Newtok Environmental Site Inventory and Assessment Project

Part II: Assessment

Prepared by:

Hobbit Environmental Consulting Corp.

Prepared for:

State of Alaska

Department of Commerce, Community and Economic Development

January 4, 2016

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Table of Contents

Appendices

Acronyms

ACM	Asbestos Containing Material
ADEC	Alaska Department of Environmental Conservation
ADHSS	Alaska Department of Health and Social Services
ATSDR	Agency for Toxic Substance and Disease Registry
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CSM	Conceptual Site Model
DCCED	Department of Commerce, Community and Economic Development
DRO	Diesel Range Organics
ft	Feet
GRO	Gasoline Range Organics
Hobbit	Hobbit Environmental Consulting Corp.
NTC	Newtok Traditional Council
NVC	Newtok Village Council
PAH	Polycyclic Aliphatic Hydrocarbons
PCOC	Potential Contaminants of Concern
PID	Photoionization Detector
RCRA	Resource Conservation and Recovery Act
RRO	Residual Range Organics
UPC	Ungusraq Power Company
USACE	United States Army Corps of Engineers
USEPA	Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
YDNWR	Yukon Delta National Wildlife Refuge

Executive Summary

Hobbit Environmental Consulting Corp. (Hobbit) was contracted by the Alaska Department of Commerce, Community and Economic Development (DCCED) to undertake an Environmental Site Inventory and Assessment project for the village of Newtok, Alaska. Ms. Sally Cox is the DCCED project manager. Newtok is experiencing severe erosion and the village is in the process of being relocated. The purpose of this project is to inventory hazardous materials in the village, assess their impact on environmental conditions and provide a cleanup plan. Task II, assessment of hazardous materials is presented in this report.

The scope of work for Task II included:

1. Preparing a preliminary qualitative conceptual site model for Newtok.
2. Providing a description of environmental work which would be required for Newtok in order for environmental conditions to be managed and/or remediated.
3. Estimating preliminary costs associated with site management and/or remediation of environmental conditions.
4. Preparing a report summarizing the results of the assessment.

The qualitative conceptual site model examined potential contaminants of concern (PCOC), exposure pathways and cleanup criteria. PCOCs for Newtok include: hydrocarbons, metals, asbestos, PCBs, creosote, glycols, dioxins and e-coli. Five complete pathways were identified in the human health scoping model and the ecoscoping model determined that an Ecological Conceptual Site Model needs to be developed for Newtok in association with site investigation activities. A risk assessment would likely be the most appropriate method for determining cleanup levels for Newtok.

Future environmental work in Newtok would comprise site assessment and remediation. Site assessment would include sampling soils and water at the landfill, tank farms, waste staging areas, power generation building and sewage lagoon. Public buildings and residences built before 1990 should be sampled for asbestos prior to being demolished if they have floor or ceiling tiles. When the potential contaminated sources have been assessed and a reasonable understanding of the concentration and extent of contamination has been defined, detailed remediation plans can be developed. Suggested cleanup options take into consideration Newtok's isolation, the high costs of transport, lack of equipment, concern for erosion, subsistence needs and the requirement to return the land to wetlands. These cleanup options examine the advantages and disadvantages of remediating in place versus hauling materials away.

1.0 Introduction

Hobbit Environmental Consulting Corp. (Hobbit) was contracted by the Alaska Department of Commerce, Community and Economic Development (DCCED) to undertake an Environmental Site Inventory and Assessment project for the village of Newtok, Alaska. Ms. Sally Cox is the DCCED project manager. The project consists of three tasks:

- Task I - prepare an inventory of hazardous materials;
- Task II - assess the hazardous materials in relation to environmental conditions; and,
- Task III - develop a cleanup strategy.

Task I was completed in October, 2015 and the inventory results are presented in the Task I report (Hobbit 2015). Task II, assessment of the hazardous materials in relation to environmental conditions was completed in November and December of 2015 and the results of the assessment are presented below. Table 1 Summary of Cleanup Options, and Figure 1 showing the location of Newtok and a village plan, follow the report text. Appendix A provides a copy of the Mercury in Northern Pike notice from the U.S. Fish and Wildlife Service (USFWS) and Alaska Department of Health and Social Services (ADHSS). Appendices B and C contain the Human Health Conceptual Site Model Scoping Form and the Ecoscoping Form, respectively.

1.1 Purpose of the Project

Newtok is a Yup'ik village located within the Yukon Delta National Wildlife Refuge (YDNWR). Severe erosion along the Ninglick River is threatening the village and Newtok residents are being relocated to Mertarvik on Nelson Island. Continued erosion could destroy the village with infrastructure potentially slumping into the river and becoming waterborne hazards.

The proximity of the village to terrestrial and marine water bodies and its location within the wildlife refuge influenced the need to inventory, assess and manage potential environmental impacts that could result from the erosion. The planned timetable for remedial work will be after the move to Mertarvik and infrastructure has been moved, demolished or decommissioned. Newtok is committed to restoring the village site to wetlands under the federal government's No Net Loss Policy for development of wetlands.

1.2 Scope of Work, Task II

The scope of work for Task II included:

5. Preparing a preliminary qualitative conceptual site model for Newtok.
6. Providing a description of environmental work which would be required for Newtok in order for environmental conditions to be managed and/or remediated.
7. Estimating preliminary costs associated with site management and/or remediation of environmental conditions.
8. Preparing a report summarizing the results of the assessment.

Hobbit performed the work under the DCCED term contract #15-013-128. No material, soil or water sampling has been conducted in association with this work. Task II is a continuation of the work completed in Task I. Details regarding background information for Newtok and compilation of the hazardous materials inventory can be found in the Task I report (Hobbit 2015).

2.0 Hazardous Source Material

The locations of hazardous material sources in Newtok are provided in Figure 1. For the purposes of this report, the assessment of hazardous materials will be discussed according to the source material rather than according to their location. For example, hydrocarbon contaminated soils will be addressed as a unit, rather than addressing each tank farm individually. The inventory identified four sources of potentially hazardous materials in Newtok:

1. **Solid waste materials held in the landfill and other staging areas**. Although solid waste is not of itself a hazardous waste, the lack of control of dumping in the landfill has resulted in some material containing hazardous substances (fluorescent lights, e-waste, batteries, containers with solvents, automotive cleaners, paint thinners, etc.) to have been disposed in the landfill.
2. **Contaminated soil.** The soil will be divided into two categories: *Hydrocarbon Contaminated Soil* and *Other Contaminated Soil*. *Hydrocarbon contaminated soil* originates in tank farms and other fuel dispensing areas and most likely has no other contaminants than petroleum based constituents. *Other contaminated soil* originates in waste storage areas and could include heavy metals, polychlorinated biphenyls (PCBs), dioxins and glycols, as well as petroleum based constituents.
3. **Hazardous wastes.** Waste material such as asbestos containing material (ACM), lead paint, miscellaneous drums containing used oil, used glycol, etc. and potentially PCB containing transformers would fall under this designation.

4. **Sewage Lagoon.** The sewage lagoon does not contain raw sewage wastes but does store wastewater discharge from the Newtok School and former discharge from the washeteria. The lagoon may require assessment prior to closure.

It is important to note that no water, soil or material sampling or laboratory analysis was conducted as part of this project. Contaminated soil is actually *potentially* contaminated soil and is assumed to be present in fuel handling areas but has not been definitively identified or delineated. Similarly, contaminated soil is potentially below the landfill materials but again has not been definitively identified or delineated. For discussion purposes, contaminated soil volumes were estimated in Task I of this project based on the footprint of tank farms and waste holding areas, and where soil staining or stressed vegetation was observed. Hazardous wastes have also not been tested and have been identified solely by observation or from labels (sometimes hand written) on drums and containers.

3.0 Preliminary Conceptual Site Model

A conceptual site model (CSM) is an evaluation of how contaminants might affect human and ecological health. It examines the medium that the contaminant might be in (soil, water, air), the exposure routes or pathways for the contaminant to migrate from the source medium to human or ecological receptors, and whether or not the risk to human or ecological health is significant. Pathways are said to be “complete” when conditions exist that a human, plant or animal could be exposed to a contaminant. A complete pathway does not automatically mean that the risk to the receptor is significant and has to be remediated. For example, if the pathway for human ingestion of groundwater is complete, but the contaminant concentrations in the groundwater are 1/10 below the cleanup criteria established for the contaminants, then the risk to human health is considered insignificant. Other factors affecting a classification of insignificant include the remoteness of the site, the length of time humans potentially exposed to contamination and the extent and volume of contaminants at the site.

The CSM is a work in progress and will be continually updated as more information and data is collected for the site. This CSM is a preliminary evaluation and is based on *potential* contamination in Newtok. Our assessment will follow the human health (ADEC 2010) and ecoscoping forms (ADEC 2014) that provide an initial indication of exposure pathways that should be assessed during future site investigation activities. This assessment assumes that all inhabitants of Newtok will have moved to Mertarvik and there are no residents remaining in the area. Future human use of the area would be for subsistence hunting and gathering, and visitors who are temporarily passing through. Short term exposure to contaminants could also occur during cleanup activities.

3.1 Potential Contaminants of Concern

Potential contaminants of concern (PCOC) are substances that might be present in the soil, air or water of Newtok and pose a risk to human and/or ecological health. A brief description of the expected PCOCs is provided below. Detailed information about these chemicals can be found on the Agency for Toxic Substances and Disease Registry website (ATSDR 2015). Additional contaminants may be suspected or encountered when conducting future field assessment work.

3.1.1 Petroleum Constituents

Petroleum products such as gasoline, diesel and heating oil are widely used and stored in Newtok. Hydrocarbon based contaminants can migrate through soils or water, dissolve into water, and volatilize in air. Common constituents of hydrocarbons that are assessed at petroleum storage sites include: benzene, toluene, ethylbenzene, xylenes (BTEX), gasoline range organics (GRO), diesel range organics (DRO), residual range organics (RRO), and polycyclic aliphatic hydrocarbons (PAH).

Hydrocarbons are organic chemicals and, under the right conditions, will naturally decompose over time. Oxygen, heat or sunlight and bacteria in the soil contribute to the decomposition of hydrocarbons. In Alaska, due to the cold temperatures and lack of light in the winter, natural decomposition is a very slow process. Lighter petroleum products, such as gasoline, are more mobile and will migrate faster in soils and water than heavier products, such as heating oil. Lighter hydrocarbons are also more volatile and under the right conditions will degrade faster than the heavier hydrocarbons.

Human health issues with hydrocarbons can include headaches, nausea, dizziness and skin irritations when exposed to short term fumes or occasional ingestion. Long term exposure can potentially cause cancer. Benzene, a component of gasoline, is categorized as a known carcinogen by the United States Environmental Protection Agency (USEPA).

3.1.2 Metals

Metals occur naturally in the environment but high concentrations can cause health problems in humans and animals. Some metals can cause health problems even at low concentrations. These metals include the Resource Recovery and Conservation Act (RCRA) 8 metals: arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver.

If metal contamination is found in Newtok soils the most likely constituents would be mercury and lead. Some mercury containing products can include: electrical switches, batteries, non-digital thermostats and thermometers, fluorescent light bulbs, LCD screens and laptop computers. Although mercury has been phased out of many products, older versions such as old appliances or TVs may contain mercury. Mercury is highly toxic and can affect the nervous system, kidneys, stomach, intestines, heart and immune system.

Mercury is considered a persistent bioaccumulative contaminant which means that it remains in the environment for a long time, can build up in the bodies of humans and animals, and can pass from one body to another through consumption. Mercury travels up the food chain from plants to animals or as predator eats prey, and since species are mobile, bioaccumulative contaminants can affect species beyond the immediate geographic source area of the contamination. Some fish, in particular have been found to have elevated mercury. For example, in Alaska, the USFWS and the ADHSS have issued a warning about elevated mercury levels in northern pike in parts of the YDNWR (specifically parts of the Kuskokwim and Yukon Rivers) and suggests that women of child bearing age, nursing women and children under the age of 12 reduce the amount of this fish that they eat (ADHSS website). A copy of the warning is provided in Appendix A. These types of warnings are based on the bioaccumulative properties of contaminants such as mercury.

Lead can be found in products such as: leaded gasoline, batteries, ammunition, electronics and older paint. Ingestion of lead can affect the nervous system and exposure to high levels can severely damage the brain and kidneys. Because of its deleterious health effects, the sale of lead paint was banned in 1978 but the use of lead based paint continued and structures pre and post 1978 could have lead based paint present.

3.1.3 Asbestos

Asbestos has been widely used in many building materials due to its strength, flexibility and heat resistant capabilities. It was banned in the U.S. in 1978 but the ban was overturned in 1991. Buildings built prior to 1978 likely have ACM, but building materials used after 1978 could also contain asbestos. Asbestos can commonly be found in roof shingles, ceiling and floor tiles, heat resistant fabrics and gaskets. It is a chemically inert substance and is typically stable and non-reactive in the environment. Asbestos is harmless when it is intact; however, it can become harmful when asbestos fibers become airborne due to ACM friability. Inhalation of airborne fibers can seriously damage the lungs and cause cancer. The key to handling asbestos is to prevent fibers from becoming airborne when renovating or demolishing buildings. Special training and certification is required for anyone working around potentially disturbed ACM materials.

3.1.4 PCBs

PCBs can be found in some electrical transformers and fluorescent light ballasts. Manufacturing of PCBs was banned in 1976 but similarly to asbestos and lead paint, PCB containing transformers are still commonly in use. Any materials currently containing PCBs must be labeled. Like mercury, PCBs are a persistent bioaccumulative contaminant and can build up in the tissue of fish, animals and humans. They are known to cause cancer in animals and are suspected to cause cancer in humans.

3.1.5 Creosote

Creosote can be a mixture of chemicals; coal tar creosote is the most common creosote used for wood preservation in the United States. Treated wood was found in tank farm platforms and in building pilings in Newtok. Creosote is mobile in soil and dissolves in water. Bioaccumulation is possible in plants and animals. Wood preserved with creosote must not be burned because the vapors can irritate the respiratory system. Long term exposure can cause skin damage and ingestion by animals has resulted in liver and kidney problems. The USEPA lists creosote as a probable human carcinogen.

3.1.6 Glycols

The most commonly used glycols are propylene glycol and ethylene glycol. Both are used to make antifreeze. Propylene glycol is the less toxic of the two and is even used as an additive in foods. The ingestion of very small amounts of ethylene glycol should not seriously affect health but ingestion of larger amounts can cause serious illness or death. Used antifreeze can also contain hydrocarbons and metals. Propylene glycol was used in the washeteria and used glycol was stored in drums within the Newtok School tank farm.

3.1.7 Dioxins

Dioxins are a group of chemicals that can be produced as a byproduct of burning wastes. The landfill had been on fire prior to Hobbit's site visit. They are persistent in the environment and take a long time to break down naturally. Dioxins are highly toxic and can cause damage to the immune system, reproductive system and cancer. They bioaccumulate and can be stored for long periods of time in body fats. Most human exposure is through the food supply from eating tainted meats, fish and seafood.

3.1.8 E-Coli

Wastewater discharge from the Newtok School enters the sewage lagoon. According to the Alaska Department of Environmental Conservation (ADEC) permit the wastewater system uses a membrane bioreactor filter treatment and ultraviolet radiation for disinfection. PCOCs in a sewage lagoon can include microorganisms (e-coli) and metals. Although e-coli live naturally in human intestines, some strains of e-coli can be harmful to humans and cause severe abdominal cramps, vomiting and dehydration. Extreme cases of e-coli infections can result in kidney failure and death.

3.2 Exposure Pathways

A CSM examines the exposure pathways for the contaminant to migrate from its origin to human, animal or plant receptors. Typical exposure pathways for humans are through ingestion (eating and drinking), inhalation (breathing) and dermal (skin) contact. Typical ecological exposure pathways are through direct contact and uptake of the root system, incidental ingestion of soil and water and through the food chain. These pathways will be examined below through the scoping exercises as they apply to Newtok.

3.2.1 Human Health Scoping Model

The completed human health scoping model form is provided in Appendix B. The scoping form identified five pathways as complete and one pathway as incomplete. As explained in the introduction to Section 3.0, a complete pathway is not automatically a significant risk factor. The complete pathways must be taken into consideration when developing a site investigation plan.

Complete pathways include:

1. *Direct contact with soil*. This pathway is a mix of two pathways called *incidental soil ingestion* and *dermal absorption of contaminants in soil*. It is considered complete whenever soil contamination may be present in soils 0 to 15 feet (ft) below the ground surface and soil contaminants could permeate the skin. Since most potential contaminant sources in Newtok are likely to be encountered at ground surface, any impacts would be initially to surface soils. PCOCs in Newtok include hydrocarbons, mercury and PCBs which have the ability to permeate the skin.
2. *Ingestion of Groundwater*. Currently groundwater is used as the drinking water source for the Newtok School, therefore this pathway is considered complete. It will not be a drinking water source after the village has moved. Groundwater could be impacted by contaminants if it is in contact with contaminated soils.

3. *Ingestion of Surface Water.* The existence of surface waters near potential contaminant sources makes this pathway complete. A pond is currently used as a drinking water source and may be occasionally used for drinking water by future subsistence users. The pond is located upgradient approximately 0.25 miles from the nearest suspected contaminant sources.
4. *Ingestion of Wild Foods.* This pathway focuses on: the use of the area for hunting, fishing or harvesting wild foods; site contaminants having the potential to bioaccumulate; and, site contaminants having the potential to be taken up by plant roots or burrowing animals. All of these elements can apply to the Newtok area.
5. *Inhalation of Outdoor Air.* When contaminants are present in surface soils at depths of 0 to 15 ft and these contaminants are considered volatile the outdoor inhalation pathway is considered complete. Potential volatile chemicals in Newtok would include BTEX, GRO, DRO and RRO.

The pathway considered incomplete from the scoping exercise is *Inhalation of Indoor Air.* Inhalation of indoor air will not apply to Newtok as all buildings will have been demolished or removed.

3.2.2 Ecoscoping Model

The ecoscoping process is a preliminary means to determine if a more in depth assessment of risk to the environment is necessary. Ecological receptors include both terrestrial plants and animals and aquatic plants and animals. Potential ecological exposure routes for the Newtok area include:

1. Wading or swimming in contaminated waters or ingesting contaminated water;
2. Terrestrial plants whose roots are in contact with contaminated surface water;
3. Terrestrial plants whose roots are in contact with soil moisture or groundwater present within the root zone;
4. Incidental ingestion or exposure while animals grub for food, burrow or groom;
5. Bioaccumulatives taken up by soil (on land) or sediment (in water) invertebrates which are in turn eaten by higher food chain organisms;
6. Contaminated surface runoff to water bodies; and
7. Aquatic receptors exposed to contaminated sediments by foraging or burrowing.

The ecoscoping exercise also identified that potential contamination is within a wildlife refuge, and that non-petroleum contaminants and bioaccumulative chemicals may be present. Based on the ecoscoping exercise, a detailed Ecological Conceptual Site Model needs to be developed in association with site investigation activities.

3.3 Cleanup Criteria

Clean up criteria are the specific chemical concentrations that can be left in the soil, water or air without being considered hazardous to human health or the environment. ADEC has developed tables providing default clean up criteria that are considered most protective of a site. These tables are based on long term exposure in a residential setting (ADEC 2010). In Newtok, the primary land use will be subsistence where exposure to many contaminants would be short term and the ADEC default clean up levels may not apply. ADEC does not have clean up levels designed for subsistence use. A risk assessment would be the most appropriate method to determine clean up levels at Newtok. A risk assessment is a formal evaluation of hazards to human health and environment at a specific location by specific contaminants. The evaluation would include examining: concentrations and toxicity of the contaminants; areal extent, depth and volume of the contamination; possibility for contaminant migration; exposure pathways to human and ecological receptors; and, how harmful the contamination would be to humans and the environment.

4.0 Future Environmental Work at Newtok

ADEC has protocols for remediating impacted soil and water (surface and groundwater) at contaminated sites. This protocol follows a process which is overseen by ADEC contaminated sites personnel and approval must be obtained at various points in the process prior to continuing to the next stage. Some aspects of the Newtok site cleanup would fall under other regulatory oversight. Demolishing buildings having ACM falls under Alaska Occupational Safety and Health Administration regulations. Landfill and sewage lagoon closure is overseen by ADEC Solid Waste Program personnel and hazardous waste is regulated through RCRA.

It should be noted that some assessment and remediation techniques require equipment or disposal involving transportation by barge. Due to erosion damage there is no barge landing currently in Newtok. Barging capabilities will likely be required for the village move and some type of barge landing may be built. When assessment and remediation activities will be undertaken in Newtok, techniques may require adaptation based on barging capabilities at that time.

The protocol for assessing contaminated sites in Alaska comprises the following steps:

1. Develop a workplan for assessing the site. This workplan presents an initial CSM and details the plan for: determining sample locations; collecting soil, groundwater and/or surface water samples at the site; field screening samples; and laboratory analysis that should be requested. Based on the ecoscoping

exercise conducted in Section 3.2.2 an Ecological Conceptual Site Model should be developed as part of site assessment activities. Approval of the workplan is needed before performing the field work.

2. Conduct the field assessment. The main purpose of the field assessment is to determine what types of contaminants are on site, the concentrations of the contaminants and their extent both vertically and horizontally. The field investigation usually includes sampling soil, groundwater if encountered and surface water if in the vicinity of suspected contamination.
3. Prepare a Site Characterization Report. This report presents an analysis of field and laboratory data, determines clean up criteria and recommends clean up techniques. A risk assessment may be included as part of the report if necessary. This report is submitted for review and approval by ADEC. Sometimes site conditions require multiple field investigations before a reasonable cleanup plan can be determined.
4. Remediate the site. Once a cleanup technique has been decided upon, a plan is submitted for ADEC approval and then the work commences. If the site has been remediated to acceptable standards a "cleanup complete" status will be given by ADEC. If a complete cleanup is not reasonable for the site, ADEC may allow residual contamination to remain if it is not deemed high risk to human or ecological health. Certain conditions, restrictions to land use or institutional controls (such as surface water monitoring) may be placed on the site by ADEC.

4.1 Contaminated Soil and Water Assessment

4.1.1 Field Assessment of Potential Contaminant Sources

The field investigation portion of the clean up plan for Newtok is essentially the same for *hydrocarbon contaminated soil* as for *other contaminated soil*. The exceptions are the field screening instruments and techniques used, and the laboratory analyses requested. Currently, information related to contamination in Newtok is subjective and derived from observations and experience with other contaminated sites. The first step in cleaning up the site would be to conduct the field investigation so as to have quantitative data regarding the type of contamination, degree of contamination, horizontal and vertical extent of contamination and the media (soil, groundwater, surface water) impacted. Soil samples are usually collected with the use of an excavator or a drilling rig. If groundwater is a concern than a drilling rig may be required to install monitoring wells.

Since assessment equipment availability in Newtok is limited and the cost of transporting equipment is high, Hobbit suggests first conducting a screening program to determine if contaminated soil exists.

Proposed Screening Program

The initial screening program would be conducted by manually augering into surface soils at suspected contaminated source locations (tank farms, landfill, waste staging areas, power generation building, etc). A hand auger or two man power auger could be used to dig into the soils. Since permafrost is suspected to be approximately 1 ft deep, only shallow soils would be sampled. All field and laboratory samples would be collected as per ADEC protocols. Samples would be collected on a grid pattern. For hydrocarbon contaminated soils, headspace vapors would be screened in the field using a photoionization detector (PID). Headspace vapor measurements can provide an initial indication of hydrocarbons in soil and aid in determining which samples to submit for laboratory analysis. Vapor probes could also be advanced into suspect soils for initial screening of hydrocarbon vapors. For other contaminated soils, both the headspace vapor screening and field screening for metals would be conducted. Field screening for metals can be conducted with the use of x-ray fluorescence spectroscopy (XRF). Sampling equipment would be decontaminated between sampling events to prevent cross contamination. Confirmatory laboratory analysis of metals would be completed through composite or muti-incremental sampling.

Select soil samples would be submitted for laboratory analysis. Chemistry results provide a more accurate characterization of chemicals in the soil than the field screening techniques. Samples from petroleum sources would be analyzed for hydrocarbons although some soil samples from the tank farms would also be analyzed for metals due to the possibility of historic storage of leaded gasoline. Soil samples from the landfill and staging areas would be submitted for hydrocarbons, metals, dioxins glycols and PCBs at a minimum. Additional analyses may be conducted based on materials observed in the landfill.

Permafrost is believed to be approximately 1 ft below ground surface and provides a barrier to groundwater. The active water layer (permafrost meltwater) could be sampled through probes or manually installed wells. Surface water samples could be collected from standing water in the proximity of the landfill, tank farms, and from any standing water exhibiting hydrocarbon sheen. Samples would be collected using ADEC surface water sampling protocols and analyzed for hydrocarbons, metals, PCBs, dioxins, and water quality parameters.

4.1.2 Sewage Lagoon Water Sampling

Surface water samples should be collected from the sewage lagoon using surface water sampling protocols and analyzed for fecal coliform bacteria, metals, and water quality parameters. The water sampling could be collected during the initial screening program described above.

4.1.3 Asbestos Sampling

Public buildings and residences built before 1990 should be sampled for asbestos if they have floor or ceiling tiles, as well as any other building that may be suspect. Asbestos cannot be identified by sight. Identification requires collecting samples of the building material and having the samples analyzed by a laboratory. Caution must be taken when sampling for asbestos so as not to inhale the airborne fibers that could be released when breaking off a sample. Special training or certification is not necessary for sampling ACM, but it is important that the sampler(s) are accurate and careful when working around potential ACM. Newtok could designate one or more residents to conduct the asbestos sampling under the guidance of an environmental professional.

4.2 Contaminated Source Cleanup Options

When the potential contaminated sources have been assessed and a reasonable understanding of the concentration and extent of contamination has been defined, the remediation options can be developed. Remediation techniques are numerous; a general rule of thumb is that more expensive techniques remediate sites faster while less expensive techniques require more time. Preliminary remediation suggestions are provided below. They are based on accepted industry techniques for the assumed contamination in Newtok. Actual remediation to be determined after site assessment has been conducted could comprise a mix of techniques. Cleanup suggestions take into consideration Newtok’s isolation, the high costs of transport, lack of equipment, concern for erosion, subsistence needs and the requirement to return the land to wetlands. A summary of cleanup techniques, advantages, disadvantages and preliminary costs are provided in Table 1 following the report text.

4.2.1 Landfill Contents

There are two methods for closing a landfill: closing in place or hauling out wastes. These methods will be described below together with a discussion of the advantages and disadvantages associated with leaving the landfill as is, closing in place or hauling out wastes.

Prior to closing the landfill any material not moved to Mertarvik should be considered waste and placed in the landfill. These wastes would include: material held in staging areas, household wastes, discarded trash, abandoned snowmachines, empty tanks, etc. Hazardous wastes must not be discarded in the landfill but should be separated and disposed separately.

Regardless of which method is chosen, closing a landfill properly requires creating a closure plan and submitting the plan to ADEC Solid Waste Program for approval. ADEC also must be informed within 90 days of the site work being completed and a closure report must be submitted after five years of visual monitoring.

Do Nothing

The Do Nothing option would involve leaving the landfill as is. Advantages and disadvantages to this option are listed below.

Advantages

- Leaving the landfill as is would be the least expensive option and would not have any labor or equipment requirements.

Disadvantages

- Wind and water flowing through the landfill could carry waste materials out of the immediate area. If flooding were to occur or erosion by the Ninglick River would reach the landfill, larger waste materials could be carried into the Ninglick River and cause navigational safety issues as well as environmental issues.
- If material in the landfill is contaminating soil, groundwater or surface waters, the contamination could expand beyond the source location and impact a larger area over time.
- This method would likely not meet “restore to wetlands” criteria especially for a wildlife refuge.

Closing in Place

Closing in Place involves leaving the wastes where they are and covering them with a soil cap. According to solid waste regulations 18 AAC 60.390 the final cover should be at least 24 inches thick, graded to promote drainage without erosion and be revegetated (ADEC 2013). The owner must conduct visual inspections of the closed landfill for 5 years, repair any damages or erosion to the cover during that time, and submit a report to ADEC after the 5 years have been completed. Placing the cover correctly can be difficult as compaction, settling, cracking, the creation of runoff channels and depressions are common. These issues can result in on-going cap maintenance obligations. If the landfill is in a flood zone, area of high wind or causing contamination to the surrounding area, a more robust capping system may be needed. Wastes should be consolidated and compacted prior to covering. Fencing the site reduces trespassing and provides a marker for site observation, but could provide a potential hazard for snowmachines.

<u>Advantages</u>

- Generally less expensive than hauling out materials.
- Keeps wastes intact and prevents them from blowing or flowing away.
- Prevents people or animals that are passing through from coming into contact with waste material.
- Removes the unsightliness of an open dump and provides a medium for vegetative growth on the landfill cap to bring the landfill into conformity with the surrounding landscape.
- Is an approved method for closing landfills and fulfills ADEC regulatory requirements thus setting a higher standard than the Do Nothing option.

<u>Disadvantages</u>

- Higher costs than the Do Nothing option.
- Finding soil with which to build the cap may be difficult. One possibility would be to use remediated hydrocarbon contaminated soil from the tank farms if they are remediated in place.
- Requires engineering and heavy equipment to design and construct the landfill cap.
- Will not contain wastes should the Ninglick River erosion meet the landfill. Waste material could still be carried downstream posing environmental and navigational safety issues.
- Does not remove the contaminant source if soil contamination exists below the landfill. However, if contamination is limited largely to the landfill footprint, monitoring of surrounding waters could be implemented during the 5 year observational period to determine if contaminants are migrating and are a risk to human health or the environment.
- Should the land change ownership in the future the landfill would remain on the property deed as a restrictive covenant.

Removing Landfill Wastes

Removing landfill wastes would be the most complete means of reducing future contaminant and physical impacts from the landfill. Wastes would be consolidated, loaded onto a barge and shipped to a regulated landfill elsewhere. Alternatively, waste material potentially could be transported to the new Mertarvik landfill. Any hazardous material would have to be disposed in a licensed hazardous material facility in the lower 48 (there are none in Alaska). Once the waste material has been removed, potentially contaminated soil below the landfill could be remediated and reclamation activities would restore the property to its surroundings.

<u>Advantages</u>

- Potential source contaminants and physical obstacles emanating from the landfill would be removed and the land restored to its natural condition.
- No environmental or navigational safety issues should the Ninglick River erosion reach the landfill.
- Does not require the additional repair work that capping the landfill may require.
- Allows for a more complete remediation of contaminant sources.

<u>Disadvantages</u>

- Would be significantly more expensive than the other two options due to the high costs of equipment mobilization, material excavation, shipping and landfill disposal fees.
- Would require more equipment, labor and logistical support than the other options. Use of heavy equipment needed to complete the work would have to be scheduled to minimize collateral ground disturbance. The ideal timing to minimize ground disturbance would be in winter which would reduce productivity and increase costs.

Alternative Closure Techniques

1. Reducing the amount of material in the landfill may help to make covering in place more effective by removing some of the harmful material and decreasing the footprint. A cost benefit analysis could determine if these reductions would be more cost effective than leaving the material in the landfill. Some reduction activities could include:
   - Segregating out materials containing metals such as: snowmachines, appliances, empty drums, empty steel tanks, etc. The metal material could be crushed and consolidated, along with the metal material in the appliance/snow machine staging area, decommissioned tanks, or any other

metal material not being moved to Mertarvik. The scrap metal could be shipped to a scrap metal dealer elsewhere in Alaska.

- Segregating out and burning combustible material in the burn unit that is currently at the landfill.
- Removing e-waste and shipping it to a recycler. Some of the e-waste had already been segregated to one side of the landfill but may have been damaged in the 2015 landfill fire.
- Removing any obvious hazardous wastes such as fluorescent lights, containers with oil, solvents, paints, cleaners, etc. and adding this material to the hazardous wastes already stored separately in Newtok.

This work would require manual labor to segregate wastes and possibly equipment to crush and consolidate scrap metal. Laborers contracted to segregate wastes should have Hazwoper training.

2. Another alternative to preparing wastes for landfill cover could involve use of a baling machine. Wastes could be crushed and baled together into a more stabilized state. The wastes would remain in the landfill but require less space and would be less likely to be transported by flooding. They would also provide a more stable base for the soil cap potentially reducing the future repair work required. When the work in Newtok is completed, the baling machine would be used in Mertarvik.

4.2.2 Hazardous Waste

Some hazardous waste is stored in the hazardous materials shed by the Newtok Traditional Council building (#5 on Figure 1). Hazardous waste is also stored in drums in the Newtok School tank farm. Other sources of hazardous waste in Newtok include materials containing asbestos and potentially PCB containing transformers. When buildings are demolished, fluorescent lights should be segregated and fluorescent light ballasts checked for PCBs. None of these materials can go into the landfill. As there is no hazardous waste disposal facility in Alaska, these wastes would have to be shipped to a licensed facility in the lower 48, likely in Washington or Oregon. Alternatively they could be taken to Mertarvik and stored until being shipped out in the future. Given the cost of shipping and disposal it would be useful to investigate alternative disposal or reuse of some of the materials.

Used Oil Burning

Used oil can be burned in an oil burner. The Newtok School had an oil burner in its storage shed during Hobbit's site visit. Burning the used oil would reduce the amount of hazardous waste requiring disposal.

Recycling

Fluorescent lights, fluorescent light ballasts, e-waste and batteries can be recycled in Alaska. Antifreeze can be recycled and reused if Newtok has access to an antifreeze recycling machine. Leftover paints, paint thinners, and household cleaners could be taken to Mertarvik and made available to any residents who could use them.

Asbestos

It is possible to try segregating ACM from other parts of a building prior to demolishing it, but it is likely more cost effective to crush and seal the entire building and treat it as ACM. Removal and disposal of ACM must be conducted by certified asbestos abatement professionals. If the volume of ACM from Newtok is low, it may be possible to obtain a one time disposal authorization through the Solid Waste Department of ADEC.

4.2.3 Hydrocarbon Contaminated Soil

Hydrocarbons are organic and will biodegrade naturally if they are aerated and have access to sufficient heat and a viable population of hydrocarbon consuming microbes. In Alaska due to our cold temperatures and reduced sunlight in the winter natural decomposition can be slow. Impacts to human, animal or plant receptors may preclude allowing for the slow, natural decomposition. Hydrocarbon remediation techniques involve enhancing the natural decomposition process to speed up the cleanup of hydrocarbons. Often physical barriers, such as containment berms are used to prevent surface runoff of contaminants outside of the treatment area. Monitoring of surrounding surface water bodies and/or the active water layer may be required to ensure that contaminants are not migrating out of the treatment area. A discussion of possible cleanup strategies is provided below in order of increasing costs. ADEC approval would be required for any final cleanup strategy.

Leave in Place

Based on the Army Corp of Engineers erosion projections through 2027, many areas in Newtok that contain fuel storage are away from short term erosional effects. These areas would include the Ungusraq Power Company (UPC) tank farm, the Newtok Village Council tank farm, Tom's store tanks and possibly the Bureau of Indian Affairs tank farm. The Newtok School area is projected to start eroding by 2022 and depending on the timing of remediation work may qualify for a leave in place plan if contaminated soils are found there.

When tanks and associated piping have been removed from the tank farms, contaminated soils would be excavated into biopiles within the already existing secondary containment. Aeration could be provided by installing piping throughout the piles. A soil and water sampling program would likely be required to monitor the degradation success and ensure there is no migration of contaminants. A risk assessment plan would have to be developed and submitted for approval from ADEC prior to implementing this remedial option.

<u>Advantages</u>

- Inexpensive. Costs would involve the development of a risk assessment plan, creation of biopiles and occasional soil and possibly water sampling.
- Secondary containment around the tank farms already exists. Some repair work may be required to maintain their integrity.
- Remediated soil could be used to cap the landfill.
- Although cleanup could be slow, it would not interfere with subsistence activities on the land.
- Does not require any barge transport of materials, however equipment for creating the biopiles would be needed.

<u>Disadvantages</u>

- Remediation of soil would probably require several years.
- The secondary containment would not prevent animals from having contact with contaminated soil.
- These areas could be flooded during major storms.
- Soil and water monitoring would continue for the length of cleanup time.

Landspread Soils in Newtok

Landspreading differs from creating the biopiles in that the contaminated soil is thinly spread over a land surface and tilled into the ground. Ideally soil would be moved to a higher elevation where flooding would be less of a concern. Soil and groundwater sampling would be required to monitor the extent of degradation and ensure contaminants do not migrate out of the treatment area. Advantages and disadvantages would be very similar to those for leaving in place with a few exceptions noted below.

<u>Advantages</u>

- Inexpensive. Costs would involve physically moving and spreading the soil and occasional soil and possibly water sampling.
- Soil would be spread thinly and have more surface exposure to air and microbes.
- Does not require any barge transport of materials, however equipment for excavating and moving the soil would be needed.
- Soils could be spread in an area less prone to flooding during storm events.
- If soils are spread in strategic locations impact to subsistence activity areas should not be a concern.

<u>Disadvantages</u>

- Remediation of soil would probably require several years.
- People and animals would not be prevented from having contact with contaminated soil.
- Soil and water monitoring would continue for the length of cleanup time.

Excavate Contaminated Soil and Haul to a Landfill or Treatment Facility

The quickest method of remediating hydrocarbon contaminated soil in Newtok would be to excavate it and haul it away to either a landfill or treatment facility. There are no landfills in Alaska licensed to accept contaminated soil so soils would have to be taken to a licensed landfill in Washington or Oregon. An alternative to a landfill would be a soil burning facility where soils are heated to an extent that hydrocarbons are completely volatilized. There is a licensed soil burning facility in Anchorage which also has a mobile unit. Using an on-site burner would leave soils available for building a cap over the landfill.

Advantages

- Quickest form of soil remediation as contamination completely removed from Newtok. If contaminated soils have impacted surrounding water, it also removes the source of water contamination.
- Eliminates the concerns of encroaching erosion or flooding events spreading contaminants.
- Does not impact subsistence use of the land and animals would have no contact with contaminated soil.

Disadvantages

- Considerably more expensive than the other remediation techniques. Costs would include equipment, transportation and disposal fees regardless of whether soils taken to a landfill or thermal facility.

4.2.4 Other Contaminated Soil

Soils contaminated with metals, PCBs, dioxins or other non-organic chemicals could not be remediated using the previously mentioned techniques. These contaminants do not break down in nature as refined hydrocarbons do and, if in sufficient concentrations and quantity to do harm, would have to be removed. If there are other contaminated soils in Newtok they would likely be found below the landfill and possibly at other waste staging areas.

Leave in Place and Manage Risk

This option may be possible if PCBs, dioxins and inorganic based contamination is relatively low, limited to within the footprint of the landfill and can be left in place applying risk assessment methods. If ADEC would approve a leave in place option there would likely be a water monitoring component to ensure that risk assessment outputs are properly monitored and managed.

Advantages

- Inexpensive. Costs would involve development of risk management plan and possible water monitoring of surface water bodies near the landfill.

Disadvantages

- There would be no cleanup of contaminated soils.

- Contaminated soils could be washed into the Ninglick River should erosion reach the landfill.
- Water monitoring would likely be required for a number of years.

Excavate Soils and Haul to a Licensed Hazardous Waste Facility

The only way to completely cleanup other contaminated soil in Newtok would be to excavate it and haul it away. Soils contaminated with metal, PCBs or dioxins are considered hazardous waste and would have to be taken to a licensed hazardous waste facility. There are no licensed hazardous waste facilities in Alaska so the most likely locations would be in Washington or Oregon.

Advantages:

- Only technique that would remove other contaminated soil from Newtok. If contaminated soils have impacted surrounding water, it also removes the source of water contamination.
- Eliminates the concerns of encroaching erosion or flooding events.
- Does not impact subsistence use of the land and animals would have no contact with contaminated soil.

Disadvantages:

- Significantly more expensive than leaving in place. Costs would include equipment, transportation and disposal fees.

4.2.5 Sewage Lagoon

Closing the sewage lagoon would include pumping off the fluids and covering sludges left in place. Both ADEC Wastewater Regulations and ADEC Solid Waste regulations apply to closing the sewage lagoon. Sampling of sewage water could be accomplished during the proposed initial site screening or during a site investigation. If the water meets pump off criteria it can be disposed to surface. Treatment of the water may be necessary if it does not meet criteria. Leaving sludges in place comes under the jurisdiction of ADEC Solid Waste regulations. A closure plan must be prepared and submitted to ADEC at least 180 days prior to lagoon closure. The plan must include a description of how the lagoon will be covered, including at least 2 ft of soil cover, drainage control and revegetation. One of the priorities in closure design is to prevent water from pooling within the closed lagoon. Annual monitoring must continue for 5 years and includes visual inspection of the closed lagoon. Surface water and groundwater monitoring are generally not required unless they had been required while the lagoon was active. Methane monitoring would not be required as there would be no buildings left in Newtok.

5.0 Cleanup Cost Ranges

Cleanup cost ranges (high, low and most likely) are provided in Table 1. The cost ranges are provided solely for comparing possible cleanup techniques and are for discussion purposes only. These costs are based on generally accepted industry ranges and the estimated in-situ volumes determined in Task I. No soil, water, or material testing has been conducted to refine the volume estimates, define contaminant type or delineate the extent of contamination. No formal quotes or estimates for transport, tipping fees, equipment, labor, etc. have been obtained. Only after assessment activities have defined and delineated potential contaminant sources can actual remediation costs be determined.

Assumptions/conditions for remediation costs include:

- Assumes equipment and labor landed and available in Newtok.
- Costs are based on conducting field work in the summer and moving 650 yd^3 of material a day. Work conducted in the winter would result in lower daily production and higher daily costs.
- The estimated in-situ volumes used were: landfill contents 28,000 yd^3 , hydrocarbon contaminated soil 1100 yd^3, other contaminated soil 5000 yd^3 , hazardous waste 250 yd^3 and sewage lagoon 2700 yd^3 .
- In-situ volume for sewage lagoon determined from area of footprint and assumed depth of 2 ft.
- Costs do not include site assessment.
- Costs do not include soil or water monitoring that may be required to accompany the remediation.
- Costs assume backfill/capping material sourced locally.
- Costs are in 2015 dollars.

6.0 References

Alaska Department of Environmental Conservation. (2010). *Policy Guidance on Developing Conceptual Site Models.* October, 2010.

Alaska Department of Environmental Conservation. (2013). *18 AAC60 Solid Waste Management Regulation*. As amended through April 12, 2013.

Alaska Department of Environmental Conservation. (2014). *Ecoscoping Guidance: A Tool for Developing an Ecological Conceptual Site Model.* March 20014.

Agency for Toxic Substances and Disease Registry. (2015) . Retrieved from: http://www.atsdr.cdc.gov/.

Hobbit Environmental Consulting Corp. (2015). *Newtok Environmental Site Inventory and Assessment Project. Part I: Hazardous Materials Inventory.* Prepared for State of Alaska, Department of Commerce, Community and Economic Development. October 29, 2015.

7.0 Limitation of Liability

This report has been prepared and the work referred to in this report has been undertaken by Hobbit Environmental Consulting Corporation hereinafter referred to as Hobbit for the Alaska Department of Commerce, Community and Economic Development. The work was performed in accordance with generally accepted environmental consulting practices. The work undertaken by Hobbit with respect to this report and any conclusions or recommendations made in this report reflect Hobbit's judgment based on the site conditions observed at the time of the site inspection on the date(s) set out in this report and on information available at the time of preparation of this report. This report has been prepared for specific application to this site and it is based solely upon visual observation of the site and readily available information, all as described in this report. No material, soil or water sampling was conducted. No formal quotes or estimates have been obtained. Unless otherwise stated, the findings cannot be extended to previous or future site conditions, or portions of the site which were unavailable for viewing directly. No warranty, express or implied, is made.

If site conditions or applicable standards change or if any additional information becomes available at a future date, modifications to the findings in this report may be necessary.

Table 1
Summary of Clean Up Options

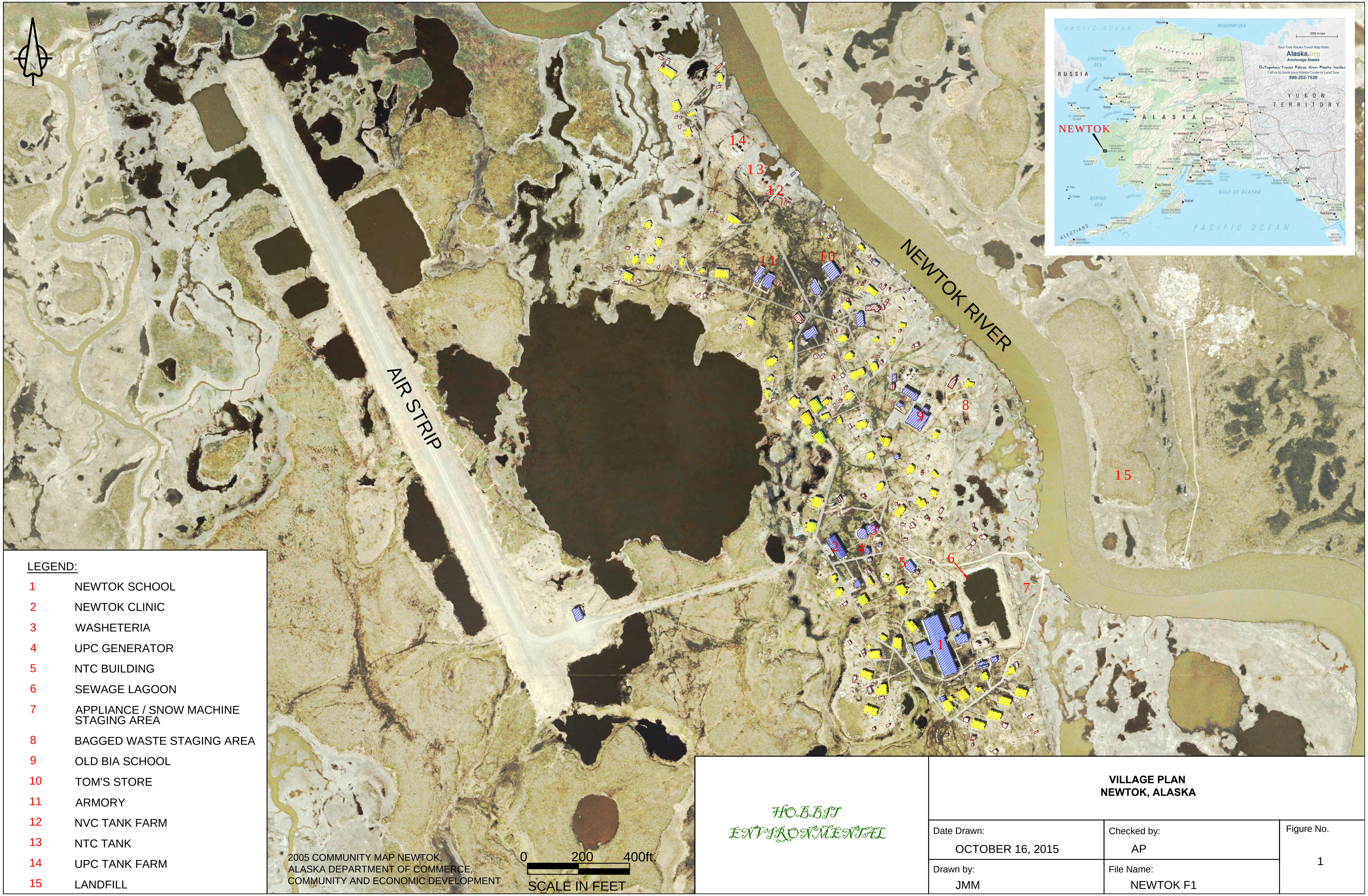
Source Material	Potential Contaminants of Concern	Estimated Volume (yd^3)	Clean Up Option	Advantages	Disadvantages	Cost Range[1]: Low, Most Likely, High
Landfill Contents	Hydrocarbons, Metals, PCBs, Dioxins, Glycols	28,000	Do Nothing	No financial cost, labor or equipment requirements.	Wind and water flowing through the landfill could carry waste materials out of the immediate area of the landfill. If flooding were to occur or erosion by the Ninglick River would reach the landfill, larger waste materials and volumes could be carried into the Ninglick River causing navigational safety issues and increasing environmental impacts downstream. If material in the landfill is contaminating soil, groundwater or surface waters, the contamination could expand beyond the source location and impact a larger area over time. This method would likely not meet "restore to wetlands" criteria especially for a wildlife refuge.	Not Applicable
			Close in Place	Less expensive than hauling out materials. Keeps wastes intact and prevents them from being eleased beyond the landfill area. Prevents people and animals from contact with landfill wastes. Removes unsightliness of open dump and provides a medium for vegetative growth on the landfill cap to bring the landfill into conformity with the surrounding landscape. Is an approved method for closing landfills and fulfills ADEC regulatory requirements thus setting a higher standard than the Do Nothing option.	Higher cost than Do Nothing option Finding soil with which to build the cap may be difficult. One possibility would be to use remediated hydrocarbon contaminated soil if it is remediated in place. Requires engineering and heavy equipment to design and construct landfill cap. Will not contain wastes should Ninglick River erode to landfill. Waste material could be carried downstream posing environmental and navigational safety issues. Does not remove contaminant source if soil contamination exists below the landfill. However, if contamination is limited to the landfill footprint, monitoring of surrounding waters could be implemented during the 5 year observational period to determine if contaminants are migrating. Should land change ownership in the future, landfill remains on property deed as a restrictive covenant.	$1,400,000 (low) $2,100,000 (most likely) $3,500,000 (high)
			Haul Away Landfill Contents	Potential source contaminants and physical obstacles emanating from the landfill would be removed and the land restored to its natural condition. No environmental or safety issues should Ninglick River erosion reach landfill. No repair work that a landfill cap may require. Allows for more complete remediation of contaminant sources.	Significantly more expensive due to high costs of equipment mobilization, material excavation, shipping and landfill disposal fees More equipment, labor and logistical support required than other options. Depending on the season of work activities, additional reclamation work may be required, i.e. less reclamation work in winter, more in summer due to heavy equipment tearing up the ground.	$4,200,000 (low) $5,600,000 (most likely) $8,400,000 (high)
Hazardous Waste	Hydrocarbons, Metals, PCBs, Dioxins, Glycols	250	Haul to a Hazardous Waste Facility	Not Applicable	Not Applicable	$75,000 (low) $100,000 (most likely) $125,000 (high)

Source Material	Potential Contaminants of Concern	Estimated Volume in Cubic Yards	Clean Up Option	Advantages	Disadvantages	Cost Range[1]: Low, Most Likely, High
Hydrocarbon Contaminated Soil	Hydrocarbons	1100	Leave in Place	Least expensive option. Costs would involve developing risk assessment plan, receiving approval from ADEC, the creation of biopiles and occasional soil and possible water sampling. Secondary containment around tank farms already exists. Some repair work may be required to maintain their integrity. Remediated soil could be used to cap the landfill. Would not interfere with subsistence use. Does not require transport of materials, however equipment for creating the biopiles would be needed.	Remediation of soil would probably require several years. People and animals not prevented from having contact with soil. These areas could be flooded during major storms. Soil and water monitoring would continue for length of cleanup time.	$275,000 (low) $385,000 (most likely) $550,000 (high)
			Landspread Soils	Relatively inexpensive. Costs would involve physically moving and spreading the soil and occasional soil and possibly water sampling. Soils would be spread thinly and have more surface exposure to air and microbes. Would not require barging soils away, however equipment for excavating and moving the soil would be required. Soils could be spread in an area less prone to flooding. If soils are spread in strategic locations, impact to subsistence activity areas should not be a concern.	Remediation of soil would probably require several years. Soil and water monitoring would continue for length of cleanup time. People and animals not prevented from having contact with soil.	$302,500 (low) $423,500 (most likely) $605,000 (high)
			Excavate and Haul to Landfill or Treatment Facility	Quickest remediation technique. Eliminates concerns of encroaching erosion or flooding events, Does not impact subsistence use of land and people and animals would have no contact with contaminated soil.	Considerably more expensive due to high costs of equipment mobilization, transportation and disposal fees regardless of whether soils taken to a landfill or thermal facility.	$600,000 (low) $800,000 (most likely) $1,000,000 (high)
Other Contaminated Soil	Hydrocarbons, Metals, PCBs, Dioxins, Glycols	5000	Leave in Place / Manage Risk	Inexpensive. Cost would involve development of risk management plan and possible water monitoring of surface water bodies near the landfill. Would require ADEC approval.	No remediation of source material. Contaminated soil would wash into Ninglick River should erosion reach landfill. Water monitoring would likely be required for a number of years.	$30,000
			Excavate and Haul to Landfill or Treatment Facility	Completely removes source of contamination. Eliminates concerns of encroaching erosion or flooding events. Does not impact subsistence use of land and people and animals would have no contact with contaminated soil.	Significantly more expensive than leaving in place. Costs would include equipment, transportation and disposal fees.	$2,800,000 (low) $3,800,000 (most likely) $5,700,000 (high)
Sewage Lagoon	E-Coli, Metals	2700	Close in Place	Not Applicable	Not Applicable	$135,000 (low) $225,000 (most likely) $335,000 (high)

[1]Cost Range Assumptions:

Costs based on generally accepted industry ranges and Task I estimated in-situ volumes
No soil, water or material testing conducted to determine in-situ volumes.
No formal quotes or estimates for transport, tipping fees, equipment, labor, etc have been obtained
Equipment and labor landed and available in Newtok
Field work conducted in summer and assumes moving 650 yd^3 of soil a day

Costs do not include site assessment.
Costs do not include soil or water monitoring that will likely be required to accompany the remediation.
Costs assume backfill/capping material sourced locally.
Costs in 2015 dollars.



2005 COMMUNITY MAP NEWTOK,
ALASKA DEPARTMENT OF COMMERCE,
COMMUNITY AND ECONOMIC DEVELOPMENT

LEGEND:

1	NEWTOK SCHOOL
2	NEWTOK CLINIC
3	WASHETERIA
4	UPC GENERATOR
5	NTC BUILDING
6	SEWAGE LAGOON
7	APPLIANCE / SNOW MACHINE STAGING AREA
8	BAGGED WASTE STAGING AREA
9	OLD BIA SCHOOL
10	TOM'S STORE
11	ARMORY
12	NVC TANK FARM
13	NTC TANK
14	UPC TANK FARM
15	LANDFILL

HOBBIT ENVIRONMENTAL

VILLAGE PLAN
NEWTOK, ALASKA

Date Drawn:	Checked by:	Figure No.
OCTOBER 16, 2015	AP	1
Drawn by: JMM	File Name: NEWTOK F1	

APPENDIX A

MERCURY IN NORTHERN PIKE FROM THE YUKON DELTA NATIONAL WILDLIFE REFUGE NOTICE

Mercury in Northern Pike from the Yukon Delta National Wildlife Refuge

U.S. Fish and Wildlife Service and Alaska Dept. of Health and Social Services – Division of Public Health

Why are we concerned about mercury?

Mercury is a neurotoxin - at high levels it can damage the developing brains of babies (including babies in the womb) and children. Mercury levels in most Alaska fish are low, so any health effects would be very subtle. Still, health officials recommend a margin of safety to protect our children's health.

Should I worry about eating fish?

Overall, mercury levels in Alaska fish are low, so the ***only*** people who need to think about limiting the amount of fish they eat are ***women who are or can become pregnant, nursing mothers, and children age 12 years and under.*** Women and children can still get the benefits of eating fish by choosing to eat fish that are low in mercury, like salmon.

Men, elders, and teenage boys may eat unlimited amounts of most Alaska fish, including pike.

The State of Alaska has developed guidelines for women and children on how much of each fish they can safely eat, based on the amount of mercury in a variety of fish species. These guidelines:

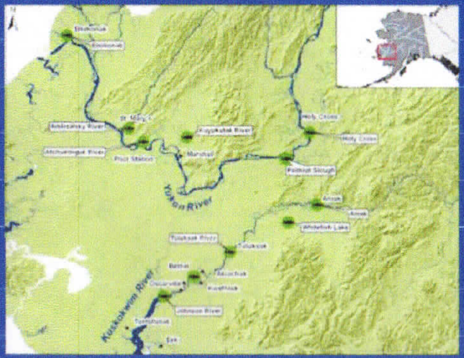
- Reflect guidelines developed by other states and national agencies.
- Incorporate studies of dietary mercury effects on children.
- Include a large safety factor, so do not have to be viewed as strict dietary limits.

Why study mercury in pike?

There is more of the toxic form of mercury – methylmercury – in fish that eat other fish and in older fish, like large pike. In this study, we measured mercury in pike muscle, from pike caught at traditional and well-used subsistence fishing sites. We are sharing this information with you because you live in an area where people eat a lot of pike.

With the help of subsistence fishermen, we collected 163 pike from 11 sites in the Yukon Delta National Wildlife Refuge in 2005 (on the Kuskokwim River) and 2006 (on the Lower Yukon River).

Sample sites in the Kuskokwim River area (2005) and the Lower Yukon River area (2006).



How much pike from the Yukon Delta area should women and children eat?

Methylmercury concentration in fish (mg/kg)	Meals per month	Fresh pike	Dried pike
0 - 0.15	Unlimited		
>0.15 - 0.32	up to 16	Kuskokwim < 2 ft	
>0.32 - 0.40	up to 12		
>0.40 - 0.64	up to 8	Kuskokwim > 2 ft, All Lower Yukon	
>0.64 – 1.2	up to 4		Kuskokwim < 2 ft
>1.2 - 1.4	up to 3		
>1.4 - 2.0	up to 2		
>2.0 - 3.4	up to 1		Kuskokwim > 2 ft, All Lower Yukon

The most recent (2007) guidelines, *Fish Consumption Advice for Alaskans: A Risk Management Strategy to Optimize Public Health*, is available at: http://www.epi.hss.state.ak.us/bulletins/docs/rr2007_04.pdf.

For pike in the Yukon Delta National Wildlife Refuge, the recommendations for women and children are:

Kuskokwim River area pike *shorter than 2 feet* may be eaten in up to 16 meals per month if fresh, and up to 4 meals per month if dried.

Kuskokwim River area pike *longer than 2 feet* may be eaten in up to 8 meals per month if fresh, and in up to 1 meal per month if dried.

All Lower Yukon River area pike may be eaten in up to 8 meals per month if fresh, and in up to 1 meal per month if dried.

A "meal" is one six-ounce portion of fish, dried or fresh.

Notes: Small pike (< 2 feet long) often have less mercury than large pike (> 2 feet long). Also, dried pike has a higher mercury concentration than fresh pike (the mercury is "diluted" with the water in the fresh pike), so the guidance allows fewer meals of dried pike than fresh pike.

Where does mercury in Alaska come from?

- *Anthropogenic (human-caused) sources* such as global air pollution from burning fuels and garbage, and mining runoff
- *Natural sources* such as forest fires, volcanoes, and local bedrock weathering into streams

Mercury gets into wetlands where it is transformed by bacteria into methylmercury. From there, it accumulates in fish and animals.

For more information on mercury in pike contact Angela Matz (angela_matz@fws.gov, 907-456-0442), U.S. Fish and Wildlife Service, 101-12th Ave., Room 110, Fairbanks, AK 99701.

Measuring Mercury in Humans

Although mercury concentrations in fish can give us an idea of possible mercury exposure, Alaska has a program that tests for actual mercury levels in humans. ***If you are a woman of child-bearing age, you can get your hair tested and find out your own mercury levels – for free!***

The Alaska Division of Public Health will analyze a small hair sample from any Alaskan woman of child-bearing age for mercury. Hair collection is done by a health care provider, and results are sent to the woman and her health care provider within two months. If you are one of the very few women in Alaska who has a high hair mercury level, the Alaska Division of Public Health and your health care provider will work with you to help reduce your mercury exposure.

A simple hair test can tell you how much mercury you may have in your body. For more information on hair mercury monitoring, or to arrange for testing, contact the Environmental Public Health Program at the Alaska Division of Public Health, 3601 C Street, Suite 540, Anchorage, AK 99503, 907-269-8000, http://www.epi.hss.state.ak.us/eh/default/stm

When Deciding What to Eat, Remember…

Subsistence foods, including almost all fish, are better for you and less expensive than store-bought foods. Also, the subsistence way of life helps keep Alaska Native cultures healthy and traditional ways alive.

Fish are nutritious, with vitamins A, E, and C, iron, zinc, protein, and very important omega-3 fatty acids. These nutrients help keep your nervous system, your immune system, and your heart healthy, and are important for a healthy pregnancy.

Subsistence foods are low in sugar and saturated fats. Store-bought foods can have unhealthy amounts of sugars and fats, which can contribute to obesity and diabetes, both of which are at epidemic levels in Alaskans, and heart disease. All these diseases are increasing among Alaska Natives.

Most subsistence foods are very clean. For example, all five species of Alaska salmon have very low contaminant levels and are safe to eat in unlimited quantities.

For more information on fish consumption guidelines, or the benefits of eating subsistence foods, contact the Environmental Public Health Program, 907-269-8000, Alaska Division of Public Health, 3601 C Street, Suite 540, Anchorage, AK 99503.

APPENDIX B

HUMAN HEALTH CONCEPTUAL SITE MODEL SCOPING FORM

Print Form

Human Health Conceptual Site Model
Scoping Form

Site Name: Newtok, Alaska

File Number:

Completed by: Annemieke Powers

Introduction

The form should be used to reach agreement with the Alaska Department of Environmental Conservation (DEC) about which exposure pathways should be further investigated during site characterization. From this information, summary text about the CSM and a graphic depicting exposure pathways should be submitted with the site characterization work plan and updated as needed in later reports.

General Instructions: Follow the italicized instructions in each section below.

1. General Information:

Sources *(check potential sources at the site)*

- [ ] USTs
- [x] ASTs
- [ ] Dispensers/fuel loading racks
- [x] Drums
- [ ] Vehicles
- [x] Landfills
- [x] Transformers
- [x] Other: Hazardous wastes, sewage lagoon

Release Mechanisms *(check potential release mechanisms at the site)*

- [x] Spills
- [x] Leaks
- [x] Direct discharge
- [x] Burning
- [ ] Other:

Impacted Media *(check potentially-impacted media at the site)*

- [x] Surface soil (0-2 feet bgs*)
- [x] Subsurface soil (>2 feet bgs)
- [ ] Air
- [ ] Sediment
- [ ] Groundwater
- [x] Surface water
- [ ] Biota
- [x] Other: Potential active water layer on permafrost

Receptors *(check receptors that could be affected by contamination at the site)*

- [ ] Residents (adult or child)
- [ ] Commercial or industrial worker
- [x] Construction worker
- [x] Subsistence harvester (i.e. gathers wild foods)
- [x] Subsistence consumer (i.e. eats wild foods)
- [x] Site visitor
- [x] Trespasser
- [x] Recreational user
- [ ] Farmer
- [ ] Other:

* bgs - below ground surface

2. Exposure Pathways: *(The answers to the following questions will identify complete exposure pathways at the site. Check each box where the answer to the question is "yes".)*

a) Direct Contact -

1. Incidental Soil Ingestion

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site-specific basis.) ☒

If the box is checked, label this pathway complete: Complete

Comments:

The sources of potential contamination are above ground.

2. Dermal Absorption of Contaminants from Soil

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Can the soil contaminants permeate the skin (see Appendix B in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

Potential contaminants include hydrocarbons, PAHs, mercury, PCBs

b) Ingestion -

1. Ingestion of Groundwater

Have contaminants been detected or are they expected to be detected in the groundwater, or are contaminants expected to migrate to groundwater in the future? ☐

Could the potentially affected groundwater be used as a current or future drinking water source? Please note, only leave the box unchecked if DEC has determined the groundwater is not a currently or reasonably expected future source of drinking water according to 18 AAC 75.350. ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

Groundwater currently used as a drinking water source for the Newtok School. Groundwater not expected to be impacted by contamination due to permafrost layer.

2. Ingestion of Surface Water

Have contaminants been detected or are they expected to be detected in surface water, or are contaminants expected to migrate to surface water in the future? ☒

Could potentially affected surface water bodies be used, currently or in the future, as a drinking water source? Consider both public water systems and private use (i.e., during residential, recreational or subsistence activities). ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

Contaminants could potentially migrate to surface water. A pond is currently used as a drinking water source and may occasionally be used for drinking water by future subsistence users. It is located approximately 0.25 miles up gradient from suspected contaminant sources.

3. Ingestion of Wild and Farmed Foods

Is the site in an area that is used or reasonably could be used for hunting, fishing, or harvesting of wild or farmed foods? ☒

Do the site contaminants have the potential to bioaccumulate (see Appendix C in the guidance document)? ☒

Are site contaminants located where they would have the potential to be taken up into biota? (i.e. soil within the root zone for plants or burrowing depth for animals, in groundwater that could be connected to surface water, etc.) ☒

If all of the boxes are checked, label this pathway complete: Complete

Comments:

Potential site contaminants include PAHs, lead mercury and PCBs.

c) Inhalation-

1. Inhalation of Outdoor Air

Are contaminants present or potentially present in surface soil between 0 and 15 feet below the ground surface? (Contamination at deeper depths may require evaluation on a site specific basis.) ☒

Are the contaminants in soil volatile (see Appendix D in the guidance document)? ☒

If both boxes are checked, label this pathway complete: Complete

Comments:

Potential volatile contaminants would include BTEX, GRO, DRO and RRO.

2. Inhalation of Indoor Air

Are occupied buildings on the site or reasonably expected to be occupied or placed on the site in an area that could be affected by contaminant vapors? (within 30 horizontal or vertical feet of petroleum contaminated soil or groundwater; within 100 feet of non-petroleum contaminted soil or groundwater; or subject to "preferential pathways," which promote easy airflow like utility conduits or rock fractures) ☐

Are volatile compounds present in soil or groundwater (see Appendix D in the guidance document)? ☐

If both boxes are checked, label this pathway complete: Incomplete

Comments:

No structures are expected to remain in Newtok after the move.

3. **Additional Exposure Pathways:** *(Although there are no definitive questions provided in this section, these exposure pathways should also be considered at each site. Use the guidelines provided below to determine if further evaluation of each pathway is warranted.)*

Dermal Exposure to Contaminants in Groundwater and Surface Water

Dermal exposure to contaminants in groundwater and surface water may be a complete pathway if:

- Climate permits recreational use of waters for swimming.
- Climate permits exposure to groundwater during activities, such as construction.
- Groundwater or surface water is used for household purposes, such as bathing or cleaning.

Generally, DEC groundwater cleanup levels in 18 AAC 75, Table C, are assumed to be protective of this pathway.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Volatile Compounds in Tap Water

Inhalation of volatile compounds in tap water may be a complete pathway if:

- The contaminated water is used for indoor household purposes such as showering, laundering, and dish washing.
- The contaminants of concern are volatile (common volatile contaminants are listed in Appendix D in the guidance document.)

Generally, DEC groundwater cleanup levels in 18 AAC 75, Table C, are assumed to be protective of this pathway.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Inhalation of Fugitive Dust

Inhalation of fugitive dust may be a complete pathway if:

- Nonvolatile compounds are found in the top 2 centimeters of soil. The top 2 centimeters of soil are likely to be dispersed in the wind as dust particles.
- Dust particles are less than 10 micrometers (Particulate Matter - PM_{10}). Particles of this size are called respirable particles and can reach the pulmonary parts of the lungs when inhaled.
- Chromium is present in soil that can be dispersed as dust particles of any size.

Generally, DEC direct contact soil cleanup levels in Table B1 of 18 AAC 75 are protective of this pathway because it is assumed most dust particles are incidentally ingested instead of inhaled to the lower lungs. The inhalation pathway only needs to be evaluated when very small dust particles are present (e.g., along a dirt roadway or where dusts are a nuisance). This is not true in the case of chromium. Site specific cleanup levels will need to be calculated in the event that inhalation of dust containing chromium is a complete pathway at a site.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

Direct Contact with Sediment

This pathway involves people's hands being exposed to sediment, such as during some recreational, subsistence, or industrial activity. People then incidentally ingest sediment from normal hand-to-mouth activities. In addition, dermal absorption of contaminants may be of concern if the the contaminants are able to permeate the skin (see Appendix B in the guidance document). This type of exposure should be investigated if:

- Climate permits recreational activities around sediment.
- The community has identified subsistence or recreational activities that would result in exposure to the sediment, such as clam digging.

Generally, DEC direct contact soil cleanup levels in 18 AAC 75, Table B1, are assumed to be protective of direct contact with sediment.

Check the box if further evaluation of this pathway is needed: ☐

Comments:

4. Other Comments *(Provide other comments as necessary to support the information provided in this form.)*

APPENDIX C

ECOSCOPING FORM

Appendix C: Blank Ecoscoping Form

Site Name: Newtok, AK
Completed by: Annemieke Powers
Date: December 19, 2015

Instructions: Follow the italicized instructions in each section below. "Off-ramps," where the evaluation ends before completing all of the sections, can be taken when indicated by the instructions. Comment boxes should be used to help support your answers.

1. Direct Visual Impacts and Acute Toxicity

Are direct impacts that may result from the site contaminants evident, or is acute toxicity from high contaminant concentrations suspected? *Check the appropriate box.*

☐ Yes – D*escribe observations below and evaluate all of the remaining sections without taking any off-ramps.*

☒ No – *Go to next section.*

Comments:

2. Terrestrial and Aquatic Exposure Routes

Check each terrestrial and aquatic route that could occur at the site.

Terrestrial Exposure Routes

☒ Exposure to water-borne contaminants as a result of wading or swimming in contaminated waters or ingesting contaminated water.

☒ Contaminant uptake in terrestrial plants whose roots are in contact with contaminated surface water.

☐ Contaminant migration via saturated or unsaturated groundwater zones and discharge at upland "seep" locations (not associated with a wetland or waterbody).

☒ Contaminant uptake by terrestrial plants whose roots are in contact with soil moisture or groundwater present within the root zone (generally no more than 4 feet below ground surface.

☐ Particulates deposited on plants directly or from rain splash.

☒ Incidental ingestion and/or exposure while animals grub for food, burrow (up to 2 feet for small animals or 6 feet for large animals), or groom.

☒ Inhalation of fugitive dust or vapors disturbed by foraging or burrowing activities.

☒ Bioaccumulatives (other than PAHs, which bioaccumulate more readily in aquatic environments) taken up by soil invertebrates, which are in turn eaten by higher food chain organisms (see the *Policy Guidance on Developing Conceptual Site Models*).

☐ Other site-specific exposure pathways.

Aquatic Exposure Routes

☒ Contaminated surface runoff migration to water bodies through swales, drainage ditches, or overland flow.

☐ Aquatic receptors exposed through osmotic exchange, respiration, or ventilation of surface waters.

☐ Contaminant migration via saturated or unsaturated groundwater zones and discharge at "seep" locations along banks or directly to surface water.

☐ Deposition into sediments from upwelling of contaminated groundwater.

☐ Aquatic receptors may be exposed directly to contaminated sediments through foraging or burrowing, or indirectly exposed due to osmotic exchange, respiration, or ventilation of sediment pore water.

☐ Aquatic plants rooted in contaminated sediments.

☐ Bioaccumulatives (see the *Policy Guidance on Developing Conceptual Site Models*) taken up by sediment invertebrates, which are in turn eaten by higher food chain organisms.

☐ Other site-specific exposure pathways.

If any of the above boxes are checked, go on to the next section. If none are checked, end the evaluation and check the box below.

☐ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:

3. Habitat

Check all that may apply. See Ecoscoping Guidance for additional help.

☒ Habitat that could be affected by the contamination supports valued species (i.e., species that are regulated, used for subsistence, have ceremonial importance, have commercial value, or provide recreational opportunity).

☐ Critical habitat or anadromous stream in an area that could be affected by the contamination.

☒ Habitat that is important to the region that could be affected by the contamination.

☒ Contamination is in a park, preserve, or wildlife refuge.

If any of the above boxes are checked, go on to the next scoping factor. If none are checked, end the evaluation and check the box below.

☐ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:

4. Contaminant Quantity

Check all that may apply. See Ecoscoping Guidance for additional help.

☐ Endangered or threatened species are present.

☒ The aquatic environment is or could be affected.

☒ Non-petroleum contaminants may be present, or the total area of petroleum-contaminated surface soil exceeds one-half acre.

If any of the above boxes are checked, go on to the next scoping factor. If none are checked, end the evaluation and check the box below.

☐ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:

5. Toxicity Determination

Check all that apply.

☒ Bioaccumulative chemicals are present (see *Policy Guidance on Developing Conceptual Site Models*).

☐ Contaminants exceed benchmark levels (see the Ecological Benchmark Tool in RAIS, available at: http://rais.ornl.gov/tools/eco_search.php).

If either box is checked, complete a detailed Ecological Conceptual Site Model (see DEC's Policy Guidance on Developing Conceptual Site Models*) and submit it with the form to your DEC project manager.*

If neither box is checked, check the box below and submit this form to your DEC project manager.

☐ OFF-RAMP: NO FURTHER ECOLOGICAL EVALUATION NECESSARY

Comments:
