ELIZABETH MINE

HEALTH AND SAFETY PLAN
For
OPERATIONS AND MAINTENANCE ACTIVITIES

Prepared by
Vermont Department of Environmental Conservation
Waste Management Division
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ELIZABETH MINE HEALTH AND SAFETY PLAN FOR OPERATIONS AND MAINTENACNE ACTIVITIES

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1. INTRODUCTION

1.1 PURPOSE

This Health and Safety Plan (HSP) presents health and safety procedures designed to minimize potential risks of harm to personnel performing operation and maintenance activities at the Elizabeth Mine Superfund Site. This HSP was developed based on the knowledge of potential hazards that are currently anticipated for the activities to be conducted as part of the operation and maintenance of the site and is based on information developed during previous investigations and response actions. This HSP is considered a supplement to a contractor's general obligations and requirements related to health and safety.

1.2 SCOPE AND APPLICATION

This HSP applies to all operation and maintenance personnel who may be potentially exposed to safety and/or health hazards associated with the activities described in Section 4 (Scope of Work).

1.3 DISSEMINATION

Copies of the HSP will be provided to all personnel engaged in activities described in Section 4.

1.4 DOCUMENTATION OF EMPLOYEE INDOCTRINATION

At least once a year, all personnel that will be performing work described in Section 4.0 shall attend a pre-entry briefing to inform them of the contents of the HSP. The briefing shall be conducted by VTDEC WMD personnel. Attendance at this briefing shall be documented on the pre-entry briefing form contained in Appendix A of this HSP. By signing the pre-entry briefing form, personnel acknowledge that they have attended the briefing, understand the potential safety and health hazards as described in this HSP and agree to perform work according to the requirements outlined in the HSP.

1.5 MODIFICATION OF THE HSP

This HSP applies only to the activities/tasks and site-specific hazards described in Section 4.0 (Scope of Work), Section 5.0 (Hazard Identification) and 6.0 (Task Hazard Analysis). If additional O&M activities or tasks are identified during the course of the project, a revision to the HSP shall be prepared before those tasks are initiated. All revisions to this HSP shall be prepared by the VTDEC-WMD and approved by the O&M Project Manager.

2. ORGANIZATION AND RESPONSIBILITIES

2.1 GENERAL

The goal of a health and safety program is to prevent accidents, injuries and illnesses associated with activities performed at the site. This HSP is considered a supplement to a contractor's general obligations and requirements related to health and safety. The responsibility for site health and safety is distributed through all the parties that will be participating in on-site activities.

2.2 STATE OF VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION (VTDEC), WASTE MANAGEMENT DIVISION (WMD)

The VTDEC-WMD is the lead agency for the operation and maintenance (O&M) activities at the site. It is responsible for the development, implementation, maintenance and distribution of this HSP.

EPA, through their contractors, is still performing work at the site. If construction is taking place simultaneously with O&M activities, then coordination is required with EPA's designated field representative, which in most cases will be the U.S. Corps of Engineering onsite representative. The VT DEC O&M project manager will take the lead coordinating with EPA, or their designated representatives, prior to any O&M activities.

2.3 CONTRACTORS

Contractors that perform work for the VTDEC at this site are responsible for the health and safety of their own employees. Specific responsibilities of contractors performing work under this HSP include:

- Maintaining a safe and healthy work environment.
- Cooperating and providing assistance when requested in the preparation and implementation of the HPS or revisions.
- Reviewing this HSP to ensure that the health and safety requirements for the operations and scope of work they are contracted to perform are met.
- Providing HSP briefings for their employees.
- Meeting all contract/subcontract and applicable regulatory and industry requirements related to health and safety.
- Check-in with EPA's designated field representative prior to performing O&M activities for a general site health and safety briefing if EPA construction activities are occurring simultaneously with O&M activities.

2.4 FIELD PERSONNEL

All field personnel, regardless of their employer, are responsible for following all applicable

HSPs and for performing their work in a safe and responsible manner. Specific responsibilities include:

- Attending pre-entry briefings regarding the HSP contents and potential site hazards. This task includes reading the HSP in its entirety and signing acknowledgment that they have read and understand the contents of the HSP.
- Voicing questions or concerns regarding the HSP contents to their supervisor, VT DEC O&M project manager, or both.
- Reporting unsafe working conditions to their supervisor, VT DEC O&M project manager, or both.
- Immediately reporting accidents and incidents to their supervisor, VT DEC O&M project manager, or both.
- Complying with the HSP Using required controls and safety devices, including personal protective equipment.

TABLE 2-1
KEY PERSONNEL

POSITION	NAME	AFFILIATION	TELEPHONE
VTDEC O&M Manager	John Schmeltzer	VTDEC	802-241-3886
EPA Field Representative*	Christopher Caisse	US Corps of Engineers	802-765-4063
Contractor #1	TBD		
Contractor #2	TBD		

*If EPA construction activities are actively taking place at the site.

3. SITE DESCRIPTION AND HISTORY

The Site is an abandoned copper and copperas (iron sulfate) mine located in the towns of Strafford and Thetford, Vermont. The Site is located in the vicinity of Copperas Hill, and constitutes the largest mining complex of the Vermont Copper Belt (Figure 1). Access to the site is via Mine Road.

Mining began in the early 1800s. The initial mining operations focused on processing the high iron sulfide ore to produce copperas (iron sulfate). Copperas was used as a dye and disinfectant. In the mid-1800s, the scope of mining was expanded to extract copper. Underground mining took did not take place until the late 1800s. Mine operations ended in 1958. The primary physical features created during mining operations at Elizabeth Mine include the following:

- three open cuts,
- two pit lakes,

- two tailing piles (TP-1 and TP-2),
- several waste rock/heap leach piles,
- a copperas factory complex,
- World War II-era support buildings, and
- an underground mine that extends 8000 feet from one of the open cuts.

The two tailing piles, TP-1 and TP-2, are approximately 34-acres of water-deposited deposits. The tailings on the property are rich in metals and sulfides. As water passes over and through the tailings, sulfuric acid is produced and the metals within the tailings are dissolved and mobilized. This results in acid mine drainage. Acid mine drainage contributes an elevated load of metals to Copperas Brook and the West Branch Ompompanoosuc River.

The site has been on the National Priorities List, commonly known at the Superfund list since 2001. As part of their activities, EPA completed a remedial investigation in 2006, which included a human health and ecological risk assessment associated with the contamination from the Elizabeth Mine Site. This assessment determined that the acid mine drainage had a detrimental effect on fish and aquatic organisms in Copperas Brook and an approximately 4 mile reach of the West Branch of the Ompompanoosuc River.

The human health risk assessment identified the potential human health threat from contact with the lead contaminated soil at the location of the former Copperas Factories and from drinking groundwater beneath the tailing piles. The evaluation determined that contact with surface water and sediment while swimming or wading does not pose an unacceptable risk of non-carcinogenic or carcinogenic effects for residential exposure. The executive summary of this human health risk assessment is included in Appendix A.

Since 2003, EPA has undertaken response action at the site. In 2003, EPA initiated work at the site to stabilize the largest of the tailing dams, TP-1. This included the construction of buttress and the installation of a toe drainage system. EPA work at the site has been ongoing. Action has included construction of diversion channels and groundwater interceptor trenches, waste rock removal, and the installation of a rock cap over the copperas factory area. In 2009 and 2010, EPA removed the largest of the waste rock/heap leach piles (TP-3) and placed this material, approximately 250,000 cubic yards, on top of TP-1. The next step is to install a cover system over TP-1 and TP-2. This work is planned to begin in the Spring of 2011.

Once EPA completes their response action, the VT DEC will be responsible for all operation and maintenance (O&M) of all features constructed by EPA. At this time (2011), VT DEC is responsible for lawn maintenance of the TP-1 buttress, periodically cleanup out the drains located at the toe of the TP-1 buttress, and maintenance of the rock cap for the copperas factory area.

4. SCOPE OF OPERATION AND MAINTENANCE (O&M) WORK

4.1 SITE INSPECTIONS

Periodic inspection of buttress area, toe drain area, and rock cap for copperas factory area (Figure 2). Inspection will likely occur once or twice a year at will likely be conducted by VT DEC personnel.

4.2 LAWN MAINTENANCE

Regular maintenance of the grass slope area, including mowing, fertilizing, re-seeding, and erosion/settling damage repair (if necessary). It is anticipated that there will typically be one possibly two mowing events per year. Each mowing event will likely take one to two days.

4.3 MAINTAINING ROCK CAP OF COPPERAS FACTORY AREA

Regular maintenance of rock cover. Maintenance will primarily consist of removing vegetation from the rock cap and repairing minor damage. Minor damage repair means those repairs that will not result, or have the potential to result, in the exposure of the lead-contaminated soil beneath the rock cap. This maintenance task will likely occur once a year and will likely take one day to complete.

4.4 CLEANING OUT TP-1 TOE AND HORIZONTAL DRAINS

Removing primarily iron precipitate, to the extent practical, from the toe drains and horizontal drains located in the toe area of TP-1. In 2011, there are eight toe drains and eight horizontal drains that require cleaning. This task will likely take place at least once a year, but could be more depending on the need. Each event will like take one to two full day to complete. The flow from the drains discharge into riprap, so the work area to clean drains can be uneven and slippery.

4.5 PLANNED DURATION OF SITE ACTIVITY

The above activities will continue throughout the life of each facility.

4.6 ADDITIONAL WORK

This HSP will be revised, as necessary, to reflect the change in scope of activities or in potential hazards associated with any additional required activities.

5. HAZARD IDENTIFICATION

This section identifies those hazards that are likely to be encountered on site during operation and maintenance activities. A Task Hazard Analysis for each specific task is provided in Section 6.0 of this document.

5.1 POTENTIAL FOR CHEMICAL EXPOSURE

Since the maintenance work for the buttress and copperas factory area is confined to the surface, it is not anticipated that contractors will come in contact with acid mine drainage, mine tailings, lead-contaminated soil, and mine waste rock. As part of the remedial investigation and subsequent sampling during the design process, the degree and extent of the lead-contaminated soils was determined. A rock cap was placed over the lead-contaminated soils. A portion of the lead-contaminated soil was moved to the top of the tailing pile awaiting the installation of the cap over the tailing pile. This re-located soil is in an area of this site away from O&M areas. Since the O&M work will be confined to the buttress and copperas factory area, it is not anticipated that contractors will come into contact with any other site contaminants.

During the cleaning out the drains at the toe of the buttress, the potential exists for contacting acid mine drainage and its associated sludge. The Vermont Department of Health (VDH) derived risk-based screening values for a specific worker scenario (Appendix B). These screening values were compared to the maximum concentrations detected in site-related sediment sludge samples. In their memorandum, VDH indicated that the only inorganic that may warrant consideration is chromium because it was not known how much of the chromium in the sample consisted of hexavalent chromium. Without specific hexavalent chromium data, VDH assumed that all the chromium was hexavalent chromium. This is a conservative assumption. In May 2011, additional sludge samples were collected and no hexavalent chromium was detected (Appendix C).

In addition, the scenario-specific risk-based concentration for vanadium was derived using the more stringent of the two non-cancer based oral toxicity values. Using the higher toxicity value, the scenario-specific risk-based concentration for vanadium is estimated to be slightly greater than the maximum concentration reported. Given the highly conservative nature of this assessment (both in terms of exposure assumptions and comparison to maximum detects), it is likely that exposure to vanadium may not be of significant concern for the receptor of interest.

The control measures described under each Task Hazard Analysis in Section 6.0 shall ensure that any potential exposure to these inorganics is minimized.

Subsurface petroleum contamination from past underground storage tank releases is present at several locations in the World War II-era support buildings. The O&M activities will not take place in these areas.

If any other hazardous conditions which could pose an immediate danger to field personnel are encountered, field work will cease and the HSP will be re-evaluated, amended as appropriate and reviewed as required in Section 1.

5.2 CHEMICALS TO BE BROUGHT ONSITE

No chemical are anticipated to be brought onsite to perform the O&M tasks other than oils and fuels necessary to support equipment performing O&M tasks. Equipment likely necessary for these tasks include a tractor, or similar device for mowing, pump truck to clean out drains, and potentially a water truck. Contractor is responsible to have available all Material Safety Data Sheets (MSDSs) that are brought onto the site.

The precautions described under each Task Hazard Analysis in Section 6.0 shall ensure that potential exposure to chemicals brought on-site is minimized.

At this time, it is anticipated that herbicides will likely be used in the O&M tasks. If a contractor uses herbicides, their HSP must address the use of these chemicals.

5.3 PHYSICAL HAZARDS

In addition to the chemical hazards identified above, numerous physical hazards are associated with the activities to be performed under this HSP. The hazards listed below are common to all activities at the site. Additional task specific hazards are noted as a part of each Task Hazard Analysis.

- Slip, trip and fall hazards;
- Crushing injuries from unstable equipment and site structures; and
- Injuries associated with operation of automobiles or other vehicles at the site.

5.4 HEAT AND COLD STRESS

The majority of site activities will be performed during moderate weather and will not require a high level of physical exertion. However, site personnel should be aware of the potential for heat and cold stress based upon the prevailing weather conditions at the site, and take appropriate precautions.

5.5 BIOLOGICAL HAZARDS

Potential biological hazards which may be encountered during all phases of the site work include contact with poisonous plants, insects, and animals. No other biological hazards are anticipated.

5.6 CONFINED SPACES

Routine O&M activities will not require entry into confined spaces. If a confined space entry becomes necessary, a task-specific health and safety plan with a confined space entry component will be prepared.

6. TASK HAZARD ANALYSES

This section presents a Hazard Analysis for each field task. Common hazards associated with nearly all site activities have been identified in Section 5.0 of this HSP. Task-specific hazards are identified in each of the following task hazard analyses along with control measures that will be implemented to minimize the potential hazards.

6.1 INSPECTIONS AND MAINTENANCE ACTIVITIES

Most inspection activities will involve no additional hazards beyond those identified in Section 5.0. Inspection and maintenance activities are to be non-intrusive.

- Regular inspections and maintenance of the buttress cover, including mowing, fertilizing, re-seeding, and erosion/settling damage repair.
    - Mowing poses an increased hazard for physical injury due to a vehicular mishap, especially when mowing the side slope, which are 2.5 horizontal to 1 vertical.

- Regular inspection and maintenance of the rock cap for the copperas factory area.
    - Removing vegetation from rock cap will require walking on uneven surfaces. Caution is needed to prevent trips, slips, and falls during this task.

Maintenance activities may involve additional physical hazards, depending on the nature of the work. If intrusive action is needed for maintenance, then the HSP will need to be revised to reflect this activity.

Control measures to minimize the potential hazards are to wear the personal protective equipment (Level D) as described in Section 7 and to include the work practices listed in Section 9.3.

6.2 CLEANING OUT TOE AND HORIZONTAL DRAINS

This task will likely require the injection of a pressurized hose into the drains. This task will typically take one to two people.

- The flow from the drains discharge into riprap so work area to clean drains can be uneven.
- Workers will likely be in contact with acid mine drainage during this activity

Maintenance activities may involve additional physical hazards, depending on the nature of the work. If intrusive action is needed for maintenance, then the HSP will need to be revised

to reflect this activity.

Even though the VDH memorandum shows that the maximum concentrations of metals are below the scenario-specific risk-based concentrations, with the exception of vanadium, workers should minimize exposure to the acid mine drainage and associated sludge. Control measures are to wear the personal protective equipment (Level D) as described in Section 7 and to follow work practices listed in Section 9.3. As an added precautionary measure to minimize direct contact with the acid mine drainage and associated sludge, tyvek suits, safety glasses, and gloves should be worn.

7. PERSONAL PROTECTIVE EQUIPMENT

At a minimum, all activities described in Section 4.0 will take place in Level D protection. This level of protection will include use of:

- Steel-toed work boots
- Dedicated Work gloves (as required)
- Disposable gloves (as required)
- Long pants and long-sleeve work shirt
- Tyvek when working on the toe drains
- Hard hat (if overhead hazard is present)
- Safety glasses (with side shields)
- Hearing protection (if appropriate)
- Additional appropriate outdoor dress as required by weather conditions.

8. AIR MONITORING

The proposed O&M activities are not anticipated to create a potential for worker exposure to airborne contaminants. The inspection and maintenance activities are non-intrusive and the cleaning the drains are completed in wet conditions; the potential for dust generation is low. Therefore, no real-time monitoring program is considered necessary.

9. SITE CONTROLS

9.1 SITE ACCESS

9.1.1 Buttress and Toe Drain Area

- Access to this area is gated and locked if EPA construction activities are not taking place. Access must be coordinated through VT DEC O&M project manager, or representative at all times.
- If EPA construction activities are taking place, contractor must check-in with EPA field representative at onsite trailer for general health and safety briefing in addition to coordinating with VT DEC O&M project manager, or representative.

9.1.2 Copperas Factory Area

- Access to this area is not restricted; however, site activities must still be coordinated with VT DEC project manager, or representative, and EPA field representative is EPA construction activities are ongoing.

9.2 WORK ZONES

The maintenance of the buttress area and copperas factory area rock cap are not invasive in nature; therefore, establishment of exclusion and contaminant reduction zones is not required.

An exclusion and contaminant reduction zone is also not required for the cleaning of the drains given the nature of the acid mine drainage as described in Section 5.1.

9.3 WORK PRACTICES

The following work practices shall be established and enforced on site for all activities:

- Maintain safety awareness at all times;
- Do not violate any posted zones or restricted areas;
- All electrical equipment and tools shall be properly grounded or used with Ground Fault Circuit Interrupters;
- All pressurized hoses and connectors should be routinely checked
- Do not remove any material from the site;
- No eating, drinking, smoking, chewing gum or tobacco, or applying cosmetics shall be allowed in areas where operation and maintenance activities are being performed;
- Inform the VTDEC of any suspicious odors or unsafe working conditions.

10. TRAINING

The contractor is responsible for health and safety for its contractor and subcontractors, so it is their responsibility to determine the appropriate training requirements for the proposed services, including whether 29 CFR 1910.120 is applicable.

10.1 SITE SPECIFIC HEALTH AND SAFETY ORIENTATION

All landscaping contractors will receive an annual safety and health orientation, conducted by the VTDEC. The training will include the following:

- A review of task activities to be performed
- Site-specific hazards
- Chemical and physical hazards identified at the site
- Personal protective equipment requirements
- Site controls and safety rules

- Standard operating procedures (if applicable)
- Emergency response procedures

Due to the nature of the O&M activities and the chemical composition of the toe tailing discharge (acid mine drainage), no additional training will be required.

11. DECONTAMINATION

Given the non-hazardous nature of the material, no decontamination procedures are required.

12. EMERGENCY RESPONSE

Emergency guidelines and information specific to this project are summarized below.

12.1 SITE EMERGENCIES

In the event of an emergency, site personnel will take appropriate action that could include: evacuating the work zone to a safe place of refuge and notifying the appropriate emergency authorities of the need for emergency assistance/services.

The following entities are sources of emergency assistance/services and should be contacted in the event of emergencies:

Police:	
Vermont State Police	Telephone: 911
Strafford Constable Jude Bishop	802 765-4670
Orange County Sheriff	802 685-4875
Thetford Police Department	802 765-2200
Fire or Emergency:	Telephone: 911
State of Vermont Hazardous Spill Response Hotline	Telephone 1-800-641-5005
Medical Facility: Dartmouth Hitchcock Medical Center	
1 Medical Center Drive	
Lebanon, NH	
603 650-5000	

*Directions and maps to medical facilities are included in Appendix D of this plan.

In the event outside assistance is required, the VTDEC O&M Manager shall be notified as soon as possible.

12.2 MEDICAL EMERGENCY

In any life-threatening situation, the health and safety of the individual takes precedence over all procedures designed for protection against environmental contamination at the site.

12.2.1 Worker Procedure

The nearest workers should immediately assist any person who shows signs of medical distress or who has suffered an accident. If a breathing or heart problem is apparent, loosen the clothing around the victim's neck and chest.

Site personnel shall immediately make contact with the appropriate emergency response authorities to alert them of the situation. He/She should relay the following information:

- X Location of the victim;
- X Nature of the emergency;
- X Whether the victim is conscious or not; and
- X The specific conditions contributing to the emergency, if known.

12.2.2 Accident Site to Remain Undisturbed

The area surrounding any accident site is not to be disturbed until any changes to the site have been cleared by the Site Manager.

12.3 FIRE EMERGENCY

Because of the presence of flammable materials (gasoline) at this site, fire is a potential hazard. Site personnel are not trained, professional fire fighters. If there is any doubt whether a fire can be quickly contained and extinguished, personnel are to notify the local fire department, and immediately evacuate the area. Only persons properly trained in fire suppression will attempt to contain and extinguish fires.

In the event of a small fire that the worker extinguishes, the incident must be reported to the VTDEC.

12.4 EMERGENCY EVACUATION

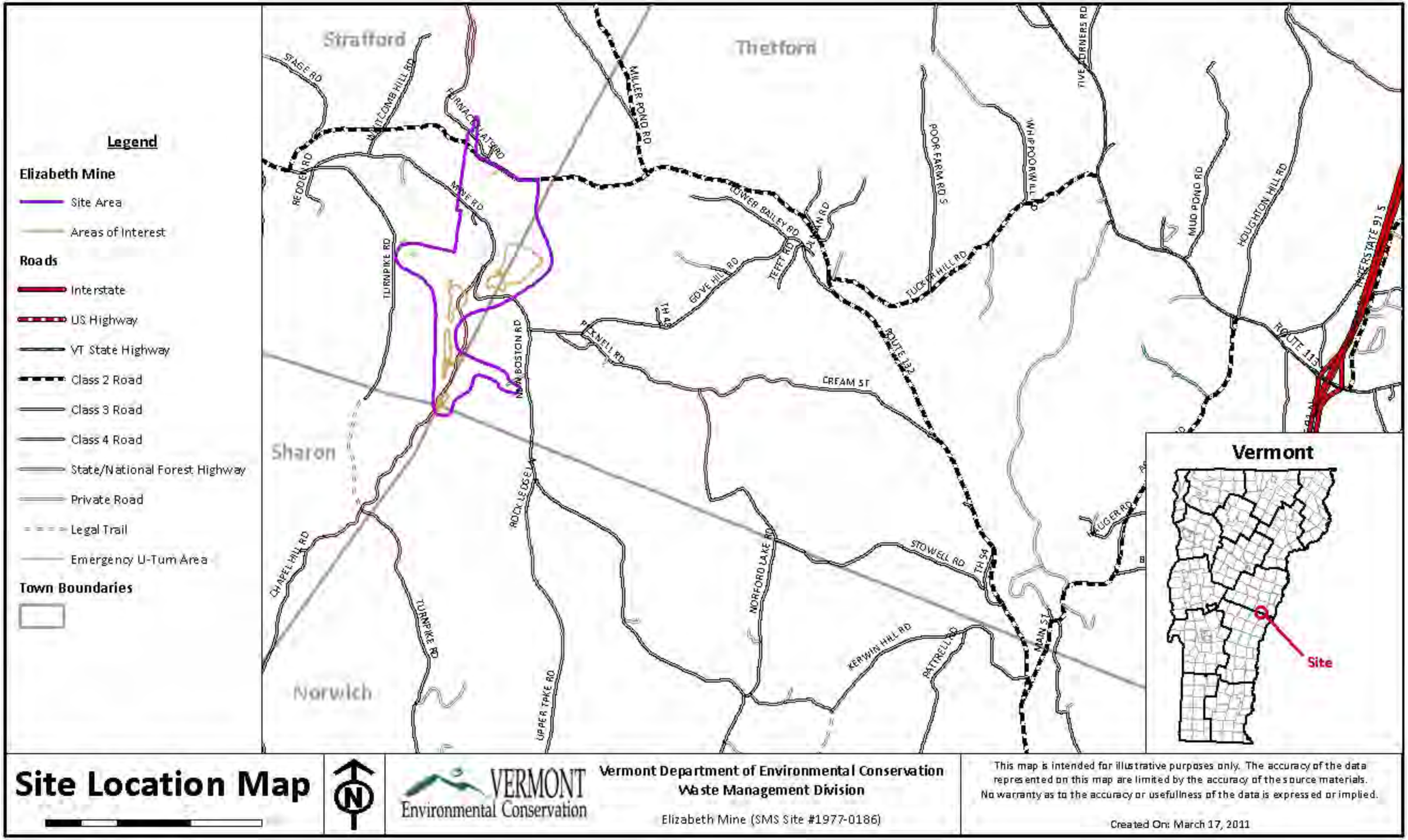
Emergency evacuations at this site will be conducted in the event of an uncontrolled fire, explosion, or other catastrophe which places site personnel in a life threatening situation or risk of personal injury. In the event of these incidents, the main objective is to remove site personnel in the most expedient manner possible.

12.5 SPILL AND DISCHARGE CONTROL PLAN

For the purposes of this HSP, it is assumed that the quantities of hazardous materials or fuels to be brought onto the site will not exceed those which require a formal SPCC or Spill Prevention Plan under the Clean Water Act (CWA) or the Resource Conservation and Recovery Act (RCRA). Any spill in excessive of the federal or state reportable quantity must be reported to the Haz Mat Hotline at 800-641-5005.

All refueling of equipment will be performed with due care to ensure that small spills do not occur during refueling operations. No fuel is to be stored anywhere at the site.

Contractors will supply necessary equipment to contain and clean-up small spills or leaks. Where required, contaminated soil would be cleaned up and disposed of in accordance with state regulatory requirements. It is not anticipated that quantities of hazardous materials would be brought to the site that would require outside responders.



Site Location Map

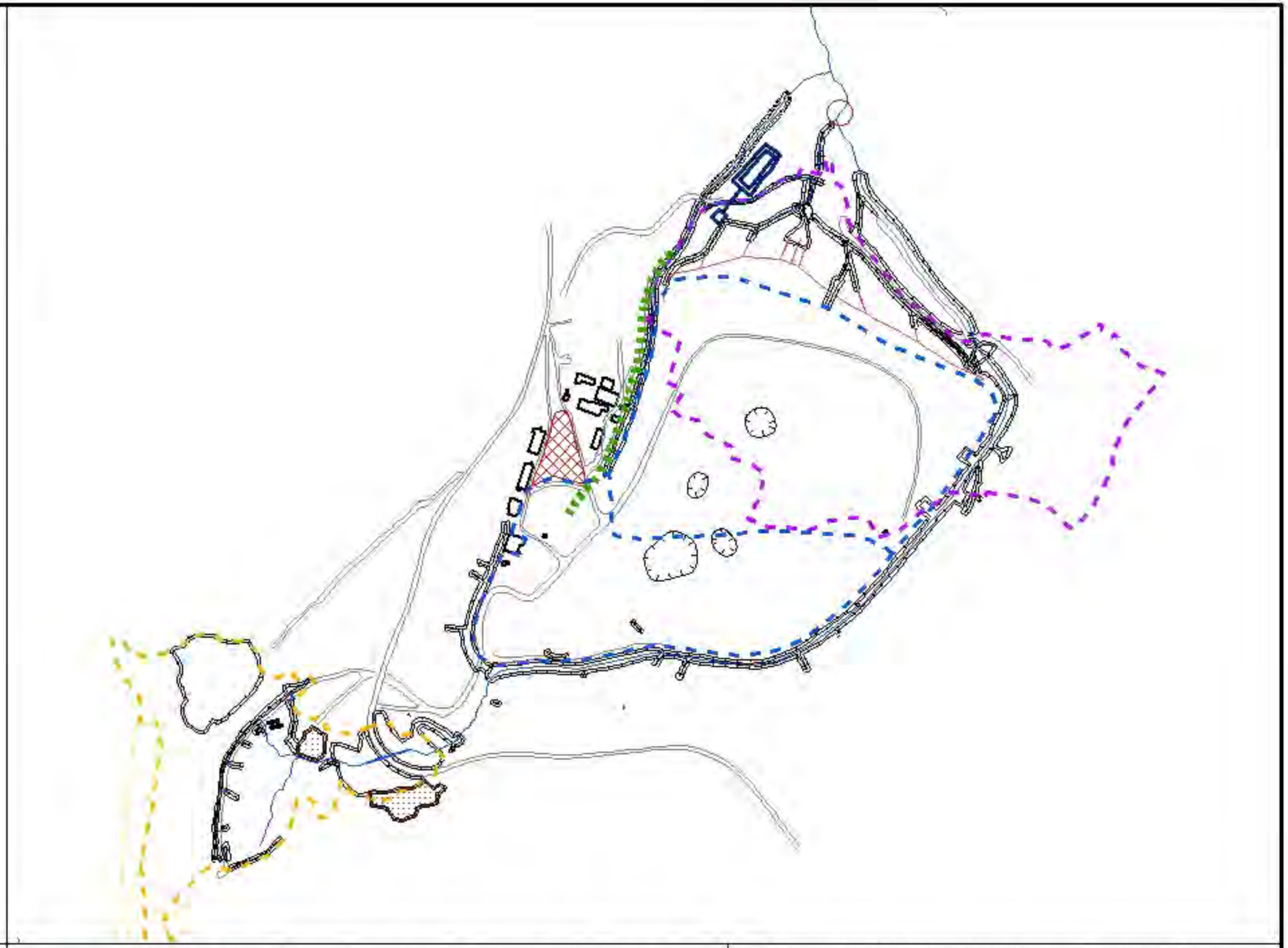
Vermont Department of Environmental Conservation
Waste Management Division

Elizabeth Mine (SMS Site #1977-0186)

Created On: March 17, 2011

Legend

- Horizontal and Toe Drains
- TP 1 and 2 Cover
- TCRA Outline
- WW II Groundwater Cutoff Alignment
- Surface Water
- Culverts
- Rip Rap
- Roads
- Open Mine Cuts
- WWII Era Infrastructure
- Sedimentation Basin
- Treatment Plant
- Impacted Soils
- Primary Point of Compliance
- ACM Waste
- Copperas Factory Covers
- Limit of TP-3 Waste Removal



Site Location Map

VERMONT Environmental Conservation

Vermont Department of Environmental Conservation
Waste Management Division

Elizabeth Mine (SMS Site #1977-0186)

Created On: March 22, 2011

A Human Health Risk Assessment was performed to evaluate potential risks to human health under current and reasonably foreseeable future conditions for the Elizabeth Mine property (the Site) located in the towns of South Strafford and Thetford, Vermont. The Site is an abandoned copper and iron sulfate (copperas) mine located on Mine Road in the Village of South Strafford within the Town of Strafford, Orange County, Vermont approximately 10 miles west of the Connecticut River Valley. For the purposes of this assessment, the Site includes the Elizabeth Mine property, adjacent properties, and local associated surface waters including the pit lakes, Copperas Brook, Lord Brook, mine drainage tributaries to Lord Brook, the West Branch of the Ompompanoosuc River, and the Ompompanoosuc River.

The risk assessment was performed in accordance with U.S. Environmental Protection Agency (EPA) guidance documents. The EPA develops an estimate of noncarcinogenic effects by the hazard index method. The potential exposure level at the site is divided by a reference level. The reference level (or Reference Dose) represents an exposure level below which health effects are highly unlikely and above which some level of impact could occur. As the hazard index increases above 1, the potential for adverse impact increases. The EPA considers a hazard index above 1 to represent a potentially unacceptable level of risk.

The EPA also develops an estimate of the potential for carcinogenic effects. Potential carcinogenic effects are expressed as a probability or risk of cancer resulting from the exposure. The EPA generally considers a probability of cancer greater than 1 in 10,000 to be the risk level that requires remediation.

The detailed evaluation of human health risks was divided into four major sections: hazard identification, dose-response assessment, exposure assessment, and risk characterization. Risks were evaluated with respect to exposure to chemicals detected in soil, ground water, surface water, sediment, and fish.

The hazard identification section describes the procedures used to identify chemicals of concern. The Site is impacted primarily with metals. The dose-response assessment describes the data relating potential doses received from exposure to chemicals to potential noncarcinogenic or

carcinogenic health effects (response). The exposure assessment presents the estimated level of exposure (i.e., the exposure dose) for each exposure scenario. Table ES-1 summarizes the exposure pathways for this assessment. The following exposure scenarios were considered:

- Adults and children who could live on properties located adjacent to the former Elizabeth Mine property under both current and future conditions;
- Adults and children who could live on the former Elizabeth Mine property (e.g., tailing piles, etc.) under future conditions;
- Adults and children who could swim in surface water bodies on the Site under both current and future conditions;
- Adults and children who could wade in surface water bodies on the Site under both current and future conditions;
- Adults and children who could occasionally eat fish caught locally from the Site under both current and future conditions; and
- Adults and children who could subsist on fish caught locally from the Site under both current and future conditions.

In addition, risks due to exposure to lead for children (the most sensitive receptor) were evaluated using EPA's Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) model to estimate blood lead concentrations. The model calculates the probability that children's blood lead concentrations will exceed 10 micrograms of lead per deciliter (µg Pb/dl). If the probability that children's blood lead concentrations exceeds 10 µg/dl is not greater than 5 percent, the risk is considered acceptable.

The following table summarizes the results of this assessment:

Exposure Pathway	Non Cancer Risk Below EPA Risk Management Criteria? (HI ≤ 1)	Chemicals above EPA Non-Cancer Risk Management Criteria	Cancer Risk Below EPA Risk Management Criteria (Risk ≤ 1 x 10^{-4})	Chemicals above EPA Cancer Risk Management Criteria
Residential Exposure to Soil				
Residential properties	YES		YES	
TP-1 and TP-2	YES		YES	
TP-3	YES		YES	
TP-4	YES		YES	
Artesian Vent (Air Vent) (Underground Workings)	YES		YES	
Sargent Brook	YES		YES	
Copperas Ore Roast Bed, Sargent Brook	YES		YES	
Copperas Factories - Lead Hot Spot	NO	Lead	YES	
South Mine and Waste Rock Piles	YES		YES	
South Open Cut	YES		YES	
Furnace Flats North	YES		YES	
Furnace Flats South	YES		YES	
Lord Brook	YES		YES	
Lower Copperas Brook	YES		YES	
West Branch Ompompanoosuc	YES		YES	
Residential Exposure to Ground Water				
Residential wells*	NO	Manganese, Cadmium	YES	
TP-1 and TP-2	NO	Manganese, Cadmium, Arsenic, Barium, Nickel, Thallium, Vanadium, Zinc, Lead	NO	Arsenic
TP-3	NO	Manganese, Cadmium, Arsenic, Nickel, Thallium, Vanadium, Zinc, Lead	NO	Arsenic
TP-4	NO	Manganese, Thallium	YES	
Lower Copperas Brook	NO	Manganese	YES	
Copperas Factories - Lead Hot Spot	NO	Manganese, Cadmium, Zinc	YES	
South Open Cut	YES		YES	
South Vent	YES		YES	
Artesian Vent (Underground Workings)	NO	Cadmium, Manganese, Mercury, Zinc	YES	
Contact with Surface Water while Swimming	YES		YES	
Contact with Sediment and Surface Water While Wading	YES		YES	
Fishing and Ingestion of Fish (recreational)	YES		YES	
Fishing and Ingestion of Fish (subsistence)	NO	Mercury, Lead	YES	

*Ingestion of water from former residential wells RES-03 and RES-03A pose an unacceptable risk; risks are within acceptable limits for the other residential wells.

Under current and future conditions, the results from all residential wells except RES-03 and RES-03A indicate the cancer risks and non-cancer risks for residential exposure to groundwater are below EPA risk management criteria. The results also indicate that the hazard indices (i.e., non-cancer risks) and incremental lifetime carcinogenic risks for contact with soil on the residential properties are within acceptable limits.

Under future conditions, the following potential exposures could pose a non-cancer risk above EPA risk management criteria (i.e., hazard index greater than 1) to residents who could live on the former Elizabeth Mine property:

- Ingestion of groundwater within TP-1 and TP-2;
- Ingestion of groundwater within TP-3;
- Ingestion of groundwater within TP-4:
- Ingestion of groundwater within the Lower Copperas Brook Area;
- Ingestion of groundwater within the Artesian Vent (Air Vent) Area (Underground Workings);
- Ingestion of groundwater in the Copperas Brook area near the Lead Hot Spot; and
- Contact with soil in the Lead Hot Spot Area.

In addition, the following potential exposures result in a potential carcinogenic risk above EPA risk management criteria to future residents who could live on the former Elizabeth Mine property:

- Ingestion of groundwater within TP-1 and TP-2; and
- Ingestion of groundwater within TP-3.

Under current or future conditions, contact with surface water or sediment from swimming or wading in surface water bodies located on the Site does not pose an unacceptable risk of noncarcinogenic or carcinogenic effects.

The results also show that contact with surface water or sediment while fishing does not pose an unacceptable risk of noncarcinogenic or carcinogenic risks under current or future conditions. In addition, ingestion of fish from recreational fishing does not pose a significant risk under current or future conditions. Ingestion of fish on a subsistence basis, however, poses a risk above EPA risk management criteria due to mercury and lead under current and future conditions.

In summary, this risk assessment was performed to evaluate current and reasonably foreseeable future risk to human health. This assessment indicates that ingestion of well water from residential wells RES-03 and RES-03A could pose a significant risk to residents using this water as a source of tap water. This assessment also indicates that contact with soil in Copperas Factories – Lead Hot Spot Area poses a significant risk to residents. This assessment also indicates that contact with groundwater within TP-1, TP-2 and the tailing fan below TP-1, TP-3, TP-4, Lower Copperas Brook, the Copperas Factories – Lead Hot Spot Area, and the Artesian Vent (or Underground Workings Area) could pose a risk above EPA risk management criteria to residents if it is used as a source of tap water under future conditions. In addition, ingestion of fish poses a significant risk if fish are ingested on a subsistence basis under current and future conditions. Risks due to swimming, wading, and recreational fishing are all within acceptable limits.

TABLE ES-1
SELECTION OF EXPOSURE PATHWAYS
ELIZABETH MINE

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Groundwater	Groundwater	Tap Water (Private Wells)	Residents	Adult	Ingestion	Quantitative	Assumes nearby residential wells may be impacted by metals from the Site.
						Dermal Contact	Quantitative	Assumes nearby residential wells may be impacted by metals from the Site.
						Inhalation	Qualitative	Metals are non-volatile, this pathway is negligible.
					Child	Ingestion	Quantitative	Assumes nearby residential wells may be impacted by metals from the Site.
						Dermal Contact	Quantitative	Assumes nearby residential wells may be impacted by metals from the Site.
						Inhalation	Qualitative	Metals are non-volatile, this pathway is negligible.
	Soil	Surface Soil	Lots #1, #2, and #3	Residents	Adult	Ingestion	Quantitative	Assumed that residents living adjacent to the Site may be exposed to site impacted soils.
						Dermal Contact	Quantitative	Assumed that residents living adjacent to the Site may be exposed to site impacted soils.
						Inhalation	Quantitative	Assumed that residents living adjacent to the Site may be exposed wind-blown dust from the Site.
					Child	Ingestion	Quantitative	Assumed that residents living adjacent to the Site may be exposed to site impacted soils.
						Dermal Contact	Quantitative	Assumed that residents living adjacent to the Site may be exposed to site impacted soils.
						Inhalation	Quantitative	Assumed that residents living adjacent to the Site may be exposed wind-blown dust from the Site.
	Sediment	Sediment	Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc River and Connecticut Confluence	Swimmers	Adult	Ingestion	Qualitative	Ingestion of sediment is not likely during swimming.
						Dermal Contact	Qualitative	Contact with sediment is not likely during swimming.
					Child	Ingestion	Qualitative	Ingestion of sediment is not likely during swimming.
						Dermal Contact	Qualitative	Contact with sediment is not likely during swimming.
			Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc River and Connecticut Confluence	Waders	Adult	Ingestion	Quantitative	Ingestion of sediment is likely during wading.
						Dermal Contact	Quantitative	Contact with sediment likely to occur during wading.
					Child	Ingestion	Quantitative	Ingestion of sediment is likely during wading.
						Dermal Contact	Quantitative	Contact with sediment likely to occur during wading.
			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Recreational Fishermen	Adult	Ingestion	Quantitative	Ingestion of sediment may occur while fishing.
						Dermal Contact	Quantitative	Contact with sediment may occur during fishing.
					Child	Ingestion	Quantitative	Ingestion of sediment may occur while fishing.
						Dermal Contact	Quantitative	Contact with sediment may occur during fishing.
			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Subsistence Fishermen	Adult	Ingestion	Quantitative	Ingestion of sediment may occur while fishing.
						Dermal Contact	Quantitative	Contact with sediment may occur during fishing.
					Child	Ingestion	Quantitative	Ingestion of sediment may occur while fishing.
						Dermal Contact	Quantitative	Contact with sediment may occur during fishing.
	Surface Water	Surface Water	Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Swimmers	Adult	Ingestion	Quantitative	Ingestion of surface water likely during swimming.
						Dermal Contact	Quantitative	Contact with surface water occurs during swimming.
					Child	Ingestion	Quantitative	Ingestion of surface water likely during swimming.
						Dermal Contact	Quantitative	Contact with surface water occurs during swimming.
			Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Waders	Adult	Dermal Contact	Quantitative	Contact with surface water occurs during wading.
					Child	Dermal Contact	Quantitative	Contact with surface water occurs during wading.

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ELIZABETH MINE

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Current	Surface Water	Surface Water	Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Recreational Fishermen	Adult	Dermal Contact	Quantitative	Contact with surface water may occur while fishing.
					Child	Dermal Contact	Quantitative	Contact with surface water may occur while fishing.
			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Subsistence Fishermen	Adult	Dermal Contact	Quantitative	Contact with surface water may occur while fishing.
					Child	Dermal Contact	Quantitative	Contact with surface water may occur while fishing.
	Biota	Fin Fish Tissue	Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Recreational Fishermen	Adult	Ingestion	Quantitative	Assumes adults fish on the Site for recreational purposes.
					Child	Ingestion	Quantitative	Assumes children fish on the Site for recreational purposes.
			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Subsistence Fishermen	Adult	Ingestion	Quantitative	Assumes adults could subsist on locally caught fish.
					Child	Ingestion	Quantitative	Assumes children could subsist on locally caught fish.
Future	Groundwater	Groundwater	Tap Water (On-site Monitoring Wells)	Residents	Adult	Ingestion Dermal Contact Inhalation	Quantitative Quantitative Qualitative	Assumes on-site residential wells may be impacted by metals at the Site. Assumes on-site residential wells may be impacted by metals at the Site. Metals are non-volatile, this pathway is negligible.
					Child	Ingestion Dermal Contact Inhalation	Quantitative Quantitative Qualitative	Assumes on-site residential wells may be impacted by metals at the Site. Assumes on-site residential wells may be impacted by metals at the Site. Metals are non-volatile, this pathway is negligible.
	Soil	Surface Soil	Air Vent; Sargent Brook; Copperas Ore Roast Bed; Sargent Brook; Copperas Works – Lead Hot Spot; South Mine and Waste Rock Piles; South Open Cut; Furnace Flats North; Furnace Flats South; TP-1; TP-2 and tailing fan below TP-1; TP-3; TP-4; Lord Brook; Lower Copperas Brook; Lots #1, #2, and #3	Residents	Adult	Ingestion Dermal Contact Inhalation	Quantitative Quantitative Quantitative	Assumed that residents living on and adjacent to Site property may be exposed to site impacted soils. Assumed that residents living on and adjacent to Site property may be exposed to site impacted soils. Assumed that residents living on the Site may be exposed wind-blown dust from he Site.
					Child	Ingestion Dermal Contact Inhalation	Quantitative Quantitative Quantitative	Assumed that residents living on and adjacent to Site property may be exposed to site impacted soils. Assumed that residents living on and adjacent to Site property may be exposed to site impacted soils. Assumed that residents living on the Site may be exposed wind-blown dust from he Site.
	Sediment	Sediment	Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc River and Connecticut Confluence	Swimmers	Adult	Ingestion Dermal Contact	Qualitative Qualitative	Ingestion of sediment is not likely during swimming. Contact with sediment is not likely during swimming.
					Child	Ingestion Dermal Contact	Qualitative Qualitative	Ingestion of sediment is not likely during swimming. Contact with sediment is not likely during swimming.

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Future	Sediment	Sediment	Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc River and Connecticut Confluence	Waders	Adult	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of sediment is likely during wading. Contact with sediment is likely to occur while wading.
					Child	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of sediment is likely during wading. Contact with sediment is likely to occur while wading.
			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Recreational Fishermen	Adult	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of sediment may occur while fishing. Contact with sediment may occur during fishing.
					Child	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of sediment may occur while fishing. Contact with sediment may occur during fishing.
			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Subsistence Fishermen	Adult	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of sediment may occur while fishing. Contact with sediment may occur during fishing.
					Child	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of sediment may occur while fishing. Contact with sediment may occur during fishing.
	Surface Water	Surface Water	Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Swimmers	Adult	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of surface water likely during swimming. Contact with surface water occurs during swimming.
					Child	Ingestion Dermal Contact	Quantitative Quantitative	Ingestion of surface water likely during swimming. Contact with surface water occurs during swimming.
			Air Vent; South Open Cut; TP-1; TP-2 and tailing fan below TP-1; Lord Brook; Lower Copperas; TP-4; Upper Copperas Brook; Sargent Brook; South Mine and Waste Rock Piles; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Waders	Adult	Dermal Contact	Quantitative	Contact with surface water occurs during wading.
					Child	Dermal Contact	Quantitative	Contact with surface water occurs during wading.
			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Recreational Fishermen	Adult	Dermal Contact	Quantitative	Contact with surface water may occur while fishing.
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			Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Subsistence Fishermen	Adult	Dermal Contact	Quantitative	Contact with surface water may occur while fishing.
					Child	Dermal Contact	Quantitative	Contact with surface water may occur while fishing.
	Biota	Fin Fish Tissue	Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Recreational Fishermen	Adult	Ingestion	Quantitative	Assumes adults fish on the Site for recreational purposes.
					Child	Ingestion	Quantitative	Assumes children fish on the Site for recreational purposes.

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Future	Biota	Fin Fish Tissue	Lord Brook; West Branch Ompompanoosuc; Ompompanoosuc River; and Ompompanoosuc and Connecticut Confluence	Subsistence Fishermen	Adult	Ingestion	Quantitative	Assumes adults could subsist on locally caught fish.
					Child	Ingestion	Quantitative	Assumes children could subsist on locally caught fish.

VERMONT
DEPARTMENT OF HEALTH
Agency of Human Services
Division of Health Surveillance
Environmental Health Section
108 Cherry Street – PO Box 70
Burlington, VT 05402-0070
[phone] 802-652-0357
[fax] 802-863-7632

MEMORANDUM

TO: John Schmeltzer
DEPARTMENT: Department of Environmental Conservation, Sites Management Section

FROM: Razelle Hoffman-Contois
DEPARTMENT: Department of Health, Environmental Health, Risk Assessment Section

SUBJECT: Elizabeth Mine Sediment/Sludge Removal Scenario
DATE: May 20, 2011

Per your request, I have derived risk-based screening values for a number of inorganics detected in sediment and/or sludge at the Elizabeth Mine Site located in Stratford, Vermont based on a specific hypothetical Sediment/Sludge Removal Worker exposure scenario you provided. As discussed, potential ingestion and dermal contact were the only exposure pathways considered in this investigation.

As directed, scenario-specific risk-based concentrations were compared to the maximum concentration detected for each inorganic in site-related sediment/sludge (as reported by you via e-mail and phone).

Based on this evaluation, the only inorganic that may warrant further consideration is chromium, if pending laboratory results reveal a high concentration of hexavalent chromium is indeed present in these site-related media. In addition, the scenario-specific risk-based concentration for vanadium derived using the more stringent of the two noncancer based oral toxicity values examined is estimated to be slightly greater than the maximum concentration reported. Given the highly conservative nature of this assessment (both in terms of exposure assumptions and comparison to maximum detects), it is likely that exposure to vanadium may not be of significant concern for the receptor of interest.

Several conservative assumptions were made in order to estimate the potential intake of sediment/sludge by the hypothetical receptor examined. In reality, the magnitude and frequency of exposure will vary depending on individual circumstances. The use of such health protective assumptions, which tend to represent upper bound estimates of exposure, adds additional conservatism to the screening values derived.

At your request, total chromium was assessed assuming that all reported was in the trivalent form and then again assuming all was in the more toxic hexavalent form (using the draft oral cancer slope factor presented in EPA, 2010a). This highly conservative approach may be useful for worst-case discussion purposes and can be refined once results of the laboratory speciation analyses currently underway become available. In addition, vanadium was evaluated using both the chronic oral Reference Dose presented in the Regional Screening Tables (EPA, 2010b) and the more conservative (stringent) Provisional Peer-Reviewed value (EPA, 2009).

The remainder of this memo presents a summary of the exposure assumptions employed and comparison of risk-based concentrations to site-related data.

CC: Dr. William C. Bress, Department of Health

EXPOSURE SCENARIO

ON-SITE SEDIMENT/SLUDGE REMOVAL WORKER

Our recent discussions indicate that periodic removal of accumulated sludge and/or sediment in on-site drains and basins will need to occur.

Given your knowledge of the required activities, it was determined that on-site drains would need to be cleared a maximum of 3 times a year with each cleaning lasting a maximum of 2 work days (total of 6 work days per year). It was also determined that on-site sediment basins would need to be cleared 2 times a year with each episode lasting a maximum of 5 work days (total of 10 days per year). Thus, a hypothetical On-Site Sediment/Sludge Removal Worker was assumed to be present on Site for a total of 16 days per year, every year, during a 25 year career (highly conservative). Direct contact with sediment and/or sludge via inadvertent ingestion and dermal contact was assumed to occur each day the worker is on-site.

A combined sediment/sludge ingestion rate of 330 milligrams/day was assumed based on the construction worker scenario presented in the Supplemental Soil Screening Guidance (EPA, 2002). Under certain circumstances this value may underestimate or overstate actual exposure.

A total of 5651 square centimeters of skin was assumed to be exposed to Site-related sediment/sludge. This represents the average fiftieth percentile surface area of the head, hands, forearms and lower legs for adult males and females (EPA, 1997). A soil to skin adherence factor of .3 milligrams per square centimeter was assumed (EPA, 2002).

An average body weight of 70 kilograms was employed (EPA, 2002).

SUMMARY TABLE

Analyte	Maximum Concentration (a) (mg/kg)	On-Site Sediment/Sludge Removal Worker Risk-Based Screening Value (mg/kg)
Aluminum	69700.0	4602568.65
Antimony (metallic)	0.22	1441.81
Arsenic (inorganic)	5.2	7.83
Barium	201.0	558166.68
Beryllium and compounds	2.8	1160.58
Cadmium	3.0	4014.14
Chromium(III), insoluble salts (b)	89.1	1465850.52
Chromium (VI) (b)	89.1	8.87
Cobalt	47.1	1380.77
Copper	899.0	184102.75
Iron	690200.0	3221798.05
Lead and compounds	22.0	400 (c)
Manganese	5000.0	50840.71
Molybdenum	10.0	23012.84
Nickel	33.3	105918.15
Selenium	12.0	23012.84
Silver	1.5	10591.82
Thallium	5.46	NA
Uranium (d)	5.64	13807.71
Vanadium and compounds (e)	138.0	113.83
Vanadium and compounds (f)	138.0	8130.41
Zinc (metallic)	381.0	1380770.59

Notes:

NA - Not assessed. No toxicity values available

(a) Concentrations reported by John Schmeltzer via e-mail and phone May 2011

(b) Value represents Total Chromium

(c) Highly conservative comparison to federal Housing and Urban Development Section 13 Guideline for Evaluation and Control of Lead Based Paint Hazards in Housing – Child Contact Area value

(d) Based on oral Reference Dose for Uranium Soluble Salts

(e) Based on PPRTV oral Reference Dose for Vanadium of 7E-05 (mg/kg-d)

(f) Based on Regional Screening Table oral Reference Dose for Vanadium of 5E-03 (mg/kg-d) derived from RfDo for Vanadium pentoxide

REFERENCES

EPA, 1997. Exposure Factors Handbook. Office of Research and Development, Washington, DC. EPA/600/P-95/002Fa.

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Office of Emergency and Remedial Response. Washington, D.C. OSWER 9355.4-24. December 2002.

EPA, 2009. Provisional Peer-Reviewed Toxicity Values for Vanadium and its soluble inorganic compounds other than Vanadium pentoxide. Superfund Health Risk Technical Support Center. National Center for Environmental Assessment. Final. September 30, 2009.

EPA, 2010a. Integrated Risk Information System (IRIS) Toxicological Review of Hexavalent Chromium (External Review Draft). Washington, DC, EPA/635/R-10/004A. September 2010.

EPA, 2010b. Regional Screening Levels for Chemical Contaminants at Superfund Sites. Regional Screening Levels Summary Table. Vanadium. November 2010.

May 31, 2011

STONE ENVIRONMENTAL INC

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05602 USA

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Web Site / www.stone-env.com

Mr. John Schmeltzer
Waste Management Division
103 South Main Street / West Office
Waterbury, VT 05671-0404

SEI No. 092173-R/09
RE: Sludge and Water Sample Results
Elizabeth Mine
Strafford, Vermont (SMS #77-0186) (Site)

Dear John:

This letter provides the analytical results for sludge and water samples collected by Stone Environmental, Inc. (Stone) at the Elizabeth Mine, located in Strafford, Vermont. This work was completed, at your request, under Stone's Site Investigation Contract with the Vermont Department of Environmental Conservation (VT DEC) Waste Management Division (WMD) (Purchase Order # 14271-0186).

On May 2, 2011, under your direction, Stone collected two (2) sludge samples and one (1) water sample, including:

- Sludge sample "Sludge Sed Basin NO", which was collected near the outlet of the Sediment Basin;
- Sludge sample "Sludge HD-2/TD-2", which was collected eight (8) to nine (9) feet below Toe Drain HD-2/TD-2; and
- Water sample "TD-2", which was collected from Toe Drain 2, which is located at the base of the tailings.

Sludge samples were collected using a properly decontaminated stainless-steel trowel. Sludge sample "Sludge HD-2/TD-2" was collected directly from "in-situ" deposits present below the Toe Drain. Sludge sample "Sludge Sed Basin NO" was collected from a 5-gallon bucket of sludge that had previously been collected from the Sediment Basin by another contractor. The water sample from Toe Drain 2 was collected directly from the outlet of the conveyance hose after disconnecting it from the drain collection system manifold. After collection, all samples were stored in an ice-filled cooler and transported under a chain-of-custody to AMRO of Merrimack, New Hampshire for analysis of TAL Metals via EPA Method SW6010B (as well as SW7060A, SW7470A, SW7421, SW7041, SW7740, and SW7841) and Chromium VI via EPA Methods SW7196 and M3500-CR.

The complete laboratory report is attached. A brief summary of the analytical results is as follows:

- Chromium VI (hexavalent chromium) was not detected above the laboratory detection limits in any of the samples; of note, the detection limit was significantly elevated for water sample TD-2 due to a high concentration of iron.
- Water sample TD-2 contained detectable concentrations of calcium, iron, magnesium, manganese, potassium, sodium and zinc.
- Sludge sample Sed Basin NO contained detectable concentrations of calcium, iron magnesium and manganese.
- Sludge sample Sludge HD-2/TD-2 contained detectable concentrations of aluminum and iron.

Stone appreciates the opportunity to assist you on this project. Please contact me if you have any questions or concerns.

Sincerely yours,

Dave Linari

Direct Phone/ 802-229-6434
E-Mail /dlinari@stone-env.com

AMRO Environmental Laboratories Corp.

Date: *23-May-11*

CLIENT: Stone Environmental, Inc.
Project: 092173-R-09 Elizabeth Mine
Lab Order: 1105001
Date Received: 5/2/2011

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Collection Date	Collection Time
1105001-01A	Sludge HD-2/TD-2	5/2/2011	12:00 PM
1105001-02A	Sludge Sed Basin NO	5/2/2011	11:30 AM
1105001-03A	TD2	5/2/2011	12:15 PM
1105001-03B	TD2	5/2/2011	12:15 PM

DATA COMMENT PAGE

Organic Data Qualifiers

ND	Indicates compound was analyzed for, but not detected at or above the reporting limit.
J	Indicates an estimated value. This flag is used either when estimating a concentration for tentatively identified compounds where a 1:1 response is assumed, or when the data indicates the presence of a compound that meets the identification criteria but the result is less than the sample quantitation limit but greater than the method detection limit.
H	Method prescribed holding time exceeded.
E	This flag identifies compounds whose concentrations exceed the calibration range of the instrument for that specific analysis.
B	This flag is used when the analyte is found in the associated blank as well as in the sample.
R	RPD outside accepted recovery limits
RL	Reporting limit; defined as the lowest concentration the laboratory can accurately quantitate.
S	Spike Recovery outside accepted recovery limits.
#	See Case Narrative

Micro Data Qualifiers

TNTC	Too numerous to count

Inorganic Data Qualifiers

ND or U	Indicates element was analyzed for, but not detected at or above the reporting limit.
J	Indicates a value greater than or equal to the method detection limit, but less than the quantitation limit.
H	Indicates analytical holding time exceedance.
B	Indicates that the analyte is found in the associated blank, as well as in the sample.
MSA	Indicates value determined by the Method of Standard Addition
E	This flag identifies compounds whose concentrations exceed the calibration range of the instrument for that specific analysis.
R	RPD outside accepted recovery limits
RL	Reporting limit; defined as the lowest concentration the laboratory can accurately quantitate.
S	Spike Recovery outside accepted recovery limits.
W	Post-digestion spike for Furnace AA analysis is out of control limits (85-115), while sample absorbance is less than 50% of spike absorbance.
*	Duplicate analysis not within control limits.
+	Indicates the correlation coefficient for the Method of Standard Addition is less than 0.995
#	See Case Narrative

Report Comments:

1. Soil, sediment and sludge sample results are reported on a "dry weight" basis.
2. Reporting limits are adjusted for sample size used, dilutions and moisture content, if applicable.

AMRO Environmental Laboratories Corp.

Date: *23-May-11*

CLIENT:	Stone Environmental, Inc.	**Client Sample ID:**	Sludge HD-2/TD-2
Lab Order:	1105001	**Collection Date:**	5/2/2011 12:00:00 PM
Project:	092173-R-09 Elizabeth Mine	**Matrix:**	SLUDGE
Lab ID:	1105001-01A		

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
ICP METALS TOTAL SW-846 - 3051/6010		**SW6010B**				Analyst: **AL**
Aluminum	3,870	613		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Antimony	ND	123		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Barium	ND	613		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Beryllium	ND	7.67		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Cadmium	ND	15.3		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Calcium	ND	7,670		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Chromium	ND	30.7		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Cobalt	ND	153		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Copper	111	76.7		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Iron	419,000	307		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Lead	ND	76.7		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Magnesium	ND	7,670		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Manganese	71.9	46.0		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Nickel	ND	123		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Potassium	ND	1,530		mg/Kg-dry	1	5/18/2011 3:03:38 PM
Silver	ND	42.9		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Sodium	ND	1,530		mg/Kg-dry	1	5/18/2011 3:03:38 PM
Vanadium	ND	153		mg/Kg-dry	5	5/13/2011 7:43:18 PM
Zinc	ND	61.3		mg/Kg-dry	5	5/13/2011 7:43:18 PM
ARSENIC, SOIL 3051/7060		**SW7060A**				Analyst: **REB**
Arsenic	ND	6.13		mg/Kg-dry	1	5/16/2011 11:25:26 AM
MERCURY, 7471A		**SW7471A**				Analyst: **AL**
Mercury	ND	0.124		mg/Kg-dry	1	5/3/2011 2:40:23 PM
SELENIUM, SOIL 3051/7740		**SW7740**				Analyst: **REB**
Selenium	ND	6.1		mg/Kg-dry	1	5/16/2011 12:52:24 PM
THALLIUM, SOIL 3051/7841		**SW7841**				Analyst: **REB**
Thallium	ND	6.1		mg/Kg-dry	1	5/16/2011 2:28:07 PM

AMRO Environmental Laboratories Corp.

Date: *23-May-11*

CLIENT:	Stone Environmental, Inc.	**Client Sample ID:**	Sludge Sed Basin NO
Lab Order:	1105001	**Collection Date:**	5/2/2011 11:30:00 AM
Project:	092173-R-09 Elizabeth Mine	**Matrix:**	SLUDGE
Lab ID:	1105001-02A		

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
ICP METALS TOTAL SW-846 - 3051/6010		**SW6010B**				Analyst: **AL**
Aluminum	ND	593		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Antimony	ND	119		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Barium	ND	593		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Beryllium	ND	7.41		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Cadmium	ND	14.8		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Calcium	112,000	7,410		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Chromium	ND	29.7		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Cobalt	ND	148		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Copper	ND	74.1		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Iron	329,000	297		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Lead	ND	74.1		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Magnesium	44,300	7,410		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Manganese	4,060	44.5		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Nickel	ND	119		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Potassium	ND	1,480		mg/Kg-dry	1	5/18/2011 3:05:53 PM
Silver	ND	41.5		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Sodium	ND	1,480		mg/Kg-dry	1	5/18/2011 3:05:53 PM
Vanadium	ND	148		mg/Kg-dry	5	5/13/2011 7:49:21 PM
Zinc	ND	59.3		mg/Kg-dry	5	5/13/2011 7:49:21 PM
ARSENIC, SOIL 3051/7060		**SW7060A**				Analyst: **REB**
Arsenic	ND	5.93		mg/Kg-dry	1	5/16/2011 11:31:00 AM
MERCURY, 7471A		**SW7471A**				Analyst: **AL**
Mercury	ND	0.137		mg/Kg-dry	1	5/3/2011 2:43:42 PM
SELENIUM, SOIL 3051/7740		**SW7740**				Analyst: **REB**
Selenium	ND	5.9		mg/Kg-dry	1	5/16/2011 12:58:22 PM
THALLIUM, SOIL 3051/7841		**SW7841**				Analyst: **REB**
Thallium	ND	5.9		mg/Kg-dry	1	5/16/2011 2:39:10 PM

AMRO Environmental Laboratories Corp.

Date: *23-May-11*

CLIENT:	Stone Environmental, Inc.	**Client Sample ID:**	TD2
Lab Order:	1105001	**Collection Date:**	5/2/2011 12:15:00 PM
Project:	092173-R-09 Elizabeth Mine	**Matrix:**	AQUEOUS
Lab ID:	1105001-03A		

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
ICP METALS TOTAL SW-846		**SW6010B**				Analyst: **AL**
Aluminum	ND	1,000		µg/L	5	5/13/2011 6:59:25 PM
Barium	ND	1,000		µg/L	5	5/13/2011 6:59:25 PM
Beryllium	ND	20.0		µg/L	5	5/13/2011 6:59:25 PM
Cadmium	ND	20.0		µg/L	5	5/13/2011 6:59:25 PM
Calcium	293,000	12,500		µg/L	5	5/13/2011 6:59:25 PM
Chromium	ND	50.0		µg/L	5	5/13/2011 6:59:25 PM
Cobalt	ND	250		µg/L	5	5/13/2011 6:59:25 PM
Copper	ND	125		µg/L	5	5/13/2011 6:59:25 PM
Iron	575,000	500		µg/L	5	5/13/2011 6:59:25 PM
Magnesium	52,500	12,500		µg/L	5	5/13/2011 6:59:25 PM
Manganese	12,600	75.0		µg/L	5	5/13/2011 6:59:25 PM
Nickel	ND	200		µg/L	5	5/13/2011 6:59:25 PM
Potassium	23,000	2,500		µg/L	1	5/18/2011 2:14:15 PM
Silver	ND	35.0		µg/L	5	5/13/2011 6:59:25 PM
Sodium	11,700	2,500		µg/L	1	5/18/2011 2:14:15 PM
Vanadium	ND	250		µg/L	5	5/13/2011 6:59:25 PM
Zinc	138	100		µg/L	5	5/13/2011 6:59:25 PM
ARSENIC, TOTAL		**SW7060A**				Analyst: **REB**
Arsenic	ND	4.0		µg/L	1	5/6/2011 11:09:50 AM
MERCURY, TOTAL		**SW7470A**				Analyst: **AL**
Mercury	ND	0.200		µg/L	1	5/6/2011 6:01:39 PM
LEAD, TOTAL		**SW7421**				Analyst: **AL**
Lead	ND	5.0		µg/L	1	5/9/2011 11:25:38 AM
ANTIMONY, TOTAL		**SW7041**				Analyst: **REB**
Antimony	ND	5.0		µg/L	1	5/10/2011 12:26:27 PM
SELENIUM, TOTAL		**SW7740**				Analyst: **REB**
Selenium	ND	5.0		µg/L	1	5/6/2011 1:17:49 PM
THALLIUM, TOTAL		**SW7841**				Analyst: **REB**
Thallium	ND	2.0		µg/L	1	5/6/2011 3:31:22 PM

AMRO Environmental Laboratories Corp.

Date: *23-May-11*

CLIENT: Stone Environmental, Inc.
Project: 092173-R-09 Elizabeth Mine

Lab Order: 1105001

Lab ID: 1105001-01 **Collection Date:** 5/2/2011 12:00:00 PM
Collection Time:
Client Sample ID: Sludge HD-2/TD-2 **Matrix:** SLUDGE

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
HEXAVALENT CHROMIUM		**SW7196**				Analyst: **AL**
Chromium, Hexavalent	ND	12		mg/kg-dry	5	5/18/2011
PERCENT MOISTURE		**D2216**				Analyst: **MG**
Percent Moisture	60.8	0		wt%	1	5/4/2011

Lab ID: 1105001-02 **Collection Date:** 5/2/2011 11:30:00 AM
Collection Time:
Client Sample ID: Sludge Sed Basin NO **Matrix:** SLUDGE

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
HEXAVALENT CHROMIUM		**SW7196**				Analyst: **AL**
Chromium, Hexavalent	ND	2.6		mg/kg-dry	1	5/18/2011
PERCENT MOISTURE		**D2216**				Analyst: **MG**
Percent Moisture	63.5	0		wt%	1	5/4/2011

Lab ID: 1105001-03 **Collection Date:** 5/2/2011 12:15:00 PM
Collection Time:
Client Sample ID: TD2 **Matrix:** AQUEOUS

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
HEXAVALENT CHROMIUM		**M3500-CR**				Analyst: **AL**
Chromium, Hexavalent	ND	500		mg/L	50000	5/3/2011 9:45:00 AM

AMRO Environmental Laboratories Corporation
111 Herrick Street
Merrimack, NH 03054

CHAIN-OF-CUSTODY RECORD

60947

Office: (603) 424-2022
Fax: (603) 429-8496
web: www.amrolabs.com

Project No.: 09-2173-R/09	Project Name: Elizabeth Mine	Project State: VT	Project Manager: Eric Swiech	Samplers (Signature):	AMRO Project No.:
P.O.#:	Results Needed by:				
QUOTE #:	Seal Intact? Yes No N/A				

Sample ID.:	Date/Time Sampled	Matrix	Total # of Cont. & Size	Comp.	Grab	TAL Metals	Cu VT	Remarks
Sludge HD-2/TD-2	12:00	Soil	1-160z		X	X	X	
Sludge 50 Basin NO	11:30	Soil	1-160z		X	X	X	
TD 2	12:15	H2O	1-50mL		X	X		HNO3
TD 2	12:15	H2O	1-50mL		X		X	

Preservative: Cl-HCl, MeOH, N-HN03, S-H2SO4, Na-NaOH, O- Other

Send Results To:
STONE ENV.
535 STONE Cutters Way
Montpelier, VT 05602

PHONE #: FAX #:
E-mail:

PRIORITY TURNAROUND TIME AUTHORIZATION
Before submitting samples for expedited TAT, you must *have a coded AUTHORIZATION NUMBER*
AUTHORIZATION No.: BY:

METALS 8 RCRA ☐ 13 PP ☐ 23 TAL ☐ 14 MCP ☐
Method: 6010 ☐ 200.7 ☐ Other Metals:
Dissolved Metals Field Filtered? YES ☐ NO ☐

MCP Presumptive Certainty Required? YES ☐ NO ☐

MCP Methods Needed: YES ☐ NO ☐

Required Reporting Limits:
S-1 ☐ GW-1 ☐
S-2 ☐ GW-2 ☐
S-3 ☐ GW-3 ☐
Other:

Relinquished By:	Date/Time	Received By
	5/2/11 13:00	

AMRO report package level needed:
EDD required:

Please print clearly, legibly and completely. Samples can not be logged in and the turnaround time clock will not start until any ambiguities are resolved.

Samples arriving after 12:00 noon will be tracked and billed as received on the following day.

AMRO policy requires notification in writing to the laboratory in cases where the samples were collected from highly contaminated sites.

KNOWN SITE CONTAMINATION:

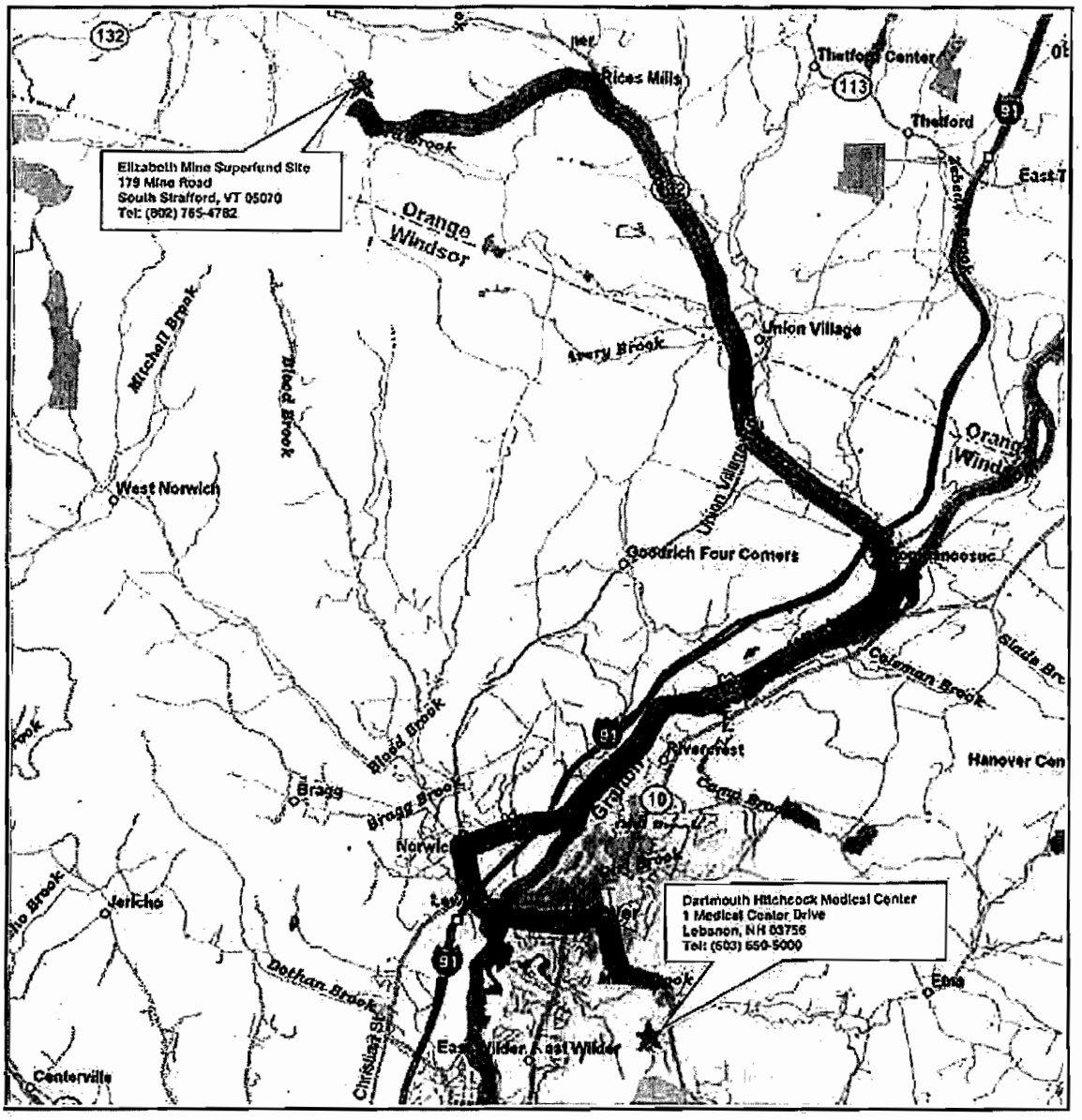
White: Lab Copy Yellow: Client Copy

SHEET OF

AMROCOC2004, Rev.3 08/18/04

HOSPITAL ROUTE MAP AND DIRECTIONS

Dartmouth Hitchcock Medical Center, 1 Medical Center Drive, Lebanon, NH
Tel: (603) 650-5000



Depart the Elizabeth Mine Site on Copper Mine Road (South). Bear left (east) onto Gove Hill Road. Bear right (southeast) onto State Route- (SR) 132. Bear left (south) onto SR-132. Bear right (south) onto US Route 5. Continue south on Main Street. Continue east onto West Wheelock Street. Bear left (east) onto US Route 4 (SR-10). Continue east on East Wheelock Street. Turn right (south) onto SR-120 (Darmouth College Highway). Bear right (west) onto Medical Center Drive (Dump Road). Bear right (south) onto Medical Center Drive. Arrive at Dartmouth Hitchcock Medical Center. Proceed to Emergency Room entrance.

APPENDIX E

SITE HEALTH and SAFETY PLAN
EMPLOYEE SIGNOFF SHEET

Elizabeth Mine Superfund Site
Strafford/Thetford, Vermont

I have read a copy of the Site Safety and Health Plan for this facility. I understand its contents and I agree that I will abide by its requirements. I have also attended a pre-entry briefing, which reviewed the contents of the Plan.

NAME	EMPLOYER	SIGNATURE	DATE