

Health Consultation

**ARSENIC EXPOSURE
FROM PRIVATE DRINKING WATER WELLS
NEW RIVER, MARICOPA COUNTY, ARIZONA**

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**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
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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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

ARSENIC EXPOSURE
FROM PRIVATE DRINKING WATER WELLS
NEW RIVER, MARICOPA COUNTY, ARIZONA

Prepared By:

Arizona Department of Health Services
Office of Environmental Health
Environmental Health Consultation Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Purpose

The Arizona Department of Health Services (ADHS) evaluated private wells in the New River community in 2002 and 2004. Community members in New River requested to have additional information regarding the arsenic levels detected in their well water and urine samples. These samples were collected as a part of the Rocky Mountain Biomonitoring Consortium (RMBC). RMBC personnel generously shared their laboratory analyses with the ADHS' Risk Assessment and Health Consultation program staff. The objective of this public health consultation is to make use of the RMBC information and to determine if anything new could be learned from it.

Background

New River, Arizona is a predominately rural community in northern Maricopa County. It is located approximately 20 miles north of Phoenix, Arizona. A map of this area can be found in Appendix D of this report. The ZIP code for this area is 85087 and it is located in Congressional District 03 (AZ). According to the US Census Bureau, this community has an estimated population of 10,740. New River's geographic area takes up nearly 71 square miles, and consists of 4,514 single family housing units. Housing density is 63.7 units per square mile. The New River Utility Company, Inc. serves a small portion of these homes; however, most home sites rely on individual wells for their domestic water supply. Inorganic arsenic (As) is commonly found in rock and soil samples assayed throughout this region. This mineral is slowly dissolved by water moving through underground aquifers. New River's groundwater is replenished by the watersheds contributing to the formation of Agua Fria and Verde Rivers.

Table 1. New River Demographics (Source: 2000 Census)

Characteristic	Number	% New River	% US
Total Population	10,740		
Male	5,474	51.0	49.1
Female	5,266	49.0	50.9
Age < 5 years old	685	6.4	6.8
>18	7,948	74.0	74.3
>65	804	7.5	12.4
Race White	10,296	95.9	75.1
Black	45	0.4	12.3
American Indian	64	0.6	0.9
Asian	49	0.5	3.6
Latino (of any race)	521	4.9	12.5
Owner Occupied Housing	3,627	92.5	66.2
Disability Status	1,755	17.3	19.3
Labor Force	5,962	72.0	63.9

Chemical concentrations in private wells were evaluated twice before by the Arizona Department of Health Services (Welch 2002, Hasty 2004). On the evening of October 10, 2006 the ADHS' Health Educator and Risk Assessor, with the Risk Assessment/Health Consultation program, were invited to a New River/Desert Hills Community Association meeting to discuss the findings in the earlier surveys. Nearly 60 homeowners attended. The Health Educator made a presentation regarding the health effects of arsenic in private wells. After the meeting, several members of the community requested additional information pertaining to a more recent (actually, on-going) study involving arsenic in both water and urine. This special study is the undertaking of the Rocky Mountain Biomonitoring Consortium (RMBC). RMBC personnel generously shared their laboratory analyses with the ADHS' Risk Assessment/Health Consultation program staff.

Similar Health Consultations were published in 2002 and 2004. The objective of this public health consultation is to make use the RMBC information and to determine if anything new could be learned from it.

Methods

During 2005, 95 adult (>18 years old), New River residents answered a questionnaire, submitted urine samples and had their wells tested. A total of 65 wells were tested for 14 different chemicals. Metals selected for detection were: beryllium (Be), cobalt (Co), molybdenum (Mo), cadmium (Cd), antimony (Sb), cesium (Cs), barium (Ba), tungsten (W), platinum (Pt), thallium (Tl), lead (Pb), uranium (U), arsenic (As), and selenium (Se). All laboratory analyses were performed by the ADHS' Public Health Laboratory located in Phoenix, Arizona. Arsenic (As) in water ranged from 0 to 343 ppb. Arsenic in urine ranged from 0.98 to 288 ppb. The US EPA's maximum contaminant level for As is 10 ppb. Also 10 ppb is the standard used for As in urine as it represents the 95th percentile of subjects tested as part of the National Health and Nutrition Examination Survey (NHANES). The urine As concentrations will not be discussed in this health consultation since it will be discussed in detail in the RMBC's report. A summary of water/urine analytical results can be found in Appendix C of this report.

The ADHS' assessment process selects a chemical for further toxicological evaluation, if that chemical was detected in excess of Agency for Toxic Substances and Disease Registry's (ATSDR's) chronic exposure comparison value (CV) for children. Concentrations of chemicals less than the corresponding comparison values are unlikely to cause adverse health effects.

Results

Arsenic and molybdenum were the only chemicals detected in excess of the ATSDR chronic exposure, comparison value for children. Of the 65 wells sampled, 52 (80%) contained arsenic at levels exceeding the minimum risk level for children. Only one (1) well (1.5%) exceeded the Minimal Risk Level (MRL) for molybdenum. The following table summarizes the analytical results of well water samples.

Table 2. Private Well Sampling Results in parts per billion (ppb) (Source: RMBC 2006)

Water sample number = 65

Chem.	Mean (ppb)	Range (ppb)	EPA MCL (ppb)	EMEG Child (ppb)	Number of samples > EMEG
Be	0.0000	ND ^a to 0.18	4	20	0
Co	0.1220	ND to 1.936	NS ^b	100	0
Mo	7.4480	ND to 205.648	NS	50	1
Cd	0.0000	ND	5	2	0
Sb	0.2300	0.136 to 1.244	6	4	0
Cs	0.6155	ND to 17.971	NS	NS	0
Ba	21.1810	ND to 056.796	2000	6000	0
W	0.5110	ND to 6.164	NS	NS	0
Pt	0.0000	ND to 0.057	NS	NS	0
Tl	0.0710	0.052 to 0.203	2	NS	0
Pb	1.0380	0.002 to 13.776	15	NS	0
U	6.1790	ND to 53.541	30	NS	1
As	43.3970	ND to 343.294	10	3	53
Se	0.2850	ND to 5.78	50	50	0

^a ND= Non-detect
^b NS= No Standard

Discussion

Source of Exposure

The two (2) previous ADHS Health Consultations (Welch 2002, Hasty 2004) clearly identified the source of arsenic contamination in privately owned water supplies as coming from the natural geology of this region. Besides water, arsenic intake can come from many other sources such as: seafood, dietary supplements, home remedies, vitamins, hobbies, and industrial exposure. This report will only focus on the impact of arsenic in drinking water.

Exposure Pathway Evaluation

The ADHS identified the exposure pathways to determine if, and how residents might be exposed to chemicals in the water. There are five components to consider in evaluating exposure pathways:

- A source of contamination
- Transport through an environmental medium
- A point of exposure
- Route of exposure
- A receptor population

Exposure pathways are classified as completed, potential, or eliminated. Completed pathways exist when the five conditions (above) are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring now. Potential pathways are those that may occur in the past, present, or future. In eliminated pathways, at least one of the five elements is missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant.

Completed and potential exposure pathways may result from people using the water for domestic purposes. Typical domestic water exposures to metals include dermal exposures from bathing and showering, and ingestion exposures from drinking and using water for cooking. Table 4 shows the completed and potential exposure pathway elements.

Table 3. Complete and Potential Exposure Pathways

Exposure Pathway Elements					Time	Type of Exposure Pathway
Source	Media	Point of Exposure	Route of Exposure	Estimated Exposed Population		
Naturally Occurring Arsenic (As) in Rocks and Soil	Aquifer: Water Saturated Soils	Individual Water Systems	Ingestion, Skin Contact	Approximately 140 Residents*	Past	Completed
					Current	Completed
					Future	Potential

*Estimate using data from Table 1 and the finding that 80% of wells tested exceeded the Children’s MRL for As.

Exposure Quantification

To quantify exposures, ADHS made several assumptions regarding children's intake of As, including: Children drink 1 liter of water per day from this water source, from ages 0 to 6. Also, children are assumed to ingest 0.6 ml of water daily from brushing their teeth twice a day (Barnhart et al.1974). Bathing was not considered to contribute to arsenic exposure, as studies have shown that dermal contact with arsenic, at doses observed in this study, does not significantly contribute to the body's burden of this contaminant (ATSDR 2005). The dose calculations assume a child's bodyweight of 15 Kg. The exposure variables and equations used to determine exposure can be found in Appendix B.

Exposure Analysis

To evaluate the health effects of exposure to contaminants in specific environmental media, which include water, soil, and air, ATSDR has developed a Minimal Risk Level (MRL) comparison value for common chemical contaminants. The MRL is an estimate of daily human exposure to a contaminant below which non-cancerous, adverse health effects are unlikely to occur. MRLs are developed for acute (less than 14 days), intermediate (14 to 365 days), and chronic (greater than 365 days) exposures. Health guidance values, such as MRLs do not represent a level above which toxic effects are likely to happen. MRLs are established solely as screening tools to determine whether further evaluation of the contaminant is necessary. When exposure estimates exceed MRLs, additional evaluation is necessary to determine whether a health hazard exists. The *No Observed Adverse Effect Level* (NOAEL) is the highest exposure dose at which no effect was observed on the animal or human population in a study. The *Lowest Observed Effect Level* (LOAEL) for a chemical is the lowest exposure dose at which a measurable adverse health effect is observed in a human or animal study population. Whenever possible, NOAELs and LOAELs from studies involving human cases are reviewed. If, however, no human studies exist, studies on laboratory animals are reviewed. Also, the health assessor might include safety factors to address human differences when evaluating whether health effects from animal studies are fully applicable. The appendix contains a discussion of potential health effects from chronic, oral, arsenic exposure.

Private Well Health Hazard Analysis

ADHS calculated the estimated daily exposure doses of arsenic for each well in which the arsenic concentration exceeded the ATSDR chronic, comparison value for children as displayed in Table 2. Fifty-two of the Sixty-five wells sampled (80%) contained arsenic levels exceeding the chronic oral exposure, MRL for children. These wells contain greater than 4.19 parts per billion (ppb) arsenic. This contaminant was below the MRL comparison value for the other thirteen wells (20%).

A brief discussion of the acute MRL health effects is contained in the *Child Health Consideration* portion of this Health Consultation.

Toxicological Considerations

(1) Arsenic

Arsenic is a naturally occurring element widely distributed in the earth's crust. Arsenic can be released to water by natural weathering of soil and rocks, and can also be leached from soil and minerals into groundwater. 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. Ingestion of arsenic can increase the risk for skin cancer and internal cancers: liver, lung, bladder, and kidney (ATSDR 2005).

(A) Non-Cancer Health Effects

- **Tier I.** Thirteen (13) of the 65 wells (20%) (99,84,97,58,59,36,53,71,86,104,76,43,and 57) pose **no apparent health hazard**. These water systems meet the USEPA's drinking water standard for Arsenic.

Tier I

RMBC Number	As ug/L	Child (mg/Kg/day)	Adult Dose	>MCL?	>MRL?	>NOAEL?	>LOAEL?
99	3.1023	0.0002	0.0001	no	no	no	no
84	2.7127	0.0002	0.0001	no	no	no	no
97	2.5729	0.0002	0.0001	no	no	no	no
58	1.6329	0.0001	0.0000	no	no	no	no
59	1.4614	0.0001	0.0000	no	no	no	no
36	0.9425	0.0001	0.0000	no	no	no	no
53	0.6186	0.0000	0.0000	no	no	no	no
71	0.2633	0.0000	0.0000	no	no	no	no
86	0.1376	0.0000	0.0000	no	no	no	no
104	0.0143	0.0000	0.0000	no	no	no	no
76	0	0.0000	0.0000	no	no	no	no
43	0	0.0000	0.0000	no	no	no	no
57	0	0.0000	0.0000	no	no	no	no

- **Tier II.** Twelve (12) wells (19%) (62, 85, 38, 61, 82, 112, 110, 65, 52, 56, 96, and 26) contained arsenic at a level that presents a lower risk threshold of causing chronic **health effects in children**. For this susceptible population, this dosage exceeds the ATSDR's Acute Oral MRL of 0.0003 mg As/kg/day, and could produce subtle, adverse health effects in children such as; fatigue, numbness, or changes in skin pigmentation. This water presents no apparent health hazard for adults who drink it.

Tier II

RMBC Number	As ug/L	Child (mg/Kg/day)	Adult Dose	>MCL?	>MRL?	>NOAEL?	>LOAEL?
62	8.3401	0.0005	0.0002	no	yes	no	no
85	8.1398	0.0005	0.0002	no	yes	no	no
38	7.9132	0.0005	0.0002	no	yes	no	no
61	6.9812	0.0004	0.0002	no	yes	no	no
82	6.7155	0.0004	0.0002	no	yes	no	no
112	6.6614	0.0004	0.0002	no	yes	no	no
110	6.6093	0.0004	0.0002	no	yes	no	no
65	6.4185	0.0004	0.0002	no	yes	no	no
52	5.6844	0.0004	0.0002	no	yes	no	no
56	5.2417	0.0003	0.0001	no	yes	no	no
96	5.0459	0.0003	0.0001	no	yes	no	no
26	4.1975	0.0003	0.0001	no	yes	no	no

- Tier III.** Nineteen (19) wells (29%) (49, 108, 31, 105, 37, 54, 100, 72, 33, 35, 80, 90, 44, 92, 29, 34, 45, 74, and 88) pose a more serious health hazard for children than the *Tier I* water systems, and also create a lower risk threshold for causing chronic **health effects in adults**. Arsenic is present in the water at levels that exceed both the MRL, and the USEPA’s Maximum Contaminant Level (>10 ug/l). Although it should not be used for drinking, this water can still be used for bathing, cleaning and sanitation purposes.

Tier III

RMBC Number	As ug/L	Child (mg/Kg/day)	Adult Dose	>MCL?	>MRL?	>NOAEL?	>LOAEL?
49	26.2961	0.0017	0.0007	yes	yes	no	no
108	26.0221	0.0017	0.0007	yes	yes	no	no
31	24.9917	0.0016	0.0007	yes	yes	no	no
105	23.6894	0.0015	0.0007	yes	yes	no	no
37	21.0766	0.0013	0.0006	yes	yes	no	no
54	19.4497	0.0012	0.0005	yes	yes	no	no
100	18.5183	0.0012	0.0005	yes	yes	no	no
72	18.2949	0.0012	0.0005	yes	yes	no	no
33	16.456	0.0011	0.0005	yes	yes	no	no
35	15.1336	0.0010	0.0004	yes	yes	no	no
80	15.0718	0.0010	0.0004	yes	yes	no	no
90	14.6447	0.0009	0.0004	yes	yes	no	no
44	13.0968	0.0008	0.0004	yes	yes	no	no
92	13.0525	0.0008	0.0004	yes	yes	no	no
29	12.6238	0.0008	0.0003	yes	yes	no	no
34	11.2005	0.0007	0.0003	yes	yes	no	no
45	10.7699	0.0007	0.0003	yes	yes	no	no

74	10.5872	0.0007	0.0003	yes	yes	no	no
88	10.0446	0.0006	0.0003	yes	yes	no	no

- Tier IV.** Seventeen (17) wells (26%) (69, 113, 39, 47, 67, 28, 107, 114, 78, 21, 19, 20, 94, 41, 50, 48, and 64) exceed; ATSDR's Acute Oral MRL, the EPA's MCL, ATSDR's No Observed Adverse Effect Level (NOAEL) of 0.0008 mg As/kg/day, and those numbers in the red font exceed ATSDR's Acute Oral MRL of 0.005 mg As/kg/day. Water from these wells should not be used for drinking or cooking.

Tier IV

RMBC Number	As ug/L	Child (mg/Kg/day)	Adult Dose	>MCL?	>MRL?	>NOAEL?	>LOAEL?
69	162.004	0.0104	0.0045	yes	yes	yes	no
113	124.597	0.0080	0.0034	yes	yes	yes	no
39	123.621	0.0079	0.0034	yes	yes	yes	no
47	112.871	0.0072	0.0031	yes	yes	yes	no
67	106.095	0.0068	0.0029	yes	yes	yes	no
28	87.9631	0.0056	0.0024	yes	yes	yes	no
107	83.9959	0.0054	0.0023	yes	yes	yes	no
114	83.9959	0.0054	0.0023	yes	yes	yes	no
78	66.4954	0.0043	0.0018	yes	yes	yes	no
21	59.786	0.0038	0.0016	yes	yes	yes	no
19	58.4051	0.0037	0.0016	yes	yes	yes	no
20	56.4097	0.0036	0.0016	yes	yes	yes	no
94	54.4233	0.0035	0.0015	yes	yes	yes	no
41	46.152	0.0030	0.0013	yes	yes	yes	no
50	35.3372	0.0023	0.0010	yes	yes	yes	no
48	34.6055	0.0022	0.0010	yes	yes	yes	no
64	30.6138	0.0020	0.0008	yes	yes	yes	no

- Tier V.** Four (4) wells (6%) (22, 24, 102, and 46) represent very poor quality water and pose an unreasonable risk for anyone drinking it. They exceed the USEPA's Maximum Contaminant Level, the ATSDR's Chronic and Acute Oral Minimum Risk Levels, and the NOAEL for both children and adults. More importantly, they also exceed the Lowest Observed Adverse Effect Level (LOAEL) of 0.014 mg As/kg/day. Again, the numbers in red indicate the risk for an acute health effect which could result in serious gastrointestinal, neurological, and/or cardiovascular illness with an onset of less than two weeks. One well, (RMBC#102) poses multiple risk factors. Beyond being a threat for arsenic poisoning, it also exceeds the EPA's chronic oral reference dose for molybdenum (0.005 mg/Kg/day) by 2.6 times and it exceeds the EPA's MCL for Uranium (30 ppb) by 1.7 times.

Tier V

RMBC Number	As ug/L	Child (mg/Kg/day)	Adult Dose	>MCL?	>MRL?	>NOAEL?	>LOAEL?
22	343.294	0.0220	0.0094	yes	yes	yes	yes
24	335.8923	0.0215	0.0092	yes	yes	yes	yes
102	307.622	0.0197	0.0085	yes	yes	yes	yes
46	302.806	0.0194	0.0083	yes	yes	yes	yes

- None of these wells would pose an apparent health hazard **IF** water is used only for bathing, washing dishes, tooth brushing and general sanitary purposes.
- Other private wells in the area were not tested. Some of these wells could contain Contaminants at levels that might cause adverse health effects.

(B) Cancer Health Effect

The excess lifetime cancer risks due to ingesting dissolved arsenic in water were based on the ADHS, *Deterministic Risk Assessment Guidance* (ADHS 2003) and the cancer slope factor of arsenic developed by the US EPA. The “acceptable cancer risk” is calculated on a lifetime exposure, and would not exceed 1 excess case in a population of 10,000 people. It is important that these numbers be kept in perspective. Over the course of a 70-year life span it is estimated that one in three people will develop cancer. Below are the calculated cancer risks for only those water systems that exceeded the 1:10,000 rate.

Table 4. New River, Private Wells (Excess Cancer Risk 60.5 to 1 Case(s)/10,000 Pop.)

RMBC	As ppb	Adult Cancer CDI	Ca Risk	RMBC	As ppb	Adult Cancer CDI	Ca Risk
22	343.294	0.0040	6.05E-03	37	21.0766	0.0002	3.71E-04
24	335.8923	0.0039	5.92E-03	54	19.4497	0.0002	3.43E-04
102	307.622	0.0036	5.42E-03	100	18.5183	0.0002	3.26E-04
46	302.806	0.0036	5.33E-03	72	18.2949	0.0002	3.22E-04
69	162.004	0.0019	2.85E-03	33	16.456	0.0002	2.90E-04
113	124.597	0.0015	2.19E-03	35	15.1336	0.0002	2.67E-04
39	123.621	0.0015	2.18E-03	80	15.0718	0.0002	2.65E-04
47	112.871	0.0013	1.99E-03	90	14.6447	0.0002	2.58E-04
67	106.095	0.0012	1.87E-03	44	13.0968	0.0002	2.31E-04
28	87.9631	0.0010	1.55E-03	92	13.0525	0.0002	2.30E-04
107	83.9959	0.0010	1.48E-03	29	12.6238	0.0001	2.22E-04
114	83.9959	0.0010	1.48E-03	34	11.2005	0.0001	1.97E-04
78	66.4954	0.0008	1.17E-03	45	10.7699	0.0001	1.90E-04
21	59.786	0.0007	1.05E-03	74	10.5872	0.0001	1.86E-04
19	58.4051	0.0007	1.03E-03	88	10.0446	0.0001	1.77E-04
20	56.4097	0.0007	9.94E-04	62	8.3401	0.0001	1.47E-04
94	54.4233	0.0006	9.59E-04	85	8.1398	0.0001	1.43E-04

41	46.152	0.0005	8.13E-04		38	7.9132	0.0001	1.39E-04
50	35.3372	0.0004	6.22E-04		61	6.9812	0.0001	1.23E-04
48	34.6055	0.0004	6.09E-04		82	6.7155	0.0001	1.18E-04
64	30.6138	0.0004	5.39E-04		112	6.6614	0.0001	1.17E-04
49	26.2961	0.0003	4.63E-04		110	6.6093	0.0001	1.16E-04
108	26.0221	0.0003	4.58E-04		65	6.4185	0.0001	1.13E-04
31	24.9917	0.0003	4.40E-04		52	5.6844	0.0001	1.00E-04
105	23.6894	0.0003	4.17E-04					

The chronic daily intake (CDI) of arsenic for well #52 is 0.0001 mg/Kg/day. When multiplied by the EPA's Cancer Slope Factor for arsenic, the lifetime cancer risk is one (1) additional case in a population of 10,000 people, over a lifetime. This is the EPA's upper-bound threshold for acceptable risk. The sixteen (16) New River wells with a lower cancer risk were not included in this table.

An April 1991 memo from Assistant Administrator Donald Clay, of the Office of Solid Waste and Emergency Response (OSWER), states that in certain cases the agency, "may consider risk estimates slightly greater than 10,000 to be protective." For example, the EPA's MCL for arsenic of 10 ug/L is associated with an excess lifetime cancer risk of 0.00018 (i.e. 1.8 cases per 10,000 persons).

In addition, the cancer slope factor of arsenic may be overestimated due to the uncertainty related to the model assumptions and differences in the health and nutrition between Taiwanese and American populations (ATSDR 2005). As a result, the ability of arsenic to cause cancer is reduced. Thus, the estimated, excess lifetime cancer risks (i.e. 0.0001 through 0.000371) from twenty-four (24) wells in this study: 37, 54, 100, 72, 33, 35, 80, 90, 44, 92, 29, 34, 45, 74, 88, 62, 85, 38, 61, 82, 112, 110, 65, and 52 are considered by the Arizona Department of Health Services to be within the range of "acceptable risk".

There is clear evidence from studies in humans that exposure to inorganic arsenic by oral routes increase the risk of cancer. Thirty-eight percent (38%) of the wells in this study exceeded the level of "Acceptable Risk" for cancer (>4 additional cases/10,000 people). The greatest risk is for skin cancer. The most common tumors seen are squamous cell carcinomas, which may develop from hyperkeratotic warts or corns (ATSDR 2005). Arsenic has been linked to cancer of the bladder, lungs, skin, kidney, nasal passages, liver, and prostate (EPA "Arsenic in Drinking Water" 2006) (Smith 1992).

Twenty-five (25) (38%) wells had cancer risk rates ranging from 60.5 to 4.17 excess cases per 10,000 population, again this is based on a lifetime exposure. The identifiers for these wells are: **22, 24, 102, 46, 69, 113, 39, 47, 67, 28, 107, 114, 78, 21, 19, 20, 94, 41, 50, 48, 64, 49, 108, 31, and 105**. After a review of available exposure and health effect data, the ADHS has determined that the arsenic content in these wells exceed an acceptable risk, for causing cancer.

(2) *Molybdenum*

This mineral too is often found in the geology of this region. It is not classifiable as a human carcinogen. The EPA's reference dose (RfD) is 0.005mg Mo/kg/day. The drinking water equivalent level (DWEL) is 0.2 mg/L (USEPA 2006). The LOAEL for Molybdenum is 0.14 mg/Kg/day, there is no NOAEL determination. Human toxicological symptoms are gout-like; pain, swelling, inflammation and deformities of the joints and an increase of uric acid content in the blood (EPA IRIS). Only one well (RMBC#102) exceeded the child EMEG of 50 ppb, its concentration was 205.648 ppb. At this level, the Mo chronic dose intake (CDI) for a child is 0.0132 mg/Kg/day. This exceeds the EPA's reference dose, but is below LOAEL. The concentration of Mo in this water is approximately equal to the EPA's DWEL. The combined effect of excessively high arsenic, molybdenum, and uranium is unknown; therefore, water from this well should only be used for non-drinking water purposes.

(3) *Uranium*

The previous paragraph indicated that the RMBC#102 well also exceeded the EPA's MCL for Uranium which is set at 30 ppb. The results from this well were 53.541 ppb. Large amounts of uranium can react with human tissues and damage the kidneys (ATSDR's Website- ToxFAQs). The carcinogenic assessment for this substance has been withdrawn pending further review (EPA's IRIS website).

Child Health Considerations

ATSDR recognizes the unique vulnerabilities of infants and children and places special emphasis on this sensitive population in making toxicological determinations. A child's developing body can sustain permanent damage if toxic exposures occur during critical growth stages. Children ingest a larger amount of water, relative to body weight, resulting in higher burden of contaminants. Therefore, with the exception of determining cancer risk (based on lifetime exposure), all exposure dose estimates gave consideration to children.

Acute Duration Health Effects

Water from twelve (12) systems in this study exceeded the provisional, acute-duration (<14 days) Minimal Risk Level (MRL) for children. The five wells with the highest As readings ("Tier V") also presented an acute-duration health risk for adults. There was a documented, human poisoning outbreak (Mizuta et al. 1956) in Japan involving soy sauce. Victims were dosed with approximately 0.05 mg As/kg/day of arsenic. Symptoms included; edema of the face, gastrointestinal disease (nausea, diarrhea, vomiting), upper respiratory symptoms, skin lesions and neuropathy. The gastrointestinal effects were serious enough to apply an uncertainty factor of 10 to the *Lowest Observed Adverse Effect Level* (LOAEL) of this outbreak, thus setting the provisional, acute-duration MRL at 0.005 mg/Kg/day (ATSDR 2005).

Conclusions

The concentrations of arsenic in water in the New River area of Arizona are a health concern for most of the residents using private water systems. These drinking water supplies are unregulated, and homeowners have a personal responsibility to protect household members from the significant health effects associated with drinking this chemically unsafe water. The private wells: **22, 24, 102, 46, 69, 113, 39, 47, 67, 28, 107, 114, 78, 21, 19, 20, 94, 41, 50, 48, 64, 49, 108, 31, and 105** are identified as “Public Health Hazard” because one or more metal concentrations are higher than the acceptable levels. Residents using the well water for drinking or cooking for a long time may experience adverse health effects.

If further information becomes available, ADHS will evaluate it and update conclusions as necessary.

Recommendations

Alternatives to drinking private well water include: bottled water and treated water (i.e. reverse osmosis, iron oxide absorption, etc.)

Figure 1. Under the Counter Iron Oxide Absorption Unit



Figure 2. New River Elementary School Iron Oxide Absorption Unit



APU-30 System – New River, AZ
Arsenic Treatment Project



Figure 3. Reverse Osmosis



Figure 4. Bottled Water Dispenser

- Residents of homes whose drinking water is supplied from wells identified in Tier II, III, IV and V of this report should install a treatment system on the household fixture used most to supply drinking and cooking water. Another alternative is to use bottled water.
- All residents in the New River area who are served by a private well should have their well water tested for arsenic.

Public Health Action Plan

Public Health Action	Who Will Implement the Action	Time Frame for Implementation	Desired Outcome When Implemented	Public Health Impact
Notify residents of testing results and associated potential health effects	ADHS	November 2006	Raise residents' individual awareness about their well water quality	Reduction in exposure to heavy metals in private well water
Develop and mail "Well Water and Your Health" flyers	ADHS	1. November 2006 2. Upon request by community association	Raise residents' individual awareness about well water, health & treatment options	1. Increase frequency of well water testing by homeowners 2. Increase installation of filtration systems
Mail finalized health consultation to residents	ADHS	After the Health Consultation is finalized	Raise residents' individual awareness about the overall well water quality in their area	1. Reduction in exposure to heavy metals in drinking water 2. Increase frequency of well water testing by homeowners
Post flyer, health consultation, and arsenic brochure on ADHS' website	ADHS	After the Health Consultation is finalized	Raise the community's awareness about well water quality, potential health effects, and methods of reduction of exposure	1. Reduction in exposure to potential contaminants in drinking water 2. Increase frequency of well water testing by all homeowners in the community
Organize a Public Meeting	ADHS & other interested agencies	After the Health Consultation is finalized	Raise the community's awareness about well water quality, potential health effects, and methods of reduction of exposure	Assures residents' concerns will be heard and addressed. If needed, ADHS will organize additional meetings

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Certification

This Exposure Investigation of Private Drinking Water Wells in New River, Maricopa County, Arizona was prepared by the Arizona Department of Health Services under cooperative agreement with the Agency for Toxic Substances and Disease Registry. It is in accordance with approved methodology and a procedure existing at the time the exposure investigation report was begun. Editorial review was completed by Cooperative Agreement Partner.

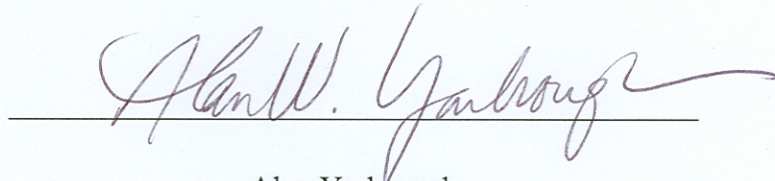
A handwritten signature in cursive script, reading "Charisse J. Walcott", is written over a horizontal line.

Charisse Walcott

Technical Project Officer

CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with the findings.

A handwritten signature in cursive script, reading "Alan W. Yarbrough", is written over a horizontal line.

Alan Yarbrough

Team Leader-Cooperative agreement Program

CAT, CAPEB, DHAC, ATSDR

Appendix A

Health Effects from Chronic Arsenic Ingestion:

One of the most common effects of both acute and long-term arsenic ingestion is a pattern of skin changes, including changes in skin pigmentation (hyperpigmentation, interspersed with small areas of hypopigmentation of the face, neck, and back), generalized hyperkeratosis, or thickening of the skin, and formation of hyperkeratotic warts on the palms and soles. These effects are most often reported at chronic dose levels ranging from about 0.01 to 0.1 mg/kg/day. Human studies document gastrointestinal irritation from chronic oral exposure to arsenic at dose levels of about 0.01 mg/kg/day and above. Symptoms include nausea, diarrhea, and vomiting. Damage to the liver and elevated levels of hepatic enzymes are reported at dose levels of 0.01 to 0.01 mg/kg/day. Hematological effects, including anemia and, have been documented at chronic oral exposures of 0.05 mg/kg/day and above. Neurological effects are reported at chronic oral doses of 0.03-0.1 mg/kg/day, including peripheral neuropathy and numbness in hands and feet, possibly developing into a painful “pins and needles” sensation. Cardiovascular effects include cardiac arrhythmia and myocardial depolarization. A serious vascular condition called Blackfoot disease is endemic in an area of Taiwan where residents are exposed to arsenic in drinking water from about 0.014-0.065 mg/kg/day. Studies in Chile report indicate that consumption of drinking water doses of 0.02-0.06 mg/kg/day increases in the incidence of Raynaud’s disease and cyanosis of the fingers and toes (ATSDR 2005). Arsenic has been classified as a human carcinogen by the U.S. Environmental Protection Agency (USEPA), the National Toxicology Program (NTP), and the International Agency for Research on Cancer (IARC). Reports indicate that arsenic in drinking water increases the risk of skin, liver, bladder, kidney, lung, and prostate cancers. Numerous studies have shown that cancer effects may occur following long-term exposure to drinking arsenic-contaminated water (ATSDR 2005).

Appendix B

Calculations:

Exposure Dose Equations

ADHS used the ATSDR exposure assessment documents to calculate an exposure dose for persons living in the New River area. The doses were calculated using the following equations:

Ingestion of chemicals in water:

$$CDI = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

CDI: chronic daily intake (mg/kg/day)

CW: concentration in water (mg/L)

IR: intake rate (L/day)

EF: exposure frequency (days/yr)

ED: exposure duration (yrs)

BW: body weight (kg)

AT: Averaging time (days)

Variable Assumptions	Adults	Children
IR (ingestion, liters):	2	1
EF (days/yr.):	350	350
ED (years):	30	6
BW (Kg):	70	15
AT (days) Non-Cancer:	10950	2190
AT (days) Cancer:	25550	25550

Appendix C

Correlation between Chemicals in Drinking Water and Urine (RMBC 2006) New River, Maricopa County, Arizona

Chem.	Water n=65					Urine n=95			
	Mean (ppb)	Range (ppb)	EPA MCL (ppb)	EMEG Child (ppb)	# > EMEG	Mean (ppb)	Range (ppb)	Reference ^c (ppb)	#>Ref
Be	0.0000	ND ^a to 0.18	4	20	0	0	ND	<0.05	0
Co	0.1220	ND to 1.936	NS ^b	100	0	0.697	0.0068 to 27.3134	1.32	4
Mo	7.4480	ND to 205.648	NS	50	1	52.71	0.0324 to 64.75	178	0
Cd	0.0000	ND	5		0	0.347	0.034 to 1.45	1.36	1
Sb	0.2300	0.136 to 1.244	6	4	0	0.05	ND to 0.3568	0.42	0
Cs	0.6155	ND to 17.971	NS	NS	0	5.302	0.1247 to 23.3288	11.4	8
Ba	21.1810	ND to 156.796	2000	6000	0	2.729	0.0731 to 23.4686	6.8	9
W	0.5110	ND to 6.164	NS	NS	0	0.289	ND to 8.0693	0.5	11
Pt	0.0000	ND to 0.057	NS	NS	0	0	ND to 0.0057	<0.03	0
Tl	0.0710	0.052 to 0.203	2	NS	0	0.153	0.0156 to 0.4507	0.45	1
Pb	1.0380	0.002 to 13.776	15	NS	0	0.675	ND to 4.5269	2.9	3
U	6.1790	ND to 53.541	30	NS	0 ^d	0.02	ND to 0.1909	0.046	13
As	43.3970	ND to 343.294	10	3	53	36.102	0.975 to 288.086	10	75
Se	0.2850	ND to 5.78	50	50	0	59.716	4.68 to 249.437	200	2

^a ND= Non-detect

^b NS= No Standard

^c 95th Percentile NHANES

^d One sample was > MCL

Appendix D

Map

New River

