Health Consultation

Swift Creek Sediment Asbestos
Whatcom County, Washington

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Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

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Glossary

Acute	Occurring over a short time [compare with **chronic**].
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Aquifer	An underground formation composed of materials such as sand, soil, or gravel that can store and/or supply groundwater to wells and springs.
Cancer Risk Evaluation Guide (CREG)	The concentration of a chemical in air, soil or water that is expected to cause no more than one excess cancer in a million persons exposed over a lifetime. The CREG is a *comparison value* used to select contaminants of potential health concern and is based on the *cancer slope factor* (CSF).
Cancer Slope Factor	A number assigned to a cancer causing chemical that is used to estimate its ability to cause cancer in humans.
Carcinogen	Any substance that causes cancer.
Chronic	Occurring over a long time (more than 1 year) [compare with **acute**].
Comparison value	Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal Contact	Contact with (touching) the skin (see route of exposure).
Dose (for chemicals that are not radioactive)	The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Environmental Protection Agency (EPA)	United States Environmental Protection Agency.
Epidemiology	The study of the occurrence and causes of health effects in human populations. An epidemiological study often compares two groups of people who are alike except for one factor, such as exposure to a chemical or the presence of a health effect. The investigators try to determine if any factor (i.e., age, sex, occupation, economic status) is associated with the health effect.
Exposure	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [**acute exposure**], of intermediate duration, or long-term [**chronic exposure**].
Hazardous substance	Any material that poses a threat to public health and/or the environment. Typical hazardous substances are materials that are toxic, corrosive, ignitable, explosive, or chemically reactive.
Indeterminate public health hazard	The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.
Ingestion	The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].
Ingestion rate	The amount of an environmental medium that could be ingested typically on a daily basis. Units for IR are usually liter/day for water, and mg/day for soil.
Inhalation	The act of breathing. A hazardous substance can enter the body this way [see **route of exposure**].
Media	Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.
Route of exposure	The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].
Surface Water	Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with **groundwater**].

Summary and Statement of Issues

The Washington State Department of Health (DOH) prepared this health consultation in response to concerns raised by the Whatcom County Health Department (WCHD) regarding potential human exposure to asbestos. The purpose of this health consultation is to summarize potential health threats related to naturally occurring asbestos in Swift Creek sediments and to make recommendations for actions that ensure the public's health is protected. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Many potential pathways of human exposure to asbestos exist in the Swift Creek area where dredged sediments are stored as well as areas in Whatcom County where asbestos contaminated sediments have been used by the public. Current knowledge of asbestos content and physical properties in Swift Creek sediments is insufficient for determining human health risks and appropriate end use of dredged sediments. Therefore, DOH recommends that the asbestos in Swift Creek be fully characterized and that several measures be taken to mitigate the potential for current exposure to sediment.

Background

Swift Creek drains an area of about three square miles (mi^2) near the town of Everson in Whatcom County, Washington (Figure 1). The creek originates on the west flank of Sumas Mountain, and flows approximately four miles west through agricultural land into the Sumas River. The Sumas River in turn meanders roughly 15 miles northeast to the Canadian border (about 7 mile straight line distance) where it eventually flows into British Columbia's Fraser River 10 miles north of the border.

A large landslide on Sumas Mountain that occurred in the 1930s is a source of a large annual load of sediment to Swift Creek during periods of rain and snowmelt. Much of this sediment is deposited in the lower reaches (approximately 2 miles) of Swift Creek where an estimated 40,000 cubic yards (yds^3) was deposited annually from 1999 – 2002.[1] Sediment deposition causes continuing flood control problems.

Compounding flood control problems is the fact that the slide material has high levels of metals and naturally occurring asbestos. Consequently Swift Creek sediments are also rich in metals, such as magnesium and nickel, and in asbestos.[1,2] Flooding in past years has deposited sediments in adjacent agricultural fields and damaged agricultural properties in that high metal concentration of these sediments inhibits vegetative growth (Figure 2). Naturally occurring asbestos has also been deposited on agricultural lands.

Limited past sampling had documented the presence of asbestos in sediment, but it was not until recent sampling efforts that levels of asbestos were revealed to be potentially high. Sample results are discussed in more detail starting on page 6.

The immense scale of the landslide and the vast amount of material that is available for transport into Swift Creek has left few cost-effective remedies for preventing continued sedimentation and flooding. The U.S. Army Corps of Engineers began flood control in the 1950s by dredging and maintaining Swift Creek channel. Since then, studies have been conducted attempting to design remedies for either stabilizing the slide or dealing with sediment deposition.[3] To date, no remedies have been deemed feasible largely due to the enormous cost of proposed controls. Whatcom County Public Works Division of River and Flood (Whatcom County) later took on dredging responsibilities for the lower reaches of the creek from Goodwin road west beyond Oat Coales Rd (Figure 3). Whatcom County removed approximately 85,000 cubic yards from this reach during the summer of 2005. A long-term flood control plan is in the works, but adopting recommendations is contingent upon whether or not third party use of sediment as fill is appropriate with regard to asbestos content. Great Western Lumber maintains a one-mile portion of the creek east of Goodwin road (Figure 3).[4]

Site use

Swift Creek is bounded by forest in the upper reaches and agricultural and low density residential properties in the lower reaches (Figure 4). Approximately 50 residences are within 1/2 mile of the creek (Figure 5).

In the past, most dredged sediment was removed from the site by the public and contractors for use as fill in construction projects. This provided an inexpensive method for removing dredged sediments from the area. This practice was later discouraged (2004) due to renewed human health concerns related to naturally occurring asbestos in Swift Creek sediments.[5] The total amount of sediment that was transported off-site is not known, but perhaps more than 2,000,000 yds^3 have been removed from the site for various uses.[a] It is not known where the bulk of this material was transported.

Currently, sediments are piled on either side of the creek forming high levees providing temporary storage until a better solution can be determined. Roughly 150,000 cubic yards of sediment are stockpiled along the banks of Swift Creek.[4] Continued piling of sediments is not practical nor feasible because the levees cannot continue to grow in height and remain stable. Widening the levees would further reduce the amount of productive land available for agriculture.

Access to the creek and levees is restricted with fencing at Goodwin and Oat Coales Roads, but off-road recreational vehicles frequently drive through creek sediments or atop creek levees. Foot traffic is also possible on the levees. Two warning signs are posted on the gates (Appendix A, Image 1 and 2). Property owners along Swift Creek have signed statements declaring they will not remove sediments from the site until further notice.[4,6]

Site Visit

DOH, ATSDR, and Whatcom County Health District staff conducted a Swift Creek site visit on August 30, 2005. Staff accessed the site from Oat Coles Road gate where two large metal signs were posted warning people not to remove sediment from the site due to asbestos concerns (Appendix A).

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[a] This figure was derived by estimating an annual deposition of roughly 40,000 cubic yards over the past 50+ years.

Staff walked along the north bank of Swift Creek on the levee that is composed of stockpiled sediments from past dredge events. Fine-grained light-colored platy deposits of sediment were evident on the surface of Swift Creek bed. These sediments were suspected of containing asbestos.

Off-road recreational vehicle tracks in Swift Creek sediments were observed. The use of off-road vehicles was reported to be a common occurrence at the site.[6]

Contractors were actively dredging the creek during the visit. Numerous pieces of heavy equipment were removing sediment from the creek and placing it on the bank, or moving it around on the levees (Appendix A, Image 4-6). A water tanker truck sprayed water on the levee soils to minimize dust generated by dredging and vehicle traffic.

During recent dredging, creek water was noticeably turbid, which is reported to be typical during dredging. The turbidity rapidly decreased as fine-grained suspended particles coagulated and settled forming a light colored layer on the creek bed (Appendix A, Image 7). The rapid coagulation and settling of suspended particles is not typical of clay materials indicating that physical properties of Swift Creek's fine-grained sediments are conducive for coagulation and settling.

Agricultural fields were on either side of Swift Creek. Evidence of past flooding was seen in areas where vegetation was stunted due to deposition of metal rich sediment. A child's big wheel was observed in a portion of field with stunted vegetation directly adjacent to the levee (Appendix A, Image 8).

Asbestos Analysis

Asbestos is a broad name given to a group of fibrous minerals that occur naturally in the environment. It is found in deposits or as contaminants in other minerals. The properties that make asbestos commercially viable are its high tensile strength, ability to be woven, heat resistance, and resistance to attack by acid or alkali. EPA banned most asbestos containing products in 1989 in response to public health concerns, but much of the rule was remanded by the U.S. Fifth Circuit Court of Appeals in 1991.[7] Current uses of asbestos include roofing products, gaskets, and friction products (e.g., brake linings, clutch facings).[8]

Asbestos occurs in two mineralogical forms: serpentine and amphibole. Chrysotile belongs to the serpentine family, and is the most common asbestiform used commercially. Chrysotile fibers are curved and flexible. Amphiboles are rod or needle shaped and very brittle, and some evidence indicates that they may be more toxic than serpentine forms. Current evidence indicates that fibers found in Swift Creek primarily belong to the serpentine family.

Asbestos *fibers* are defined by regulatory agencies (i.e., Occupational Safety and Health Administration) as particles with a length-to-width ratio of $\geq 3:1$ and which are longer than 5 μm. Concentrations in air are reported as fibers or structures per cubic centimeter; asbestos content in bulk materials is reported as a percentage. Asbestos can be detected in air or bulk materials (e.g., soil, sediment) using light and electron microscopy.

The National Institute for Occupational Safety and Health's (NIOSH) method 7400 uses phase contrast microscopy (PCM) to determine airborne fibers in the workplace. This method does not distinguish asbestos from fiberglass, cellulose or other fiber types. Therefore, it is useful only when the main source of dust is expected to be asbestos, and not in situations where asbestos fibers are mixed with other fiber types.[9] In addition, PCM may not detect very thin fibers (light microscopy can detect particles only down to a diameter of about 0.3 μm). As a result of these limitations, a PCM count can be biased high if fibers other than asbestos are present, or low if thin asbestos fibers are present.

Polarized light microscopy (PLM) is the EPA accepted screening method for asbestos in bulk samples (e.g., soil, sediment). The main purpose of the PLM analysis is to determine if asbestos exists in a medium. The limit of detection for this method is typically 0.25-1% asbestos by weight. PLM uses polarized light to compare refractive indices of minerals and can distinguish between asbestos and non-asbestos fibers and between different types of asbestos. The method fails, however, in samples where asbestos fibers are fine.

Transmission Electron Microscopy (TEM) can also analyze for asbestos in air and bulk samples. TEM uses electron diffraction and energy-dispersive x-ray methods, which give information on crystal structure and elemental composition, respectively. This information can help determine the elemental composition of the visualized fibers. Advantages of using TEM are that it can detect smaller fibers than PCM or PLM and can also determine the fiber type. When soil asbestos concentrations are low, the number of grids that are examined for a given sample can limit the accuracy of the TEM method. If the laboratory analyst does not count enough grids, the sample results will likely be inaccurate. In general the TEM approach is more time consuming – and therefore more costly – than PLM, but it provides the best approach for fiber identification and quantification at low sample concentrations and small fiber size.

Asbestos Analysis of Swift Creek Sediment

Although it was commonly known that the Swift Creek sediments contained asbestos, prevailing thought at this site, until recently, considered asbestos levels not to be a public health concern. In the past 15 years, some attempts were made to characterize asbestos content in sediment, air, and water. These sampling events are briefly summarized below and in Table 1.

In 1990, Whatcom County hired Landau and Associates to test Swift Creek sediments for asbestos. Eight samples were taken from the bed and bank and analyzed for asbestos using PLM. Each sample had a reported level of 1-3% chrysotile by weight.[1] The presence of chrysotile was attributed to the weathering of serpentine-rich slide material.

A study designed to determine exposure to asbestos while working fields that had previously flooded was conducted adjacent to Swift Creek in 1991.[1,10] A single bulk soil sample was collected from a field where about 16 inches of sediment was deposited during flooding in 1975 and contained less than 1% asbestos. Twenty-two ambient air samples were taken during tilling of the field. Although specific results were not reported, none exceeded 0.1 fiber per cubic centimeter (f/cc). The results were considered to be health protective in that all fibers greater than 0.5 um were counted and no fibers exceeded 5 um in length. Fibers less than 5 um are considered to be less toxic (with regard to cancer) than fibers longer than 5 um.

In spring 2005, Western Washington University, working independently, analyzed 12 sediment samples using scanning electron microscopy (SEM). Similar to TEM, SEM is capable of detecting shorter, thinner fibers than typical light microscope methods. Chrysotile was the predominant asbestos type found. Percentage of asbestos content was not reported, but fibers were generally shorter than 2 um in length and smaller than 0.002 um in diameter, but larger fibers were also present.[11] Also observed was the fact that layers of fine grained asbestos rich sediment were deposited on top of coarser sand and fine gravel. The fine grained material was likely suspended in the water column and settled out to form thin layers during periods of low water flow resulting in the deposition of sediments that have very different compositions: fine layers that are chrysotile asbestos rich, underlain by sand and fine gravel that is relatively asbestos-free.

Whatcom County Health Department took six sediment samples from Swift Creek in June 2005. Two samples of fine-grained cake-like [b] (Appendix A, Image 3 and 4) material taken from the surface of Swift Creek's bed were analyzed using PLM and found contain as much as 24% chrysotile asbestos. Higher concentrations were revealed in the fine fraction (46%) of sediment when samples were further sorted by grain size (coarse fraction 0.3% chrysotile). Other types of asbestos fibers (i.e., amphiboles) were also detected at trace levels.[12]

Whatcom County and Washington State Department of Labor and Industries (L&I) monitored air for asbestos during recent dredging on August 22 and 23, 2005. Wet-methods[c] were used during dredging to minimize dust, and respirators were offered to workers prior to each work day as recommended by L&I. Eight personal air samples were taken on each day. Personal air samplers drew air from worker's breathing zone for roughly 3-5 hours per sample. Asbestos fibers were detected in 12 of 16 samples, but most samples had concentrations below analytical reporting levels (0.004 -0.008 f/cc) except three samples (0.007, 0.014 and 0.018 f/cc).[13] Measured levels are below L&I's permissible exposure limit (0.1 f/cc).[14] It is likely that more asbestos fibers would have been detected using TEM given that some information indicates Swift Creek asbestos fibers tend to be smaller than what PCM can detect.

[b] The "cake-like" material is a layer of fine-grained sediment that settles on the bed of Swift Creek. These sediments typically overlay layers of coarser sands and small gravels.
[c] Wet-methods consisted of a constant wetting of Swift Creek sediments with a water tanker truck to minimize airborne dust from dredging and vehicle traffic.

Table 1. Summary of asbestos analyses of samples taken at Swift Creek Whatcom County, Washington

Sampled by	Year	Medium	N	Location	Method	Asbestos concentration	Notes
Landau and Associates for Whatcom County	1990	Sediment	8	Swift Creek bank and bed	Unknown (assumed PLM)	1-3%	
NWAPA	1991	Air	22	Air samples near active tilling in fields adjacent to Swift Creek	PCM and TEM	<0.1 f/cc	No fibers detected greater than 5 um in length
		Soil	1	Soil sample from field	PLM	<1%	
		Sediment	1	Swift Creek	PLM	3%	
Western Washington University	2005	Sediment	12	Swift Creek bank and bed	SEM	Not reported	Majority of fibers less than 5 um in length Mostly chrysotile fibers
Whatcom County Health Department	2005	Sediment	6	Biased samples of "cake" material	PLM	Bulk sample: 12-24% Fine fraction: 42-46% Coarse fraction: 0.2-0.3%	6 samples taken only 2 results reported Mostly chrysotile fibers
Washington State Department of Labor and Industries	2005	Air	16	Personal Air Samples	PCM	<0.004 – 0.018 f/cc	

Asbestos regulations

The National Emission Standards for Hazardous Air Pollutants (NESHAP), under the Clean Air Act, defines an asbestos containing material (ACM) to contain more than 1% asbestos. NESHAP primarily establishes work practices to minimize the release of fibers during processing, handling, and disposal of asbestos and asbestos containing material while renovating or demolishing structures. It is important to note that the NESHAP designation of ACM at 1% is not considered a health-based standard in that materials containing less than 1% asbestos may still pose some health risk when disturbed. Other than mined materials, NESHAP does not apply to naturally occurring asbestos, so does not appear relevant to the Swift Creek sediment asbestos issue.[15]

Asbestos in the workplace is regulated by the Occupational Safety and Health Administration (OSHA) and the Washington State Department of Labor and Industries (L&I). The occupational permissible exposure level (PEL) for asbestos is 0.1 f/cc in air as an eight-hour time-weighted average.[14,16] Wet-methods are required when conducting construction activities in areas with high levels of naturally occurring asbestos.[17]

Potential Health Effects

The main concern with respect to asbestos exposure is the inhalation of asbestos fibers. Ingestion of asbestos poses little or no risk of non-cancer effects. However, some evidence shows that acute oral exposure might induce precursor lesions of colon cancer, and that chronic oral exposure might lead to an increased risk of gastrointestinal tumors.[18] Occupational dermal (skin) exposure to amosite asbestos has been shown to cause small warts or corns on exposed skin.

In general, inhaled asbestos fibers wider than 3 μm lodge in upper airways, and narrower ones can reach deeper into the lung and alveolar region. Exposure to long, thin, needle-like fibers is of the most concern because these fibers can reach the lower airways and become embedded in the lung tissue, where they may remain for the remainder of the person's life. Repeat exposure to asbestos in air has been shown to cause lung disease, including asbestosis, lung cancer, and mesothelioma.[18] Some reports have suggested that amphibole asbestos is more toxic than chrysotile asbestos, mainly because of physical characteristics of the fibers that allow chrysotile to be broken down and cleared from the lung, whereas amphibole is not removed and builds up to high levels in lung tissue. Some researchers believe that the resulting increased duration of exposure to amphibole asbestos significantly increases the risk of mesothelioma and, to a lesser extent, asbestosis and lung cancer. New risk assessment methodology that utilizes fiber specific potency factors for quantifying mesothelioma and lung cancer risk is currently being evaluated by EPA.[2] However, EPA's current risk models consider asbestos toxicity to be independent of size and mineralogy, and the Occupational Safety and Health Administration (OSHA) continues to regulate chrysotile and amphibole asbestos as one substance, as both types increase the risk of disease.

The lack of exposure information distinguishing the different fiber types limits evidence suggesting that the different types of asbestos fibers vary in carcinogenic potency. Other data indicate that differences in fiber-size distribution and other process differences can impact toxicity as much as, or more than, fiber type.[18]

It is important to note that the following asbestos related diseases discussed below have occurred primarily in humans exposed in the workplace to higher airborne levels than have been measured to date surrounding activities adjacent to Swift Creek. That being said, thorough characterization has not been conducted, and detailed human health risks have not yet been assessed.

Asbestosis

Asbestosis is caused by inhalation of asbestos fibers. Asbestos fibers in the lungs cause irritation and inflammation. The body attempts to neutralize these foreign fibers with phagocytes, a type of white blood cell that engulfs and absorbs waste material, harmful microorganisms, or other foreign bodies in the blood stream and tissues. The phagocytes are unable to remove all of the asbestos fibers, however, and instead actually help to inflame tissues. Eventually a scar tissue or fibrosis develops in the spaces around the small airways and alveoli. This thickening and scarring prevents oxygen and carbon dioxide moving to and from the blood, so breathing becomes much less efficient. The specific asbestos fiber type (amphibole or serpentine) to which the worker was exposed does not seem to be significant in the development of asbestosis. Although research in animals suggests that longer fibers appear to be more potent than short fibers in causing asbestosis, shorter fibers may also cause asbestosis in humans.[18] People with asbestosis are at additional high risk of developing lung cancer or mesothelioma.[18]

Other non-cancer effects include *pleural plaques*, localized or diffuse areas of thickening of the lung lining (pleura); *pleural thickening*, extensive thickening of the pleura, which restricts breathing; *pleural calcification*, the depositing of calcium in pleural areas, which is thickened by chronic inflammation and scarring; and *pleural effusions*, fluid buildup in the pleural space between the lungs and the chest cavity.[18]

Lung Cancer

Much evidence suggests that asbestos exposure contributes to lung cancer. The risk of developing lung cancer is much greater for those with significant exposure (usually at work) to asbestos, as compared to the general population. A long period of time—often as long as 30 years—can pass between asbestos exposure and the development of lung cancer. In addition, the combination of tobacco smoking and asbestos exposure further increases the risk of developing lung cancer far beyond the risk associated with separate exposures. In fact, the risk of lung cancer from combined exposure is greater than both factors added together.[18]

Pleural Mesothelioma

Pleural mesothelioma is a cancer of the cells that make up the pleura, or lining around the outside of the lungs and inside the ribs. It is an extremely rare disease with an incidence rate of one new case per 100,000 people per year, or about 2,000 to 3,000 new cases per year in the United States. The incidence rate of lung cancer in the United States, by comparison, is about 65 times greater. The primary factor associated with mesothelioma is previous exposure to asbestos fibers.[b] Amphibole fibers are thought to be more potent than serpentine fibers with regard to inducing mesothelioma.[18] Mesothelioma is a terminal disease. Fewer than half of the patients survive longer than seven months after diagnosis.

Public Health Implications

The presence of asbestos in Swift Creek sediments does not pose a health risk unless people are exposed by breathing in asbestos fibers. Inhalation of asbestos is of most concern. Oral and dermal exposure to asbestos in soil is not likely to be a significant health risk. The degree to which asbestos in Swift Creek sediments poses a health risk depends on the following factors:

[b] In some cases, pleural mesothelioma has occurred in people with no known asbestos exposure. There is likely to be a baseline incidence of mesothelioma around the world that is not attributable to asbestos exposure, just as there may be other factors that contribute to inducing mesothelioma.

- The extent to which asbestos fibers become airborne when Swift Creek sediments are disturbed.
- Human activities (exposure pathways).
- Duration of exposure.
- Asbestos fiber type(s) (i.e., serpentine and amphibole).
- Fiber length and width.

Asbestos in soil becomes a concern if the soil is disturbed. EPA Region 10 has demonstrated that disturbing soils or other materials containing low levels of asbestos can generate airborne asbestos at levels of health concern.[19] In the case of Swift Creek, people may be exposed to asbestos is sediments through numerous pathways. Table 2 shows hypothetical potential pathways of exposure to asbestos in Swift Creek sediments and downstream surface water. In general, airborne exposure to asbestos in Swift Creek sediments is possible if sediments are disturbed by wind or other mechanic agitation.

The greatest potential for exposure exists near the Swift Creek channel. Fortunately, the wet climate of western Washington serves to limit the period of potential exposure to airborne asbestos to a period of roughly four months (June 1 to September 30). Conditions in the summer months tend to be dry, and levee soils and creek sediments are more likely to be dry and potentially suspended in air.

Downstream exposures to asbestos are possible if there is significant deposition along Sumas River, or if Sumas River is used as a source of drinking water. Asbestos concentrations in surface water downstream of Swift Creek have been measured at levels [d] exceeding EPA's maximum contaminant level (MCL) for drinking water (EPA asbestos MCL = 7 million fibers > 10 um in length per liter). Although no drinking water systems currently draw water from Swift Creek or the Sumas River in the U.S., DOH has no information on whether Sumas River is used as a source of drinking water in British Columbia, or what the impacts are on Fraser River's water quality.[e]

Other sources of asbestos not related to sediments in Swift Creek are possible due to the presence of naturally occurring asbestos in local geologic formations. Drinking water wells in the area may contain asbestos due to the prevalence of asbestos in bedrock and soils in the region. However, a search of DOH's Division of Drinking Water Sentry database revealed no exceedances of EPA's MCL in local public water systems. Smaller water systems with less than 15 connections or private wells are not required to test for asbestos, so it is not known if asbestos occurs in drinking water in these systems.

[d] 10^7 to 10^{13} fibers per liter were measured in the Sumas River Watershed. It is not known if fiber counts considered all fibers or only those in excess of 10 um.
[e] Sumas River meanders many miles north east before the confluence with Fraser River. The likelihood for significant asbestos deposition or discharge from Sumas River into Fraser River is not known.

Table 2. Potential pathways of exposure to naturally occurring asbestos in Swift Creek sediment Whatcom County, WA.

Exposure Route	Pathway	Source	Mechanism	Receptors
Inhalation	Air	Dredge spoils	Windblown dust from piles	Nearby residents
		Swift Creek sediment and dredge spoils	Off-road recreational vehicles stirring up dust in creek or on levees	Vehicle operators Nearby residents
		Swift Creek take home fill	Dust in yards where sediments used as fill	Residences where swift creek sediments used as fill for driveways etc
		Indoor dust	Dust blown from piles, or brought in from sediments used as driveway or yard fill	Nearby residences Residences where swift creek sediments used as fill for driveways etc
		Fields	Tilling or working earth where sediments have been deposited	Farm workers Nearby residents
		Active Dredging	Periodic dredging for flood control	Dredge workers Nearby residents
		Downstream deposition	Deposition of sediments in Sumas and Fraser River floodplain	Downstream residents
		Downstream irrigation	Irrigation of fields using Sumas / Fraser River water	Downstream farm workers

From limited data collected in previous sampling efforts, it has been demonstrated the presence of low to high levels of asbestos in Swift Creek sediments. Dredging and removal or disposal of asbestos rich layers separately from relatively asbestos free sediments does not seem possible. Layering of fine grained and coarse grained sediments is discontinuous making it difficult to isolate asbestos rich sediments from asbestos free sediments, and therefore, separately dredging each type. The act of dredging is likely to further mix coarse and fine sediments, and consequently, dilute asbestos rich sediments with less contaminated sediments.

Specific information regarding fiber type and length indicate that most fibers are chrysotile and tend to be shorter than legal definition (> or = 5 um). Fiber type and length are important with regard to toxicity in that chrysotile is believed to be less persistent in lungs and perhaps less toxic than amphiboles, and short fibers are currently thought to have lower carcinogenic potential than longer fibers.

While limited samples of Swift Creek sediments have shown the presence of asbestos fibers, a thorough characterization of sediments has not yet been done. Whether or not windblown or human activities substantially suspend Swift Creek asbestos fibers in the air, or the majority of fibers are too short to be of toxicological significance has not been determined. Health risks related to asbestos in Swift Creek sediments cannot be assessed without a better understanding of asbestos levels, fiber types, fiber lengths, and potential for airborne exposure.

Children's Health Concerns

DOH and ATSDR recognize that infants and children are often more vulnerable to exposures than adults in communities faced with environmental contamination. Because children depend completely on adults for risk identification and management decisions, DOH and ATSDR are committed to evaluating children's special interests at the site.

The effects of asbestos on children are thought to be similar to the effects on adults. However, children could be especially vulnerable to asbestos exposures because they are more likely to disturb fiber-laden soils or indoor dust while playing. Children also breathe air that is closer to the ground and may thus be more likely to inhale airborne fibers from contaminated soils or dust.

Furthermore, children who are exposed could be more at risk of actually developing asbestos-related disease than people exposed later in life because of the long latency period between exposure and onset of asbestos-related respiratory disease.

Conclusions

1. An *indeterminate public health hazard* exists from potential exposure to Swift Creek sediments asbestos.
    - The presence of layers of highly concentrated asbestos intermixed with sandy/gravelly sediments in Swift Creek causes concern for potential human exposure when disturbed by human activity or wind.
    - Numerous potential pathways of human exposure to asbestos exist in the Swift Creek area where dredged sediments are stored as well as areas in Whatcom County where asbestos contaminated sediments have been used by the public.
        - Current knowledge of asbestos physical properties and content in Swift Creek sediments is insufficient for determining human health risks and appropriate end uses.

2. Asbestos containing sediments will be deposited in Swift Creek for many years causing long-term sediment management problems. Remedies for minimizing sedimentation and flood control are expensive. Whatcom County has few options with regard to removal or storage of dredged sediments unless suitable uses or disposal alternatives for material are determined.
    - Short-term strategies are also necessary as Whatcom County will likely need to dredge Swift Creek in the summer of 2006 without a practical place for sediment disposal or storage.

3. Wet-methods employed during recent dredging event appear to limit occupational exposure to asbestos.
    - Although wet-methods proved to be effective in reducing airborne asbestos and minimizing worker health risk, low-levels of asbestos were detected in air during dredging. The presence of asbestos fibers in air during wet-method dredging highlights the potential for asbestos exposure in the absence of controls.
    - It is currently not known if privately funded dredging projects employ wet-methods.

4. Sediments are transported into Sumas River impairing water quality and possibly depositing asbestos containing sediments along the banks and floodplain.

Recommendations

1. Additional characterization of Swift Creek sediments and downstream portions of Sumas River sediment and surface is necessary to determine health risks.
    - Environmental and public health agencies (i.e., DOH, ATSDR, Ecology, EPA, Army Corps of Engineers and WCHD) should work together to form a sampling plan that characterizes asbestos in sediments.
    - The sampling plan should also consider testing that will enable the assessment of potential exposures to airborne asbestos.
    - Dredged asbestos containing sediments should be tested and monitored to ensure protection of public health.
    - Planning should begin as soon as possible so that sampling can be conducted prior to next summer's dredge event.
    - Removal of sediment from the site should continue to be discouraged until adequate characterization has been completed.

2. Agencies should work collaboratively with Whatcom County and Great Western Lumber to determine strategies for managing sediment and asbestos issues. Suitable end uses for material should be determined based on studies designed to evaluate potential long-term health risks associated with various use or removal options.
    - Dredged asbestos containing sediments should be contained or managed to ensure protection of public health.

3. Wet methods should be employed during future dredge events by both private and public entities to reduce worker and nearby community exposures.

4. Water use associated with Sumas River downstream of Swift Creek should be researched to determine if drinking water or surface water are being withdrawn from the River.

Public Health Action Plan

Completed Actions

1. Whatcom County has advised property owners not to use Swift Creek sediments as fill until further notice. Property owners signed letters indicating that they were aware that sediments are not to be removed from the site.
2. Warning signs have been posted along Swift Creek Goodwin and Oat Coales Road
3. Access to the levee has been restricted to vehicles with gates along Oat Coales Road and Goodwin Road.
4. Whatcom County used wet-methods during dredging to minimize worker exposure to asbestos.
5. L&I conducted air sampling to ensure workers were not exposed to hazardous levels of airborne asbestos.
6. DOH has determined that surface water from Sumas River downstream of Swift Creek is not used as drinking water source.

Planned Actions

1. DOH will solicit help from local, state, and federal environmental and public health agencies to develop a sampling plan that characterizes asbestos in Swift Creek sediments, the potential for asbestos to become airborne, and the human health risk from various pathways.
2. DOH will encourage the use of wet-methods for future privately and publicly funded dredging projects at Swift Creek.
3. DOH will work with Whatcom County to develop updated warning signs at Goodwin and Oat Coales Roads.
4. In the event that additional sampling reveals a wider health concern, DOH will work with Whatcom County to identify locations where material was transported and whether it poses a health risk in its current state.
5. DOH will determine if Sumas River is being used for irrigation.
6. DOH will determine the need for contacts with Canadian public health officials contingent on the results of further study of public health implications of asbestos-rich sediments.
7. DOH will work with Whatcom County to develop additional signage that clearly states potential health risks associated with removing or Swift Creek sediments.
8. DOH will prepare a brief summary fact sheet to distribute to residents in the Swift Creek area.
9. DOH will develop an education and outreach plan.

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Figure 1. Swift Creek site location, Whatcom County, Washington.

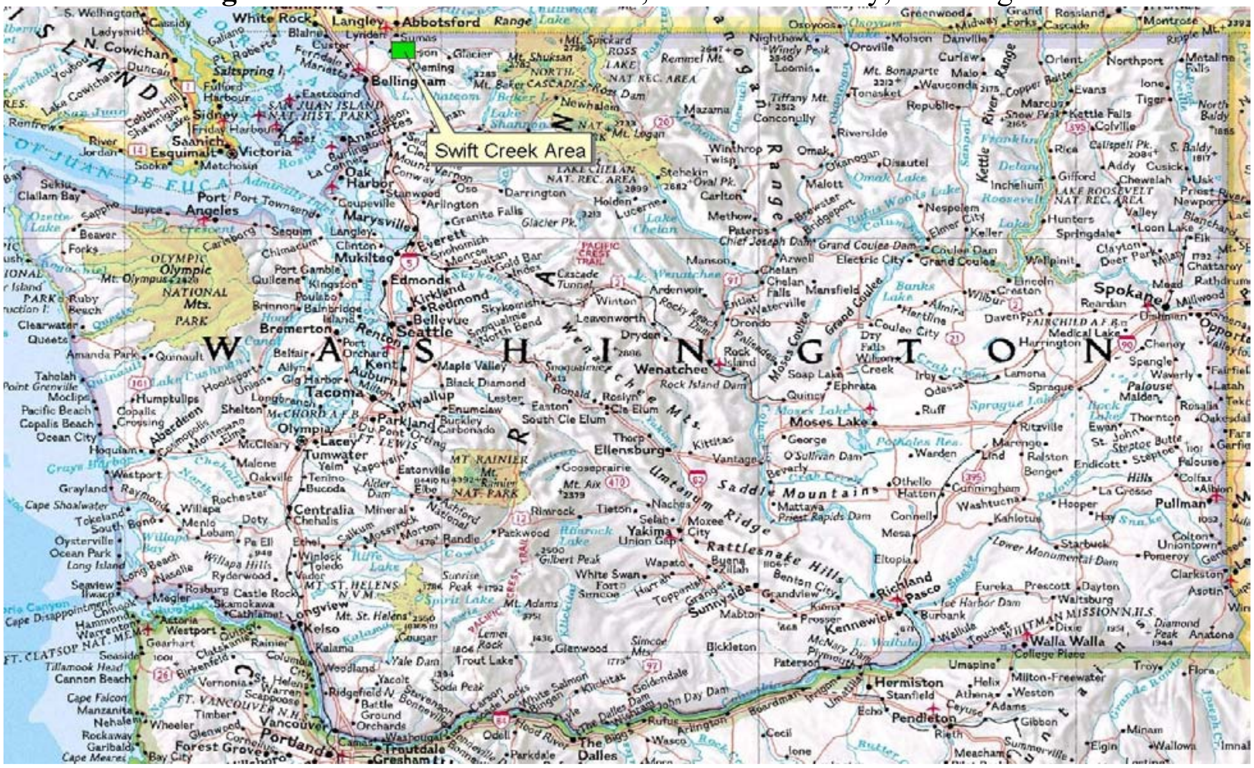


Figure 2. Evidence of impaired vegetative growth in agricultural fields adjacent to Swift Creek where sediments were deposited during past floods. Whatcom County, Washington.

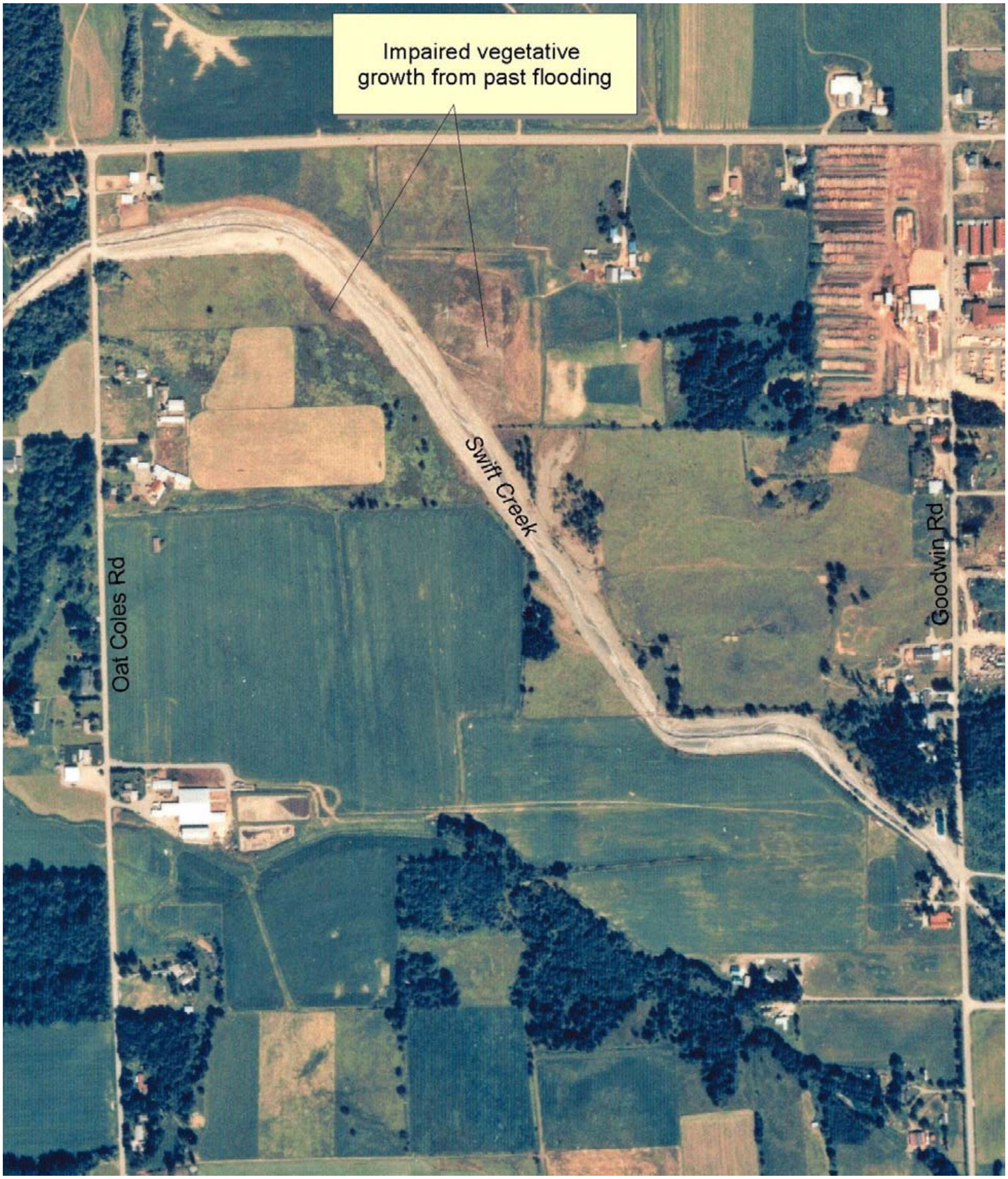


Figure 3. Areas where active channel maintenance is occurring at Swift Creek. Whatcom County, Washington.

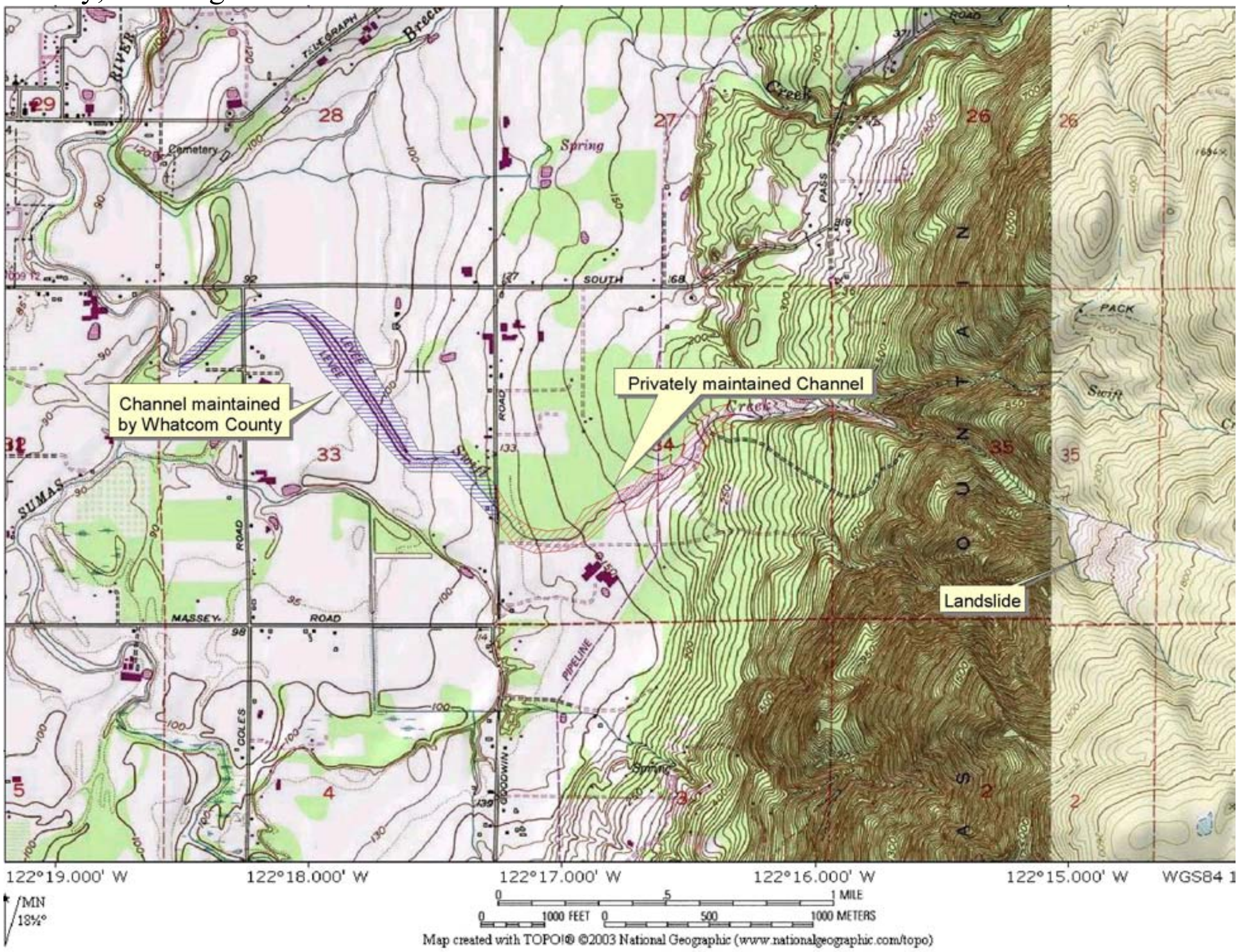


Figure 4. Land use classification in the Swift Creek vicinity. Whatcom County, Washington. (AG = Agriculture, R5A = Residential 5 acre, and CF = Commercial Forest).

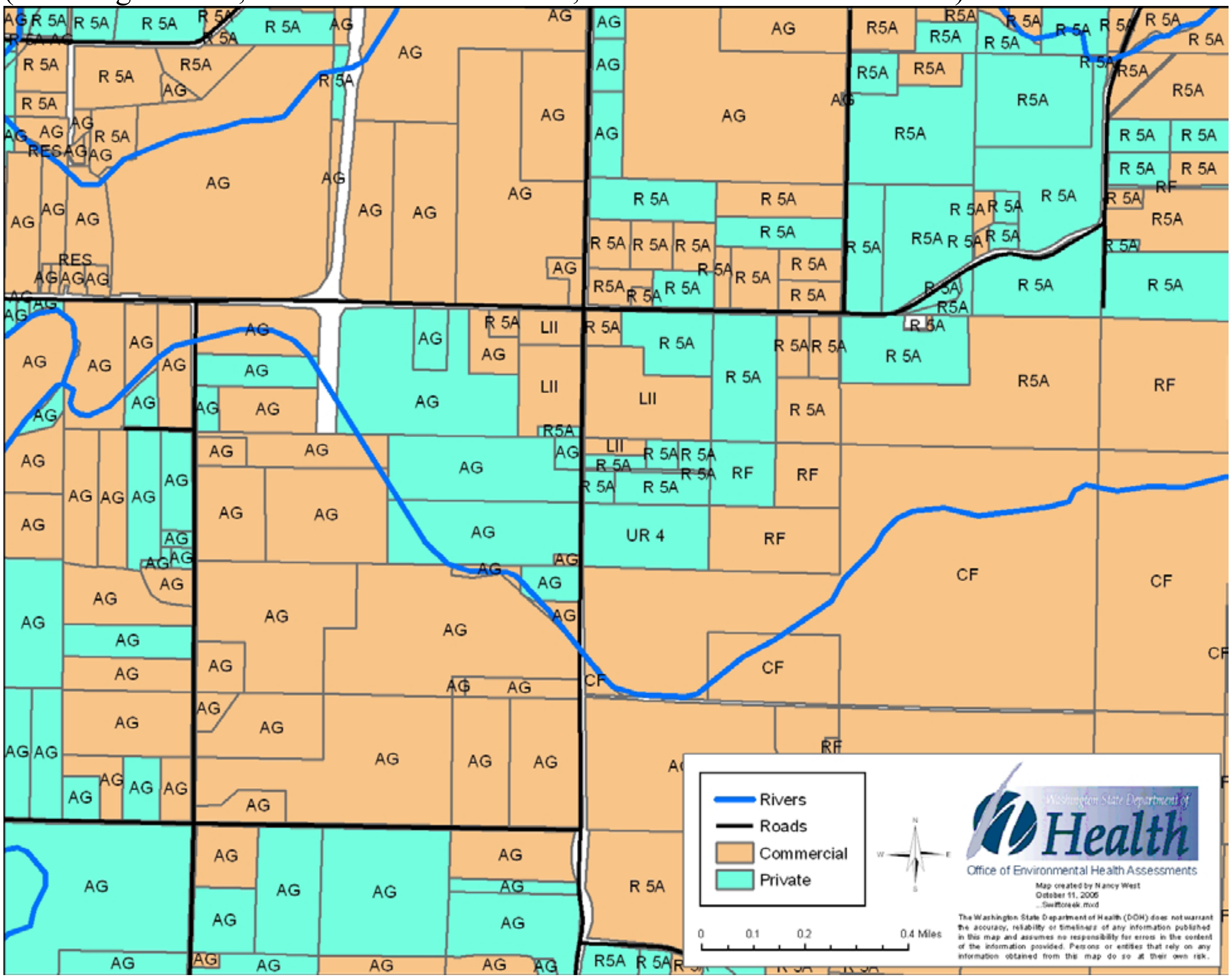
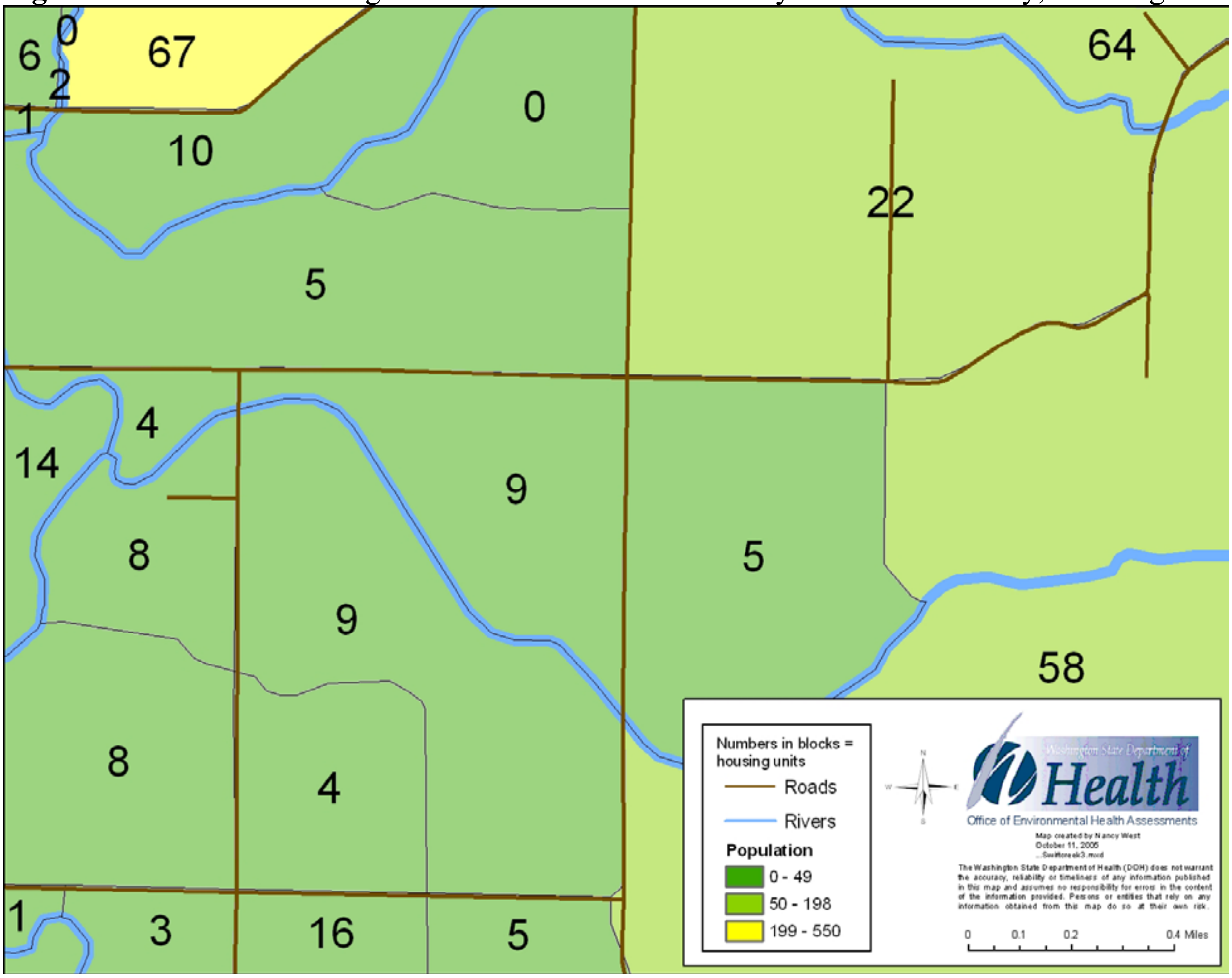


Figure 5. Residential housing units in the Swift Creek vicinity. Whatcom County, Washington.



Appendix A: Site Photographs

Image 1. Sign placed on levee gates at Swift Creek deterring removal of sediment from site.

Image 2. Sign place on levee gates at Swift Creek warning the public of potential hazards related to naturally occurring asbestos.

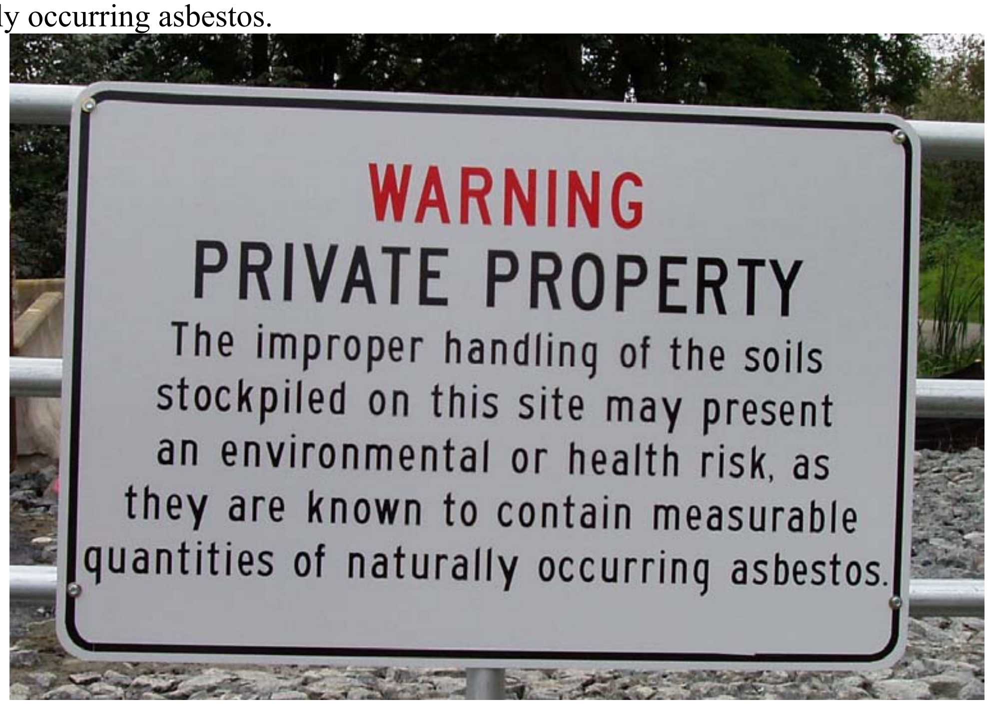


Image 3. “Cake” layers of fine-grained asbestos rich sediment on the bed of Swift Creek

Image 4. .Close up of “Cake” layers of fine-grained asbestos rich sediment on the bed of Swift Creek

Image 5. Swift Creek post-dredge. At the time of this photo, water in the creek was clear revealing light colored fine-grained sediments that settled rapidly after dredging was completed.

Image 6. Child's toy big wheel observed adjacent to Swift Creek levee on sparsely vegetated area.

Image 7. Dredging activity at Swift Creek

Image 8. Dredging activity at Swift Creek

Image 9. Dredging activity at Swift Creek

Certification

This Swift Creek_Public Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation was initiated. Editorial review was completed by the Cooperative Agreement partner.

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Technical Project Officer, CAT, SPAB, DHAC

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

____

Team Lead, CAT, SPAB, DHAC, ATSDR

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