

Health Consultation

PUBLIC COMMENT VERSION

Cyprus Tohono Corporation Mine
Tohono O'odham Nation, Arizona

DECEMBER 8, 2014

COMMENT PERIOD ENDS: MARCH 6, 2015

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

PUBLIC COMMENT RELEASE

Cyprus Tohono Corporation Mine
Tohono O'odham Nation, Arizona

Prepared By:

Western Branch
Division of Community Health Investigations
Agency for Toxic Substances and Disease Registry

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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 which chemicals are present at a site, where they are, and how people might come into contact with them. 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 (even if naturally occurring) 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.

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. While the mine is currently inoperative, 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 four important conclusions in this health consultation:

Conclusion 1 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 in the area.

Potential health effects of past exposure to arsenic: People who drank North Komelik water for more than one year before April 2013 could have been at increased risk for skin changes, stomachache, nausea, and cancer of the skin, liver, bladder, and lung during the time they were drinking the water. These people may also be at increased risk of developing those cancers in the future.

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

Basis for Conclusion Exposure doses exceeded chronic exposure (more than 1 year) 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 recommends that physicians who treat North Komelik residents follow ATSDR guidance for 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 ATSDR concludes that the drinking water the Tohono O’odham Utility Agency (TOUA) currently provides in North Komelik does not pose a current or future health hazard.

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 3 There are insufficient data to fully assess potential exposures to chemicals 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 be harmful (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, in addition to air monitoring data in the future if mining restarts. Possible air sampling could include particulate matter, metals and chemicals found in vehicle emissions. If biota samples are collected and analyzed, ATSDR will review the data, upon request.

Conclusion 4 There is not enough information to know if restart of copper mining operations could pose future health risks to tribal members; for instance, by impacting air quality, surface water and groundwater quality, and noise levels.

Basis for Conclusion ATSDR notes that since 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, the Bureau of Land Management (BLM), the Bureau of Indian Affairs (BIA), and EPA consider analyzing the potential impacts to air, water, and noise associated with mine restart with the goal of minimizing any potential health risks.

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>.

Purpose and Health Issues

In 2012, 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 EPA requested the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate human exposures and potential public health impacts at the site and advise on actions needed to mitigate exposures, if necessary. 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 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. ATSDR used the tribal consultation process to gain input from the Nation about the evaluation process.

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 the North Komelik community drinking water contained levels of arsenic and fluoride that could have posed a health hazard until April 2013. These chemicals and elements 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 pose a current or future health hazard. Additionally, average fluoride results sampled from the new system in April 2013 were not at levels expected to cause a health hazard.

This is the second document 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 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 a health consultation (ATSDR 2000).

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

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), along with its holding company Freeport-McMoRan Copper & Gold, Inc., 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, 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

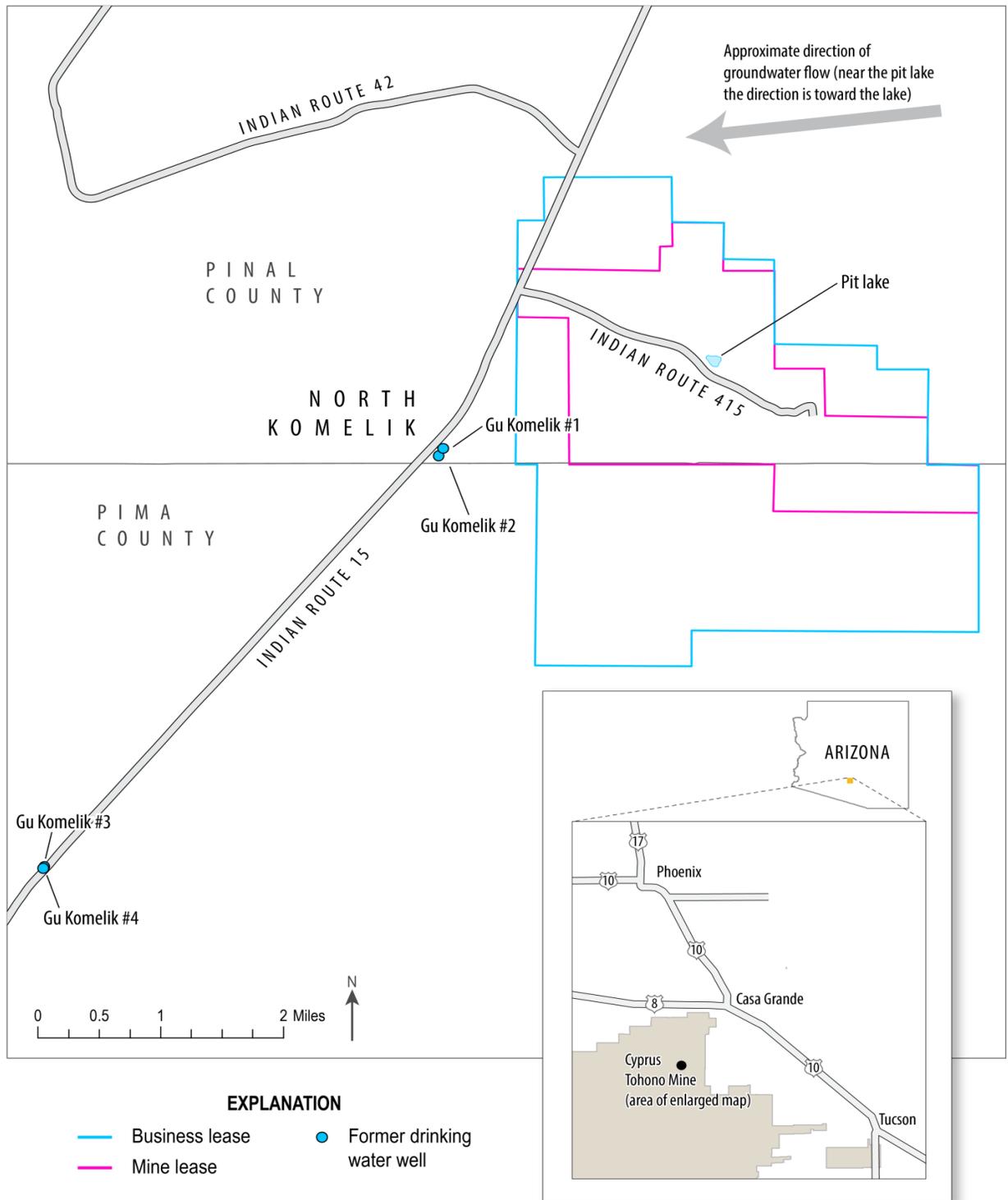
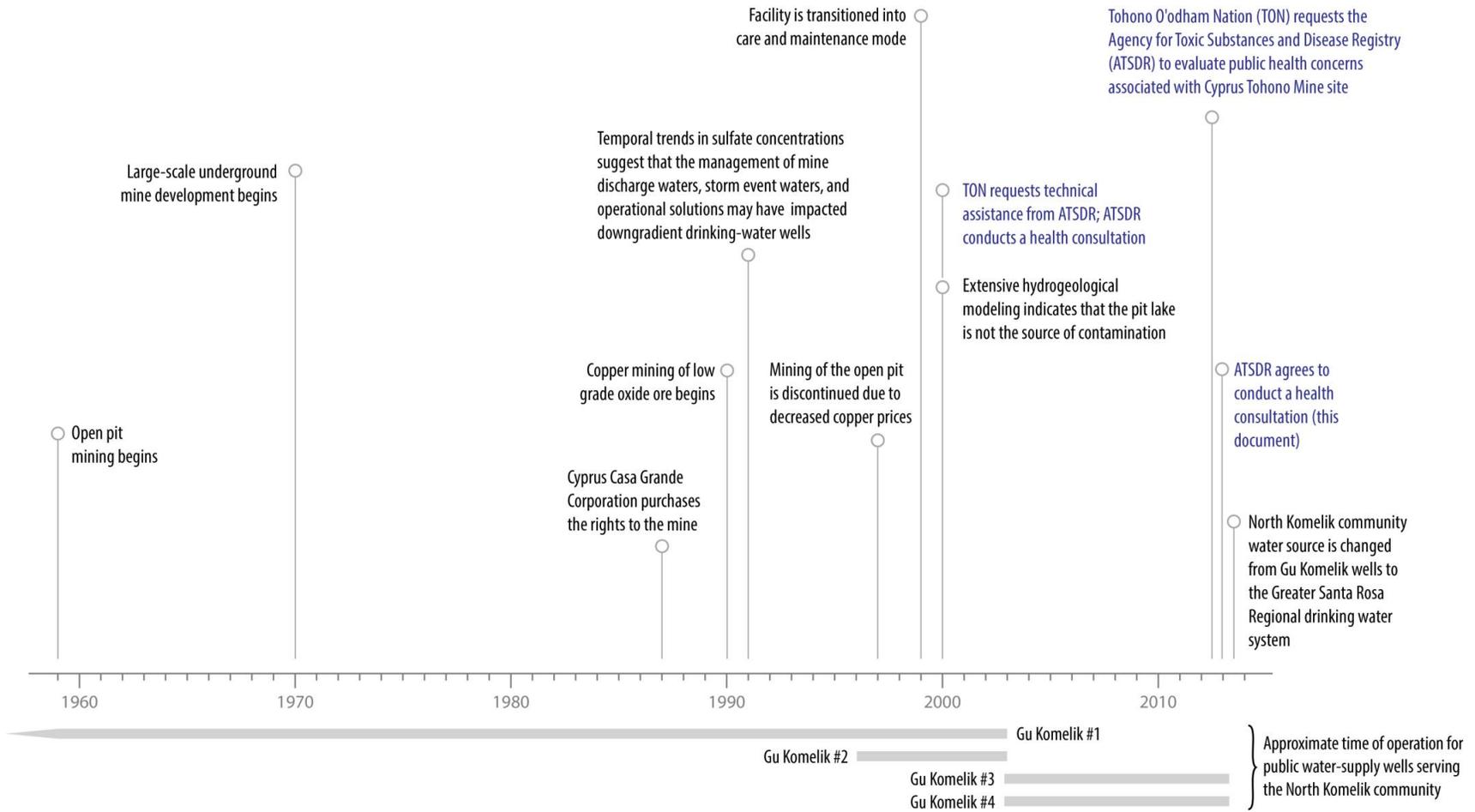


Figure 2: Cyprus Tohono Mine timeline



Note: ATSDR related events are highlighted in blue

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 mile 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

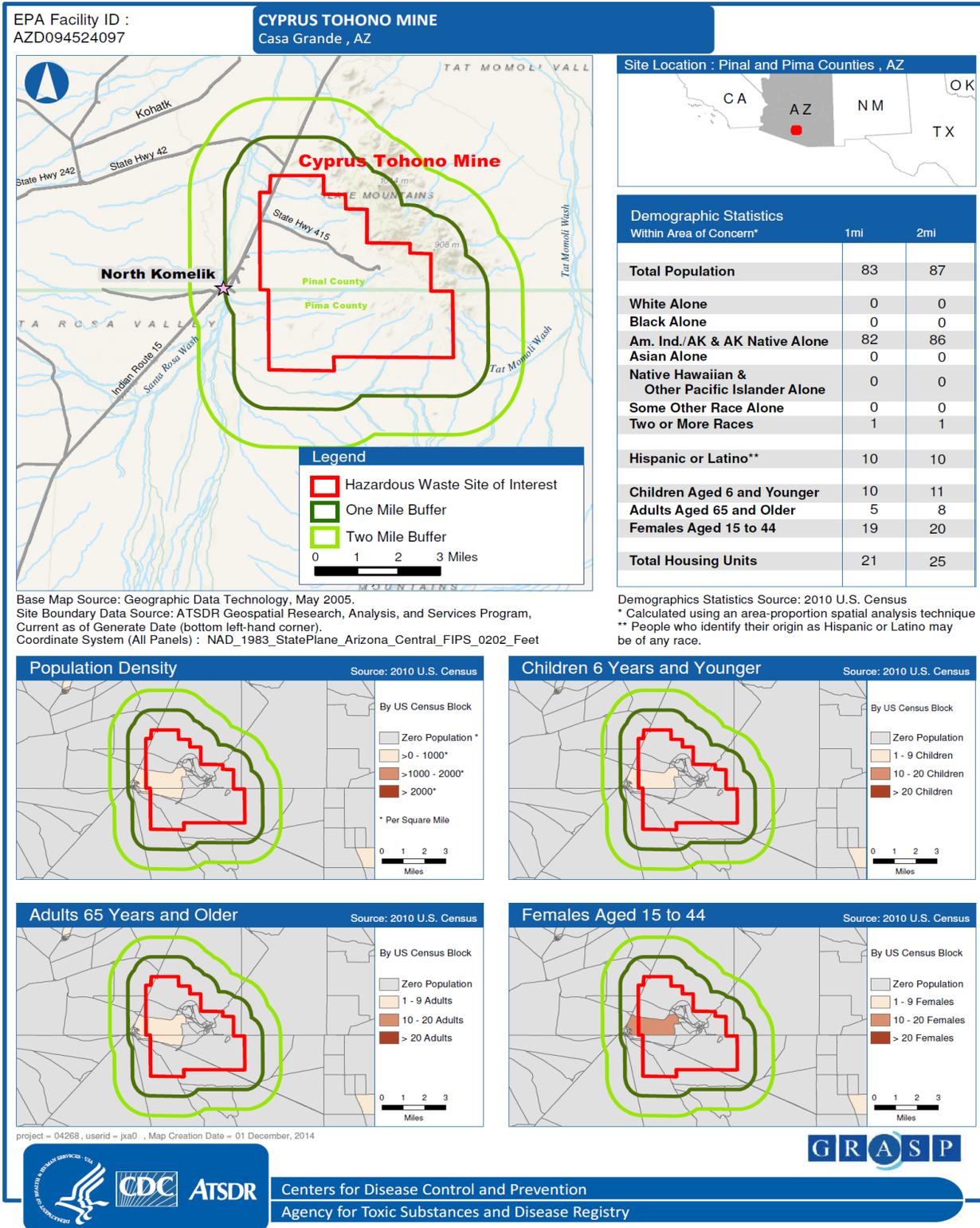
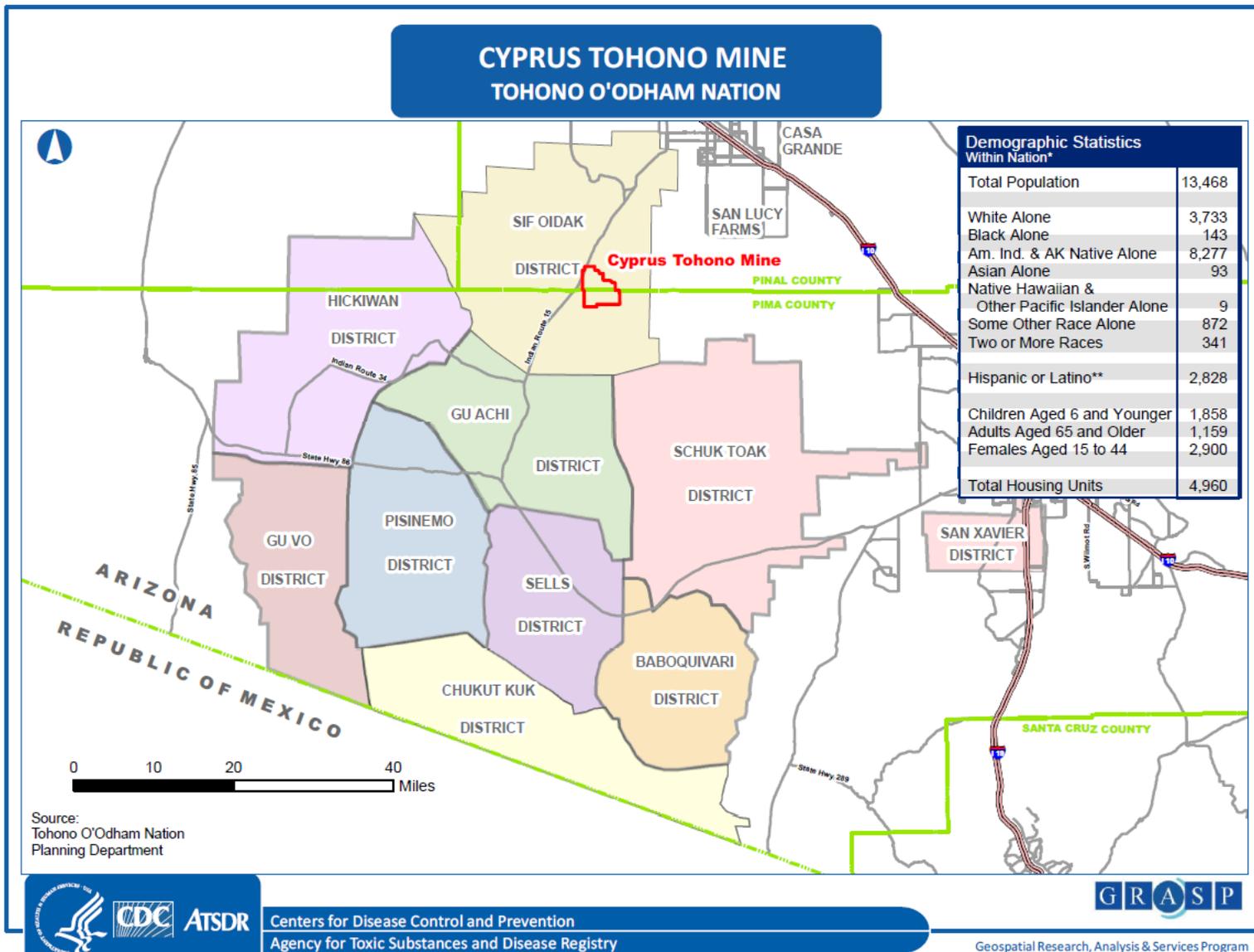


Figure 4: Tohono O'odham Nation Demographics



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. Through these activities, ATSDR understands that Tribal officials and North Komelik community members have several exposure and health-related concerns including:

- groundwater and drinking water contamination;
- air quality impacts and noise;
- bioaccumulation of contaminants in animals, and uptake in plants, that Tribal members hunt and harvest in the area.

Based on ATSDR’s review of the available data, chemicals and elements 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. Tribal members also expressed concerns about whether the proposed mine restart could pose future health risks. The Nation has formally requested that BLM require a supplement to the 1995 Environmental Impact Statement (EIS) if the mine restarts.

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 (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. 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. 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 1 shows the chemicals and elements that exceed ATSDR Comparison Values (CVs) in groundwater, mine water, and surface water. Comparison Values (CVs) are substance concentrations set well 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 1 from the remedial investigation (RI) report (Clear Creek Associates 2012). The data obtained from the RI report included groundwater samples, as well as surface water and mine water samples. The 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 screening.

Many of the organic chemicals were not listed in Table 1 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 4 of Appendix A. The CVs that were below quantitation limits were Cancer Risk Evaluation Guides (CREG). CREGs are screening tools intended for drinking water over a lifetime. These waters were never used as drinking water; therefore the CREG is a very conservative tool. 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 and elements of concern in groundwater at the mine include arsenic, cadmium, lead, perchlorate, radionuclides, and sulfate (Table 1). 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. Specifically, it was detected above CVs from 2009-2012 in a monitoring well formerly used as Gu Komelik drinking water well #2. Use of this well for drinking water was discontinued in December 2002, when residents were temporarily provided bottled water. In April 2003 two new drinking water wells were installed and bottled water service was discontinued. It is possible that well #2 was contaminated with

perchlorate when it was used as a drinking water well, but there are no past data to confirm or reject this possibility. 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).

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). The North Komelik drinking water came from groundwater, which was the only exposure pathway to groundwater. As shown on the bottom of the timeline, North Komelik used two wells (Gu Komelik #1 and #2) near the mine boundary before 2003, and 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 Authority, more than 5 miles south (upgradient) from the mine.

Table 1: Chemicals and elements in groundwater, mine water, and surface water exceeding ATSDR comparison values

Chemical	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; **CEMG**, 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

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 compared the values to the existing EPA Maximum Contaminant Level (MCL) for radiological contamination in public drinking water supplies. None of the background samples in either the bedrock groundwater system or the basin-fill aquifer exceed the established MCL.

For those samples not considered background samples, the concentration of adjusted gross alpha and gross beta radiation exceeded the MCL screening values of 15 pCi/L and 50 pCi/L, respectively (EPA 1980). Likewise, the concentration of total uranium exceeded its MCL of 30 µg/L (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 300 pCi/L or more than 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. Groundwater near the mine is not used as a public water supply; therefore this exposure pathway can be eliminated. As discussed below, community drinking water wells were also tested for radionuclides and none of the average values exceeded ATSDR 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).

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. 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 2000). In 2003, CTC provided new drinking water wells located six miles south (upgradient) of the village of North Komelik.

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

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

Chemicals and elements of potential concern

Chemicals and elements 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 5 of Appendix A. Table 2 shows only those chemicals that exceeded ATSDR CVs in drinking water, from 1978 to 2013. Those chemicals with average values greater than ATSDR CVs (arsenic and fluoride) were evaluated further to determine if people’s exposure to those chemicals over time could be of health concern. Average values were used because the data were evenly distributed and there were no “non-detect” values.

Table 2: List of chemicals in 1978 - 2013 drinking water samples exceeding ATSDR comparison values (CV)

Chemical	Maximum Concentration (mg/L)	Average Concentration (mg/L)	ATSDR CV (mg/L)	CV Type	# samples/# exceeding CV
arsenic	0.29	0.034	0.000023	CREG	50/50
copper	0.4	0.057	0.10	IEMEG-child	45/5
fluoride	2.6	1.29	0.50	CEMEG-child	14/13

(adjusted) gross alpha	19 pCi/L	9.45 pCi/L	15 pCi/L	MCL	11/3
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[CEMEG, Chronic Environmental Media Evaluation Guide; CREG, Cancer Risk Evaluation Guide; IEMEG, Intermediate Environmental Media Evaluation Guide; MCL, maximum contaminant level]

For further evaluation, exposure doses were calculated for arsenic and fluoride, 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:

$$\text{Exposure Dose} = \frac{\text{conc} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

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)

Although drinking water was blended prior to distribution, 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.

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 chemicals analyzed, arsenic and fluoride exposure doses exceeded MRLs. Table 3 shows the calculated exposure doses using the average concentrations of chemicals that exceeded ATSDR CVs. Health guidelines, as well as the basis for the guidelines, are also

presented. If the exposure dose approaches or exceeds the NOAEL or LOAEL, the chemical may be considered a health hazard. The exposure doses for arsenic and fluoride exceeded the MRL and NOAEL (for children only, in the case of fluoride).

Table 3: Exposure doses for chemicals that exceeded CVs in North Komelik former wells

Chemical		Exposure Dose (mg/kg/day)	Health Guideline (chronic MRL)	Basis for Health Guideline	Cancer Risk	Health Hazard
arsenic	adult	0.00145	0.0003	0.0008 (NOAEL)	2.2×10^{-3}	yes (past)
	child	0.00509			5.2×10^{-4}	yes (past)
fluoride	adult	0.0554	0.05	0.15 (NOAEL)	not carcinogenic	no
	child	0.194				yes (past)

The average dose of arsenic in drinking water exceeded the chronic MRL, as well as the NOAEL. Therefore, North Komelik drinking water contained arsenic at levels that could have harmed the health of people who drank it for more than one year. Exposure to inorganic arsenic via drinking water is associated with gastrointestinal, hematological, renal, cardiovascular, and neurological effects. 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 contact with inorganic arsenic may cause redness and swelling. 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. The doses calculated for 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 (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 resulted in an estimated cancer risk near 2 in 1,000 (2.2×10^{-3}) for adults, and 5 in 10,000 (5.2×10^{-4}) for children. U.S. 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 an increased risk compared to EPA's target range.

The average dose (for children only) of fluoride in drinking water exceeded the chronic MRL, as well as the NOAEL. Children under 8 years old who drank North Komelik water for more than one year 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 harm your health. 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 (the most sensitive health endpoint and the one used in the NOAEL study). This condition is called dental fluorosis. Higher fluorosis was found in children living in communities with 4 ppm fluoride in drinking water compared to children living in communities with 1 ppm 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). The high levels of arsenic and fluoride may be due to naturally-occurring levels in the area. 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 drinking water exposures

In April 2013, the North Komelik community wells (wells 3 and 4 in the timeline above) were taken off-line and the town was supplied with water from the Greater Santa Rosa Regional System. This system uses treatment technology that removes arsenic through adsorption. Adsorption is the adhesion of molecules of gas, liquid, or dissolved solids to a surface.

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 ppb was above ATSDR's most conservative CV of 0.023 ppb. 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 pose a current or future health hazard. Additionally, the detection limit was well below EPA's Maximum Contaminant Level (MCL) of 10 ppb 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, it would be prudent to set detection limits below ATSDR CVs whenever 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 pose a current or future health hazard. Additionally, the maximum value for fluoride never exceeded the regulatory MCL of 4 ppm; and the average value never exceeded the secondary MCL of 2 ppm 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 ASTM² and AWWA³ standards for municipal potable water systems, and does not transfer harmful chemicals to water. 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 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.

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.

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 pose a health hazard.

Air Quality and Noise

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

² American Society of Testing and Materials

³ American Water Works Association

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. The TON recently received an EPA grant to conduct limited air quality monitoring on the Nation. Through this grant TON will monitor PM10 (particulate matter less than 10 micrometers in diameter) at several locations across the Nation for months at a time. The North Komelik community is one of the proposed sites for a mobile air monitor (Aaran Udensi, TON, personal communication, September 17, 2013). Additionally, 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.

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). If noise becomes a problem for residents of North Komelik, they may contact the National Institute for Occupational Safety and Health (NIOSH) at 1-800-CDC-INFO. 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 be taken up by plants. Depending on the level of contamination,

this pathway could potentially present a health risk to people who consume the animals and 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 potential risk from eating local deer.

Some uptake of arsenic and other metals into plants can occur. However, high concentrations of elements such as zinc, copper, nickel, and arsenic will usually 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). 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). Because surface deposition of metals is such a dominant exposure pathway, 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. If biota samples and/or soil and surface water samples are collected and analyzed in the future, ATSDR will review the data, upon request.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing and medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

Conclusions

1. Until April 2013, North Komelik drinking water contained 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 more than one year before April 2013 could have been at increased risk for skin changes, stomachache, nausea, and cancer of the skin, liver, bladder, and lung during the time they were drinking the water. These people may also be at increased risk of developing those cancers in the future. Due to this past exposure to fluoride, children under 8 years old who drank North Komelik water for more than one year before April 2013 could have been at increased risk for discoloration of teeth. Arsenic and fluoride occur naturally in groundwater in the area.
2. ATSDR concludes that the drinking water Tohono O'odham Utility Agency (TOUA) currently provides in North Komelik does not pose a current or future health hazard.
3. There are insufficient data to fully assess the air or biota pathways surrounding the mine.
4. There is not enough information to know if 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 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 recommends that physicians who treat North Komelik residents follow ATSDR guidance for 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 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, and use arsenic treatment techniques to ensure that the Nation's drinking water systems meet EPA standards.
3. ATSDR recommends that CTC, TON, and/or EPA consider collecting baseline air quality data on particulate matter, metals, and chemicals found in vehicle emissions near the mine; as well as air monitoring data in the future if mining restarts. Studies from other sites with the same contaminants and similar exposures suggest that eating plants and animals 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). However, local sampling would need to be conducted to rule out the possibility of contamination in biota near the mine.

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4. ATSDR recommends that CTC, TON, Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), and EPA consider analyzing the potential health impacts associated with mine restart with the goal of minimizing any potential health risks. ATSDR notes that since the Cyprus Tohono Corporation'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 will meet with Tohono O'odham National officials and North Komelik community members to discuss the findings in the health consultation and answer their questions.
- ATSDR will 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 pursue partnering with the University of Arizona Superfund Research Program to provide North Komelik community members with educational opportunities related to mining.

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Appendix A

Table 4: 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 5: 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