P	1.1E-06	1.8E-08	5.2E-05	5.3E-05	32%
Thorium-228	2.52E+00	soil	1.40E+09	P	1.0E-08	2.9E-09	8.0E-09	2.1E-08	<1%
Radium-224	2.52E+00	soil	1.40E+09	P	6.9E-11	1.3E-12	3.1E-10	3.8E-10	<1%
Lead-212	2.52E+00	soil	1.40E+09	P	1.3E-12	9.1E-15	4.5E-10	4.5E-10	<1%
Bismuth-212	2.52E+00	soil	1.40E+09	P	4.2E-15	1.1E-16	4.3E-11	4.3E-11	<1%
Thallium-208	2.52E+00	soil	1.40E+09	P	NA	NA	7.6E-11	7.6E-11	<1%
Uranium-235	1.85E-01	soil	1.40E+09	P	5.2E-09	3.7E-10	5.5E-07	5.5E-07	<1%
Protactinium-231	1.85E-01	soil	1.40E+09	P	1.6E-08	1.1E-09	1.2E-07	1.4E-07	<1%
Actinium-227	1.85E-01	soil	1.40E+09	P	1.4E-08	1.5E-09	1.3E-10	1.6E-08	<1%
Francium-223	1.85E-01	soil	1.40E+09	P	1.2E-15	1.5E-18	3.1E-13	3.1E-13	<1%
Astatine-219	1.85E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.85E-01	soil	1.40E+09	P	NA	NA	8.6E-13	8.6E-13	<1%
Thorium-227	1.85E-01	soil	1.40E+09	P	6.3E-12	1.5E-12	1.2E-09	1.3E-09	<1%
Radium-223	1.85E-01	soil	1.40E+09	P	2.3E-11	7.8E-13	1.2E-09	1.2E-09	<1%
Lead-211	1.85E-01	soil	1.40E+09	P	1.1E-16	2.4E-18	1.1E-12	1.1E-12	<1%
Astatine-215	1.85E-01	soil	1.40E+09	P	NA	NA	1.2E-22	1.2E-22	<1%
Bismuth-211	1.85E-01	soil	1.40E+09	P	NA	NA	4.2E-14	4.2E-14	<1%
Thallium-207	1.85E-01	soil	1.40E+09	P	NA	NA	7.9E-15	7.9E-15	<1%
Polonium-211	1.85E-01	soil	1.40E+09	P	NA	NA	3.4E-17	3.4E-17	<1%
					3E-06	5E-08	2E-04		
Total							**Total ELCR**	2E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-8 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	3.15E+00	soil	1.40E+09	P	9.9E-08	3.0E-09	9.6E-07	1.1E-06	1%
Uranium-234	3.07E+00	soil	1.40E+09	P	8.8E-08	3.5E-09	2.0E-09	9.4E-08	<1%
Thorium-230	3.07E+00	soil	1.40E+09	P	1.3E-07	4.2E-09	6.7E-09	1.4E-07	<1%
Radium-226	2.58E+00	soil	1.40E+09	P	4.3E-07	2.9E-09	5.5E-05	5.6E-05	65%
Lead-210	2.58E+00	soil	1.40E+09	P	6.0E-07	1.2E-09	6.8E-09	6.1E-07	<1%
Bismuth-210	2.58E+00	soil	1.40E+09	P	4.3E-12	3.8E-14	1.5E-11	1.9E-11	<1%
Polonium-210	2.58E+00	soil	1.40E+09	P	4.6E-08	3.4E-11	6.5E-12	4.6E-08	<1%
Thorium-232	2.52E+00	soil	1.40E+09	P	1.1E-06	8.8E-09	2.6E-05	2.7E-05	32%
Thorium-228	2.52E+00	soil	1.40E+09	P	1.0E-08	1.5E-09	4.0E-09	1.5E-08	<1%
Radium-224	2.52E+00	soil	1.40E+09	P	6.9E-11	6.5E-13	1.6E-10	2.3E-10	<1%
Lead-212	2.52E+00	soil	1.40E+09	P	1.3E-12	4.5E-15	2.2E-10	2.3E-10	<1%
Bismuth-212	2.52E+00	soil	1.40E+09	P	4.2E-15	5.7E-17	2.1E-11	2.1E-11	<1%
Thallium-208	2.52E+00	soil	1.40E+09	P	NA	NA	3.8E-11	3.8E-11	<1%
Uranium-235	1.85E-01	soil	1.40E+09	P	5.2E-09	1.9E-10	2.7E-07	2.8E-07	<1%
Protactinium-231	1.85E-01	soil	1.40E+09	P	1.6E-08	5.7E-10	6.0E-08	7.7E-08	<1%
Actinium-227	1.85E-01	soil	1.40E+09	P	1.4E-08	7.7E-10	6.5E-11	1.5E-08	<1%
Francium-223	1.85E-01	soil	1.40E+09	P	1.2E-15	7.4E-19	1.5E-13	1.6E-13	<1%
Astatine-219	1.85E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.85E-01	soil	1.40E+09	P	NA	NA	4.3E-13	4.3E-13	<1%
Thorium-227	1.85E-01	soil	1.40E+09	P	6.3E-12	7.7E-13	6.2E-10	6.3E-10	<1%
Radium-223	1.85E-01	soil	1.40E+09	P	2.3E-11	3.9E-13	5.9E-10	6.2E-10	<1%
Lead-211	1.85E-01	soil	1.40E+09	P	1.1E-16	1.2E-18	5.5E-13	5.5E-13	<1%
Astatine-215	1.85E-01	soil	1.40E+09	P	NA	NA	6.2E-23	6.2E-23	<1%
Bismuth-211	1.85E-01	soil	1.40E+09	P	NA	NA	2.1E-14	2.1E-14	<1%
Thallium-207	1.85E-01	soil	1.40E+09	P	NA	NA	4.0E-15	4.0E-15	<1%
Polonium-211	1.85E-01	soil	1.40E+09	P	NA	NA	1.7E-17	1.7E-17	<1%
					3E-06	3E-08	8E-05		
Total							**Total ELCR**	9E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-9 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	3.15E+00	soil	1.40E+09	P	4.6E-09	1.6E-11	2.2E-08	2.7E-08	1%
Uranium-234	3.07E+00	soil	1.40E+09	P	4.1E-09	1.8E-11	4.6E-11	4.1E-09	<1%
Thorium-230	3.07E+00	soil	1.40E+09	P	6.2E-09	2.2E-11	1.5E-10	6.3E-09	<1%
Radium-226	2.58E+00	soil	1.40E+09	P	2.0E-08	1.5E-11	1.3E-06	1.3E-06	64%
Lead-210	2.58E+00	soil	1.40E+09	P	3.5E-08	7.6E-12	2.0E-10	3.5E-08	2%
Bismuth-210	2.58E+00	soil	1.40E+09	P	5.0E-13	5.0E-16	8.5E-13	1.3E-12	<1%
Polonium-210	2.58E+00	soil	1.40E+09	P	5.3E-09	4.5E-13	3.8E-13	5.3E-09	<1%
Thorium-232	2.52E+00	soil	1.40E+09	P	4.9E-08	4.7E-11	6.1E-07	6.6E-07	32%
Thorium-228	2.52E+00	soil	1.40E+09	P	1.1E-09	1.9E-11	2.3E-10	1.4E-09	<1%
Radium-224	2.52E+00	soil	1.40E+09	P	8.0E-12	8.5E-15	9.1E-12	1.7E-11	<1%
Lead-212	2.52E+00	soil	1.40E+09	P	1.5E-13	6.0E-17	1.3E-11	1.3E-11	<1%
Bismuth-212	2.52E+00	soil	1.40E+09	P	4.8E-16	7.5E-19	1.2E-12	1.2E-12	<1%
Thallium-208	2.52E+00	soil	1.40E+09	P	NA	NA	2.2E-12	2.2E-12	<1%
Uranium-235	1.85E-01	soil	1.40E+09	P	2.4E-10	9.8E-13	6.4E-09	6.6E-09	<1%
Protactinium-231	1.85E-01	soil	1.40E+09	P	7.4E-10	3.0E-12	1.4E-09	2.1E-09	<1%
Actinium-227	1.85E-01	soil	1.40E+09	P	8.3E-10	5.1E-12	1.9E-12	8.4E-10	<1%
Francium-223	1.85E-01	soil	1.40E+09	P	1.4E-16	9.7E-21	9.0E-15	9.1E-15	<1%
Astatine-219	1.85E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.85E-01	soil	1.40E+09	P	NA	NA	2.5E-14	2.5E-14	<1%
Thorium-227	1.85E-01	soil	1.40E+09	P	7.3E-13	1.0E-14	3.6E-11	3.7E-11	<1%
Radium-223	1.85E-01	soil	1.40E+09	P	2.7E-12	5.2E-15	3.5E-11	3.7E-11	<1%
Lead-211	1.85E-01	soil	1.40E+09	P	1.3E-17	1.6E-20	3.2E-14	3.2E-14	<1%
Astatine-215	1.85E-01	soil	1.40E+09	P	NA	NA	3.6E-24	3.6E-24	<1%
Bismuth-211	1.85E-01	soil	1.40E+09	P	NA	NA	1.2E-15	1.2E-15	<1%
Thallium-207	1.85E-01	soil	1.40E+09	P	NA	NA	2.3E-16	2.3E-16	<1%
Polonium-211	1.85E-01	soil	1.40E+09	P	NA	NA	9.8E-19	9.8E-19	<1%
					1E-07	2E-10	2E-06		
Total							**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix D, Table D-10 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Construction Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	3.15E+00	soil	1.40E+09	P	1.5E-08	2.7E-10	8.5E-08	1.0E-07	1%
Uranium-234	3.07E+00	soil	1.40E+09	P	1.3E-08	3.1E-10	1.8E-10	1.3E-08	<1%
Thorium-230	3.07E+00	soil	1.40E+09	P	2.0E-08	3.7E-10	5.9E-10	2.1E-08	<1%
Radium-226	2.58E+00	soil	1.40E+09	P	6.3E-08	2.6E-10	4.9E-06	5.0E-06	63%
Lead-210	2.58E+00	soil	1.40E+09	P	1.3E-07	1.5E-10	8.6E-10	1.3E-07	2%
Bismuth-210	2.58E+00	soil	1.40E+09	P	1.6E-11	8.4E-14	3.2E-11	4.8E-11	<1%
Polonium-210	2.58E+00	soil	1.40E+09	P	1.4E-07	6.4E-11	1.2E-11	1.4E-07	2%
Thorium-232	2.52E+00	soil	1.40E+09	P	1.6E-07	7.8E-10	2.3E-06	2.5E-06	31%
Thorium-228	2.52E+00	soil	1.40E+09	P	1.1E-08	9.8E-10	2.7E-09	1.5E-08	<1%
Radium-224	2.52E+00	soil	1.40E+09	P	2.5E-10	1.4E-12	3.5E-10	6.0E-10	<1%
Lead-212	2.52E+00	soil	1.40E+09	P	4.8E-12	1.0E-14	5.0E-10	5.0E-10	<1%
Bismuth-212	2.52E+00	soil	1.40E+09	P	1.5E-14	1.3E-16	4.7E-11	4.7E-11	<1%
Thallium-208	2.52E+00	soil	1.40E+09	P	NA	NA	8.4E-11	8.4E-11	<1%
Uranium-235	1.85E-01	soil	1.40E+09	P	7.6E-10	1.7E-11	2.4E-08	2.5E-08	<1%
Protactinium-231	1.85E-01	soil	1.40E+09	P	2.4E-09	5.0E-11	5.4E-09	7.8E-09	<1%
Actinium-227	1.85E-01	soil	1.40E+09	P	3.0E-09	9.8E-11	8.2E-12	3.1E-09	<1%
Francium-223	1.85E-01	soil	1.40E+09	P	4.5E-15	1.6E-18	3.4E-13	3.5E-13	<1%
Astatine-219	1.85E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.85E-01	soil	1.40E+09	P	NA	NA	9.5E-13	9.5E-13	<1%
Thorium-227	1.85E-01	soil	1.40E+09	P	2.3E-11	1.7E-12	1.4E-09	1.4E-09	<1%
Radium-223	1.85E-01	soil	1.40E+09	P	8.5E-11	8.7E-13	1.3E-09	1.4E-09	<1%
Lead-211	1.85E-01	soil	1.40E+09	P	4.0E-16	2.6E-18	1.2E-12	1.2E-12	<1%
Astatine-215	1.85E-01	soil	1.40E+09	P	NA	NA	1.4E-22	1.4E-22	<1%
Bismuth-211	1.85E-01	soil	1.40E+09	P	NA	NA	4.7E-14	4.7E-14	<1%
Thallium-207	1.85E-01	soil	1.40E+09	P	NA	NA	8.8E-15	8.8E-15	<1%
Polonium-211	1.85E-01	soil	1.40E+09	P	NA	NA	3.7E-17	3.7E-17	<1%
					6E-07	3E-09	7E-06		
Total							**Total ELCR**	8E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 330 × 250 × 1 × [1 - exp(-λ × 1)] × CSFo) / (1,000 × 1 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 250 × 1 × [1 - exp(-λ × 1)] × CSFi) / (1.40E+09 × 1 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 250 × 1 × [1 - exp(-λ × 1)] × CSFe) / (365 × 1 × λ)

Appendix D, Table D-11 (RME)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.10E+00	1.40E+09	P	6.6E-08	4.0E-09	1.3E-06	1.4E-06	<1%
Uranium-234	2.12E+00	1.40E+09	P	6.1E-08	4.8E-09	2.8E-09	6.8E-08	<1%
Thorium-230	2.12E+00	1.40E+09	P	9.2E-08	5.8E-09	9.2E-09	1.1E-07	<1%
Radium-226	2.60E+00	1.40E+09	P	4.3E-07	5.9E-09	1.1E-04	1.1E-04	70%
Lead-210	2.60E+00	1.40E+09	P	6.1E-07	2.3E-09	1.4E-08	6.3E-07	<1%
Bismuth-210	2.60E+00	1.40E+09	P	4.3E-12	7.6E-14	2.9E-11	3.4E-11	<1%
Polonium-210	2.60E+00	1.40E+09	P	4.6E-08	6.9E-11	1.3E-11	4.6E-08	<1%
Thorium-232	2.19E+00	1.40E+09	P	9.3E-07	1.5E-08	4.5E-05	4.6E-05	29%
Thorium-228	2.19E+00	1.40E+09	P	8.7E-09	2.5E-09	7.0E-09	1.8E-08	<1%
Radium-224	2.19E+00	1.40E+09	P	6.0E-11	1.1E-12	2.7E-10	3.3E-10	<1%
Lead-212	2.19E+00	1.40E+09	P	1.1E-12	7.9E-15	3.9E-10	3.9E-10	<1%
Bismuth-212	2.19E+00	1.40E+09	P	3.6E-15	9.8E-17	3.7E-11	3.7E-11	<1%
Thallium-208	2.19E+00	1.40E+09	P	NA	NA	6.6E-11	6.6E-11	<1%
Uranium-235	1.12E-01	1.40E+09	P	3.1E-09	2.3E-10	3.3E-07	3.3E-07	<1%
Protactinium-231	1.12E-01	1.40E+09	P	9.7E-09	6.9E-10	7.3E-08	8.3E-08	<1%
Actinium-227	1.12E-01	1.40E+09	P	8.7E-09	9.3E-10	7.9E-11	9.7E-09	<1%
Francium-223	1.12E-01	1.40E+09	P	7.4E-16	8.9E-19	1.9E-13	1.9E-13	<1%
Astatine-219	1.12E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.12E-01	1.40E+09	P	NA	NA	5.2E-13	5.2E-13	<1%
Thorium-227	1.12E-01	1.40E+09	P	3.8E-12	9.3E-13	7.6E-10	7.6E-10	<1%
Radium-223	1.12E-01	1.40E+09	P	1.4E-11	4.7E-13	7.2E-10	7.3E-10	<1%
Lead-211	1.12E-01	1.40E+09	P	6.6E-17	1.4E-18	6.6E-13	6.6E-13	<1%
Astatine-215	1.12E-01	1.40E+09	P	NA	NA	7.5E-23	7.5E-23	<1%
Bismuth-211	1.12E-01	1.40E+09	P	NA	NA	2.6E-14	2.6E-14	<1%
Thallium-207	1.12E-01	1.40E+09	P	NA	NA	4.8E-15	4.8E-15	<1%
Polonium-211	1.12E-01	1.40E+09	P	NA	NA	2.0E-17	2.0E-17	<1%
				2E-06	4E-08	2E-04		
Total						**Total ELCR**	2E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-12 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.10E+00	1.40E+09	P	6.6E-08	2.0E-09	6.4E-07	7.1E-07	<1%
Uranium-234	2.12E+00	1.40E+09	P	6.1E-08	2.4E-09	1.4E-09	6.5E-08	<1%
Thorium-230	2.12E+00	1.40E+09	P	9.2E-08	2.9E-09	4.6E-09	1.0E-07	<1%
Radium-226	2.60E+00	1.40E+09	P	4.3E-07	2.9E-09	5.6E-05	5.6E-05	69%
Lead-210	2.60E+00	1.40E+09	P	6.1E-07	1.2E-09	6.9E-09	6.2E-07	<1%
Bismuth-210	2.60E+00	1.40E+09	P	4.3E-12	3.8E-14	1.5E-11	1.9E-11	<1%
Polonium-210	2.60E+00	1.40E+09	P	4.6E-08	3.4E-11	6.6E-12	4.6E-08	<1%
Thorium-232	2.19E+00	1.40E+09	P	9.3E-07	7.7E-09	2.3E-05	2.4E-05	29%
Thorium-228	2.19E+00	1.40E+09	P	8.7E-09	1.3E-09	3.5E-09	1.3E-08	<1%
Radium-224	2.19E+00	1.40E+09	P	6.0E-11	5.6E-13	1.4E-10	2.0E-10	<1%
Lead-212	2.19E+00	1.40E+09	P	1.1E-12	3.9E-15	2.0E-10	2.0E-10	<1%
Bismuth-212	2.19E+00	1.40E+09	P	3.6E-15	4.9E-17	1.9E-11	1.9E-11	<1%
Thallium-208	2.19E+00	1.40E+09	P	NA	NA	3.3E-11	3.3E-11	<1%
Uranium-235	1.12E-01	1.40E+09	P	3.1E-09	1.1E-10	1.7E-07	1.7E-07	<1%
Protactinium-231	1.12E-01	1.40E+09	P	9.7E-09	3.4E-10	3.7E-08	4.7E-08	<1%
Actinium-227	1.12E-01	1.40E+09	P	8.7E-09	4.7E-10	3.9E-11	9.2E-09	<1%
Francium-223	1.12E-01	1.40E+09	P	7.4E-16	4.5E-19	9.4E-14	9.4E-14	<1%
Astatine-219	1.12E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.12E-01	1.40E+09	P	NA	NA	2.6E-13	2.6E-13	<1%
Thorium-227	1.12E-01	1.40E+09	P	3.8E-12	4.7E-13	3.8E-10	3.8E-10	<1%
Radium-223	1.12E-01	1.40E+09	P	1.4E-11	2.4E-13	3.6E-10	3.7E-10	<1%
Lead-211	1.12E-01	1.40E+09	P	6.6E-17	7.2E-19	3.3E-13	3.3E-13	<1%
Astatine-215	1.12E-01	1.40E+09	P	NA	NA	3.7E-23	3.7E-23	<1%
Bismuth-211	1.12E-01	1.40E+09	P	NA	NA	1.3E-14	1.3E-14	<1%
Thallium-207	1.12E-01	1.40E+09	P	NA	NA	2.4E-15	2.4E-15	<1%
Polonium-211	1.12E-01	1.40E+09	P	NA	NA	1.0E-17	1.0E-17	<1%
				2E-06	2E-08	8E-05		
Total						**Total ELCR**	8E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-13 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.10E+00	1.40E+09	P	3.1E-09	1.1E-11	1.5E-08	1.8E-08	<1%
Uranium-234	2.12E+00	1.40E+09	P	2.8E-09	1.3E-11	3.2E-11	2.9E-09	<1%
Thorium-230	2.12E+00	1.40E+09	P	4.3E-09	1.5E-11	1.1E-10	4.4E-09	<1%
Radium-226	2.60E+00	1.40E+09	P	2.0E-08	1.6E-11	1.3E-06	1.3E-06	67%
Lead-210	2.60E+00	1.40E+09	P	3.5E-08	7.6E-12	2.0E-10	3.5E-08	2%
Bismuth-210	2.60E+00	1.40E+09	P	5.0E-13	5.0E-16	8.5E-13	1.4E-12	<1%
Polonium-210	2.60E+00	1.40E+09	P	5.3E-09	4.5E-13	3.8E-13	5.3E-09	<1%
Thorium-232	2.19E+00	1.40E+09	P	4.3E-08	4.0E-11	5.3E-07	5.7E-07	29%
Thorium-228	2.19E+00	1.40E+09	P	9.8E-10	1.6E-11	2.0E-10	1.2E-09	<1%
Radium-224	2.19E+00	1.40E+09	P	7.0E-12	7.4E-15	7.9E-12	1.5E-11	<1%
Lead-212	2.19E+00	1.40E+09	P	1.3E-13	5.2E-17	1.1E-11	1.1E-11	<1%
Bismuth-212	2.19E+00	1.40E+09	P	4.2E-16	6.5E-19	1.1E-12	1.1E-12	<1%
Thallium-208	2.19E+00	1.40E+09	P	NA	NA	1.9E-12	1.9E-12	<1%
Uranium-235	1.12E-01	1.40E+09	P	1.5E-10	6.0E-13	3.9E-09	4.0E-09	<1%
Protactinium-231	1.12E-01	1.40E+09	P	4.5E-10	1.8E-12	8.5E-10	1.3E-09	<1%
Actinium-227	1.12E-01	1.40E+09	P	5.0E-10	3.1E-12	1.1E-12	5.1E-10	<1%
Francium-223	1.12E-01	1.40E+09	P	8.6E-17	5.9E-21	5.5E-15	5.5E-15	<1%
Astatine-219	1.12E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.12E-01	1.40E+09	P	NA	NA	1.5E-14	1.5E-14	<1%
Thorium-227	1.12E-01	1.40E+09	P	4.4E-13	6.2E-15	2.2E-11	2.2E-11	<1%
Radium-223	1.12E-01	1.40E+09	P	1.6E-12	3.1E-15	2.1E-11	2.3E-11	<1%
Lead-211	1.12E-01	1.40E+09	P	7.6E-18	9.4E-21	1.9E-14	1.9E-14	<1%
Astatine-215	1.12E-01	1.40E+09	P	NA	NA	2.2E-24	2.2E-24	<1%
Bismuth-211	1.12E-01	1.40E+09	P	NA	NA	7.5E-16	7.5E-16	<1%
Thallium-207	1.12E-01	1.40E+09	P	NA	NA	1.4E-16	1.4E-16	<1%
Polonium-211	1.12E-01	1.40E+09	P	NA	NA	5.9E-19	5.9E-19	<1%
				1E-07	1E-10	2E-06		
Total						**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix D, Table D-14 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m³/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	8.7E-08	5.3E-09	1.7E-06	1.8E-06	1%
Uranium-234	2.71E+00	soil	1.40E+09	P	7.8E-08	6.1E-09	3.5E-09	8.7E-08	<1%
Thorium-230	2.71E+00	soil	1.40E+09	P	1.2E-07	7.4E-09	1.2E-08	1.4E-07	<1%
Radium-226	2.43E+00	soil+sed	1.40E+09	P	4.0E-07	5.5E-09	1.0E-04	1.0E-04	65%
Lead-210	2.43E+00	soil+sed	1.40E+09	P	5.7E-07	2.2E-09	1.3E-08	5.8E-07	<1%
Bismuth-210	2.43E+00	soil+sed	1.40E+09	P	4.0E-12	7.1E-14	2.7E-11	3.1E-11	<1%
Polonium-210	2.43E+00	soil+sed	1.40E+09	P	4.3E-08	6.4E-11	1.2E-11	4.3E-08	<1%
Thorium-232	2.51E+00	soil	1.40E+09	P	1.1E-06	1.8E-08	5.2E-05	5.3E-05	33%
Thorium-228	2.51E+00	soil	1.40E+09	P	9.9E-09	2.9E-09	8.0E-09	2.1E-08	<1%
Radium-224	2.51E+00	soil	1.40E+09	P	6.9E-11	1.3E-12	3.1E-10	3.8E-10	<1%
Lead-212	2.51E+00	soil	1.40E+09	P	1.3E-12	9.1E-15	4.5E-10	4.5E-10	<1%
Bismuth-212	2.51E+00	soil	1.40E+09	P	4.2E-15	1.1E-16	4.2E-11	4.2E-11	<1%
Thallium-208	2.51E+00	soil	1.40E+09	P	NA	NA	7.6E-11	7.6E-11	<1%
Uranium-235	1.20E-01	soil	1.40E+09	P	3.4E-09	2.4E-10	3.6E-07	3.6E-07	<1%
Protactinium-231	1.20E-01	soil	1.40E+09	P	1.0E-08	7.3E-10	7.8E-08	8.9E-08	<1%
Actinium-227	1.20E-01	soil	1.40E+09	P	9.4E-09	1.0E-09	8.4E-11	1.0E-08	<1%
Francium-223	1.20E-01	soil	1.40E+09	P	7.9E-16	9.6E-19	2.0E-13	2.0E-13	<1%
Astatine-219	1.20E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.20E-01	soil	1.40E+09	P	NA	NA	5.6E-13	5.6E-13	<1%
Thorium-227	1.20E-01	soil	1.40E+09	P	4.1E-12	1.0E-12	8.1E-10	8.2E-10	<1%
Radium-223	1.20E-01	soil	1.40E+09	P	1.5E-11	5.1E-13	7.7E-10	7.9E-10	<1%
Lead-211	1.20E-01	soil	1.40E+09	P	7.0E-17	1.5E-18	7.1E-13	7.1E-13	<1%
Astatine-215	1.20E-01	soil	1.40E+09	P	NA	NA	8.0E-23	8.0E-23	<1%
Bismuth-211	1.20E-01	soil	1.40E+09	P	NA	NA	2.8E-14	2.8E-14	<1%
Thallium-207	1.20E-01	soil	1.40E+09	P	NA	NA	5.1E-15	5.1E-15	<1%
Polonium-211	1.20E-01	soil	1.40E+09	P	NA	NA	2.2E-17	2.2E-17	<1%
					2E-06	5E-08	2E-04		
Total							**Total ELCR**	2E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-15 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m³/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	8.7E-08	2.6E-09	8.4E-07	9.3E-07	1%
Uranium-234	2.71E+00	soil	1.40E+09	P	7.8E-08	3.1E-09	1.8E-09	8.3E-08	<1%
Thorium-230	2.71E+00	soil	1.40E+09	P	1.2E-07	3.7E-09	5.9E-09	1.3E-07	<1%
Radium-226	2.43E+00	soil+sed	1.40E+09	P	4.0E-07	2.7E-09	5.2E-05	5.2E-05	64%
Lead-210	2.43E+00	soil+sed	1.40E+09	P	5.7E-07	1.1E-09	6.4E-09	5.8E-07	<1%
Bismuth-210	2.43E+00	soil+sed	1.40E+09	P	4.0E-12	3.6E-14	1.4E-11	1.8E-11	<1%
Polonium-210	2.43E+00	soil+sed	1.40E+09	P	4.3E-08	3.2E-11	6.2E-12	4.3E-08	<1%
Thorium-232	2.51E+00	soil	1.40E+09	P	1.1E-06	8.8E-09	2.6E-05	2.7E-05	33%
Thorium-228	2.51E+00	soil	1.40E+09	P	9.9E-09	1.4E-09	4.0E-09	1.5E-08	<1%
Radium-224	2.51E+00	soil	1.40E+09	P	6.9E-11	6.4E-13	1.6E-10	2.3E-10	<1%
Lead-212	2.51E+00	soil	1.40E+09	P	1.3E-12	4.5E-15	2.2E-10	2.2E-10	<1%
Bismuth-212	2.51E+00	soil	1.40E+09	P	4.2E-15	5.6E-17	2.1E-11	2.1E-11	<1%
Thallium-208	2.51E+00	soil	1.40E+09	P	NA	NA	3.8E-11	3.8E-11	<1%
Uranium-235	1.20E-01	soil	1.40E+09	P	3.4E-09	1.2E-10	1.8E-07	1.8E-07	<1%
Protactinium-231	1.20E-01	soil	1.40E+09	P	1.0E-08	3.7E-10	3.9E-08	5.0E-08	<1%
Actinium-227	1.20E-01	soil	1.40E+09	P	9.4E-09	5.0E-10	4.2E-11	9.9E-09	<1%
Francium-223	1.20E-01	soil	1.40E+09	P	7.9E-16	4.8E-19	1.0E-13	1.0E-13	<1%
Astatine-219	1.20E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.20E-01	soil	1.40E+09	P	NA	NA	2.8E-13	2.8E-13	<1%
Thorium-227	1.20E-01	soil	1.40E+09	P	4.1E-12	5.0E-13	4.1E-10	4.1E-10	<1%
Radium-223	1.20E-01	soil	1.40E+09	P	1.5E-11	2.5E-13	3.8E-10	4.0E-10	<1%
Lead-211	1.20E-01	soil	1.40E+09	P	7.0E-17	7.7E-19	3.6E-13	3.6E-13	<1%
Astatine-215	1.20E-01	soil	1.40E+09	P	NA	NA	4.0E-23	4.0E-23	<1%
Bismuth-211	1.20E-01	soil	1.40E+09	P	NA	NA	1.4E-14	1.4E-14	<1%
Thallium-207	1.20E-01	soil	1.40E+09	P	NA	NA	2.6E-15	2.6E-15	<1%
Polonium-211	1.20E-01	soil	1.40E+09	P	NA	NA	1.1E-17	1.1E-17	<1%
					2E-06	2E-08	8E-05		
Total							**Total ELCR**	8E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix D, Table D-16 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m³/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	4.0E-09	1.4E-11	2.0E-08	2.4E-08	1%
Uranium-234	2.71E+00	soil	1.40E+09	P	3.6E-09	1.6E-11	4.1E-11	3.7E-09	<1%
Thorium-230	2.71E+00	soil	1.40E+09	P	5.4E-09	2.0E-11	1.4E-10	5.6E-09	<1%
Radium-226	2.43E+00	soil+sed	1.40E+09	P	1.9E-08	1.5E-11	1.2E-06	1.2E-06	63%
Lead-210	2.43E+00	soil+sed	1.40E+09	P	3.2E-08	7.1E-12	1.8E-10	3.3E-08	2%
Bismuth-210	2.43E+00	soil+sed	1.40E+09	P	4.7E-13	4.7E-16	8.0E-13	1.3E-12	<1%
Polonium-210	2.43E+00	soil+sed	1.40E+09	P	5.0E-09	4.2E-13	3.6E-13	5.0E-09	<1%
Thorium-232	2.51E+00	soil	1.40E+09	P	4.9E-08	4.6E-11	6.1E-07	6.5E-07	33%
Thorium-228	2.51E+00	soil	1.40E+09	P	1.1E-09	1.9E-11	2.3E-10	1.4E-09	<1%
Radium-224	2.51E+00	soil	1.40E+09	P	8.0E-12	8.5E-15	9.1E-12	1.7E-11	<1%
Lead-212	2.51E+00	soil	1.40E+09	P	1.5E-13	6.0E-17	1.3E-11	1.3E-11	<1%
Bismuth-212	2.51E+00	soil	1.40E+09	P	4.8E-16	7.4E-19	1.2E-12	1.2E-12	<1%
Thallium-208	2.51E+00	soil	1.40E+09	P	NA	NA	2.2E-12	2.2E-12	<1%
Uranium-235	1.20E-01	soil	1.40E+09	P	1.6E-10	6.4E-13	4.1E-09	4.3E-09	<1%
Protactinium-231	1.20E-01	soil	1.40E+09	P	4.8E-10	1.9E-12	9.1E-10	1.4E-09	<1%
Actinium-227	1.20E-01	soil	1.40E+09	P	5.4E-10	3.3E-12	1.2E-12	5.4E-10	<1%
Francium-223	1.20E-01	soil	1.40E+09	P	9.2E-17	6.3E-21	5.8E-15	5.9E-15	<1%
Astatine-219	1.20E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.20E-01	soil	1.40E+09	P	NA	NA	1.6E-14	1.6E-14	<1%
Thorium-227	1.20E-01	soil	1.40E+09	P	4.7E-13	6.6E-15	2.4E-11	2.4E-11	<1%
Radium-223	1.20E-01	soil	1.40E+09	P	1.7E-12	3.3E-15	2.2E-11	2.4E-11	<1%
Lead-211	1.20E-01	soil	1.40E+09	P	8.1E-18	1.0E-20	2.1E-14	2.1E-14	<1%
Astatine-215	1.20E-01	soil	1.40E+09	P	NA	NA	2.3E-24	2.3E-24	<1%
Bismuth-211	1.20E-01	soil	1.40E+09	P	NA	NA	8.0E-16	8.0E-16	<1%
Thallium-207	1.20E-01	soil	1.40E+09	P	NA	NA	1.5E-16	1.5E-16	<1%
Polonium-211	1.20E-01	soil	1.40E+09	P	NA	NA	6.4E-19	6.4E-19	<1%
					1E-07	1E-10	2E-06		
Total							**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix D, Table D-17 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Construction Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	1.3E-08	2.3E-10	7.5E-08	8.8E-08	1%
Uranium-234	2.71E+00	soil	1.40E+09	P	1.1E-08	2.7E-10	1.6E-10	1.2E-08	<1%
Thorium-230	2.71E+00	soil	1.40E+09	P	1.7E-08	3.3E-10	5.2E-10	1.8E-08	<1%
Radium-226	2.43E+00	soil+sed	1.40E+09	P	5.9E-08	2.5E-10	4.6E-06	4.7E-06	62%
Lead-210	2.43E+00	soil+sed	1.40E+09	P	1.2E-07	1.4E-10	8.1E-10	1.2E-07	2%
Bismuth-210	2.43E+00	soil+sed	1.40E+09	P	1.5E-11	7.9E-14	3.0E-11	4.5E-11	<1%
Polonium-210	2.43E+00	soil+sed	1.40E+09	P	1.3E-07	6.0E-11	1.1E-11	1.3E-07	2%
Thorium-232	2.51E+00	soil	1.40E+09	P	1.6E-07	7.8E-10	2.3E-06	2.5E-06	33%
Thorium-228	2.51E+00	soil	1.40E+09	P	1.1E-08	9.8E-10	2.7E-09	1.5E-08	<1%
Radium-224	2.51E+00	soil	1.40E+09	P	2.5E-10	1.4E-12	3.5E-10	6.0E-10	<1%
Lead-212	2.51E+00	soil	1.40E+09	P	4.7E-12	1.0E-14	5.0E-10	5.0E-10	<1%
Bismuth-212	2.51E+00	soil	1.40E+09	P	1.5E-14	1.3E-16	4.7E-11	4.7E-11	<1%
Thallium-208	2.51E+00	soil	1.40E+09	P	NA	NA	8.4E-11	8.4E-11	<1%
Uranium-235	1.20E-01	soil	1.40E+09	P	5.0E-10	1.1E-11	1.6E-08	1.6E-08	<1%
Protactinium-231	1.20E-01	soil	1.40E+09	P	1.5E-09	3.3E-11	3.5E-09	5.0E-09	<1%
Actinium-227	1.20E-01	soil	1.40E+09	P	2.0E-09	6.3E-11	5.3E-12	2.0E-09	<1%
Francium-223	1.20E-01	soil	1.40E+09	P	2.9E-15	1.1E-18	2.2E-13	2.3E-13	<1%
Astatine-219	1.20E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.20E-01	soil	1.40E+09	P	NA	NA	6.2E-13	6.2E-13	<1%
Thorium-227	1.20E-01	soil	1.40E+09	P	1.5E-11	1.1E-12	9.0E-10	9.2E-10	<1%
Radium-223	1.20E-01	soil	1.40E+09	P	5.5E-11	5.6E-13	8.6E-10	9.1E-10	<1%
Lead-211	1.20E-01	soil	1.40E+09	P	2.6E-16	1.7E-18	7.9E-13	7.9E-13	<1%
Astatine-215	1.20E-01	soil	1.40E+09	P	NA	NA	8.9E-23	8.9E-23	<1%
Bismuth-211	1.20E-01	soil	1.40E+09	P	NA	NA	3.1E-14	3.1E-14	<1%
Thallium-207	1.20E-01	soil	1.40E+09	P	NA	NA	5.7E-15	5.7E-15	<1%
Polonium-211	1.20E-01	soil	1.40E+09	P	NA	NA	2.4E-17	2.4E-17	<1%
					5E-07	3E-09	7E-06		
Total							**Total ELCR**	8E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 330 × 250 × 1 × [1 - exp(-λ × 1)] × CSFo) / (1,000 × 1 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 250 × 1 × [1 - exp(-λ × 1)] × CSFi) / (1.40E+09 × 1 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 250 × 1 × [1 - exp(-λ × 1)] × CSFe) / (365 × 1 × λ)

APPENDIX E

Lead Model Output

Appendix E
Adult Lead Model Worksheets
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Current/Future

Exposure Area: Former CLEAR Plant

Soil/Sediment Data Set: 0-0.5 feet below ground surface

Receptor Population: Outdoor Commercial/Industrial Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	87
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	225
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.9**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.0
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.0007%**

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Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Current/Future

Exposure Area: Former Esperanza Mill

Soil/Sediment Data Set: 0-2 feet below ground surface

Receptor Population: Outdoor Commercial/Industrial Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	116
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	225
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.9**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.2
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.001%**

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Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former CLEAR Plant

Soil/Sediment Data Set: 0-0.5 feet below ground surface

Receptor Population: Outdoor Commercial/Industrial Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	136
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	225
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**1.0**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.4
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.002%**

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Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former CLEAR Plant

Soil/Sediment Data Set: 0-0.5 feet below ground surface

Receptor Population: Hypothetical Adolescent Trespasser

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	136
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	52
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.6**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	1.5
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.00007%**

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Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former CLEAR Plant

Soil/Sediment Data Set: 0-0.5 feet below ground surface

Receptor Population: Hypothetical Adolescent Trespasser

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	87
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	52
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.6**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	1.5
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.00005%**

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Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Current/Future
Exposure Area: Former Esperanza Mill
Soil/Sediment Data Set: 0-2 feet below ground surface
Receptor Population: Hypothetical Adolescent Trespasser

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	116
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	52
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.6**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	1.5
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.00006%**

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Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former CLEAR Plant

Soil/Sediment Data Set: 0-15 feet below ground surface

Receptor Population: Outdoor Commercial/Industrial Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	113.5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	225
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.9**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.2
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.001%**

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Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future
Exposure Area: Former CLEAR Plant
Soil/Sediment Data Set: 0-15 feet below ground surface
Receptor Population: Hypothetical Adolescent Trespasser

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	113.5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	52
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.6**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	1.5
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.00006%**

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Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future
Exposure Area: Former CLEAR Plant
Soil/Sediment Data Set: 0-15 feet below ground surface
Receptor Population: Hypothetical Construction Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	113.5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	250
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**1.8**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	4.3
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.1%**

Appendix E
Adult Lead Model Worksheets
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former Esperanza Mill

Soil/Sediment Data Set: 0-15 feet below ground surface

Receptor Population: Outdoor Commercial/Industrial Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	117
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	225
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.9**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.2
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.001%**

Appendix E
Adult Lead Model Worksheets
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Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former Esperanza Mill

Soil/Sediment Data Set: 0-15 feet below ground surface

Receptor Population: Hypothetical Adolescent Trespasser

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	117
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	52
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**0.6**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	1.5
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.00006%**

Appendix E
Adult Lead Model Worksheets
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former Esperanza Mill

Soil/Sediment Data Set: 0-15 feet below ground surface

Receptor Population: Hypothetical Construction Worker

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	117
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	250
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**1.9**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	4.4
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.1%**

APPENDIX F

Hypothetical Future Resident Evaluation

Appendix F
Hypothetical Future Resident Evaluation
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Introduction

In accordance with the Arizona Department of Environmental Quality (ADEQ) approved baseline human health risk assessment (BHHRA) Work Plan, this appendix presents an evaluation of the potential for human health risks to hypothetical future child/adult residents from exposure to soil and sediment (soil/sediment) at the Freeport-McMoRan Sierrita Copper Mine, Green Valley, Arizona (Site). A hypothetical future resident evaluation was performed to address potential unrestricted future land use for the property. The Site is an active open pit mine and mineral concentration facility and although it is highly unlikely it will ever be redeveloped for residential land use, per the Arizona Revised Statutes (A.R.S.) §R49-152(B,C), the hypothetical future resident evaluation is the basis for determining whether a "declaration of environmental use restriction" is required for commercial/industrial land use, or whether unrestricted land use may be suitable for the Site.

Methods

The hypothetical future resident evaluation used the same approach and methodology (e.g., soil/sediment data sets, exposure point concentrations, risk assessment equations, toxicity values, etc.) as was used for the receptors evaluated in the main portion of the BHHRA. The BHHRA was prepared consistent with United States Environmental Protection Agency (USEPA) and ADEQ risk assessment guidelines and followed the ADEQ approved BHHRA Work Plan (Arcadis 2015).

The shallow and deep soil/sediment interval (0 to 15 feet below ground surface) dataset was used to evaluate hypothetical future residential exposure at the two exposure areas (EAs): the former CLEAR Plant EA and the former Esperanza Mill EA. As discussed in Section 5.7.2 of the main report, a soil only dataset (0 to 15 feet below ground surface) was also evaluated in addition to the soil/sediment dataset to assess hypothetical future residential exposure and ensure the sediment data was not biasing the exposure point concentration. Potentially complete exposure routes included incidental soil/sediment ingestion, dermal contact with soil/sediment, and inhalation of fugitive dust particulates. External exposure to ionizing radiation was also evaluated.

Tables F-1 through F-4 present the selection of constituents of potential concern (COPCs) in shallow and deep soil/sediment at each EA based on a comparison of maximum detected concentrations to risk-based screening levels for residential soil. The Arizona Soil Remediation Levels for residential land use (r-SRLs) (Arizona Administrative Code Title 18) were used for inorganic constituents, and the USEPA Preliminary Remediation Goals (PRGs) for residents were used for radionuclides (USEPA 2014). The following COPCs were identified for each EA:

- Former CLEAR Plant EA – antimony, arsenic, copper, lead, molybdenum, Ra-226, Ra-228, U-234, U-235, and U-238
- Former Esperanza Mill EA – antimony, arsenic, copper, lead, molybdenum, uranium, Ra-226, Ra-228, U-234, U-235, and U-238.

Table F-5 presents the exposure parameters specific to hypothetical future child/adult residents. Constituent-specific absorption parameters and toxicity values were presented in, respectively, the BHHRA Tables 6-2 and 7-1. Chronic reference doses and reference concentrations were used to assess potential noncancer hazards. Slope factors for radionuclide COPCs were presented in Table 7-2. The "Soil Ingestion" slope factors are lifetime values that were used for evaluating hypothetical future residential exposures.

Results and Discussion

Cancer Risks

In general, excess lifetime cancer risks (ELCRs) that range between 1×10^{-6} to 1×10^{-4} are generally considered to be acceptable (AAC 2009; USEPA 1991) and therefore this target range is used for risk management decision purposes at the Sierrita Mine. The estimated ELCRs for hypothetical future residents exposed to the metal COPCs in soil/sediment are presented in Tables F-6 (former CLEAR Plant EA) and F-7 (former Esperanza Mill EA). ELCRs from exposure to the radionuclide COPCs in soil/sediment are presented in Tables F-8 (former CLEAR Plant EA) and F-9 (former Esperanza Mill EA).

Tables F-10 and F-11 summarize the estimated ELCRs for hypothetical future child/adult residents at each EA. The calculated cumulative ELCRs are 4×10^{-4} for the former CLEAR Plant and former Esperanza Mill EAs. The primary contributors to the calculated cancer risks are Ra-226 and thorium-232 (Th-232) in soil/sediment. These estimated ELCRs are greater than the USEPA and Arizona Administrative Code (R18-7-206) target risk range (i.e., 1×10^{-6} to 1×10^{-4}). USEPA (1997), however, clarified the interpretation of the 1×10^{-4} for radionuclides specifically:

> Cleanup should generally achieve a level of risk within the 10^{-4} to 10^{-6} carcinogenic risk ranges based on the reasonable maximum exposure for an individual….As noted in previous policy, "the upper boundary of the risk range is not a discrete line at 1×10^{-4}, although EPA generally uses 1×10^{-4} in making risk management decisions. A specific risk estimate around 10^{-4} may be considered acceptable if justified based on site-specific conditions."
>
> If a dose assessment is conducted at the site, then 15 millirem per year (mrem/yr) effective dose equivalent (EDE) should generally be the maximum dose limit for humans. This level equates to approximately 3×10^{-4} increased lifetime risk and is consistent with levels generally considered protective in other governmental actions, particularly regulations and guidance developed by EPA in other radiation control programs.

As discussed in Sections 9.1.4 and 11.1 of the main report, metals and radionuclides are naturally present in soils in and around Sierrita Mine. Therefore, cancer risks based on mean background concentrations and activity levels were also estimated. Site and background ELCRs calculated using mean EPCs, and incremental ELCRs associated with exposure to metals and radionuclides in soils, are summarized in Tables F-12 (former CLEAR Plant EA) and F-13 (former Esperanza Mill EA).

Total risks are those associated with the Site data. Background risks are those associated with exposures of the same receptors to metal concentrations and radionuclide activity at locations other than the Site. The only difference between the total risks and the background risks are the concentrations/activities of the COPCs. Incremental risks are total risks minus background risks. As shown in Tables F-12 and F-13, the

background risks are 2×10^{-4} for the former CLEAR Plant and former Esperanza Mill EAs. Incremental risks are 1×10^{-4}, which is at the upper end of the USEPA and Arizona Administrative Code (R18-7-206) target risk range (i.e., 1×10^{-6} to 1×10^{-4}).

Noncancer Hazards

In addition, the cumulative noncancer hazard indices (HIs) for a hypothetical future child/adult resident are 3 and 4 for the former CLEAR Plant and the former Esperanza Mill EAs, respectively. These HIs are greater than the target HI of 1. At the former CLEAR Plant EA, the primary contributors to the HI of 3 is copper with a hazard quotient (HQ) of 2 (rounded from 1.9), and molybdenum with an HQ of 1 (Table F-6). At the former Esperanza Mill EA, the primary contributors to the HI of 4 is copper with an HQ of 1 (rounded from 1.2), and molybdenum with an HQ of 3 (rounded from 2.9) (Table F-7).

Non-cancer HIs based on mean background concentrations were also estimated. Site and background HIs calculated using mean EPCs, and incremental HIs associated with exposure to metals in soils, are summarized in Tables F-12 (former CLEAR Plant EA) and F-13 (former Esperanza Mill EA).

Total HIs are those associated with the Site data. Background HIs are those associated with exposures of the same receptors to metal concentrations at locations other than the Site. The only difference between the total HIs and the background HIs are the concentrations of the COPCs. Incremental HIs are total HIs minus background HIs. As shown in Tables F-12 and F-13, the background HIs are 0.1 for the former CLEAR Plant and former Esperanza Mill EAs. Incremental HIs are 2 for both EAs, which is greater than the target HI of 1.

The risk estimates assumed 100 percent bioavailability, which based on our experience is overly conservative. Although no site-specific bioavailability data exist for the Sierrita site, it is reasonable to expect that bioavailability data observed/reported from similar soils and similar sites (i.e., mining areas) would be expected in soil at the Sierrita site. For example, at Chino Mine in Southeast New Mexico, a similar mine to Sierrita with a porphyry copper deposit, bioaccessibility analyses were conducted in 2005 based on USEPA *in-vitro* methods. The mean copper bioaccessibility was estimated to be 65 percent. At Questa Mine, in New Mexico, the *in-vitro* bioaccessibility of molybdenum was determined to be 18-26 percent. Therefore, if the average bioavailability for copper and molybdenum in soil at the Sierrita site is similar to these other mining areas, then the estimated HQs from this BHHRA would be lower.

Lead Exposure Evaluation

Lead was identified as a COPC for the former CLEAR Plant and former Esperanza Mill EAs. The USEPA's Adult Lead Methodology and Adult Lead Model (ALM) and Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (USEPA 1994, 2002) were used to evaluate the potential for adverse health effects to hypothetical future residents from exposure to lead in soil/sediment at the Site.

The BHHRA Section 6.3.5 describes the general approach for evaluating lead exposures and specifics of the ALM. The ALM was used to predict blood lead (PbB) concentrations in hypothetical future resident adults exposed to lead in soil/sediment and to estimate the probability that the target PbB concentration of 10 micrograms per deciliter (µg/dL) would be exceeded.

For hypothetical future resident children exposed to lead in soil/sediment, the IEUBK model was used to predict PbB concentrations in children and estimate the probability that target PbB concentrations are exceeded. The focus of the IEUBK model is the prediction of PbB concentrations in young children exposed to lead from several sources and by ingestion and inhalation exposure routes. The model uses four interrelated modules (exposure, uptake, biokinetic, and probability distribution) to mathematically and statistically link environmental lead exposure to PbB concentrations for a population of young children (birth to 84 months of age). A plausible distribution of PbB concentrations, centered on a geometric mean PbB concentration, is predicted and used to estimate the probability that a child's or a population of children's PbB concentrations will exceed the target PbB concentration. The IEUBK model is intended for a residential exposure scenario, as it considers inhalation and ingestion exposures to indoor air and dust that result from tracking soil into the home, as well as dietary and drinking water exposures.

Based on the results of the ALM and IEUBK model, included in Appendix F, exposure to lead in soil/sediment at the former CLEAR Plant EA or the former Esperanza Mill EA is not likely to result in adverse health effects in hypothetical future resident adults or children.

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USEPA. 2014. Preliminary Remediation Goals for Radionuclides. Available at: epa-prgs.ornl.gov/radionuclides/. U.S. Environmental Protection Agency, Office of Superfund and Oak Ridge National Laboratory. November.

Appendix F, Table F-1
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Arithmetic Average Concentration	Residential Soil Screening Level [b]		Is Maximum Concentration > 10x r-SRL?	Is Constituent a COPC? [c]	
				Min - Max		Min - Max								
	No. of Detects	No. of Samples	(%)	(mg/kg)		(mg/kg)			(mg/kg)	(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics														
Antimony	62	/ 116	53	1.00E+00	- 2.00E+00	2.00E-01	- 6.60E+01	CP-2 081304(8/13/2004)	2.27E+00	3.10E+01	–	no	**YES**	ASL
Arsenic	216	/ 226	96	2.50E+00	- 2.50E+00	7.00E-01	- 1.66E+02	CP-2 081304(8/13/2004)	8.35E+00	1.00E+01	–	YES	**YES**	ASL
Barium	96	/ 96	100	–	- –	3.68E+01	- 6.54E+02	CP-JS-01-0-1_07152008(7/15/2008)	1.52E+02	1.50E+04	–	no	no	BSL
Beryllium	118	/ 131	90	1.00E+00	- 5.00E+00	1.10E-01	- 1.40E+00	CP-T-3-6 100504(10/5/2004)	5.75E-01	1.50E+02	–	no	no	BSL
Cadmium	36	/ 116	31	2.00E-01	- 8.00E+00	4.20E-01	- 2.49E+01	CP-9 081304(8/13/2004)	2.58E+00	3.90E+01	–	no	no	BSL
Chromium	116	/ 116	100	–	- –	2.00E+00	- 4.70E+02	CP-T-4-18IN 100404(10/4/2004)	1.42E+01	1.20E+05	Chromium III	no	no	BSL
Cobalt	101	/ 101	100	–	- –	3.00E+00	- 7.60E+01	CP-1 081304(8/13/2004)	1.10E+01	9.00E+02	–	no	no	BSL
Copper	226	/ 226	100	–	- –	2.70E+01	- 1.09E+05	CP-16 081304(8/13/2004)	3.59E+03	3.10E+03	–	YES	**YES**	ASL
Lead	226	/ 226	100	–	- –	1.20E+00	- 3.22E+03	CPS-SWN-D2-01_20120511(5/11/2012)	1.00E+02	4.00E+02	–	no	**YES**	ASL
Manganese	115	/ 116	99	4.00E-01	- 4.00E-01	7.10E+01	- 1.24E+03	CP-JS-01-10-12_07152008(7/15/2008)	3.30E+02	3.30E+03	–	no	no	BSL
Mercury	21	/ 116	18	3.30E-02	- 2.00E-01	3.70E-02	- 6.20E-01	CP-2 081304(8/13/2004)	1.70E-01	2.30E+01	–	no	no	BSL
Molybdenum	131	/ 131	100	–	- –	2.00E+00	- 3.02E+03	CP-2 081304(8/13/2004)	2.46E+02	3.90E+02	–	no	**YES**	ASL
Nickel	116	/ 116	100	–	- –	2.00E+00	- 7.00E+01	CP-T-4-18IN 100404(10/4/2004)	1.43E+01	1.60E+03	–	no	no	BSL
Selenium	104	/ 116	90	3.00E-01	- 4.00E+00	7.00E-02	- 5.00E+01	CP-2 081304(8/13/2004)	2.48E+00	3.90E+02	–	no	no	BSL
Thallium	104	/ 116	90	1.00E-01	- 1.50E+00	1.00E-01	- 5.20E+00	CP-2 081304(8/13/2004)	3.96E-01	5.20E+00	–	no	no	BSL
Uranium	96	/ 96	100	–	- –	9.30E-01	- 1.60E+01	CP-JS-04-5-7_08272008(8/27/2008)	4.61E+00	1.60E+01	–	no	no	BSL
Zinc	116	/ 116	100	–	- –	2.60E+01	- 6.21E+03	CP-9 081304(8/13/2004)	2.51E+02	2.30E+04	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] The selected screening levels for inorganic constituents are the Arizona Department of Environmental Quality's Residential Soil Remediation Levels. 2007. Available online at: http://apps.azsos.gov/public_services/Title_18/18-07.pdf.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (HTSPT) (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency. Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
r-SRL: residential Soil Remediation Level.

Appendix F, Table F-2
Statistical Summary and Selection of Chemical Constituents of Potential Concern:
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Arithmetic Average Concentration	Residential Soil Screening Level [b]		Is Maximum Concentration > 10x r-SRL?	Is Constituent a COPC? [c]	
	Min - Max			Min - Max		Min - Max								
	No. of Detects	No. of Samples	(%)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)		(mg/kg)	(mg/kg)	Surrogate	(YES/no)	(YES/no)	Rationale
Inorganics														
Antimony	86 /	114	75	2.00E-01 -	1.00E+00	2.00E-01 -	6.90E+01	EM-17 081304(8/13/2004)	1.99E+00	3.10E+01	–	no	**YES**	ASL
Arsenic	112 /	119	94	1.01E+01 -	8.97E+01	1.00E+00 -	1.01E+02	EM-17 081304(8/13/2004)	9.90E+00	1.00E+01	–	YES	**YES**	ASL
Barium	95 /	95	100	– -	–	3.92E+01 -	3.66E+02	CS-JS-02-5-7_08042008(8/4/2008)	1.13E+02	1.50E+04	–	no	no	BSL
Beryllium	107 /	119	90	1.00E+00 -	5.00E+00	1.70E-01 -	6.20E+00	RA-JS-02-5-7_08112008(8/11/2008)	8.12E-01	1.50E+02	–	no	no	BSL
Cadmium	51 /	114	45	2.00E+00 -	2.00E+00	2.60E-01 -	8.30E+00	CS-JS-02-10-11_08042008(8/4/2008)	1.86E+00	3.90E+01	–	no	no	BSL
Chromium	114 /	114	100	– -	–	2.00E+00 -	1.93E+02	EM-JS-08-10-12_08122008(8/12/2008)	1.21E+01	1.20E+05	Chromium III	no	no	BSL
Chromium VI	1 /	5	20	4.00E+00 -	9.00E+00	4.00E+00 -	4.00E+00	EM-JS-08-10-12_08122008(8/12/2008)	5.80E+00	3.00E+01	–	no	no	BSL
Cobalt	98 /	99	99	5.00E+00 -	5.00E+00	1.00E+00 -	4.20E+01	EM-JS-08-5-7_08122008(8/12/2008)	1.03E+01	9.00E+02	–	no	no	BSL
Copper	119 /	119	100	– -	–	6.20E+01 -	3.02E+04	RA-JS-02-0-1_08112008(8/11/2008)	2.66E+03	3.10E+03	–	no	**YES**	ASL
Lead	119 /	119	100	– -	–	2.81E+00 -	3.74E+03	C-JS-05-1-3_08052008(8/5/2008)	1.16E+02	4.00E+02	–	no	**YES**	ASL
Manganese	114 /	114	100	– -	–	3.00E+01 -	9.32E+02	EM-JS-08-5-7_08122008(8/12/2008)	3.56E+02	3.30E+03	–	no	no	BSL
Mercury	35 /	114	31	4.00E-02 -	2.00E-01	4.00E-02 -	6.00E-01	EM-JS-08-5-7_08122008(8/12/2008)	1.66E-01	2.30E+01	–	no	no	BSL
Molybdenum	118 /	119	99	5.00E+00 -	5.00E+00	3.00E+00 -	6.83E+03	EM-JS-07-0-1_08132008(8/13/2008)	6.12E+02	3.90E+02	–	YES	**YES**	ASL
Nickel	103 /	114	90	1.00E+00 -	5.00E+00	2.00E+00 -	3.30E+01	EM-JS-08-5-7_08122008(8/12/2008)	7.17E+00	1.60E+03	–	no	no	BSL
Selenium	93 /	114	82	1.90E-01 -	1.11E+01	5.00E-02 -	9.40E+00	EM-3 081304(8/13/2004)	1.55E+00	3.90E+02	–	no	no	BSL
Thallium	98 /	111	88	1.20E-01 -	3.00E-01	7.00E-02 -	1.10E+00	EM-T-2-2.5 100504(10/5/2004)	2.58E-01	5.20E+00	–	no	no	BSL
Uranium	95 /	95	100	– -	–	1.17E+00 -	2.99E+01	RA-JS-02-5-7_08112008(8/11/2008)	5.42E+00	1.60E+01	–	no	**YES**	ASL
Zinc	111 /	111	100	– -	–	2.50E+01 -	3.63E+03	CS-JS-02-10-11_08042008(8/4/2008)	2.63E+02	2.30E+04	–	no	no	BSL

Notes:
[a] All detected constituents are presented.
[b] The selected screening levels for inorganic constituents are the Arizona Department of Environmental Quality's Residential Soil Remediation Levels. 2007. Available online at: http://apps.azsos.gov/public_services/Title_18/18-07.pdf.
[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (HTSPT) (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency. Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
mg/kg: milligram(s) per kilogram.
min: minimum.
No.: number.
r-SRL: residential Soil Remediation Level.

Appendix F, Table F-3
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Arithmetic Average Concentration	Resident PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
	No. of Detects	No. of Samples	(%)	Min (pCi/g)	Max (pCi/g)	Min (pCi/g)	Max (pCi/g)		(pCi/g)	(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides													
Radium-226	80	82	98	4.00E-01	8.40E-01	4.30E-01	5.30E+00	CP-JS-03-5-7_07142008(7/14/2008)	2.20E+00	6.4E-03	YES	**YES**	ASL
Radium-228	82	82	100	–	–	1.20E+00	7.60E+00	CP-O09-0-1_07112008(7/11/2008)	2.26E+00	1.2E-02	YES	**YES**	ASL
Uranium-234	82	82	100	–	–	8.40E-01	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	2.51E+00	6.6E-02	YES	**YES**	ASL
Uranium-235	63	82	77	3.90E-02	2.30E-01	2.00E-02	7.40E-01	CP-JS-02-0-1_07112008(7/11/2008)	1.49E-01	4.9E-02	YES	**YES**	ASL
Uranium-238	82	82	100	–	–	8.40E-01	1.20E+01	CP-JS-02-0-1_07112008(7/11/2008)	2.59E+00	5.0E-02	YES	**YES**	ASL

Notes:

[a] Only detected constituents are presented.

[b] The selected screening levels for radiological constituents are the United States Environmental Protection Agency's Preliminary Remediation Goals (PRGs) for Radionuclides (USEPA 2014). PRGs for residents were used. Available online at: epa- prgs.ornl.gov/radionuclides/.

[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Appendix F, Table F-4
Statistical Summary and Selection of Radionuclide Constituents of Potential Concern:
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent [a]	Frequency of Detection			Reporting Limits		Detected Concentrations		Sample Identification of Maximum Concentration (Sample Date)	Arithmetic Average Concentration	Resident PRG for Soil [b]	Is Maximum Concentration > 10x PRG?	Is Constituent a COPC? [c]	
	No. of Detects	No. of Samples	(%)	Min (pCi/g)	Max (pCi/g)	Min (pCi/g)	Max (pCi/g)		(pCi/g)	(pCi/g)	(YES/no)	(YES/no)	Rationale
Radionuclides													
Radium-226	88	/ 88	100	–	–	5.40E-01	5.80E+00	RA-JS-03-0-1_08072008(8/7/2008)	2.24E+00	6.4E-03	YES	**YES**	ASL
Radium-228	85	/ 88	97	2.00E+00	2.50E+00	1.00E+00	8.90E+00	RA-JS-02-1-3_08112008(8/11/2008)	2.30E+00	1.2E-02	YES	**YES**	ASL
Uranium-234	88	/ 88	100	–	–	8.50E-01	1.20E+01	EM-JS-08-10-12_08122008(8/12/2008)	2.43E+00	6.6E-02	YES	**YES**	ASL
Uranium-235	68	/ 88	77	4.20E-02	2.00E-01	4.20E-02	5.70E-01	EM-JS-08-10-12_08122008(8/12/2008)	1.25E-01	4.9E-02	YES	**YES**	ASL
Uranium-238	88	/ 88	100	–	–	9.00E-01	1.20E+01	EM-JS-08-10-12_08122008(8/12/2008)	2.47E+00	5.0E-02	YES	**YES**	ASL

Notes:

[a] Only detected constituents are presented.

[b] The selected screening levels for radiological constituents are the United States Environmental Protection Agency's Preliminary Remediation Goals (PRGs) for Radionuclides (USEPA 2014). PRGs for residents were used. Available online at: epa- prgs.ornl.gov/radionuclides/.

[c] Constituents detected at a maximum concentration above their screening level (ASL) are designated as COPCs unless the frequency of detection (FOD) is less than or equal to 5%. However, constituents detected in hotspots (at a maximum concentration greater than 10x the respective screening level) were designated as COPCs regardless of the detection frequency (HTSPT). Constituents with maximum detected concentrations below the screening levels (BSL) are not designated as COPCs.

–: not available or not applicable.
COPC: constituent of potential concern.
ft bgs: feet below ground surface.
max: maximum.
min: minimum.
No.: number.
pCi/g: picoCurie(s) per gram.
PRG: preliminary remediation goal.

Appendix F, Table F-5
Human Health Exposure Parameters
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Parameter	Symbol	Units	Resident					
			Child (1 through 6 years)		Adult (27 years)		Age-Averaged Radiological Exposure Only	
General Factors								
Averaging Time (cancer)	ATc	days	28,470	[1]	28,470	[1]	–	
Averaging Time (noncancer)	ATnc	days	2,190	[2]	12,045	[2]	–	
Body Weight	BW	kg	19	[3]	80	[4]	–	
Exposure Frequency	EF	days/year	350	[5]	350	[5]	350	[5]
Exposure Duration	ED	years	6	[6]	27	[7]	33	[7]
Inhalation								
Exposure Time	ET	hours/day	24	[8]	24	[8]	24	[8]
Exposure Time, indoor	ET_i	hours/day	–		–		16.416	[9]
Exposure Time, outdoor	ET_o	hours/day	–		–		1.753	[9]
Conversion Factor	CF	day/hour	0.042		0.042		0.042	
Particulate Emission Factor	PEF	m^3/kg	1.396E +09	[10]	1.396E +09	[10]	1.396E +09	[10]
Inhalation Rate	InhR	m^3/day	–		–		–	
Age-Adjusted Inhalation Rate	$InhR_{adj}$	m^3/day	–		–		18	[11]
Soil - Ingestion (Oral)								
Incidental Soil Ingestion Rate	IRs	mg/day	200	[12]	100	[13]	–	
Age-Adjusted Soil Ingestion Rate	IR_{adj}	mg/day	–		–		118	[14]
Soil - Dermal Contact								
Exposed Skin Surface Area	SA	cm^2	2,350	[15]	6,125	[16]	–	
Soil-to-Skin Adherence Rate	SAR	$mg/cm^2/day$	0.19	[17]	0.15	[18]	–	

Notes:

[1] The averaging time for assessing cancer risk is the average expected lifespan of 78 years (Table 18-1, USEPA 2011) expressed in days.

[2] The averaging time for evaluating non-cancer health effects is the exposure duration expressed in days (e.g., 25 years x 365 days/year = 9,125 days) (USEPA 1989).

[3] Professional Judgment: Represents the age-weighted average of the mean body weights for boys and girls, ages 1 through 6 years (Table 8-1, USEPA 2011).

[4] Mean recommended body weight for adults (Table 8-1, USEPA 2011).

[5] Standard default residential exposure frequency (ADHS 2003; ADEQ 2002).

[6] Standard default exposure duration for a resident child (ADHS 2003; ADEQ 2002).

[7] The total exposure duration is 33 years, based on the 95th percentile residential occupancy period (Table 16-5, USEPA 2011). Cancer risks for the resident adult are calculated assuming 6 years at the child's rate of exposure and 27 years at the adult's rate of exposure.

[8] Professional Judgment: Assumes continuous exposure.

[9] Recommended default exposure parameter (USEPA 2015g).

[10] Standard default particulate emission factor (ADHS 2003; ADEQ 2002).

[11] Based on an age-weighted average of recommended default inhalation rates for a resident child ($10 m^3$/day) and resident adult ($20 m^3$/day) (USEPA 2015g).

[12] Recommended upper percentile soil and dust ingestion rate for an individual between the ages of 1 to <6 years (Table 5-1, USEPA 2011).

[13] Standard default soil ingestion rate for an adult (ADEQ 2002).

[14] Based on an age-weighted average of recommended default soil ingestion rates for a resident child (100 mg/day) and resident adult (200 mg/day) (USEPA 2015g).

[15] Based on an age-weighted average of 95th percentile total skin surface areas for combined males and females, ages 1 through 6 (0.94 m^2 or 9,400 cm^2) (Table 7-9; USEPA 2011). The exposed skin surface area was assumed to be 25% of the total skin surface area (ADEQ, 2002); 9,400 cm^2 x 0.25 = 2,350 cm^2.

[16] Based on an age-weighted average of 95th percentile total skin surface areas for combined males and females, ages 18 to 60 (2.45 m^2 or 24,500 cm^2) (Table 7-9; USEPA 2011). The exposed skin surface area was assumed to be 25% of the total skin surface area (ADEQ, 2002); 24,500 cm^2 x 0.25 = 6,125 cm^2.

[17] Average of recommended values for mean solids adherence to skin for children's hands (0.17 mg/cm^2) and feet (0.20 mg/cm^2), during "activities with soil" (Table 7-4, USEPA 2011).

[18] Average of recommended values for mean solids adherence to skin for adult hands (0.1595 mg/cm^2) and feet (0.1393 mg/cm^2), during "activities with soil" (Table 7-4, USEPA 2011).

References:

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U.S. Environmental Protection Agency. 2011. Exposure Factors Handbook 2011 Edition (Final). EPA/600/R-09/052F. National Center for Environmental Assessment, Office of Research and Development, USEPA, Washington, DC. (September)

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ADEQ: Arizona Department of Environmental Quality.
ADHS: Arizona Department of Health Services.
cm^2: square centimeter(s).
kg: kilogram(s).
m^2: square meter(s).
m^3: cubic meter(s).
mg: milligram(s).
USEPA: United States Environmental Protection Agency.

Appendix F, Table F-6
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Child/Adult Resident
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK						TOTAL CANCER RISK					NONCANCER HAZARD					NONCANCER HAZARD				
				Age-Specific Risk for Carcinogenic Constituents						Route-Specific Risk			Total		Route-Specific Hazard			Total		Route-Specific Hazard			Total	
				1 through 6 years			27 years			33 years					1 through 6 years					27 years				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m³/kg)	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation	ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Hazard (Child)	Percent Total HI (Child)	Oral	Dermal	Inhalation	Hazard (Adult)	Percent Total HI (Adult)
				ELCRo	ELCRd	ELCRi	ELCRo	ELCRd	ELCRi	ELCRo	ELCRd	ELCRi			HQo	HQd	HQi			HQo	HQd	HQi		
Inorganics																								
Antimony	NA	6.91E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		1.8E-01	–	NA	1.8E-01	5%	1.7E-02	–	NA	1.7E-02	5%
Arsenic	A	9.99E+00	1.40E+09 P	4.7E-06	7.9E-07	2.3E-09	2.5E-06	1.7E-06	1.0E-08	7.2E-06	2.5E-06	1.2E-08	9.7E-06	100%	1.4E-01	2.3E-02	4.6E-04	1.6E-01	5%	1.3E-02	9.0E-03	3.7E-04	2.2E-02	7%
Copper	D	7.39E+03	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		1.9E+00	–	NA	1.9E+00	58%	1.8E-01	–	NA	1.8E-01	57%
Lead	B2	2.09E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	5.03E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		1.0E+00	–	NA	1.0E+00	32%	9.9E-02	–	NA	9.9E-02	31%
				5E-06	8E-07	2E-09	2E-06	2E-06	1E-08	7E-06	2E-06	1E-08			3	0.02	0.0005			0.3	0.009	0.0004		

Total **Total ELCR** 1E-05 **Total Child HI** **3** **Total Adult HI** 0.3

Group A Total ELCR	1E-05	HI (skin)	0.2
Group B Total ELCR	–	HI (circulatory)	1
Group C Total ELCR	–	HI (gastrointestinal)	**2**
Group D Total ELCR	–	HI (neurological)	0.0005
		HI (development)	0.0005
		HI (kidney)	1
		HI (whole body)	1

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table F-7. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

Child (1 through 6 years):
ELCRo = (EPCs x 1 x 200 x 350 x 6 x RBA x CSFo) / (1,000,000 x 19 x 28470)
ELCRd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6 x CSFa) / (1,000,000 x 19 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6 x IUR) / (28470)

Adult (7 through 33 years):
ELCRo = (EPCs x 1 x 100 x 350 x 27 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27 x IUR) / (28470)

Child (1 through 6 years):
HQo = (EPCs x 1 x 200 x 350 x 6 x RBA) / (1,000,000 x 19 x 2190 x RfDo)
HQd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6) / (1,000,000 x 19 x 2190 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6) / (2190 x RfC)

Adult (7 through 33 years):
HQo = (EPCs x 1 x 100 x 350 x 27 x RBA) / (1,000,000 x 80 x 12045 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27) / (1,000,000 x 80 x 12045 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27) / (12045 x RfC)

Appendix F, Table F-7
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Child/Adult Resident
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	CANCER RISK: Age-Specific Risk for Carcinogenic Constituents — 1 through 6 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	27 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	TOTAL CANCER RISK: Route-Specific Risk — 33 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	Total ELCR	Percent Total ELCR	NONCANCER HAZARD: Route-Specific Hazard — 1 through 6 years: Oral (HQo)	Dermal (HQd)	Inhalation (HQi)	Total Hazard (Child)	Percent Total HI (Child)	NONCANCER HAZARD: Route-Specific Hazard — 27 years: Oral (HQo)	Dermal (HQd)	Inhalation (HQi)	Total Hazard (Adult)	Percent Total HI (Adult)
Inorganics																								
Antimony	NA	4.64E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		1.2E-01	–	NA	1.2E-01	3%	1.1E-02	–	NA	1.1E-02	3%
Arsenic	A	1.29E+01	1.40E+09 P	6.1E-06	1.0E-06	2.9E-09	3.2E-06	2.2E-06	1.3E-08	9.2E-06	3.2E-06	1.6E-08	1.2E-05	100%	1.7E-01	2.9E-02	5.9E-04	2.0E-01	5%	1.7E-02	1.2E-02	4.8E-04	2.9E-02	7%
Copper	D	4.66E+03	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		1.2E+00	–	NA	1.2E+00	27%	1.1E-01	–	NA	1.1E-01	26%
Lead	B2	1.33E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	1.44E+03	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		2.9E+00	–	NA	2.9E+00	66%	2.8E-01	–	NA	2.8E-01	64%
Uranium [c]	NA	7.16E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		2.4E-02	–	1.2E-04	2.4E-02	<1%	2.3E-03	–	1.0E-04	2.4E-03	<1%
				6E-06	1E-06	3E-09	3E-06	2E-06	1E-08	9E-06	3E-06	2E-08			4	0.03	0.0007			0.4	0.01	0.0006		
Total													**Total ELCR**	1E-05				**Total Child HI**	**4**				**Total Adult HI**	0.4
													Group A Total ELCR	1E-05				HI (developmental)	0.0006					
													Group B Total ELCR	–				HI (circulatory)	**3**					
													Group C Total ELCR	–				HI (skin)	0.2					
													Group D Total ELCR	–				HI (neurological)	0.0006					
																			HI (kidney)	**3**					
																			HI (whole body)	**3**					
																			HI (GI)	1					

Notes:

[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table F-7. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

Child (1 through 6 years):
ELCRo = (EPCs x 1 x 200 x 350 x 6 x RBA x CSFo) / (1,000,000 x 19 x 28470)
ELCRd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6 x CSFa) / (1,000,000 x 19 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6 x IUR) / (28470)

Adult (7 through 33 years):
ELCRo = (EPCs x 1 x 100 x 350 x 27 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27 x IUR) / (28470)

Child (1 through 6 years):
HQo = (EPCs x 1 x 200 x 350 x 6 x RBA) / (1,000,000 x 19 x 2190 x RfDo)
HQd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6) / (1,000,000 x 19 x 2190 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6) / (2190 x RfC)

Adult (7 through 33 years):
HQo = (EPCs x 1 x 100 x 350 x 27 x RBA) / (1,000,000 x 80 x 12045 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27) / (1,000,000 x 80 x 12045 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27) / (12045 x RfC)

Appendix F, Table F-8
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Child/Adult Resident Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	3.15E+00	1.40E+09	P	2.4E-07	1.1E-08	4.1E-06	4.4E-06	1%
Uranium-234	3.07E+00	1.40E+09	P	2.1E-07	1.3E-08	8.5E-09	2.3E-07	<1%
Thorium-230	3.07E+00	1.40E+09	P	3.2E-07	1.6E-08	2.8E-08	3.7E-07	<1%
Radium-226	2.58E+00	1.40E+09	P	1.0E-06	1.1E-08	2.4E-04	2.4E-04	66%
Lead-210	2.58E+00	1.40E+09	P	1.3E-06	3.8E-09	2.6E-08	1.3E-06	<1%
Bismuth-210	2.58E+00	1.40E+09	P	7.9E-12	1.1E-13	4.7E-11	5.5E-11	<1%
Polonium-210	2.58E+00	1.40E+09	P	8.4E-08	9.6E-11	2.1E-11	8.4E-08	<1%
Thorium-232	2.52E+00	1.40E+09	P	2.6E-06	3.3E-08	1.1E-04	1.1E-04	32%
Thorium-228	2.52E+00	1.40E+09	P	1.8E-08	4.1E-09	1.3E-08	3.5E-08	<1%
Radium-224	2.52E+00	1.40E+09	P	1.3E-10	1.8E-12	5.1E-10	6.4E-10	<1%
Lead-212	2.52E+00	1.40E+09	P	2.4E-12	1.3E-14	7.3E-10	7.3E-10	<1%
Bismuth-212	2.52E+00	1.40E+09	P	7.7E-15	1.6E-16	6.9E-11	6.9E-11	<1%
Thallium-208	2.52E+00	1.40E+09	P	NA	NA	1.2E-10	1.2E-10	<1%
Uranium-235	1.85E-01	1.40E+09	P	1.3E-08	6.9E-10	1.2E-06	1.2E-06	<1%
Protactinium-231	1.85E-01	1.40E+09	P	3.9E-08	2.1E-09	2.6E-07	3.0E-07	<1%
Actinium-227	1.85E-01	1.40E+09	P	3.1E-08	2.6E-09	2.5E-10	3.4E-08	<1%
Francium-223	1.85E-01	1.40E+09	P	2.2E-15	2.1E-18	5.0E-13	5.0E-13	<1%
Astatine-219	1.85E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.85E-01	1.40E+09	P	NA	NA	1.4E-12	1.4E-12	<1%
Thorium-227	1.85E-01	1.40E+09	P	1.2E-11	2.2E-12	2.0E-09	2.0E-09	<1%
Radium-223	1.85E-01	1.40E+09	P	4.2E-11	1.1E-12	1.9E-09	2.0E-09	<1%
Lead-211	1.85E-01	1.40E+09	P	2.0E-16	3.3E-18	1.8E-12	1.8E-12	<1%
Astatine-215	1.85E-01	1.40E+09	P	NA	NA	2.0E-22	2.0E-22	<1%
Bismuth-211	1.85E-01	1.40E+09	P	NA	NA	6.9E-14	6.9E-14	<1%
Thallium-207	1.85E-01	1.40E+09	P	NA	NA	1.3E-14	1.3E-14	<1%
Polonium-211	1.85E-01	1.40E+09	P	NA	NA	5.5E-17	5.5E-17	<1%
				6E-06	1E-07	4E-04		
Total						**Total ELCR**	4E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table F-7.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 118 × 350 × 33 × [1 - exp(-λ × 33)] × CSFo) / (1,000 × 33 × λ)
ELCRi = (EPCs × 1,000 × 18 × 24 × 0.042 × 350 × 33 × [1 - exp(-λ × 33)] × CSFi) / (1.40E+09 × 33 × λ)
ELCRe = (EPCs × ACF × [(1.752 × 0.042 × 1) + (16.416 × 0.042 × 0.4)] × 350 × 33 × [1 - exp(-λ × 33)] × CSFe) / (365 × 33 × λ)

Appendix F, Table F-9
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Child/Adult Resident Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.76E+00	1.40E+09	P	2.1E-07	9.7E-09	3.6E-06	3.8E-06	1%
Uranium-234	2.71E+00	1.40E+09	P	1.9E-07	1.1E-08	7.5E-09	2.1E-07	<1%
Thorium-230	2.71E+00	1.40E+09	P	2.8E-07	1.4E-08	2.5E-08	3.2E-07	<1%
Radium-226	2.43E+00	1.40E+09	P	9.7E-07	1.0E-08	2.2E-04	2.2E-04	65%
Lead-210	2.43E+00	1.40E+09	P	1.2E-06	3.6E-09	2.5E-08	1.3E-06	<1%
Bismuth-210	2.43E+00	1.40E+09	P	7.4E-12	1.0E-13	4.4E-11	5.2E-11	<1%
Polonium-210	2.43E+00	1.40E+09	P	7.9E-08	9.0E-11	2.0E-11	7.9E-08	<1%
Thorium-232	2.51E+00	1.40E+09	P	2.6E-06	3.3E-08	1.1E-04	1.1E-04	33%
Thorium-228	2.51E+00	1.40E+09	P	1.8E-08	4.1E-09	1.3E-08	3.5E-08	<1%
Radium-224	2.51E+00	1.40E+09	P	1.3E-10	1.8E-12	5.1E-10	6.3E-10	<1%
Lead-212	2.51E+00	1.40E+09	P	2.4E-12	1.3E-14	7.2E-10	7.3E-10	<1%
Bismuth-212	2.51E+00	1.40E+09	P	7.6E-15	1.6E-16	6.9E-11	6.9E-11	<1%
Thallium-208	2.51E+00	1.40E+09	P	NA	NA	1.2E-10	1.2E-10	<1%
Uranium-235	1.20E-01	1.40E+09	P	8.2E-09	4.5E-10	7.6E-07	7.7E-07	<1%
Protactinium-231	1.20E-01	1.40E+09	P	2.5E-08	1.4E-09	1.7E-07	1.9E-07	<1%
Actinium-227	1.20E-01	1.40E+09	P	2.0E-08	1.7E-09	1.6E-10	2.2E-08	<1%
Francium-223	1.20E-01	1.40E+09	P	1.5E-15	1.3E-18	3.2E-13	3.3E-13	<1%
Astatine-219	1.20E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.20E-01	1.40E+09	P	NA	NA	9.0E-13	9.0E-13	<1%
Thorium-227	1.20E-01	1.40E+09	P	7.5E-12	1.4E-12	1.3E-09	1.3E-09	<1%
Radium-223	1.20E-01	1.40E+09	P	2.8E-11	7.1E-13	1.2E-09	1.3E-09	<1%
Lead-211	1.20E-01	1.40E+09	P	1.3E-16	2.1E-18	1.2E-12	1.2E-12	<1%
Astatine-215	1.20E-01	1.40E+09	P	NA	NA	1.3E-22	1.3E-22	<1%
Bismuth-211	1.20E-01	1.40E+09	P	NA	NA	4.5E-14	4.5E-14	<1%
Thallium-207	1.20E-01	1.40E+09	P	NA	NA	8.3E-15	8.3E-15	<1%
Polonium-211	1.20E-01	1.40E+09	P	NA	NA	3.5E-17	3.5E-17	<1%
				6E-06	9E-08	3E-04		
Total						**Total ELCR**	3E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table F-7.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 118 × 350 × 33 × [1 - exp(-λ × 33)] × CSFo) / (1,000 × 33 × λ)
ELCRi = (EPCs × 1,000 × 18 × 24 × 0.042 × 350 × 33 × [1 - exp(-λ × 33)] × CSFi) / (1.40E+09 × 33 × λ)
ELCRe = (EPCs × ACF × [(1.752 × 0.042 × 1) + (16.416 × 0.042 × 0.4)] × 350 × 33 × [1 - exp(-λ × 33)] × CSFe) / (365 × 33 × λ)

Appendix F, Table F-10
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on 95% UCLs:
Former CLEAR Plant, Hypothetical Future Residential Scenario
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

		Former CLEAR Plant Exposure Area			
		TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX	
Human Receptors	Exposure Type (Table Reference)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	COPCs accounting for >10% of ELCR (if ELCR >1E-04)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	COPCs accounting for >10% of HI (if HI >1)
Hypothetical Future Scenario					
Hypothetical Child/Adult Resident	Chemical (Table F-6)	1E-05	–	**3**	Copper (57%) Molybdenum (31%)
	Radiological (Table F-8)	**4E-04**	Ra-226 (66%) Th-232 (32%)	–	–
	Receptor Total	**4E-04**	Ra-226 (66%) Th-232 (32%)	**3**	Copper (57%) Molybdenum (31%)

Notes:
The hypothetical future scenarios evaluated for the Former CLEAR Plant Exposure Area are based on soil and sediment data from sample locations that are currently exposed at the surface and from sample locations that are currently covered (i.e., paved or developed) at the surface. This assumes that the currently covered soils will become exposed in the future.
Excess lifetime cancer risks exceeding 1E-04 and noncancer hazard indices exceeding 1 are shown in bold.

– : not applicable.
%: percent.
COPC: constituent of potential concern.
ELCR: excess lifetime cancer risk.
ft bgs: feet below ground surface.
HI: hazard index.
UCL: upper confidence limit of the mean concentration.

Appendix F, Table F-11
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on 95% UCLs:
Former Esperanza Mill, Hypothetical Future Residential Scenario
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

		Former Esperanza Mill Exposure Area			
		TOTAL EXCESS LIFETIME CANCER RISK		NONCANCER HAZARD INDEX	
Human Receptors	Exposure Type (Table Reference)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	COPCs accounting for >10% of ELCR (if ELCR >1E-04)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	COPCs accounting for >10% of HI (if HI >1)
Hypothetical Future Scenario					
Hypothetical Child/Adult Resident	Chemical (Table F-7)	1E-05	–	**4**	Copper (26%) Molybdenum (64%)
	Radiological (Table F-5)	**3E-04**	Ra-226 (65%) Th-232 (33%)	–	–
	Receptor Total	**4E-04**	Ra-226 (65%) Th-232 (33%)	**4**	Copper (26%) Molybdenum (64%)

Notes:
Excess lifetime cancer risks exceeding 1E-04 and noncancer hazard indices exceeding 1 are shown in bold.

– : not applicable.
%: percent.
COPC: constituent of potential concern.
ELCR: excess lifetime cancer risk.
ft bgs: feet below ground surface.
HI: hazard index.
UCL: upper confidence limit of the mean concentration.

Appendix F, Table F-12
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on Mean EPCs:
Former CLEAR Plant Exposure Area, Background, and Incremental Cancer Risks and Hazard Indices
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

	Former CLEAR Plant Exposure Area			Background			Incremental		
		TOTAL EXCESS LIFETIME CANCER RISK	NONCANCER HAZARD INDEX		TOTAL EXCESS LIFETIME CANCER RISK	NONCANCER HAZARD INDEX		TOTAL EXCESS LIFETIME CANCER RISK	NONCANCER HAZARD INDEX
Human Receptors	Exposure Type (Table Reference)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Exposure Type (Table Reference)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Exposure Type	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)	Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)
Hypothetical Future Scenario									
Hypothetical Child/Adult Resident	Chemical (Table H-18)	9E-06	**2**	Chemical (Table G-15)	2E-06	0.1	Chemical	8E-06	**2**
	Radiological (Table I-18)	**3E-04**	–	Radiological (Table G-27)	**2E-04**	--	Radiological	1E-04	--
	Receptor Total	**3E-04**	**2**	Receptor Total	**2E-04**	0.1	Receptor Total	1E-04	**2**

Notes:
The hypothetical future scenarios evaluated for the Former CLEAR Plant Exposure Area are based on soil and sediment data from sample locations that are currently exposed at the surface and from sample locations that are currently covered (i.e., paved or developed) at the surface. This assumes that the currently covered soils will become exposed in the future.
Excess lifetime cancer risks exceeding 1E-04 and noncancer hazard indices exceeding 1 are shown in bold.

– : not applicable.
EPC: exposure point concentration.
ft bgs: feet below ground surface.

Appendix F, Table F-13
Summary of Calculated Excess Lifetime Cancer Risks and Noncancer Hazard Indices based on Mean EPCs:
Former Esperanza Mill Exposure Area, Background, and Incremental Cancer Risks and Hazard Indices
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

	Former Esperanza Mill Exposure Area			Background			Incremental		
		TOTAL EXCESS LIFETIME CANCER RISK	NONCANCER HAZARD INDEX		TOTAL EXCESS LIFETIME CANCER RISK	NONCANCER HAZARD INDEX		TOTAL EXCESS LIFETIME CANCER RISK	NONCANCER HAZARD INDEX
Human Receptors	**Exposure Type (Table Reference)**	**Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)**	**Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)**	**Exposure Type (Table Reference)**	**Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)**	**Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)**	**Exposure Type**	**Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)**	**Direct Contact with Shallow and Deep Soil/Sediment (0 to 15 ft bgs)**
Hypothetical Future Scenario									
Hypothetical Child/Adult Resident	Chemical (Table H-19)	8E-06	**2**	Chemical (Table G-16)	2E-06	0.1	Chemical	6E-06	**2**
	Radiological (Table I-19)	**3E-04**	–	Radiological (Table G-27)	**2E-04**	--	Radiological	1E-04	--
	Receptor Total	**3E-04**	**2**	Receptor Total	**2E-04**	0.1	Receptor Total	1E-04	**2**

Notes:
Excess lifetime cancer risks exceeding 1E-04 and noncancer hazard indices exceeding 1 are shown in bold.

– : not applicable.
ft bgs: feet below ground surface.

Appendix F
Adult Lead Model Worksheets
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future
Exposure Area: Former CLEAR Plant
Soil/Sediment Data Set: 0-15 feet below ground surface
Receptor Population: Hypothetical Resident Adult

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	113.5
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	350
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**1.1**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.7
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.005%**

Appendix F
Adult Lead Model Worksheets
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Calculations of Blood Lead Concentrations (PbBs)

U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 6/21/09 **EDIT RED CELLS**

Exposure Scenario: Future

Exposure Area: Former Esperanza Mill

Soil/Sediment Data Set: 0-15 feet below ground surface

Receptor Population: Hypothetical Resident Adult

Variable	Description of Variable	Units	GSDi and PbBo from Analysis of NHANES 2009-2014
PbS	Soil lead concentration	ug/g or ppm	117
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4
GSD_i	Geometric standard deviation PbB	--	1.8
PbB_0	Baseline PbB	ug/dL	0.6
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100
IR_{S+D}	Total ingestion rate of outdoor soil and indoor dust	g/day	--
W_S	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--
K_{SD}	Mass fraction of soil in dust	--	--
$AF_{S, D}$	Absorption fraction (same for soil and dust)	--	0.12
$EF_{S, D}$	Exposure frequency (same for soil and dust)	days/yr	350
$AT_{S, D}$	Averaging time (same for soil and dust)	days/yr	365
PbB_{adult}	**PbB of adult worker, geometric mean**	**ug/dL**	**1.1**
$PbB_{fetal, 0.95}$	95th percentile PbB among fetuses of adult workers	ug/dL	2.7
PbB_t	Target PbB level of concern (e.g., 10 ug/dL)	ug/dL	**10.0**
$P(PbB_{fetal} > PbB_t)$	**Probability that fetal PbB > PbB_t, assuming lognormal distribution**	**%**	**0.005%**

Appendix F
IEUBK Model Output
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

LEAD MODEL FOR WINDOWS Version 1.1

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Model Version: 1.1 Build11
User Name: ARCADIS
Date: October 2018
Site Name: Sierrita Mine, Green Valley, Arizona
Operable Unit: Former CLEAR Plant (0-15 feet below ground surface)
Run Mode: Research

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

Appendix F
IEUBK Model Output
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 89.450 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	113.500	89.450
1-2	113.500	89.450
2-3	113.500	89.450
3-4	113.500	89.450
4-5	113.500	89.450
5-6	113.500	89.450
6-7	113.500	89.450

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

Appendix F
IEUBK Model Output
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

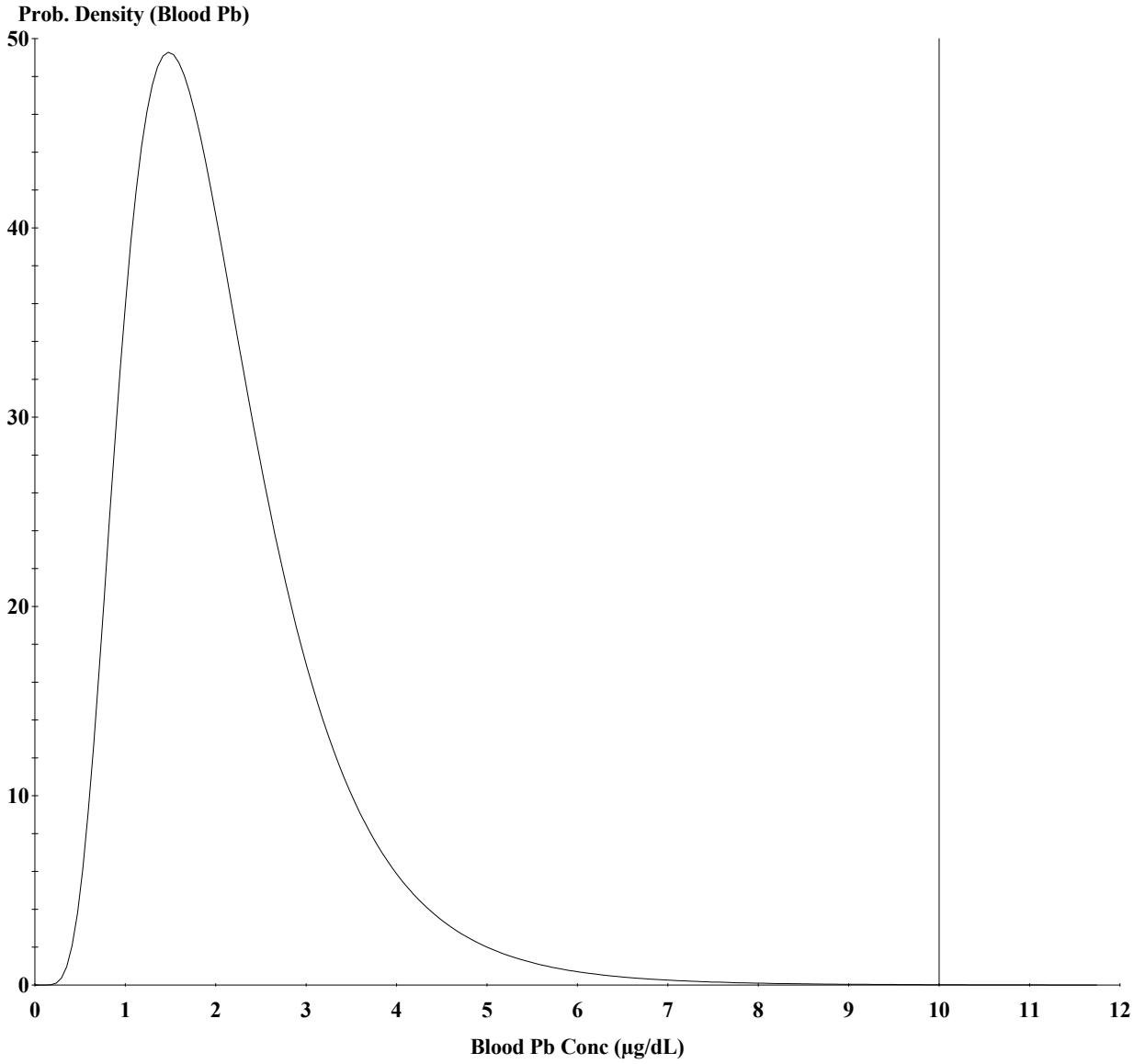
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	1.081	0.000	0.383
1-2	0.034	0.932	0.000	0.951
2-3	0.062	1.019	0.000	0.995
3-4	0.067	0.983	0.000	1.021
4-5	0.067	0.949	0.000	1.071
5-6	0.093	1.002	0.000	1.133
6-7	0.093	1.087	0.000	1.155

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	2.446	3.931	2.1
1-2	3.862	5.780	2.4
2-3	3.887	5.964	2.2
3-4	3.912	5.982	2.1
4-5	2.928	5.015	1.8
5-6	2.645	4.874	1.5
6-7	2.504	4.839	1.4



Cutoff = 10.000 µg/dl
Geo Mean = 1.921
GSD = 1.600
% Above = 0.022
% Below = 99.978

Age Range = 0 to 84 months

Run Mode = Research

Appendix F
IEUBK Model Output
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

LEAD MODEL FOR WINDOWS Version 1.1

==========

Model Version: 1.1 Build11
User Name: ARCADIS
Date: October 2018
Site Name: Sierrita Mine, Green Valley, Arizona
Operable Unit: Former Esperanza Mill (0-15 feet below ground surface)
Run Mode: Research

==========

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (µg Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(µg/day)
.5-1	2.260
1-2	1.960
2-3	2.130
3-4	2.040
4-5	1.950
5-6	2.050
6-7	2.220

Appendix F
IEUBK Model Output
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 91.900 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (µg Pb/g)	House Dust (µg Pb/g)
.5-1	117.000	91.900
1-2	117.000	91.900
2-3	117.000	91.900
3-4	117.000	91.900
4-5	117.000	91.900
5-6	117.000	91.900
6-7	117.000	91.900

****** Alternate Intake ******

Age	Alternate (µg Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

Appendix F
IEUBK Model Output
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

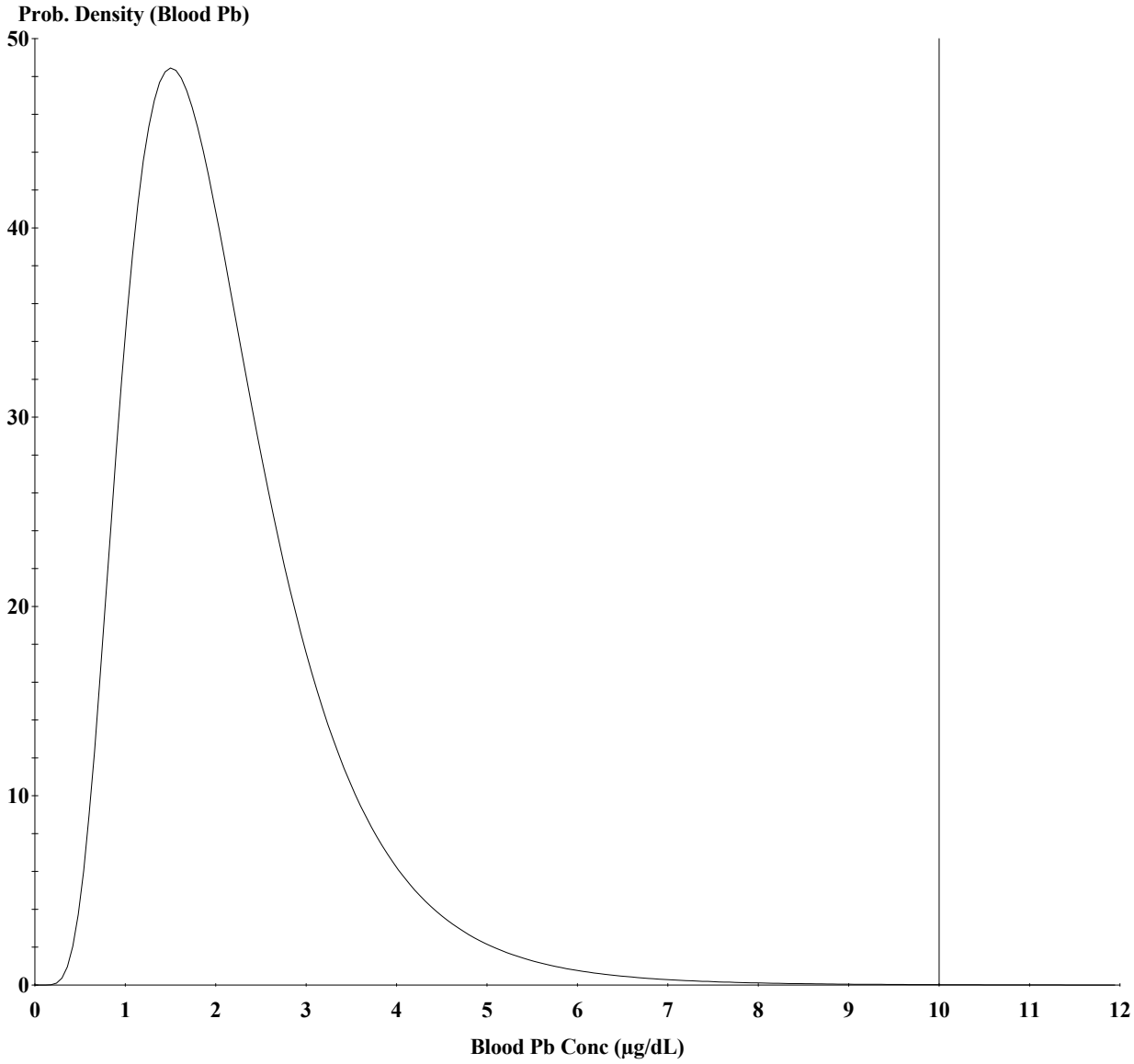
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 0.600 µg Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

Year	Air (µg/day)	Diet (µg/day)	Alternate (µg/day)	Water (µg/day)
.5-1	0.021	1.080	0.000	0.382
1-2	0.034	0.931	0.000	0.950
2-3	0.062	1.019	0.000	0.995
3-4	0.067	0.982	0.000	1.020
4-5	0.067	0.949	0.000	1.070
5-6	0.093	1.001	0.000	1.133
6-7	0.093	1.087	0.000	1.155

Year	Soil+Dust (µg/day)	Total (µg/day)	Blood (µg/dL)
.5-1	2.515	3.999	2.2
1-2	3.971	5.887	2.4
2-3	3.997	6.072	2.3
3-4	4.023	6.092	2.1
4-5	3.012	5.098	1.8
5-6	2.722	4.949	1.6
6-7	2.576	4.911	1.4



Cutoff = 10.000 µg/dl
Geo Mean = 1.954
GSD = 1.600
% Above = 0.026
% Below = 99.974

Age Range = 0 to 84 months

Run Mode = Research

APPENDIX G

Background Risk Calculations using Mean EPCs

Appendix G, Table G-1 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker at Former CLEAR Plant
Background - Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	2.27E+00	1.40E+09 P	3.4E-07	2.3E-07	4.6E-10	5.7E-07	100%	2.3E-03	1.6E-03	2.2E-05	4.0E-03	46%
Copper	D	2.45E+02	1.40E+09 P	NA	NA	NA	–		4.7E-03	–	NA	4.7E-03	54%
Lead	B2	6.01E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				3E-07	2E-07	5E-10			0.007	0.002	0.00002		
Total						**Total ELCR**	6E-07				**Total HI**	0.009	
						Group A Total ELCR	6E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-2 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker at Former CLEAR Plant
Background - Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	2.27E+00	1.40E+09 P	3.4E-07	2.3E-07	2.3E-10	5.7E-07	100%	2.3E-03	1.6E-03	1.1E-05	3.9E-03	46%
Copper	D	2.45E+02	1.40E+09 P	NA	NA	NA	–		4.7E-03	–	NA	4.7E-03	54%
Lead	B2	6.01E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				3E-07	2E-07	2E-10			0.007	0.002	0.00001		
Total						**Total ELCR**	6E-07				**Total HI**	0.009	
						Group A Total ELCR	6E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-3 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser at Former CLEAR Plant
Background - Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	2.27E+00	1.40E+09 P	2.8E-08	1.3E-08	5.3E-12	4.1E-08	100%	4.9E-04	2.3E-04	6.4E-07	7.2E-04	42%
Copper	D	2.45E+02	1.40E+09 P	NA	NA	NA	–		9.9E-04	–	NA	9.9E-04	58%
Lead	B2	6.01E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				3E-08	1E-08	5E-12			0.001	0.0002	0.0000006		
Total						**Total ELCR**	4E-08				**Total HI**	0.002	
						Group A Total ELCR	4E-08						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)
HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix G, Table G-4 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker at Former CLEAR Plant
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.69E+00	1.40E+09 P	2.5E-07	1.7E-07	3.4E-10	4.2E-07	100%	1.7E-03	1.2E-03	1.7E-05	2.9E-03	46%
Copper	D	1.81E+02	1.40E+09 P	NA	NA	NA	–		3.5E-03	–	NA	3.5E-03	54%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				3E-07	2E-07	3E-10			0.005	0.001	0.00002		
Total						**Total ELCR**	4E-07				**Total HI**	0.006	
						Group A Total ELCR	4E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-5 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker at Former CLEAR Plant
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.69E+00	1.40E+09 P	2.5E-07	1.7E-07	1.7E-10	4.2E-07	100%	1.7E-03	1.2E-03	8.3E-06	2.9E-03	46%
Copper	D	1.81E+02	1.40E+09 P	NA	NA	NA	–		3.5E-03	–	NA	3.5E-03	54%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				3E-07	2E-07	2E-10			0.005	0.001	0.000008		
Total						**Total ELCR**	4E-07				**Total HI**	0.006	
						Group A Total ELCR	4E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-6 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser at Former CLEAR Plant
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.69E+00	1.40E+09 P	2.1E-08	9.7E-09	4.0E-12	3.1E-08	100%	3.6E-04	1.7E-04	4.8E-07	5.3E-04	42%
Copper	D	1.81E+02	1.40E+09 P	NA	NA	NA	–		7.3E-04	–	NA	7.3E-04	58%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				2E-08	1E-08	4E-12			0.001	0.0002	0.0000005		
Total						**Total ELCR**	3E-08				**Total HI**	0.001	
						Group A Total ELCR	3E-08						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix G, Table G-7 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Construction Worker at Former CLEAR Plant
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.69E+00	1.40E+09 P	3.7E-08	1.5E-08	1.5E-11	5.2E-08	100%	6.4E-03	2.7E-03	1.8E-05	9.0E-03	41%
Copper	D	1.81E+02	1.40E+09 P	NA	NA	NA	–		1.3E-02	–	NA	1.3E-02	59%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				4E-08	2E-08	2E-11			0.02	0.003	0.00002		
Total						**Total ELCR**	5E-08				**Total HI**	0.02	
						Group A Total ELCR	5E-08						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 330 x 250 x 1 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1 x IUR) / (28470)
HQo = (EPCs x 1 x 330 x 250 x 1 x RBA) / (1,000,000 x 80 x 365 x RfDo)
HQd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1) / (1,000,000 x 80 x 365 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1) / (365 x RfC)

Appendix G, Table G-8 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker at Esperanza Mill
Background - Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	2.27E+00	1.40E+09 P	3.4E-07	2.3E-07	4.6E-10	5.7E-07	100%	2.3E-03	1.6E-03	2.2E-05	4.0E-03	35%
Molybdenum	NA	4.75E+01	1.40E+09 P	NA	NA	NA	–		7.3E-03	–	NA	7.3E-03	65%
				3E-07	2E-07	5E-10			0.01	0.002	0.00002		
Total						**Total ELCR**	6E-07				**Total HI**	0.01	
						Group A Total ELCR	6E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-9 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker at Esperanza Mill
Background - Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	2.27E+00	1.40E+09 P	3.4E-07	2.3E-07	2.3E-10	5.7E-07	100%	2.3E-03	1.6E-03	1.1E-05	3.9E-03	35%
Molybdenum	NA	4.75E+01	1.40E+09 P	NA	NA	NA	–		7.3E-03	–	NA	7.3E-03	65%
				3E-07	2E-07	2E-10			0.01	0.002	0.00001		
Total						**Total ELCR**	6E-07				**Total HI**	0.01	
						Group A Total ELCR	6E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-10 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser at Esperanza Mill
Background - Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	2.27E+00	1.40E+09 P	2.8E-08	1.3E-08	5.3E-12	4.1E-08	100%	4.9E-04	2.3E-04	6.4E-07	7.2E-04	32%
Molybdenum	NA	4.75E+01	1.40E+09 P	NA	NA	NA	–		1.5E-03	–	NA	1.5E-03	68%
				3E-08	1E-08	5E-12			0.002	0.0002	0.0000006		
Total						**Total ELCR**	4E-08				**Total HI**	0.002	
						Group A Total ELCR	4E-08						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix G, Table G-11 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker at Esperanza Mill
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NONCANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	1.69E+00	1.40E+09	P	2.5E-07	1.7E-07	3.4E-10	4.2E-07	100%	1.7E-03	1.2E-03	1.7E-05	2.9E-03	49%
Lead	B2	4.50E+00	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	2.00E+01	1.40E+09	P	NA	NA	NA	–		3.1E-03	–	NA	3.1E-03	51%
					3E-07	2E-07	3E-10			0.005	0.001	0.00002		
Total							**Total ELCR**	4E-07				**Total HI**	0.006	
							Group A Total ELCR	4E-07						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-12 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker at Esperanza Mill
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.69E+00	1.40E+09 P	2.5E-07	1.7E-07	1.7E-10	4.2E-07	100%	1.7E-03	1.2E-03	8.3E-06	2.9E-03	49%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	2.00E+01	1.40E+09 P	NA	NA	NA	–		3.1E-03	–	NA	3.1E-03	51%
				3E-07	2E-07	2E-10			0.005	0.001	0.000008		
Total						**Total ELCR**	4E-07				**Total HI**	0.006	
						Group A Total ELCR	4E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix G, Table G-13 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser at Esperanza Mill
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.69E+00	1.40E+09 P	2.1E-08	9.7E-09	4.0E-12	3.1E-08	100%	3.6E-04	1.7E-04	4.8E-07	5.3E-04	53%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	2.00E+01	1.40E+09 P	NA	NA	NA	–		6.5E-04	–	NA	6.5E-04	65%
				2E-08	1E-08	4E-12			0.001	0.0002	0.0000005		
Total						**Total ELCR**	3E-08				**Total HI**	0.001	
						Group A Total ELCR	3E-08						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix G, Table G-14 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Construction Worker at Esperanza Mill
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.69E+00	1.40E+09 P	3.7E-08	1.5E-08	1.5E-11	5.2E-08	100%	6.4E-03	2.7E-03	1.8E-05	9.0E-03	45%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	2.00E+01	1.40E+09 P	NA	NA	NA	–		1.1E-02	–	NA	1.1E-02	55%
				4E-08	2E-08	2E-11			0.02	0.003	0.00002		
Total						**Total ELCR**	5E-08				**Total HI**	0.02	
						Group A Total ELCR	5E-08						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 330 x 250 x 1 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1 x IUR) / (28470)

HQo = (EPCs x 1 x 330 x 250 x 1 x RBA) / (1,000,000 x 80 x 365 x RfDo)
HQd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1) / (1,000,000 x 80 x 365 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1) / (365 x RfC)

Appendix G, Table G-15
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Child/Adult Resident at Former CLEAR Plant
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	CANCER RISK: Age-Specific Risk for Carcinogenic Constituents: 1 through 6 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	27 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	TOTAL CANCER RISK: Route-Specific Risk 33 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	Total ELCR	Percent Total ELCR	NONCANCER HAZARD: Route-Specific Hazard 1 through 6 years: Oral (HQo)	Dermal (HQd)	Inhalation (HQi)	Total Hazard (Child)	Percent Total HI (Child)	NONCANCER HAZARD: Route-Specific Hazard 27 years: Oral (HQo)	Dermal (HQd)	Inhalation (HQi)	Total Hazard (Adult)	Percent Total HI (Adult)
Inorganics																								
Antimony	NA	1.98E-01	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		5.0E-03	–	NA	5.0E-03	4%	4.9E-04	–	NA	4.9E-04	4%
Arsenic	A	1.69E+00	1.40E+09 P	8.0E-07	1.3E-07	3.8E-10	4.2E-07	2.9E-07	1.7E-09	1.2E-06	4.2E-07	2.1E-09	1.6E-06	100%	2.3E-02	3.8E-03	7.7E-05	2.7E-02	23%	2.2E-03	1.5E-03	6.3E-05	3.8E-03	30%
Copper	D	1.81E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		4.6E-02	–	NA	4.6E-02	39%	4.4E-03	–	NA	4.4E-03	35%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	2.00E+01	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		4.1E-02	–	NA	4.1E-02	34%	3.9E-03	–	NA	3.9E-03	31%
				8E-07	1E-07	4E-10	4E-07	3E-07	2E-09	1E-06	4E-07	2E-09			0.1	0.004	0.00008			0.01	0.002	0.00006		
Total													**Total ELCR**	2E-06				**Total Child HI**	0.1				**Total Adult HI**	0.01
													Group A Total ELCR	2E-06				HI (skin)	0.03					
													Group B Total ELCR	–				HI (circulatory)	0.2					
													Group C Total ELCR	–				HI (gastrointestinal)	0.05					
													Group D Total ELCR	–				HI (neurological)	0.00008					
																			HI (development)	0.00008					
																			HI (kidney)	0.04					
																			HI (whole body)	0.2					

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table F-7. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

Child (1 through 6 years):
ELCRo = (EPCs x 1 x 200 x 350 x 6 x RBA x CSFo) / (1,000,000 x 19 x 28470)
ELCRd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6 x CSFa) / (1,000,000 x 19 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6 x IUR) / (28470)

Adult (7 through 33 years):
ELCRo = (EPCs x 1 x 100 x 350 x 27 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27 x IUR) / (28470)

Child (1 through 6 years):
HQo = (EPCs x 1 x 200 x 350 x 6 x RBA) / (1,000,000 x 19 x 2190 x RfDo)
HQd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6) / (1,000,000 x 19 x 2190 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6) / (2190 x RfC)

Adult (7 through 33 years):
HQo = (EPCs x 1 x 100 x 350 x 27 x RBA) / (1,000,000 x 80 x 12045 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27) / (1,000,000 x 80 x 12045 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27) / (12045 x RfC)

Appendix G, Table G-16
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Child/Adult Resident at Esperanza Mill
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	CANCER RISK: Age-Specific Risk for Carcinogenic Constituents: 1 through 6 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	27 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	TOTAL CANCER RISK: Route-Specific Risk: 33 years: Oral (ELCRo)	Dermal (ELCRd)	Inhalation (ELCRi)	Total ELCR	Percent Total ELCR	NONCANCER HAZARD: Route-Specific Hazard: 1 through 6 years: Oral (HQo)	Dermal (HQd)	Inhalation (HQi)	Total Hazard (Child)	Percent Total HI (Child)	NONCANCER HAZARD: Route-Specific Hazard: 27 years: Oral (HQo)	Dermal (HQd)	Inhalation (HQi)	Total Hazard (Adult)	Percent Total HI (Adult)
Inorganics																								
Antimony	NA	1.98E-01	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		5.0E-03	–	NA	5.0E-03	4%	4.9E-04	–	NA	4.9E-04	4%
Arsenic	A	1.69E+00	1.40E+09 P	8.0E-07	1.3E-07	3.8E-10	4.2E-07	2.9E-07	1.7E-09	1.2E-06	4.2E-07	2.1E-09	1.6E-06	100%	2.3E-02	3.8E-03	7.7E-05	2.7E-02	21%	2.2E-03	1.5E-03	6.3E-05	3.8E-03	28%
Copper	D	1.81E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		4.6E-02	–	NA	4.6E-02	36%	4.4E-03	–	NA	4.4E-03	33%
Lead	B2	4.50E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	2.00E+01	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		4.1E-02	–	NA	4.1E-02	32%	3.9E-03	–	NA	3.9E-03	29%
Uranium [c]	NA	2.76E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		9.4E-03	–	4.7E-05	9.4E-03	7%	9.0E-04	–	3.9E-05	9.4E-04	7%
				8E-07	1E-07	4E-10	4E-07	3E-07	2E-09	1E-06	4E-07	2E-09			0.1	0.004	0.0001			0.01	0.002	0.0001		
Total													**Total ELCR**	2E-06				**Total Child HI**	0.1				**Total Adult HI**	0.01
													Group A Total ELCR	2E-06				HI (developmental)	0.00008					
													Group B Total ELCR	–				HI (circulatory)	0.2					
													Group C Total ELCR	–				HI (skin)	0.03					
													Group D Total ELCR	–				HI (neurological)	0.00008					
																			HI (kidney)	0.05					
																			HI (whole body)	0.2					
																			HI (GI)	1					

Notes:

[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table F-7. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

Child (1 through 6 years):
ELCRo = (EPCs x 1 x 200 x 350 x 6 x RBA x CSFo) / (1,000,000 x 19 x 28470)
ELCRd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6 x CSFa) / (1,000,000 x 19 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6 x IUR) / (28470)

Adult (7 through 33 years):
ELCRo = (EPCs x 1 x 100 x 350 x 27 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27 x IUR) / (28470)

Child (1 through 6 years):
HQo = (EPCs x 1 x 200 x 350 x 6 x RBA) / (1,000,000 x 19 x 2190 x RfDo)
HQd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6) / (1,000,000 x 19 x 2190 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6) / (2190 x RfC)

Adult (7 through 33 years):
HQo = (EPCs x 1 x 100 x 350 x 27 x RBA) / (1,000,000 x 80 x 12045 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27) / (1,000,000 x 80 x 12045 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27) / (12045 x RfC)

Appendix G, Table G-17 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
at Former CLEAR Plant, Background Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.53E+00	1.40E+09	P	4.8E-08	2.9E-09	9.4E-07	9.9E-07	<1%
Uranium-234	1.51E+00	1.40E+09	P	4.3E-08	3.4E-09	2.0E-09	4.9E-08	<1%
Thorium-230	1.51E+00	1.40E+09	P	6.6E-08	4.1E-09	6.6E-09	7.6E-08	<1%
Radium-226	1.51E+00	1.40E+09	P	2.5E-07	3.4E-09	6.5E-05	6.5E-05	61%
Lead-210	1.51E+00	1.40E+09	P	3.5E-07	1.4E-09	8.0E-09	3.6E-07	<1%
Bismuth-210	1.51E+00	1.40E+09	P	2.5E-12	4.4E-14	1.7E-11	2.0E-11	<1%
Polonium-210	1.51E+00	1.40E+09	P	2.7E-08	4.0E-11	7.7E-12	2.7E-08	<1%
Thorium-232	1.85E+00	1.40E+09	P	7.9E-07	1.3E-08	3.8E-05	3.9E-05	37%
Thorium-228	1.85E+00	1.40E+09	P	7.3E-09	2.1E-09	5.9E-09	1.5E-08	<1%
Radium-224	1.85E+00	1.40E+09	P	5.1E-11	9.5E-13	2.3E-10	2.8E-10	<1%
Lead-212	1.85E+00	1.40E+09	P	9.6E-13	6.7E-15	3.3E-10	3.3E-10	<1%
Bismuth-212	1.85E+00	1.40E+09	P	3.1E-15	8.3E-17	3.1E-11	3.1E-11	<1%
Thallium-208	1.85E+00	1.40E+09	P	NA	NA	5.6E-11	5.6E-11	<1%
Uranium-235	9.20E-02	1.40E+09	P	2.6E-09	1.9E-10	2.7E-07	2.7E-07	<1%
Protactinium-231	9.20E-02	1.40E+09	P	8.0E-09	5.6E-10	6.0E-08	6.9E-08	<1%
Actinium-227	9.20E-02	1.40E+09	P	7.2E-09	7.7E-10	6.5E-11	8.0E-09	<1%
Francium-223	9.20E-02	1.40E+09	P	6.1E-16	7.3E-19	1.5E-13	1.5E-13	<1%
Astatine-219	9.20E-02	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	9.20E-02	1.40E+09	P	NA	NA	4.3E-13	4.3E-13	<1%
Thorium-227	9.20E-02	1.40E+09	P	3.2E-12	7.7E-13	6.2E-10	6.3E-10	<1%
Radium-223	9.20E-02	1.40E+09	P	1.1E-11	3.9E-13	5.9E-10	6.0E-10	<1%
Lead-211	9.20E-02	1.40E+09	P	5.4E-17	1.2E-18	5.5E-13	5.5E-13	<1%
Astatine-215	9.20E-02	1.40E+09	P	NA	NA	6.1E-23	6.1E-23	<1%
Bismuth-211	9.20E-02	1.40E+09	P	NA	NA	2.1E-14	2.1E-14	<1%
Thallium-207	9.20E-02	1.40E+09	P	NA	NA	3.9E-15	3.9E-15	<1%
Polonium-211	9.20E-02	1.40E+09	P	NA	NA	1.7E-17	1.7E-17	<1%
				2E-06	3E-08	1E-04		
Total						**Total ELCR**	1E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix G, Table G-18 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides at Former CLEAR Plant, Background Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK				Percent
				Route-Specific ELCR			Total	Total
Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		Ingestion ELCRo	Inhalation ELCRi	External ELCRe	ELCR	ELCR
Radionuclides								
Uranium-238	1.53E+00	1.40E+09	P	4.8E-08	1.5E-09	4.7E-07	5.2E-07	<1%
Uranium-234	1.51E+00	1.40E+09	P	4.3E-08	1.7E-09	9.8E-10	4.6E-08	<1%
Thorium-230	1.51E+00	1.40E+09	P	6.6E-08	2.1E-09	3.3E-09	7.1E-08	<1%
Radium-226	1.51E+00	1.40E+09	P	2.5E-07	1.7E-09	3.2E-05	3.3E-05	61%
Lead-210	1.51E+00	1.40E+09	P	3.5E-07	6.8E-10	4.0E-09	3.6E-07	<1%
Bismuth-210	1.51E+00	1.40E+09	P	2.5E-12	2.2E-14	8.5E-12	1.1E-11	<1%
Polonium-210	1.51E+00	1.40E+09	P	2.7E-08	2.0E-11	3.8E-12	2.7E-08	<1%
Thorium-232	1.85E+00	1.40E+09	P	7.9E-07	6.5E-09	1.9E-05	2.0E-05	37%
Thorium-228	1.85E+00	1.40E+09	P	7.3E-09	1.1E-09	3.0E-09	1.1E-08	<1%
Radium-224	1.85E+00	1.40E+09	P	5.1E-11	4.8E-13	1.2E-10	1.7E-10	<1%
Lead-212	1.85E+00	1.40E+09	P	9.6E-13	3.3E-15	1.7E-10	1.7E-10	<1%
Bismuth-212	1.85E+00	1.40E+09	P	3.1E-15	4.2E-17	1.6E-11	1.6E-11	<1%
Thallium-208	1.85E+00	1.40E+09	P	NA	NA	2.8E-11	2.8E-11	<1%
Uranium-235	9.20E-02	1.40E+09	P	2.6E-09	9.3E-11	1.4E-07	1.4E-07	<1%
Protactinium-231	9.20E-02	1.40E+09	P	8.0E-09	2.8E-10	3.0E-08	3.8E-08	<1%
Actinium-227	9.20E-02	1.40E+09	P	7.2E-09	3.8E-10	3.2E-11	7.6E-09	<1%
Francium-223	9.20E-02	1.40E+09	P	6.1E-16	3.7E-19	7.7E-14	7.7E-14	<1%
Astatine-219	9.20E-02	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	9.20E-02	1.40E+09	P	NA	NA	2.1E-13	2.1E-13	<1%
Thorium-227	9.20E-02	1.40E+09	P	3.2E-12	3.8E-13	3.1E-10	3.1E-10	<1%
Radium-223	9.20E-02	1.40E+09	P	1.1E-11	1.9E-13	2.9E-10	3.1E-10	<1%
Lead-211	9.20E-02	1.40E+09	P	5.4E-17	5.9E-19	2.7E-13	2.7E-13	<1%
Astatine-215	9.20E-02	1.40E+09	P	NA	NA	3.1E-23	3.1E-23	<1%
Bismuth-211	9.20E-02	1.40E+09	P	NA	NA	1.1E-14	1.1E-14	<1%
Thallium-207	9.20E-02	1.40E+09	P	NA	NA	2.0E-15	2.0E-15	<1%
Polonium-211	9.20E-02	1.40E+09	P	NA	NA	8.4E-18	8.4E-18	<1%
				2E-06	2E-08	5E-05		
Total						**Total ELCR**	5E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix G, Table G-19 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
at Former CLEAR Plant, Background Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK				Percent
				Route-Specific ELCR			Total	Total
Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		Ingestion ELCRo	Inhalation ELCRi	External ELCRe	ELCR	ELCR
Radionuclides								
Uranium-238	1.53E+00	1.40E+09	P	2.2E-09	7.7E-12	1.1E-08	1.3E-08	1%
Uranium-234	1.51E+00	1.40E+09	P	2.0E-09	9.0E-12	2.3E-11	2.0E-09	<1%
Thorium-230	1.51E+00	1.40E+09	P	3.0E-09	1.1E-11	7.6E-11	3.1E-09	<1%
Radium-226	1.51E+00	1.40E+09	P	1.2E-08	9.1E-12	7.6E-07	7.7E-07	59%
Lead-210	1.51E+00	1.40E+09	P	2.0E-08	4.4E-12	1.2E-10	2.0E-08	2%
Bismuth-210	1.51E+00	1.40E+09	P	2.9E-13	2.9E-16	5.0E-13	7.9E-13	<1%
Polonium-210	1.51E+00	1.40E+09	P	3.1E-09	2.6E-13	2.2E-13	3.1E-09	<1%
Thorium-232	1.85E+00	1.40E+09	P	3.6E-08	3.4E-11	4.5E-07	4.8E-07	37%
Thorium-228	1.85E+00	1.40E+09	P	8.3E-10	1.4E-11	1.7E-10	1.0E-09	<1%
Radium-224	1.85E+00	1.40E+09	P	5.9E-12	6.3E-15	6.7E-12	1.3E-11	<1%
Lead-212	1.85E+00	1.40E+09	P	1.1E-13	4.4E-17	9.6E-12	9.7E-12	<1%
Bismuth-212	1.85E+00	1.40E+09	P	3.6E-16	5.5E-19	9.1E-13	9.1E-13	<1%
Thallium-208	1.85E+00	1.40E+09	P	NA	NA	1.6E-12	1.6E-12	<1%
Uranium-235	9.20E-02	1.40E+09	P	1.2E-10	4.9E-13	3.2E-09	3.3E-09	<1%
Protactinium-231	9.20E-02	1.40E+09	P	3.7E-10	1.5E-12	7.0E-10	1.1E-09	<1%
Actinium-227	9.20E-02	1.40E+09	P	4.1E-10	2.5E-12	9.3E-13	4.2E-10	<1%
Francium-223	9.20E-02	1.40E+09	P	7.0E-17	4.8E-21	4.5E-15	4.5E-15	<1%
Astatine-219	9.20E-02	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	9.20E-02	1.40E+09	P	NA	NA	1.2E-14	1.2E-14	<1%
Thorium-227	9.20E-02	1.40E+09	P	3.6E-13	5.1E-15	1.8E-11	1.8E-11	<1%
Radium-223	9.20E-02	1.40E+09	P	1.3E-12	2.6E-15	1.7E-11	1.9E-11	<1%
Lead-211	9.20E-02	1.40E+09	P	6.2E-18	7.8E-21	1.6E-14	1.6E-14	<1%
Astatine-215	9.20E-02	1.40E+09	P	NA	NA	1.8E-24	1.8E-24	<1%
Bismuth-211	9.20E-02	1.40E+09	P	NA	NA	6.1E-16	6.1E-16	<1%
Thallium-207	9.20E-02	1.40E+09	P	NA	NA	1.1E-16	1.1E-16	<1%
Polonium-211	9.20E-02	1.40E+09	P	NA	NA	4.9E-19	4.9E-19	<1%
				8E-08	9E-11	1E-06		
Total						**Total ELCR**	1E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix G, Table G-20 (RME)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
at Former Esperanza Mill, Background Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.53E+00	1.40E+09	P	4.8E-08	2.9E-09	9.4E-07	9.9E-07	<1%
Uranium-234	1.51E+00	1.40E+09	P	4.3E-08	3.4E-09	2.0E-09	4.9E-08	<1%
Thorium-230	1.51E+00	1.40E+09	P	6.6E-08	4.1E-09	6.6E-09	7.6E-08	<1%
Radium-226	1.51E+00	1.40E+09	P	2.5E-07	3.4E-09	6.5E-05	6.5E-05	61%
Lead-210	1.51E+00	1.40E+09	P	3.5E-07	1.4E-09	8.0E-09	3.6E-07	<1%
Bismuth-210	1.51E+00	1.40E+09	P	2.5E-12	4.4E-14	1.7E-11	2.0E-11	<1%
Polonium-210	1.51E+00	1.40E+09	P	2.7E-08	4.0E-11	7.7E-12	2.7E-08	<1%
Thorium-232	1.85E+00	1.40E+09	P	7.9E-07	1.3E-08	3.8E-05	3.9E-05	37%
Thorium-228	1.85E+00	1.40E+09	P	7.3E-09	2.1E-09	5.9E-09	1.5E-08	<1%
Radium-224	1.85E+00	1.40E+09	P	5.1E-11	9.5E-13	2.3E-10	2.8E-10	<1%
Lead-212	1.85E+00	1.40E+09	P	9.6E-13	6.7E-15	3.3E-10	3.3E-10	<1%
Bismuth-212	1.85E+00	1.40E+09	P	3.1E-15	8.3E-17	3.1E-11	3.1E-11	<1%
Thallium-208	1.85E+00	1.40E+09	P	NA	NA	5.6E-11	5.6E-11	<1%
Uranium-235	9.20E-02	1.40E+09	P	2.6E-09	1.9E-10	2.7E-07	2.7E-07	<1%
Protactinium-231	9.20E-02	1.40E+09	P	8.0E-09	5.6E-10	6.0E-08	6.9E-08	<1%
Actinium-227	9.20E-02	1.40E+09	P	7.2E-09	7.7E-10	6.5E-11	8.0E-09	<1%
Francium-223	9.20E-02	1.40E+09	P	6.1E-16	7.3E-19	1.5E-13	1.5E-13	<1%
Astatine-219	9.20E-02	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	9.20E-02	1.40E+09	P	NA	NA	4.3E-13	4.3E-13	<1%
Thorium-227	9.20E-02	1.40E+09	P	3.2E-12	7.7E-13	6.2E-10	6.3E-10	<1%
Radium-223	9.20E-02	1.40E+09	P	1.1E-11	3.9E-13	5.9E-10	6.0E-10	<1%
Lead-211	9.20E-02	1.40E+09	P	5.4E-17	1.2E-18	5.5E-13	5.5E-13	<1%
Astatine-215	9.20E-02	1.40E+09	P	NA	NA	6.1E-23	6.1E-23	<1%
Bismuth-211	9.20E-02	1.40E+09	P	NA	NA	2.1E-14	2.1E-14	<1%
Thallium-207	9.20E-02	1.40E+09	P	NA	NA	3.9E-15	3.9E-15	<1%
Polonium-211	9.20E-02	1.40E+09	P	NA	NA	1.7E-17	1.7E-17	<1%
				2E-06	3E-08	1E-04		
Total						**Total ELCR**	1E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
$ELCRo = (EPCs \times 100 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFo) / (1{,}000 \times 25 \times \lambda)$
$ELCRi = (EPCs \times 1{,}000 \times 60 \times 8 \times 0.042 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFi) / (1.40E{+}09 \times 25 \times \lambda)$
$ELCRe = (EPCs \times ACF \times [(8 \times 0.042 \times 1) + (0 \times 0.042 \times 0.4)] \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFe) / (365 \times 25 \times \lambda)$

Appendix G, Table G-21 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
at Former Esperanza Mill, Background Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m³/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.53E+00	1.40E+09	P	4.8E-08	1.5E-09	4.7E-07	5.2E-07	<1%
Uranium-234	1.51E+00	1.40E+09	P	4.3E-08	1.7E-09	9.8E-10	4.6E-08	<1%
Thorium-230	1.51E+00	1.40E+09	P	6.6E-08	2.1E-09	3.3E-09	7.1E-08	<1%
Radium-226	1.51E+00	1.40E+09	P	2.5E-07	1.7E-09	3.2E-05	3.3E-05	61%
Lead-210	1.51E+00	1.40E+09	P	3.5E-07	6.8E-10	4.0E-09	3.6E-07	<1%
Bismuth-210	1.51E+00	1.40E+09	P	2.5E-12	2.2E-14	8.5E-12	1.1E-11	<1%
Polonium-210	1.51E+00	1.40E+09	P	2.7E-08	2.0E-11	3.8E-12	2.7E-08	<1%
Thorium-232	1.85E+00	1.40E+09	P	7.9E-07	6.5E-09	1.9E-05	2.0E-05	37%
Thorium-228	1.85E+00	1.40E+09	P	7.3E-09	1.1E-09	3.0E-09	1.1E-08	<1%
Radium-224	1.85E+00	1.40E+09	P	5.1E-11	4.8E-13	1.2E-10	1.7E-10	<1%
Lead-212	1.85E+00	1.40E+09	P	9.6E-13	3.3E-15	1.7E-10	1.7E-10	<1%
Bismuth-212	1.85E+00	1.40E+09	P	3.1E-15	4.2E-17	1.6E-11	1.6E-11	<1%
Thallium-208	1.85E+00	1.40E+09	P	NA	NA	2.8E-11	2.8E-11	<1%
Uranium-235	9.20E-02	1.40E+09	P	2.6E-09	9.3E-11	1.4E-07	1.4E-07	<1%
Protactinium-231	9.20E-02	1.40E+09	P	8.0E-09	2.8E-10	3.0E-08	3.8E-08	<1%
Actinium-227	9.20E-02	1.40E+09	P	7.2E-09	3.8E-10	3.2E-11	7.6E-09	<1%
Francium-223	9.20E-02	1.40E+09	P	6.1E-16	3.7E-19	7.7E-14	7.7E-14	<1%
Astatine-219	9.20E-02	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	9.20E-02	1.40E+09	P	NA	NA	2.1E-13	2.1E-13	<1%
Thorium-227	9.20E-02	1.40E+09	P	3.2E-12	3.8E-13	3.1E-10	3.1E-10	<1%
Radium-223	9.20E-02	1.40E+09	P	1.1E-11	1.9E-13	2.9E-10	3.1E-10	<1%
Lead-211	9.20E-02	1.40E+09	P	5.4E-17	5.9E-19	2.7E-13	2.7E-13	<1%
Astatine-215	9.20E-02	1.40E+09	P	NA	NA	3.1E-23	3.1E-23	<1%
Bismuth-211	9.20E-02	1.40E+09	P	NA	NA	1.1E-14	1.1E-14	<1%
Thallium-207	9.20E-02	1.40E+09	P	NA	NA	2.0E-15	2.0E-15	<1%
Polonium-211	9.20E-02	1.40E+09	P	NA	NA	8.4E-18	8.4E-18	<1%
				2E-06	2E-08	5E-05		
Total						**Total ELCR**	5E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix G, Table G-22 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
at Former Esperanza Mill, Background Shallow Soil (0 to 0.5 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK				Percent
				Route-Specific ELCR			Total	Total
Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		Ingestion ELCRo	Inhalation ELCRi	External ELCRe	ELCR	ELCR
Radionuclides								
Uranium-238	1.53E+00	1.40E+09	P	2.2E-09	7.7E-12	1.1E-08	1.3E-08	1%
Uranium-234	1.51E+00	1.40E+09	P	2.0E-09	9.0E-12	2.3E-11	2.0E-09	<1%
Thorium-230	1.51E+00	1.40E+09	P	3.0E-09	1.1E-11	7.6E-11	3.1E-09	<1%
Radium-226	1.51E+00	1.40E+09	P	1.2E-08	9.1E-12	7.6E-07	7.7E-07	59%
Lead-210	1.51E+00	1.40E+09	P	2.0E-08	4.4E-12	1.2E-10	2.0E-08	2%
Bismuth-210	1.51E+00	1.40E+09	P	2.9E-13	2.9E-16	5.0E-13	7.9E-13	<1%
Polonium-210	1.51E+00	1.40E+09	P	3.1E-09	2.6E-13	2.2E-13	3.1E-09	<1%
Thorium-232	1.85E+00	1.40E+09	P	3.6E-08	3.4E-11	4.5E-07	4.8E-07	37%
Thorium-228	1.85E+00	1.40E+09	P	8.3E-10	1.4E-11	1.7E-10	1.0E-09	<1%
Radium-224	1.85E+00	1.40E+09	P	5.9E-12	6.3E-15	6.7E-12	1.3E-11	<1%
Lead-212	1.85E+00	1.40E+09	P	1.1E-13	4.4E-17	9.6E-12	9.7E-12	<1%
Bismuth-212	1.85E+00	1.40E+09	P	3.6E-16	5.5E-19	9.1E-13	9.1E-13	<1%
Thallium-208	1.85E+00	1.40E+09	P	NA	NA	1.6E-12	1.6E-12	<1%
Uranium-235	9.20E-02	1.40E+09	P	1.2E-10	4.9E-13	3.2E-09	3.3E-09	<1%
Protactinium-231	9.20E-02	1.40E+09	P	3.7E-10	1.5E-12	7.0E-10	1.1E-09	<1%
Actinium-227	9.20E-02	1.40E+09	P	4.1E-10	2.5E-12	9.3E-13	4.2E-10	<1%
Francium-223	9.20E-02	1.40E+09	P	7.0E-17	4.8E-21	4.5E-15	4.5E-15	<1%
Astatine-219	9.20E-02	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	9.20E-02	1.40E+09	P	NA	NA	1.2E-14	1.2E-14	<1%
Thorium-227	9.20E-02	1.40E+09	P	3.6E-13	5.1E-15	1.8E-11	1.8E-11	<1%
Radium-223	9.20E-02	1.40E+09	P	1.3E-12	2.6E-15	1.7E-11	1.9E-11	<1%
Lead-211	9.20E-02	1.40E+09	P	6.2E-18	7.8E-21	1.6E-14	1.6E-14	<1%
Astatine-215	9.20E-02	1.40E+09	P	NA	NA	1.8E-24	1.8E-24	<1%
Bismuth-211	9.20E-02	1.40E+09	P	NA	NA	6.1E-16	6.1E-16	<1%
Thallium-207	9.20E-02	1.40E+09	P	NA	NA	1.1E-16	1.1E-16	<1%
Polonium-211	9.20E-02	1.40E+09	P	NA	NA	4.9E-19	4.9E-19	<1%
				8E-08	9E-11	1E-06		
Total						**Total ELCR**	1E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix G, Table G-23 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.42E+00	1.40E+09	P	4.5E-08	2.7E-09	8.7E-07	9.2E-07	<1%
Uranium-234	1.46E+00	1.40E+09	P	4.2E-08	3.3E-09	1.9E-09	4.7E-08	<1%
Thorium-230	1.46E+00	1.40E+09	P	6.3E-08	4.0E-09	6.3E-09	7.4E-08	<1%
Radium-226	1.46E+00	1.40E+09	P	2.4E-07	3.3E-09	6.2E-05	6.3E-05	63%
Lead-210	1.46E+00	1.40E+09	P	3.4E-07	1.3E-09	7.7E-09	3.5E-07	<1%
Bismuth-210	1.46E+00	1.40E+09	P	2.4E-12	4.3E-14	1.6E-11	1.9E-11	<1%
Polonium-210	1.46E+00	1.40E+09	P	2.6E-08	3.9E-11	7.4E-12	2.6E-08	<1%
Thorium-232	1.68E+00	1.40E+09	P	7.1E-07	1.2E-08	3.5E-05	3.6E-05	36%
Thorium-228	1.68E+00	1.40E+09	P	6.7E-09	1.9E-09	5.4E-09	1.4E-08	<1%
Radium-224	1.68E+00	1.40E+09	P	4.6E-11	8.6E-13	2.1E-10	2.6E-10	<1%
Lead-212	1.68E+00	1.40E+09	P	8.7E-13	6.1E-15	3.0E-10	3.0E-10	<1%
Bismuth-212	1.68E+00	1.40E+09	P	2.8E-15	7.6E-17	2.8E-11	2.8E-11	<1%
Thallium-208	1.68E+00	1.40E+09	P	NA	NA	5.1E-11	5.1E-11	<1%
Uranium-235	1.00E-01	1.40E+09	P	2.8E-09	2.0E-10	3.0E-07	3.0E-07	<1%
Protactinium-231	1.00E-01	1.40E+09	P	8.7E-09	6.1E-10	6.5E-08	7.4E-08	<1%
Actinium-227	1.00E-01	1.40E+09	P	7.8E-09	8.3E-10	7.0E-11	8.7E-09	<1%
Francium-223	1.00E-01	1.40E+09	P	6.6E-16	8.0E-19	1.7E-13	1.7E-13	<1%
Astatine-219	1.00E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.00E-01	1.40E+09	P	NA	NA	4.6E-13	4.6E-13	<1%
Thorium-227	1.00E-01	1.40E+09	P	3.4E-12	8.3E-13	6.8E-10	6.8E-10	<1%
Radium-223	1.00E-01	1.40E+09	P	1.2E-11	4.2E-13	6.4E-10	6.5E-10	<1%
Lead-211	1.00E-01	1.40E+09	P	5.9E-17	1.3E-18	5.9E-13	5.9E-13	<1%
Astatine-215	1.00E-01	1.40E+09	P	NA	NA	6.7E-23	6.7E-23	<1%
Bismuth-211	1.00E-01	1.40E+09	P	NA	NA	2.3E-14	2.3E-14	<1%
Thallium-207	1.00E-01	1.40E+09	P	NA	NA	4.3E-15	4.3E-15	<1%
Polonium-211	1.00E-01	1.40E+09	P	NA	NA	1.8E-17	1.8E-17	<1%
				1E-06	3E-08	1E-04		
Total						**Total ELCR**	1E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
$ELCRo = (EPCs \times 100 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFo) / (1{,}000 \times 25 \times \lambda)$
$ELCRi = (EPCs \times 1{,}000 \times 60 \times 8 \times 0.042 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFi) / (1.40E{+}09 \times 25 \times \lambda)$
$ELCRe = (EPCs \times ACF \times [(8 \times 0.042 \times 1) + (0 \times 0.042 \times 0.4)] \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFe) / (365 \times 25 \times \lambda)$

Appendix G, Table G-24 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK				
				Route-Specific Risk			Total	Percent Total
Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		Ingestion ELCRo	Inhalation ELCRi	External ELCRe	ELCR	ELCR
Radionuclides								
Uranium-238	1.42E+00	1.40E+09	P	4.5E-08	1.4E-09	4.3E-07	4.8E-07	<1%
Uranium-234	1.46E+00	1.40E+09	P	4.2E-08	1.6E-09	9.5E-10	4.5E-08	<1%
Thorium-230	1.46E+00	1.40E+09	P	6.3E-08	2.0E-09	3.2E-09	6.9E-08	<1%
Radium-226	1.46E+00	1.40E+09	P	2.4E-07	1.7E-09	3.1E-05	3.1E-05	62%
Lead-210	1.46E+00	1.40E+09	P	3.4E-07	6.5E-10	3.9E-09	3.5E-07	<1%
Bismuth-210	1.46E+00	1.40E+09	P	2.4E-12	2.1E-14	8.2E-12	1.1E-11	<1%
Polonium-210	1.46E+00	1.40E+09	P	2.6E-08	1.9E-11	3.7E-12	2.6E-08	<1%
Thorium-232	1.68E+00	1.40E+09	P	7.1E-07	5.9E-09	1.7E-05	1.8E-05	36%
Thorium-228	1.68E+00	1.40E+09	P	6.7E-09	9.7E-10	2.7E-09	1.0E-08	<1%
Radium-224	1.68E+00	1.40E+09	P	4.6E-11	4.3E-13	1.0E-10	1.5E-10	<1%
Lead-212	1.68E+00	1.40E+09	P	8.7E-13	3.0E-15	1.5E-10	1.5E-10	<1%
Bismuth-212	1.68E+00	1.40E+09	P	2.8E-15	3.8E-17	1.4E-11	1.4E-11	<1%
Thallium-208	1.68E+00	1.40E+09	P	NA	NA	2.5E-11	2.5E-11	<1%
Uranium-235	1.00E-01	1.40E+09	P	2.8E-09	1.0E-10	1.5E-07	1.5E-07	<1%
Protactinium-231	1.00E-01	1.40E+09	P	8.7E-09	3.1E-10	3.3E-08	4.2E-08	<1%
Actinium-227	1.00E-01	1.40E+09	P	7.8E-09	4.2E-10	3.5E-11	8.3E-09	<1%
Francium-223	1.00E-01	1.40E+09	P	6.6E-16	4.0E-19	8.4E-14	8.4E-14	<1%
Astatine-219	1.00E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.00E-01	1.40E+09	P	NA	NA	2.3E-13	2.3E-13	<1%
Thorium-227	1.00E-01	1.40E+09	P	3.4E-12	4.2E-13	3.4E-10	3.4E-10	<1%
Radium-223	1.00E-01	1.40E+09	P	1.2E-11	2.1E-13	3.2E-10	3.3E-10	<1%
Lead-211	1.00E-01	1.40E+09	P	5.9E-17	6.4E-19	3.0E-13	3.0E-13	<1%
Astatine-215	1.00E-01	1.40E+09	P	NA	NA	3.3E-23	3.3E-23	<1%
Bismuth-211	1.00E-01	1.40E+09	P	NA	NA	1.1E-14	1.1E-14	<1%
Thallium-207	1.00E-01	1.40E+09	P	NA	NA	2.1E-15	2.1E-15	<1%
Polonium-211	1.00E-01	1.40E+09	P	NA	NA	9.1E-18	9.1E-18	<1%
				1E-06	2E-08	5E-05		
Total						**Total ELCR**	5E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix G, Table G-25 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.42E+00	1.40E+09	P	2.1E-09	7.2E-12	1.0E-08	1.2E-08	<1%
Uranium-234	1.46E+00	1.40E+09	P	1.9E-09	8.7E-12	2.2E-11	2.0E-09	<1%
Thorium-230	1.46E+00	1.40E+09	P	2.9E-09	1.1E-11	7.4E-11	3.0E-09	<1%
Radium-226	1.46E+00	1.40E+09	P	1.1E-08	8.7E-12	7.3E-07	7.4E-07	60%
Lead-210	1.46E+00	1.40E+09	P	2.0E-08	4.3E-12	1.1E-10	2.0E-08	2%
Bismuth-210	1.46E+00	1.40E+09	P	2.8E-13	2.8E-16	4.8E-13	7.6E-13	<1%
Polonium-210	1.46E+00	1.40E+09	P	3.0E-09	2.5E-13	2.2E-13	3.0E-09	<1%
Thorium-232	1.68E+00	1.40E+09	P	3.3E-08	3.1E-11	4.1E-07	4.4E-07	36%
Thorium-228	1.68E+00	1.40E+09	P	7.5E-10	1.2E-11	1.5E-10	9.2E-10	<1%
Radium-224	1.68E+00	1.40E+09	P	5.4E-12	5.7E-15	6.1E-12	1.1E-11	<1%
Lead-212	1.68E+00	1.40E+09	P	1.0E-13	4.0E-17	8.7E-12	8.8E-12	<1%
Bismuth-212	1.68E+00	1.40E+09	P	3.2E-16	5.0E-19	8.3E-13	8.3E-13	<1%
Thallium-208	1.68E+00	1.40E+09	P	NA	NA	1.5E-12	1.5E-12	<1%
Uranium-235	1.00E-01	1.40E+09	P	1.3E-10	5.3E-13	3.4E-09	3.6E-09	<1%
Protactinium-231	1.00E-01	1.40E+09	P	4.0E-10	1.6E-12	7.6E-10	1.2E-09	<1%
Actinium-227	1.00E-01	1.40E+09	P	4.5E-10	2.7E-12	1.0E-12	4.5E-10	<1%
Francium-223	1.00E-01	1.40E+09	P	7.6E-17	5.3E-21	4.9E-15	4.9E-15	<1%
Astatine-219	1.00E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.00E-01	1.40E+09	P	NA	NA	1.3E-14	1.3E-14	<1%
Thorium-227	1.00E-01	1.40E+09	P	4.0E-13	5.5E-15	2.0E-11	2.0E-11	<1%
Radium-223	1.00E-01	1.40E+09	P	1.4E-12	2.8E-15	1.9E-11	2.0E-11	<1%
Lead-211	1.00E-01	1.40E+09	P	6.8E-18	8.4E-21	1.7E-14	1.7E-14	<1%
Astatine-215	1.00E-01	1.40E+09	P	NA	NA	1.9E-24	1.9E-24	<1%
Bismuth-211	1.00E-01	1.40E+09	P	NA	NA	6.7E-16	6.7E-16	<1%
Thallium-207	1.00E-01	1.40E+09	P	NA	NA	1.2E-16	1.2E-16	<1%
Polonium-211	1.00E-01	1.40E+09	P	NA	NA	5.3E-19	5.3E-19	<1%
				8E-08	9E-11	1E-06		
Total						**Total ELCR**	1E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix G, Table G-26 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Construction Worker Exposed to Radionuclides
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.42E+00	1.40E+09	P	6.6E-09	1.2E-10	3.9E-08	4.5E-08	<1%
Uranium-234	1.46E+00	1.40E+09	P	6.2E-09	1.5E-10	8.4E-11	6.4E-09	<1%
Thorium-230	1.46E+00	1.40E+09	P	9.3E-09	1.8E-10	2.8E-10	9.8E-09	<1%
Radium-226	1.46E+00	1.40E+09	P	3.6E-08	1.5E-10	2.8E-06	2.8E-06	60%
Lead-210	1.46E+00	1.40E+09	P	7.1E-08	8.2E-11	4.9E-10	7.2E-08	2%
Bismuth-210	1.46E+00	1.40E+09	P	8.9E-12	4.8E-14	1.8E-11	2.7E-11	<1%
Polonium-210	1.46E+00	1.40E+09	P	8.0E-08	3.6E-11	6.9E-12	8.0E-08	2%
Thorium-232	1.68E+00	1.40E+09	P	1.0E-07	5.2E-10	1.6E-06	1.7E-06	35%
Thorium-228	1.68E+00	1.40E+09	P	7.4E-09	6.6E-10	1.8E-09	9.9E-09	<1%
Radium-224	1.68E+00	1.40E+09	P	1.7E-10	9.6E-13	2.3E-10	4.0E-10	<1%
Lead-212	1.68E+00	1.40E+09	P	3.2E-12	6.8E-15	3.3E-10	3.4E-10	<1%
Bismuth-212	1.68E+00	1.40E+09	P	1.0E-14	8.4E-17	3.2E-11	3.2E-11	<1%
Thallium-208	1.68E+00	1.40E+09	P	NA	NA	5.6E-11	5.6E-11	<1%
Uranium-235	1.00E-01	1.40E+09	P	4.1E-10	9.0E-12	1.3E-08	1.4E-08	<1%
Protactinium-231	1.00E-01	1.40E+09	P	1.3E-09	2.7E-11	2.9E-09	4.2E-09	<1%
Actinium-227	1.00E-01	1.40E+09	P	1.6E-09	5.3E-11	4.4E-12	1.7E-09	<1%
Francium-223	1.00E-01	1.40E+09	P	2.4E-15	8.8E-19	1.9E-13	1.9E-13	<1%
Astatine-219	1.00E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.00E-01	1.40E+09	P	NA	NA	5.1E-13	5.1E-13	<1%
Thorium-227	1.00E-01	1.40E+09	P	1.3E-11	9.3E-13	7.5E-10	7.6E-10	<1%
Radium-223	1.00E-01	1.40E+09	P	4.6E-11	4.7E-13	7.1E-10	7.6E-10	<1%
Lead-211	1.00E-01	1.40E+09	P	2.2E-16	1.4E-18	6.6E-13	6.6E-13	<1%
Astatine-215	1.00E-01	1.40E+09	P	NA	NA	7.4E-23	7.4E-23	<1%
Bismuth-211	1.00E-01	1.40E+09	P	NA	NA	2.5E-14	2.5E-14	<1%
Thallium-207	1.00E-01	1.40E+09	P	NA	NA	4.8E-15	4.8E-15	<1%
Polonium-211	1.00E-01	1.40E+09	P	NA	NA	2.0E-17	2.0E-17	<1%
				3E-07	2E-09	4E-06		
Total						**Total ELCR**	5E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 330 × 250 × 1 × [1 - exp(-λ × 1)] × CSFo) / (1,000 × 1 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 250 × 1 × [1 - exp(-λ × 1)] × CSFi) / (1.40E+09 × 1 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 250 × 1 × [1 - exp(-λ × 1)] × CSFe) / (365 × 1 × λ)

Appendix G, Table G-27
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Child/Adult Resident Exposed to Radionuclides
Background - Shallow and Deep Soil (0 to 15 ft bgs)
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.42E+00	1.40E+09	P	1.1E-07	5.0E-09	1.9E-06	2.0E-06	<1%
Uranium-234	1.46E+00	1.40E+09	P	1.0E-07	6.1E-09	4.1E-09	1.1E-07	<1%
Thorium-230	1.46E+00	1.40E+09	P	1.5E-07	7.4E-09	1.4E-08	1.7E-07	<1%
Radium-226	1.46E+00	1.40E+09	P	5.8E-07	6.1E-09	1.3E-04	1.3E-04	63%
Lead-210	1.46E+00	1.40E+09	P	7.4E-07	2.2E-09	1.5E-08	7.6E-07	<1%
Bismuth-210	1.46E+00	1.40E+09	P	4.5E-12	6.0E-14	2.7E-11	3.1E-11	<1%
Polonium-210	1.46E+00	1.40E+09	P	4.7E-08	5.4E-11	1.2E-11	4.8E-08	<1%
Thorium-232	1.68E+00	1.40E+09	P	1.7E-06	2.2E-08	7.5E-05	7.6E-05	36%
Thorium-228	1.68E+00	1.40E+09	P	1.2E-08	2.7E-09	8.7E-09	2.4E-08	<1%
Radium-224	1.68E+00	1.40E+09	P	8.5E-11	1.2E-12	3.4E-10	4.3E-10	<1%
Lead-212	1.68E+00	1.40E+09	P	1.6E-12	8.5E-15	4.9E-10	4.9E-10	<1%
Bismuth-212	1.68E+00	1.40E+09	P	5.1E-15	1.1E-16	4.6E-11	4.6E-11	<1%
Thallium-208	1.68E+00	1.40E+09	P	NA	NA	8.2E-11	8.2E-11	<1%
Uranium-235	1.00E-01	1.40E+09	P	6.8E-09	3.7E-10	6.3E-07	6.4E-07	<1%
Protactinium-231	1.00E-01	1.40E+09	P	2.1E-08	1.1E-09	1.4E-07	1.6E-07	<1%
Actinium-227	1.00E-01	1.40E+09	P	1.7E-08	1.4E-09	1.3E-10	1.8E-08	<1%
Francium-223	1.00E-01	1.40E+09	P	1.2E-15	1.1E-18	2.7E-13	2.7E-13	<1%
Astatine-219	1.00E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.00E-01	1.40E+09	P	NA	NA	7.5E-13	7.5E-13	<1%
Thorium-227	1.00E-01	1.40E+09	P	6.3E-12	1.2E-12	1.1E-09	1.1E-09	<1%
Radium-223	1.00E-01	1.40E+09	P	2.3E-11	5.9E-13	1.0E-09	1.1E-09	<1%
Lead-211	1.00E-01	1.40E+09	P	1.1E-16	1.8E-18	9.6E-13	9.6E-13	<1%
Astatine-215	1.00E-01	1.40E+09	P	NA	NA	1.1E-22	1.1E-22	<1%
Bismuth-211	1.00E-01	1.40E+09	P	NA	NA	3.7E-14	3.7E-14	<1%
Thallium-207	1.00E-01	1.40E+09	P	NA	NA	6.9E-15	6.9E-15	<1%
Polonium-211	1.00E-01	1.40E+09	P	NA	NA	2.9E-17	2.9E-17	<1%
				4E-06	5E-08	2E-04		
Total						**Total ELCR**	2E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table F-7.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 118 × 350 × 33 × [1 - exp(-λ × 33)] × CSFo) / (1,000 × 33 × λ)
ELCRi = (EPCs × 1,000 × 18 × 24 × 0.042 × 350 × 33 × [1 - exp(-λ × 33)] × CSFi) / (1.40E+09 × 33 × λ)
ELCRe = (EPCs × ACF × [(1.752 × 0.042 × 1) + (16.416 × 0.042 × 0.4)] × 350 × 33 × [1 - exp(-λ × 33)] × CSFe) / (365 × 33 × λ)

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.110/3/2018 1:10:05 PM
From File	Sierrita-bkgd-soils-100318.xls
Full Precision	ON
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Antimony_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	9.0000000
Number of Detects	9.0000000	Number of Non-Detects	4.0000000
Number of Distinct Detects	7.0000000	Number of Distinct Non-Detects	3.0000000
Minimum Detect	0.1000000	Minimum Non-Detect	0.0950000
Maximum Detect	0.7300000	Maximum Non-Detect	0.1000000
Variance Detects	0.0378861	Percent Non-Detects	30.769231%
Mean Detects	0.2288889	SD Detects	0.1946435
Median Detects	0.1500000	CV Detects	0.8503844
Skewness Detects	2.6303312	Kurtosis Detects	7.2988262
Mean of Logged Detects	-1.669281	SD of Logged Detects	0.5874394

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.6263816	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8290000	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.3253939	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2744000	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.1876923	KM Standard Error of Mean	0.0484568
KM SD	0.1647214	95% KM (BCA) UCL	0.2726923
95% KM (t) UCL	0.2740562	95% KM (Percentile Bootstrap) UCL	0.2723077
95% KM (z) UCL	0.2673966	95% KM Bootstrap t UCL	0.4359492
90% KM Chebyshev UCL	0.3330627	95% KM Chebyshev UCL	0.3989105
97.5% KM Chebyshev UCL	0.4903048	99% KM Chebyshev UCL	0.6698312

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.9048213	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.7276245	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.2357529	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.2816565	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	2.7224028	k star (bias corrected MLE)	1.8890093
Theta hat (MLE)	0.0840761	Theta star (bias corrected MLE)	0.1211687
nu hat (MLE)	49.003251	nu star (bias corrected)	34.002167
Mean (detects)	0.2288889		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0100000	Mean	0.1615385
Maximum	0.7300000	Median	0.1300000
SD	0.1905626	CV	1.1796732
k hat (MLE)	0.7926851	k star (bias corrected MLE)	0.6610399
Theta hat (MLE)	0.2037864	Theta star (bias corrected MLE)	0.2443702
nu hat (MLE)	20.609814	nu star (bias corrected)	17.187036
Adjusted Level of Significance (β)	0.0300900		
Approximate Chi Square Value (17.19, α)	8.8060071	Adjusted Chi Square Value (17.19, β)	7.9640863
95% Gamma Approximate UCL (use when n>=50)	0.3152811	95% Gamma Adjusted UCL (use when n<50)	0.3486109

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.1876923	SD (KM)	0.1647214
Variance (KM)	0.0271331	SE of Mean (KM)	0.0484568
k hat (KM)	1.2983535	k star (KM)	1.0500155
nu hat (KM)	33.757191	nu star (KM)	27.300403
theta hat (KM)	0.1445618	theta star (KM)	0.1787519
80% gamma percentile (KM)	0.3008492	90% gamma percentile (KM)	0.4270058
95% gamma percentile (KM)	0.5526823	99% gamma percentile (KM)	0.8434630

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (27.30, α)	16.384388	Adjusted Chi Square Value (27.30, β)	15.189346
95% Gamma Approximate KM-UCL (use when n>=50)	0.3127414	95% Gamma Adjusted KM-UCL (use when n<50)	0.3373467

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.8427669	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8290000	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.2064927	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2744000	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.1729693	Mean in Log Scale	-2.098746
SD in Original Scale	0.1813694	SD in Log Scale	0.8287407
95% t UCL (assumes normality of ROS data)	0.2626234	95% Percentile Bootstrap UCL	0.2606837
95% BCA Bootstrap UCL	0.3059004	95% Bootstrap t UCL	0.3788881
95% H-UCL (Log ROS)	0.3192514		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-1.879926	KM Geo Mean	0.1526014
KM SD (logged)	0.5587449	95% Critical H Value (KM-Log)	2.1825598
KM Standard Error of Mean (logged)	0.1643683	95% H-UCL (KM -Log)	0.2536524
KM SD (logged)	0.5587449	95% Critical H Value (KM-Log)	2.1825598
KM Standard Error of Mean (logged)	0.1643683		

DL/2 Statistics

DL/2 Normal		DL/2 Log-Transformed	
Mean in Original Scale	0.1735000	Mean in Log Scale	-2.084505
SD in Original Scale	0.1809307	SD in Log Scale	0.8065304
95% t UCL (Assumes normality)	0.2629372	95% H-Stat UCL	0.3103069

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

95% KM Adjusted Gamma UCL	0.3373467	95% GROS Adjusted Gamma UCL	0.3486109

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	10.000000
		Number of Missing Observations	0
Minimum	1.2000000	Mean	2.2692308
Maximum	4.0000000	Median	2.1000000
SD	0.7110844	Std. Error of Mean	0.1972193
Coefficient of Variation	0.3133592	Skewness	1.1302773

Normal GOF Test

Shapiro Wilk Test Statistic	0.9107294	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.2094401	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	2.6207323	95% Adjusted-CLT UCL (Chen-1995)	2.6596884
		95% Modified-t UCL (Johnson-1978)	2.6310365

Gamma GOF Test

A-D Test Statistic	0.3637985	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7336582	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1820825	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.2365823	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.995597	k star (bias corrected MLE)	9.2786646
Theta hat (MLE)	0.1891720	Theta star (bias corrected MLE)	0.2445644
nu hat (MLE)	311.88553	nu star (bias corrected)	241.24528
MLE Mean (bias corrected)	2.2692308	MLE Sd (bias corrected)	0.7449651
		Approximate Chi Square Value (0.05)	206.28720
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	201.68167

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.6537818	95% Adjusted Gamma UCL (use when n<50)	2.7143826

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9635076	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1620821	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.1823216	Mean of logged Data	0.7771802
Maximum of Logged Data	1.3862944	SD of logged Data	0.3003952

Assuming Lognormal Distribution

95% H-UCL	2.6855096	90% Chebyshev (MVUE) UCL	2.8400094
95% Chebyshev (MVUE) UCL	3.0993089	97.5% Chebyshev (MVUE) UCL	3.4592065
99% Chebyshev (MVUE) UCL	4.1661557		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.5936277	95% Jackknife UCL	2.6207323
95% Standard Bootstrap UCL	2.5880041	95% Bootstrap-t UCL	2.7379414
95% Hall's Bootstrap UCL	2.8334410	95% Percentile Bootstrap UCL	2.5923077
95% BCA Bootstrap UCL	2.6230769		
90% Chebyshev(Mean, Sd) UCL	2.8608888	95% Chebyshev(Mean, Sd) UCL	3.1288899
97.5% Chebyshev(Mean, Sd) UCL	3.5008651	99% Chebyshev(Mean, Sd) UCL	4.2315383

Suggested UCL to Use

95% Student's-t UCL	2.6207323

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
		Number of Missing Observations	0
Minimum	53.000000	Mean	245.38462
Maximum	710.00000	Median	200.00000
SD	200.59268	Std. Error of Mean	55.634399
Coefficient of Variation	0.8174623	Skewness	1.0844917

Normal GOF Test

Shapiro Wilk Test Statistic	0.8725776	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.1955761	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	344.54111	95% Adjusted-CLT UCL (Chen-1995)	354.77551
		95% Modified-t UCL (Johnson-1978)	347.33010

Gamma GOF Test

A-D Test Statistic	0.4538473	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7483504	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1848842	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.2405093	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.6374718	k star (bias corrected MLE)	1.3108758
Theta hat (MLE)	149.85578	Theta star (bias corrected MLE)	187.19136
nu hat (MLE)	42.574268	nu star (bias corrected)	34.082770
MLE Mean (bias corrected)	245.38462	MLE Sd (bias corrected)	214.32191
		Approximate Chi Square Value (0.05)	21.730552
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	20.333885

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	384.86769	95% Adjusted Gamma UCL (use when n<50)	411.30299

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9223960	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1679560	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.9702919	Mean of logged Data	5.1674034
Maximum of Logged Data	6.5652650	SD of logged Data	0.8807202

Assuming Lognormal Distribution

95% H-UCL	506.92356	90% Chebyshev (MVUE) UCL	443.16941
95% Chebyshev (MVUE) UCL	531.20007	97.5% Chebyshev (MVUE) UCL	653.38320
99% Chebyshev (MVUE) UCL	893.38832		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	336.89506	95% Jackknife UCL	344.54111
95% Standard Bootstrap UCL	332.51540	95% Bootstrap-t UCL	365.15426
95% Hall's Bootstrap UCL	372.24023	95% Percentile Bootstrap UCL	334.15385
95% BCA Bootstrap UCL	349.38462		
90% Chebyshev(Mean, Sd) UCL	412.28781	95% Chebyshev(Mean, Sd) UCL	487.88934
97.5% Chebyshev(Mean, Sd) UCL	592.82133	99% Chebyshev(Mean, Sd) UCL	798.93990

Suggested UCL to Use

95% Student's-t UCL	344.54111

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
		Number of Missing Observations	0
Minimum	4.3000000	Mean	6.0076923
Maximum	8.7000000	Median	5.7000000
SD	1.3530592	Std. Error of Mean	0.3752711
Coefficient of Variation	0.2252211	Skewness	0.6833523

Normal GOF Test

Shapiro Wilk Test Statistic	0.9421750	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.1348676	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	6.6765333	95% Adjusted-CLT UCL (Chen-1995)	6.7009557
		95% Modified-t UCL (Johnson-1978)	6.6883874

Gamma GOF Test

A-D Test Statistic	0.2455344	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7332645	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1375400	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.2361173	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	22.427492	k star (bias corrected MLE)	17.303199
Theta hat (MLE)	0.2678718	Theta star (bias corrected MLE)	0.3472013
nu hat (MLE)	583.11479	nu star (bias corrected)	449.88317
MLE Mean (bias corrected)	6.0076923	MLE Sd (bias corrected)	1.4442570
		Approximate Chi Square Value (0.05)	401.70688
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	395.21821

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.7281886	95% Adjusted Gamma UCL (use when n<50)	6.8386517

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9651802	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1256225	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	1.4586150	Mean of logged Data	1.7705810
Maximum of Logged Data	2.1633230	SD of logged Data	0.2186399

Assuming Lognormal Distribution

95% H-UCL	6.7588769	90% Chebyshev (MVUE) UCL	7.1034534
95% Chebyshev (MVUE) UCL	7.6009695	97.5% Chebyshev (MVUE) UCL	8.2915026
99% Chebyshev (MVUE) UCL	9.6479212		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	6.6249583	95% Jackknife UCL	6.6765333
95% Standard Bootstrap UCL	6.6021104	95% Bootstrap-t UCL	6.7542018
95% Hall's Bootstrap UCL	6.7074538	95% Percentile Bootstrap UCL	6.5923077
95% BCA Bootstrap UCL	6.7153846		
90% Chebyshev(Mean, Sd) UCL	7.1335056	95% Chebyshev(Mean, Sd) UCL	7.6434611
97.5% Chebyshev(Mean, Sd) UCL	8.3512596	99% Chebyshev(Mean, Sd) UCL	9.7415927

Suggested UCL to Use

95% Student's-t UCL	6.6765333

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
		Number of Missing Observations	0
Minimum	1.2000000	Mean	47.507692
Maximum	270.00000	Median	22.000000
SD	69.664702	Std. Error of Mean	19.321512
Coefficient of Variation	1.4663878	Skewness	3.1221747

Normal GOF Test

Shapiro Wilk Test Statistic	0.5752704	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.3239481	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	81.944183	95% Adjusted-CLT UCL (Chen-1995)	97.166262
		95% Modified-t UCL (Johnson-1978)	84.732714

Gamma GOF Test

A-D Test Statistic	0.5010336	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7646905	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1769729	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.2446338	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.8588199	k star (bias corrected MLE)	0.7119128
Theta hat (MLE)	55.317407	Theta star (bias corrected MLE)	66.732462
nu hat (MLE)	22.329319	nu star (bias corrected)	18.509732
MLE Mean (bias corrected)	47.507692	MLE Sd (bias corrected)	56.305464
		Approximate Chi Square Value (0.05)	9.7602513
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	8.8673150

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	90.095494	95% Adjusted Gamma UCL (use when n<50)	99.168087

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9359742	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1879298	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.1823216	Mean of logged Data	3.1761570
Maximum of Logged Data	5.5984220	SD of logged Data	1.3176445

Assuming Lognormal Distribution

95% H-UCL	210.20591	90% Chebyshev (MVUE) UCL	113.27753
95% Chebyshev (MVUE) UCL	141.37078	97.5% Chebyshev (MVUE) UCL	180.36311
99% Chebyshev (MVUE) UCL	256.95600		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	79.288752	95% Jackknife UCL	81.944183
95% Standard Bootstrap UCL	79.188173	95% Bootstrap-t UCL	146.39094
95% Hall's Bootstrap UCL	201.55474	95% Percentile Bootstrap UCL	81.800000
95% BCA Bootstrap UCL	101.56923		
90% Chebyshev(Mean, Sd) UCL	105.47223	95% Chebyshev(Mean, Sd) UCL	131.72821
97.5% Chebyshev(Mean, Sd) UCL	168.17050	99% Chebyshev(Mean, Sd) UCL	239.75431

Suggested UCL to Use

95% Adjusted Gamma UCL	99.168087

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
		Number of Missing Observations	0
Minimum	0.6700000	Mean	2.7515385
Maximum	5.0000000	Median	2.6000000
SD	1.3526631	Std. Error of Mean	0.3751612
Coefficient of Variation	0.4916025	Skewness	0.1578566

Normal GOF Test

Shapiro Wilk Test Statistic	0.9670874	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.1201135	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.4201837	95% Adjusted-CLT UCL (Chen-1995)	3.3861743
		95% Modified-t UCL (Johnson-1978)	3.4229212

Gamma GOF Test

A-D Test Statistic	0.2096893	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7377178	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1195265	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.2378108	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.7485433	k star (bias corrected MLE)	2.9347769
Theta hat (MLE)	0.7340287	Theta star (bias corrected MLE)	0.9375631
nu hat (MLE)	97.462126	nu star (bias corrected)	76.304199
MLE Mean (bias corrected)	2.7515385	MLE Sd (bias corrected)	1.6061572
		Approximate Chi Square Value (0.05)	57.183372
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	54.829848

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.6715907	95% Adjusted Gamma UCL (use when n<50)	3.8291907

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9410799	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1307282	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.400478	Mean of logged Data	0.8728854
Maximum of Logged Data	1.6094379	SD of logged Data	0.5906566

Assuming Lognormal Distribution

95% H-UCL	4.1634643	90% Chebyshev (MVUE) UCL	4.2346356
95% Chebyshev (MVUE) UCL	4.8813261	97.5% Chebyshev (MVUE) UCL	5.7789074
99% Chebyshev (MVUE) UCL	7.5420322		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.3686238	95% Jackknife UCL	3.4201837
95% Standard Bootstrap UCL	3.3562996	95% Bootstrap-t UCL	3.4754161
95% Hall's Bootstrap UCL	3.3874971	95% Percentile Bootstrap UCL	3.3669231
95% BCA Bootstrap UCL	3.3746154		
90% Chebyshev(Mean, Sd) UCL	3.8770222	95% Chebyshev(Mean, Sd) UCL	4.3868284
97.5% Chebyshev(Mean, Sd) UCL	5.0944197	99% Chebyshev(Mean, Sd) UCL	6.4843457

Suggested UCL to Use

95% Student's-t UCL	3.4201837

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Radium-226_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
		Number of Missing Observations	0
Minimum	1.2700000	Mean	2.0000000
Maximum	3.0900000	Median	2.0000000
SD	0.5203204	Std. Error of Mean	0.1443109
Coefficient of Variation	0.2601602	Skewness	0.5078272

Normal GOF Test

Shapiro Wilk Test Statistic	0.9669575	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.1193633	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.2572036	95% Adjusted-CLT UCL (Chen-1995)	2.2590885
		95% Modified-t UCL (Johnson-1978)	2.2605912

Gamma GOF Test

A-D Test Statistic	0.1703464	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7334842	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.1301401	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.2363319	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	16.238409	k star (bias corrected MLE)	12.542366
Theta hat (MLE)	0.1231648	Theta star (bias corrected MLE)	0.1594596
nu hat (MLE)	422.19863	nu star (bias corrected)	326.10151
MLE Mean (bias corrected)	2.0000000	MLE Sd (bias corrected)	0.5647292
		Approximate Chi Square Value (0.05)	285.26217
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	279.81895

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.2863284	95% Adjusted Gamma UCL (use when n<50)	2.3308036

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9788167	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.1195309	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.2390169	Mean of logged Data	0.6620401
Maximum of Logged Data	1.1281711	SD of logged Data	0.2602688

Assuming Lognormal Distribution

95% H-UCL	2.3091348	90% Chebyshev (MVUE) UCL	2.4366191
95% Chebyshev (MVUE) UCL	2.6343131	97.5% Chebyshev (MVUE) UCL	2.9087048
99% Chebyshev (MVUE) UCL	3.4476941		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.2373703	95% Jackknife UCL	2.2572036
95% Standard Bootstrap UCL	2.2316402	95% Bootstrap-t UCL	2.2763175
95% Hall's Bootstrap UCL	2.2926939	95% Percentile Bootstrap UCL	2.2315385
95% BCA Bootstrap UCL	2.2415385		
90% Chebyshev(Mean, Sd) UCL	2.4329328	95% Chebyshev(Mean, Sd) UCL	2.6290367
97.5% Chebyshev(Mean, Sd) UCL	2.9012214	99% Chebyshev(Mean, Sd) UCL	3.4358755

Suggested UCL to Use

95% Student's-t UCL	2.2572036

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Radium-228_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
		Number of Missing Observations	0
Minimum	1.2000000	Mean	1.8515385
Maximum	2.8400000	Median	1.7700000
SD	0.5360946	Std. Error of Mean	0.1486859
Coefficient of Variation	0.2895401	Skewness	0.4520461

Normal GOF Test

Shapiro Wilk Test Statistic	0.9160711	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.1684634	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.1165395	95% Adjusted-CLT UCL (Chen-1995)	2.1160237
		95% Modified-t UCL (Johnson-1978)	2.1196464

Gamma GOF Test

A-D Test Statistic	0.4543474	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7336079	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.1889384	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.2365100	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	13.220911	k star (bias corrected MLE)	10.221213
Theta hat (MLE)	0.1400462	Theta star (bias corrected MLE)	0.1811466
nu hat (MLE)	343.74367	nu star (bias corrected)	265.75154
MLE Mean (bias corrected)	1.8515385	MLE Sd (bias corrected)	0.5791373
		Approximate Chi Square Value (0.05)	229.00110
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	224.14032

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.1486761	95% Adjusted Gamma UCL (use when n<50)	2.1952731

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9301548	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.1846655	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.1823216	Mean of logged Data	0.5777215
Maximum of Logged Data	1.0438041	SD of logged Data	0.2875484

Assuming Lognormal Distribution

95% H-UCL	2.1741878	90% Chebyshev (MVUE) UCL	2.2980673
95% Chebyshev (MVUE) UCL	2.5005285	97.5% Chebyshev (MVUE) UCL	2.7815367
99% Chebyshev (MVUE) UCL	3.3335229		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	2.0961050	95% Jackknife UCL	2.1165395
95% Standard Bootstrap UCL	2.0830699	95% Bootstrap-t UCL	2.1405087
95% Hall's Bootstrap UCL	2.0934862	95% Percentile Bootstrap UCL	2.0892308
95% BCA Bootstrap UCL	2.1184615		
90% Chebyshev(Mean, Sd) UCL	2.2975961	95% Chebyshev(Mean, Sd) UCL	2.4996452
97.5% Chebyshev(Mean, Sd) UCL	2.7800816	99% Chebyshev(Mean, Sd) UCL	3.3309444

Suggested UCL to Use

95% Student's-t UCL	2.1165395

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-238_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	11.000000
		Number of Missing Observations	0
Minimum	0.9000000	Mean	1.5323077
Maximum	2.5400000	Median	1.4400000
SD	0.5344024	Std. Error of Mean	0.1482166
Coefficient of Variation	0.3487566	Skewness	0.6169681

Normal GOF Test

Shapiro Wilk Test Statistic	0.9199173	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.1617934	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.7964722	95% Adjusted-CLT UCL (Chen-1995)	1.8032022
		95% Modified-t UCL (Johnson-1978)	1.8006993

Gamma GOF Test

A-D Test Statistic	0.3429497	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7340522	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.1496723	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.2368055	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	9.2871007	k star (bias corrected MLE)	7.1952057
Theta hat (MLE)	0.1649931	Theta star (bias corrected MLE)	0.2129623
nu hat (MLE)	241.46462	nu star (bias corrected)	187.07535
MLE Mean (bias corrected)	1.5323077	MLE Sd (bias corrected)	0.5712476
		Approximate Chi Square Value (0.05)	156.43590
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	152.44519

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.8324246	95% Adjusted Gamma UCL (use when n<50)	1.8803938

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9449261	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.1352232	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.105361	Mean of logged Data	0.3719717
Maximum of Logged Data	0.9321641	SD of logged Data	0.3433006

Assuming Lognormal Distribution

95% H-UCL	1.8662610	90% Chebyshev (MVUE) UCL	1.9744496
95% Chebyshev (MVUE) UCL	2.1751538	97.5% Chebyshev (MVUE) UCL	2.4537233
99% Chebyshev (MVUE) UCL	3.0009193		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.7761022	95% Jackknife UCL	1.7964722
95% Standard Bootstrap UCL	1.7646749	95% Bootstrap-t UCL	1.8491300
95% Hall's Bootstrap UCL	1.7942814	95% Percentile Bootstrap UCL	1.7715385
95% BCA Bootstrap UCL	1.7907692		
90% Chebyshev(Mean, Sd) UCL	1.9769573	95% Chebyshev(Mean, Sd) UCL	2.1783687
97.5% Chebyshev(Mean, Sd) UCL	2.4579198	99% Chebyshev(Mean, Sd) UCL	3.0070438

Suggested UCL to Use

95% Student's-t UCL	1.7964722

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-234_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
		Number of Missing Observations	0
Minimum	0.9900000	Mean	1.5130769
Maximum	2.4400000	Median	1.4200000
SD	0.4537140	Std. Error of Mean	0.1258376
Coefficient of Variation	0.2998618	Skewness	0.7433070

Normal GOF Test

Shapiro Wilk Test Statistic	0.9151272	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.1879082	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.7373558	95% Adjusted-CLT UCL (Chen-1995)	1.7477810
		95% Modified-t UCL (Johnson-1978)	1.7416795

Gamma GOF Test

A-D Test Statistic	0.3956690	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7336234	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1858769	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.2365322	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	12.844507	k star (bias corrected MLE)	9.9316719
Theta hat (MLE)	0.1177995	Theta star (bias corrected MLE)	0.1523487
nu hat (MLE)	333.95718	nu star (bias corrected)	258.22347
MLE Mean (bias corrected)	1.5130769	MLE Sd (bias corrected)	0.4801200
		Approximate Chi Square Value (0.05)	222.01447
Adjusted Level of Significance	0.0300900	Adjusted Chi Square Value	217.23080

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.7598491	95% Adjusted Gamma UCL (use when n<50)	1.7986031

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9397756	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.8660000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1711423	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.2337000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.010050	Mean of logged Data	0.3747133
Maximum of Logged Data	0.8919980	SD of logged Data	0.2890148

Assuming Lognormal Distribution

95% H-UCL	1.7770872	90% Chebyshev (MVUE) UCL	1.8784694
95% Chebyshev (MVUE) UCL	2.0446549	97.5% Chebyshev (MVUE) UCL	2.2753139
99% Chebyshev (MVUE) UCL	2.7283989		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.7200614	95% Jackknife UCL	1.7373558
95% Standard Bootstrap UCL	1.7110899	95% Bootstrap-t UCL	1.7724650
95% Hall's Bootstrap UCL	1.7439659	95% Percentile Bootstrap UCL	1.7192308
95% BCA Bootstrap UCL	1.7484615		
90% Chebyshev(Mean, Sd) UCL	1.8905898	95% Chebyshev(Mean, Sd) UCL	2.0615904
97.5% Chebyshev(Mean, Sd) UCL	2.2989327	99% Chebyshev(Mean, Sd) UCL	2.7651455

Suggested UCL to Use

95% Student's-t UCL	1.7373558

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-235_0-0.5

General Statistics

Total Number of Observations	13.000000	Number of Distinct Observations	13.000000
Number of Detects	6.0000000	Number of Non-Detects	7.0000000
Number of Distinct Detects	6.0000000	Number of Distinct Non-Detects	7.0000000
Minimum Detect	0.0770000	Minimum Non-Detect	0.0680000
Maximum Detect	0.1110000	Maximum Non-Detect	0.0920000
Variance Detects	1.5680E-4	Percent Non-Detects	53.846154%
Mean Detects	0.0920000	SD Detects	0.0125220
Median Detects	0.0875000	CV Detects	0.1361085
Skewness Detects	0.6738151	Kurtosis Detects	-0.619420
Mean of Logged Detects	-2.393479	SD of Logged Detects	0.1334082

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.9108725	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.7880000	Detected Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.2919696	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.3245000	Detected Data appear Normal at 5% Significance Level	

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0806282	KM Standard Error of Mean	0.0043957
KM SD	0.0137993	95% KM (BCA) UCL	0.0890220
95% KM (t) UCL	0.0884627	95% KM (Percentile Bootstrap) UCL	0.0879846
95% KM (z) UCL	0.0878585	95% KM Bootstrap t UCL	0.0867025
90% KM Chebyshev UCL	0.0938154	95% KM Chebyshev UCL	0.0997887
97.5% KM Chebyshev UCL	0.1080795	99% KM Chebyshev UCL	0.1243651

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.3981075	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.6966559	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.2919767	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.3317197	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	66.722547	k star (bias corrected MLE)	33.472385
Theta hat (MLE)	0.0013788	Theta star (bias corrected MLE)	0.0027485
nu hat (MLE)	800.67056	nu star (bias corrected)	401.66862
Mean (detects)	0.0920000		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0622192	Mean	0.0782892
Maximum	0.1110000	Median	0.0733020
SD	0.0158806	CV	0.2028453
k hat (MLE)	28.223936	k star (bias corrected MLE)	21.762002
Theta hat (MLE)	0.0027739	Theta star (bias corrected MLE)	0.0035975
nu hat (MLE)	733.82235	nu star (bias corrected)	565.81206
Adjusted Level of Significance (β)	0.0300900		
Approximate Chi Square Value (565.81, α)	511.63994	Adjusted Chi Square Value (565.81, β)	504.29671
95% Gamma Approximate UCL (use when n>=50)	0.0865784	95% Gamma Adjusted UCL (use when n<50)	0.0878391

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0806282	SD (KM)	0.0137993
Variance (KM)	1.9042E-4	SE of Mean (KM)	0.0043957
k hat (KM)	34.139549	k star (KM)	26.312474
nu hat (KM)	887.62827	nu star (KM)	684.12431
theta hat (KM)	0.0023617	theta star (KM)	0.0030643
80% gamma percentile (KM)	0.0934726	90% gamma percentile (KM)	0.1013137
95% gamma percentile (KM)	0.1081041	99% gamma percentile (KM)	0.1216253

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (684.12, α)	624.43950	Adjusted Chi Square Value (684.12, β)	616.31043
95% Gamma Approximate KM-UCL (use when n>=50)	0.0883348	95% Gamma Adjusted KM-UCL (use when n<50)	0.0894999

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.9244038	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.7880000	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.2757342	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.3245000	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0794665	Mean in Log Scale	-2.547310
SD in Original Scale	0.0148199	SD in Log Scale	0.1764192
95% t UCL (assumes normality of ROS data)	0.0867922	95% Percentile Bootstrap UCL	0.0859002
95% BCA Bootstrap UCL	0.0874143	95% Bootstrap t UCL	0.0895677
95% H-UCL (Log ROS)	0.0872123		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.531599	KM Geo Mean	0.0795317
KM SD (logged)	0.1628379	95% Critical H Value (KM-Log)	1.8037003
KM Standard Error of Mean (logged)	0.0524654	95% H-UCL (KM -Log)	0.0877245
KM SD (logged)	0.1628379	95% Critical H Value (KM-Log)	1.8037003
KM Standard Error of Mean (logged)	0.0524654		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0636923	Mean in Log Scale	-2.848837
SD in Original Scale	0.0286389	SD in Log Scale	0.4547314
95% t UCL (Assumes normality)	0.0778490	95% H-Stat UCL	0.0841692

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0884627

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Antimony_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	19.000000
Number of Detects	21.000000	Number of Non-Detects	29.000000
Number of Distinct Detects	12.000000	Number of Distinct Non-Detects	8.0000000
Minimum Detect	0.1000000	Minimum Non-Detect	0.0930000
Maximum Detect	0.7300000	Maximum Non-Detect	0.1000000
Variance Detects	0.0189462	Percent Non-Detects	58.000000%
Mean Detects	0.1980952	SD Detects	0.1376452
Median Detects	0.1500000	CV Detects	0.6948434
Skewness Detects	3.1849206	Kurtosis Detects	11.716509
Mean of Logged Detects	-1.750075	SD of Logged Detects	0.4656034

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.6096121	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.9080000	Detected Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.2665812	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.1881000	Detected Data Not Normal at 5% Significance Level	

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.1371400	KM Standard Error of Mean	0.0146850
KM SD	0.1013363	95% KM (BCA) UCL	0.1656000
95% KM (t) UCL	0.1617602	95% KM (Percentile Bootstrap) UCL	0.1627200
95% KM (z) UCL	0.1612947	95% KM Bootstrap t UCL	0.1834355
90% KM Chebyshev UCL	0.1811951	95% KM Chebyshev UCL	0.2011505
97.5% KM Chebyshev UCL	0.2288479	99% KM Chebyshev UCL	0.2832541

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	1.5652070	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.7473555	Detected Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.2589539	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.1902973	Detected Data Not Gamma Distributed at 5% Significance Level	

Detected Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	3.9738356	k star (bias corrected MLE)	3.4378909
Theta hat (MLE)	0.0498499	Theta star (bias corrected MLE)	0.0576212
nu hat (MLE)	166.90110	nu star (bias corrected)	144.39142
Mean (detects)	0.1980952		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0100000	Mean	0.0894650
Maximum	0.7300000	Median	0.0100000
SD	0.1282994	CV	1.4340729
k hat (MLE)	0.6352854	k star (bias corrected MLE)	0.6105016
Theta hat (MLE)	0.1408265	Theta star (bias corrected MLE)	0.1465435
nu hat (MLE)	63.528543	nu star (bias corrected)	61.050164
Adjusted Level of Significance (β)	0.0452000		
Approximate Chi Square Value (61.05, α)	44.080573	Adjusted Chi Square Value (61.05, β)	43.652133
95% Gamma Approximate UCL (use when n>=50)	0.1239062	95% Gamma Adjusted UCL (use when n<50)	0.1251223

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.1371400	SD (KM)	0.1013363
Variance (KM)	0.0102690	SE of Mean (KM)	0.0146850
k hat (KM)	1.8314642	k star (KM)	1.7349097
nu hat (KM)	183.14642	nu star (KM)	173.49097
theta hat (KM)	0.0748800	theta star (KM)	0.0790473
80% gamma percentile (KM)	0.2087473	90% gamma percentile (KM)	0.2758855
95% gamma percentile (KM)	0.3404825	99% gamma percentile (KM)	0.4850065

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (173.49, α)	144.02996	Adjusted Chi Square Value (173.49, β)	143.23497
95% Gamma Approximate KM-UCL (use when n>=50)	0.1651917	95% Gamma Adjusted KM-UCL (use when n<50)	0.1661085

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.8446517	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.9080000	Detected Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.2429765	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.1881000	Detected Data Not Lognormal at 5% Significance Level	

Detected Data Not Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.1115757	Mean in Log Scale	-2.525997
SD in Original Scale	0.1159390	SD in Log Scale	0.7897495
95% t UCL (assumes normality of ROS data)	0.1390648	95% Percentile Bootstrap UCL	0.1409505
95% BCA Bootstrap UCL	0.1528939	95% Bootstrap t UCL	0.1570807
95% H-UCL (Log ROS)	0.1388798		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.112622	KM Geo Mean	0.1209205
KM SD (logged)	0.4264920	95% Critical H Value (KM-Log)	1.8400394
KM Standard Error of Mean (logged)	0.0618046	95% H-UCL (KM -Log)	0.1481448
KM SD (logged)	0.4264920	95% Critical H Value (KM-Log)	1.8400394
KM Standard Error of Mean (logged)	0.0618046		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.1116100	Mean in Log Scale	-2.484648
SD in Original Scale	0.1151557	SD in Log Scale	0.6982474
95% t UCL (Assumes normality)	0.1389134	95% H-Stat UCL	0.1303222

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.1617602	KM H-UCL	0.1481448
95% KM (BCA) UCL	0.1656000		

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Arsenic_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	27.000000
		Number of Missing Observations	0
Minimum	0.4800000	Mean	1.6902000
Maximum	4.5000000	Median	1.7000000
SD	0.8094203	Std. Error of Mean	0.1144693
Coefficient of Variation	0.4788902	Skewness	1.2405715

Normal GOF Test

Shapiro Wilk Test Statistic	0.9140182	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.1309551	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.8821136	95% Adjusted-CLT UCL (Chen-1995)	1.8999441
		95% Modified-t UCL (Johnson-1978)	1.8854608

Gamma GOF Test

A-D Test Statistic	0.3654505	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7536273	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0946787	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.1256156	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	4.7152782	k star (bias corrected MLE)	4.4456948
Theta hat (MLE)	0.3584518	Theta star (bias corrected MLE)	0.3801880
nu hat (MLE)	471.52782	nu star (bias corrected)	444.56948
MLE Mean (bias corrected)	1.6902000	MLE Sd (bias corrected)	0.8016195
		Approximate Chi Square Value (0.05)	396.68559
Adjusted Level of Significance	0.0452000	Adjusted Chi Square Value	395.34876

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1.8942239	95% Adjusted Gamma UCL (use when n<50)	1.9006291

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9736216	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1194205	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.733969	Mean of logged Data	0.4150771
Maximum of Logged Data	1.5040774	SD of logged Data	0.4839019

Assuming Lognormal Distribution

95% H-UCL	1.9385562	90% Chebyshev (MVUE) UCL	2.0633059
95% Chebyshev (MVUE) UCL	2.2286939	97.5% Chebyshev (MVUE) UCL	2.4582461
99% Chebyshev (MVUE) UCL	2.9091569		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.8784853	95% Jackknife UCL	1.8821136
95% Standard Bootstrap UCL	1.8727763	95% Bootstrap-t UCL	1.9184606
95% Hall's Bootstrap UCL	1.9198110	95% Percentile Bootstrap UCL	1.8782000
95% BCA Bootstrap UCL	1.8986000		
90% Chebyshev(Mean, Sd) UCL	2.0336079	95% Chebyshev(Mean, Sd) UCL	2.1891602
97.5% Chebyshev(Mean, Sd) UCL	2.4050606	99% Chebyshev(Mean, Sd) UCL	2.8291553

Suggested UCL to Use

95% Approximate Gamma UCL	1.8942239

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Copper_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	43.000000
		Number of Missing Observations	0
Minimum	7.6000000	Mean	181.09200
Maximum	710.00000	Median	120.00000
SD	168.58372	Std. Error of Mean	23.841339
Coefficient of Variation	0.9309286	Skewness	1.2663417

Normal GOF Test

Shapiro Wilk Test Statistic	0.8545971	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.9470000	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.1814674	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.1246000	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	221.06322	95% Adjusted-CLT UCL (Chen-1995)	224.86974
		95% Modified-t UCL (Johnson-1978)	221.77483

Gamma GOF Test

A-D Test Statistic	0.4391626	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7768424	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0757808	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.1285773	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	1.1224520	k star (bias corrected MLE)	1.0684382
Theta hat (MLE)	161.33607	Theta star (bias corrected MLE)	169.49225
nu hat (MLE)	112.24520	nu star (bias corrected)	106.84382
MLE Mean (bias corrected)	181.09200	MLE Sd (bias corrected)	175.19615
		Approximate Chi Square Value (0.05)	83.988755
Adjusted Level of Significance	0.0452000	Adjusted Chi Square Value	83.387792

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	230.37086	95% Adjusted Gamma UCL (use when n<50)	232.03111

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9575496	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.9470000	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0943283	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.1246000	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	2.0281482	Mean of logged Data	4.6914543
Maximum of Logged Data	6.5652650	SD of logged Data	1.1191627

Assuming Lognormal Distribution

95% H-UCL	302.94205	90% Chebyshev (MVUE) UCL	314.98715
95% Chebyshev (MVUE) UCL	367.09896	97.5% Chebyshev (MVUE) UCL	439.42812
99% Chebyshev (MVUE) UCL	581.50477		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	220.30751	95% Jackknife UCL	221.06322
95% Standard Bootstrap UCL	220.12113	95% Bootstrap-t UCL	224.69712
95% Hall's Bootstrap UCL	226.40478	95% Percentile Bootstrap UCL	222.44000
95% BCA Bootstrap UCL	224.67200		
90% Chebyshev(Mean, Sd) UCL	252.61602	95% Chebyshev(Mean, Sd) UCL	285.01399
97.5% Chebyshev(Mean, Sd) UCL	329.98111	99% Chebyshev(Mean, Sd) UCL	418.31033

Suggested UCL to Use

95% Approximate Gamma UCL	230.37086

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Lead_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	34.000000
		Number of Missing Observations	0
Minimum	0.7800000	Mean	4.5042000
Maximum	8.7000000	Median	4.3500000
SD	2.2483210	Std. Error of Mean	0.3179606
Coefficient of Variation	0.4991610	Skewness	0.1264981

Normal GOF Test

Shapiro Wilk Test Statistic	0.9522028	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0724341	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data appear Normal at 5% Significance Level	

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	5.0372771	95% Adjusted-CLT UCL (Chen-1995)	5.0332765
		95% Modified-t UCL (Johnson-1978)	5.0382251

Gamma GOF Test

A-D Test Statistic	0.7385706	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7561603	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1017560	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.1260872	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.2234404	k star (bias corrected MLE)	3.0433673
Theta hat (MLE)	1.3973269	Theta star (bias corrected MLE)	1.4800054
nu hat (MLE)	322.34404	nu star (bias corrected)	304.33673
MLE Mean (bias corrected)	4.5042000	MLE Sd (bias corrected)	2.5819063
		Approximate Chi Square Value (0.05)	264.92446
Adjusted Level of Significance	0.0452000	Adjusted Chi Square Value	263.83687

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	5.1742806	95% Adjusted Gamma UCL (use when n<50)	5.1956101

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9051394	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.1329769	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data Not Lognormal at 5% Significance Level	

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.248461	Mean of logged Data	1.3419504
Maximum of Logged Data	2.1633230	SD of logged Data	0.6341904

Assuming Lognormal Distribution

95% H-UCL	5.6035970	90% Chebyshev (MVUE) UCL	6.0080257
95% Chebyshev (MVUE) UCL	6.6202024	97.5% Chebyshev (MVUE) UCL	7.4698799
99% Chebyshev (MVUE) UCL	9.1389069		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	5.0271987	95% Jackknife UCL	5.0372771
95% Standard Bootstrap UCL	5.0162659	95% Bootstrap-t UCL	5.0351754
95% Hall's Bootstrap UCL	5.0158563	95% Percentile Bootstrap UCL	5.0372000
95% BCA Bootstrap UCL	4.9952000		
90% Chebyshev(Mean, Sd) UCL	5.4580818	95% Chebyshev(Mean, Sd) UCL	5.8901581
97.5% Chebyshev(Mean, Sd) UCL	6.4898633	99% Chebyshev(Mean, Sd) UCL	7.6678681

Suggested UCL to Use

95% Student's-t UCL	5.0372771

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Molybdenum_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	42.000000
		Number of Missing Observations	0
Minimum	0.9300000	Mean	19.962600
Maximum	270.00000	Median	7.0500000
SD	40.607754	Std. Error of Mean	5.7428037
Coefficient of Variation	2.0341916	Skewness	5.0752190

Normal GOF Test

Shapiro Wilk Test Statistic	0.4616757	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.3196443	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data Not Normal at 5% Significance Level	

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	29.590702	95% Adjusted-CLT UCL (Chen-1995)	33.812944
		95% Modified-t UCL (Johnson-1978)	30.277679

Gamma GOF Test

A-D Test Statistic	2.0590565	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7991403	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.1749876	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.1309391	Data Not Gamma Distributed at 5% Significance Level	

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.6808048	k star (bias corrected MLE)	0.6532898
Theta hat (MLE)	29.322061	Theta star (bias corrected MLE)	30.557034
nu hat (MLE)	68.080479	nu star (bias corrected)	65.328984
MLE Mean (bias corrected)	19.962600	MLE Sd (bias corrected)	24.698135
		Approximate Chi Square Value (0.05)	47.731030
Adjusted Level of Significance	0.0452000	Adjusted Chi Square Value	47.284196

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	27.322612	95% Adjusted Gamma UCL (use when n<50)	27.580809

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9667804	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0918857	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.072571	Mean of logged Data	2.1026996
Maximum of Logged Data	5.5984220	SD of logged Data	1.2634247

Assuming Lognormal Distribution

95% H-UCL	29.316836	90% Chebyshev (MVUE) UCL	29.606961
95% Chebyshev (MVUE) UCL	35.002448	97.5% Chebyshev (MVUE) UCL	42.491174
99% Chebyshev (MVUE) UCL	57.201327		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	29.408671	95% Jackknife UCL	29.590702
95% Standard Bootstrap UCL	29.328842	95% Bootstrap-t UCL	40.861368
95% Hall's Bootstrap UCL	65.968575	95% Percentile Bootstrap UCL	29.782000
95% BCA Bootstrap UCL	35.891800		
90% Chebyshev(Mean, Sd) UCL	37.191011	95% Chebyshev(Mean, Sd) UCL	44.994901
97.5% Chebyshev(Mean, Sd) UCL	55.826397	99% Chebyshev(Mean, Sd) UCL	77.102775

Suggested UCL to Use

95% H-UCL	29.316836

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

ProUCL computes and outputs H-statistic based UCLs for historical reasons only.
H-statistic often results in unstable (both high and low) values of UCL95 as shown in examples in the Technical Guide.
It is therefore recommended to avoid the use of H-statistic based 95% UCLs.
Use of nonparametric methods are preferred to compute UCL95 for skewed data sets which do not follow a gamma distribution.

Uranium_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	35.000000
		Number of Missing Observations	0
Minimum	0.6700000	Mean	2.7608000
Maximum	8.0000000	Median	2.6000000
SD	1.4836591	Std. Error of Mean	0.2098211
Coefficient of Variation	0.5374019	Skewness	1.1038790

Normal GOF Test

Shapiro Wilk Test Statistic	0.9275339	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.0991058	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data appear Normal at 5% Significance Level	

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	3.1125757	95% Adjusted-CLT UCL (Chen-1995)	3.1409248
		95% Modified-t UCL (Johnson-1978)	3.1180350

Gamma GOF Test

A-D Test Statistic	0.2304147	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.7546464	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.0693225	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.1258824	Detected data appear Gamma Distributed at 5% Significance Level	

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.6686979	k star (bias corrected MLE)	3.4619094
Theta hat (MLE)	0.7525286	Theta star (bias corrected MLE)	0.7974790
nu hat (MLE)	366.86979	nu star (bias corrected)	346.19094
MLE Mean (bias corrected)	2.7608000	MLE Sd (bias corrected)	1.4838059
		Approximate Chi Square Value (0.05)	304.07615
Adjusted Level of Significance	0.0452000	Adjusted Chi Square Value	302.90906

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	3.1431730	95% Adjusted Gamma UCL (use when n<50)	3.1552835

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9775876	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.9470000	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.0791962	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.1246000	Data appear Lognormal at 5% Significance Level	

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.400478	Mean of logged Data	0.8730854
Maximum of Logged Data	2.0794415	SD of logged Data	0.5534494

Assuming Lognormal Distribution

95% H-UCL	3.2503602	90% Chebyshev (MVUE) UCL	3.4735793
95% Chebyshev (MVUE) UCL	3.7873871	97.5% Chebyshev (MVUE) UCL	4.2229402
99% Chebyshev (MVUE) UCL	5.0784998		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.1059250	95% Jackknife UCL	3.1125757
95% Standard Bootstrap UCL	3.1093388	95% Bootstrap-t UCL	3.1334485
95% Hall's Bootstrap UCL	3.1659087	95% Percentile Bootstrap UCL	3.1262000
95% BCA Bootstrap UCL	3.1468000		
90% Chebyshev(Mean, Sd) UCL	3.3902632	95% Chebyshev(Mean, Sd) UCL	3.6753889
97.5% Chebyshev(Mean, Sd) UCL	4.0711322	99% Chebyshev(Mean, Sd) UCL	4.8484934

Suggested UCL to Use

95% Student's-t UCL	3.1125757

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Radium-226_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	45.000000
		Number of Missing Observations	0
Minimum	0.9500000	Mean	2.3060000
Maximum	9.1000000	Median	1.9350000
SD	1.3143680	Std. Error of Mean	0.1858797
Coefficient of Variation	0.5699775	Skewness	3.5291519

Normal GOF Test

Shapiro Wilk Test Statistic	0.6513264	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.9470000	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.2082599	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.1246000	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.6176368	95% Adjusted-CLT UCL (Chen-1995)	2.7108732
		95% Modified-t UCL (Johnson-1978)	2.6330988

Gamma GOF Test

A-D Test Statistic	2.0413735	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7532907	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.1769030	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.1255367	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	5.4625573	k star (bias corrected MLE)	5.1481371
Theta hat (MLE)	0.4221466	Theta star (bias corrected MLE)	0.4479290
nu hat (MLE)	546.25573	nu star (bias corrected)	514.81371
MLE Mean (bias corrected)	2.3060000	MLE Sd (bias corrected)	1.0163288
		Approximate Chi Square Value (0.05)	463.19521
Adjusted Level of Significance	0.0452000	Adjusted Chi Square Value	461.74848

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	2.5629808	95% Adjusted Gamma UCL (use when n<50)	2.5710110

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9127220	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.9470000	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.1488436	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.1246000	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.051293	Mean of logged Data	0.7411987
Maximum of Logged Data	2.2082744	SD of logged Data	0.3983329

Assuming Lognormal Distribution

95% H-UCL	2.5205732	90% Chebyshev (MVUE) UCL	2.6635595
95% Chebyshev (MVUE) UCL	2.8428065	97.5% Chebyshev (MVUE) UCL	3.0915943
99% Chebyshev (MVUE) UCL	3.5802897		

Nonparametric Distribution Free UCL Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Distribution Free UCLs

95% CLT UCL	2.6117449	95% Jackknife UCL	2.6176368
95% Standard Bootstrap UCL	2.6126414	95% Bootstrap-t UCL	2.8691160
95% Hall's Bootstrap UCL	4.2292443	95% Percentile Bootstrap UCL	2.6112000
95% BCA Bootstrap UCL	2.7172000		
90% Chebyshev(Mean, Sd) UCL	2.8636391	95% Chebyshev(Mean, Sd) UCL	3.1162309
97.5% Chebyshev(Mean, Sd) UCL	3.4668184	99% Chebyshev(Mean, Sd) UCL	4.1554797

Suggested UCL to Use

95% Student's-t UCL	2.6176368	or 95% Modified-t UCL	2.6330988

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Radium-228_0-15

General Statistics

Total Number of Observations	50.000000	Number of Distinct Observations	39.000000
		Number of Missing Observations	0
Minimum	0.9700000	Mean	1.6816000
Maximum	2.8400000	Median	1.6650000
SD	0.3940960	Std. Error of Mean	0.0557336
Coefficient of Variation	0.2343578	Skewness	0.5535706

Normal GOF Test

Shapiro Wilk Test Statistic	0.9690242	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.9470000	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.1038669	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.1246000	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.7750402	95% Adjusted-CLT UCL (Chen-1995)	1.7779357
		95% Modified-t UCL (Johnson-1978)	1.7757674

Gamma GOF Test

A-D Test Statistic	0.2733365	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7483460	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0782128	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.1249722	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	18.805897	k star (bias corrected MLE)	17.690876
Theta hat (MLE)	0.0894188	Theta star (bias corrected MLE)	0.0950546
nu hat (MLE)	1880.5897	nu star (bias corrected)	1769.0876
MLE Mean (bias corrected)	1.6816000	MLE Sd (bias corrected)	0.3998048
		Approximate Chi Square Value (0.05)	1672.3977
Adjusted Level of Significance	0.0452000	Adjusted Chi Square Value	1669.6241

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.7788220	95% Adjusted Gamma UCL (use when n<50)	1.7817769

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.9794606	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.9470000	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.0836230	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.1246000	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.030459	Mean of logged Data	0.4929228
Maximum of Logged Data	1.0438041	SD of logged Data	0.2352761

Assuming Lognormal Distribution

95% H-UCL	1.7896491	90% Chebyshev (MVUE) UCL	1.8519288
95% Chebyshev (MVUE) UCL	1.9288638	97.5% Chebyshev (MVUE) UCL	2.0356465
99% Chebyshev (MVUE) UCL	2.2454006		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.7732736	95% Jackknife UCL	1.7750402
95% Standard Bootstrap UCL	1.7706372	95% Bootstrap-t UCL	1.7818764
95% Hall's Bootstrap UCL	1.7784893	95% Percentile Bootstrap UCL	1.7770000
95% BCA Bootstrap UCL	1.7846000		
90% Chebyshev(Mean, Sd) UCL	1.8488008	95% Chebyshev(Mean, Sd) UCL	1.9245371
97.5% Chebyshev(Mean, Sd) UCL	2.0296562	99% Chebyshev(Mean, Sd) UCL	2.2361423

Suggested UCL to Use

95% Student's-t UCL	1.7750402

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-238_0-2 (also 0-15)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	0.87	Mean	1.422
Maximum	2.54	Median	1.305
SD	0.466	Std. Error of Mean	0.0914
Coefficient of Variation	0.328	Skewness	0.753

Normal GOF Test

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.175	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.578	95% Adjusted-CLT UCL (Chen-1995)	1.587
		95% Modified-t UCL (Johnson-1978)	1.58

Gamma GOF Test

A-D Test Statistic	0.583	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.163	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.171	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.38	k star (bias corrected MLE)	9.211
Theta hat (MLE)	0.137	Theta star (bias corrected MLE)	0.154
nu hat (MLE)	539.9	nu star (bias corrected)	479
MLE Mean (bias corrected)	1.422	MLE Sd (bias corrected)	0.469
		Approximate Chi Square Value (0.05)	429.2
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	426.1

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50)	1.587	95% Adjusted Gamma UCL (use when n<50)	1.598

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.942	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.149	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.17	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.139	Mean of logged Data	0.303
Maximum of Logged Data	0.932	SD of logged Data	0.316

Assuming Lognormal Distribution

95% H-UCL	1.597	90% Chebyshev (MVUE) UCL	1.689
95% Chebyshev (MVUE) UCL	1.81	97.5% Chebyshev (MVUE) UCL	1.979
99% Chebyshev (MVUE) UCL	2.31		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.572	95% Jackknife UCL	1.578
95% Standard Bootstrap UCL	1.567	95% Bootstrap-t UCL	1.6
95% Hall's Bootstrap UCL	1.591	95% Percentile Bootstrap UCL	1.564
95% BCA Bootstrap UCL	1.591		
90% Chebyshev(Mean, Sd) UCL	1.696	95% Chebyshev(Mean, Sd) UCL	1.82
97.5% Chebyshev(Mean, Sd) UCL	1.992	99% Chebyshev(Mean, Sd) UCL	2.331

Suggested UCL to Use

95% Adjusted Gamma UCL	1.598

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-234_0-2 (also 0-15)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
		Number of Missing Observations	0
Minimum	0.77	Mean	1.464
Maximum	2.44	Median	1.33
SD	0.449	Std. Error of Mean	0.0881
Coefficient of Variation	0.307	Skewness	0.613

Normal GOF Test

Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.191	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.17	Data Not Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	1.615	95% Adjusted-CLT UCL (Chen-1995)	1.62
		95% Modified-t UCL (Johnson-1978)	1.616

Gamma GOF Test

A-D Test Statistic	0.516	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.744	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.173	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.171	Data Not Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics

k hat (MLE)	11.5	k star (bias corrected MLE)	10.2
Theta hat (MLE)	0.127	Theta star (bias corrected MLE)	0.144
nu hat (MLE)	597.9	nu star (bias corrected)	530.2
MLE Mean (bias corrected)	1.464	MLE Sd (bias corrected)	0.459
		Approximate Chi Square Value (0.05)	477.8
Adjusted Level of Significance	0.0398	Adjusted Chi Square Value	474.5

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	1.625	95% Adjusted Gamma UCL (use when n<50)	1.636

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.964	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.92	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.157	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.17	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.261	Mean of logged Data	0.337
Maximum of Logged Data	0.892	SD of logged Data	0.302

Assuming Lognormal Distribution

95% H-UCL	1.637	90% Chebyshev (MVUE) UCL	1.728
95% Chebyshev (MVUE) UCL	1.848	97.5% Chebyshev (MVUE) UCL	2.014
99% Chebyshev (MVUE) UCL	2.341		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.609	95% Jackknife UCL	1.615
95% Standard Bootstrap UCL	1.605	95% Bootstrap-t UCL	1.632
95% Hall's Bootstrap UCL	1.623	95% Percentile Bootstrap UCL	1.605
95% BCA Bootstrap UCL	1.619		
90% Chebyshev(Mean, Sd) UCL	1.729	95% Chebyshev(Mean, Sd) UCL	1.848
97.5% Chebyshev(Mean, Sd) UCL	2.014	99% Chebyshev(Mean, Sd) UCL	2.341

Suggested UCL to Use

95% Student's-t UCL	1.615

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Uranium-235_0-2 (also 0-15)

General Statistics

Total Number of Observations	26	Number of Distinct Observations	24
Number of Detects	13	Number of Non-Detects	13
Number of Distinct Detects	13	Number of Distinct Non-Detects	13
Minimum Detect	0.049	Minimum Non-Detect	0.032
Maximum Detect	0.19	Maximum Non-Detect	0.111
Variance Detects	0.00153	Percent Non-Detects	50%
Mean Detects	0.103	SD Detects	0.0391
Median Detects	0.088	CV Detects	0.381
Skewness Detects	1.068	Kurtosis Detects	0.94
Mean of Logged Detects	-2.34	SD of Logged Detects	0.366

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.914	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.188	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.234	Detected Data appear Normal at 5% Significance Level

Detected Data appear Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	0.0775	KM Standard Error of Mean	0.00881
KM SD	0.0387	95% KM (BCA) UCL	0.0935
95% KM (t) UCL	0.0926	95% KM (Percentile Bootstrap) UCL	0.0929
95% KM (z) UCL	0.092	95% KM Bootstrap t UCL	0.0929
90% KM Chebyshev UCL	0.104	95% KM Chebyshev UCL	0.116
97.5% KM Chebyshev UCL	0.133	99% KM Chebyshev UCL	0.165

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.304	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.735	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.159	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.237	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	8.143	k star (bias corrected MLE)	6.315
Theta hat (MLE)	0.0126	Theta star (bias corrected MLE)	0.0162
nu hat (MLE)	211.7	nu star (bias corrected)	164.2
Mean (detects)	0.103		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.0142	Mean	0.0733
Maximum	0.19	Median	0.0589
SD	0.0411	CV	0.562
k hat (MLE)	3.671	k star (bias corrected MLE)	3.273
Theta hat (MLE)	0.02	Theta star (bias corrected MLE)	0.0224
nu hat (MLE)	190.9	nu star (bias corrected)	170.2
Adjusted Level of Significance (β)	0.0398		
Approximate Chi Square Value (170.19, α)	141	Adjusted Chi Square Value (170.19, β)	139.3
95% Gamma Approximate UCL (use when n>=50)	0.0884	95% Gamma Adjusted UCL (use when n<50)	0.0895

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	0.0775	SD (KM)	0.0387
Variance (KM)	0.0015	SE of Mean (KM)	0.00881
k hat (KM)	4.008	k star (KM)	3.572
nu hat (KM)	208.4	nu star (KM)	185.7
theta hat (KM)	0.0193	theta star (KM)	0.0217
80% gamma percentile (KM)	0.108	90% gamma percentile (KM)	0.133
95% gamma percentile (KM)	0.155	99% gamma percentile (KM)	0.203

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (185.72, α)	155.2	Adjusted Chi Square Value (185.72, β)	153.4
95% Gamma Approximate KM-UCL (use when n>=50)	0.0928	95% Gamma Adjusted KM-UCL (use when n<50)	0.0939

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.866	Detected Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.136	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.234	Detected Data appear Lognormal at 5% Significance Level	

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	0.0775	Mean in Log Scale	-2.649
SD in Original Scale	0.0376	SD in Log Scale	0.418
95% t UCL (assumes normality of ROS data)	0.0901	95% Percentile Bootstrap UCL	0.0896
95% BCA Bootstrap UCL	0.0912	95% Bootstrap t UCL	0.0937
95% H-UCL (Log ROS)	0.0905		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	-2.674	KM Geo Mean	0.069
KM SD (logged)	0.484	95% Critical H Value (KM-Log)	1.952
KM Standard Error of Mean (logged)	0.128	95% H-UCL (KM -Log)	0.0937
KM SD (logged)	0.484	95% Critical H Value (KM-Log)	1.952
KM Standard Error of Mean (logged)	0.128		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	0.0711	Mean in Log Scale	-2.802
SD in Original Scale	0.0425	SD in Log Scale	0.574
95% t UCL (Assumes normality)	0.0853	95% H-Stat UCL	0.0904

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	0.0926

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

APPENDIX H

Excess Lifetime Cancer Risk and Hazard Index Calculations (Chemicals) using Mean EPCs

Appendix H, Table H-1 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.18E+01	1.40E+09 P	1.7E-06	1.2E-06	2.4E-09	3.0E-06	100%	1.2E-02	8.3E-03	1.2E-04	2.1E-02	17%
Copper	D	5.04E+03	1.40E+09 P	NA	NA	NA	–		9.7E-02	–	NA	9.7E-02	83%
Lead	B2	8.71E+01	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				2E-06	1E-06	2E-09			0.1	0.008	0.0001		
Total						**Total ELCR**	3E-06				**Total HI**	0.1	
						Group A Total ELCR	3E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-2 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.18E+01	1.40E+09 P	1.7E-06	1.2E-06	1.2E-09	3.0E-06	100%	1.2E-02	8.3E-03	5.8E-05	2.1E-02	17%
Copper	D	5.04E+03	1.40E+09 P	NA	NA	NA	–		9.7E-02	–	NA	9.7E-02	83%
Lead	B2	8.71E+01	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				2E-06	1E-06	1E-09			0.1	0.008	0.00006		
Total						**Total ELCR**	3E-06				**Total HI**	0.1	
						Group A Total ELCR	3E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-3 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former CLEAR Plant - Shallow Soil (0 to 0.5 ft bgs), Exposed Samples Only, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	1.18E+01	1.40E+09 P	1.5E-07	6.8E-08	2.8E-11	2.1E-07	100%	2.5E-03	1.2E-03	3.3E-06	3.7E-03	15%
Copper	D	5.04E+03	1.40E+09 P	NA	NA	NA	–		2.0E-02	–	NA	2.0E-02	85%
Lead	B2	8.71E+01	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-07	7E-08	3E-11			0.02	0.001	0.000003		
Total						**Total ELCR**	2E-07				**Total HI**	0.02	
						Group A Total ELCR	2E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix H, Table H-4 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples, Mean EPCs
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk				Percent	Route-Specific Hazard				Percent
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m³/kg)	Oral	Dermal	Inhalation	Total ELCR	Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.73E+00	1.40E+09 P	1.4E-06	9.9E-07	2.0E-09	2.4E-06	100%	1.0E-02	6.9E-03	9.5E-05	1.7E-02	18%
Copper	D	4.05E+03	1.40E+09 P	NA	NA	NA	–		7.8E-02	–	NA	7.8E-02	82%
Lead	B2	1.36E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-06	1E-06	2E-09			0.09	0.007	0.0001		
Total						**Total ELCR**	2E-06				**Total HI**	0.09	
						Group A Total ELCR	2E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-5 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples, Mean EPCs
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NON-CANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	9.73E+00	1.40E+09	P	1.4E-06	9.9E-07	9.9E-10	2.4E-06	100%	1.0E-02	6.9E-03	4.8E-05	1.7E-02	18%
Copper	D	4.05E+03	1.40E+09	P	NA	NA	NA	–		7.8E-02	–	NA	7.8E-02	82%
Lead	B2	1.36E+02	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
					1E-06	1E-06	1E-09			0.1	0.007	0.00005		
Total							**Total ELCR**	2E-06				**Total HI**	0.1	
							Group A Total ELCR	2E-06						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-6 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples, Mean EPCs
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.73E+00	1.40E+09 P	1.2E-07	5.6E-08	2.3E-11	1.8E-07	100%	2.1E-03	9.7E-04	2.8E-06	3.1E-03	16%
Copper	D	4.05E+03	1.40E+09 P	NA	NA	NA	–		1.6E-02	–	NA	1.6E-02	84%
Lead	B2	1.36E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-07	6E-08	2E-11			0.02	0.001	0.000003		
Total						**Total ELCR**	2E-07				**Total HI**	0.02	
						Group A Total ELCR	2E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)
HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix H, Table H-7 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m³/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.68E+00	1.40E+09 P	1.4E-06	9.9E-07	2.0E-09	2.4E-06	100%	9.9E-03	6.9E-03	9.5E-05	1.7E-02	18%
Copper	D	4.03E+03	1.40E+09 P	NA	NA	NA	–		7.8E-02	–	NA	7.8E-02	82%
Lead	B2	1.14E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-06	1E-06	2E-09			0.1	0.007	0.0001		
Total						**Total ELCR**	2E-06				**Total HI**	0.1	
						Group A Total ELCR	2E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-8 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.68E+00	1.40E+09 P	1.4E-06	9.9E-07	9.8E-10	2.4E-06	100%	9.9E-03	6.9E-03	4.7E-05	1.7E-02	18%
Copper	D	4.03E+03	1.40E+09 P	NA	NA	NA	–		7.8E-02	–	NA	7.8E-02	82%
Lead	B2	1.14E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				1E-06	1E-06	1E-09			0.1	0.007	0.0001		
Total						**Total ELCR**	2E-06				**Total HI**	0.1	
						Group A Total ELCR	2E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-9 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NON-CANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	9.68E+00	1.40E+09	P	1.2E-07	5.6E-08	2.3E-11	1.8E-07	100%	2.1E-03	9.7E-04	2.7E-06	3.1E-03	16%
Copper	D	4.03E+03	1.40E+09	P	NA	NA	NA	–		1.6E-02	–	NA	1.6E-02	84%
Lead	B2	1.14E+02	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
					1E-07	6E-08	2E-11			0.02	0.001	0.000003		
Total							**Total ELCR**	2E-07				**Total HI**	0.02	
							Group A Total ELCR	2E-07						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)
HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix H, Table H-10 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Construction Worker
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Sierrita Mine
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.68E+00	1.40E+09 P	2.1E-07	8.8E-08	8.7E-11	3.0E-07	100%	3.6E-02	1.5E-02	1.1E-04	5.2E-02	15%
Copper	D	4.03E+03	1.40E+09 P	NA	NA	NA	–		2.8E-01	–	NA	2.8E-01	85%
Lead	B2	1.14E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
				2E-07	9E-08	9E-11			0.3	0.02	0.0001		
Total						**Total ELCR**	3E-07				**Total HI**	0.3	
						Group A Total ELCR	3E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 330 x 250 x 1 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1 x IUR) / (28470)
HQo = (EPCs x 1 x 330 x 250 x 1 x RBA) / (1,000,000 x 80 x 365 x RfDo)
HQd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1) / (1,000,000 x 80 x 365 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1) / (365 x RfC)

Appendix H, Table H-11 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.54E+00	1.40E+09 P	1.4E-06	9.7E-07	1.9E-09	2.4E-06	100%	9.8E-03	6.8E-03	9.4E-05	1.7E-02	11%
Molybdenum	NA	8.57E+02	1.40E+09 P	NA	NA	NA	–		1.3E-01	–	NA	1.3E-01	89%
				1E-06	1E-06	2E-09			0.1	0.007	0.00009		
Total						**Total ELCR**	2E-06				**Total HI**	0.1	
						Group A Total ELCR	2E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-12 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Current/Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.54E+00	1.40E+09 P	1.4E-06	9.7E-07	9.7E-10	2.4E-06	100%	9.8E-03	6.8E-03	4.7E-05	1.7E-02	11%
Molybdenum	NA	8.57E+02	1.40E+09 P	NA	NA	NA	–		1.3E-01	–	NA	1.3E-01	89%
				1E-06	1E-06	1E-09			0.1	0.007	0.00005		
Total						**Total ELCR**	2E-06				**Total HI**	0.1	
						Group A Total ELCR	2E-06						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-13 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NONCANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	9.54E+00	1.40E+09 P	1.2E-07	5.5E-08	2.2E-11	1.7E-07	100%	2.1E-03	9.5E-04	2.7E-06	3.0E-03	10%
Molybdenum	NA	8.57E+02	1.40E+09 P	NA	NA	NA	–		2.8E-02	–	NA	2.8E-02	90%
				1E-07	5E-08	2E-11			0.03	0.001	0.000003		
Total						**Total ELCR**	2E-07				**Total HI**	0.03	
						Group A Total ELCR	2E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)
HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix H, Table H-14 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NONCANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	7.91E+00	1.40E+09	P	1.2E-06	8.1E-07	1.6E-09	2.0E-06	100%	8.1E-03	5.6E-03	7.8E-05	1.4E-02	13%
Lead	B2	1.16E+02	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	6.17E+02	1.40E+09	P	NA	NA	NA	–		9.5E-02	–	NA	9.5E-02	87%
					1E-06	8E-07	2E-09			0.1	0.006	0.00008		
Total							**Total ELCR**	2E-06				**Total HI**	0.1	
							Group A Total ELCR	2E-06						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25 x IUR) / (28470)

HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-15 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Outdoor Commercial/Industrial Worker
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NONCANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	7.91E+00	1.40E+09	P	1.2E-06	8.1E-07	8.0E-10	2.0E-06	100%	8.1E-03	5.6E-03	3.9E-05	1.4E-02	13%
Lead	B2	1.16E+02	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	6.17E+02	1.40E+09	P	NA	NA	NA	–		9.5E-02	–	NA	9.5E-02	87%
					1E-06	8E-07	8E-10			0.1	0.006	0.00004		
Total							**Total ELCR**	2E-06				**Total HI**	0.1	
							Group A Total ELCR	2E-06						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 100 x 225 x 25 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25 x IUR) / (28470)
HQo = (EPCs x 1 x 100 x 225 x 25 x RBA) / (1,000,000 x 80 x 9125 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 225 x 25) / (1,000,000 x 80 x 9125 x RfDa)
HQi = ([EPCs / PEF] x 4 x 0.042 x 225 x 25) / (9125 x RfC)

Appendix H, Table H-16 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Adolescent Trespasser
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK					NON-CANCER HAZARD				
				Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
				ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics													
Arsenic	A	7.91E+00	1.40E+09 P	9.9E-08	4.6E-08	1.9E-11	1.4E-07	100%	1.7E-03	7.9E-04	2.2E-06	2.5E-03	12%
Lead	B2	1.16E+02	1.40E+09 P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	6.17E+02	1.40E+09 P	NA	NA	NA	–		2.0E-02	–	NA	2.0E-02	100%
				1E-07	5E-08	2E-11			0.02	0.0008	0.000002		
Total						**Total ELCR**	1E-07				**Total HI**	0.02	
						Group A Total ELCR	1E-07						
						Group B Total ELCR	–						
						Group C Total ELCR	–						
						Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 50 x 52 x 10 x RBA x CSFo) / (1,000,000 x 44 x 28470)
ELCRd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10 x CSFa) / (1,000,000 x 44 x 28470)
ELCRi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10 x IUR) / (28470)

HQo = (EPCs x 1 x 50 x 52 x 10 x RBA) / (1,000,000 x 44 x 3650 x RfDo)
HQd = (EPCs x 4400 x 0.07 x ABSd x 52 x 10) / (1,000,000 x 44 x 3650 x RfDa)
HQi = ([EPCs / PEF] x 1 x 0.042 x 52 x 10) / (3650 x RfC)

Appendix H, Table H-17 (RME)
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Construction Worker
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

					CANCER RISK					NONCANCER HAZARD				
					Route-Specific Risk					Route-Specific Hazard				
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)		Oral	Dermal	Inhalation	Total ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	Total Hazard	Percent Total HI
					ELCRo	ELCRd	ELCRi			HQo	HQd	HQi		
Inorganics														
Arsenic	A	7.91E+00	1.40E+09	P	1.7E-07	7.2E-08	7.1E-11	2.4E-07	100%	3.0E-02	1.2E-02	8.6E-05	4.2E-02	11%
Lead	B2	1.16E+02	1.40E+09	P	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	6.17E+02	1.40E+09	P	NA	NA	NA	–		3.5E-01	–	NA	3.5E-01	89%
					2E-07	7E-08	7E-11			0.4	0.01	0.00009		
Total							**Total ELCR**	2E-07				**Total HI**	0.4	
							Group A Total ELCR	2E-07						
							Group B Total ELCR	–						
							Group C Total ELCR	–						
							Group D Total ELCR	–						

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:
ELCRo = (EPCs x 1 x 330 x 250 x 1 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1 x IUR) / (28470)
HQo = (EPCs x 1 x 330 x 250 x 1 x RBA) / (1,000,000 x 80 x 365 x RfDo)
HQd = (EPCs x 6125 x 0.30 x ABSd x 250 x 1) / (1,000,000 x 80 x 365 x RfDa)
HQi = ([EPCs / PEF] x 8 x 0.042 x 250 x 1) / (365 x RfC)

Appendix H, Table H-18
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Child/Adult Resident
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m^3/kg)	CANCER RISK: Age-Specific Risk for Carcinogenic Constituents						TOTAL CANCER RISK: Route-Specific Risk			Total	Percent Total
				1 through 6 years			27 years			33 years				
				Oral	Dermal	Inhalation	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation		
				ELCRo	ELCRd	ELCRi	ELCRo	ELCRd	ELCRi	ELCRo	ELCRd	ELCRi		
Inorganics														
Antimony	NA	3.96E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–	
Arsenic	A	9.68E+00	1.40E+09 P	4.6E-06	7.6E-07	2.2E-09	2.4E-06	1.7E-06	9.9E-09	7.0E-06	2.4E-06	1.2E-08	9.4E-06	100%
Copper	D	4.03E+03	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–	
Lead	B2	1.14E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–	
Molybdenum	NA	3.05E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–	
				5E-06	8E-07	2E-09	2E-06	2E-06	1E-08	7E-06	2E-06	1E-08		

Constituent	NONCANCER HAZARD: Route-Specific Hazard			Total Hazard (Child)	Percent Total HI (Child)	NONCANCER HAZARD: Route-Specific Hazard			Total Hazard (Adult)	Percent Total HI (Adult)
	1 through 6 years					27 years				
	Oral	Dermal	Inhalation			Oral	Dermal	Inhalation		
	HQo	HQd	HQi			HQo	HQd	HQi		
Inorganics										
Antimony	1.0E-01	–	NA	1.0E-01	5%	9.7E-03	–	NA	9.7E-03	5%
Arsenic	1.3E-01	2.2E-02	4.4E-04	1.5E-01	8%	1.3E-02	8.7E-03	3.6E-04	2.2E-02	11%
Copper	1.0E+00	–	NA	1.0E+00	54%	9.9E-02	–	NA	9.9E-02	52%
Lead	NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	6.2E-01	–	NA	6.2E-01	33%	6.0E-02	–	NA	6.0E-02	32%
	2	0.02	0.0004			0.2	0.009	0.0004		

Total **Total ELCR** 9E-06 **Total Child HI** **2** **Total Adult HI** 0.2

Group A Total ELCR	9E-06
Group B Total ELCR	–
Group C Total ELCR	–
Group D Total ELCR	–

HI (skin)	0.2
HI (circulatory)	0.9
HI (gastrointestinal)	1
HI (neurological)	0.0004
HI (development)	0.0004
HI (kidney)	0.6
HI (whole body)	0.8

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: Relative Bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table F-7. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

Child (1 through 6 years):
ELCRo = (EPCs x 1 x 200 x 350 x 6 x RBA x CSFo) / (1,000,000 x 19 x 28470)
ELCRd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6 x CSFa) / (1,000,000 x 19 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6 x IUR) / (28470)

Adult (7 through 33 years):
ELCRo = (EPCs x 1 x 100 x 350 x 27 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27 x IUR) / (28470)

Child (1 through 6 years):
HQo = (EPCs x 1 x 200 x 350 x 6 x RBA) / (1,000,000 x 19 x 2190 x RfDo)
HQd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6) / (1,000,000 x 19 x 2190 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6) / (2190 x RfC)

Adult (7 through 33 years):
HQo = (EPCs x 1 x 100 x 350 x 27 x RBA) / (1,000,000 x 80 x 12045 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27) / (1,000,000 x 80 x 12045 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27) / (12045 x RfC)

Appendix H, Table H-19
Excess Lifetime Cancer Risk and Noncancer Hazard Index Calculations for a Hypothetical Future Child/Adult Resident
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

				CANCER RISK						TOTAL CANCER RISK					NONCANCER HAZARD					NONCANCER HAZARD				
				Age-Specific Risk for Carcinogenic Constituents						Route-Specific Risk			Total		Route-Specific Hazard			Total		Route-Specific Hazard			Total	
				1 through 6 years			27 years			33 years					1 through 6 years			Hazard		27 years			Hazard	
Constituent	Cancer Group [a]	EPCs (mg/kg)	PEF [b] (m³/kg)	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation	Oral	Dermal	Inhalation	ELCR	Percent Total ELCR	Oral	Dermal	Inhalation	(Child)	Percent Total HI (Child)	Oral	Dermal	Inhalation	(Adult)	Percent Total HI (Adult)
				ELCRo	ELCRd	ELCRi	ELCRo	ELCRd	ELCRi	ELCRo	ELCRd	ELCRi			HQo	HQd	HQi			HQo	HQd	HQi		
Inorganics																								
Antimony	NA	2.33E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		5.9E-02	–	NA	5.9E-02	3%	5.7E-03	–	NA	5.7E-03	3%
Arsenic	A	7.91E+00	1.40E+09 P	3.7E-06	6.2E-07	1.8E-09	2.0E-06	1.4E-06	8.1E-09	5.7E-06	2.0E-06	9.9E-09	7.7E-06	100%	1.1E-01	1.8E-02	3.6E-04	1.3E-01	6%	1.0E-02	7.1E-03	3.0E-04	1.8E-02	8%
Copper	D	2.66E+03	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		6.8E-01	–	NA	6.8E-01	32%	6.5E-02	–	NA	6.5E-02	31%
Lead	B2	1.16E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		NA	NA	NA	–		NA	NA	NA	–	
Molybdenum	NA	6.17E+02	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		1.3E+00	–	NA	1.3E+00	59%	1.2E-01	–	NA	1.2E-01	57%
Uranium [c]	NA	5.39E+00	1.40E+09 P	NA	NA	NA	NA	NA	NA	–	–	–	–		1.8E-02	–	9.3E-05	1.8E-02	<1%	1.8E-03	–	7.6E-05	1.8E-03	<1%
				4E-06	6E-07	2E-09	2E-06	1E-06	8E-09	6E-06	2E-06	1E-08			2	0.02	0.0005			0.2	0.007	0.0004		
Total													**Total ELCR**	8E-06				**Total Child HI**	2				**Total Adult HI**	0.2
													Group A Total ELCR	8E-06				HI (developmental)	0.0004					
													Group B Total ELCR	–				HI (circulatory)	**2**					
													Group C Total ELCR	–				HI (skin)	0.1					
													Group D Total ELCR	–				HI (neurological)	0.0004					
																			HI (kidney)	1					
																			HI (whole body)	1					
																			HI (GI)	1					

Notes:
[a] United States Environmental Protection Agency (USEPA) cancer weight-of-evidence groups are as follows:
Group A: Human Carcinogen (sufficient evidence of carcinogenicity in humans).
Group B: Probable Human Carcinogen.
B1 - Limited evidence of carcinogenicity in humans.
B2 - Sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans.
Group C: Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data).
Group D: Not Classifiable as to Human Carcinogenicity (inadequate data or no evidence).
[b] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

–: not applicable.
%: percent.
ABSd: dermal absorption factor.
CSFa: dermal cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRd: excess lifetime cancer risk, dermal pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
HI: hazard index.
HQd: hazard quotient, dermal pathway.
HQi: hazard quotient, inhalation pathway.
HQo: hazard quotient, oral pathway.
IUR: inhalation unit risk.
m^3/kg: cubic meter(s) per kilogram.
mg/kg: milligram(s) per kilogram.
NA: not available or not applicable.
RBA: relative bioavailability.
RfC: reference concentration.
RfDa: dermal reference dose.
RfDo: oral reference dose.

Receptor-specific exposure parameters are presented in Table F-7. Constituent specific absorption parameters are presented in Table 6-2.
Constituent-specific toxicity values are presented in Table 7-1.

Equations:

Child (1 through 6 years):
ELCRo = (EPCs x 1 x 200 x 350 x 6 x RBA x CSFo) / (1,000,000 x 19 x 28470)
ELCRd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6 x CSFa) / (1,000,000 x 19 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6 x IUR) / (28470)

Adult (7 through 33 years):
ELCRo = (EPCs x 1 x 100 x 350 x 27 x RBA x CSFo) / (1,000,000 x 80 x 28470)
ELCRd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27 x CSFa) / (1,000,000 x 80 x 28470)
ELCRi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27 x IUR) / (28470)

Child (1 through 6 years):
HQo = (EPCs x 1 x 200 x 350 x 6 x RBA) / (1,000,000 x 19 x 2190 x RfDo)
HQd = (EPCs x 2350 x 0.19 x ABSd x 350 x 6) / (1,000,000 x 19 x 2190 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 6) / (2190 x RfC)

Adult (7 through 33 years):
HQo = (EPCs x 1 x 100 x 350 x 27 x RBA) / (1,000,000 x 80 x 12045 x RfDo)
HQd = (EPCs x 6125 x 0.15 x ABSd x 350 x 27) / (1,000,000 x 80 x 12045 x RfDa)
HQi = ([EPCs / PEF] x 24 x 0.042 x 350 x 27) / (12045 x RfC)

APPENDIX I

Excess Lifetime Cancer Risk Calculations (Radionuclides) using Mean EPCs

Appendix I, Table I-1 (RME)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.34E+00	1.40E+09	P	7.4E-08	4.5E-09	1.4E-06	1.5E-06	1%
Uranium-234	2.24E+00	1.40E+09	P	6.4E-08	5.0E-09	2.9E-09	7.2E-08	<1%
Thorium-230	2.24E+00	1.40E+09	P	9.7E-08	6.1E-09	9.7E-09	1.1E-07	<1%
Radium-226	1.94E+00	1.40E+09	P	3.2E-07	4.4E-09	8.3E-05	8.3E-05	61%
Lead-210	1.94E+00	1.40E+09	P	4.5E-07	1.7E-09	1.0E-08	4.6E-07	<1%
Bismuth-210	1.94E+00	1.40E+09	P	3.2E-12	5.7E-14	2.2E-11	2.5E-11	<1%
Polonium-210	1.94E+00	1.40E+09	P	3.4E-08	5.1E-11	9.8E-12	3.4E-08	<1%
Thorium-232	2.33E+00	1.40E+09	P	9.9E-07	1.6E-08	4.8E-05	4.9E-05	36%
Thorium-228	2.33E+00	1.40E+09	P	9.2E-09	2.7E-09	7.4E-09	1.9E-08	<1%
Radium-224	2.33E+00	1.40E+09	P	6.4E-11	1.2E-12	2.9E-10	3.6E-10	<1%
Lead-212	2.33E+00	1.40E+09	P	1.2E-12	8.4E-15	4.2E-10	4.2E-10	<1%
Bismuth-212	2.33E+00	1.40E+09	P	3.9E-15	1.0E-16	3.9E-11	3.9E-11	<1%
Thallium-208	2.33E+00	1.40E+09	P	NA	NA	7.0E-11	7.0E-11	<1%
Uranium-235	1.44E-01	1.40E+09	P	4.0E-09	2.9E-10	4.3E-07	4.3E-07	<1%
Protactinium-231	1.44E-01	1.40E+09	P	1.2E-08	8.8E-10	9.4E-08	1.1E-07	<1%
Actinium-227	1.44E-01	1.40E+09	P	1.1E-08	1.2E-09	1.0E-10	1.3E-08	<1%
Francium-223	1.44E-01	1.40E+09	P	9.5E-16	1.1E-18	2.4E-13	2.4E-13	<1%
Astatine-219	1.44E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.44E-01	1.40E+09	P	NA	NA	6.7E-13	6.7E-13	<1%
Thorium-227	1.44E-01	1.40E+09	P	4.9E-12	1.2E-12	9.7E-10	9.8E-10	<1%
Radium-223	1.44E-01	1.40E+09	P	1.8E-11	6.1E-13	9.2E-10	9.4E-10	<1%
Lead-211	1.44E-01	1.40E+09	P	8.4E-17	1.8E-18	8.5E-13	8.5E-13	<1%
Astatine-215	1.44E-01	1.40E+09	P	NA	NA	9.6E-23	9.6E-23	<1%
Bismuth-211	1.44E-01	1.40E+09	P	NA	NA	3.3E-14	3.3E-14	<1%
Thallium-207	1.44E-01	1.40E+09	P	NA	NA	6.2E-15	6.2E-15	<1%
Polonium-211	1.44E-01	1.40E+09	P	NA	NA	2.6E-17	2.6E-17	<1%
				2E-06	4E-08	1E-04		
Total						**Total ELCR**	1E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-2 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.34E+00	1.40E+09	P	7.4E-08	2.2E-09	7.1E-07	7.9E-07	1%
Uranium-234	2.24E+00	1.40E+09	P	6.4E-08	2.5E-09	1.5E-09	6.8E-08	<1%
Thorium-230	2.24E+00	1.40E+09	P	9.7E-08	3.1E-09	4.9E-09	1.1E-07	<1%
Radium-226	1.94E+00	1.40E+09	P	3.2E-07	2.2E-09	4.1E-05	4.2E-05	61%
Lead-210	1.94E+00	1.40E+09	P	4.5E-07	8.7E-10	5.1E-09	4.6E-07	<1%
Bismuth-210	1.94E+00	1.40E+09	P	3.2E-12	2.8E-14	1.1E-11	1.4E-11	<1%
Polonium-210	1.94E+00	1.40E+09	P	3.4E-08	2.6E-11	4.9E-12	3.4E-08	<1%
Thorium-232	2.33E+00	1.40E+09	P	9.9E-07	8.2E-09	2.4E-05	2.5E-05	37%
Thorium-228	2.33E+00	1.40E+09	P	9.2E-09	1.3E-09	3.7E-09	1.4E-08	<1%
Radium-224	2.33E+00	1.40E+09	P	6.4E-11	6.0E-13	1.5E-10	2.1E-10	<1%
Lead-212	2.33E+00	1.40E+09	P	1.2E-12	4.2E-15	2.1E-10	2.1E-10	<1%
Bismuth-212	2.33E+00	1.40E+09	P	3.9E-15	5.2E-17	2.0E-11	2.0E-11	<1%
Thallium-208	2.33E+00	1.40E+09	P	NA	NA	3.5E-11	3.5E-11	<1%
Uranium-235	1.44E-01	1.40E+09	P	4.0E-09	1.5E-10	2.1E-07	2.2E-07	<1%
Protactinium-231	1.44E-01	1.40E+09	P	1.2E-08	4.4E-10	4.7E-08	6.0E-08	<1%
Actinium-227	1.44E-01	1.40E+09	P	1.1E-08	6.0E-10	5.1E-11	1.2E-08	<1%
Francium-223	1.44E-01	1.40E+09	P	9.5E-16	5.7E-19	1.2E-13	1.2E-13	<1%
Astatine-219	1.44E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.44E-01	1.40E+09	P	NA	NA	3.3E-13	3.3E-13	<1%
Thorium-227	1.44E-01	1.40E+09	P	4.9E-12	6.0E-13	4.9E-10	4.9E-10	<1%
Radium-223	1.44E-01	1.40E+09	P	1.8E-11	3.0E-13	4.6E-10	4.8E-10	<1%
Lead-211	1.44E-01	1.40E+09	P	8.4E-17	9.2E-19	4.3E-13	4.3E-13	<1%
Astatine-215	1.44E-01	1.40E+09	P	NA	NA	4.8E-23	4.8E-23	<1%
Bismuth-211	1.44E-01	1.40E+09	P	NA	NA	1.7E-14	1.7E-14	<1%
Thallium-207	1.44E-01	1.40E+09	P	NA	NA	3.1E-15	3.1E-15	<1%
Polonium-211	1.44E-01	1.40E+09	P	NA	NA	1.3E-17	1.3E-17	<1%
				2E-06	2E-08	7E-05		
Total						**Total ELCR**	7E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
$ELCRo = (EPCs \times 100 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFo) / (1{,}000 \times 25 \times \lambda)$
$ELCRi = (EPCs \times 1{,}000 \times 60 \times 8 \times 0.042 \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFi) / (1.40E{+}09 \times 25 \times \lambda)$
$ELCRe = (EPCs \times ACF \times [(8 \times 0.042 \times 1) + (0 \times 0.042 \times 0.4)] \times 225 \times 25 \times [1 - \exp(-\lambda \times 25)] \times CSFe) / (365 \times 25 \times \lambda)$

Appendix I, Table I-3 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), Exposed Samples Only, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.34E+00	1.40E+09	P	3.4E-09	1.2E-11	1.7E-08	2.0E-08	1%
Uranium-234	2.24E+00	1.40E+09	P	3.0E-09	1.3E-11	3.4E-11	3.0E-09	<1%
Thorium-230	2.24E+00	1.40E+09	P	4.5E-09	1.6E-11	1.1E-10	4.6E-09	<1%
Radium-226	1.94E+00	1.40E+09	P	1.5E-08	1.2E-11	9.7E-07	9.8E-07	59%
Lead-210	1.94E+00	1.40E+09	P	2.6E-08	5.7E-12	1.5E-10	2.6E-08	2%
Bismuth-210	1.94E+00	1.40E+09	P	3.7E-13	3.8E-16	6.4E-13	1.0E-12	<1%
Polonium-210	1.94E+00	1.40E+09	P	4.0E-09	3.4E-13	2.9E-13	4.0E-09	<1%
Thorium-232	2.33E+00	1.40E+09	P	4.6E-08	4.3E-11	5.6E-07	6.1E-07	37%
Thorium-228	2.33E+00	1.40E+09	P	1.0E-09	1.7E-11	2.1E-10	1.3E-09	<1%
Radium-224	2.33E+00	1.40E+09	P	7.4E-12	7.9E-15	8.4E-12	1.6E-11	<1%
Lead-212	2.33E+00	1.40E+09	P	1.4E-13	5.6E-17	1.2E-11	1.2E-11	<1%
Bismuth-212	2.33E+00	1.40E+09	P	4.5E-16	6.9E-19	1.1E-12	1.1E-12	<1%
Thallium-208	2.33E+00	1.40E+09	P	NA	NA	2.0E-12	2.0E-12	<1%
Uranium-235	1.44E-01	1.40E+09	P	1.9E-10	7.7E-13	5.0E-09	5.2E-09	<1%
Protactinium-231	1.44E-01	1.40E+09	P	5.8E-10	2.3E-12	1.1E-09	1.7E-09	<1%
Actinium-227	1.44E-01	1.40E+09	P	6.4E-10	3.9E-12	1.5E-12	6.5E-10	<1%
Francium-223	1.44E-01	1.40E+09	P	1.1E-16	7.6E-21	7.0E-15	7.1E-15	<1%
Astatine-219	1.44E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.44E-01	1.40E+09	P	NA	NA	1.9E-14	1.9E-14	<1%
Thorium-227	1.44E-01	1.40E+09	P	5.7E-13	7.9E-15	2.8E-11	2.9E-11	<1%
Radium-223	1.44E-01	1.40E+09	P	2.1E-12	4.0E-15	2.7E-11	2.9E-11	<1%
Lead-211	1.44E-01	1.40E+09	P	9.8E-18	1.2E-20	2.5E-14	2.5E-14	<1%
Astatine-215	1.44E-01	1.40E+09	P	NA	NA	2.8E-24	2.8E-24	<1%
Bismuth-211	1.44E-01	1.40E+09	P	NA	NA	9.6E-16	9.6E-16	<1%
Thallium-207	1.44E-01	1.40E+09	P	NA	NA	1.8E-16	1.8E-16	<1%
Polonium-211	1.44E-01	1.40E+09	P	NA	NA	7.6E-19	7.6E-19	<1%
				1E-07	1E-10	2E-06		
Total						**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix I, Table I-4 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.63E+00	1.40E+09	P	8.3E-08	5.0E-09	1.6E-06	1.7E-06	1%
Uranium-234	2.53E+00	1.40E+09	P	7.3E-08	5.7E-09	3.3E-09	8.2E-08	<1%
Thorium-230	2.53E+00	1.40E+09	P	1.1E-07	6.9E-09	1.1E-08	1.3E-07	<1%
Radium-226	1.97E+00	1.40E+09	P	3.2E-07	4.4E-09	8.4E-05	8.4E-05	62%
Lead-210	1.97E+00	1.40E+09	P	4.6E-07	1.8E-09	1.0E-08	4.7E-07	<1%
Bismuth-210	1.97E+00	1.40E+09	P	3.3E-12	5.8E-14	2.2E-11	2.5E-11	<1%
Polonium-210	1.97E+00	1.40E+09	P	3.5E-08	5.2E-11	1.0E-11	3.5E-08	<1%
Thorium-232	2.32E+00	1.40E+09	P	9.8E-07	1.6E-08	4.8E-05	4.9E-05	36%
Thorium-228	2.32E+00	1.40E+09	P	9.2E-09	2.7E-09	7.4E-09	1.9E-08	<1%
Radium-224	2.32E+00	1.40E+09	P	6.4E-11	1.2E-12	2.9E-10	3.5E-10	<1%
Lead-212	2.32E+00	1.40E+09	P	1.2E-12	8.4E-15	4.1E-10	4.1E-10	<1%
Bismuth-212	2.32E+00	1.40E+09	P	3.8E-15	1.0E-16	3.9E-11	3.9E-11	<1%
Thallium-208	2.32E+00	1.40E+09	P	NA	NA	7.0E-11	7.0E-11	<1%
Uranium-235	1.69E-01	1.40E+09	P	4.8E-09	3.4E-10	5.0E-07	5.1E-07	<1%
Protactinium-231	1.69E-01	1.40E+09	P	1.5E-08	1.0E-09	1.1E-07	1.3E-07	<1%
Actinium-227	1.69E-01	1.40E+09	P	1.3E-08	1.4E-09	1.2E-10	1.5E-08	<1%
Francium-223	1.69E-01	1.40E+09	P	1.1E-15	1.3E-18	2.8E-13	2.8E-13	<1%
Astatine-219	1.69E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.69E-01	1.40E+09	P	NA	NA	7.8E-13	7.8E-13	<1%
Thorium-227	1.69E-01	1.40E+09	P	5.8E-12	1.4E-12	1.1E-09	1.1E-09	<1%
Radium-223	1.69E-01	1.40E+09	P	2.1E-11	7.1E-13	1.1E-09	1.1E-09	<1%
Lead-211	1.69E-01	1.40E+09	P	9.9E-17	2.2E-18	1.0E-12	1.0E-12	<1%
Astatine-215	1.69E-01	1.40E+09	P	NA	NA	1.1E-22	1.1E-22	<1%
Bismuth-211	1.69E-01	1.40E+09	P	NA	NA	3.9E-14	3.9E-14	<1%
Thallium-207	1.69E-01	1.40E+09	P	NA	NA	7.2E-15	7.2E-15	<1%
Polonium-211	1.69E-01	1.40E+09	P	NA	NA	3.1E-17	3.1E-17	<1%
				2E-06	5E-08	1E-04		
Total						**Total ELCR**	1E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-5 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.63E+00	1.40E+09	P	8.3E-08	2.5E-09	8.0E-07	8.9E-07	1%
Uranium-234	2.53E+00	1.40E+09	P	7.3E-08	2.9E-09	1.6E-09	7.7E-08	<1%
Thorium-230	2.53E+00	1.40E+09	P	1.1E-07	3.5E-09	5.5E-09	1.2E-07	<1%
Radium-226	1.97E+00	1.40E+09	P	3.2E-07	2.2E-09	4.2E-05	4.2E-05	61%
Lead-210	1.97E+00	1.40E+09	P	4.6E-07	8.8E-10	5.2E-09	4.7E-07	<1%
Bismuth-210	1.97E+00	1.40E+09	P	3.3E-12	2.9E-14	1.1E-11	1.4E-11	<1%
Polonium-210	1.97E+00	1.40E+09	P	3.5E-08	2.6E-11	5.0E-12	3.5E-08	<1%
Thorium-232	2.32E+00	1.40E+09	P	9.8E-07	8.1E-09	2.4E-05	2.5E-05	36%
Thorium-228	2.32E+00	1.40E+09	P	9.2E-09	1.3E-09	3.7E-09	1.4E-08	<1%
Radium-224	2.32E+00	1.40E+09	P	6.4E-11	5.9E-13	1.4E-10	2.1E-10	<1%
Lead-212	2.32E+00	1.40E+09	P	1.2E-12	4.2E-15	2.1E-10	2.1E-10	<1%
Bismuth-212	2.32E+00	1.40E+09	P	3.8E-15	5.2E-17	2.0E-11	2.0E-11	<1%
Thallium-208	2.32E+00	1.40E+09	P	NA	NA	3.5E-11	3.5E-11	<1%
Uranium-235	1.69E-01	1.40E+09	P	4.8E-09	1.7E-10	2.5E-07	2.5E-07	<1%
Protactinium-231	1.69E-01	1.40E+09	P	1.5E-08	5.2E-10	5.5E-08	7.0E-08	<1%
Actinium-227	1.69E-01	1.40E+09	P	1.3E-08	7.0E-10	5.9E-11	1.4E-08	<1%
Francium-223	1.69E-01	1.40E+09	P	1.1E-15	6.7E-19	1.4E-13	1.4E-13	<1%
Astatine-219	1.69E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.69E-01	1.40E+09	P	NA	NA	3.9E-13	3.9E-13	<1%
Thorium-227	1.69E-01	1.40E+09	P	5.8E-12	7.0E-13	5.7E-10	5.8E-10	<1%
Radium-223	1.69E-01	1.40E+09	P	2.1E-11	3.6E-13	5.4E-10	5.6E-10	<1%
Lead-211	1.69E-01	1.40E+09	P	9.9E-17	1.1E-18	5.0E-13	5.0E-13	<1%
Astatine-215	1.69E-01	1.40E+09	P	NA	NA	5.6E-23	5.6E-23	<1%
Bismuth-211	1.69E-01	1.40E+09	P	NA	NA	1.9E-14	1.9E-14	<1%
Thallium-207	1.69E-01	1.40E+09	P	NA	NA	3.6E-15	3.6E-15	<1%
Polonium-211	1.69E-01	1.40E+09	P	NA	NA	1.5E-17	1.5E-17	<1%
				2E-06	2E-08	7E-05		
Total						**Total ELCR**	7E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-6 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former CLEAR Plant - Shallow Soil/Sediment (0 to 0.5 ft bgs), All Samples, Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.63E+00	1.40E+09	P	3.8E-09	1.3E-11	1.9E-08	2.3E-08	1%
Uranium-234	2.53E+00	1.40E+09	P	3.4E-09	1.5E-11	3.8E-11	3.4E-09	<1%
Thorium-230	2.53E+00	1.40E+09	P	5.1E-09	1.8E-11	1.3E-10	5.2E-09	<1%
Radium-226	1.97E+00	1.40E+09	P	1.5E-08	1.2E-11	9.8E-07	1.0E-06	60%
Lead-210	1.97E+00	1.40E+09	P	2.6E-08	5.7E-12	1.5E-10	2.6E-08	2%
Bismuth-210	1.97E+00	1.40E+09	P	3.8E-13	3.8E-16	6.5E-13	1.0E-12	<1%
Polonium-210	1.97E+00	1.40E+09	P	4.0E-09	3.4E-13	2.9E-13	4.0E-09	<1%
Thorium-232	2.32E+00	1.40E+09	P	4.5E-08	4.3E-11	5.6E-07	6.1E-07	36%
Thorium-228	2.32E+00	1.40E+09	P	1.0E-09	1.7E-11	2.1E-10	1.3E-09	<1%
Radium-224	2.32E+00	1.40E+09	P	7.4E-12	7.8E-15	8.4E-12	1.6E-11	<1%
Lead-212	2.32E+00	1.40E+09	P	1.4E-13	5.5E-17	1.2E-11	1.2E-11	<1%
Bismuth-212	2.32E+00	1.40E+09	P	4.4E-16	6.9E-19	1.1E-12	1.1E-12	<1%
Thallium-208	2.32E+00	1.40E+09	P	NA	NA	2.0E-12	2.0E-12	<1%
Uranium-235	1.69E-01	1.40E+09	P	2.2E-10	9.0E-13	5.8E-09	6.0E-09	<1%
Protactinium-231	1.69E-01	1.40E+09	P	6.8E-10	2.7E-12	1.3E-09	2.0E-09	<1%
Actinium-227	1.69E-01	1.40E+09	P	7.6E-10	4.6E-12	1.7E-12	7.6E-10	<1%
Francium-223	1.69E-01	1.40E+09	P	1.3E-16	8.9E-21	8.2E-15	8.4E-15	<1%
Astatine-219	1.69E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.69E-01	1.40E+09	P	NA	NA	2.3E-14	2.3E-14	<1%
Thorium-227	1.69E-01	1.40E+09	P	6.7E-13	9.3E-15	3.3E-11	3.4E-11	<1%
Radium-223	1.69E-01	1.40E+09	P	2.4E-12	4.7E-15	3.2E-11	3.4E-11	<1%
Lead-211	1.69E-01	1.40E+09	P	1.1E-17	1.4E-20	2.9E-14	2.9E-14	<1%
Astatine-215	1.69E-01	1.40E+09	P	NA	NA	3.3E-24	3.3E-24	<1%
Bismuth-211	1.69E-01	1.40E+09	P	NA	NA	1.1E-15	1.1E-15	<1%
Thallium-207	1.69E-01	1.40E+09	P	NA	NA	2.1E-16	2.1E-16	<1%
Polonium-211	1.69E-01	1.40E+09	P	NA	NA	9.0E-19	9.0E-19	<1%
				1E-07	1E-10	2E-06		
Total						**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix I, Table I-7 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	8.7E-08	5.3E-09	1.7E-06	1.8E-06	1%
Uranium-234	2.68E+00	soil	1.40E+09	P	7.7E-08	6.0E-09	3.5E-09	8.7E-08	<1%
Thorium-230	2.68E+00	soil	1.40E+09	P	1.2E-07	7.3E-09	1.2E-08	1.4E-07	<1%
Radium-226	2.34E+00	soil	1.40E+09	P	3.9E-07	5.3E-09	1.0E-04	1.0E-04	66%
Lead-210	2.34E+00	soil	1.40E+09	P	5.5E-07	2.1E-09	1.2E-08	5.6E-07	<1%
Bismuth-210	2.34E+00	soil	1.40E+09	P	3.9E-12	6.9E-14	2.6E-11	3.0E-11	<1%
Polonium-210	2.34E+00	soil	1.40E+09	P	4.1E-08	6.2E-11	1.2E-11	4.2E-08	<1%
Thorium-232	2.30E+00	soil	1.40E+09	P	9.8E-07	1.6E-08	4.8E-05	4.9E-05	32%
Thorium-228	2.30E+00	soil	1.40E+09	P	9.1E-09	2.7E-09	7.3E-09	1.9E-08	<1%
Radium-224	2.30E+00	soil	1.40E+09	P	6.3E-11	1.2E-12	2.9E-10	3.5E-10	<1%
Lead-212	2.30E+00	soil	1.40E+09	P	1.2E-12	8.3E-15	4.1E-10	4.1E-10	<1%
Bismuth-212	2.30E+00	soil	1.40E+09	P	3.8E-15	1.0E-16	3.9E-11	3.9E-11	<1%
Thallium-208	2.30E+00	soil	1.40E+09	P	NA	NA	6.9E-11	6.9E-11	<1%
Uranium-235	1.68E-01	soil	1.40E+09	P	4.7E-09	3.4E-10	5.0E-07	5.0E-07	<1%
Protactinium-231	1.68E-01	soil	1.40E+09	P	1.5E-08	1.0E-09	1.1E-07	1.3E-07	<1%
Actinium-227	1.68E-01	soil	1.40E+09	P	1.3E-08	1.4E-09	1.2E-10	1.5E-08	<1%
Francium-223	1.68E-01	soil	1.40E+09	P	1.1E-15	1.3E-18	2.8E-13	2.8E-13	<1%
Astatine-219	1.68E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.68E-01	soil	1.40E+09	P	NA	NA	7.8E-13	7.8E-13	<1%
Thorium-227	1.68E-01	soil	1.40E+09	P	5.8E-12	1.4E-12	1.1E-09	1.1E-09	<1%
Radium-223	1.68E-01	soil	1.40E+09	P	2.1E-11	7.1E-13	1.1E-09	1.1E-09	<1%
Lead-211	1.68E-01	soil	1.40E+09	P	9.9E-17	2.1E-18	1.0E-12	1.0E-12	<1%
Astatine-215	1.68E-01	soil	1.40E+09	P	NA	NA	1.1E-22	1.1E-22	<1%
Bismuth-211	1.68E-01	soil	1.40E+09	P	NA	NA	3.9E-14	3.9E-14	<1%
Thallium-207	1.68E-01	soil	1.40E+09	P	NA	NA	7.2E-15	7.2E-15	<1%
Polonium-211	1.68E-01	soil	1.40E+09	P	NA	NA	3.1E-17	3.1E-17	<1%
					2E-06	5E-08	2E-04		
Total							**Total ELCR**	2E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-8 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	8.7E-08	2.6E-09	8.4E-07	9.3E-07	1%
Uranium-234	2.68E+00	soil	1.40E+09	P	7.7E-08	3.0E-09	1.7E-09	8.2E-08	<1%
Thorium-230	2.68E+00	soil	1.40E+09	P	1.2E-07	3.7E-09	5.8E-09	1.3E-07	<1%
Radium-226	2.34E+00	soil	1.40E+09	P	3.9E-07	2.6E-09	5.0E-05	5.0E-05	65%
Lead-210	2.34E+00	soil	1.40E+09	P	5.5E-07	1.0E-09	6.2E-09	5.5E-07	<1%
Bismuth-210	2.34E+00	soil	1.40E+09	P	3.9E-12	3.4E-14	1.3E-11	1.7E-11	<1%
Polonium-210	2.34E+00	soil	1.40E+09	P	4.1E-08	3.1E-11	5.9E-12	4.2E-08	<1%
Thorium-232	2.30E+00	soil	1.40E+09	P	9.8E-07	8.0E-09	2.4E-05	2.5E-05	32%
Thorium-228	2.30E+00	soil	1.40E+09	P	9.1E-09	1.3E-09	3.7E-09	1.4E-08	<1%
Radium-224	2.30E+00	soil	1.40E+09	P	6.3E-11	5.9E-13	1.4E-10	2.1E-10	<1%
Lead-212	2.30E+00	soil	1.40E+09	P	1.2E-12	4.1E-15	2.0E-10	2.1E-10	<1%
Bismuth-212	2.30E+00	soil	1.40E+09	P	3.8E-15	5.2E-17	1.9E-11	1.9E-11	<1%
Thallium-208	2.30E+00	soil	1.40E+09	P	NA	NA	3.5E-11	3.5E-11	<1%
Uranium-235	1.68E-01	soil	1.40E+09	P	4.7E-09	1.7E-10	2.5E-07	2.5E-07	<1%
Protactinium-231	1.68E-01	soil	1.40E+09	P	1.5E-08	5.1E-10	5.5E-08	7.0E-08	<1%
Actinium-227	1.68E-01	soil	1.40E+09	P	1.3E-08	7.0E-10	5.9E-11	1.4E-08	<1%
Francium-223	1.68E-01	soil	1.40E+09	P	1.1E-15	6.7E-19	1.4E-13	1.4E-13	<1%
Astatine-219	1.68E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.68E-01	soil	1.40E+09	P	NA	NA	3.9E-13	3.9E-13	<1%
Thorium-227	1.68E-01	soil	1.40E+09	P	5.8E-12	7.0E-13	5.7E-10	5.7E-10	<1%
Radium-223	1.68E-01	soil	1.40E+09	P	2.1E-11	3.5E-13	5.4E-10	5.6E-10	<1%
Lead-211	1.68E-01	soil	1.40E+09	P	9.9E-17	1.1E-18	5.0E-13	5.0E-13	<1%
Astatine-215	1.68E-01	soil	1.40E+09	P	NA	NA	5.6E-23	5.6E-23	<1%
Bismuth-211	1.68E-01	soil	1.40E+09	P	NA	NA	1.9E-14	1.9E-14	<1%
Thallium-207	1.68E-01	soil	1.40E+09	P	NA	NA	3.6E-15	3.6E-15	<1%
Polonium-211	1.68E-01	soil	1.40E+09	P	NA	NA	1.5E-17	1.5E-17	<1%
					2E-06	2E-08	8E-05		
Total							**Total ELCR**	8E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-9 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	4.0E-09	1.4E-11	2.0E-08	2.4E-08	1%
Uranium-234	2.68E+00	soil	1.40E+09	P	3.6E-09	1.6E-11	4.1E-11	3.6E-09	<1%
Thorium-230	2.68E+00	soil	1.40E+09	P	5.4E-09	1.9E-11	1.4E-10	5.5E-09	<1%
Radium-226	2.34E+00	soil	1.40E+09	P	1.8E-08	1.4E-11	1.2E-06	1.2E-06	64%
Lead-210	2.34E+00	soil	1.40E+09	P	3.1E-08	6.8E-12	1.8E-10	3.1E-08	2%
Bismuth-210	2.34E+00	soil	1.40E+09	P	4.5E-13	4.5E-16	7.7E-13	1.2E-12	<1%
Polonium-210	2.34E+00	soil	1.40E+09	P	4.8E-09	4.1E-13	3.5E-13	4.8E-09	<1%
Thorium-232	2.30E+00	soil	1.40E+09	P	4.5E-08	4.3E-11	5.6E-07	6.0E-07	32%
Thorium-228	2.30E+00	soil	1.40E+09	P	1.0E-09	1.7E-11	2.1E-10	1.2E-09	<1%
Radium-224	2.30E+00	soil	1.40E+09	P	7.3E-12	7.8E-15	8.3E-12	1.6E-11	<1%
Lead-212	2.30E+00	soil	1.40E+09	P	1.4E-13	5.5E-17	1.2E-11	1.2E-11	<1%
Bismuth-212	2.30E+00	soil	1.40E+09	P	4.4E-16	6.8E-19	1.1E-12	1.1E-12	<1%
Thallium-208	2.30E+00	soil	1.40E+09	P	NA	NA	2.0E-12	2.0E-12	<1%
Uranium-235	1.68E-01	soil	1.40E+09	P	2.2E-10	8.9E-13	5.8E-09	6.0E-09	<1%
Protactinium-231	1.68E-01	soil	1.40E+09	P	6.7E-10	2.7E-12	1.3E-09	2.0E-09	<1%
Actinium-227	1.68E-01	soil	1.40E+09	P	7.5E-10	4.6E-12	1.7E-12	7.6E-10	<1%
Francium-223	1.68E-01	soil	1.40E+09	P	1.3E-16	8.8E-21	8.2E-15	8.3E-15	<1%
Astatine-219	1.68E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.68E-01	soil	1.40E+09	P	NA	NA	2.3E-14	2.3E-14	<1%
Thorium-227	1.68E-01	soil	1.40E+09	P	6.6E-13	9.2E-15	3.3E-11	3.4E-11	<1%
Radium-223	1.68E-01	soil	1.40E+09	P	2.4E-12	4.7E-15	3.1E-11	3.4E-11	<1%
Lead-211	1.68E-01	soil	1.40E+09	P	1.1E-17	1.4E-20	2.9E-14	2.9E-14	<1%
Astatine-215	1.68E-01	soil	1.40E+09	P	NA	NA	3.3E-24	3.3E-24	<1%
Bismuth-211	1.68E-01	soil	1.40E+09	P	NA	NA	1.1E-15	1.1E-15	<1%
Thallium-207	1.68E-01	soil	1.40E+09	P	NA	NA	2.1E-16	2.1E-16	<1%
Polonium-211	1.68E-01	soil	1.40E+09	P	NA	NA	8.9E-19	8.9E-19	<1%
					1E-07	1E-10	2E-06		
Total							**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix I, Table I-10 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Construction Worker Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.76E+00	soil	1.40E+09	P	1.3E-08	2.3E-10	7.5E-08	8.8E-08	1%
Uranium-234	2.68E+00	soil	1.40E+09	P	1.1E-08	2.7E-10	1.5E-10	1.2E-08	<1%
Thorium-230	2.68E+00	soil	1.40E+09	P	1.7E-08	3.3E-10	5.2E-10	1.8E-08	<1%
Radium-226	2.34E+00	soil	1.40E+09	P	5.7E-08	2.4E-10	4.5E-06	4.5E-06	63%
Lead-210	2.34E+00	soil	1.40E+09	P	1.1E-07	1.3E-10	7.8E-10	1.1E-07	2%
Bismuth-210	2.34E+00	soil	1.40E+09	P	1.4E-11	7.6E-14	2.9E-11	4.4E-11	<1%
Polonium-210	2.34E+00	soil	1.40E+09	P	1.3E-07	5.8E-11	1.1E-11	1.3E-07	2%
Thorium-232	2.30E+00	soil	1.40E+09	P	1.4E-07	7.2E-10	2.1E-06	2.3E-06	31%
Thorium-228	2.30E+00	soil	1.40E+09	P	1.0E-08	9.0E-10	2.5E-09	1.4E-08	<1%
Radium-224	2.30E+00	soil	1.40E+09	P	2.3E-10	1.3E-12	3.2E-10	5.5E-10	<1%
Lead-212	2.30E+00	soil	1.40E+09	P	4.3E-12	9.2E-15	4.6E-10	4.6E-10	<1%
Bismuth-212	2.30E+00	soil	1.40E+09	P	1.4E-14	1.1E-16	4.3E-11	4.3E-11	<1%
Thallium-208	2.30E+00	soil	1.40E+09	P	NA	NA	7.7E-11	7.7E-11	<1%
Uranium-235	1.68E-01	soil	1.40E+09	P	6.9E-10	1.5E-11	2.2E-08	2.3E-08	<1%
Protactinium-231	1.68E-01	soil	1.40E+09	P	2.1E-09	4.6E-11	4.9E-09	7.1E-09	<1%
Actinium-227	1.68E-01	soil	1.40E+09	P	2.7E-09	8.9E-11	7.5E-12	2.8E-09	<1%
Francium-223	1.68E-01	soil	1.40E+09	P	4.1E-15	1.5E-18	3.1E-13	3.2E-13	<1%
Astatine-219	1.68E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.68E-01	soil	1.40E+09	P	NA	NA	8.6E-13	8.6E-13	<1%
Thorium-227	1.68E-01	soil	1.40E+09	P	2.1E-11	1.6E-12	1.3E-09	1.3E-09	<1%
Radium-223	1.68E-01	soil	1.40E+09	P	7.7E-11	7.9E-13	1.2E-09	1.3E-09	<1%
Lead-211	1.68E-01	soil	1.40E+09	P	3.6E-16	2.4E-18	1.1E-12	1.1E-12	<1%
Astatine-215	1.68E-01	soil	1.40E+09	P	NA	NA	1.2E-22	1.2E-22	<1%
Bismuth-211	1.68E-01	soil	1.40E+09	P	NA	NA	4.3E-14	4.3E-14	<1%
Thallium-207	1.68E-01	soil	1.40E+09	P	NA	NA	8.0E-15	8.0E-15	<1%
Polonium-211	1.68E-01	soil	1.40E+09	P	NA	NA	3.4E-17	3.4E-17	<1%
					5E-07	3E-09	7E-06		
Total							**Total ELCR**	7E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 330 × 250 × 1 × [1 - exp(-λ × 1)] × CSFo) / (1,000 × 1 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 250 × 1 × [1 - exp(-λ × 1)] × CSFi) / (1.40E+09 × 1 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 250 × 1 × [1 - exp(-λ × 1)] × CSFe) / (365 × 1 × λ)

Appendix I, Table I-11 (RME)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.93E+00	1.40E+09	P	6.1E-08	3.7E-09	1.2E-06	1.2E-06	<1%
Uranium-234	1.93E+00	1.40E+09	P	5.5E-08	4.3E-09	2.5E-09	6.2E-08	<1%
Thorium-230	1.93E+00	1.40E+09	P	8.4E-08	5.3E-09	8.4E-09	9.7E-08	<1%
Radium-226	2.25E+00	1.40E+09	P	3.7E-07	5.1E-09	9.6E-05	9.7E-05	68%
Lead-210	2.25E+00	1.40E+09	P	5.3E-07	2.0E-09	1.2E-08	5.4E-07	<1%
Bismuth-210	2.25E+00	1.40E+09	P	3.8E-12	6.6E-14	2.5E-11	2.9E-11	<1%
Polonium-210	2.25E+00	1.40E+09	P	4.0E-08	6.0E-11	1.1E-11	4.0E-08	<1%
Thorium-232	2.05E+00	1.40E+09	P	8.7E-07	1.4E-08	4.2E-05	4.3E-05	30%
Thorium-228	2.05E+00	1.40E+09	P	8.1E-09	2.4E-09	6.5E-09	1.7E-08	<1%
Radium-224	2.05E+00	1.40E+09	P	5.6E-11	1.0E-12	2.5E-10	3.1E-10	<1%
Lead-212	2.05E+00	1.40E+09	P	1.1E-12	7.4E-15	3.7E-10	3.7E-10	<1%
Bismuth-212	2.05E+00	1.40E+09	P	3.4E-15	9.2E-17	3.5E-11	3.5E-11	<1%
Thallium-208	2.05E+00	1.40E+09	P	NA	NA	6.2E-11	6.2E-11	<1%
Uranium-235	1.13E-01	1.40E+09	P	3.2E-09	2.3E-10	3.3E-07	3.4E-07	<1%
Protactinium-231	1.13E-01	1.40E+09	P	9.8E-09	6.9E-10	7.4E-08	8.4E-08	<1%
Actinium-227	1.13E-01	1.40E+09	P	8.8E-09	9.4E-10	7.9E-11	9.8E-09	<1%
Francium-223	1.13E-01	1.40E+09	P	7.5E-16	9.0E-19	1.9E-13	1.9E-13	<1%
Astatine-219	1.13E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.13E-01	1.40E+09	P	NA	NA	5.2E-13	5.2E-13	<1%
Thorium-227	1.13E-01	1.40E+09	P	3.9E-12	9.4E-13	7.6E-10	7.7E-10	<1%
Radium-223	1.13E-01	1.40E+09	P	1.4E-11	4.8E-13	7.2E-10	7.4E-10	<1%
Lead-211	1.13E-01	1.40E+09	P	6.6E-17	1.4E-18	6.7E-13	6.7E-13	<1%
Astatine-215	1.13E-01	1.40E+09	P	NA	NA	7.5E-23	7.5E-23	<1%
Bismuth-211	1.13E-01	1.40E+09	P	NA	NA	2.6E-14	2.6E-14	<1%
Thallium-207	1.13E-01	1.40E+09	P	NA	NA	4.8E-15	4.8E-15	<1%
Polonium-211	1.13E-01	1.40E+09	P	NA	NA	2.1E-17	2.1E-17	<1%
				2E-06	4E-08	1E-04		
Total						**Total ELCR**	1E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-12 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Current/Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.93E+00	1.40E+09	P	6.1E-08	1.8E-09	5.9E-07	6.5E-07	<1%
Uranium-234	1.93E+00	1.40E+09	P	5.5E-08	2.2E-09	1.3E-09	5.9E-08	<1%
Thorium-230	1.93E+00	1.40E+09	P	8.4E-08	2.6E-09	4.2E-09	9.1E-08	<1%
Radium-226	2.25E+00	1.40E+09	P	3.7E-07	2.5E-09	4.8E-05	4.9E-05	67%
Lead-210	2.25E+00	1.40E+09	P	5.3E-07	1.0E-09	5.9E-09	5.3E-07	<1%
Bismuth-210	2.25E+00	1.40E+09	P	3.8E-12	3.3E-14	1.3E-11	1.6E-11	<1%
Polonium-210	2.25E+00	1.40E+09	P	4.0E-08	3.0E-11	5.7E-12	4.0E-08	<1%
Thorium-232	2.05E+00	1.40E+09	P	8.7E-07	7.2E-09	2.1E-05	2.2E-05	31%
Thorium-228	2.05E+00	1.40E+09	P	8.1E-09	1.2E-09	3.3E-09	1.3E-08	<1%
Radium-224	2.05E+00	1.40E+09	P	5.6E-11	5.2E-13	1.3E-10	1.8E-10	<1%
Lead-212	2.05E+00	1.40E+09	P	1.1E-12	3.7E-15	1.8E-10	1.8E-10	<1%
Bismuth-212	2.05E+00	1.40E+09	P	3.4E-15	4.6E-17	1.7E-11	1.7E-11	<1%
Thallium-208	2.05E+00	1.40E+09	P	NA	NA	3.1E-11	3.1E-11	<1%
Uranium-235	1.13E-01	1.40E+09	P	3.2E-09	1.1E-10	1.7E-07	1.7E-07	<1%
Protactinium-231	1.13E-01	1.40E+09	P	9.8E-09	3.5E-10	3.7E-08	4.7E-08	<1%
Actinium-227	1.13E-01	1.40E+09	P	8.8E-09	4.7E-10	4.0E-11	9.3E-09	<1%
Francium-223	1.13E-01	1.40E+09	P	7.5E-16	4.5E-19	9.4E-14	9.5E-14	<1%
Astatine-219	1.13E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.13E-01	1.40E+09	P	NA	NA	2.6E-13	2.6E-13	<1%
Thorium-227	1.13E-01	1.40E+09	P	3.9E-12	4.7E-13	3.8E-10	3.9E-10	<1%
Radium-223	1.13E-01	1.40E+09	P	1.4E-11	2.4E-13	3.6E-10	3.8E-10	<1%
Lead-211	1.13E-01	1.40E+09	P	6.6E-17	7.2E-19	3.3E-13	3.3E-13	<1%
Astatine-215	1.13E-01	1.40E+09	P	NA	NA	3.8E-23	3.8E-23	<1%
Bismuth-211	1.13E-01	1.40E+09	P	NA	NA	1.3E-14	1.3E-14	<1%
Thallium-207	1.13E-01	1.40E+09	P	NA	NA	2.4E-15	2.4E-15	<1%
Polonium-211	1.13E-01	1.40E+09	P	NA	NA	1.0E-17	1.0E-17	<1%
				2E-06	2E-08	7E-05		
Total						**Total ELCR**	7E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-13 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former Esperanza Mill - Shallow Soil/Sediment (0 to 0.5 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific ELCR: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	1.93E+00	1.40E+09	P	2.8E-09	9.7E-12	1.4E-08	1.7E-08	<1%
Uranium-234	1.93E+00	1.40E+09	P	2.6E-09	1.1E-11	2.9E-11	2.6E-09	<1%
Thorium-230	1.93E+00	1.40E+09	P	3.9E-09	1.4E-11	9.7E-11	4.0E-09	<1%
Radium-226	2.25E+00	1.40E+09	P	1.7E-08	1.3E-11	1.1E-06	1.1E-06	66%
Lead-210	2.25E+00	1.40E+09	P	3.0E-08	6.6E-12	1.7E-10	3.0E-08	2%
Bismuth-210	2.25E+00	1.40E+09	P	4.3E-13	4.4E-16	7.4E-13	1.2E-12	<1%
Polonium-210	2.25E+00	1.40E+09	P	4.6E-09	3.9E-13	3.3E-13	4.6E-09	<1%
Thorium-232	2.05E+00	1.40E+09	P	4.0E-08	3.8E-11	4.9E-07	5.3E-07	31%
Thorium-228	2.05E+00	1.40E+09	P	9.1E-10	1.5E-11	1.9E-10	1.1E-09	<1%
Radium-224	2.05E+00	1.40E+09	P	6.5E-12	6.9E-15	7.4E-12	1.4E-11	<1%
Lead-212	2.05E+00	1.40E+09	P	1.2E-13	4.9E-17	1.1E-11	1.1E-11	<1%
Bismuth-212	2.05E+00	1.40E+09	P	3.9E-16	6.1E-19	1.0E-12	1.0E-12	<1%
Thallium-208	2.05E+00	1.40E+09	P	NA	NA	1.8E-12	1.8E-12	<1%
Uranium-235	1.13E-01	1.40E+09	P	1.5E-10	6.0E-13	3.9E-09	4.0E-09	<1%
Protactinium-231	1.13E-01	1.40E+09	P	4.5E-10	1.8E-12	8.6E-10	1.3E-09	<1%
Actinium-227	1.13E-01	1.40E+09	P	5.1E-10	3.1E-12	1.1E-12	5.1E-10	<1%
Francium-223	1.13E-01	1.40E+09	P	8.6E-17	5.9E-21	5.5E-15	5.6E-15	<1%
Astatine-219	1.13E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.13E-01	1.40E+09	P	NA	NA	1.5E-14	1.5E-14	<1%
Thorium-227	1.13E-01	1.40E+09	P	4.5E-13	6.2E-15	2.2E-11	2.3E-11	<1%
Radium-223	1.13E-01	1.40E+09	P	1.6E-12	3.1E-15	2.1E-11	2.3E-11	<1%
Lead-211	1.13E-01	1.40E+09	P	7.7E-18	9.5E-21	2.0E-14	2.0E-14	<1%
Astatine-215	1.13E-01	1.40E+09	P	NA	NA	2.2E-24	2.2E-24	<1%
Bismuth-211	1.13E-01	1.40E+09	P	NA	NA	7.5E-16	7.5E-16	<1%
Thallium-207	1.13E-01	1.40E+09	P	NA	NA	1.4E-16	1.4E-16	<1%
Polonium-211	1.13E-01	1.40E+09	P	NA	NA	6.0E-19	6.0E-19	<1%
				1E-07	1E-10	2E-06		
Total						**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix I, Table I-14 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.49E+00	soil	1.40E+09	P	7.9E-08	4.8E-09	1.5E-06	1.6E-06	1%
Uranium-234	2.44E+00	soil	1.40E+09	P	7.0E-08	5.5E-09	3.2E-09	7.9E-08	<1%
Thorium-230	2.44E+00	soil	1.40E+09	P	1.1E-07	6.7E-09	1.1E-08	1.2E-07	<1%
Radium-226	2.24E+00	soil+sed	1.40E+09	P	3.7E-07	5.1E-09	9.6E-05	9.6E-05	65%
Lead-210	2.24E+00	soil+sed	1.40E+09	P	5.2E-07	2.0E-09	1.2E-08	5.4E-07	<1%
Bismuth-210	2.24E+00	soil+sed	1.40E+09	P	3.7E-12	6.6E-14	2.5E-11	2.9E-11	<1%
Polonium-210	2.24E+00	soil+sed	1.40E+09	P	4.0E-08	5.9E-11	1.1E-11	4.0E-08	<1%
Thorium-232	2.34E+00	soil	1.40E+09	P	9.9E-07	1.6E-08	4.8E-05	4.9E-05	33%
Thorium-228	2.34E+00	soil	1.40E+09	P	9.3E-09	2.7E-09	7.5E-09	1.9E-08	<1%
Radium-224	2.34E+00	soil	1.40E+09	P	6.4E-11	1.2E-12	2.9E-10	3.6E-10	<1%
Lead-212	2.34E+00	soil	1.40E+09	P	1.2E-12	8.4E-15	4.2E-10	4.2E-10	<1%
Bismuth-212	2.34E+00	soil	1.40E+09	P	3.9E-15	1.1E-16	4.0E-11	4.0E-11	<1%
Thallium-208	2.34E+00	soil	1.40E+09	P	NA	NA	7.0E-11	7.0E-11	<1%
Uranium-235	1.35E-01	soil	1.40E+09	P	3.8E-09	2.7E-10	4.0E-07	4.0E-07	<1%
Protactinium-231	1.35E-01	soil	1.40E+09	P	1.2E-08	8.3E-10	8.8E-08	1.0E-07	<1%
Actinium-227	1.35E-01	soil	1.40E+09	P	1.1E-08	1.1E-09	9.5E-11	1.2E-08	<1%
Francium-223	1.35E-01	soil	1.40E+09	P	8.9E-16	1.1E-18	2.3E-13	2.3E-13	<1%
Astatine-219	1.35E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.35E-01	soil	1.40E+09	P	NA	NA	6.3E-13	6.3E-13	<1%
Thorium-227	1.35E-01	soil	1.40E+09	P	4.6E-12	1.1E-12	9.1E-10	9.2E-10	<1%
Radium-223	1.35E-01	soil	1.40E+09	P	1.7E-11	5.7E-13	8.7E-10	8.8E-10	<1%
Lead-211	1.35E-01	soil	1.40E+09	P	7.9E-17	1.7E-18	8.0E-13	8.0E-13	<1%
Astatine-215	1.35E-01	soil	1.40E+09	P	NA	NA	9.0E-23	9.0E-23	<1%
Bismuth-211	1.35E-01	soil	1.40E+09	P	NA	NA	3.1E-14	3.1E-14	<1%
Thallium-207	1.35E-01	soil	1.40E+09	P	NA	NA	5.8E-15	5.8E-15	<1%
Polonium-211	1.35E-01	soil	1.40E+09	P	NA	NA	2.5E-17	2.5E-17	<1%
					2E-06	5E-08	1E-04		
Total							**Total ELCR**	1E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-15 (Site-Specific Evaluation)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Outdoor Commercial / Industrial Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m³/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.49E+00	soil	1.40E+09	P	7.9E-08	2.4E-09	7.6E-07	8.4E-07	1%
Uranium-234	2.44E+00	soil	1.40E+09	P	7.0E-08	2.8E-09	1.6E-09	7.4E-08	<1%
Thorium-230	2.44E+00	soil	1.40E+09	P	1.1E-07	3.3E-09	5.3E-09	1.1E-07	<1%
Radium-226	2.24E+00	soil+sed	1.40E+09	P	3.7E-07	2.5E-09	4.8E-05	4.8E-05	64%
Lead-210	2.24E+00	soil+sed	1.40E+09	P	5.2E-07	1.0E-09	5.9E-09	5.3E-07	<1%
Bismuth-210	2.24E+00	soil+sed	1.40E+09	P	3.7E-12	3.3E-14	1.3E-11	1.6E-11	<1%
Polonium-210	2.24E+00	soil+sed	1.40E+09	P	4.0E-08	3.0E-11	5.7E-12	4.0E-08	<1%
Thorium-232	2.34E+00	soil	1.40E+09	P	9.9E-07	8.2E-09	2.4E-05	2.5E-05	34%
Thorium-228	2.34E+00	soil	1.40E+09	P	9.3E-09	1.3E-09	3.7E-09	1.4E-08	<1%
Radium-224	2.34E+00	soil	1.40E+09	P	6.4E-11	6.0E-13	1.5E-10	2.1E-10	<1%
Lead-212	2.34E+00	soil	1.40E+09	P	1.2E-12	4.2E-15	2.1E-10	2.1E-10	<1%
Bismuth-212	2.34E+00	soil	1.40E+09	P	3.9E-15	5.3E-17	2.0E-11	2.0E-11	<1%
Thallium-208	2.34E+00	soil	1.40E+09	P	NA	NA	3.5E-11	3.5E-11	<1%
Uranium-235	1.35E-01	soil	1.40E+09	P	3.8E-09	1.4E-10	2.0E-07	2.0E-07	<1%
Protactinium-231	1.35E-01	soil	1.40E+09	P	1.2E-08	4.1E-10	4.4E-08	5.6E-08	<1%
Actinium-227	1.35E-01	soil	1.40E+09	P	1.1E-08	5.6E-10	4.7E-11	1.1E-08	<1%
Francium-223	1.35E-01	soil	1.40E+09	P	8.9E-16	5.4E-19	1.1E-13	1.1E-13	<1%
Astatine-219	1.35E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.35E-01	soil	1.40E+09	P	NA	NA	3.1E-13	3.1E-13	<1%
Thorium-227	1.35E-01	soil	1.40E+09	P	4.6E-12	5.6E-13	4.6E-10	4.6E-10	<1%
Radium-223	1.35E-01	soil	1.40E+09	P	1.7E-11	2.8E-13	4.3E-10	4.5E-10	<1%
Lead-211	1.35E-01	soil	1.40E+09	P	7.9E-17	8.6E-19	4.0E-13	4.0E-13	<1%
Astatine-215	1.35E-01	soil	1.40E+09	P	NA	NA	4.5E-23	4.5E-23	<1%
Bismuth-211	1.35E-01	soil	1.40E+09	P	NA	NA	1.5E-14	1.5E-14	<1%
Thallium-207	1.35E-01	soil	1.40E+09	P	NA	NA	2.9E-15	2.9E-15	<1%
Polonium-211	1.35E-01	soil	1.40E+09	P	NA	NA	1.2E-17	1.2E-17	<1%
					2E-06	2E-08	7E-05		
Total							**Total ELCR**	8E-05	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 100 × 225 × 25 × [1 - exp(-λ × 25)] × CSFo) / (1,000 × 25 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 225 × 25 × [1 - exp(-λ × 25)] × CSFi) / (1.40E+09 × 25 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 225 × 25 × [1 - exp(-λ × 25)] × CSFe) / (365 × 25 × λ)

Appendix I, Table I-16 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Adolescent Trespasser Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m³/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.49E+00	soil	1.40E+09	P	3.6E-09	1.3E-11	1.8E-08	2.1E-08	1%
Uranium-234	2.44E+00	soil	1.40E+09	P	3.2E-09	1.5E-11	3.7E-11	3.3E-09	<1%
Thorium-230	2.44E+00	soil	1.40E+09	P	4.9E-09	1.8E-11	1.2E-10	5.0E-09	<1%
Radium-226	2.24E+00	soil+sed	1.40E+09	P	1.7E-08	1.3E-11	1.1E-06	1.1E-06	62%
Lead-210	2.24E+00	soil+sed	1.40E+09	P	3.0E-08	6.5E-12	1.7E-10	3.0E-08	2%
Bismuth-210	2.24E+00	soil+sed	1.40E+09	P	4.3E-13	4.3E-16	7.3E-13	1.2E-12	<1%
Polonium-210	2.24E+00	soil+sed	1.40E+09	P	4.6E-09	3.9E-13	3.3E-13	4.6E-09	<1%
Thorium-232	2.34E+00	soil	1.40E+09	P	4.6E-08	4.3E-11	5.6E-07	6.1E-07	34%
Thorium-228	2.34E+00	soil	1.40E+09	P	1.0E-09	1.7E-11	2.1E-10	1.3E-09	<1%
Radium-224	2.34E+00	soil	1.40E+09	P	7.4E-12	7.9E-15	8.5E-12	1.6E-11	<1%
Lead-212	2.34E+00	soil	1.40E+09	P	1.4E-13	5.6E-17	1.2E-11	1.2E-11	<1%
Bismuth-212	2.34E+00	soil	1.40E+09	P	4.5E-16	6.9E-19	1.2E-12	1.2E-12	<1%
Thallium-208	2.34E+00	soil	1.40E+09	P	NA	NA	2.1E-12	2.1E-12	<1%
Uranium-235	1.35E-01	soil	1.40E+09	P	1.8E-10	7.2E-13	4.7E-09	4.8E-09	<1%
Protactinium-231	1.35E-01	soil	1.40E+09	P	5.4E-10	2.2E-12	1.0E-09	1.6E-09	<1%
Actinium-227	1.35E-01	soil	1.40E+09	P	6.0E-10	3.7E-12	1.4E-12	6.1E-10	<1%
Francium-223	1.35E-01	soil	1.40E+09	P	1.0E-16	7.1E-21	6.6E-15	6.7E-15	<1%
Astatine-219	1.35E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.35E-01	soil	1.40E+09	P	NA	NA	1.8E-14	1.8E-14	<1%
Thorium-227	1.35E-01	soil	1.40E+09	P	5.3E-13	7.4E-15	2.7E-11	2.7E-11	<1%
Radium-223	1.35E-01	soil	1.40E+09	P	1.9E-12	3.8E-15	2.5E-11	2.7E-11	<1%
Lead-211	1.35E-01	soil	1.40E+09	P	9.2E-18	1.1E-20	2.3E-14	2.3E-14	<1%
Astatine-215	1.35E-01	soil	1.40E+09	P	NA	NA	2.6E-24	2.6E-24	<1%
Bismuth-211	1.35E-01	soil	1.40E+09	P	NA	NA	9.0E-16	9.0E-16	<1%
Thallium-207	1.35E-01	soil	1.40E+09	P	NA	NA	1.7E-16	1.7E-16	<1%
Polonium-211	1.35E-01	soil	1.40E+09	P	NA	NA	7.2E-19	7.2E-19	<1%
					1E-07	1E-10	2E-06		
Total							**Total ELCR**	2E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 50 × 52 × 10 × [1 - exp(-λ × 10)] × CSFo) / (1,000 × 10 × λ)
ELCRi = (EPCs × 1,000 × 60 × 1 × 0.042 × 52 × 10 × [1 - exp(-λ × 10)] × CSFi) / (1.40E+09 × 10 × λ)
ELCRe = (EPCs × ACF × [(1 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 52 × 10 × [1 - exp(-λ × 10)] × CSFe) / (365 × 10 × λ)

Appendix I, Table I-17 (RME)
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Construction Worker Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)		PEF [a] (m³/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides									
Uranium-238	2.49E+00	soil	1.40E+09	P	1.2E-08	2.1E-10	6.8E-08	7.9E-08	1%
Uranium-234	2.44E+00	soil	1.40E+09	P	1.0E-08	2.4E-10	1.4E-10	1.1E-08	<1%
Thorium-230	2.44E+00	soil	1.40E+09	P	1.6E-08	3.0E-10	4.7E-10	1.6E-08	<1%
Radium-226	2.24E+00	soil+sed	1.40E+09	P	5.4E-08	2.3E-10	4.3E-06	4.3E-06	62%
Lead-210	2.24E+00	soil+sed	1.40E+09	P	1.1E-07	1.3E-10	7.4E-10	1.1E-07	2%
Bismuth-210	2.24E+00	soil+sed	1.40E+09	P	1.4E-11	7.3E-14	2.8E-11	4.2E-11	<1%
Polonium-210	2.24E+00	soil+sed	1.40E+09	P	1.2E-07	5.5E-11	1.1E-11	1.2E-07	2%
Thorium-232	2.34E+00	soil	1.40E+09	P	1.5E-07	7.3E-10	2.2E-06	2.3E-06	33%
Thorium-228	2.34E+00	soil	1.40E+09	P	1.0E-08	9.1E-10	2.5E-09	1.4E-08	<1%
Radium-224	2.34E+00	soil	1.40E+09	P	2.4E-10	1.3E-12	3.2E-10	5.6E-10	<1%
Lead-212	2.34E+00	soil	1.40E+09	P	4.4E-12	9.4E-15	4.6E-10	4.7E-10	<1%
Bismuth-212	2.34E+00	soil	1.40E+09	P	1.4E-14	1.2E-16	4.4E-11	4.4E-11	<1%
Thallium-208	2.34E+00	soil	1.40E+09	P	NA	NA	7.8E-11	7.8E-11	<1%
Uranium-235	1.35E-01	soil	1.40E+09	P	5.6E-10	1.2E-11	1.8E-08	1.8E-08	<1%
Protactinium-231	1.35E-01	soil	1.40E+09	P	1.7E-09	3.7E-11	3.9E-09	5.7E-09	<1%
Actinium-227	1.35E-01	soil	1.40E+09	P	2.2E-09	7.1E-11	6.0E-12	2.3E-09	<1%
Francium-223	1.35E-01	soil	1.40E+09	P	3.3E-15	1.2E-18	2.5E-13	2.5E-13	<1%
Astatine-219	1.35E-01	soil	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.35E-01	soil	1.40E+09	P	NA	NA	6.9E-13	6.9E-13	<1%
Thorium-227	1.35E-01	soil	1.40E+09	P	1.7E-11	1.3E-12	1.0E-09	1.0E-09	<1%
Radium-223	1.35E-01	soil	1.40E+09	P	6.2E-11	6.3E-13	9.6E-10	1.0E-09	<1%
Lead-211	1.35E-01	soil	1.40E+09	P	2.9E-16	1.9E-18	8.9E-13	8.9E-13	<1%
Astatine-215	1.35E-01	soil	1.40E+09	P	NA	NA	1.0E-22	1.0E-22	<1%
Bismuth-211	1.35E-01	soil	1.40E+09	P	NA	NA	3.4E-14	3.4E-14	<1%
Thallium-207	1.35E-01	soil	1.40E+09	P	NA	NA	6.4E-15	6.4E-15	<1%
Polonium-211	1.35E-01	soil	1.40E+09	P	NA	NA	2.7E-17	2.7E-17	<1%
					5E-07	3E-09	7E-06		
Total							**Total ELCR**	7E-06	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table 6-1.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPC: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.
RME: reasonable maximum exposure.

Receptor-specific exposure parameters are presented in Table 6-1.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 330 × 250 × 1 × [1 - exp(-λ × 1)] × CSFo) / (1,000 × 1 × λ)
ELCRi = (EPCs × 1,000 × 60 × 8 × 0.042 × 250 × 1 × [1 - exp(-λ × 1)] × CSFi) / (1.40E+09 × 1 × λ)
ELCRe = (EPCs × ACF × [(8 × 0.042 × 1) + (0 × 0.042 × 0.4)] × 250 × 1 × [1 - exp(-λ × 1)] × CSFe) / (365 × 1 × λ)

Appendix I, Table I-18
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Child/Adult Resident Exposed to Radionuclides
Former CLEAR Plant - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.76E+00	1.40E+09	P	2.1E-07	9.7E-09	3.6E-06	3.8E-06	1%
Uranium-234	2.68E+00	1.40E+09	P	1.9E-07	1.1E-08	7.4E-09	2.1E-07	<1%
Thorium-230	2.68E+00	1.40E+09	P	2.8E-07	1.4E-08	2.5E-08	3.2E-07	<1%
Radium-226	2.34E+00	1.40E+09	P	9.3E-07	9.8E-09	2.1E-04	2.1E-04	66%
Lead-210	2.34E+00	1.40E+09	P	1.2E-06	3.5E-09	2.4E-08	1.2E-06	<1%
Bismuth-210	2.34E+00	1.40E+09	P	7.2E-12	9.6E-14	4.3E-11	5.0E-11	<1%
Polonium-210	2.34E+00	1.40E+09	P	7.6E-08	8.7E-11	1.9E-11	7.6E-08	<1%
Thorium-232	2.30E+00	1.40E+09	P	2.4E-06	3.0E-08	1.0E-04	1.0E-04	32%
Thorium-228	2.30E+00	1.40E+09	P	1.7E-08	3.7E-09	1.2E-08	3.2E-08	<1%
Radium-224	2.30E+00	1.40E+09	P	1.2E-10	1.6E-12	4.6E-10	5.8E-10	<1%
Lead-212	2.30E+00	1.40E+09	P	2.2E-12	1.2E-14	6.6E-10	6.7E-10	<1%
Bismuth-212	2.30E+00	1.40E+09	P	7.0E-15	1.4E-16	6.3E-11	6.3E-11	<1%
Thallium-208	2.30E+00	1.40E+09	P	NA	NA	1.1E-10	1.1E-10	<1%
Uranium-235	1.68E-01	1.40E+09	P	1.1E-08	6.3E-10	1.1E-06	1.1E-06	<1%
Protactinium-231	1.68E-01	1.40E+09	P	3.5E-08	1.9E-09	2.3E-07	2.7E-07	<1%
Actinium-227	1.68E-01	1.40E+09	P	2.9E-08	2.3E-09	2.3E-10	3.1E-08	<1%
Francium-223	1.68E-01	1.40E+09	P	2.0E-15	1.9E-18	4.5E-13	4.6E-13	<1%
Astatine-219	1.68E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.68E-01	1.40E+09	P	NA	NA	1.3E-12	1.3E-12	<1%
Thorium-227	1.68E-01	1.40E+09	P	1.1E-11	2.0E-12	1.8E-09	1.8E-09	<1%
Radium-223	1.68E-01	1.40E+09	P	3.9E-11	9.9E-13	1.7E-09	1.8E-09	<1%
Lead-211	1.68E-01	1.40E+09	P	1.8E-16	3.0E-18	1.6E-12	1.6E-12	<1%
Astatine-215	1.68E-01	1.40E+09	P	NA	NA	1.8E-22	1.8E-22	<1%
Bismuth-211	1.68E-01	1.40E+09	P	NA	NA	6.2E-14	6.2E-14	<1%
Thallium-207	1.68E-01	1.40E+09	P	NA	NA	1.2E-14	1.2E-14	<1%
Polonium-211	1.68E-01	1.40E+09	P	NA	NA	5.0E-17	5.0E-17	<1%
				5E-06	9E-08	3E-04		
Total						**Total ELCR**	3E-04	

Notes:
[a] Default particulate emission factor ([PEF] identified with [P]) provided in Table F-7.

%: percent.
ACF: area correction factor.
CSFe: external cancer slope factor.
CSFi: inhalation cancer slope factor.
CSFo: oral cancer slope factor.
ELCR: excess lifetime cancer risk.
ELCRe: excess lifetime cancer risk, external pathway.
ELCRi: excess lifetime cancer risk, inhalation pathway.
ELCRo: excess lifetime cancer risk, oral pathway.
EPCs: exposure point concentration in soil/sediment.
ft bgs: feet below ground surface.
m^3/kg: cubic meter(s) per kilogram.
pCi/g: picoCurie(s) per gram.

Receptor-specific exposure parameters are presented in Table F-7.
Radionuclide-specific parameters and slope factors are presented in Table 7-2.

Equations:
ELCRo = (EPCs × 118 × 350 × 33 × [1 - exp(-λ × 33)] × CSFo) / (1,000 × 33 × λ)
ELCRi = (EPCs × 1,000 × 18 × 24 × 0.042 × 350 × 33 × [1 - exp(-λ × 33)] × CSFi) / (1.40E+09 × 33 × λ)
ELCRe = (EPCs × ACF × [(1.752 × 0.042 × 1) + (16.416 × 0.042 × 0.4)] × 350 × 33 × [1 - exp(-λ × 33)] × CSFe) / (365 × 33 × λ)

Appendix I, Table I-19
Excess Lifetime Cancer Risk Calculations for a Hypothetical Future Child/Adult Resident Exposed to Radionuclides
Former Esperanza Mill - Shallow and Deep Soil/Sediment (0 to 15 ft bgs), Mean EPCs
Baseline Human Health Risk Assessment
Freeport-McMoRan Sierrita
Sierrita Mine, Green Valley, Arizona

Constituent	EPCs (pCi/g)	PEF [a] (m^3/kg)		CANCER RISK: Route-Specific Risk: Ingestion ELCRo	Inhalation ELCRi	External ELCRe	Total ELCR	Percent Total ELCR
Radionuclides								
Uranium-238	2.49E+00	1.40E+09	P	1.9E-07	8.8E-09	3.3E-06	3.5E-06	1%
Uranium-234	2.44E+00	1.40E+09	P	1.7E-07	1.0E-08	6.8E-09	1.9E-07	<1%
Thorium-230	2.44E+00	1.40E+09	P	2.6E-07	1.2E-08	2.3E-08	2.9E-07	<1%
Radium-226	2.24E+00	1.40E+09	P	8.9E-07	9.3E-09	2.0E-04	2.0E-04	65%
Lead-210	2.24E+00	1.40E+09	P	1.1E-06	3.3E-09	2.3E-08	1.2E-06	<1%
Bismuth-210	2.24E+00	1.40E+09	P	6.8E-12	9.2E-14	4.1E-11	4.8E-11	<1%
Polonium-210	2.24E+00	1.40E+09	P	7.3E-08	8.3E-11	1.8E-11	7.3E-08	<1%
Thorium-232	2.34E+00	1.40E+09	P	2.4E-06	3.0E-08	1.0E-04	1.1E-04	33%
Thorium-228	2.34E+00	1.40E+09	P	1.7E-08	3.8E-09	1.2E-08	3.3E-08	<1%
Radium-224	2.34E+00	1.40E+09	P	1.2E-10	1.7E-12	4.7E-10	5.9E-10	<1%
Lead-212	2.34E+00	1.40E+09	P	2.2E-12	1.2E-14	6.7E-10	6.8E-10	<1%
Bismuth-212	2.34E+00	1.40E+09	P	7.1E-15	1.5E-16	6.4E-11	6.4E-11	<1%
Thallium-208	2.34E+00	1.40E+09	P	NA	NA	1.1E-10	1.1E-10	<1%
Uranium-235	1.35E-01	1.40E+09	P	9.2E-09	5.0E-10	8.5E-07	8.6E-07	<1%
Protactinium-231	1.35E-01	1.40E+09	P	2.8E-08	1.5E-09	1.9E-07	2.2E-07	<1%
Actinium-227	1.35E-01	1.40E+09	P	2.3E-08	1.9E-09	1.8E-10	2.5E-08	<1%
Francium-223	1.35E-01	1.40E+09	P	1.6E-15	1.5E-18	3.6E-13	3.7E-13	<1%
Astatine-219	1.35E-01	1.40E+09	P	NA	NA	NA	–	
Bismuth-215	1.35E-01	1.40E+09	P	NA	NA	1.0E-12	1.0E-12	<1%
Thorium-227	1.35E-01	1.40E+09	P	8.5E-12	1.6E-12	1.5E-09	1.5E-09	<1%
Radium-223	1.35E-01	1.40E+09	P	3.1E-11	8.0E-13	1.4E-09	1.4E-09	<1%
Lead-211	1.35E-01	1.40E+09	P	1.5E-16	2.4E-18	1.3E-12	1.3E-12	<1%
Astatine-215	1.35E-01	1.40E+09	P	NA	NA	1.5E-22	1.5E-22	<1%
Bismuth-211	1.35E-01	1.40E+09	P	NA	NA	5.0E-14	5.0E-14	<1%
Thallium-207	1.35E-01	1.40E+09	P	NA	NA	9.3E-15	9.3E-15	<1%
Polonium-211	1.35E-01	1.40E+09	P	NA	NA	4.0E-17	4.0E-17	<1%
				5E-06	8E-08	3E-04		
Total						**Total ELCR**	3E-04	

Notes:
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ELCRe = (EPCs × ACF × [(1.752 × 0.042 × 1) + (16.416 × 0.042 × 0.4)] × 350 × 33 × [1 - exp(-λ × 33)] × CSFe) / (365 × 33 × λ)

APPENDIX J

Summary and Response Intentions for Comments on the Baseline Human Health Risk Assessment

ARCADIS Design & Consultancy for natural and built assets

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ENVIRONMENT

Subject:
Summary and Response Intentions for Comments on the Baseline Human Health Risk Assessment, Freeport Sierrita Inc., 6200 W. Duvall Mine Rd., Green Valley, Arizona. VRP Site Code: 100073-03

Date:
December 19, 2017

Contact:
Katy Brantingham

Phone:
602.797.4523

Email:
Katy.Brantingham
@arcadis.com

Our ref:
AZ001233.0022.00001

Dear Ms. Pace:

On behalf of Freeport Sierrita Inc. (Freeport), Arcadis is providing this letter to summarize Arizona Department of Environmental Quality's (ADEQ's) August 18, 2016 comments to the Baseline Human Health Risk Assessment (BHHRA) dated June 7, 2016 for the Freeport Site referenced above. This letter also documents Freeport's intent to respond or not respond to each comment when revising the BHHRA as requested during the call between Freeport, Arcadis, ADEQ, and the Arizona Department of Health Services (ADHS) on December 14, 2017.

The table below lists the comment number in the left column, the comments in the center column, and Freeport's intent to respond or not respond in the right column. Comments tagged with "SC" are ADEQ's comments related to site characterization. Comments tagged with "RA" are ADEQ's comments related to the BHHRA. Comments tagged with "K" are Kleinfelder's comments on the BHHRA.

#	Comment	Intend to Respond
SC1	The VRP has determined the nature and extent of all source areas within the EAs were not fully characterized for the nature and extent of source contamination, pursuant to A.R.S. § 49- 175(A), before the areas were evaluated for potential risks to receptors. The process of completing characterization for any area for which an NFA is sought should be completed before the submittal of a remedial action document or any document which seeks VRP concurrence that no further characterization and/or remediation is warranted.	No
SC2	The VRP does not concur with the incorporation of the Demetrie Wash within the boundaries of the CLEAR Plant EA (BHHRA Figure 5-2a). The Demetrie Wash has not been characterized, and should not be included in other release areas identified in the CLEAR Plant EA. The Demetrie Wash should be characterized separately and should be isolated as its own EA in future risk evaluations.	No
SC3	The VRP cannot accept the inclusion of facilities which are currently under the authority of another program into an EA which will be used to support an NFA area. For example, section 2.3 of the BHHRA states that the EAs "encompass nine subareas identified as the focus of VRP site investigations because they are… operations identified as "to be closed" under the A[quifer] P[rotection] P[rogram]". The VRP does not have the authority to issue an NFA for areas currently overseen by another program in the agency. In addition, VRP will not issue an NFA for areas which are still actively utilized by the mine for purposes which may continue to contribute to soil impacts. This includes areas such as "active operations with the potential to releases mining-related constituents to groundwater", as cited in section 2.3 of the BHHRA.	No
SC4	As indicated in an August 29, 2013 letter from the VRP for this Site, FMI should not compare the 95% Upper Confidence Limit (UCL) to Groundwater Protection Levels (GPLs). The GPLs are screening levels treated as not-to-exceed values, based on the consideration that individual, isolated areas may contribute to groundwater contamination. As such, samples within each EA must be compared to the default GPL and/or compared to an EA-specific alternate GPL that has been developed based on data collected within that EA.	Yes
SC5	Pursuant to A.R.S. § 49-152(B) and (C), and Arizona Administrative Code (A.A.C.) R18-7- 208, a Declaration of Environmental Use Restriction (DEUR) is required for an NFA determination in any instance, regardless of current land use or zoning, where characterization and/or compliance data used in support of closure exceeds the residential soil remediation levels (SRLs) or when a site-specific (ss)-SRL is developed for any receptor other than a residential scenario. If FMI is seeking an NFA for the EAs without conditions, as indicated in the June 7, 2016 cover letter for the BHHRA, then FMI must submit a risk assessment that adequately and appropriately evaluates a residential scenario for each EA. All other risk-based scenarios will require a DEUR and result in a conditional NFA for any EA not evaluated to a residential scenario. In addition, any NFA issued with conditions will supersede prior unconditional NFAs for areas incorporated into the EAs.	No

#	Comment	Intend to Respond
RA1	Pursuant to the Arizona Department of Health Services (ADHS) 2003 Deterministic Risk Assessment Guidance, site-specific screening/initial remediation levels usually limit Excess Lifetime Cancer Risk (ELCR) to one-in-one million (10^{-6}) for Class A proven human carcinogens and to one-in-one-hundred-thousand (10^{-5}) for Class B probable and Class C possible human carcinogens. ADEQ will not consider a 10^{-4} ELCR without ADHS review and evaluation. Upon revision to the BHHRA, if FMI resubmits a risk assessment containing ELCR values of 10^{-4} ADEQ will rely on ADHS for review of the document. FMI should note, since 1997, ADEQ has had a policy decision to use 1 x 10^{-5} as the ELCR for Class B and C carcinogens. ADEQ documented this decision in the Arizona Administrative Record, 1997 Volume 3, Issue #52, on page 3652.	No
K1	**Executive Summary, Human Receptors and Exposure Routes:** The BHHRA notes that groundwater is not used for potable purposes. Identify current source and system supplying potable water to the site.	Yes
K2	**Executive Summary, Key Findings, last sentence on page ES-5:** Reference is made to "these data" but it's not clear what data are being invoked.	Yes
K3	**Introduction, fourth paragraph:** The BHHRA notes that the potential for exposure to site-related constituents in groundwater was not evaluated because groundwater is not a potable supply. Could site-related constituents migrate to groundwater and affect a potable supply elsewhere? A discussion about the potential to affect water supplies should be included.	Yes
K4	**Section 2 – Geology and Hydrogeology:** It would be helpful to know how this information relates to the assessment of health risk at the subject site. For example, are there characteristics of the geology known to be high in metals that might be of health concern? Are there characteristics of the geology and hydrogeology that could affect migration of COPCs within and beyond the subject site?	No
K5	**Section 3 – Previous Site Investigations, first paragraph:** First appearance of the acronym "COIs." How are COIs identified? How do they relate to COPCs? Is there purpose behind using the two classifications instead of one or the other?	Yes
K6	**Section 3.1.1, first paragraph:** The BHHRA states that 54 surface soil and 39 subsurface soil samples were collected but these numbers do not match up with sample numbers reported in Table 5-1. Second paragraph of this section also reports sample numbers for CLEAR and Esperanza that do not match Table 5-1.	Yes
K7	**Section 3.1.2.1, first paragraph:** Similar to preceding comment, sample numbers (n=171) do not match Table 5-1.	Yes
K8	**Section 3.1.3:** Data discussed are not referenced to a specific report.	Yes
K9	**Section 3.1.3:** Similar to preceding comments, sample numbers do not match Table 5-1.	Yes
K10	**Section 3.1.4:** Similar to preceding comments, sample numbers do not match Table 5-1.	Yes

#	Comment	Intend to Respond
K11	**Section 3.1.2.2:** The BHHRA states that, "The unconsolidated deposits and parent bedrock complex at the Sierrita mine…contain natural levels of radioactivity." Where in the BHHRA are natural levels of radioactivity presented? Later in the paragraph, maximum activities for Ra-226 are reported – are these the natural levels? If so, more detail about the range of activities (not just the maximums) should be provided.	Yes
K12	**Section 3.1.4, second paragraph:** The BHHRA notes that ten percent of the grid samples were analyzed – does that mean three samples? Ten percent of 29 is about three.	Yes
K13	**Section 5.1, second paragraph:** The BHHRA notes that groundwater is not currently used or likely to be used in the future as a potable supply. Is it possible, however, that site-related constituents could migrate to groundwater and affect potable supplies off-site?	Yes
K14	**Section 5.1, third paragraph:** The BHHRA notes natural levels of radionuclides but does not provide evidence to support that statement. If such evidence appears in ARCADIS (2013a) [not (2013b) as indicated in report], then that evidence should be presented in the BHHRA.	Yes
K15	**Section 5.3:** Data usability was evaluated based on several criteria, including spatial characteristics and sampling size and density. These criteria, however, were not defined and the data were not evaluated, except in a cursory way, against these criteria. For example, the report states that randomly selected sample locations were identified based on a 200-square foot grid system in the CLEAR and Esperanza areas but no information is provided regarding how many samples were collected based on that grid or the locations of those samples on a grid. Sample location and density can be ascertained to some extent from Figures 5-2a through 5-2C, 5-3, and 5-4, however the sample locations appear clustered or of insufficient number to adequately characterize the various sites, particularly for residential land use where standard lot sizes may be in the range of 0.25 acres. Some areas also appear to have been not sampled (large swaths of the CLEAR and Esperanza areas) or minimally sampled (Former Evaporation Pond, Old D Pond, and the Former Rhenium Ponds). As an example, the Former C Pond Spoils area is approximately 1,000 feet long and as much as 350 feet wide but only four samples have been collected from that area. Also, no analysis is provided to demonstrate data sufficiency.	No
K16	**Section 5.5.1, second bullet:** Verify that ADEQ (2002) is the correct reference for the statement regarding future unrestricted land use.	Yes
K17	**Section 5.5.2:** Are samples presented on Figure 5-2b not actually included in the BHHRA data set used to estimate cancer risk and noncancer hazard for this location? It's not clear from Figure 5-2b which samples characterized current conditions and which characterized future conditions.	Yes
K18	**Section 5.5.3:** Was the "parent" sample used to characterize the site whether it was greater than the "duplicate" or not? Has the relative percent difference been addressed for parents and duplicates?	Yes

#	Comment	Intend to Respond
K19	**Section 5.6, second bullet:** Because this bullet refers to radionuclides, highest detected concentration should be "highest reported activity."	Yes
K20	**Section 6.1.2, last sentence:** Inclusion of sediment data in the 0-15 feet bgs data set is not necessarily a conservative approach if sediment concentrations tend to be lower than soil concentrations. A comparison of sediment data to soil data should be performed to verify whether combining these data is defensible. Also, it's not clear from Table 5-2, which samples are sediment samples.	Yes
K21	**Section 6.1.3.1, second paragraph:** How was the potential for radon gas evaluated?	Yes
K22	**Section 6.1.3.1, third paragraph:** Indicate the location in the BHHRA where potential indoor-related exposure to radionuclides is discussed.	No
K23	**Section 6.1.3.2:** Explain why a future outdoor commercial/industrial worker is not included for evaluation.	Yes
K24	**Section 6.2.2:** Site specific exposure assumptions are acceptable for use where such assumptions are consistent with current and future land use and activities. Should land use or activities change, site specific assumptions no longer apply and health risk must be re-evaluated.	No
K25	**Section 6.3.2:** The BHHRA notes that for exposure scenarios wherein the exposure duration is less than seven years, subchronic toxicity values were used. The exposure scenarios for which subchronic toxicity values were used should be identified here.	No
K26	**Section 6.3.3.1:** The relative bioavailability factor for arsenic should be noted here.	Yes
K27	**Section 6.3.3.1:** Equation 6-1 includes an "FI" factor but this factor is not defined or discussed.	Yes
K28	**Sections 6.3.4.1 and 6.3.4.2:** Equations 6-6 and 6-7 includes a factor of 10^3 (1,000) but this factor is not defined or discussed.	Yes
K29	**Section 7.2, Table 7-1:** Subchronic toxicity values are discussed (sources and uses) here, however, it does not appear that subchronic toxicity values or the surrogates mentioned (e.g., intermediate MRLs from ATSDR) were actually used in the risk assessment. Also, all subchronic toxicity values presented in Table 7-1 appear to be chronic values adopted for subchronic exposure scenarios. Please identify and discuss subchronic exposure scenarios if such scenarios were evaluated.	Yes
K30	**Section 9.1.4, third paragraph:** This discussion of radionuclides and background would be helpful in Section 2.4.	Yes
K31	**Section 9.1.4, third through sixth paragraph:** If an argument is being made that the radionuclides that account for cancer risk within the areas evaluated are background, then a formal evaluation should be provided that at a minimum compares site-specific radionuclide activities to documented background activities.	Yes

#	Comment	Intend to Respond
K32	**Section 10.3:** The use of site specific exposure assumptions and factors (especially exposure frequency and duration) have not been addressed but are a significant source of uncertainty. The fact that these assumptions and factors address only specific exposure conditions that do not apply to other land uses or human activities should be discussed.	Yes
K33	**Section 11.1.1:** Much of this section is material that appears in Section 9.1.4 without additional analysis or interpretation particularly with regard to background radionuclides. Again, if an argument that background radionuclides account for the cancer risk associated with radionuclides, then a formal evaluation should be presented.	Yes
K34	**Section 11.2:** There are no recommendations although this section is titled, "Conclusions and Recommendations".	Yes
K35	**Table 6-1:** Soil ingestion rate for commercial/industrial worker should be 100 mg/day,not 50 mg/day.	Yes
K36	**Appendix F, Results and Discussion, Cancer Risks:** Discussion of acceptable risk ranges is provided but an explicit discussion of the applicability of those risk ranges to the subject site is not. The applicability or appropriateness of risk management ranges other than those generally applied at other sites in Arizona is not provided. A discussion of the applicability of background radionuclide activities to the subject siteis not provided.	Yes
K37	**Appendix F, Results and Discussion, Noncancer Hazards:** Although bioavailability may be a factor in the interpretation of the high hazard indices presented, a more rigorousanalysis is necessary before alternative risk calculations should be considered.	Yes
K38	**Appendix F:** The cancer risk and noncancer hazard estimates presented for the residential exposure scenario do not support an unconditional no further action decision regarding radionuclide and metal contamination based on the significant exceedance of regulatory thresholds.	No
K39	**Appendix F, Table F-7:** Footnote 14 lists the soil ingestion rates for the child and adult incorrectly. Child should be 200 mg/day, adult should be 100 mg/day. How does the adult value presented in this footnote relate to the 50 mg/day ingestion rate presented for the adult receptor in column 6 of this table?	Yes
K40	**Appendix F, Table F-10:** Toxicity values for U234 need to be added to Table 7-2.	Yes

#	Comment	Intend to Respond
K41	**Cover Letter:** The results of the BHHRA do not support an unconditional no further action decision for the areas evaluated on the basis of the exceedance of cancer risk and noncancer hazard thresholds typically accepted on sites in Arizona and throughout the United States and based on the density of soil sampling which does not represent exposure units consistent with residential land use.	No

Please contact the undersigned with any questions

Sincerely,

Arcadis U.S., Inc.

Kathryn Brantingham
Associate Vice President/CPM2

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