Health Consultation

Health risks associated with arsenic in
fish from arsenic-contaminated areas of the
MENOMINEE RIVER near
TYCO SAFETY PRODUCTS - ANSUL

MARINETTE, MARINETTE COUNTY, WISCONSIN

EPA FACILITY ID: WID006125215

MAY 15, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR 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 which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

Wisconsin Department of Health and Family Services
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Summary
As part of a sediment cleanup project of the Menominee River in Marinette, Wisconsin, the Wisconsin Department of Health and Family Services (DHFS) evaluated health risks from consuming fish near arsenic-contaminated sediments and direct contact with those sediments and overlying surface water. DHFS concluded that arsenic in sediment adjacent to Tyco Safety Products-Ansul ("Ansul") is a **public health hazard**, to dredge or construction workers expected to come in contact with these sediments, primarily due to the acute risk posed by a single accidental ingestion of small amounts of these sediments. Similarly, local changes resulting in greater recreational usage of the river near the arsenic-contaminated sediments represents a **future public health hazard.** DHFS recommends that the public and river workers be informed of these hazards through warning signs and that existing access barriers to the river around Ansul be maintained. Greater-than-background levels of arsenic in sediment near the Sixth Street boat ramp are **not an apparent health hazard** due to the relatively low arsenic concentration and the expectation of infrequent contact. Based upon a literature review of the bioavailability of arsenic in fish, and data for arsenic in fish in Wisconsin waters, **no apparent health hazard** was identified associated with arsenic in fish found in the Menominee River. However, the existing Fish Consumption Advisory should continue to be observed by the angling public due to the presence of mercury and PCBs. Contact or accidental ingestion of arsenic in Menominee River water is **not an apparent health hazard** due to the low arsenic concentration. In establishing a cleanup goal for arsenic in sediments of the Menominee River, arsenic concentrations that are protective of the aquatic resource will also be protective of human health. DHFS concurs with the WDNR recommendation of 10-20 ppm as a cleanup goal for arsenic in sediment, based on the research review developed in the WDNR Consensus-Based Sediment Quality Guidelines.

Background and Statement of Issues

Purpose

The Wisconsin Department of Natural Resources (WDNR) asked the Wisconsin Department of Health and Family Services (DHFS) to evaluate the safety of arsenic-contaminated sediments in the Menominee River adjacent to the Ansul Chemical property in Marinette. This question arose in the context of WDNR and U.S. EPA efforts to establish cleanup goals for removing the arsenic-contaminated sediments. Two exposure pathways were considered: 1) fish consumption and 2) direct contact with arsenic in sediment and surface water. In preparing a response, DHFS relied on several sources of information. These included environmental data for the site (URS 2003; data summarized in this consultation included in Table 1), analyses of arsenic in Menominee River fish and of fish elsewhere in Wisconsin (Table 2), published studies of arsenic in fish exposed to high levels of arsenic in diet or habitat, and a literature review of the toxicity to humans of arsenic in fish.

Background environmental data

Direct contact exposure pathways. The Menominee River in Marinette (population 11,749; 2000 census) is a Great Lakes shipping port with a variety of environmental issues related to industries located along the riverfront. Tyco Safety Products-Ansul ("Ansul"; 1 Stanton St., Marinette, 54143) is located on the Menominee River where dimethyl arsenate herbicides were produced

from 1957-1977 (URS 2003). During that time arsenical wastes were stockpiled (Figure 1) on the Ansul property and dispersed into the surrounding environment. Arsenic concentrations in river sediments exceeding 2000 milligrams per kilogram (mg/kg; maximum 3670 mg/kg) have been detected in the turning basin adjacent to the former stockpile (URS, 2003). Arsenic reported in sediments near the Sixth St. boat ramp (Figure 1) was 87 mg/kg.

Contact with affected surface water is a possible exposure pathway for people boating or fishing in the area. URS (2003) report total arsenic in surface waters near Ansul (mean 6.8 micrograms per liter (μg/L); range 0.75-19 μg/L) that is similar to background levels (<2.3 μg/L).

Fish data. The well-documented acute and chronic toxicity of inorganic and some forms of organic arsenic have raised concerns about arsenic in fish from the Menominee River near the Ansul Chemical site. Table 2 is a list 11 fish samples having the greatest concentration of arsenic from 1496 Wisconsin DNR specimens. These 11 samples include 2 of 51 Menominee River specimens from 1977-1990, and represent the thirteen years after arsenical herbicide manufacture ceased at Ansul.

Discussion

Fish data. The toxicological and site-specific sources reviewed collectively indicate **no apparent health hazard** from arsenic exposure due to consuming fish from the Menominee River. This is primarily due to the expectation of low bioavailability of arsenic and low total arsenic in these fish. The available fish arsenic data from the Menominee River and elsewhere in Wisconsin indicate that, with the exception of whole fish chub samples from Lake Michigan grid 707, the highest concentrations of total arsenic in fish in Wisconsin is within the normal range for all freshwater fish reported by Donohue *et al.* (1999). Results specific to the Menominee River are within the normal range for freshwater fish and well below the range for marine fish. Furthermore, little consumption of fish from the Menominee River is expected due to an existing Fish Consumption Advisory for polychlorinated biphenyl (PCB) and mercury contamination (WDNR 2003a). Should Menominee River fish be consumed, an exposure estimate is included in the exposure pathways evaluation to support the conclusion that there is no apparent health hazard from arsenic in these fish.

Current DHFS fish arsenic policy. DHFS staff scientists concur with studies that conclude 80-99% of the arsenic in fish is in the form of arsenobetaine and arsenocholine, organoarsenicals that have low bioavailability, low toxicity, and are rapidly cleared in urine (Knobeloch *et al.* 1998; Ahmed, 1991). Most studies reporting these conclusions deal with marine fish and shellfish, which are major sources of dietary arsenic. Donohue *et al.* (1999) report that the mean total arsenic in 77 marine fish species is 2.1 mg/kg (range 0.19-65 mg/kg,). This average for naturally occurring arsenic in marine fish exceeds the EPA Region III risk-based concentration, 0.0021 mg/kg (cancer effects). Donohue *et al.* also report that mean total arsenic in 24 freshwater fish species is 0.3 mg/kg (range 0.007-1.46 mg/kg), 17-fold lower than in marine fish. Donohue and Abernathy (1999) estimate that at least 70-85% of total arsenic in freshwater fish is not bioavailable.

In light of these and similar studies, DHFS has not advocated monitoring arsenic in fish as has been done for mercury and PCBs. In order to protect the health of people fishing in the Menominee River, DHFS expects the existing WDNR fish consumption advisory for mercury and PCBs in the Menominee River to be sufficient. Nonetheless, if sampling and analysis for arsenic in fish from the Menominee River or any other Wisconsin waters are performed, DHFS is available to review and evaluate those data.

Arsenic in Menominee River sediments. The purpose of this health consultation is to identify health risks that are due both to the presence of environmental contaminants and to corresponding routes of exposure to those contaminants. Although high concentrations of contaminants are present in sediment, risks are limited by the probable infrequency of a completed exposure route. Nonetheless, these sediments have been handled in the past and *will* be handled in the future. Plausible scenarios where sustained exposure is expected are for workers during seasonal maintenance of the dock at the Sixth Street boat ramp, and for workers dredging sediments during maintenance or remediation of the turning basin (Figure 1). The turning basin has been historically maintained for commerce, and future maintenance or remediation is likely. Workers at these locations should be made aware of risks from contact with these sediments, and of any personal protection measures needed for workers. Finally, DHFS acknowledges that arsenic contamination in the Menominee River has broader ecological risks for fish health and the aquatic resource, and supports efforts to understand and remediate those risks. Health-based sediment screening values for arsenic are not widely available, but it is expected that any ecologically-based screening values would be more stringent than health-based values due to the sustained exposure experienced by benthic and limnotic organisms.

In earlier discussions of cleanup goals for arsenic in the Menominee River, 10-20 ppm had been proposed, based on Table 1 of the WDNR (2003b) Consensus-Based Sediment Quality Guidelines. These concentrations were derived from a literature review of toxic effects of arsenic on benthic organisms. It is generally assumed that aquatic biota continuously exposed to non-bioaccumulating toxicants are more sensitive to a given toxicant concentration in sediment than are upland animals whose exposure is intermittent. For this reason, DHFS considers a cleanup goal that is protective of the aquatic resource to be sufficiently protective of public health. DHFS concurs with the WDNR recommendation that the ecological endpoints reviewed in the Wisconsin Consensus-based Sediment Quality Guidelines (WDNR 2003b) be used as the criteria for establishing arsenic cleanup goals in Menominee River sediments at the Ansul site.

Exposure pathways evaluation

Consumption of Menominee River fish. A WDNR Fish Consumption Advisory for mercury and PCBs is currently in place for the Menominee River. To the extent that the advisory is followed, exposure to arsenic in Menominee River fish should be limited. The following exposure scenario is based upon an adult woman who ignores the fish advisory and consumes one meal per month of Menominee River Rock Bass containing 600 μg As/kg fish fillet, which is the maximum arsenic (As) concentration reported from 51 Menominee River samples (Table 1).

1. ATSDR Minimum Risk Level (MRL) for chronic oral exposure to arsenic:

0.3 µg arsenic/kg body wt/day .

2. Equivalent MRL exposure to 60 kg adult female:

   (0.3 µg arsenic/kg body wt/day)(60 kg) = **18 µg arsenic/day**

   Typical daily adult consumption of arsenic from all dietary sources: **30 µg/day** (FDA 1993). FDA tolerable intake of inorganic As: 130 µg/day.

3. Fish consumption: typical one-half pound Rock Bass fish meal, once per month. Equivalent to consuming **0.008 kg fish/day**.

4. Average arsenic reported in Menominee River Rock Bass: **600 µg As/kg fish fillet**.

5. Arsenic dose from consuming Menominee River Rock Bass:

   (600 µg As/kg fish)(0.008 kg fish/day) = **4.8 µg As/day**

Note: if 4 meals/month, dose would be 17 µg As/day

6. Chronic dose to 60 kg female:

   (4.8 µg As/day)/60kg = **0.08 µg As/kg body wt/day**, or **3.75-fold less** than the ATSDR MRL.

It is noteworthy that the daily U.S. consumption of total arsenic from all food sources is 1-2 fold higher than the ATSDR MRL, depending upon body weight. This discrepancy is due partly to an MRL based on the cancer endpoint, and partly to the low toxicity of some of the arsenic included in the daily total. Under the arsenic exposure calculated here, if the fish consumption was increased 4-fold (to 1 meal per week), total arsenic exposure from these fish would be slightly above the ATSDR MRL, but still 1.6-fold less than the typical 30 µg/day arsenic consumption (FDA 1993) from all dietary sources.

Comparison fish studies. The Menominee River fish samples reported here are comparable in arsenic content to those fish samples taken elsewhere in Wisconsin having the highest arsenic concentration, and to freshwater fish exposed to high levels of arsenic in Canada and Taiwan. The 11-highest concentrations of total arsenic from 1496 fish sampled at various locations in Wisconsin (Table 1) ranged from 0.4 to 0.6 mg/kg in muscle and 1.5-1.7 mg/kg in whole fish. In other studies, Canadian Whitefish exposed to up to 100 mg/kg dietary arsenate (Pedlar and Klaverkamp, 2002) had total arsenic of 0.38-0.56 mg/kg in muscle (wet weight; control = 0.48 mg/kg) and 0.30-0.57 mg/kg in bone (control = 0.08 mg/kg). Liao, *et al.* (2003) report the same order of tissue-specific accumulation of arsenic (intestine > stomach > liver, gill > muscle) in freshwater tilapia from a Taiwanese pond having up to 49 µg As/L water. This study analyzed dry tissue weight, so total arsenic is higher (muscle tissue = 3.55 mg/kg). These studies from fish exposed to high concentrations of arsenic are consistent with the Wisconsin fish samples,

and also suggest that where fish are exposed to high levels of arsenic, little of that excess arsenic accumulates in fish muscle.

Contact with sediment exposure pathways. Arsenic in sediment in the river turning basin adjacent to Ansul exceeds 2000 mg/kg in some locations, with 3670 mg/kg reported from the southeast part of the turning basin (location SD025; URS 2003).[1] An accidental ingestion of 200 mg of sediment containing 3670 mg As/kg sediment would compare to an arsenic exposure of 0.73 mg/day. This would exceed the provisional ATSDR acute oral MRL (0.005 mg/kg/day), which translates to 0.1, 0.3, and 0.4 mg As/day for people weighing 20, 60, and 80 kg. A 20 kg child who consumes 0.73 mg As would have an exposure of 0.04 mg/kg, just under the lowest observable adverse effect level (LOAEL) for serious gastrointestinal effects (0.05 mg/kg/day; ATSDR 2000). The most likely exposure to arsenic contaminated sediments in this part of the Menominee would be to those working in or on the river, including dredging, utility installations, and construction work on adjacent shoreline that would bring workers in contact with river sediments. DHFS considers such exposure a **public health hazard** due to the possibility of acute effects from accidental ingestion of sediment. Remediation of contaminated sediments is recommended as a long-term solution to this hazard. Information to the public, such as signs at the Sixth Street boat ramp, is recommended as a means to prevent current exposures.

Care should be taken that the public is not exposed to arsenic-contaminated dredge spoils from the Menominee River during the removal, staging, or disposal of these sediments. A work plan has not been proposed to address the future disposition of arsenic contaminated sediments, but the Wisconsin DNR has indicated that these will likely be designated hazardous waste that will require disposal in a secure facility

A possible but less likely exposure scenario to arsenic-contaminated sediments in the turning basin area is to those using the river recreationally, including fishing from small watercraft and shoreline wading. Although exposure to these sediments is a health concern, the likelihood of ingestion following contact is low. The property is secured against free access by fences and security guards, and the shoreline area is unsuitable for swimming, but the waters overlying these sediments are accessible by the nearby Sixth Street boat ramp, and it is possible that someone might use a small watercraft to explore the shoreline or drop anchor around the contaminated area. Any shoreline changes or other changes that result in increased recreational use of arsenic-contaminated areas of the river represent a **future public health hazard.**

Another possible exposure pathway to arsenic-contaminated sediments exists near the Sixth Street boat ramp (Figure 1), where URS (2003) reports 87 ppm arsenic in sediments. Exposure to sediments at this boat ramp is more likely than to sediments in the turning basin. A single 200 mg accidental ingestion of these sediments might represent an arsenic dose of 17.4 μg (= 200mg soil x 87mg As/kg soil), whereas the U.S. Food and Drug Administration (FDA 1993) considers 130 μg/day inorganic arsenic the maximum of tolerability. Although 87 ppm arsenic in a *residential soil* would represent a possible health hazard from long-term frequent contact and

[1] The U.S. EPA (1999) Exposure factors handbook cites studies of adult incidental ingestion of soil ranging from 4-708 mg/day, with a mean of 65 mg/day. 200 mg/day is commonly used as the child exposure factor, but was also chosen in this exposure estimate to typify the greater than average exposures expected in a construction environment.

accidental ingestion of that soil, arsenic-contaminated sediments at the boat ramp is **not an apparent health hazard** because the arsenic concentration is not high enough to present an acute exposure hazard, and occasional accidental ingestion of sediment at this location would not be frequent enough to present a chronic exposure. This conclusion is complicated by a lack of established health-based standards for arsenic in sediment. Warning signs placed at this boat ramp would help prevent unnecessary exposure.

Contact with surface water exposure pathway. URS (2003) also report arsenic in surface waters near Ansul (mean 6.8 μg/L; range 0.75-19 μg/L) that is similar to background levels (<2.3 μg/L). The ATSDR Environmental Media Evaluation Guideline (EMEG) for chronic exposure in drinking water is 10 μg/L. The river in this location is not a source of municipal drinking water, therefore arsenic in surface water is **not a health hazard** due to the low concentration and lack of ingestion pathways. Similarly, Lake Michigan surface water that is the municipal supply for the City of Marinette is also less than the 10 μg/L ATSDR EMEG for arsenic.

Public Health Implications

Of the various exposure scenarios to arsenic from the Menominee River discussed above, acute effects from a single exposure to concentrated inorganic arsenic in sediments is the route identified as a public health hazard. The expected health effects from a single acute oral exposure or repeated exposure to lower doses are serious gastrointestinal irritation (ATSDR 2000). Those potentially exposed to these sediments are anyone involved in work or recreation that would bring them into contact and accidental ingestion of sediments. Other arsenic-related pathology, such as encephalophathy, peripheral neuropathy, skin lesions, and cancer, are chronic effects not expected under the exposure scenarios discussed here. There is no evidence in the present environmental assessment of past chronic or acute exposures at this site. Under current conditions, acute exposures are probably infrequent, but the hazard will be present indefinitely until remediation of affected sediment is completed.

Child Health Considerations

Arsenic, as reviewed in the ATSDR (2000) Toxicological Profile, affects adults and children similarly, and there is no evidence of differences in adsorption of arsenic among children and adults. Where children have been chronically exposed to arsenic, increases in childhood cancers have been noted, and arsenic at doses toxic to women are also toxic to developing embryos. Arsenic from either natural or human sources is a frequent contaminant of soil. Children are more prone than adults to arsenic exposure in soil through incidental ingestion of soil on dirty hands. For that reason, children are those most likely to be exposed in the scenarios discussed in this health consultation. Where arsenic is known to exist in high concentrations in soil or sediments, exposure can be interrupted by avoidance, by placing vegetative groundcover over contaminated soil, and by hand washing after contact with contaminated soil or sediment.

Conclusions

- Concentrated arsenic in Menominee River sediments in the turning basin adjacent to the Ansul property is a **public health hazard** due to the acute risk posed by a single exposure from accidental ingestion of small amounts of sediment. This hazard applies to

river construction workers, dredge workers, or others expected to come in contact with these sediments.

- Any shoreline changes or other changes that result in increased recreational use of arsenic-contaminated areas of the river represent a **future public health hazard.**
- Greater-than-background levels of arsenic in sediment near the Sixth Street boat ramp are **not an apparent health hazard** due to the relatively low arsenic concentration and the expectation of infrequent contact.
- There is **no apparent public health hazard** with regard to arsenic in fish from the Menominee River due to the low bioavailability, toxicity, and overall concentration of the predominant forms of arsenic found in fish. However, there is a current Fish Consumption Advisory based upon mercury and PCB contaminants in Menominee River fish that will assist in preventing exposure.
- Contact or accidental ingestion of arsenic in Menominee River water is **not an apparent health hazard** due to the low arsenic concentration.
- DHFS concurs with the WDNR recommendation of 10-20 ppm as a cleanup goal for arsenic in sediment, based on the research review developed in the WDNR Consensus-Based Sediment Quality Guidelines.

Recommendations

- Maintain existing barriers for access to the Ansul property until arsenic in sediments in the turning basin are reduced. Inform the public of hazards associated with accidentally ingesting contaminated sediments.
- Inform workers who may handle arsenic-contaminated sediments in the Menominee River, so that dredge spoils are managed safely to avoid exposure to workers and to the public during dredging, staging, and disposal.
- Future remediation and characterization efforts should include the Sixth Street boat slip and ramp, since this location contains potential exposure routes to arsenic in sediment.
- Although an exposure hazard was not identified in Menominee River fish, the existing Fish Consumption Advisory should continue to be observed by the angling public due to the presence of mercury and PCBs.

Public Health Action Plan

The public health needs in Marinette, Wisconsin stemming from arsenic contamination around the Ansul property will be met by on-site and off-site remediation of that contamination, to be administered by state and federal environmental agencies. Although this health consultation addressed off-site issues in sediments and fish, past work by the property owner included removal of the arsenic stockpile, capping of the stockpile site, and fencing around the property. These actions interrupt exposure pathways to the remaining contaminants. Current and ongoing actions to address the arsenic contamination include efforts by the property owner and environmental agencies to further assess the remaining contamination and plan for their removal. DHFS has been a partner in these ongoing efforts by participating in agency reviews of the environmental assessments and in planning meetings for the remediation. DHFS will work with state and local environmental and health agencies to place warning signs or otherwise inform the public of environmental hazards from sediment in the Menominee River. Due to the lack of

identified health hazards from arsenic in fish and sediments in the Menominee River, no other immediate public health actions are planned. If there is future sampling for arsenic or other contaminants in Menominee River fish, DHFS will be available to review fish analysis data. Also, due to the complexity of the ongoing Menominee River remediation effort, future public health questions are anticipated. DHFS will continue as an active partner in other aspects of the assessment and remediation of this site.

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References.

Ahmed FE (editor). 1991. *Seafood Safety: Committee on evaluation of the safety of fishery products.* Food and Nutrition Board, Inst.of Medicine. National Acadamy Press.

ATSDR. 2000. *Toxicological Profile for Arsenic.* Atlanta, GA: US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. Web: http://www.atsdr.cdc.gov/toxprofiles/tp2.html

Donohue JM and Abernathy CO. 1999. Exposure to inorganic arsenic from fish and shellfish. *In* (Chappell, Abernathy and Calderon, *eds.*) *Arsenic Exposure and Health Effects.* Elsevier Science Ltd, Amsterdam.

EPA. 1999. Exposure factors Handbook. United States Environmental Protection Agency, National Center for Environmental Assessment. Document EPA/600/C-99/001.

FDA. 1993. Guidance document for arsenic in Shellfish. U.S. Food and Drug Administration, Center for Food Safety & Applied Nutrition. Available: www.cfsan.fda.gov/~frf/guid-as.html

Knobeloch L, Korthof S, Anderson H. 1998. Never on a Saturday (or a Sunday): the case against using weekend urine specimens to assess arsenic exposure. *Wisc. Medical J.:* Oct. 1998.

Liao CM, Chen BC, Singh S, Lin MC, Liu CW, Han BC. 2003. Acute toxicity and bioaccumulation of arsenic in tilapia (Oreochromis mosambicus) from a blackfoot disease area in Taiwan. *Environ. Toxicol 18:* 252-9.

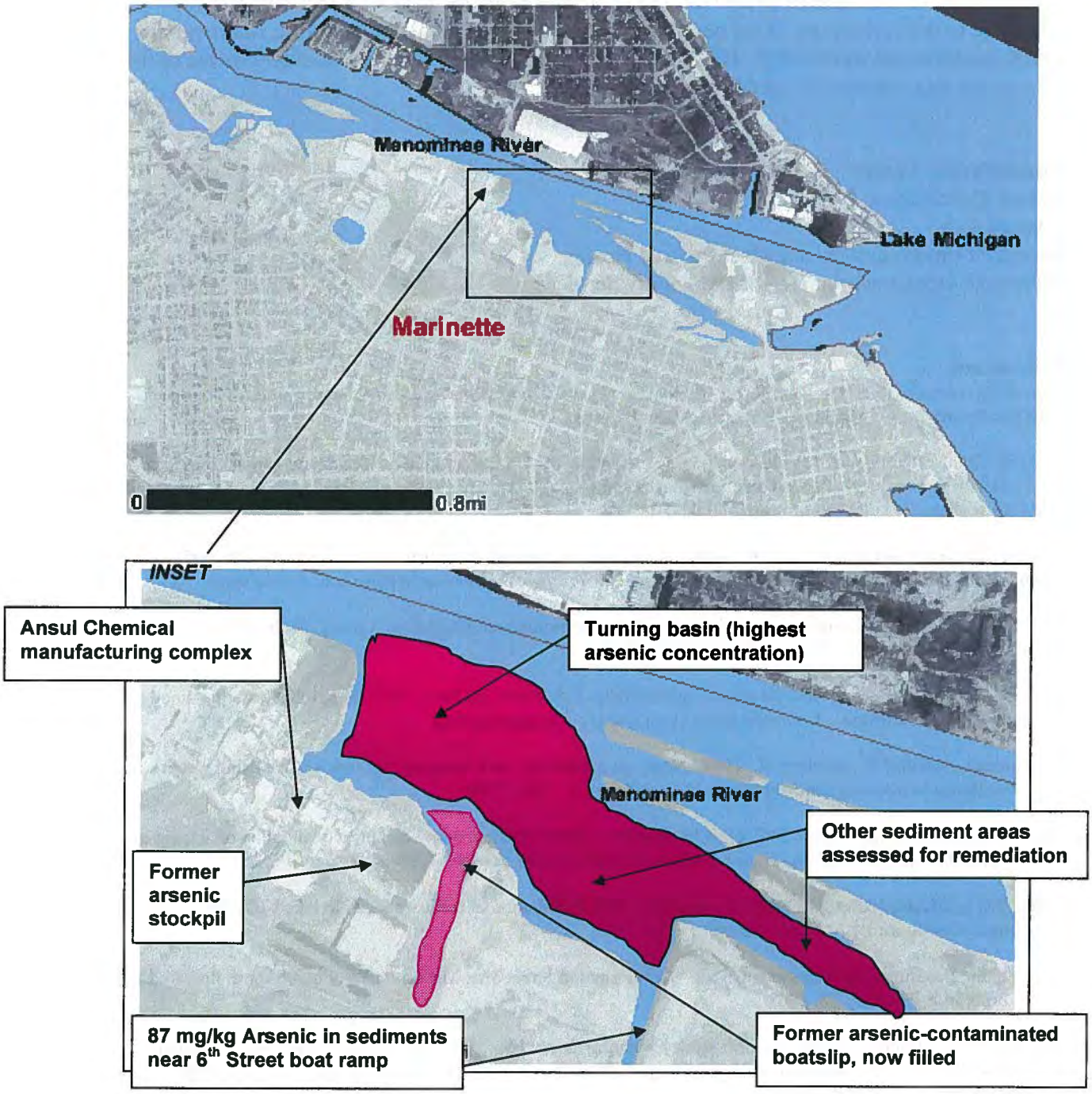
Pedlar RM and Klaverkamp JF. 2002. Accumulation and distribution of dietary arsenic in lake whitefish (Coregonus clupeaformis). *Aquatic Toxicol. 57:* 153-166.

URS. 2003. Baseline Risk Assessment, TSS – Ansul Stanton Street Site, Marinette, WI. Final Report. Prepared by URS Corporation February 28, 2003.

WDNR. 2003a. *Choose Wisely: A health guide for eating fish in Wisconsin.* Wisconsin Department of Natural Resources. PUB-FH-824 2003. Available http://www.dnr.state.wi.us/org/water/fhp/fish/advisories/Tables.pdf

WDNR. 2003b. Consensus-Based Sediment Quality Guidlelines, Interim Guidance. WT-732-2003. web: http://dnr.wi.gov/org/aw/rr/technical/cbsqg_interim_final.pdf

Figure 1. Menominee River near Ansul Chemical Co., Marinette, Wisconsin.



Map reference: Wisconsin Department of Natural Resources Webview (http://maps.dnr.state.wi.us/imf/dnrimf.jsp?site=webview)

Table 1. Summary of environmental arsenic and fish arsenic reviewed for the Menominee River, Marinette, Wisconsin.

Media	Exposure route	Highest concentration	Health-based Comparison value
Sediment (Ansul turning basin)	Incidental ingestion	3670 mg/kg	Not available
Sediment (6th St. boat slip and ramp)	Incidental ingestion	87 mg/kg	Not available
Surface water	Incidental ingestion	6.8 µg/L (average)	10 mg/L[1]
Fish (Rock Bass filet)	Consumption	0.6 µg/kg	2.1 µg/kg[2]

[1]U.S. Clean Water Act, arsenic standard for drinking water.
[2]U.S. Environmental Protection Agency, Region III Risk-based concentration table.
Sediment and surface water reference: URS. 2003. Baseline Risk Assessment, TSS – Ansul Stanton Street Site, Marinette, WI. Final Report. Prepared by URS Corporation February 28, 2003
Fish reference: WDNR Arsenic Concentrations in Fish and Aquatic Invertebrates from Wisconsin. Candy Schrank memorandum, July 20, 2005
Mg/kg: milligram per kilogram
µg/kg: Microgram per kilogram

Table 2. Individual Fish Samples with Highest Arsenic Concentration[1]
Ref. WDNR Arsenic Concentrations in Fish and Aquatic Invertebrates from Wisconsin.
Candy Schrank memorandum, July 20, 2005

Year	Form	Species (#Fish/sample)	Water body	Arsenic (µg/g)
1991	whole fish	bloater chubs (n=30 fish)	Lake Michigan Grid 707	1.56
1991	whole fish	bloater chubs (n=30 fish)	Lake Michigan Grid 707	1.69
1987	whole fish	cisco/lake herring (n=40 fish)	Milwaukee River GLRF	1.5
1989	skin on fillet	rock bass (n=5)	**Menominee R below Ansul chemical**	0.6**
1994	skin on fillet	smallmouth bass	Kewaunee River mouth	0.5
1984	whole fish	burbot (n=2)	Lake Superior Grid 1210	0.5
1985	whole fish	burbot (n=2)	Lake Superior Grid 1211	0.5
1988	edible portion	lake sturgeon	**Menominee River Hattie St**	0.5**
1999	whole fish	white sucker	Hackett Branch Grant River	0.4
1999	whole fish	white sucker	Muskellunge Creek	0.4
1994	skin on fillet	smallmouth bass	Kewaunee River mouth	0.4

µg/g: micrograms arsenic per gram of fish tissue.

[1]**WDNR's fish contaminant database contains 1496 total arsenic results collected during the years 1977 to 1999.** A majority (86%) of the results have a results qualifier code of "less than the lower level of the report range". Only 4.5% of the result of the 1496 results are qualified as normal detect.Of the 67 samples with normal results reported, 30 are for fish samples and the rest for are freshwater clams and crayfish. Table 1 contains the fish samples with the 11 highest concentrations of arsenic. Samples collected prior to 1994 were analyzed by Wi SLOH using hydride generation with flame AAS with a reporting limit of 0.5 µg/g. After 1994, most samples were analyzed using graphite furnace AAS with an LOD of 0.1 µg/g.

****Menominee River Fish Samples:** Of the 51 fish samples taken from the Menominee River, only 3 samples contained arsenic reported at normal detectable concentrations. Two of the samples are included in the above list. The third sample was collected from an upstream reach at the Little Quinnesec Flowage in 1989 (walleye skin on fillet 0.12 µg/g, 1989). The 51 samples span the collection years 1977 to 1990. The analytical methods used prior to 1994 limit use of that data. However, it seems reasonable to conclude that edible portions of fish contain total arsenic in concentrations in the range of 0 to 0.6 µg/g.

Certification

This health consultation for health risks associated with arsenic in fish and sediment in the Menominee River in Marinette, Marinette County, was prepared by the Wisconsin Department of Health and Family Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedure existing at the time the Health Consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

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

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