

# Letter Health Consultation

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Arsenic – Hazard From Exposure in Well Water

WHISKEY JACK COMMUNITY

BONNER COUNTY, IDAHO

**Prepared by the  
Idaho Department of Health & Welfare**

SEPTEMBER 30, 2009

Prepared under a Cooperative Agreement with the  
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Agency for Toxic Substances and Disease Registry  
Division of Health Assessment and Consultation  
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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LETTER HEALTH CONSULTATION

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September 11, 2009

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**RE: Arsenic—Hazard From Exposure in Well Water, Whiskey Jack Community,  
Bonner County, Idaho (ID)**

**SUMMARY**

**Introduction**

The top priority of the Bureau of Community and Environmental Health (BCEH) is to ensure that the Whiskey Jack Community has good information to safeguard its health. The Idaho Department of Environmental Quality (IDEQ) asked BCEH to evaluate data and community concerns documented in this letter health consultation. The purpose of the consultation is to: 1) evaluate the public health risk of drinking water that is high in arsenic and iron and eating food made with this water; and 2) address the community's concerns.

**Conclusions**

BCEH concludes that drinking the water from the Whiskey Jack community water system could potentially cause changes to skin color and thickness due to the arsenic present if the water is consumed on a daily basis for longer than one year. The potential effects are not considered to be serious health effects, but could contribute to further skin problems. Risk of skin, bladder and lung cancers is not expected to increase after 1 year of exposure *unless* there is also significant exposure to other arsenic sources throughout the lifetime. BCEH concludes that the iron content alone will not harm the health of residents drinking the water.

**Basis for Decision**

The levels of arsenic in the Whiskey Jack community water system are below levels known to cause skin changes in other studies, but *well above levels known to have no effect*. There is a

lack of definitive human data for this range of arsenic exposure concentration. The levels of iron in the system are well below a concentration known to cause adverse health effects.

### **Next Steps**

BCEH will work with IDEQ to continue advising the system owner and the residents of the following:

- the ongoing possible health risks of drinking their water
- the need to drink treated water, bottled water, or water that meets federal drinking water standards
- to need to prepare all foods (including infant formula) using treated water, bottled water, or water that meets federal standards
- the need to talk to their health care provider if they continue to drink the untreated water at home
- the fact that heating or boiling the water does not reduce the amount of arsenic
- the types of water treatment systems they can install to reduce the level of arsenic

BCEH will work with IDEQ to encourage:

- quick restoration of the current treatment system to bring the water back into compliance with federal standards
- the proposed connection to the neighboring Oden Bay water system that meets federal standards
- the completion of the non-potable irrigation system for the Whiskey Jack community

### **For More Information**

If you have concerns about arsenic or iron in your water, you should contact Dr. Kai Elgethun at 208-334-5682. You may also call ATSDR at 1-800-CDC-INFO and ask for information on the Whiskey Jack site.

### **BACKGROUND**

The Bureau of Community and Environmental Health (BCEH) Environmental Health Education and Assessment Program (EHEAP) was asked in early 2009 to review water quality data for the Whiskey Jack community water system located in north Idaho. The system was out of compliance with federal water quality standards. EHEAP also attended a community meeting and received questions from community members about possible health effects from exposures to the drinking water. This letter addresses the possible health risks to the residents during the time that the system is out of compliance and answers the questions raised by the community members.

### **Exposure Situation and Nature of Request**

The Whiskey Jack community on the north shore of Lake Pend Oreille has a water system serving approximately 98 people full-time. The water was known in the past to have elevated concentrations of arsenic and iron. A water softener followed by chlorination and ion exchange has been in use for the last several years, but had fallen into disrepair. The softener precipitates out iron, the chlorine oxidizes arsenic III to arsenic V to form arsenic-laden solids, and the ion exchange media removes the remaining dissolved arsenic V. The ion exchange media can become easily overloaded if the softening or oxidizing steps are not sufficient for the volume of

water being treated. The softening system causes the water to be quite salty. It is believed that residents have been exposed to marginally-treated water at their homes for approximately one year, from August 2008 to present. The system is currently non-compliant, largely due to increased water usage for irrigation during summer months.

The Idaho Department of Environmental Quality (IDEQ) and community residents have concerns about what health effects may result from this duration (approximately 1 year) of exposure to arsenic above the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 10 µg/L and iron above the EPA Secondary Standard of 0.3 mg/L.

### **Inorganic Arsenic Toxicity**

At a sufficient dose, inorganic arsenic is considered a probable human carcinogen. It has also been associated with heart and vascular system disorders. Total arsenic analysis provides the combined level of both inorganic (toxic) and organic (non-toxic) forms of arsenic; however, only a small fraction of arsenic in groundwater is the organic form. Total arsenic analysis also does not discern between arsenic V and the more toxic arsenic III and thus, provides less accurate information about risk to human health. Speciated arsenic analysis allows for differentiation of the forms of arsenic. No speciated arsenic data were available for this consultation.

### **Iron Toxicity**

Iron can be toxic at levels available in iron supplements, but not at levels present in most drinking water. Acute gastrointestinal symptoms may occur after ingestion of 10 mg/kg of iron, with more severe symptoms at higher doses. Iron data were available for some sampling dates and are evaluated below.

### **METHODS**

Sampling was performed by IDEQ according to IDEQ protocol. Analysis was performed by Accurate Testing Labs of Coeur d'Alene, ID. Arsenic was analyzed according to EPA method 200.9. Iron was analyzed according to EPA method 200.7. The samples considered in this analysis were collected between January 2008 and August 2009.

### **RESULTS**

See Table 1. The running annual average arsenic concentration at the time of first non-compliance was 14 µg/L (micrograms per liter) with a maximum single sample concentration of 35 µg/L in August 2008 prior to the new improvements to the treatment system. The running annual average for the summer of 2009 has been between 16 and 17 µg/L. The arsenic concentration has fluctuated between non-detect (ND) and 35 µg/L between January 2008 and August 2009.

**Table 1: Arsenic and iron water concentration at the Whiskey Jack system distribution station ('plant tap')**

<b>Sample Date</b>	<b>Arsenic (<math>\mu\text{g/L}</math>)</b>	<b>Exceeds MCL? (10 <math>\mu\text{g/L}</math>)</b>	<b>Iron (<math>\text{mg/L}</math>)</b>	<b>Exceeds Secondary Standard? (0.3 <math>\text{mg/L}</math>)</b>
1/08/08	ND	No		
2/28/08	17	<b>Yes</b>		
4/15/08	ND	No		
5/29/08	ND	No		
5/31/08	7	No		
8/21/08	35	<b>Yes</b>		
10/08/08	13	<b>Yes</b>	0.02	No
10/08/08	12	<b>Yes</b>	0.08	No
10/28/08	16	<b>Yes</b>		
11/12/08	30	<b>Yes</b>		
11/26/08	15	<b>Yes</b>		
12/10/08	19	<b>Yes</b>		
12/16/08	16	<b>Yes</b>		
1/15/09	29	<b>Yes</b>		
1/27/09	14	<b>Yes</b>		
2/11/09	25	<b>Yes</b>		
2/11/09	19	<b>Yes</b>		
2/26/09	13	<b>Yes</b>		
3/05/09	13	<b>Yes</b>		
3/10/09	8	No		
3/18/09	10	<b>Yes</b>		
3/25/09	13	<b>Yes</b>		
4/13/09	6	No	0.10	No
4/28/09	7	No		
5/4/09	ND	No	0.09	No
5/7/09	5	No		
5/19/09	5	No	0.07	No
6/2/09	9	No		
6/23/09	11	<b>Yes</b>	0.16	No
6/23/09	10	<b>Yes</b>		
7/08/09	7	No		
7/14/09	9	No	0.19	No
7/28/09	7	No		
8/4/09	11	<b>Yes</b>	0.23	No
8/4/09	12	<b>Yes</b>		

## **DISCUSSION**

### **Health Assessment Approach**

The purpose of this letter health consultation, in keeping with the request of IDEQ, is to: 1) evaluate the public health risk of drinking water that is high in arsenic and iron and eating food made with this water; and 2) address the community's concerns.

### **Exposure Pathways**

A completed exposure pathway exists because contaminants are present in the community's drinking water system at the point-of-use and residents drink the water.

### **Exposure Assumptions**

Adults are assumed to drink 2 liters of water per day for one year or greater. Children are assumed to drink 1 liter of water per day for one year or greater. Children are also assumed to have incidental ingestion of 0.05 liters (50 mL) of water per day due to bathing and/or play in water. Infants are assumed to drink 0.64 liters of water per day. These exposure estimates are delineated by the EPA Exposure Factors Handbooks.

### **Oral (Ingestion) Comparison Values**

To evaluate the health effects of exposure to contaminants in specific environmental media, including 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 (14–365 days), and chronic (greater than 365 days) exposure.

The MRL is neither a threshold for toxicity nor a level beyond which toxicity is likely to occur. MRLs are established 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. Literature sources, such as ATSDR's Toxicological Profiles, are reviewed to determine what exposure doses through different routes of exposure (ingestion, inhalation, or dermal contact) have been documented to actually cause a health problem. The *no-observed-adverse-effect level* (NOAEL) is the highest exposure dose at which no adverse effect was observed on the animal or human population in a study. The *lowest-observed-adverse-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. When evaluating possible health effects from exposure to the contaminant, NOAELs and LOAELs from studies in humans are reviewed, if available. If, however, no human studies exist, studies on laboratory animals are reviewed. The health assessor might include safety factors to address human differences when evaluating animal studies.

The ATSDR acute Minimal Risk Level (MRL) for arsenic is 5 µg/kg/day. The ATSDR chronic Minimal Risk Level (MRL) for arsenic is 0.3 µg/kg/day. See Attachment 1 for dose calculations. Data from multiple human studies suggest an association between certain cancers and arsenic ingestion but for exposure over many years and at arsenic concentrations higher than those found in the Whiskey Jack System. Table 2 shows estimated doses from water

consumption compared to the two MRLs. Child estimates include an extra incidental ingestion estimate to account for swallowing water while bathing and/or playing in water.

**Table 2: Arsenic dose estimates and comparison to MRL values**

	Estimated Dose ( $\mu\text{g}/\text{kg}/\text{day}$ )	Exceeds Acute MRL? ( $5 \mu\text{g}/\text{kg}/\text{day}$ )	Exceeds Chronic MRL? ( $0.3 \mu\text{g}/\text{kg}/\text{day}$ )
Adult (max)	1.0	No	Yes
Child (max)	2.4	No	Yes
Infant (max)	5.0	No	Yes
Adult (mean)	0.40	No	Yes
Child (mean)	0.98	No	Yes
Infant (mean)	2.0	No	Yes

max =  $35 \mu\text{g}/\text{L}$   
 mean =  $14 \mu\text{g}/\text{L}$

*Acute Exposure.* At the acute LOAEL of  $50 \mu\text{g}/\text{kg}/\text{day}$ , an infant is likely to experience edema (swelling) of the face and/or nausea, vomiting and diarrhea as a result of drinking the water. The infant maximum dose estimate in Table 2, while at the Acute MRL, is 10 times lower than the LOAEL. If levels approaching the LOAEL were consumed, ill effects could happen as a result of drinking the water for 14 days or less. Effects would be noticed soon after drinking the water. However, there is no evidence that the highest dose was ever greater than  $5 \mu\text{g}/\text{kg}/\text{day}$ .

*Chronic Exposure—Non-Cancer.* At the chronic LOAEL of  $14 \mu\text{g}/\text{kg}/\text{day}$ , infants, children and adults are likely to experience toughening and darkening of the skin as a result of drinking the water. These are chronic effects—they can happen as a result of drinking the water for 1 year or more. Effects may not be noticed for a year or more. The respective dose estimates in Table 2 (at both mean and maximum concentrations) are at least three times lower than this LOAEL. However, there is a great deal of uncertainty because it is not known whether effects could occur at doses between the NOAEL of  $0.8 \mu\text{g}/\text{kg}/\text{day}$  and  $14 \mu\text{g}/\text{kg}/\text{day}$  (the LOAEL). While this effect on the skin by itself is arguably not a compromise to overall health, changes in skin pigmentation can be a risk factor for later skin problems.

*Chronic Exposure—Cancer.* Residents are not at a discernable increased risk for skin, bladder and lung cancers as a result of drinking water at the mean or maximum concentrations for approximately 1 year *unless* there is also significant exposure to other sources of arsenic throughout the lifetime. Human studies suggest an association between skin, bladder and lung cancers and ingestion of arsenic at concentrations that are 3-20 times higher than what people in the Whiskey Jack community have been consistently drinking. Using the EPA cancer slope factor method for calculating risk based on 1 year of exposure also showed that drinking the water is not expected to pose an unacceptable carcinogenic risk if considered independent of other lifetime exposures.

There is not an MCL for iron, but the Secondary Standard (non-enforceable) is  $0.3 \text{ mg}/\text{L}$ . This level was not exceeded. The highest iron level recorded for the Whiskey Jack system was approximately 140 times lower than the NOAEL. While acute iron toxicity is not possible from

water ingestion, chronic iron consumption in water could potentially lessen the efficacy of certain prescription medications. The effect would likely be slight at the levels found in the Whiskey Jack system.

### **Dermal Effects**

Arsenic is known to cause contact dermatitis in occupational settings and in findings from various animal studies. A dermal comparison value is not provided by ATSDR, EPA, or other agencies. As with many mineral-rich waters, drying of the skin can occur with frequent bathing. Inorganic arsenic and arsenicals are also known to be contact allergens and may negatively affect sensitive individuals. High concentrations of arsenic acid are known to readily cross the skin, but elemental, inorganic and organic forms at levels found in most waters do not readily cross the skin. Therefore, systemic uptake and effects do not occur as a result of dermal exposure.

### **Inhalation Effects**

The inhalation comparison values for arsenic are occupational standards. The American Conference of Governmental Industrial Hygienists sets an 8-hour time-weighted average Threshold Limit Value (TLV) of 0.01 mg arsenic/m<sup>3</sup> of air, or 10 µg arsenic/m<sup>3</sup> of air. The health endpoint of concern is lung and skin cancer. It is not possible for air concentration of arsenic to reach 10 µg/m<sup>3</sup> from aerosolization of water containing 35 µg/L of arsenic. One m<sup>3</sup> is equal to 1000 liters. Assuming air becomes completely saturated with the water vapor, the highest achievable concentration would be approximately 0.035 µg/m<sup>3</sup>.

### **Status of the Water System and Future Plans**

The breakdown of the treatment system was related to two factors: the insufficiency of the softener (due to wear and tear and higher demands) and the greater volume of water demanded during the summer months. This in turn caused the overloading of the ion exchange media, allowing too much arsenic to pass through. The community has installed an irrigation-only pipeline this summer to carry a non potable surface water supply from Lake Pend Oreille (in preparation for summer 2010). This will lessen the demand on the treatment system. A second water softener will be installed and the ion exchange resin will be replaced. These two factors should prevent future overloading of the ion exchange media. It is expected that the arsenic concentration will drop below the MCL for individual samples taken in fall 2009. To be back in compliance, the system must have a yearly running average that is below the MCL. This could take as long as 6 months.

A long-term plan for the community involves completely switching water sources for the community. An agreement is being negotiated to buy water from the neighboring Oden Bay Water System, a filtered surface water source. The likelihood of this switch appears high since Oden Bay will pay all costs for installation of supply lines (approximately one mile of pipe) and the bulk water cost will not be significantly different from the current cost of maintaining the softening, chlorination, and ion exchange system. The Oden Bay system consistently meets Federal Standards.

### **Community Concerns**

The following questions and concerns were raised at a community meeting on 3-11-09.

1. *Cancer*

*Community has had 2 brain, 2 lung and 1 bladder cancer in the recent past. Is there any association with arsenic or iron exposure?*

There is an association between chronic arsenic ingestion and skin, bladder and lung cancers. The studies that found increased rates of lung cancer are not as convincing as those for skin and bladder cancer. There is not an association between arsenic exposure and brain cancer. It is important to consider that cancer is a very common disease. It is estimated that 2 out of every 3 men and 1 out of every 2 women will develop some type of cancer in their lifetimes.

Environmental exposures, such as arsenic in drinking water, can potentially increase the risk of a person developing cancer so efforts should be made to reduce the exposure. The short window of exposure to the arsenic concentration at Whiskey Jack by itself would not be associated with the lung or bladder cancers, but cumulative exposure from multiple sources over a longer period of time is a plausible risk factor.

2. *Are there any autoimmune system consequences of exposure to arsenic or iron?*

If you or someone you know has an autoimmune disorder, it would be a good idea to ask your medical provider if exposure to arsenic and/or iron might affect the disease. We are not aware of peer-reviewed research suggesting low-level arsenic or elevated iron exacerbates such disorders. Arsenic trioxide has been used in low doses as an experimental *treatment* for autoimmune disorders of the digestive system.

3. *What are the implications of exposure to arsenic and iron for diabetics?*

Recent research has found that low level chronic arsenic ingestion may play a role in the prevalence of diabetes. Further research is needed in order to be able to say for certain that low levels of arsenic ingestion cause diabetes.

4. *Why are there more dental cavities and filmy teeth?*

Increased incidence of cavities could be linked to lack of fluoridation of the water, or possibly to pH. None of the three contaminants (arsenic, iron, and sodium) is known to increase the incidence of cavities. A filmy teeth effect is most likely due to the sodium from the water treatment process.

5. *I bought 4 pairs of goldfish and all died within a day or 2 of putting them in the water. I bought a 5<sup>th</sup> pair and put them in purified, bottled water and they lived. Why?*

Freshwater fish are very sensitive to salt and chlorine. The sodium and/or chlorine in the Whiskey Jack water system are potentially high enough to kill certain freshwater species.

6. *What do the sodium levels in our water mean? Should I be concerned about cardiovascular health?*

A diet higher in sodium than the RDA of 2400 mg/day can lead to increased incidence of high blood pressure. Water can be a significant contributor to sodium in diet for people on treatment systems that release sodium.

7. *Is there an interaction problem between the contaminants in our water and prescription medications we might be taking?*

Iron has known interactions with many classes of drugs so it is always a good idea to discuss possible drug interactions with your health care provider. There is no information to suggest that low-level arsenic or sodium have any interaction with prescription drugs.

### **CONCLUSIONS**

BCEH concludes that drinking the Whiskey Jack system water with elevated levels of arsenic could potentially harm people's skin if consumed for 1 year or more. Infants, children and adults could potentially experience toughening and darkening of the skin as a result of drinking the water for 1 year or longer if the system is not repaired and the arsenic levels lowered. This potential health effect is not a serious by itself, but could lead to further skin problems. Risk of skin, bladder and lung cancers is not expected to increase after 1 year of exposure *unless* there is also significant exposure to other arsenic sources throughout the lifetime.

BCEH concludes that the iron content alone will not harm the health of residents drinking the water. Ingestion exposure has now diminished since most residents are currently not drinking the water or using it to prepare food. The system is expected to drop below the MCL for arsenic in the next few months once a new softener and resin are installed and water demand due to irrigation subsides. No residents are reporting current health effects associated with arsenic exposure.

### **RECOMMENDATIONS**

Further recommendations are:

- Use bottled or treated water that meets Federal Standards for drinking and for preparing food
- Continue monitoring this system given the history of treatment problems
- Closely monitor and regularly service the treatment system at the well head
- Follow through with the installation of the irrigation system
- Follow through with the new water supply from Oden Bay

### **PUBLIC HEALTH ACTION PLAN**

- Continue to encourage using bottled or treated water and do outreach with the community, including a follow-up visit to the site at the end of September 2009
- Follow-up with IDEQ to determine if repaired treatment system has brought arsenic below the MCL (sometime fall 2009)
- Follow-up with IDEQ to establish when the water supply will change (late 2010)

If you have questions, please feel free to contact BCEH any time.

Best regards,

A handwritten signature in black ink, appearing to read 'K. Elgethun', with a stylized flourish at the end.

Kai Elgethun Ph.D., MPH  
Public Health Toxicologist  
Idaho Dept. of Health and Welfare

Attachments: 1. Calculations; 2. References

## **CALCULATIONS--INGESTION**

IR: Ingestion Rate  
BW: Body Weight  
IR: Ingestion Rate  
Conc: Concentration

### **Drinking Water Ingestion Calculation**

$$\text{Oral Dose} = [\text{IR (L/day)} * \text{Conc. (mg/L)}] / \text{BW (kg)}$$

*Dose Based on Max of 35 µg/L*

$$\text{Adult} = [2 \text{ L/day} * 35 \text{ µg/L}] / 70 \text{ kg} = 1.0 \text{ µg/kg/day}$$

$$\text{Child} = [1 \text{ L/day} * 35 \text{ µg/L}] / 15 \text{ kg} = 2.3 \text{ µg/kg/day}$$

$$\text{Infant} = [0.64 \text{ L/day} * 35 \text{ µg/L}] / 4.5 \text{ kg} = 5.0 \text{ µg/kg/day}$$

*Dose Based on Mean of 14 µg/L*

$$\text{Adult} = [2 \text{ L/day} * 14 \text{ µg/L}] / 70 \text{ kg} = 0.40 \text{ µg/kg/day}$$

$$\text{Child} = [1 \text{ L/day} * 14 \text{ µg/L}] / 15 \text{ kg} = 0.93 \text{ µg/kg/day}$$

$$\text{Infant} = [0.64 \text{ L/day} * 14 \text{ µg/L}] / 4.5 \text{ kg} = 2.0 \text{ µg/kg/day}$$

### **Incidental Water Ingestion Calculation**

$$\text{Oral Dose} = [\text{IR (L/day)} * \text{Conc. (mg/L)}] / \text{BW (kg)}$$

*Dose Based on Max of 35 µg/L*

$$\text{Child} = [0.05 \text{ L/day} * 35 \text{ µg/L}] / 15 \text{ kg} = 0.12 \text{ µg/kg/day}$$

*Dose Based on Mean of 14 µg/L*

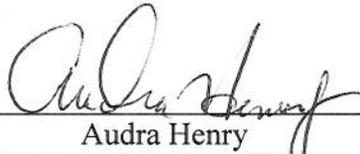
$$\text{Child} = [0.05 \text{ L/day} * 14 \text{ µg/L}] / 15 \text{ kg} = 0.05 \text{ µg/kg/day}$$

### **Notes on Exposure from Home-grown Vegetables**

None of the residents reported growing vegetables with the water during the time period when arsenic was elevated in the water. Arsenic is known to concentrate in root vegetables, which can be a particular concern for home gardeners.

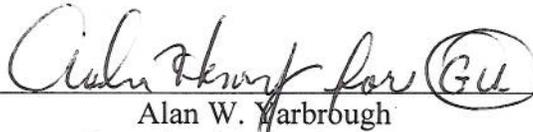
## Certification

This health consultation was prepared by the Idaho Division of Public Health (IDPH) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodologies and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.



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Audra Henry  
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