Health Consultation—Final

Cyprus Tohono Corporation Mine

Tohono O'odham Nation, Arizona

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Prepared by

Division of Community Health Investigations

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Foreword

The Agency for Toxic Substances and Disease Registry, ATSDR, was established by Congress in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act, also known as the Superfund law. This law set up a fund to identify and clean up our country's hazardous waste sites. The Environmental Protection Agency (EPA) and the individual states regulate the investigation and cleanup of the sites.

Since 1986, ATSDR has been required by law to conduct a public health assessment at each of the sites on the EPA National Priorities List. The aim of these evaluations is to find out if people are being exposed to hazardous substances and, if so, whether that exposure is harmful and should be stopped or reduced. If appropriate, ATSDR also conducts public health assessments when petitioned by concerned individuals. Public health assessments are carried out by environmental and health scientists from ATSDR and states with which ATSDR has cooperative agreements. The public health assessment process allows ATSDR scientists and cooperative agreement partners flexibility in the format of the document when they present findings about the public health impact of hazardous waste sites. The flexible format allows health assessors to convey to affected populations important public health messages in a clear and expeditious way.

Exposure: As the first step in the evaluation, ATSDR scientists review environmental data to see how much contamination is at a site, where it is, and how people might come into contact with it. Generally, ATSDR does not collect its own environmental sampling data but reviews information provided by EPA, other government agencies, businesses, and the public. When there is not enough environmental information available, the report will indicate what further sampling data are needed.

Health Effects: If the review of the environmental data shows that people have or could come into contact with hazardous substances, ATSDR scientists evaluate whether or not these contacts may result in harmful effects. ATSDR recognizes that children, because of their play activities and their growing bodies, may be more vulnerable to these effects. As a policy, unless data are available to suggest otherwise, ATSDR considers children to be more sensitive and vulnerable to hazardous substances. Thus, the health impact to children is considered first when evaluating the health threat to a community. The health impacts to other high-risk groups within the community (such as the elderly, chronically ill, and highly exposed people) also receive special attention during the evaluation.

ATSDR uses existing scientific information to evaluate the possible health effects that may result from exposures. The science of environmental health is still developing, and sometimes scientific information on the health effects of certain substances is not available.

Community: ATSDR also needs to learn from the local community about the site and what concerns they may have about its impact on their health. Consequently, throughout the evaluation process, ATSDR actively gathers information and comments from the people who live or work near a site, including residents of the area, civic leaders, health professionals, and community groups. To ensure that the report responds to the community's health concerns, an early version is also distributed to the public for their comments. All public comments related to the document are addressed in the final version of the report.

Conclusions: The report presents conclusions about the public health threat posed by a site. Ways to stop or reduce exposure will then be recommended in the public health action plan. ATSDR is primarily an advisory agency, so usually these reports identify what actions are appropriate to be undertaken by EPA or other regulatory agencies. However, if there is an urgent health threat, ATSDR can issue a public health advisory warning people of the risks. ATSDR can also recommend health education or pilot studies of health effects, full-scale epidemiology studies, disease registries, surveillance studies or research on specific hazardous substances.

Comments: If, after reading this report, you have questions or comments, we encourage you to send them to us.

Letters should be addressed as follows:

Attention: Manager, ATSDR Record Center, Agency for Toxic Substances and Disease Registry, 1600 Clifton Road (F-09), Atlanta, GA 30333 or ATSDRRecordsCenter@cdc.gov.

Summary

INTRODUCTION The US Environmental Protection Agency (EPA) and the Tohono O'odham Nation (TON) requested the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate human exposures and potential public health impacts at the Cyprus Tohono Mine Site and advise on actions needed to reduce exposures, if necessary. The site is a copper mine located on the Tohono O'odham Nation, 32 miles south of Casa Grande, Arizona. The village of North Komelik is located near the mine site. While the mine is currently in care and maintenance status, the Cyprus Tohono Corporation (CTC) is evaluating whether to resume mining activities. ATSDR used environmental data collected by EPA and input from Tribal officials and community members to evaluate a number of exposure scenarios and draw the following conclusions.

CONCLUSIONS ATSDR reached five important conclusions in this health consultation:

Conclusion 1 Until April 2013, when connection to the Greater Santa Rosa water system was completed, North Komelik drinking water contained arsenic and fluoride at levels that could have harmed people's health. Arsenic and fluoride occur naturally in groundwater at numerous locations on the Tohono O'odham Nation (TON 2010 & TOUA 2011).

Potential health effects of past exposure to arsenic: People who drank North Komelik water for a year or more before April 2013 could have been at increased risk for skin changes, stomachache, and nausea during the time they were drinking the water. If people drank North Komelik water for a lifetime (70 years for adults and 18 years for children), risk of cancer of the skin, bladder, and lung could be elevated.

Potential health effects of past exposure to fluoride: Children under 8 years old who drank North Komelik water for a year or more before April 2013 could have been at increased risk for discoloration of teeth.

Basis for Conclusion Exposure doses exceeded chronic exposure (a year or more) health guidelines for arsenic (adults and children) and fluoride (children only) in the past (pre-April 2013), before a new drinking water source was provided.

Next Steps ATSDR recommends that residents who drank North Komelik water before April 2013 tell their physician about their past exposure to arsenic. ATSDR has produced a Case Study in Environmental Medicine for physicians to utilize when evaluating and caring for arsenic-exposed patients (available at http://www.atsdr.cdc.gov/csem/csem.asp?csem=1).

In light of the naturally-occurring and site-generated groundwater contamination, ATSDR recommends testing any new or existing groundwater wells for chemical and biological contamination prior to any future use as a potable water source.

Conclusion 2	The past drinking water supply may have contained elevated levels of perchlorate, but sampling data are not available to confirm this possibility.
Basis for Conclusion	Perchlorate was detected above comparison values from 2009-2012 in a monitoring well formerly used as North Komelik drinking water well #2. However, perchlorate sampling was not conducted for drinking water or groundwater prior to 2009, and ATSDR had only reviewed perchlorate data up to 2012.The monitoring well with elevated perchlorate levels from 2009-2012 was used as a drinking water well from 1994-2002. Sulfate appears to be a good overall indicator of impacts to groundwater from mine materials, including perchlorate. The sulfate concentrations at North Komelik showed an increasing trend beginning sometime between 1987 and 1990.
Next Steps	North Komelik well #2 has not been used for drinking water since December 2002, therefore there is no current or future exposure to perchlorate in North Komelik drinking water. There are no future plans to use groundwater near the mine as a drinking water source, however if groundwater near the mine is used as a drinking water source in the future, ATSDR recommends sampling for perchlorate and other contaminants of concern.
Conclusion 3	ATSDR concludes that the drinking water the Tohono O'odham Utility Authority (TOUA) currently provides to North Komelik will not harm people's health.
Basis for Conclusion	Since April 2013, TOUA has provided North Komelik drinking water from the Greater Santa Rosa Regional System. This system treats water for arsenic and was in compliance with all U.S. Environmental Protection Agency (EPA) primary drinking water standards (including fluoride) as of December 2013. ATSDR agrees with TOUA and EPA efforts to install, test, and use arsenic treatment techniques to ensure that the Nation's drinking water systems meet EPA standards.
Next Steps	ATSDR recommends that North Komelik residents drink the water TOUA now provides to the community.
Conclusion 4	There are insufficient data to fully assess potential exposures to contaminants that may be present in air or in plants and animals that community members hunt and harvest near the mine.
Basis for Conclusion	Neither air monitoring nor biota data were available from EPA, TON, or CTC. Studies from other sites with the same contaminants and similar exposures suggest that eating plants and animals from the North Komelik area should not pose a health risk (USACHPPM 1994; USAEHA 1994; Chaney 1985; Chaney et al. 1998, Chaney et al. 1999a, and Chaney et al. 1999b). However, local samples would need to be collected to rule out the possibility of contamination in biota near the mine.

Next Steps ATSDR recommends that CTC, EPA, and TON consider collecting baseline air quality data near the North Komelik community. ATSDR will review any future data, upon request.

Conclusion 5 There is not enough information to know if restarting copper mining operations could harm people's health, for instance, through potential impacts to air quality, surface water and groundwater quality, and noise levels.

Basis for Conclusion ATSDR notes that since the Bureau of Land Management (BLM) approved CTC's Mine Plan of Operations in 1995, there have been advances in environmental health sciences that could better assess potential health risks related to future mining activities. An analysis of potential future health risks could address some of the health concerns Tribal members expressed to ATSDR about future mining operations.

Next Steps ATSDR recommends that CTC, TON, BLM, the Bureau of Indian Affairs (BIA), and EPA continue to work together to analyze the potential impacts to air, water, and noise associated with mine restart with the goal of minimizing any potential health risks. ATSDR also encourages air monitoring in the future if mining restarts. Air sampling should include PM 2.5 (particulate matter less than 2.5 micrometers in diameter), metals, and chemicals found in vehicle emissions.

FOR MORE

INFORMATION If you have questions or comments, you can call ATSDR toll-free at 1-800-CDC-INFO and ask for information on the Cyprus Tohono Mine Site. Detailed information about the toxicology of arsenic is available in ATSDR's Toxicological Profile for arsenic at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=22&tid=3; the Toxicological Profile for fluoride is available at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=212&tid=38; the Toxicological Profile for uranium is available at http://www.atsdr.cdc.gov/ToxProfiles/tp.asp?id=440&tid=77; and the Toxicological Profile for perchlorate is available at http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=895&tid=181.

Purpose and Health Issues

In 2009, the US Environmental Protection Agency (EPA) designated the Cyprus Tohono Mine Site, located on the Tohono O'odham Nation (TON or Nation), as a Superfund alternative approach site.[1] In 2012, EPA requested the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate human exposures and potential public health impacts at the site. In a letter dated July 16, 2012, the Nation requested that ATSDR evaluate public health impacts potentially associated with the Cyprus Tohono Corporation Mine site. ATSDR agreed to conduct a health

[1] Additional information about the EPA Superfund alternative approach is available at http://www2.epa.gov/enforcement/superfund-alternative-approach.

consultation in a letter dated December 18, 2012. This document is the result of that agreement and focuses on the specific concerns of the Tribe—water contamination, air quality, and bioaccumulation of contaminants in the foods they hunt and harvest.

An ATSDR health consultation provides advice on specific public health issues that occur as a result of actual or potential human exposure to hazardous material in the environment (ATSDR 2005). Through the health consultation process, ATSDR determined that, until April 2013, the North Komelik community drinking water supply contained levels of arsenic and fluoride that could have harmed people's health. These contaminants occur naturally in the area's groundwater (TON 2010 & Myrt Mcintyre, TOUA, personal communication November 6, 2013); their presence in the North Komelik drinking water supply is not likely related to mining activities. Because the community drinking water is now provided by a water system that treats for arsenic, ATSDR does not expect the water to harm people's health now or in the future. Additionally, average fluoride results sampled from the new system in April 2013 were not at levels expected to harm people's health.

This is the second health consultation that ATSDR has prepared on health issues in the community near the Cyprus Tohono Mine. In 2000, the Assistant Attorney General of the Tohono O'odham Nation requested technical assistance from ATSDR in reviewing sulfate levels in two samples from a drinking water well serving the village of North Komelik. The sulfate concentrations were 470 mg/L and 570 mg/L, and were taken in 2000. The well was suspected of being affected by contaminants from the Cyprus Tohono Corporation Mine site one mile east of the village. ATSDR determined that the sulfate and total dissolved solids levels in the well did not pose a public health concern, but did exceed aesthetic values and therefore might be unpalatable or bad tasting. ATSDR published its findings in 2000 (ATSDR 2000).

Background

Site Description and History

The Cyprus Tohono Corporation Mine site is located on Highway 15, approximately 32 miles south of Casa Grande, Arizona. Cyprus Casa Grande Corporation (later Cyprus Tohono Corporation) purchased the rights to the mine in 1987. The Cyprus Tohono Corporation (CTC) holds a 4,180 acre mining lease with the Bureau of Indian Affairs (BIA) and the Tohono O'odham Nation. The business lease includes an additional 6,325.5 acres, for a total of 10,505.5 acres. In addition, CTC holds a water lease with the BIA to obtain raw water for the mining operations. The site is located in an undeveloped, rural area of the Nation. The lease boundary of the site is approximately 1 mile east of the village of North Komelik (Weston 2003). Figure 1 shows the location of the mine, as well as the former public water supply wells.

Copper mining of low-grade oxide ore from surface outcrops began on the site in the 1880s. Open-pit mining began in 1959. In 1970, large-scale underground mine development began from the decline shaft collar at 1,915 feet above sea level to the lower mine crushing facility located at sea level. Oxide and sulfide ores were mined. Oxide was processed through a vat leaching system using a dilute sulfuric acid solution. The leached ore material was excavated and hauled to the nearby vat leach tailings storage areas. The sulfide ore was processed through a conventional crushing and ball mill system and the tailings were piped to the mill tailings impoundment which was constructed, in part, of vat leach tailings. Excess water was drained to evaporation ponds west of the mill tailings impoundment (Weston 2003).

Mining of the open pit was discontinued in 1997 due to decreased copper prices. In 1999, the entire facility was transitioned into care and maintenance mode. Figure 2 shows a timeline of activities at the mine. The current open pit is approximately 2,000 feet in diameter and 600 feet deep (Weston 2003). The Pit Lake is inaccessible to the public. While the mine is currently inoperative, CTC has a Bureau of Land Management (BLM) mining plan of operation approval and the company is evaluating whether to resume mining activities. BLM was delegated the authority to approve mining plans on Indian lands from the Secretary of Interior in 1983 and by BIA regulations at 25 CFR 216. The current Environmental Impact Statement (EIS) was written and approved in 1995 (BLM 1995).

Figure 1: Map showing former water supply wells and business and mine lease for Cyprus Tohono Mine

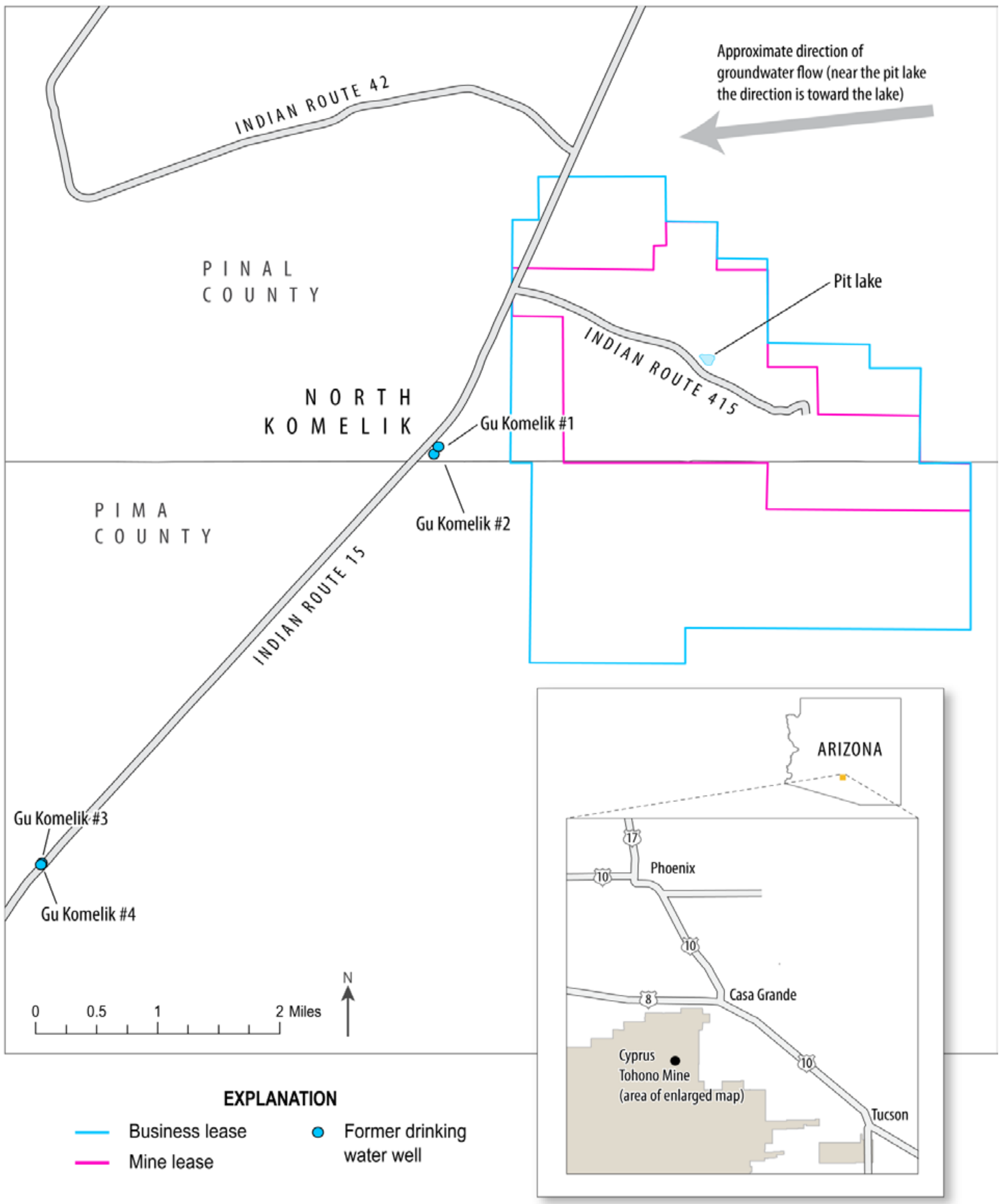
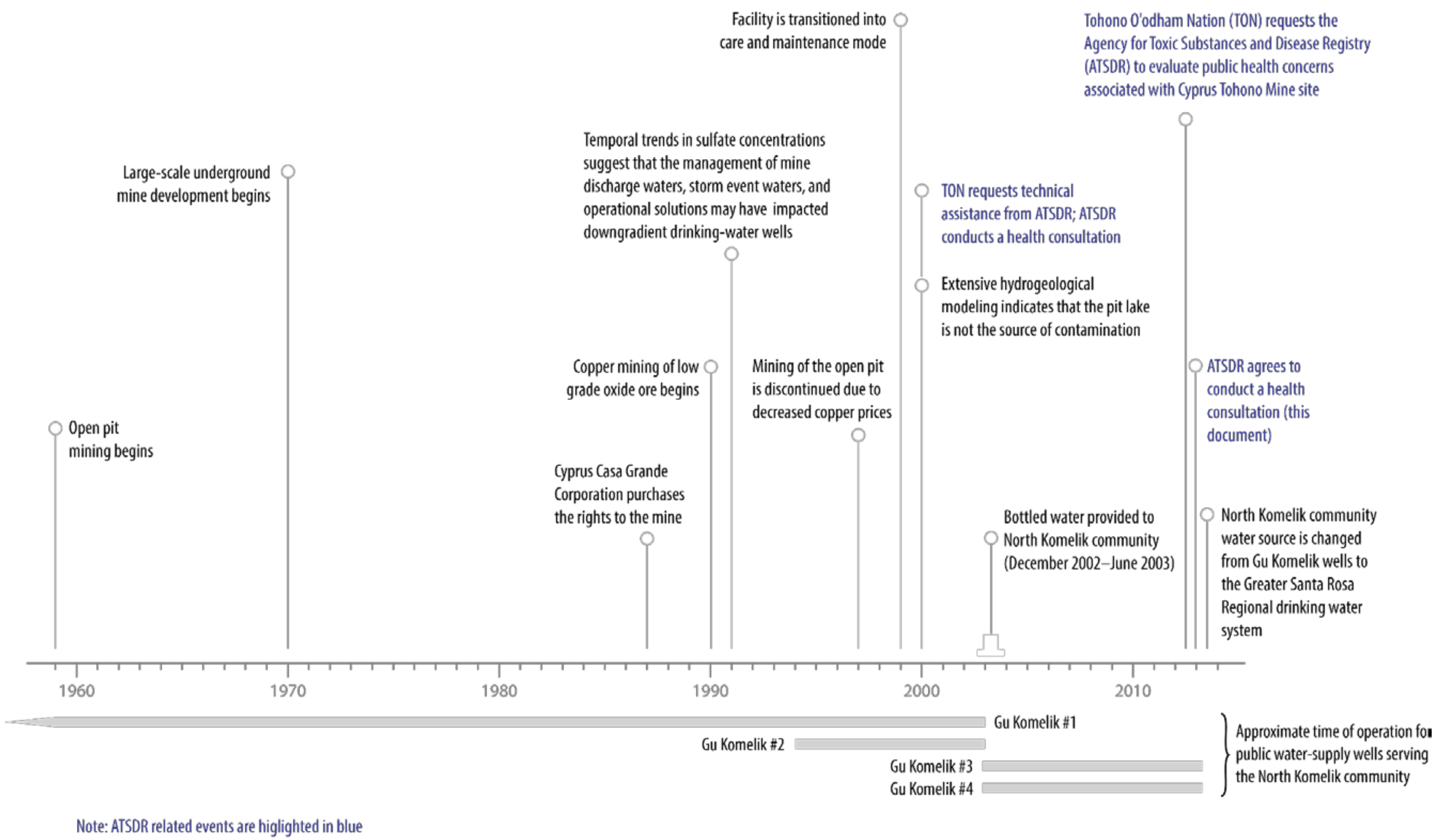


Figure 2: Cyprus Tohono Mine timeline



Demographics

The Cyprus Tohono Mine is located in the Sif Oidak District of the Tohono O'odham Nation. The nearest community of North Komelik is about a mile away from the lease boundary of the mine. According to the 2010 United States Census, the total population within one mile of the site is 83 people, 82 of which are American Indian. There are 10 children aged six and younger, and 19 females of childbearing age. Figures 3 and 4 show the demographics within one and two miles of the mine, and the entire Nation, respectively.

Almost half of Tohono O'odham Tribal members live under the poverty line. Poverty rates on the Nation are more than twice the State and County rates. Half the children under 18 years of age are considered to be living in poverty. The median household income for the TON Tribe is $27,040; less than both the County ($45,521) and the State ($50,448). Households on the Nation are three times more likely to participate in the Supplemental Nutrition Assistance Program (SNAP) than are residents of the State and the County. They are also five times more likely to receive public assistance income than residents of the State or the County. Female head of households account for almost half of all the Nation's households, in contrast to approximately 12% in the State and County. Households of the Nation are more than three times less likely to have single occupants than other households in the State or County, and four times more likely to contain other relatives. Children under age 18 are fifteen times more likely to live with grandparents on the Nation than they are in the State or County (Arizona Rural Policy Institute 2012).

Figure 3: Demographics within 1 and 2 miles of the Cyprus Tohono Mine

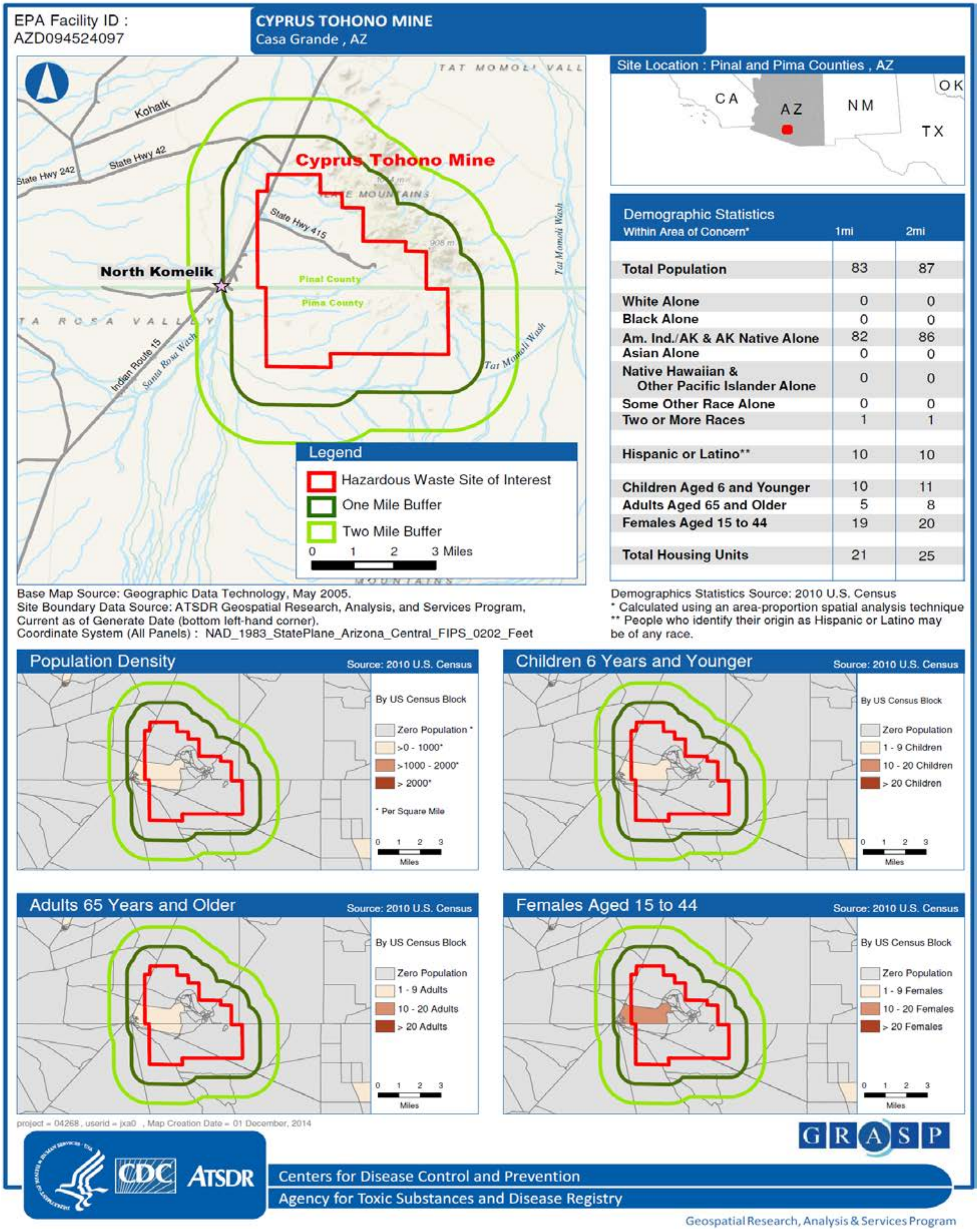
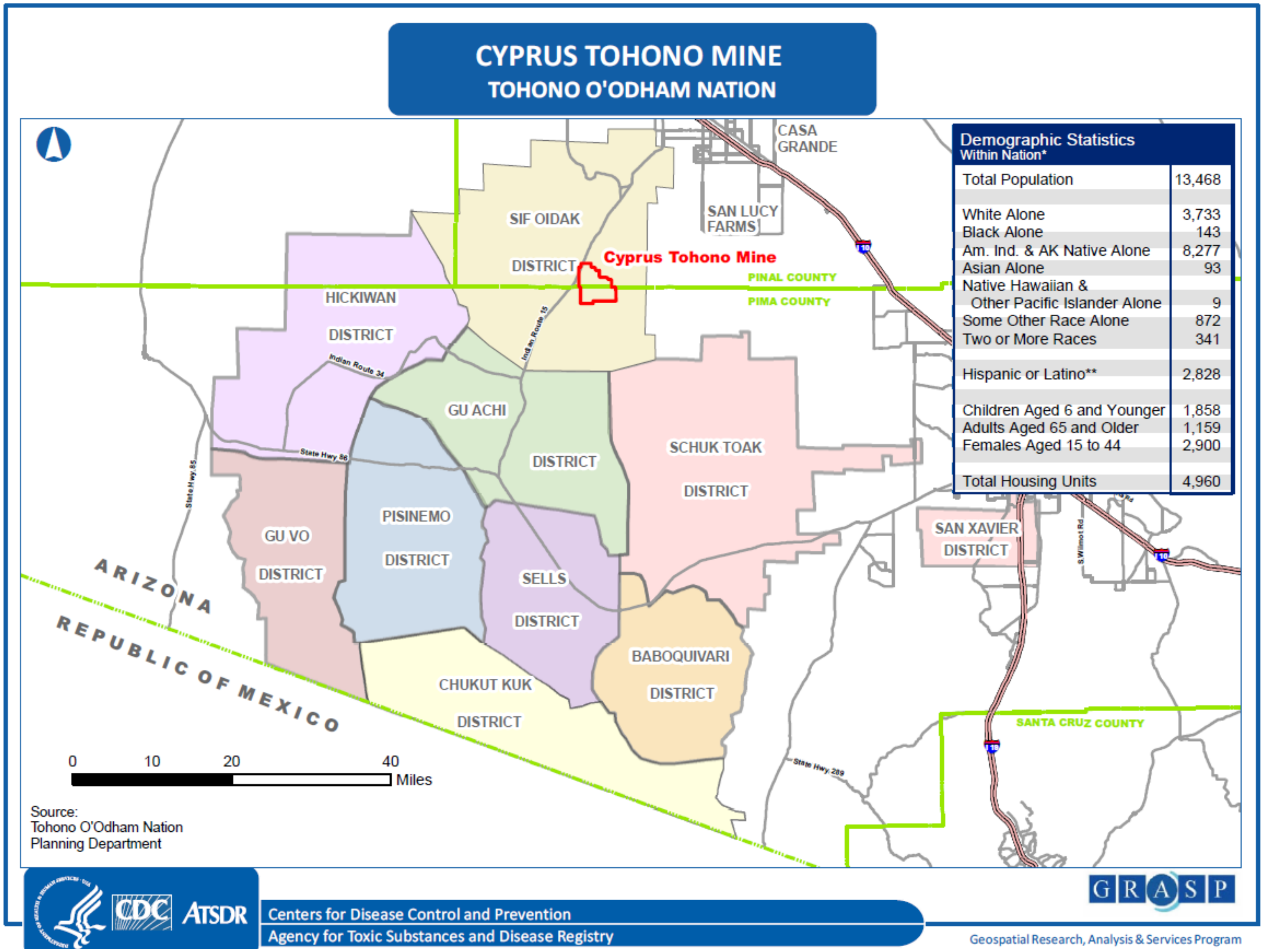


Figure 4: Tohono O'odham Nation Demographics



Demographic Statistics Within Nation*	
Total Population	13,468
White Alone	3,733
Black Alone	143
Am. Ind. & AK Native Alone	8,277
Asian Alone	93
Native Hawaiian & Other Pacific Islander Alone	9
Some Other Race Alone	872
Two or More Races	341
Hispanic or Latino**	2,828
Children Aged 6 and Younger	1,858
Adults Aged 65 and Older	1,159
Females Aged 15 to 44	2,900
Total Housing Units	4,960

Community Health Concerns

ATSDR staff held several conference calls with Tohono O'odham Nation staff to learn about the Nation's health concerns regarding environmental contamination from the mine. ATSDR staff also visited the Nation, the village of North Komelik, and the mine site in September 2013 and January 2015. Through these activities, ATSDR understands that Tribal officials and North Komelik community members have several exposure and health-related concerns including those noted in Table 1.

Table 1: Community health concerns related to the Cyprus Tohono Mine Site

Community Concern	***ATSDR Comment***
Groundwater and drinking water contamination	This concern is discussed in conclusions 1, 2, and 3, the "Groundwater at the Mine Site" section, and the "Drinking Water" section. Groundwater in the vicinity of the site has been impacted by mining activities. Until April 2013, North Komelik drinking water contained arsenic and fluoride at levels that could have harmed people's health. Arsenic and fluoride occur naturally in groundwater at numerous locations on the Tohono O'odham Nation. Past drinking water may have contained elevated levels of perchlorate, but sampling data are not available to confirm this possibility. The drinking water TOUA currently provides to North Komelik is safe. ATSDR provides recommendations to community members and organizations to address health risks associated with contaminants in drinking water.
Air quality impacts, including exposure to dust and Valley Fever	This concern is discussed in conclusion 4 and the "Air Quality and Noise" section. There are not enough data to assess potential exposures to contaminants that may be present in air near the mine. ATSDR recommends that CTC, EPA, and TON consider collecting baseline air quality data near the North Komelik community, in addition to air monitoring data in the future, if mining restarts. If air monitoring is conducted, ATSDR will review the data, upon request. ATSDR can also put the community in touch with appropriate contacts at CDC to assess risk of Valley Fever.
Noise	General information about noise levels associated with mining is provided in the "Air Quality and Noise" section. If noise from mining operations becomes a problem for residents of North Komelik, they may find information on noise exposure from the National Institute for Occupational Safety and Health (NIOSH) at 1-800-CDC-INFO. On the reservation, the Department of Public Safety serves and protects all people within the Tohono O'odham Nation by providing a broad range of public safety services that includes the enforcement of all tribal laws, codes,

	regulations or ordinances as required, including noise violations.
Bioaccumulation of contaminants in animals, and uptake in plants, that Tribal members hunt and harvest in the area	This concern is discussed in conclusion 4 and the "Contamination in Biota" section. There is no data available to assess potential exposures to contaminants in plants and animals that community members hunt and harvest near the mine. Studies from other sites with the same contaminants and similar exposures suggest that eating plants and animals from the North Komelik area should not pose a health risk (USACHPPM 1994; USAEHA 1994; Chaney 1985; Chaney et al. 1998, Chaney et al. 1999a, and Chaney et al. 1999b). However, local samples would need to be collected to rule out the possibility of contamination in biota near the mine.
Potential health risks associated with the proposed resumption of mining activities	This concern is discussed in conclusion 5. There is not enough information to know if restart of copper mining operations could pose future health risks to Tribal members; for instance, through potential impacts to air quality, surface water and groundwater quality, and noise levels. ATSDR recommends that CTC, TON, BLM, BIA, and EPA continue to work together to analyze the potential impacts to air, water, and noise associated with mine restart with the goal of minimizing any potential health risks. The Nation has requested and EPA has recommended that BLM prepare a supplement to the 1995 Environmental Impact Statement before allowing mining operations to resume. BLM has encouraged the parties to continue discussing the proposed mine restart.

Based on ATSDR's review of the available data, contaminants of concern include perchlorate, sulfate, fluoride, uranium, arsenic, and other metals. The details of this review are provided in the next section of this report.

Discussion

Exposure Pathway Evaluation

An exposure pathway is the process by which an individual is exposed to contaminants that come from some source of contamination. There are five elements to an exposure pathway:

1) source of contamination
2) environmental media (water, soil, air, waste, and biota)
3) point of exposure (e.g. residence, business, and recreational site)
4) route of exposure (ingestion, inhalation, and dermal contact)
5) receptor population (exposed people)

An exposure pathway includes all the elements that link a contaminant source to a receptor population. All five elements of the exposure pathway must be present in order for people to be exposed and have potential health effects. The elements of an exposure pathway may occur in the past, present, or future (ATSDR 1992). ATSDR conducted an exposure pathway evaluation, taking into consideration the concerns of the Tribe, in order to determine which pathways are completed.

Groundwater at the Mine Site

Groundwater in the vicinity of the site has been impacted by mining activities over many decades. The Tohono O'odham Nation requested that ATSDR review contaminant data for water from the mine site because the mine is located near the village of North Komelik. The following review of mine site data are meant to aid the Nation in understanding the relative contaminant levels on-site at the mine, compared to those in wells in the village. Community members are not expected to come into contact with water on the mine site. Thus this section is not intended to inform the Nation about health risks related to mine site water. It should also be noted that several of the contaminants present in water in the area are ubiquitous naturally-occurring elements.

Temporal trends in sulfate concentrations suggest that the management of mine discharge waters, storm event waters, and operational solutions may have first impacted downgradient monitoring wells in 1981, and North Komelik supply wells (Gu Komelik #1 in Figure 1) in 1991 (Montgomery Watson 2000). Extensive hydrogeological modeling conducted in the 2000's determined that the Pit Lake is not the source of contamination. Rather, the Evaporation Ponds were the primary source of groundwater contamination. Contaminated soils were excavated, transferred to a lined repository, and capped in 2008. The former Evaporation Ponds are now capped and vegetated.

Groundwater data have been collected since 1980. Between 1980 and 1997, data are scarce and limited to a few locations as the site groundwater investigation was developed in phases. Overall, data came from 142 locations at the site (business lease boundary), and 25 locations outside of the site. Groundwater, mine water, and surface waters were analyzed for 308 different chemicals; there were a total of 142,525 sample results.

Table 2 shows the contaminants that exceed ATSDR Comparison Values (CVs) in groundwater, mine water, and surface water. Comparison Values (CVs) are substance concentrations set far below levels that are known or anticipated to result in adverse health effects. There are different CVs for acute exposure (14 days or less), intermediate exposure (15-364 days), and chronic exposure (365 days or more). ATSDR obtained the sampling results utilized for the summary statistics in Table 2 from the remedial investigation (RI) report (Clear Creek Associates 2012). The data obtained from the RI report included groundwater samples, as well as some surface water and mine water samples. The overwhelming majority of the samples reported in the RI were from groundwater; however, ATSDR could not clearly identify and exclude surface water and mine water samples from the information given in the database, therefore all water sample results were included in the review. There is no exposure to mine water, surface water, or groundwater on the mine site, since the mine is currently in care and maintenance status.

Many of the organic chemicals were not listed in Table 2 because they had detection limits (also known as Practical Quantitation Limits) above the corresponding CV. Therefore, there is no way to know if the actual value exceeded the CV or was something much lower. These chemicals, and their corresponding detection limits and CVs, are listed in Table 5 of Appendix A. The CVs that were below quantitation limits were Cancer Risk Evaluation Guides (CREG). In addition, sometimes it is not technically or practically possible for laboratory equipment to detect and quantify chemicals at levels as low as ATSDR CVs.

Contaminants of potential concern in groundwater at the mine include arsenic, cadmium, lead, perchlorate, radionuclides, and sulfate (Table 2). Note that Di(2-ethylhexyl)phthalate, which also appears in the table, is a common laboratory contaminant. Phthalates are not believed to be present at the site. The maximum extent of groundwater contamination from the site is represented by the perchlorate and sulfate plumes that have migrated 3.5 miles downgradient (northwest-north) from the former evaporation tailings ponds area (Clear Creek Associates 2012).

Perchlorate was first detected in groundwater at the mine in 2009 as part of an EPA initiative to identify perchlorate at contaminated sites (Andria Benner, EPA, personal communication, September 18, 2013). Once perchlorate was detected, it was added to the list of analytes at the site and detected above ATSDR CVs in monitoring wells. At this time, it is not known how or when groundwater at the mine became contaminated with perchlorate (Andria Benner, EPA, personal communication, September 18, 2013). Sulfate appears to be a good overall indicator of impacts to groundwater from mine materials, including perchlorate. The sulfate concentrations at North Komelik showed an increasing trend beginning sometime between 1987 and 1990 (Montgomery Watson 2000). See the Drinking Water section below for discussion of perchlorate in North Komelik drinking water wells.

People do not frequent the mine site currently because it is very remote, fenced, and operating only in care and maintenance mode. The nearest community of North Komelik is about a mile to the west of the mine lease boundary (see Figure 1).

Table 2: Contaminants in groundwater, mine water, and surface water on the mine site exceeding ATSDR comparison values (CV)[2]

Contaminant	Number of samples	Percent of non-detects	Maximum concentration	Number of samples exceeding CV	Percent of samples exceeding CV	ATSDR CV	Type
METALS, concentration in µg/L							
Antimony	1,692	96	9.2	8	0.5	4	RMEG ch
Arsenic	2,283	51	265	539	23.6	0.023	CREG
Beryllium	1,787	90	363.5	8	0.4	20	CEMEG ch
Cadmium	2,096	88	2,060	39	1.9	1	CEMEG ch
Chromium	4,085	85	370.5	1	0.02	100	MCL
Cobalt	92	78	17,000	3	3.3	100	IEMEG ch
Copper	2,285	66	3,620,000	119	5.2	100	IEMEG ch
Lead	2,112	91	100.5	190	9.0	0	MCLG
Manganese	2,277	54	259,000	26	1.1	500	RMEG ch
Molybdenum	85	54	405	2	2.4	50	RMEG ch
Nickel	1,937	83	10,275	8	0.4	200	RMEG ch
Phosphorus	1,229	58	27,300	168	13.7	0.2	RMEG ch
Selenium	2,283	82	557	9	0.4	50	CEMEG ch
Silver	2,074	94	114.5	1	0.05	50	RMEG ch
Thallium	1,692	99	0.8	0	0.0	2	MCL
Uranium	2,057	8.7	530	88	4.3	30	MCL
Vanadium	69	43	5,550	1	1.4	100	IEMEG ch
INORGANIC, concentration in µg/L							
Cyanide	1,661	98	47.5	3	0.2	6	RMEG ch
Perchlorate	540	33	18,500	331	61.3	7	CEMEG ch
ORGANIC, concentration in µg/L							
Benzene	44	95	0.4	0	0.0	0.64	CREG
Di(2-ethylhexyl)phthalate	4	50	3.7	1	25.0	2.5	CREG
Ethylbenzene	44	95	1.3	0	0.0	700	LTHA
RADIOLOGICAL, concentration in pCi/L							
Alpha radiation	3,909	12	1,070	1,067	27.3	15	MCL
Beta radiation	2,751	12	764	1,619	58.9	4	MCL
Uranium 238	2,531	3.3	288	171	6.8	30*	MCL
Uranium	554	2.2	352	141	25.5	30*	MCL

[ATSDR, Agency for Toxic Substances and Disease Registry; **ch**, child; **CEMEG**, Chronic Environmental Media Evaluation Guidelines; **CREG**, Cancer Risk Evaluation Guide; **CV**, comparison value; **IEMEG**, Intermediate Environmental Media Evaluation Guide; **L**, liters; **LTHA**, Lifetime Health Advisory; **MCL**, Maximum Contaminant Level; **MCLG**, Maximum Contaminant Level Goal; **µg**, micrograms; **pCi**, picocuries; **RMEG**, Reference Dose Media Evaluation Guide]
*The USEPA MCL is 30 micrograms per liter, which is approximately 20 pCi/L natural uranium

[2] No completed exposure pathway, for comparison purposes only.

Evaluation of radioactivity in groundwater

Groundwater sampling around the mine also included the analysis of radiological activity and source elements. Over 20,000 groundwater data points collected since 1996 were supplied to ATSDR. The data included gross alpha radiation, gross beta radiation, total uranium as well as individual isotopic analyses, thorium 232, radium 226 (a decay product of uranium 238), radium 228 (a decay product of thorium 232), and radon gas.

Background levels of radioactive elements in groundwater were reported in the Groundwater Remedial Investigation Report (Clear Creek Associates 2012). Although no regulatory requirements exist for radioactive materials in non-drinking water groundwater, ATSDR is reviewing these data at the request of the Nation. No ATSDR CVs exist for radioactivity or elemental uranium so measured values were compared to EPA Maximum Contaminant Levels (MCLs) for radioactivity and uranium in public drinking water supplies.

For those samples not considered background samples, the concentration of adjusted gross alpha and gross beta radiation exceeded the MCL activity values of 15 pCi/L and 50 pCi/L, respectively (EPA 1980). Note that these units are units of radioactivity per volume, not concentration per volume. Likewise, the concentration of total uranium exceeded its MCL of 30 µg/L (which equates to approximately 20 pCi/L). The other radioactive materials detected were not in excess of their respective MCLs.

Elevated levels of gross alpha radiation and gross beta radiation would be expected as the levels of uranium were extremely high, in some cases exceeding 4,500 µg/L (10 CFR 20; ATSDR 2013). The isotopic analyses of these total uranium samples indicated that the uranium present was naturally occurring.

Uranium is a naturally occurring element in some minerals in the region. There are at least two scenarios that might explain why the groundwater radioactivity is elevated in these samples. First, as groundwater flows through such minerals, uranium could be dissolved and move with the groundwater, depending on its chemistry. In the second scenario, the mining and waste generation at the Cyprus Tohono Mine could have generated acidic wastes. These wastes could have interacted with naturally occurring radioactive minerals making them more soluble in the groundwater system. As discussed below, community drinking water wells were tested for radionuclides and none of the average values exceeded ATSDR's current screening levels.

Drinking Water

Past drinking water exposures

Prior to April 2013, the North Komelik community drinking water was drawn from nearby groundwater wells. Before 1986, North Komelik was considered autonomous and the Nation provided drinking water well support via the Tribal Well Maintenance Department. The Indian Health Service (IHS) provided technical assistance (on a limited scale) but was not involved in operation, maintenance or sampling. In 1985, the community of North Komelik, by Resolution, elected to turn the drinking water system over to the Tohono O'odham Utility Authority (TOUA). Upon completion of some needed upgrades by IHS, TOUA assumed control in February 1986 (David Saddler, TOUA, personal communication, March 26, 2013).

As shown on the bottom of the timeline (Figure 2), North Komelik used two wells (Gu Komelik #1 and #2) near the mine boundary before 2003. North Komelik used two newer wells (Gu Komelik #3 and #4) six miles further south of the village from 2003-2013. The water from these wells was blended prior to distribution. The village is now provided drinking water from the Greater Santa Rosa Regional System, more than 5 miles south (upgradient) of the mine.

Concentrations of sulfate and uranium in downgradient wells increased steadily beginning in the 1980's (Weston 2003). High sulfate levels were discovered in community drinking water wells in 1991. In 2000, the Tohono O'odham Nation requested technical assistance from ATSDR in reviewing sulfate and total dissolved solids levels in a drinking water well in the village of North Komelik. ATSDR conducted a health consultation and determined that the sulfate and total dissolved solids levels in the well did not pose a public health concern, but did exceed aesthetic values and therefore might be unpalatable or bad tasting (ATSDR 2000).

Uranium was detected in North (Gu) Komelik drinking water wells 1 and 2 significantly above background levels of 12.8 µg/L beginning in 1998. Two of the 1999 monthly samples exceeded the uranium MCL (at that time) of 20 µg/L (Weston 2003). Note that there is no ATSDR MRL nor EPA RfD for uranium ingestion. The MCL is based on both technical feasibility and health risks. Uranium causes reversible kidney changes, and no amount of uranium exposure is without some kidney effects. The average uranium concentration of all of the samples taken from these two wells between 1980 and 2002 was 15.8 µg/L. In 1991, EPA proposed an MCL of 20 µg/L for uranium, which was determined to be as close as feasible to the Maximum Contaminant Level Goal (MCLG) of 0 µg/L. Based on human kidney toxicity data collected since that time and on EPA's estimate of the costs and benefits of regulating uranium in drinking water, EPA determined that the benefits of a uranium MCL of 20 µg/L did not justify the costs. Instead, EPA determined in 2000 that 30 µg/L is the appropriate MCL, because it maximizes the net benefits (benefits minus costs), while being protective of permanent kidney damage with an adequate margin of safety (EPA 2015). The average of all uranium samples taken in North Komelik between 1980 and 2007 was 15 µg/L. Uranium samples in North Komelik wells never exceeded the current MCL of 30 µg/L. However, because samples occasionally exceeded the former MCL for uranium and drinking water wells contained levels of sulfate and uranium significantly above background levels, the Cyprus Tohono Corporation provided bottled water to the residents of North Komelik until new wells were constructed in April 2003 (Weston 2003).

Perchlorate was detected upon initial testing in a groundwater monitoring well in 2009. Specifically, it was detected above CVs when sampled from 2009-2012[3] in a monitoring well formerly used as North (Gu) Komelik drinking water well #2. This monitoring well was used as a drinking water well from 1994-2002. Use of this well for drinking water was discontinued in December 2002, due to concerns about sulfate and uranium contamination, and residents were temporarily provided bottled water. In April 2003 two new drinking water wells were installed by CTC and bottled water service was discontinued in June 2003. The new wells were located six miles south (upgradient) of the village of North Komelik. Perchlorate was not sampled for prior to 2009, so ATSDR does not know if it was present during the time well #2 was used as a drinking water source. However, any exposure to elevated levels of both sulfate and perchlorate

[3] 2012 is the most recent year that data was reviewed for this health consultation.

would have ceased in December 2002 when North Komelik drinking water wells 1 and 2 were taken out of use.

Since April 2013, the community of North Komelik has received its drinking water from the Greater Santa Rosa Regional System. This system draws water from groundwater wells, but did not have elevated levels of arsenic, fluoride, or sulfate and was in compliance with all U.S. Environmental Protection Agency (EPA) primary drinking water standards as of December 2013. Perchlorate was not sampled for in the Greater Santa Rosa Regional System. The source of drinking water is now more than 5 miles south (upgradient) from the mine. The perchlorate plume has migrated 3.5 miles northwest-north (downgradient) from the mine.

Perchlorate affects the ability of the thyroid gland to take up iodine. Iodine is needed in order for the thyroid to make hormones that regulate many body functions. However, perchlorate's inhibition of iodine uptake must be great enough to affect the thyroid before it is considered harmful (ATSDR 2008). It is not possible to know if residents were exposed to levels of perchlorate sufficient to affect thyroid function because historical perchlorate sampling data does not exist for the time period when wells 1 and 2 were in use.

ATSDR reviewed North Komelik drinking water data provided by EPA and TOUA for samples taken from 1978 to 2013. TOUA sampled for:

- volatile organic compounds (VOCs),
- synthetic organic chemicals (SOCs)/pesticides,
- inorganic chemicals (IOCs),
- radionuclides,
- metals, and
- disinfection byproducts (DBPs).

Contaminants of potential concern

Contaminants of potential concern include those hazardous substances that were detected at elevated levels in drinking water. Sample results were first compared to ATSDR screening levels called Comparison Values (CV). A CV is a calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful health effects in exposed people. Several of these chemicals had detection limits, also known as Practical Quantitation Limits, above ATSDR's lowest CVs; therefore, there is no way to know if the actual value exceeded the CV or was something much lower. These chemicals, and their corresponding detection limits and CVs, are listed in Table 6 of Appendix A. Table 3 shows only those chemicals that exceeded CVs, in drinking water, from 1978 to 2013. Those chemicals with average values greater than CVs (arsenic, fluoride, and uranium) were evaluated further to determine if people's exposure to those chemicals over time could be of health concern. Average values were used to calculate exposure doses because the data were evenly distributed (mean and median confirmed to be very close) and there were very few "non-detect" values.

An exposure dose was not calculated for sulfate because there are no health guidelines with which to compare it, but there is a CDC/EPA study that provides some guidance (EPA 1999). The average concentration of sulfate in 14 samples taken between 1990 and 2006 was 258 mg/L.

EPA has a Secondary Drinking Water Regulation of 250 mg/L for aesthetic effects from sulfate. The 1999 CDC/EPA study of human exposure found no significant difference in lower gastrointestinal problems in people drinking water at up to 1000 mg/L compared to people drinking water with lower levels of sulfates. As noted in ATSDR's 2000 Health Consultation, based on these findings, sulfate levels <1000 mg/L are not expected to have health effects (EPA 1999).

Table 3: List of chemicals in 1978 - 2013 drinking water samples exceeding ATSDR comparison values (CV)

Chemical	Maximum Concentration (mg/L)	Average Concentration (mg/L)	Comparison Value (CV) (mg/L)	CV Type	# exceeding CV/total # samples
arsenic	0.29	0.033	0.000023	CREG	53/53
copper	0.4	0.057	0.10	IEMEG-child	5/45
fluoride	2.6	1.33	0.50	CEMEG-child	15/16
sulfate	577	258	250	EPA Secondary Drinking Water Regulation	6/14
(adjusted) gross alpha	19 pCi/L	9.45 pCi/L	15 pCi/L*	MCL*	3/11
uranium	0.0282	0.015	0.002	IEMEG-child^	37/37

[**CREG**, Cancer Risk Evaluation Guide; **IEMEG**, Intermediate Environmental Media Evaluation Guide; **CEMEG**, Chronic Environmental Media Evaluation Guide; **MCL**, Maximum Contaminant Level]

* The MCL Goal (MCLG) is zero for both gross alpha and uranium.

^Intermediate EMEG for child based on Soluble uranium salts MRL(i). Adult intermediate EMEG is 0.007.

For further evaluation, exposure doses were calculated for arsenic, fluoride, and uranium, the chemicals of concern which had average concentrations exceeding CVs. An exposure dose is the amount of a substance to which a person is exposed over some time period, and is calculated using the following equation:

$$\textbf{Exposure Dose} = \frac{\textbf{conc x IR x EF x ED}}{\textbf{BW x AT}}$$

conc=concentration (mg/L)
IR=ingestion rate (3L/day adult, 1.5L/day child)
EF=exposure frequency (365 days/yr)
ED=exposure duration (30 yrs adult, 6 yrs child)
BW=body weight (70 kg adult, 10 kg child)
AT=averaging time (ED x EF)

Drinking water was blended prior to distribution and the chemical concentrations in different supply wells were all on the same order of magnitude. Therefore, even after blending, finished drinking water would have similar concentrations as the average supply well concentrations. Even so, separate exposure doses were calculated for North (Gu) Komelik drinking water wells 1 and 2 (in use through 2002) and wells 3 and 4 (in use from 2003-2013).

ATSDR used an ingestion rate of 3 liters of drinking water per day (L/day) for adults and 1.5 L/day for children, rather than the standard 2L/day for adults and 1L/day for children. Higher ingestion rates are recommended for Tribal members in arid climates (Sophia Serda, US EPA, personal communication, May 9, 2014). Calculated exposure doses were compared to ATSDR Minimal Risk Levels (MRL). An MRL is an ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful noncancerous effects. The MRL is a conservative estimate of daily human exposure to a substance that is unlikely to result in non-cancer effects over a specified duration. Most MRLs are based on no-observed-adverse-effect-levels (NOAEL) or lowest-observed-adverse-effect-levels (LOAEL). The NOAEL is the highest tested dose of a substance that has been reported to have no harmful health effects in people or animals. The LOAEL is the lowest tested dose of a substance that has been reported to cause harmful health effects in people or animals. *Estimated exposure doses that are less than these health guidelines were not considered to be of health concern.* If an exposure dose is higher than the MRL, it does not necessarily follow that harmful health effects will occur. It simply indicates to ATSDR that further evaluation is required before a conclusion can be drawn. This process enables ATSDR to weigh the available evidence in light of uncertainties and offer perspective on the plausibility of harmful health outcomes under site-specific conditions.

Of the drinking water contaminants analyzed, arsenic, fluoride, and uranium exposure doses exceeded MRLs. Table 4 shows the calculated exposure doses using average arsenic, fluoride, and uranium concentrations. Cancer risk, health guidelines, as well as the basis for the guidelines, are also presented. The exposure doses for arsenic, fluoride, and uranium exceeded the MRL. The exposure doses for arsenic and fluoride exceeded the NOAEL (for children only, in the case of fluoride). The highest average exposure dose for uranium was 25 times below the LOAEL. Therefore, uranium in North Komelik drinking water was unlikely to pose a health risk.

Table 4: Exposure doses for contaminants of concern in North Komelik former drinking water wells

Chemical		**Exposure Dose (wells) [mg/kg/day]**	**Cancer Risk**	**Health Hazard**	**Health Guideline (MRL) [mg/kg/day]**	**Basis for Health Guideline [mg/kg/day]**
arsenic	adult	0.00143 (all wells)	2.1×10^{-3}	yes (past)	0.0003* (chronic)	0.0008 (NOAEL)
		0.00179 (1&2)	2.7×10^{-3}			
		0.00134 (3&4)	2×10^{-3}			

	child	0.00499 (all wells)	5.1 x 10^{-4}			
		0.00627 (1&2)	6.5 x 10^{-4}			
		0.00468 (3&4)	4.8 x 10^{-4}			
fluoride	adult	0.0569 (all wells)	N/A (not considered carcinogenic)	no	0.05* (chronic)	0.15 (NOAEL)
		0.0608 (1&2)				
		0.0485 (3&4)				
	child	0.199 (all wells)		yes (past)		
		0.213 (1&2)				
		0.17 (3&4)				
uranium	adult	0.000644 (all wells)	N/A (not considered carcinogenic)	no	0.0002^ (intermediate)	0.06 (LOAEL)
		0.000676 (1&2)				
		0.000436 (3&4)				
	child	0.00226 (all wells)		no		
		0.00237 (1&2)				
		0.00153 (3&4)				

*Chronic exposure duration of 365 days or more.

^Intermediate exposure duration of 15-364 days. Intermediate MRL for soluble uranium salts MRL(i).

The average dose of arsenic in drinking water exceeded the chronic MRL, as well as the NOAEL. This was true when arsenic levels in North Komelik drinking water wells 1, 2, 3 and 4 were all averaged together; as well as wells 1 and 2 averaged together, and wells 3 and 4 averaged together. Therefore, North Komelik drinking water contained arsenic at levels that could have posed a health risk to people who drank it for a year or more, prior to April 2013. Exposure to inorganic arsenic via drinking water is associated with gastrointestinal, hematological, renal, cardiovascular, dermal, and neurological effects at doses similar to those found in North Komelik’s former drinking water source (ATSDR 2007a). There is some evidence that ongoing exposure of children to arsenic in drinking water may result in lower intelligence quotient (IQ) scores (Wasserman et al. 2014).

Skin changes are some of the most common health effects from exposure to inorganic arsenic. Skin contact with inorganic arsenic may cause redness and swelling. Ingesting low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso. The doses calculated for pre-2013 North Komelik drinking water are consistent with the doses that caused these skin changes in human studies.

Several studies have shown that long-term ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Doses similar to those found in North Komelik's former drinking water source were reported in the literature to increase risk of skin, lung, and bladder cancer (ATSDR 2007a). In this analysis, all arsenic in drinking water was assumed to be the more harmful inorganic form, which is a slightly conservative assumption.

Cancer risk is calculated similarly to exposure dose. However, for an adult, the calculation uses a lifetime risk of 70 years rather than the standard 30 years, and 18 years for children. Multiplying the exposure dose by the EPA slope factor generates the possible cancer risk estimate. The average levels of arsenic in North Komelik drinking water in the past resulted in an estimated cancer risk near 2 in 1,000 (2.1×10^{-3}) for adults, and 5 in 10,000 (5.1×10^{-4}) for children. EPA uses a target range of 1 in 10,000 (1×10^{-4}) to 1 in 1,000,000 (1×10^{-6}) to make risk management decisions at Superfund sites. The calculated cancer risk from North Komelik drinking water represents a moderately increased risk for adults exposed over a lifetime, compared to EPA's target range.

The average dose of fluoride in drinking water exceeded the chronic MRL, as well as the NOAEL (for children only). This was true when fluoride levels in North Komelik drinking water wells 1, 2, 3 and 4 were all averaged together; as well as wells 1 and 2 averaged together. When wells 3 and 4 were averaged together, both the chronic MRL and NOAEL were exceeded for children only. It is important to note, however, that the NOAEL is based on a study of people over 50 years of age who ingested 0.15 mg/kg/day of fluoride. The health effect was an increased fracture rate when people consumed fluoride above the NOAEL. Children under 8 years old who drank North Komelik water for a year or more before April 2013 could have been at increased risk for discoloration of teeth. Small amounts of fluoride help prevent tooth cavities, but high levels can be harmful. When used appropriately (i.e. orally, at low doses), fluoride is both safe and effective in preventing and controlling cavities. However, drinking or eating excessive fluoride during the time teeth are being formed (before 8 years of age) can cause visible changes in teeth. This condition is called dental fluorosis. Higher fluorosis was found in children living in communities with 4 mg/L fluoride in drinking water compared to children living in communities with 1 mg/L fluoride in drinking water (Heifetz et al. 1988; Jackson et al. 1995; Selwitz et al. 1995). At very high concentrations of fluoride, the teeth can become more fragile and sometimes can break.

Background arsenic concentrations in the basin-fill aquifer at the mine exceed the EPA Primary Maximum Contaminant Levels (MCL) for arsenic (up to 0.058 mg/L as compared to the MCL of 0.01 mg/L) and fluoride (up to 10.4 mg/L as compared to the MCL of 4 mg/L) (Clear Creek Associates 2012). Naturally-occurring dissolved arsenic occurs in groundwater at concentrations exceeding the EPA MCL at numerous locations on the Tohono O'odham Nation (TON 2010 & TOUA 2011).

Current exposures to contaminants in drinking water

In April 2013, the North Komelik community wells (Gu Komelik wells 3 and 4 in the timeline above) were taken off-line and the village was supplied with water from the Greater Santa Rosa Regional System. This system draws on groundwater and uses a treatment technology that removes arsenic.

ATSDR reviewed pre- and post-treatment water sampling arsenic results for the Greater Santa Rosa Regional System from April 2013. Before treatment, all of the samples exceeded ATSDR's CV for arsenic. After treatment, arsenic was not detected in the Greater Santa Rosa Regional System sample. It should be noted that the detection limit of 0.5 µg/L was above ATSDR's most conservative CV (CREG) of 0.023 µg/L. It is not possible to know if arsenic was present below the detection limit, yet still above ATSDR's CV. If the average concentration of arsenic in drinking water is assumed to be at the detection limit, the exposure dose for arsenic would be below the MRL. Therefore, even if arsenic is present at or just below the detection limit, it is not expected to harm people's health, now or in the future. Additionally, the detection limit was well below EPA's Maximum Contaminant Level (MCL) of 10 µg/L for arsenic. The MCL is the regulatory standard that public water systems are required to meet.

The discrepancy between ATSDR's CV and the laboratory's Practical Quantitation Limit is a limitation of this analysis. When groundwater and drinking water samples are analyzed in the future, setting detection limits below ATSDR CVs is recommended, when possible.

The average fluoride exposure dose from the Greater Santa Rosa Regional System in April 2013 was above the MRL (for children only) but below the NOAEL that the MRL is based on. Therefore, fluoride is not expected to harm people's health, now or in the future, as long as fluoride concentrations remain approximately the same or lower. Additionally, the maximum value for fluoride never exceeded the regulatory MCL of 4 mg/L; and the average value never exceeded the secondary MCL of 2 mg/L for cosmetic or aesthetic effects.

ATSDR conducted a public meeting in North Komelik during the September 2013 site visit. During this meeting, some residents mentioned a rubber or plastic smell to the new water. According to the TOUA, this is most likely because the water travels through five miles of high-density polyethylene piping to reach the village. The HDPE water piping used meets ASTM[4] and AWWA[5] standards for municipal potable water systems. Although the new pipes were flushed before water distribution to homes began, it may take some time for the smell to completely dissipate. ATSDR recommends that North Komelik residents drink the water TOUA is now providing to the community.

There are no known active public drinking water wells located within several miles of the mine site (Clear Creek Associates 2012). The nearest domestic drinking water well is located 10.4 miles north-northwest (cross-gradient) of the site at Vaiva Vo Farms. Because this well is more than 10 miles away, it is not likely to be affected by the mine. The farm grows mostly cotton and pumps approximately 6,000 acre-ft of irrigation water per year, making it the largest user of groundwater in the valley.

[4] American Society of Testing and Materials

[5] American Water Works Association

Soil and Sediment

ATSDR reviewed Cyprus Tohono Mine soil data from 2003 (Weston 2003) and sediment data from 2002 (USFWS 2002). Soil samples were analyzed for metals, radionuclides, and other constituents such as nitrite, nitrate, and sulfate. Sediment samples were analyzed for metals and radionuclides. ATSDR compared the sample results to available CVs and found elevated levels of antimony, cadmium, chromium, lead, and molybdenum in some of the samples. Most of the samples had elevated arsenic and copper. Exposure doses were not calculated because there is not a completed exposure pathway to soil or sediment at the mine for community members. Additionally, the TON did not list soil or sediment as a concern. ATSDR does not expect people who do not work at the mine to come into direct contact with soils or sediments on the mine site. ATSDR recommends mine workers follow good housekeeping practices such as changing clothes after work, and before entering their vehicles or homes, to prevent bringing contamination from the mine home with them. If the mine reopens, additional worker exposures should be considered.

ATSDR reviewed soil samples taken from the community of North Komelik in 2003 (Weston 2003). These samples were also analyzed for metals, radionuclides, and other constituents such as nitrite, nitrate, and sulfate. Only arsenic was detected above ATSDR's CV. All the samples contained arsenic above ATSDR's CV, but not at levels considerably above local background. Southwestern states have higher rates of naturally-occurring arsenic in soil and groundwater (Gustavsson, Bolviken, Smith, and Severson 2001). An exposure dose was calculated for arsenic in North Komelik soil. The dose was below the MRL; therefore exposure to soil in North Komelik is not expected to harm people's health.

Air Quality

Members of the Nation expressed concern about the air quality in their community. Residents have reported that dust from the mine blows into the village during certain weather conditions (Weston 2003). During ATSDR's September 2013 site visit, members of the North Komelik community expressed concern about air quality in their village. They were particularly concerned about air quality during the monsoon/rainy season, as well as dust control. They informed ATSDR that some children and elders in the village have allergies and asthma, and one resident died of Valley Fever. Valley Fever is caused by a fungus that lives in the top layer of soil. It is endemic to Arizona and other southwestern states. People are more likely to be exposed to Valley Fever in dusty environments. Mining operations that disturb topsoil and expose people to dust could increase the risk for Valley Fever (CDC 2013). However, a preliminary analysis comparing mining and non-mining areas near metropolitan Phoenix found that living near a mine was not associated with higher rates of Valley Fever (ADHS 2008). For more information, residents may visit CDC's website on Valley Fever: http://www.cdc.gov/fungal/coccidioidomycosis/.

Residents also voiced concerns about dust, emissions, and noise from high volume traffic and heavy equipment passing through the village, if mining restarts. Fugitive dust and particulate matter can affect public health. ATSDR attempted to obtain air monitoring data from EPA, TON, and the Cyprus Tohono Mine Corporation, but was unable to find any. If the mine restarts, air quality monitoring may be conducted to fulfill EPA air emission permitting requirements (La Weeda Ward, US EPA, personal communication, November 13, 2013). ATSDR is available, upon request, for consultation in reviewing sampling plans to ensure results can be used to determine possible community health impacts and/or reviewing future air quality data.

Noise

During the September 2013 site visit, members of the Nation expressed concern about noise from the mine, if mining operations resume. The estimated noise level associated with mining activities is 51 decibels (dB) at North Komelik, and 93 dB during blasting activity (BLM 1995). Baseline noise levels associated with rural undeveloped areas is 35 dB (NAS 1977). While ATSDR does not have its own standards for noise exposure, it is recognized that mining-related noise can be unnerving to nearby residents. It is recommended that the mine be required to notify residents of blasting activity so they may be prepared for it. If noise becomes a problem for residents of North Komelik, they may refer to the National Institute for Occupational Safety and Health (NIOSH) website at http://www.cdc.gov/niosh. NIOSH provides some helpful information about mining and noise at http://www.cdc.gov/niosh/topics/noise/ and http://www.cdc.gov/niosh/mining/topics/HearingLossPreventionOverview.html.

Contamination in Biota

According to the TON Wildlife and Vegetation Office and North Komelik residents, members of the Nation harvest plants and animals near the mine. During ATSDR's September 2013 public availability session in North Komelik, residents shared that they hunt mule deer, rabbit (cottontail and jackrabbit), javelina, quail, and mourning doves. Some of the plants that TON members gather are saguaro fruit, prickly pear fruit, cholla buds, mesquite pods, wild spinach, and organ pipe cactus fruit. In the past, residents caught small and large mouth bass and catfish in watering holes near the mine. There is a barbed wire fence that keeps cattle from grazing on the mine property, but ranchers may graze cattle adjacent to the mine site (Lorinda Sam, TON, personal communication, July 17, 2013). It is possible for environmental contaminants to bioaccumulate in animals and to be taken up by plants.

There are no plant or animal data from the Cyprus Tohono Mine area available for review. In the absence of site-specific data, ATSDR reviewed the findings of studies that investigated whether grazing deer at military sites had accumulated surface arsenic (as well as other substances not relevant to the mine site) by grazing on the vegetation at the sites (USACHPPM 1994; USAEHA 1994). The studies showed that deer had limited ability to bioaccumulate arsenic at these sites, and that the risk from consuming meat from the military installation was no greater than the risk from consuming off-post deer (USACHPPM 1994). The authors of these studies concluded that the health hazard from consuming muscle (and liver) from the deer was minimal (USAEHA 1994). The maximum arsenic level in soil in North Komelik samples was 3.3 mg/kg and the average was 2.33 mg/kg. Assuming arsenic levels in vegetation in North Komelik are no higher than those on the military land, potentially harmful levels of arsenic are unlikely to bioaccumulate in deer that graze near the mine. People who consume deer taken from the community are not likely to be at risk from harmful health effects of arsenic. It must be emphasized that this is an assumption, and that North Komelik deer samples would be needed to make a proper estimate of any potential risk from consumption.

Some uptake of arsenic and other metals into plants can occur. Some studies indicate that high concentrations of elements such as zinc, copper, nickel, and arsenic will kill the plant before it can be harmful to animals or humans consuming the plants (ATSDR 2001). People generally have a greater chance of ingesting arsenic from the soil found on plants rather than from arsenic uptake into the plant tissue itself (Chaney 1985; Chaney et al. 1998, Chaney et al. 1999a, and Chaney et al. 1999b).

An exposure dose was calculated for the maximum arsenic concentration in North Komelik soil. The dose was below the MRL. Further, because the soil exposure dose was below the MRL, the amount of arsenic that a person consuming plants grown in the soil would be exposed to is not expected to be above the MRL.

Uranium can also concentrate in plants, but the uranium levels in North Komelik water were much lower than those believed to pose a health hazard when used to irrigate plants that are eaten (Hayes et al. 2000). Uranium was detected in North Komelik soils, but not at levels exceeding ATSDR CVs.

Because metals are often found in soil, ATSDR recommends several best practices for safe gardening. ATSDR recommends that Tribal members thoroughly wash plants before eating them, peel plants with skin, discard outer leaves, and wear gardening gloves and wash hands well after harvesting plants from the soil. Residents may also wish to amend their soil with compost in order to decrease the bioavailability of contaminants, and garden in raised beds with clean soil. These recommendations are offered as best practices for gardening in areas with elevated metals in soil. If biota samples and/or soil and surface water samples are collected and analyzed in the future, ATSDR will review the data, upon request.

Conclusions

1. Until April 2013, North Komelik drinking water contained naturally-occurring arsenic and fluoride at levels that could have harmed people's health. Due to this past exposure to arsenic, people who drank North Komelik water for a year or more before April 2013 could have been at increased risk for skin changes, stomachache, and nausea during the time they were drinking the water. People who drank this water for a lifetime (70 years for adults and 18 years for children) may also be at moderately increased risk of developing skin, bladder, and lung cancers in the future. Due to the past exposure to fluoride, children under 8 years old who drank North Komelik water for a year or more before April 2013 could have been at increased risk for discoloration of teeth.
2. ATSDR concludes that the drinking water Tohono O'odham Utility Authority (TOUA) currently provides in North Komelik will not harm people's health, now or in the future, as long as contaminant concentrations remain approximately the same or lower. TOUA monitors the water in compliance with EPA's Safe Drinking Water Act.
3. ATSDR cannot determine the risk associated with perchlorate exposure because sampling data are not available from the time period when perchlorate may have been present in North Komelik drinking water.
4. There are insufficient data to fully assess the air or biota pathways surrounding the mine. Studies from other sites with the same contaminants and similar exposures suggest that eating plants and animals grown or harvested from the community should not be harmful (USACHPPM 1994; USAEHA 1994; Chaney 1985; Chaney et al. 1998, Chaney et al. 1999a, and Chaney et al. 1999b).
5. There is not enough information to know if possible restart of copper mining operations could pose future health risks to Tribal members. Mine restart could potentially increase noise, impact surface water and groundwater, affect air quality, and disturb soil that could contain the Coccidioides (Valley Fever) fungus. Tribal members are concerned about these potential future environmental and health impacts that could result from restarting the mine.

Recommendations

1. ATSDR recommends that residents who drank North Komelik water before April 2013 tell their physician about their past exposure to arsenic. ATSDR has produced a Case Study in Environmental Medicine for physicians to utilize when evaluating and caring for arsenic-exposed patients (http://www.atsdr.cdc.gov/csem/csem.asp?csem=1).

   In light of the naturally-occurring and site-generated groundwater contamination, ATSDR recommends testing any new or existing groundwater wells for chemical and biological contamination, including perchlorate, prior to any future use as a potable water source.
2. ATSDR recommends that North Komelik residents drink the water that TOUA now provides to the community. ATSDR also agrees with TOUA and EPA efforts to install, test, use, and maintain arsenic treatment techniques to ensure that the Nation's drinking water systems meet EPA standards. When groundwater and drinking water samples are

analyzed in the future, setting detection limits below ATSDR CVs is recommended, when possible.

3. ATSDR recommends that CTC, TON, and/or EPA consider collecting baseline air quality data on PM 2.5 (particulate matter less than 2.5 micrometers in diameter), metals, and chemicals found in vehicle emissions near the mine; as well as air monitoring data in the future, if mining restarts.
4. ATSDR recommends that CTC, TON, Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), and EPA continue to work together to analyze the potential health impacts associated with possible mine restart with the goal of minimizing any potential health risks. ATSDR notes that since CTC's Mine Plan of Operations was approved in 1995, there have been advances in environmental health sciences that could better assess potential health risks related to future mining activities.

Public Health Action Plan

ATSDR will take the following public health actions following release of this health consultation:

- ATSDR is available to meet with Tohono O'odham Nation officials and North Komelik community members to discuss the findings in the health consultation and answer their questions.
- ATSDR is available work with the Tohono O'odham Nation to educate North Komelik community members about risks related to arsenic exposure, including cancer.
- Upon request, ATSDR will consider reviewing additional data that are collected on potential exposure pathways at the site (e.g. air or biota).
- ATSDR will support a potential partnership between the University of Arizona Superfund Research Program and the Tohono O'odham Nation to provide North Komelik community members with educational opportunities related to mining.

Authors, Technical Advisors

Katherine Pugh, MS
Environmental Health Scientist
Division of Community Health Investigations, Western Branch
Agency for Toxic Substances and Disease Registry

Benjamin Gerhardstein, MPH
Public Health Advisor, Region 9
Division of Community Health Investigations, Western Branch
Agency for Toxic Substances and Disease Registry

Paul Charp, PhD
Senior Health Physicist
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry

Reviewers

Kai Elgethun, PhD, MPH
Western Branch Associate Director for Science
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry

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Appendix A: Chemicals with Detection Limits that Exceeded CVs

Table 5: Chemicals in groundwater, mine water, and surface water with detection limits that exceeded ATSDR CVs (date range 2009-2012)

Chemical	Number of samples	Minimum Detection Limit (µg/L)	Comparison Value (CV) (µg/L)	CV type
1,1,2,2-Tetrachloroethane	44	0.5	0.18	CREG
1,2,3-Trichloropropane	44	0.5	0.0012	CREG
1,2-Dibromoethane	44	0.5	0.018	CREG
1,2-Dichloroethane	44	0.5	0.38	CREG
1,2-Diphenylhydrazine	4	0.5	0.044	CREG
3,3'-Dichlorobenzidine	4	0.5	0.078	CREG
Acrylonitrile	4	0.5	0.065	CREG
Benzidine	4	0.5	0.00015	CREG
Benzo(a)pyrene	44	0.1	0.0048	CREG
Bis(2-chloroethyl) ether	4	0.5	0.032	CREG
Dibromochloromethane	44	0.5	0.42	CREG
Hexachlorobenzene	4	0.5	0.022	CREG
Hexachlorobutadiene	44	0.5	0.45	CREG
n-Nitrosodimethylamine	4	0.5	0.00069	CREG
n-Nitrosodi-n-propylamine	4	0.5	0.005	CREG
Pentachlorophenol	4	0.5	0.088	CREG
Vinyl Chloride	44	0.5	0.025	CREG

Table 6: Chemicals in drinking water with detection limits that exceeded ATSDR CVs

Chemical	Detection Limit (µg/L)	Comparison Value (CV) (µg/L)	CV type
1,1,2,2-Tetrachloroethane	0.5	0.18	CREG
1,2,3-Trichloropropane	0.5	0.0012	CREG
1,2-Dichloroethane	0.5	0.38	CREG
1,3-Dichloropropene	0.5	0.35	CREG
Chlorodibromomethane	0.5	0.42	CREG
Dibromomethane	0.5	0.42	CREG
Vinyl Chloride	0.5	0.025	CREG

Appendix B: Exposure Dose and Cancer Risk Calculations

Soil

Chemical	Receptor	Conc mg/kg	IR kg/day	EF Days/Yr	ED Yrs	BW kg	AT days	DOSE (mg/kg/day)	MRL/RFD (mg/kg/day)		Health Guideline
arsenic (max)	adult	3.3	0.0001	365	30	70	10950	4.71E-06	5.0E-03	below	acute MRL
	child	3.3	0.0002	365	6	10	2190	6.60E-05		below	

$$\text{Dose} = \frac{\text{Conc x IR x EF x ED}}{\text{Bw x AT}}$$

Where

Conc. Concentration (mg/kg) (can be average or maximum or other value representative of exposures)

IR Ingestion Rate: adult = 100 mg/day, child = 200 mg/day (standard ATSDR assumptions); 1 mg = 10^{-6} kg

EF Exposure frequency or number of exposed events: 365 days/year (can change according to site-specific exposure)

ED Exposure duration: adult = 30 years, child = 6 years (typical ATSDR assumptions except 70 years for adult exposure to represent lifetime exposure)

BW Body weight: adult = 70 kg, child = 10 kg (represents an infant-1 year old)

AT Averaging time, period over which cumulative exposures are averaged (expressed in days) for noncancer AT=ED*365 days/year, for cancer AT=70 years*365 days/year

Drinking Water

Chemical	Receptor	Conc mg/L	IR L/day	EF Days/Yr	ED Yrs	BW kg	AT days	DOSE (mg/kg/day)	MRL (mg/kg/day)		Health Guideline	Basis for MRL			EPA SF	Cancer Dose	Cancer Risk
arsenic (max)	adult	0.29	3	365	30	70	10950	1.24E-02	5.0E-03	above	acute MRL	5.00E-02	below	LOAEL			
	child	0.29	1.5	365	6	10	2190	4.35E-02		above			below				
arsenic (avg)	adult	0.0333	3	365	30	70	10950	1.43E-03	3.0E-04	above	chronic MRL	8.00E-04	**above**	NOAEL	1.5	1.4E-03	2.1E-03
	child	0.0333	1.5	365	6	10	2190	4.99E-03	3.0E-04	above			**above**		1.5	3.4E-04	5.1E-04
arsenic (avg 1&2)	adult	0.0418	3	365	30	70	10950	1.79E-03	3.0E-04	above	chronic MRL	8.00E-04	**above**	NOAEL	1.5	1.8E-03	2.7E-03
	child	0.0418	1.5	365	6	10	2190	6.27E-03	3.0E-04	above			**above**		1.5	4.3E-04	6.5E-04
arsenic (avg 3&4)	adult	0.0312	3	365	30	70	10950	1.34E-03	3.0E-04	above	chronic MRL	8.00E-04	**above**	NOAEL	1.5	1.3E-03	2.0E-03
	child	0.0312	1.5	365	6	10	2190	4.68E-03	3.0E-04	above			**above**		1.5	3.2E-04	4.8E-04
fluoride (max)	adult	2.6	3	365	30	70	10950	1.11E-01	5.0E-02	above	chronic MRL	1.50E-01	below	NOAEL			
	child	2.6	1.5	365	6	10	2190	3.90E-01		above			**above**				
fluoride (avg)	adult	1.3288	3	365	30	70	10950	5.69E-02	5.0E-02	above	chronic MRL	1.50E-01	below	NOAEL			
	child	1.3288	1.5	365	6	10	2190	1.99E-01		above			**above**				
fluoride (avg 1&2)	adult	1.4182	3	365	30	70	10950	6.08E-02	5.0E-02	above	chronic MRL	1.50E-01	below	NOAEL			
	child	1.4182	1.5	365	6	10	2190	2.13E-01		above			**above**				
fluoride (avg 3&4)	adult	1.132	3	365	30	70	10950	4.85E-02	5.0E-02	below	chronic MRL	1.50E-01	below	NOAEL			
	child	1.132	1.5	365	6	10	2190	1.70E-01		above			**above**				
fluoride (avg Santa Rosa)	adult	0.98	3	365	30	70	10950	4.20E-02	5.0E-02	below	chronic MRL	1.50E-01	below	NOAEL			
	child	0.98	1.5	365	6	10	2190	1.47E-01		above			below				
uranium (max)	adult	0.0282	3	365	30	70	10950	1.21E-03	2.0E-04	above	int MRL	6.00E-02	below	LOAEL			
	child	0.0282	1.5	365	6	10	2190	4.23E-03		above			below				
uranium (avg)	adult	0.015	3	365	30	70	10950	6.44E-04	2.0E-04	above	int MRL	6.00E-02	below	LOAEL			
	child	0.015	1.5	365	6	10	2190	2.26E-03		above			below				
uranium (avg 1&2)	adult	0.0158	3	365	30	70	10950	6.76E-04	2.0E-04	above	int MRL	6.00E-02	below	LOAEL			
	child	0.0158	1.5	365	6	10	2190	2.37E-03		above			below				
uranium (avg 3&4)	adult	0.0102	3	365	30	70	10950	4.36E-04	2.0E-04	above	int MRL	6.00E-02	below	LOAEL			
	child	0.0102	1.5	365	6	10	2190	1.53E-03		above			below				

$$\text{Dose} = \frac{\text{Conc} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{Bw} \times \text{AT}}$$

Where

Conc.	Concentration (mg/L) (can be average or maximum or other value representative of exposures); ug = 10^{-3} mg
IR	Ingestion Rate: adult = 2 liters/day, child = 1 liter/day (standard ATSDR assumptions, may use 3 liters/day for adult and 1.5 liters/day for child if in a warm climate)
EF	Exposure frequency or number of exposed events: 365 days/year (can change according to site-specific exposure)
ED	Exposure duration: adult = 30 years, child = 6 years (typical ATSDR assumptions, except 70 years for adult exposure and 18 years for child exposure to represent lifetime exposure)
BW	Body weight: adult = 70 kg, child = 10 kg (represents an infant-1 year old)
AT	Averaging time, period over which cumulative exposures averaged (expressed in days) for noncancer AT=ED*365 days/year, for cancer AT=70 years*365 days/year

Appendix C: ToxFAQs for arsenic, fluoride, uranium, and perchlorate

Arsenic - ToxFAQs™

CAS # 7440-38-2

This fact sheet answers the most frequently asked health questions (FAQs) about arsenic. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to higher than average levels of arsenic occur mostly in the workplace, near hazardous waste sites, or in areas with high natural levels. At high levels, inorganic arsenic can cause death. Exposure to lower levels for a long time can cause a discoloration of the skin and the appearance of small corns or warts. Arsenic has been found in at least 1,149 of the 1,684 National Priority List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is arsenic?

Arsenic is a naturally occurring element widely distributed in the earth's crust. In the environment, arsenic is combined with oxygen, chlorine, and sulfur to form inorganic arsenic compounds. Arsenic in animals and plants combines with carbon and hydrogen to form organic arsenic compounds.

Inorganic arsenic compounds are mainly used to preserve wood. Copper chromated arsenate (CCA) is used to make "pressure-treated" lumber. CCA is no longer used in the U.S. for residential uses; it is still used in industrial applications. Organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.

What happens to arsenic when it enters the environment?

- Arsenic occurs naturally in soil and minerals and may enter the air, water, and land from wind-blown dust and may get into water from runoff and leaching.
- Arsenic cannot be destroyed in the environment. It can only change its form.
- Rain and snow remove arsenic dust particles from the air.
- Many common arsenic compounds can dissolve in water. Most of the arsenic in water will ultimately end up in soil or sediment.
- Fish and shellfish can accumulate arsenic; most of this arsenic is in an organic form called arsenobetaine that is much less harmful.

How might I be exposed to arsenic?

- Ingesting small amounts present in your food and water or breathing air containing arsenic.
- Breathing sawdust or burning smoke from wood treated with arsenic.
- Living in areas with unusually high natural levels of arsenic in rock.
- Working in a job that involves arsenic production or use, such as copper or lead smelting, wood treating, or pesticide application.

How can arsenic affect my health?

Breathing high levels of inorganic arsenic can give you a sore throat or irritated lungs.

Ingesting very high levels of arsenic can result in death. Exposure to lower levels can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands and feet.

Ingesting or breathing low levels of inorganic arsenic for a long time can cause a darkening of the skin and the appearance of small "corns" or "warts" on the palms, soles, and torso.

Skin contact with inorganic arsenic may cause redness and swelling.

Almost nothing is known regarding health effects of organic arsenic compounds in humans. Studies in animals show that some simple organic arsenic

Arsenic

CAS # 7440-38-2

compounds are less toxic than inorganic forms. Ingestion of methyl and dimethyl compounds can cause diarrhea and damage to the kidneys.

How likely is arsenic to cause cancer?

Several studies have shown that ingestion of inorganic arsenic can increase the risk of skin cancer and cancer in the liver, bladder, and lungs. Inhalation of inorganic arsenic can cause increased risk of lung cancer. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic arsenic is carcinogenic to humans.

How can arsenic affect children?

There is some evidence that long-term exposure to arsenic in children may result in lower IQ scores. There is also some evidence that exposure to arsenic in the womb and early childhood may increase mortality in young adults.

There is some evidence that inhaled or ingested arsenic can injure pregnant women or their unborn babies, although the studies are not definitive. Studies in animals show that large doses of arsenic that cause illness in pregnant females, can also cause low birth weight, fetal malformations, and even fetal death. Arsenic can cross the placenta and has been found in fetal tissues. Arsenic is found at low levels in breast milk.

How can families reduce the risks of exposure to arsenic?

- If you use arsenic-treated wood in home projects, you should wear dust masks, gloves, and protective clothing to decrease exposure to sawdust.
- If you live in an area with high levels of arsenic in water or soil, you should use cleaner sources of water and limit contact with soil.
- If you work in a job that may expose you to arsenic, be aware that you may carry arsenic home on your clothing, skin, hair, or tools. Be sure to shower and change clothes before going home.

Is there a medical test to determine whether I've been exposed to arsenic?

There are tests available to measure arsenic in your blood, urine, hair, and fingernails. The urine test is the most reliable test for arsenic exposure within the last few days. Tests on hair and fingernails can measure exposure to high levels of arsenic over the past 6-12 months. These tests can determine if you have been exposed to above-average levels of arsenic. They cannot predict whether the arsenic levels in your body will affect your health.

Has the federal government made recommendations to protect human health?

The EPA has set limits on the amount of arsenic that industrial sources can release to the environment and has restricted or cancelled many of the uses of arsenic in pesticides. EPA has set a limit of 0.01 parts per million (ppm) for arsenic in drinking water.

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit (PEL) of 10 micrograms of arsenic per cubic meter of workplace air (10 μg/m^3) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Health and Human Services. Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

FLUORIDES, HYDROGEN FLUORIDE, AND FLUORINE

CAS # 7681-49-4, 7664-39-3, 7782-41-4

Division of Toxicology ToxFAQs™ September 2003

This fact sheet answers the most frequently asked health questions (FAQs) about fluorides, hydrogen fluoride, and fluorine. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Fluorides are naturally occurring compounds. Low levels of fluorides can help prevent dental cavities. At high levels, fluorides can result in tooth and bone damage. Hydrogen fluoride and fluorine are naturally-occurring gases that are very irritating to the skin, eyes, and respiratory tract. These substances have been found in at least 188 of the 1,636 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What are fluorides, hydrogen fluoride, and fluorine?

Fluorides, hydrogen fluoride, and fluorine are chemically related. Fluorine is a naturally-occurring, pale yellow-green gas with a sharp odor. It combines with metals to make fluorides such as sodium fluoride and calcium fluoride, both white solids. Sodium fluoride dissolves easily in water, but calcium fluoride does not. Fluorine also combines with hydrogen to make hydrogen fluoride, a colorless gas. Hydrogen fluoride dissolves in water to form hydrofluoric acid.

Fluorine and hydrogen fluoride are used to make certain chemical compounds. Hydrofluoric acid is used for etching glass. Other fluoride compounds are used in making steel, chemicals, ceramics, lubricants, dyes, plastics, and pesticides.

Fluorides are often added to drinking water supplies and to a variety of dental products, including toothpaste and mouth rinses, to prevent dental cavities.

What happens to fluorides, hydrogen fluoride, and fluorine when they enter the environment?

- Fluorine cannot be destroyed in the environment; it can only change its form. Fluorine forms salts with minerals in soil.
- Hydrogen fluoride gas will be absorbed by rain and into clouds and fog to form hydrofluoric acid, which will fall to the ground.
- Fluorides released to the air from volcanoes and industry are carried by wind and rain to nearby water, soil, and food sources.
- Fluorides in water and soil will form strong associations with sediment or soil particles.
- Fluorides will accumulate in plants and animals. In animals, the fluoride accumulates primarily in the bones or shell rather than in soft tissues.

How might I be exposed to fluorides, hydrogen fluoride, and fluorine?

- The general population can be exposed to fluorides in contaminated air, food, drinking water and soil.
- People living in communities with fluoridated water or high levels of naturally-occurring fluoride may be exposed to higher levels.
- People who work or live near industries where fluoride-containing substances are used may be exposed to higher levels.

How can fluorides, hydrogen fluoride, and fluorine affect my health?

Small amounts of fluoride help prevent tooth cavities, but high levels can harm your health. In adults, exposure to high levels of fluoride can result in denser bones. However, if exposure is high enough, these bones may be more fragile and brittle and there may be a greater risk of breaking the bone. In animals, exposure to extremely high doses of fluoride can result in decreased fertility and sperm and testes damage.

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html

Fluorine and hydrogen fluoride are very irritating to the skin, eyes, and respiratory tract. At high levels, such as may occur through exposure from an industrial accident, hydrogen fluoride may also damage the heart.

How likely are fluorides, hydrogen fluoride, and fluorine to cause cancer?

Most of the studies of people living in areas with fluoridated water or naturally high levels of fluoride in drinking water did not find an association between fluoride and cancer risk. Two animal cancer studies were inconclusive. The international Agency for Research on Cancer (IARC) has determined that the carcinogenicity of fluoride to humans is not classifiable.

How can fluorides, hydrogen fluoride, and fluorine affect children?

When used appropriately, fluoride is both safe and effective in preventing and controlling cavities. Drinking or eating excessive fluoride during the time teeth are being formed (before 8 years of age) can cause visible changes in teeth. This condition is called dental fluorosis. At very high concentrations of fluoride, the teeth can become more fragile and sometimes can break.

No studies have addressed whether low levels of fluoride will cause birth defects in humans. Birth defects have not been found in most studies of animals.

How can families reduce the risk of exposure to fluorides, hydrogen fluoride, and fluorine?

In the home, children may be exposed to high levels of fluorides if they swallow dental products containing fluoridated toothpaste, gels, or rinses. Parents should supervise brushing and place at most, a small pea size dab of toothpaste on the brush and teach children not to swallow dental products. People who live in areas with high levels of naturally-occurring fluoride in the water should use alternative sources of dinking water, such as bottled water.

Is there a medical test to show whether I've been exposed to fluoride, hydrogen fluoride, and fluorine?

Tests are available to measure fluoride levels in urine; these tests can determine if you have been exposed to higher-than-normal levels of fluorides. The urine test must be performed soon after exposure because fluoride that is not stored in bones leaves the body within a few days. The test cannot be performed in the doctor's office, but can be done at most laboratories that test for chemical exposure. The urine fluoride test cannot be used to predict the nature or severity of toxic effects. Bone sampling can be done in special cases to measure long-term exposure to fluorides.

Has the federal government made recommendations to protect human health?

The EPA has set a maximum amount of fluoride allowable in drinking water of 4.0 milligrams per liter of water (4.0 mg/L). For the prevention of dental decay, the Public Health Service (PHS) has, since 1962, recommended that public water supplies contain between 0.7 and 1.2 milligrams of fluoride per liter of drinking water.

The Occupational Safety and Health Administration (OSHA) has set limits of 0.2 milligrams per cubic meter (0.2 mg/m^3) for fluorine, 2.0 mg/m^3 for hydrogen fluoride, and 2.5 mg/m^3 for fluoride in workroom air to protect workers during an 8-hour shift over a 40-hour work week.

Source of Information

Agency for Toxic Substances and Disease Registry (ATSDR). 2003. Toxicological Profile for Fluorides, Hydrogen Fluoride, and Fluorine. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Natural & Depleted Uranium - ToxFAQs™

CAS # 7440-61-1

This fact sheet answers the most frequently asked health questions (FAQs) about natural and depleted uranium. For more information, call the CDC Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Natural uranium is a naturally occurring chemical substance that is mildly radioactive. Depleted uranium is an adjusted mixture of natural uranium isotopes that is less radioactive. Everyone is exposed to low amounts of uranium through food, water, and air. Exposure to high levels of natural or depleted uranium can cause kidney disease. Uranium has been found in at least 67 of 1,699 National Priorities List (NPL) sites identified by the Environmental Protection Agency (EPA).

What is uranium?

Uranium is a naturally occurring radioactive element. It is naturally present in nearly all rocks, soils, and air; can be redistributed in the environment through wind and water erosion; and more can be released into the environment through volcanic eruptions. Natural uranium is a mixture of three isotopes: ^{234}U,235U, and ^{238}U. The most common isotope is ^{238}U; it makes up over 99% of natural uranium. All three isotopes behave the same chemically, but they have different radioactive properties. The half-lives of uranium isotopes (the amount of time needed for half of the isotope to give off its radiation and change into a different element) is very long. The least radioactive isotope is ^{238}U with a half life of 4.5 billion years. Depleted uranium is a mixture of the same three uranium isotopes except that it has very little ^{234}U and ^{235}U. It is less radioactive than natural uranium. Enriched uranium is another mixture of isotopes that has more ^{234}U and ^{235}U than natural uranium. Enriched uranium is more radioactive than natural uranium.

Uranium is almost as hard as steel and much denser than lead. Natural uranium is used to make enriched uranium; depleted uranium is the leftover product. Enriched uranium is used to make fuel for nuclear power plants. Depleted uranium is used as a counterbalance on helicopters rotors and airplane control surfaces, as a shield to protect against ionizing radiation, as a component of munitions to help them penetrate enemy armored vehicles, and as armor in some parts of military vehicles.

What happens to uranium when it enters the environment?

- Natural and depleted uranium that exist in the dust in the air settle onto water, land, and plants. Uranium deposited on land can be reincorporated into soil, washed into surface water, or stick to plant roots. Uranium in air, surface water, or groundwater can be transported large distances.

How might I be exposed to uranium?

- Food and drinking water are the primary sources of intake for the general public. Very low levels of uranium are found in the air.
- Root crops such as potatoes, parsnips, turnips, and sweet potatoes contribute the highest amounts of uranium to the diet. Because uranium in soil can stick to these vegetables, the concentrations in these foods are directly related to the concentrations of uranium in the soil where the foods are grown.
- In most areas of the United States, low levels of uranium are found in the drinking water. Higher levels may be found in areas with elevated levels of naturally occurring uranium in rocks and soil.
- People may be exposed to higher levels of uranium if they live near uranium mining, processing, and manufacturing facilities. People may also be exposed if they live near areas where depleted uranium weapons are used.

How can uranium enter and leave my body?

Most of the uranium you breathe or ingest is not absorbed and leaves the body in the feces. Absorbed uranium is deposited throughout the body. The highest levels are found in the bones, liver, and kidneys; 66% of the uranium in the body is found in your bones. It can remain in the bones for a long time; the half-life of uranium in bones is 70–200 days. Most of the uranium that is not in bones leaves the body in the urine in 1–2 weeks.

How can uranium affect my health?

Natural uranium and depleted uranium have the identical chemical effect on your body. Kidney damage has been seen in humans and animals after inhaling or ingesting

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Natural and Depleted Uranium

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uranium compounds. However, kidney damage has not been consistently found in soldiers who have had uranium metal fragments in their bodies for several years. Ingesting water-soluble uranium compounds will result in kidney effects at lower doses than following exposure to insoluble uranium compounds.

Studies in animals have shown that inhalation exposure to insoluble uranium compounds can result in lung damage. In male rats and mice, exposure to uranium has been shown to decrease fertility. Uranium compounds on the skin caused skin irritation and mild skin damage in animals.

Health effects of natural and depleted uranium are due to chemical effects and not to radiation.

How likely is uranium to cause cancer?

Neither the National Toxicology Program (NTP), the International Agency for Research on Cancer (IARC) nor the EPA have classified natural uranium or depleted uranium with respect to carcinogenicity.

How can uranium affect children?

The health effects seen in children from exposure to toxic levels of uranium are expected to be similar to the effects seen in adults.

Exposure of animals to high levels of uranium during pregnancy, which caused toxicity in the mothers, has induced early deaths and birth defects in the young. It is not clear if this can happen in the absence of effects on the mother. We do not know whether uranium can cause birth defects in people. There are some studies that suggest that exposure to depleted uranium increased the frequency of birth defects, but the studies are deficient to allow valid conclusions.

How can families reduce the risk of exposure to uranium?

- Avoid eating root vegetables grown in soils with high levels of uranium. Consider washing fruits and vegetables grown in that soil and discard the outside portion of root vegetables.
- Consider having your water tested if you suspect that your drinking water might have elevated levels of uranium; if elevated levels are found, consider using bottled water.

Is there a medical test to determine whether I've been exposed to uranium?

Natural uranium is in your normal diet, so there will always be some level of uranium in all parts of your body. If depleted uranium is present, it adds to the total uranium level. Uranium can be measured in blood, urine, hair, and body tissues. Most tests are for total uranium; however, expensive tests are available to estimate the amounts of both natural and depleted uranium that are present.

Has the federal government made recommendations to protect human health?

The government has made recommendations for uranium which apply to natural and depleted uranium combined.

The EPA established a maximum drinking water contaminant level of 0.03 mg/L.

The Occupational Safety and Health Administration (OSHA) has limited workers' exposure in air to an average of 0.05 mg U/m^3 for soluble uranium and 0.25 mg U/m^3 for insoluble uranium over an 8-hour workday.

The National Institute for Occupational Safety and Health (NIOSH) recommends workers exposure be limited to 0.05 mg U/m^3 of air for soluble uranium and 0.2 mg U/m^3 for insoluble uranium averaged over a 10-hour workday and recommends that exposure to soluble uranium not exceed 0.6 mg U/m^3 for more than 15 minutes.

The Nuclear Regulatory Commission (NRC) has established air concentration limits for uranium and its individual isotopes that apply to occupational exposure and releases from facilities.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2013. Toxicological Profile for Uranium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information?

For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Human Health Sciences, 1600 Clifton Road NE, Mailstop F-57, Atlanta, GA 30333.

Phone: 1-800-232-4636.

ToxFAQs™ Internet address via WWW is http://www.atsdr.cdc.gov/toxfaqs/index.asp.

ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

PERCHLORATES

CAS #10034-81-8, 7778-74-7, 7790-98-9, 7601-89-0, 7791-03-9

Division of Toxicology and Environmental Medicine ToxFAQs™ September 2005

This fact sheet answers the most frequently asked health questions (FAQs) about perchlorates. For more information, call the ATSDR Information Center at 1 888 422 8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration of exposure, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Solid perchlorates are very reactive chemicals that are used mainly in fireworks, explosives, and rocket motors. The general population may be exposed to perchlorate from contaminated drinking water, food, and milk. High levels of perchlorate can affect the thyroid gland, which in turn can alter the function of many organs in the body. Developing organisms can be especially susceptible. The Environmental Protection Agency (EPA) reported that perchlorate has been found in 40 of the 1547 National Priority List sites.

What are perchlorates?

Perchlorates are colorless salts that have no odor. There are five perchlorate salts that are manufactured in large amounts: magnesium perchlorate, potassium perchlorate, ammonium perchlorate, sodium perchlorate, and lithium perchlorate. Perchlorate salts are solids that dissolve easily in water.

The health effects of perchlorate salts are due to the perchlorate itself and not to the other component (i.e., magnesium, ammonium, potassium, etc.).

One place where perchlorate occurs naturally is in saltpeter deposits in Chile, where the saltpeter is used to make fertilizer. In the past, the United States used a lot of this fertilizer on tobacco plants, but now uses very little. Perchlorates are very reactive chemicals that are used mainly in explosives, fireworks, and rocket motors. The solid booster rocket of the space shuttle is almost 70% ammonium perchlorate.

Perchlorates are also used for making other chemicals. Many years ago, perchlorate was used as a medication to treat an over-reactive thyroid gland.

What happens to perchlorate when it enters the environment?

- Normally, perchlorate does not remain in soil because it washes away with rain water. However, in arid environments, it may remain in soil to provide a potential for dermal exposure.
- Perchlorate will eventually end up in ground water.
- We do not know exactly how long perchlorate will last in water and soil, but the information available indicates that it is a very long time, that is, many years.
- Perchlorates have been found in milk and food.

How might I be exposed to perchlorate?

Perchlorates entered the environment where rockets were made, tested, and taken apart. Factories that make or use perchlorates may also release them to soil and water.

- Drinking water that is contaminated with perchlorate. Most contaminated water supplies are found near sites where perchlorate has been found.
- Eating food, including milk, contaminated with perchlorate.
- Living near factories that make fireworks, flares, or other explosive devices, or living near a waste site or a rocket manufacturing or testing facility.
- Smoking or chewing tobacco may expose you to perchlorates because a variety of tobacco products contain perchlorate.

How can perchlorate affect my health?

Perchlorate affects the ability of the thyroid gland to take up iodine. Iodine is needed to make thyroid hormones that regulate many body functions after they are released into the blood. Perchlorate's inhibition of iodine uptake must be great enough to affect the thyroid before it is considered harmful. Healthy volunteers who took about 35 milligrams (35 mg) of perchlorate every day for 14 days showed no signs of abnormal functioning of their thyroid gland or any other health problem; however, it did inhibit iodide uptake by the thyroid. Studies of workers exposed for years to approximately the same amount of perchlorate found no evidence of alterations in the worker's

PERCHLORATES

CAS #10034-81-8, 7778-74-7, 7790-98-9, 7601-89-0, 7791-03-9

thyroids, livers, kidneys, or blood. However, there is concern that exposure of people to higher amounts of perchlorate for a long time may lower the level of thyroid activity leading to hypothyroidism. Low levels of thyroid hormones in the blood may lead to adverse effects on the skin, cardiovascular system, pulmonary system, kidneys, gastrointestinal tract, liver, blood, neuromuscular system, nervous system, skeleton, male and female reproductive system, and numerous endocrine organs. Studies in animals also have shown that the thyroid gland is the main target of toxicity for perchlorate. Animal studies provided inconclusive results regarding effects of perchlorate on the immune system. Perchlorate did not affect reproduction in a study in rats.

How likely is perchlorate to cause cancer?

There are no adequate studies of exposure to perchlorate and cancer in humans. Long-term exposure to perchlorate induced thyroid cancer in rats and mice, but there are reasons to believe that humans are less likely than rodents to develop this type of cancer. The National Academy of Sciences (NAS) concluded that based on the understanding of the biology of human and rodent thyroid tumors, it is unlikely that perchlorate poses a risk of thyroid cancer in humans. Perchlorate has not been classified for carcinogenic effects by the Department of Health and Human Services (DHHS), the EPA, or the International Agency for Research on Cancer (IARC).

How can perchlorate affect children?

Children are more likely to be affected by perchlorate than adults because thyroid hormones are essential for normal growth and development.

Perchlorate has been found in breast milk. Limited studies of thyroid function of babies and young children whose mothers were exposed to perchlorate in their drinking water have not indicated thyroid abnormalities associated with perchlorate.

Studies in animals have shown that perchlorate can alter the thyroid gland in the newborn animals. Studies in rats also found alterations in the brain from pups born to rats exposed to perchlorate while pregnant; however, as rats are more sensitive to agents that disturb thyroid function than are humans, the relevance of rat studies to humans is limited.

How can families reduce the risk of exposure to perchlorate?

❑ It is very unlikely that perchlorate is present in the average home or apartment.

❑ Use bottled water if you live near an area where perchlorate has been found and you have concerns about the presence of perchlorate in your tap water.

❑ Prevent children from playing in dirt or eating dirt if you live near a waste site that has perchlorates.

❑ Contact local water purveyors, health agencies, state environmental agencies, or EPA regional offices if you have any questions.

Is there a medical test to show whether I've been exposed to perchlorate?

There are no routine medical tests to measure perchlorate in the body, but it can be measured in the urine with special tests. Because perchlorate leaves the body fairly rapidly, perchlorate in urine only indicates recent exposure and is not an indication of any adverse health effects.

Has the federal government made recommendations to protect human health?

The EPA is currently evaluating whether regulation of perchlorate in drinking water would be appropriate for reducing risks to human health. Also, other federal agencies, including the United States Department of Agriculture, the Food and Drug Administration, and the Department of Defense, are also working on this.

Reference

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Perchlorates (Draft for Public Comment). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Appendix D: Public Comments

Comment set #1

1) On page 19 paragraph 2, the last sentence statement would be appropriate in the beginning conclusion 1 and the summary fact sheet where it states: "Naturally-occurring dissolved arsenic occurs in groundwater at concentrations exceeding the EPA MCL at numerous location on the Tohono O'odham Nation…" This would be a stronger statement in Conclusion 1 page 1 and add …*not associated with the mining activities*…

2) On page 24 there is a typo: bullet point one under Public Health Plan which says "…Tohono O'odham National…" instead of "…Tohono O'odham Nation…"

3) Information concerning possible/potential perchlorate exposure health risks should be included, even though there isn't data to support actual exposure, in the Conclusions section(s). You have expressed that ATSDR has considered this modification and it will be made.

4) Table 1 & 2 of the report could lead to confusion, however the report explains why only arsenic and fluoride are of concern, if read.

ATSDR response

1) ATSDR changed Conclusion 1 to read, "Arsenic and fluoride occur naturally in groundwater at numerous locations on the Tohono O'odham Nation."
2) Corrected
3) Added a perchlorate conclusion, and discussion to *Past drinking water exposures* section.
4) Added "on the mine site" to Table 2 (which was Table 1 in the public comment version) title to distinguish between Table 2 and Table 3 (Table 3 was Table 2 in the public comment version).

Comment set #2

Drinking water:

1. There is no mention of the potential perchlorate exposure in North Komelik public drinking water system in the past. Specifically between the years of 1993 to 2002. (ten year time period)
2. Based on the current Remedial Investigation study by the USEPA that is ongoing, when you analyze the footprint of sulfate and perchlorate, they are very similar in nature and extent. One can reasonable conclude that both contaminants movement and presents are similar in the main basin aquifer. If that statement is true, then if the North Komelik (Gu Komelik) wells had a water sample that measured sulfate over the USEPA secondary drinking water standard of 250 ppm, which was true for the North Komelik drinking supply wells beginning in 1993 through 2002 (Gu Komelik #1 & #2), then perchlorate most likely was also present in levels above the Interim Health Advisory level of 15 ppb set by USEPA.

Recommended actions:

1. In the ATSDR report, discuss the relationship between sulfate and perchlorate as manifested in the USEPA Remedial Investigation study. Basically acknowledged the fact that when sulfate is sampled in wells above the 250 ppm secondary drinking water standard, it is common to have perchlorate above the 15 ppb Interim Health Advisory level in the same well.
2. Once the relationship between sulfate and perchlorate has been acknowledged, then discuss historical water sampling on sulfate at the North Komelik (Gu Komelik #1 & #2) wells that were the primary drinking water source for the community between the time period of 1993-2002. Also, acknowledge that perchlorate was not sampled for in the North Komelik (Gu Komelik #1 & #2) wells during this time period.
3. After providing the history, provide risks associated with perchlorate exposures over this length of time and recommendations for community members to follow if they are concerned about this potential perchlorate exposure.
4. Acknowledge that in December 2002, the North Komelik (Gu Komelik) wells were taking off line and replace with wells drilled in the Santa Rosa Valley that did not have elevated levels of sulfate and perchlorate that exceed the USEPA drinking water standards.
5. Acknowledge that the community's current drinking water is not impacted by sulfate or perchlorate at this time, since the primary drinking water supply is from the Greater Santa Rosa Regional system as of April 2013.

Note: I believe the last two recommendations are partially addressed in the ATSDR report, but they don't reference the potential historic perchlorate exposure to community members, which the Department is strongly recommending to include.

Verifying dataset on water quality

1. While analyzing the data ATSDR was relying upon, some discrepancies did appear that need to be investigated, which are the following:
    a. The amount of water quality data is limited. The Department believes there is more data available.

Recommend Action: The Department is recommending ATSDR to revisit this item by contacting both the Tohono O'odham Utility Authority and Cyprus to compare the current dataset against what these entities have available. If there is more data available, the Department recommends ATSDR to reanalyze the new dataset and revise the report as necessary based on new information.

b. Correctly identify the well names with well locations. While reviewing the water quality dataset, names such as Well #3, NK-3 & North Komelik #3 were commonly seen. In 2002, North Komelik #3 well was drilled south of the village approximately 6 miles and was used as the primary drinking water supply well for the village of North

Komelik from 2002-2013. When you analyze the data for the #3 name, you will find water quality samples taken prior to 2002. If ATSDR made the assumption that these names are referring to the same well location, this would be incorrect because it would be physically impossible to take a water sample before a well like, North Komelik #3 was installed.

Recommended Action: Providing a quality control check on this item to verify the data being analyzed at a particular well location is correct. It is imperative to conduct this quality control check before a proper evaluation of the health risks can be conducted. This comment also applies to wells that have the following numbers in their name: #1, #2 and #4.

Air quality statements

1. In several locations throughout the Health Consultation report, ATSDR mentions the Nation having plans to start air monitoring in the near future.

Recommend Action: I would recommend removing these statements unless you get confirmation from the Department of Public Safety – Environmental Protection Office that these activities will indeed take place. I believe the Environmental Protection Office at the January 14, 2015 meeting did say air monitoring activities are necessary, but when I asked them about plans to install air monitoring devices, no response was given.

Future public meeting with the community of North Komelik, Sif Oidak District and the Tohono O'odham Nation.

1. During a discussion with ATSDR staff, it was mentioned that unless major changes were made in the Health Consultation report, ATSDR customarily would not return to present a final report to the public.

Recommended Action: Acknowledging the complexity of issues at this site and multiple unanswered concerns that are documented above, I believe it would align with ATSDR mission to protect the public's health and I would hope and support ATSDR in continuing to host public meetings to education everyone affected. The progress reports, final recommendations and report findings are complex and need to have public interaction face to face, not only to educate affected people, but to allow the Nation's leadership to gain a better understanding on how to properly protect the public from environmental issues in the North Komelik area that will be everlasting.

ATSDR response

Drinking water recommended actions:

1) Added discussion of the relationship between sulfate and perchlorate in the *Groundwater at the Mine Site* section and Conclusion 2.
2) Added discussion of historical water sampling for sulfate to *Contaminants of potential concern* section. Expanded discussion of perchlorate in *Past drinking water*

exposures section, including acknowledgement that perchlorate was not sampled for during the time wells 1 and 2 were used as drinking water wells.

3) Added discussion of the health effects of perchlorate to the *Past drinking water exposures* section. ATSDR cannot provide the risks associated with perchlorate exposure because sampling data are not available from the time period during which perchlorate may have been present in drinking water.
4) Acknowledged that post-December 2002 drinking water source did not have elevated levels of sulfate or perchlorate in the *Past drinking water exposures* section.
5) Acknowledged that community's current drinking water is not impacted by sulfate or perchlorate in the *Past drinking water exposures* section.

Verifying dataset on water quality recommended actions:

a) Integrated additional drinking water data from TOUA's Water Quality Analysis for North Komelik, and EPA's PA/SI report.
b) Quality checked water dataset. Considered samples taken prior to 2002 to be from wells 1 or 2.

Air quality statements recommended action:

1) Removed statements about forthcoming air quality monitoring.

Future public meeting recommended action:

1) Upon request from the Tohono O'odham Nation, ATSDR will conduct a public meeting to present the final Health Consultation, if possible.

Comment set #3

- Discussion historic uranium levels in Komelik wells 1 and 2, utilizing data from preliminary assessment and other non-EPA drinking water program sources.
- Providing separate exposure estimates for Komelik wells 1 and 2 (1970s-2003) and Komelik wells 3 and 4 (2003-2013) (in addition to averaging across the entire timeframe and all wells, as was done in the draft Health Consultation)
- Adding a conclusion specific to perchlorate

ATSDR response

- Added discussion of historic uranium levels to *Past drinking water exposures* section.
- Provided separate exposure doses for North Komelik wells 1 & 2 and 3 & 4 in Table 4.
- Added Conclusion 2 pertaining to perchlorate.

Comment set #4

Inconsistent Language Regarding "Health Risks" and "Elements of Potential Concern"

The current draft of the HC interchangeably uses language regarding “harm” or “impacts” to health, versus possible hazardous substance “exposures” or possible health “risks.” This could be misconstrued to suggest that ATSDR has identified cases of actual exposures that have resulted in harm to residents. To illustrate: one draft conclusion in the HC suggests that residents have suffered arsenic “exposure” sufficient to recommend that physicians medically “treat” them. Instead, the proper recommendation likely should be that interested residents simply be “examined” for possible exposure and medical concerns, if any.

Second, ATSDR has substituted several terms for the “elements of potential concern” it reviewed to produce the HC and Summary, such as “dangerous chemical,” “hazardous material,” or just “chemicals.” As noted in our electronic comments, these terms appear to be used interchangeably (even though they may have distinct legal or factual connotations); moreover, ATSDR has not identified or explained any differences between the terms. In turn, some parts of the HC and Summary mistakenly seem to imply that the elements in question are (1) not naturally occurring, and (2) “hazardous” at any concentration. Thus, CTC recommends that ATSDR use consistent terminology in the HC and Summary (e.g., “elements of potential concern”) to avoid confusion.

Apparent Recommendations Regarding the National Environmental Policy Act or the Mine Plan of Operations (“MPO”)

ATSDR has included statements in the HC and Summary suggesting that some agencies undertake a process to revisit or update BLM’s 1995 review of the Environmental Impact Statement (“EIS”) and MPO for the Mine. These statements are not relevant to the HC process, and are beyond ATSDR’s area of expertise. At the time of this writing, CTC is having ongoing discussions with the Tohono O’odham Nation (“TON”), the U.S. Bureau of Land Management (“BLM”), and the U.S. Bureau of Indian Affairs (“BIA”) regarding EIS requirements, the MPO, and the path forward. Because those discussions are ongoing, CTC respectfully requests that ATSDR not suggest a process to revisit or identify possible updates to the EIS or MPO in the HC or the Summary. In any case, those ongoing discussions are beyond the scope of the HC.

Conjectural Discussion of Impacts from Mine Restart

ATSDR has added language to the HC and Summary that seem to forecast the types of impacts that ATSDR believes might occur if the CTC Mine is restarted, without having any real knowledge about how the mine would be operated if it were to restart. This language was apparently included to respond to community concerns. However, based on the available analysis presented in the HC, some of the suggested impacts would be non-existent (e.g., ATSDR has concluded there likely will be no increase to Valley Fever risk), even assuming that a restart occurs. In some passages, ATSDR does not qualify that the various anticipated impacts are merely “possible” or conjectural at this time.

Furthermore, as noted above, CTC is having ongoing discussions with the TON, BLM, and BIA regarding the possible restart. Thus, as above, CTC respectfully requests that ATSDR limit its forecasts of impacts regarding the possible restart; discussions on that topic are ongoing. In any case, those ongoing discussions are beyond the scope of the HC.

Origin of Elements of Potential Concern

Some parts of the HC appear to suggest that the elements of potential concern detected in drinking water before 2013 were not naturally-occurring in groundwater, or implicitly were attributable to the CTC Mine. These suggestions appear to be directly inconsistent with ATSDR's specific findings in the HC. ATSDR should clearly distinguish when it is identifying elements that are naturally-occurring (e.g., arsenic and fluoride previously detected in drinking water),9 versus those that may be attributable to human activities (e.g., those detected in water samples collected at the CTC Mine that clearly have no nexus to the human health risks from the pre-2013 drinking water source). It is important to describe these elements accurately throughout the document — otherwise, lay readers could make inaccurate assumptions regarding particular elements and their sources. Thus, ATSDR should clearly identify the actual or likely source(s) it has identified at the outset of the relevant passages of the HC and Summary10 to avoid confusion.

Water Quality Database

On page 12 of the HC, ATSDR states that it could not clearly identify or exclude surface water or mine water samples from the database provided by CTC. Surface samples collected from the pit lake at the CTC Mine were clearly identified in the database, and CTC identified in its Remedial Investigation Report the locations where mine water (versus groundwater) samples were collected. As such, CTC invites further coordination with ATSDR on this point to help refine the HC; for instance, CTC would be happy to help ATSDR omit irrelevant data to help clarify the discussion in the draft HC. At a minimum, ATSDR should note that there is no exposure to mine water, surface water, or groundwater on the mine site.

ATSDR response

- For consistency, used the term "harm." Changed "treat" to "examine.", Used "contaminants of concern" when referring to chemicals or elements detected above ATSDR comparison values.
- Changed recommendation to, "CTC, TON, BLM, Bureau of Indian Affairs (BIA), and EPA continue to work together to analyze the potential health impacts associated with possible mine restart with the goal of minimizing any potential health risks."
- Added "possible" and "potential" when discussing mine restart.
- Added "naturally-occurring" to arsenic and fluoride discussions.
- Added, "There is no exposure to mine water, surface water, or groundwater on the mine site, since the mine is currently in care and maintenance status," to *Groundwater at the Mine Site* section.

Comment set #5

ATSDR's evaluation of the overall risk is sound. The immediate health risk from water ingestion is moot since the community water system from TOUA is working and safe. I did have some issues with how they calculated their exposure and risk assessments for arsenic and fluoride historical exposures (basically not complete enough, i.e. they left out respiratory exposures from showering, absorption via bathing, ingestion from foods cooked in water, etc.), but they probably didn't see the need for that level of calculation since they determined there was a cancer risk and regardless - current drinking water is safe (and I agree).

The only recommendation I have is the air quality piece will need to be thorough. PM10 monitoring is great, but like ATSDR said, it has to be carefully designed. I am not familiar with which grant EPO received, but that grant may not be robust enough to meet the data demands of a community wide airborne health risk assessment. This is especially true if the analysis includes only 1 machine, 1 limited time space, gravimetric analysis only versus metals, etc. - the data EPO would collect in those cases would be very limited. EPO would hopefully also coordinate with Pima County's air quality division (to compare data with their PM10 and PM2.5 monitors), ADEQ (if applicable, and EPA (if applicable) since their monitors are close enough to provide some reference. I would recommend metals analysis of air and adding PM 2.5 monitors (especially if blasting is conducted).

I've been told no private wells exist at N. Komelik (aside from company monitoring wells) and I think that is what all the reports have said, so I don't have any concerns there. The estimated trophic level transfers of arsenic from vegetation, to animal, to human are accurate and we agree with ATSDR on that assessment – livestock and plant life are likely safe for consumption so long as proper sanitary techniques are followed for consumption preparation.

ATSDR response

- Added, "PM 2.5 (particulate matter less than 2.5 micrometers in diameter)" to list of recommended air monitoring constituents, which included metals.

Comment set #6

Overall, we are satisfied with your evaluations and conclusions.

We suggest you revisit the question of whether arsenic uptake in plants could occur at levels that might be harmful, which may depend on the type of plant, and the volume and frequency of plant consumption.

We suggest you confirm with EPA the date when the site became a Superfund Alternative Site, as there appears to be a discrepancy between the health consultation (states 2012) and the EPA website (states 2009).

We would also like to offer our resources to work with the North Komelik community and ATSDR to answer questions that arose during the health consultation which were unable to be answered, if the community is interested, and if the questions align with our capabilities and expertise.

ATSDR response

- Added, "An exposure dose was calculated for the maximum arsenic concentration in North Komelik soil. The dose was below the MRL; therefore exposure to soil in North Komelik is not expected to harm people's health. Likewise, because the soil exposure dose was below the MRL, the amount that a person consuming plants grown in the soil is exposed to would not be expected to be above the MRL," to the *Contamination in Biota* section. This was previously discussed in the *Soil and Sediment* section. Offered additional best practices for gardening.

- Corrected date mine became a Superfund Alternative Site.
- Public Health Action Plan states, "ATSDR will support a potential partnership between the University of Arizona Superfund Research Program and the Tohono O'odham Nation to provide North Komelik community members with educational opportunities related to mining."