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Ore Hill Mine

White Mountain National Forest
Grafton County, New Hampshire

SUPPLEMENTAL ENGINEERING EVALUATION/ COST ANALYSIS

May 6, 2008

Prepared For:
U.S. Forest Service

MSE

Millennium Science & Engineering, Inc.

SUPPLEMENTAL
ENGINEERING EVALUATION/COST ANALYSIS

Ore Hill Mine
White Mountain National Forest, NH — May 2008

Prepared For:

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ACRONYMS AND ABBREVIATIONS

$CaCO_3$	Calcium carbonate
cy	Cubic yard
gpm	Gallon per minute
mg/L	Milligram per liter
sy	Square yard
ALD	Anoxic limestone drain
AMD	Acid mine drainage
APS	Alkalinity producing system
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient water quality criteria
BLM	U.S. Bureau of Land Management
BMP	Best management practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CCC	Criteria Continuous Concentration
CFR	Code of Federal Regulations
DO	Dissolved oxygen
EE/CA	Engineering Evaluation/Cost Analysis
EPA	United States Environmental Protection Agency
HDPE	High density polyethylene
LHD	Low head dam
LLB	Limestone leach bed
LSP	Limestone pond
MCL	Maximum Contaminant Level (in drinking water)
MSE	Millennium Science and Engineering, Inc.
NHDES	New Hampshire Department of Environmental Services
NHDOT	New Hampshire Department of Transportation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	Operation and maintenance
OLC	Open limestone channel
PA	Preliminary Assessment
PRB	Permeable reactive barrier
PSU	Plymouth State University
PVC	Polyvinyl chloride
RAO	Removal action objective
RMC	Risk Management Criteria

ACRONYMS AND ABBREVIATIONS (continued)

SAPS	Successive alkalinity producing system
SC	Site Characterization
SI	Site Inspection
SLB	Slag leach bed
SRB	Sulfate reducing bioreactor
TN&A	TN & Associates, Inc.
USDA-FS	United States Department of Agriculture - Forest Service

EXECUTIVE SUMMARY

A Supplemental Engineering Evaluation/Cost Analysis (EE/CA) was performed for a proposed Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) removal action at the Ore Hill abandoned mine site (Ore Hill or the Site). The Site is located on the White Mountain National Forest, about 3.5 miles west of Warren, New Hampshire, in northwest Grafton County (Figure 1). Acid mine drainage (AMD) and surface water flowing from the Site contribute significant metals and acid loading to the Ore Hill Brook located about 320 feet downstream of the Site.

The scope of removal actions evaluated in this Supplemental EE/CA focus on:

(1) Improving surface water quality; and
(2) Reducing or eliminating the migration of contaminants to the environment.

Potential human health and ecological risks at the Site were evaluated by comparing contaminant concentrations in surface water monitoring samples collected for the U.S. Department of Agriculture Forest Service (USDA-FS) by Plymouth State University (PSU) to New Hampshire State and Federal water quality risk screening criteria. The evaluation indicated significant potential risk to ecological receptors at the Site from exposure to high concentrations of metals. There is also a potential human health risk to recreational users at the Site who may occasionally use the surface water as a drinking source. Surface water is considered to be the primary contaminant source at the Site and is the main focus of this Supplemental EE/CA. Groundwater is not used for drinking water at the Site and future use as a drinking source is not anticipated; therefore, treatment of groundwater is beyond the scope of this removal action. Sediment was also eliminated from the scope of this removal action because it does not appear to pose a significant human health risk at the Site.

More than 15 removal action technologies were reviewed to develop potential removal action alternatives and three alternatives with multiple options were evaluated in detail:

- Alternative 1 – No Action
- Alternative 2 – Partial Staged Passive Treatment
  - Option A – Anaerobic Wetlands
  - Option B – Sulfate Reducing Bioreactor (SRB)
- Alternative 3 – Complete Staged Passive Treatment
  - Option A – ViroMine™ Media
  - Option B – Aerobic Wetlands

The recommended alternative is a combination of Alternative 2 – Option B and Alternative 3 – Option B. This combination is expected to provide the greatest reduction in acid and metals loading to Ore Hill Brook. An open limestone channel (OLC) would convey the adit discharge from the adit to the main pond area to increase alkalinity and provide aeration. Two low head dams (LHD) would be installed in the main pond area to create a settling pond and SRB. The settling pond would increase retention time and also serve as an equalization basin for the converging flows. The SRB would promote precipitation of metal hydroxides and sulfides. A pilot study would be conducted to determine the optimum organic substrate mixture and configuration for the SRB. A series of two aerobic wetlands would be constructed further downstream to provide a final polishing step by promoting oxidation and precipitation of metal hydroxides. Storm water would be intercepted and conveyed around the treatment areas to regulate flows, minimize fluctuations in water chemistry, and provide protection during flood events.

The recommended alternative is expected to treat ~14,400 gallons of AMD per day (~10 gallons per minute) and significantly reduce acid and metals loading to Ore Hill Brook with the overall goal of achieving state surface water quality standards. While lime-based and organic components will require periodic replacement, long-term operation and maintenance (O&M) should be minimal. Metal-laden precipitate will be a by-product of the proposed passive water treatment system and will be captured and addressed periodically, as needed, by the USDA-FS. [redacted] and the estimated average annual O&M cost is **$5,968** (present value) including the periodic replacement of lime-based and organic components. The total estimated monitoring cost for 3 years of biannual surface water quality monitoring is **$12,000**.

1.0 INTRODUCTION

Millennium Science and Engineering, Inc. (MSE) has been contracted by the U.S. Department of Agriculture Forest Service (USDA-FS) to perform a Supplemental Engineering Evaluation/Cost Analysis (EE/CA) for a contemplated non-time critical removal action at the Ore Hill Mine (Ore Hill or the Site) on the White Mountain National Forest near Warren, New Hampshire.

- This Supplemental EE/CA is being performed by the USDA-FS under its cleanup authorities (42 USC 9604(a), 7 Code of Federal Regulations [CFR] 2.60(m) and Federal Executive Order 12580). The purpose of this Supplemental EE/CA is to recommend an alternative to minimize or eliminate any release or threat of release of a hazardous substance into the environment or impact on public health and welfare as outlined in 40 CFR 300.415(b)(2)(i)-(viii).
- This Supplemental EE/CA has been prepared utilizing the U.S. Environmental Protection Agency (EPA) *"Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA"* (1991) and is in general accordance with the provisions of National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 CFR 300.415(b)(4)(i).
- The purpose of a removal action is to "abate, prevent, minimize, stabilize, mitigate or eliminate the release or the threat of a release" (40 CFR 300.415). The EE/CA for a removal action is intended to:
  - Satisfy environmental review requirements for removal actions;
  - Satisfy administrative record requirements for documentation of removal action selection; and
  - Provide a framework for evaluating and selecting alternative technologies.
- To meet those purposes, this Supplemental EE/CA identifies objectives for the removal action and evaluates the effectiveness, implementability, and cost of various alternatives that may satisfy these objectives.
- Groundwater is not used for drinking water at the Site and future use as a drinking source is not anticipated; therefore, treatment of groundwater is beyond the scope of this removal action.
- Sediment does not pose a significant human health risk at the Site; therefore, treatment or removal of sediment is not addressed in this Supplemental EE/CA.
- The primary source of data used to evaluate conditions at the Site and develop removal action alternatives was surface water quality monitoring data collected by Plymouth State University (PSU 2008). In a cooperative effort with the USDA-FS, PSU is conducting ongoing surface water quality monitoring at the Site with more than 25 monitoring stations.

2.0 SITE CHARACTERIZATION

The Ore Hill Mine is an abandoned copper, lead, and zinc sulfide mine located in Grafton County, New Hampshire, approximately 3.5 miles west of the town of Warren (Figure 1). The mine was operated intermittently from 1840 to circa 1914 and was one of the largest in New Hampshire. A major CERCLA removal action was completed at the Site in 2006 to mitigate acid mine drainage (AMD) from the Site that was impacting surface water quality in Ore Hill Brook. Approximately 36,000 cubic yards (cy) of metal sulfide tailings and waste rock were excavated from the bedrock surface, stabilized and placed in an on-site repository.

A relatively small watershed (~28.5 acres) encompasses the Site and several unnamed intermittent streams drain the Site and converge to form the Ore Hill Mine Site Tributary which discharges to Ore Hill Brook about 320 feet downstream of the Site (TN & Associates [TN&A] 2002). Water samples collected at the Site by the USDA-FS in 1998 indicated acidic water with high concentrations of metals characteristic of AMD. In 2000, the USDA-FS completed a Preliminary Assessment (PA) of the Site and TN&A completed a Site Inspection (SI). Results of the PA and SI indicated impacts to Ore Hill Brook from AMD discharging as seeps from tailings at the Site. In 2001-2002, TN&A conducted a Site Characterization (SC) to identify site conditions posing a risk to human health and the environment, address data gaps from the previous investigations, collect additional field data needed to complete an EE/CA, and evaluate human health risks at the Site. The SC confirmed impacts to water quality in Ore Hill Brook and indicated potential human health risks to workers at the Site from exposure to lead and arsenic.

TN&A completed a draft final EE/CA of the Site in 2002, and a revised EE/CA in 2003. The EE/CA recommended alternative consisted of excavating the tailings and waste rock and hauling to an on-site repository area for treatment and disposal. The EE/CA did not evaluate specific treatment options to reduce metals dissolution and outflow from the tailings and waste rock once removed. Subsequent to the EE/CA, the USDA-FS issued a contract for construction design, with the intent to implement the removal action in Summer 2005; however, the construction design and bid package were not completed in time to award a construction contract and bid protests further delayed award of the construction contract until the following field season.

In 2006, the mine waste and tailings were excavated down to bedrock, stabilized, and placed in an on-site repository. During the removal action, approximately 40 feet of a previously unknown adit was uncovered and exposed within the excavated area at the Site, and water began discharging from the adit at a rate of approximately 0.5 to 1 gallon per minute (gpm). The discharge is characteristic of AMD with a low pH and high concentrations of metals, particularly aluminum, cadmium, copper, magnesium, lead, and zinc. The discharge flows about 200 feet from the adit to a large depression (approximately 100-foot long by 50-foot wide) where it mixes with surface water from the upper west area of the Site and collects in a pond (referred to as the main pond). Discharge from the main pond either infiltrates bedrock or continues downstream through a series of small check dams and ponds for approximately 300 feet parallel to another drainage on the west side of the excavated area. Flows from the two drainages converge just below the excavated area to form the Ore Hill Mine Tributary which discharges to Ore Hill Brook about 320 feet downstream. Before the removal action, six seeps were mapped in the tailings and waste rock areas. Following the removal action, 14 rock check dams were installed in the excavated area.

In a cooperative effort with the USDA-FS, PSU began monitoring surface water quality at the Site before the removal action in Spring 2006 and has been monitoring post-removal Site surface water quality at more than 25 monitoring stations. Following discovery of the discharging adit in Fall 2006, the USDA-FS partnered with PSU to conduct a study specifically to monitor post-removal action water quality from the discharging adit and in the excavated area. The study consisted of three rounds of surface water sampling and flow measurements at six locations. Results of the study are discussed below and presented in the *Ore Hill Adit Water Quality Monitoring 2008 Report*, provided in Appendix A.

Completed in 2006, the removal action reduced metals loading to Ore Hill Brook by an estimated 80 percent by removing the tailings and waste rock from an area where they were continuously exposed to surface and storm water resulting in AMD, and placing the material in an on-site repository.

2.1 Data Gap Investigation

No additional site data were collected by MSE during preparation of this Supplemental EE/CA.

2.2 Source, Nature and Extent of Contamination

The source, nature and extent of contamination at the Site are briefly described in the following paragraphs. Analytical results of surface water samples collected by PSU are summarized in Table 1 and the sample locations are shown on Figure 2. Photographs of the Site are provided in Appendix B.

<u>Surface Water</u>

Surface water features at the Site include adit discharge, ponds, and several unnamed intermittent streams that converge to form the Ore Hill Mine Tributary (Figure 2).

- Surface water quality data collected by PSU consists of multiple samples from more than 25 monitoring stations at the Site and on Ore Hill Brook. However, because this Supplemental EE/CA is focused on water quality associated with the discharging adit discovered in the excavated area of the Site, the data set was limited primarily to the *Ore Hill Adit Water Quality Monitoring 2008 Report* (PSU 2008) and one background monitoring location on Ore Hill Brook.
- The Ore Hill Adit Water Quality Monitoring Study by PSU consisted of three rounds of surface water sampling and flow measurement at six locations on the Site in June, July, and October 2007. Three rounds of background samples were collected from Ore Hill Brook around the same times. The samples were submitted to the USDA-FS laboratory in Durham, New Hampshire for analysis of selected metals. The sampling locations, shown on Figure 2, are listed below and the results are presented in Table 1:
    - One background surface water location on Ore Hill Brook (OHB-1)
    - Adit discharge at portal (AS01)
    - Adit discharge upstream of main pond (AS02)
    - Drainage from the upper west area of the Site upstream of main pond (AS03)
    - Main drainage downstream of the main pond (AS04)
    - Main drainage upstream of confluence with west drainage (AS05)
    - Ore Hill Mine Tributary downstream of the Site (AS06)
- Background samples from Ore Hill Brook (OHB1):
    - pH ranged from 5.66 to 6.70.
    - Nine metals were detected: aluminum, antimony, arsenic, cadmium, copper, iron, manganese, selenium and zinc.
    - Arsenic exceeded one or more human health screening criteria.
    - Cadmium, copper, selenium, and zinc exceeded one or more ecological screening criteria.
- Adit discharge at portal (AS01):
    - Characteristic of AMD with high acidity, low pH, and elevated levels of metals.
    - pH ranged from 4.18 to 5.02.
    - Antimony, arsenic, beryllium, mercury, manganese and zinc exceeded one or more human health screening criteria.
    - Aluminum, cadmium, copper, lead, mercury, nickel, selenium and zinc exceeded one or more ecological screening criteria.
    - Flow ranged from 0.5 to 1.2 gpm.
- Adit discharge upstream of main pond (AS02):
    - Characteristic of AMD with high acidity, moderately low pH, and elevated levels of aluminum and zinc.
    - pH ranged from 6.45 to 6.93.
    - Antimony, arsenic, manganese and zinc exceeded one or more human health screening criteria.
    - Cadmium, copper, lead, nickel, selenium and zinc exceeded one or more ecological screening criteria.
    - Flow ranged from 0.5 to 1.6 gpm.

- Drainage from the upper west area of the Site upstream of main pond (AS03):
  - pH = 7.38 to 7.51.
  - Antimony, arsenic, barium and manganese exceeded one or more human health screening criteria.
  - Cadmium, copper, lead and zinc exceeded one or more ecological screening criteria.
  - Flow ranged from 0.8 to 4.1 gpm.
- Main drainage downstream from main pond (AS04):
  - pH = 6.18 to 7.72.
  - Antimony, arsenic, iron and manganese exceeded one or more human health screening criteria.
  - Cadmium, copper, lead, selenium and zinc exceeded one or more ecological screening criteria.
  - Flow ranged from 1.9 to 9.0 gpm.
- Main drainage upstream of the confluence with Ore Hill Brook (AS05):
  - pH = 7.17 to 7.26.
  - Antimony, arsenic, iron, manganese and mercury exceeded one or more human health screening criteria.
  - Cadmium, copper, lead, selenium and zinc exceeded one or more ecological screening criteria.
  - Flow ranged from 9.5 to 11.9 gpm.
- Ore Hill Mine Tributary downstream of the Site (AS06):
  - pH = 6.82 to 7.71.
  - Antimony and manganese exceeded one or more human health screening criteria.
  - Cadmium, copper, lead and zinc exceeded one or more ecological screening criteria.
  - Flow ranged from 6.8 to 42.0 gpm.

The highest concentrations of metals are in the adit discharge at the portal (AS01). In general, metals concentrations decrease significantly as the flow progresses downstream of the adit, particularly between stations AS01 and AS02. The hydraulic and chemical loadings are discussed below.

Hydraulic and Chemical Loading

Based on results of the Ore Hill Adit Water Quality Monitoring Study conducted by PSU, a brief analysis of hydraulic and chemical loads and a characterization of existing landscape features that will affect potential removal action applications is provided below.

Hydraulic Loads – Hydraulic loads in the excavated area consist of groundwater discharge from the mine adit at AS01, surface water drainage from the upper west area of the Site at AS03, groundwater discharges along the main drainage, and periodic storm water from precipitation. Flow from the adit at AS01 ranged from 0.5 to 1.2 gpm, and from 0.5 to 1.6 gpm at AS02. Flow from the upper west area of the Site ranged from 0.8 to 4.1 gpm at AS03. Downstream of the main pond, surface and groundwater flows converge in the main drainage to form a gaining stream and the flow at AS04 ranged from 1.9 to 9.0 gpm. Flows continue to aggregate downstream and the flow at AS05 ranged from 9.5 to 11.9 gpm. Downstream of the confluence with the west drainage, flow in the Ore Hill Mine Tributary ranged from 6.8 to 42 gpm at AS06. It should be noted that during periods of high flow, station AS06 also receives flow from a small drainage to the west of the excavated area that typically does not flow during drier conditions.

Overall, the concentrated AMD discharge at the adit (AS01) constitutes less than 10 percent of the total hydraulic flow in the drainage. On average, the adit discharge is expected to range from 0.5 to 2 gpm at AS01 while flows at the bottom of the drainage (AS05) are expected to range from 5 to 20 gpm. These flow ratios are expected to be relatively consistent during non-runoff periods, whereas storm water would increase contributions in the upper portions of the Site during rain events.

Chemical Loads – The highest load of most metals is at the adit discharge (AS01) but the load decreases significantly between AS01 and AS02, presumably from natural physical and chemical processes (i.e. adsorption and precipitation). For example, aluminum decreases by an average of 99 percent, copper by an average of 91 percent, and lead by an average of 97 percent. Concentrations of silver, cadmium, nickel, and zinc also decrease about 40 percent between AS01 and AS02, and pH increases from an average of 4.5 to 6.7. For some metals, particularly aluminum, copper, and lead, flow from the upper west area of the Site (AS03) contributes more loading than flow from the adit. Between the main pond and AS05, pH remains relatively neutral (7.09 to 7.72) and concentrations of aluminum, copper, lead, and silver continue to decrease; however, concentrations of cadmium, iron, manganese, nickel, antimony, and zinc increase.

Implications of the observed trends in hydraulic and chemical loading are summarized below:

- There is currently significant improvement in water quality between the adit portal (AS01) and AS02, and the natural processes occurring along that reach should not be disrupted; however, providing additional buffering capacity between the adit and the main pond may be beneficial and could increase metals removal.
- While aluminum, copper and lead loads decrease on average more than 90 percent between AS01 and AS02, the decrease in loads of other metals, most notably zinc and manganese, is much less.
- Flow from the upper west area of the Site is neutral (average pH = 7.4) and metals concentrations are significantly lower than in the adit discharge; however, because of the higher flow rate (up to 8 times the flow at AS02), the loading from AS03 is greater than from AS02 for most metals.
- The existing main pond provides an excellent opportunity to treat a significant portion of the metals loading at a relatively small flow rate. The area is large enough to provide significant retention time and is ideal for establishing a wetlands or similar passive treatment system.
- Metals loading continues to occur downstream of the main pond from groundwater inflows between AS04 and AS05; therefore, additional treatment in the lower portion of the drainage would be beneficial.
- Treatment options consist of: (1) source treatment at the adit and between AS01 and AS02 to increase alkalinity; (2) using the main pond area to increase retention time and promote metals removal through aerobic, anaerobic, and/or microbial processes; and (3) implementing measures in the lower portion of the drainage between AS04 and AS05 to increase overall retention and provide a final polishing step.

3.0 RISK SCREENING

Analytical results from the surface water samples collected by PSU were compared to New Hampshire State and Federal surface water quality risk screening criteria, and U.S. Bureau of Land Management (BLM) Risk Management Criteria (RMC) to evaluate potential risks to human and ecological receptors at the Site (Table 2). The New Hampshire screening criteria consisted of Interim Water Quality Criteria for Toxic Substances for Protection of Freshwater Aquatic Life, Criteria Continuous Concentration (CCC), and Interim Water Quality Criteria for Toxic Substances for Protection of Human Health, Water and Fish Ingestion, Table 1703.1, (NHDES 2007). Federal screening criteria consisted of EPA's Ambient Water Quality Criteria (AWQC) for Freshwater Aquatic Life, and for Human Health (water and organism ingestion) (2006). The surface water sample results were also compared to RMCs developed by the BLM for selected contaminants using exposure scenarios typical of abandoned mines on public lands

(Ford 2004). Since residential use of the Site is extremely unlikely, the next most stringent RMCs (for campers) were used. Relative risk is assigned to RMCs on a logarithmic scale, as displayed in Table 2. It should be noted that the surface water data and analytical results have not been validated by MSE and the results provided by PSU were used simply for general risk screening purposes. A detailed risk assessment has not been completed and is beyond the scope of this Supplemental EE/CA.

The results, summarized in Table 2, indicate potential risks to both human and ecological receptors from exposure to surface water at the Site. Based on the New Hampshire State and Federal screening criteria, surface water poses a moderate to extremely high risk to both human health and aquatic life. Mercury and arsenic both exceed EPA's human health criteria by factors of 13,800[1] and 850[1], respectively. Antimony, barium, beryllium, iron, manganese, and zinc pose a moderate human health risk, and lead poses a high human health risk. Cadmium, copper, lead, manganese, mercury, and zinc pose an extremely high risk to aquatic life, and iron, nickel and selenium pose a moderate risk. Lead poses the highest risk and exceeds the freshwater CCC by a factor of 10,860. Mercury[1] and lead exceeded the camper RMC by factors of 7 and 43, respectively, indicating a moderate to high human health risk.

4.0 SITE CLEANUP CRITERIA

There are two general types of cleanup criteria:

(1) Risk-based cleanup criteria developed from human health risk equations using acceptable risk levels and site-specific factors, and
(2) Applicable or Relevant and Appropriate Requirements (ARAR).

Risk-based cleanup criteria are site-specific levels determined to be protective of human health based on acceptable risk levels, and site-specific contaminant concentrations, land uses, and exposure pathways. Because a human health risk assessment was not completed as part of this Supplemental EECA, risk-based cleanup criteria were not developed for Ore Hill. Therefore, the proposed site cleanup criteria are based on ARARs, which are "applicable" or "relevant and appropriate" federal and state environmental requirements. Applicable requirements include cleanup standards and other substantive requirements, criteria, or limitations promulgated under federal or state laws that apply to hazardous substances and removal actions at the Site. Relevant and appropriate requirements are not applicable to the Site but may be suitable for use because they address issues or problems sufficiently similar to those at present at the Site. In addition to ARARs, federal and state environmental and public health guidance and proposed standards that are not legally binding but may prove useful are "to be considered" standards.

ARARs are used to:

(1) Evaluate the extent of site cleanup needed;
(2) Scope and develop removal action alternatives; and
(3) Guide the implementation and operation of the preferred alternative.

The NCP (40CFR 300.415(j)) establishes that a removal action shall "to the extent practical, considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental facility siting laws."

[1] Based on the current arsenic criteria of 0.000018 mg/L, which is under evaluation by the EPA. By comparison, EPA's drinking water Maximum Contaminant Level (MCL) for arsenic is 0.01 mg/L. Mercury was analyzed for using an Inductively Coupled Plasma (ICP), which is generally not the recommended method and may provide falsely high results.

To determine whether compliance with ARARs is practicable, two factors are specified in 40 CFR 415(j):

- Urgency, and
- Scope of the removal action.
  - The scope of the removal action is often directed at minimizing and mitigating a potential hazard rather than totally eliminating the hazard; even though a particular standard may be an ARAR for a particular medium, it may be outside the scope of the immediate problem the removal action is addressing.

A list of ARARs generated and evaluated for the Site is presented in Appendix C. The ARARs were used to determine the design specifications and performance standards for the project. They are grouped as federal or State of New Hampshire ARARs, and are identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR, and whether the ARAR is applicable, or relevant and appropriate, or not applicable, relevant and appropriate.

- Administrative requirements are not ARARs and thus do not apply to actions conducted entirely onsite. Administrative requirements are those that involve consultation, issuance of permits, documentation, reporting, record keeping, and enforcement.
- The CERCLA program has its own set of administrative procedures that assure proper implementation of CERCLA. The preamble to the final NCP states that the application of additional or conflicting administrative requirements could result in delay or confusion.
- Provisions of statutes or regulations that contain general goals that merely express legislative intent about desired outcomes or conditions, but are non-binding, are not ARARs. In accordance with Section 121(e) of CERCLA, no permits are required for portions of the removal action conducted at the Site.

4.1 ARAR–based Cleanup Criteria for Surface Water

ARAR-based cleanup criteria apply to surface water at the Site and include state and federal criteria and guidelines for protection of human health and ecological receptors. Groundwater is not used for drinking water at the Site and future use of ground water as a drinking water source at the Site is not anticipated due to extensive federal ownership; therefore, no cleanup criteria were identified for groundwater. Similarly, sediment does not pose a significant human health risk; therefore, no cleanup criteria were identified for sediment.

ARAR-based cleanup criteria for surface water (summarized in Table 3) include New Hampshire State standards and federal criteria for the protection of aquatic life and human health and are listed below in the order of preference:

- New Hampshire Interim Water Quality Criteria for Toxic Substances for Protection of Freshwater Aquatic Life, CCC, (NHDES 2007);
- New Hampshire Interim Water Quality Criteria for Toxic Substances for Protection of Human Health, Water and Fish Ingestion, Table 1703.1, (NHDES 2007);
- EPA's recommended chronic AWQC for freshwater aquatic life (2006); and
- EPA's recommended chronic AWQC for human consumption of water and fish (2006).

Several metals in the surface water samples exceed the ARAR-based cleanup criteria, including background samples from Ore Hill Brook:

- Background concentrations of antimony, arsenic, copper, selenium and zinc all exceeded one or more surface water quality ARARs; therefore, the proposed cleanup levels for these metals default to the background concentrations.
- Background concentrations of chromium, mercury, lead, titanium and vanadium were all non detect. Because it is unknown whether the background concentrations of these metals exceed screening criteria, the proposed cleanup levels default to the background concentration.
- Arsenic, barium, iron, mercury, manganese, antimony and zinc exceeded human health criteria.
- Aluminum, beryllium, cadmium, copper, iron, lead, manganese, mercury, nickel, selenium and zinc exceeded ecological criteria.
- The highest concentrations of most metals were in samples from the adit discharge (AS01).

5.0 IDENTIFICATION OF REMOVAL ACTION OBJECTIVES

The general goal of a removal action is to protect human health and the environment by preventing or minimizing the potential release of a hazardous substance and reducing the potential for direct contact and transport of contaminants to the environment. Based on water quality conditions at the Site, the following removal action objectives (RAO) were developed for the Site:

- Improve surface water quality to reduce potential risk to human and ecological receptors from ingestion and dermal contact; and
- Reduce the potential for erosion and contaminant migration downstream of the Site.

The following sections discuss the justification for a removal action at the Site, scope of the removal action, and the proposed removal action schedule.

5.1 Removal Action Justification

According to 40 CFR 300.415(b), a removal action is justified if there is a threat to human health or the environment based on the eight factors listed below:

Factor	Site Condition	Justification
(1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants.	Public access to surface water containing high concentrations of metals.	**Yes**
(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems.	Lacks public water supply, but ponds are drinking source for wildlife; high metals concentrations in surface water leaving the Site and contributing to downstream water degradation.	**Yes**

Factor	Site Condition	Justification
(3) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release.	No drums, barrels, tanks, or bulk storage containers on the Site.	No
(4) High levels of hazardous substances, pollutants, or contaminants in soils largely at, or near, the surface that may migrate.	Concentrations of metals in reclaimed soils subject to short-term erosion and migration.	No
(5) Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released.	Sediment subject to erosion during high flows, rain events and snowmelt could cause sediment migration.	**Yes**
(6) Threat of fire or explosion.	No flammable materials on the Site.	No
(7) The availability of other appropriate federal or state response mechanisms to respond to the release.	Site is on USDA-FS-administered federal land and is being addressed under USDA-FS CERCLA authorities.	**Yes**
(8) Other situations or factors that may pose threats to public health or the environment.	None.	No

5.2 Scope of Removal Action

The scope of removal actions evaluated in this Supplemental EE/CA focus on:

(1) Improving surface water quality,
(2) Reducing or eliminating the migration of contaminants to the environment; and
(3) Reducing or eliminating human and ecological contact with metals in surface water.

The primary source of contaminants at the Site is the mine discharge and impacted surface water, both of which contain high concentrations of metals. Groundwater infiltrating the stream along the drainage and contributing additional metals loading to surface water at the Site is also considered a primary contaminant source. Because the excavated area consists primarily of exposed bedrock, there is minimal sediment accumulation in the drainage and any fine-grained materials (sediments) that may have been deposited in, or migrated to, the stream and ponds are considered a secondary contaminant source; therefore, treatment of sediment is beyond the scope of this removal action. Treatment of groundwater is also beyond the scope of this removal action; however, some improvement in groundwater and sediment quality is expected to occur from the improved surface water quality and reduction in contaminant migration to groundwater.

5.3 Removal Action Schedule

The removal action is tentatively scheduled for 2008; however, the date is dependent on federal funding and may be subject to change by the USDA-FS.

6.0 IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section describes the selection of a removal action using a three–step process:

(1) Identifying potential removal action technologies and alternatives applicable to the Site and screening to eliminate ineffective or unfeasible alternatives;
(2) Analyzing selected removal action alternatives based on effectiveness, implementability, and cost; and
(3) Identifying existing data gaps that are relevant to the selected alternatives.

6.1 Identification and Screening of Removal Action Technologies

Removal action technologies applicable to the Site were identified based on a review of technical literature and previous experience at similar mine sites. The technologies were screened to eliminate inappropriate, ineffective, infeasible or cost prohibitive methods. In addition, technologies with unproven or uncertain performance were eliminated if they have relatively high implementation costs and/or would likely require implementation with other costly mitigation components. Technologies with uncertain or unproven performance were retained if they represented potentially cost effective mitigation and the performance can be investigated through pilot or bench scale testing. For this Supplemental EE/CA, a potentially cost effective technology is one that could provide protection comparable to other standard methods utilized in mine reclamation, at a cost similar to or less than the costs of those methods. All components not screened out were retained as potential technologies that could be implemented at the Site.

Two classes of treatment technologies were evaluated as possible alternatives for Ore Hill: (1) active, and (2) passive. Active treatment technologies typically involve in-stream mechanical treatment and usually require significant operation and maintenance (O&M), such as restocking neutralizing agents and replacing filters. Active treatment is generally limited to at-source treatment systems while passive treatment technologies are designed to be more self-sufficient and are typically designed for a 20- to 30-year project life. Unlike active systems, passive systems require minimal O&M and are designed to capture precipitating metals in addition to increasing pH. While the efficiency of most passive systems decrease during colder conditions or high flows, this can be compensated for by increasing the size of the system to provide greater retention times and accommodate higher flow rates. General descriptions of the treatment technologies evaluated for the Site are described below:

<u>Technology Class: Engineering Controls/Active Treatment</u>

Active Lime Dosing
Lime product (generally pebble quicklime or hydrated lime) is mechanically introduced into a stream in regular increments. The lime particles may be stored and dispensed from a large hopper. The doser can be electric powered or water driven. Maintenance, weather, regular access, vandalism, and the need to adjust the dosing rate require regular maintenance. While in-stream dosing can be an effective restoration alternative for low pH, dosing does not address metal precipitants and O&M costs can be very high. Therefore, active lime dosing was screened out as a candidate technology.

Active Limestone Sand Dumping
Limestone fines are added directly into a stream. Unlike dosing where the limestone is released incrementally, an entire truckload of limestone is literally dumped into the stream. Additional limestone is dumped after the previous dump has dissolved. Limestone sand dumping requires a

strong stream flow and a relatively steep gradient to move the sand grains downstream and mobilize metal precipitates. Because limestone dumping does not address metal precipitants and the relatively low flow and shallow stream gradients in Ore Hill, active limestone sand dumping was screened out as a candidate technology.

Technology Class: Engineering Controls/Passive Treatment

Open Limestone Channel (OLC)
An OLC is an adequately sized open channel that contains large limestone and conveys and can treat AMD. Ideally, the OLC should be on a fairly steep slope (greater than 10 percent) to ensure sufficient oxygen necessary to precipitate metals and to transport the metal precipitates down the channel, otherwise the metals (ferric iron and aluminum hydroxides) will precipitate onto the limestone decreasing the efficiency of the system. An OLC is suited for AMD with high dissolved oxygen (DO), elevated metal concentrations, and low pH. OLCs were retained as a candidate technology, primarily to provide some degree of pH adjustment above the main pond.

Anoxic Limestone Drain (ALD)
An ALD is a buried channel containing limestone that is designed to limit oxygen contact with the mine discharge. An ALD requires relatively low metal concentrations (dissolved aluminum <1 milligram per liter [mg/L] and <1 mg/L ferric iron) and low DO (<1 mg/L). Typically, an ALD is used upstream of aeration and a wetland system of settling ponds to allow for ferrous ion oxidation and precipitation. High aluminum and high DO will limit the applicability of this alternative at Ore Hill. ALDs were screened out because of the plugging potential and near neutral conditions at the main pond.

Settling Pond
Settling ponds are one of the most basic forms of passive treatment and are primarily used as a pretreatment step to remove suspended solids and precipitates that have formed on contact with the air. The ponds are typically sized to provide a minimum retention time of 24-hours to allow all of the larger particles to settle out. Periodic dredging is usually required to remove the accumulated sediment. Settling ponds were retained as a candidate technology.

Aerobic Wetland
Aerobic wetlands are shallow, surface flow wetlands with emergent vegetation. They provide residence time and aeration to promote precipitation and oxidation of metals, particularly aluminum, iron, and manganese. Metal removal efficiency depends on several factors, including metals concentrations, dissolved oxygen content, pH, net alkalinity of the water, detention time, and presence of microbial biomass. They are most suitable to relatively low flows and water with a net alkalinity; pre-treatment with another limestone-based technology may be required to raise the pH of incoming water to above 6. Wetland vegetation is planted in relatively impermeable sediments to provide adsorption surfaces for the metals and algal growth. Periodic dredging may be required to remove the accumulated metal hydroxides. Removal efficiency tends to decrease with high flows or cold climate conditions; however, the efficiency can be improved by sizing the wetland to provide additional retention time. Because of the neutral pH water in the main pond and the available area, aerobic ponds were retained as a candidate technology.

Anaerobic Wetland
Anaerobic wetlands are deeper subsurface flow wetlands that combine metal oxidation and hydrolysis in aerobic surface layers with a deeper more permeable substrate of organic material to promote chemical and microbial reduction reactions to precipitate metals. They are suitable for acidic or alkaline water with high concentrations of iron and dissolved oxygen. Anaerobic wetlands

incorporate deeper flow through wetland vegetation and a permeable organic mixture of compost, straw/manure etc., underlain or mixed with limestone. Alkalinity is generated through a combination of bacterially mediated sulfate reduction and limestone dissolution. In some cases, a downstream, aerobic settling pond may be needed for oxidation and metal precipitation. Periodic dredging may be required to remove the accumulated metal hydroxides. As with aerobic wetlands, removal efficiency tends to decrease with high flows or cold climate conditions; however, the efficiency can be improved by sizing the wetland to provide additional retention time. Compared to aerobic wetlands, anaerobic wetlands can provide enhanced treatment and metals removal because of the formation and precipitation of metal sulfides, and therefore, apply to a broader range of metals. Anaerobic ponds were retained as a candidate technology.

Sulfate Reducing Bioreactor (SRB)
SRBs can range from complex systems composed of tanks or lined trenches to specially constructed anaerobic wetlands. SRBs use sulfate-reducing bacteria to produce sulfide ions that precipitate metals as sulfides. They require relatively neutral water (pH from 5 to 8), a source of organic carbon (e.g. saw dust, cow manure, compost, etc.), a reducing or anaerobic environment, and matrices for microbial attachment and development. In some cases limestone is also added to the substrate to increase alkalinity. Whether constructed in tanks, trenches, or a wetland, they require flow through a multi-layered substrate and typically employ a system of collection pipes under the substrate to convey the treated effluent to a discharge point. If improperly designed, the substrate and piping can be subject to plugging. The pipes may also be prone to freezing in cold climates. Removal efficiency tends to decrease with high volume flows, highly acidic inflow, or cold climate conditions; however, they have been proven to be effective in some cold environments. Proper design is critical to success and pilot studies or batch tests are typically used to optimize the system design. Periodic dredging may be required to remove the accumulated metal hydroxides and the organic substrate and sulfate reducing bacteria may require periodic replenishment. While they require careful design and significant maintenance, metals removal efficiency can be very high for a broad range of metals. While a tank or trench system could both be used at the Site, the existing main pond area is well configured for a SRB vertical flow wetland; therefore, SRBs were retained as a candidate technology.

Successive Alkalinity Producing System (APS or SAPS):
SAPS combine the use of an ALD and an anaerobic wetland. Oxygen concentrations are often a design limitation for ALDs. They are generally ineffective where DO concentrations are greater than 1 or 2 mg/L. In situations where the DO concentrations are above 1 or 2 mg/L, the water can be introduced into an anaerobic pond. In APS and SAPS, a mechanical drainage system is installed in the bottom of the pond. The drainage pipes are overlain by limestone, which is then overlain by organic material. Water ponds over the organic layer to a depth of 4 to 8 feet. The principle is to introduce the semi-aerated water into the pond and cause the water to move down through the organic matter to filter out ferric iron or reduce it by microbial iron reduction to ferrous iron. The reduced water then continues downward into the limestone, picking up additional alkalinity by limestone dissolution. The water then discharges through the drainage system in the bottom of the pond, ideally having a pH of above 6 and a much higher level of alkalinity in the water. The treated water is then aerated and the metals precipitate in a sedimentation pond or aerobic wetland. SAPS are prone to plugging and the construction and O&M costs can be significant. SAPS were screened out because of near neutral conditions at the main pond and high O&M requirements.

Limestone Pond (LSP):
An LSP is a relatively new passive treatment technology where a pond is constructed at the upwelling of an AMD seep or underground water daylight point. Limestone is placed in the bottom of the pond and the water flows through the limestone. LSPs are most suitable with water at a pH less than 3 and are sized with minimal residence time so that the pH remains below 3. At this pH, minimal ferric iron

will precipitate. This technology could be incorporated with a limestone-based treatment at the AMD locations. Like OLCs, this method has the potential to inexpensively remove approximately 10 to 15 percent of the acid load. However, because of the limited landscape available for a pond at the adit portal and near neutral acid conditions in the lower portions of the drainage, LSPs were screened out.

Limestone Leach Bed (LLB):
A LLB is a buried cell or trench of limestone through which the impacted water flows. The limestone dissolves in the water and increases alkalinity. The purpose of LLBs is to provide alkalinity to fresh water sources upstream of any AMD location or to condition AMD before subsequent precipitation of metals downstream. A mechanical drainage system is installed in the bottom of the bed and requires periodic flushing. The piping systems typically used as underdrains require significant maintenance and significant elevation differences to operate. LLBs were screened out because of the potential for plugging with aluminum hydroxide and high maintenance requirements.

Slag Leach Bed (SLB):
Steel slag, a by-product of steel manufacturing, is produced during the separation of molten steel from impurities in steel-making furnaces. Steel slags are often locally available in large quantities at low cost. Studies indicate that, when charged with non-metalliferous water, columns of steel slag maintain constant hydraulic conductivity over time and produce highly alkaline leachate (>1,000 mg/L as $CaCO_3$). Steel slag can be used as an alkaline amendment as well as a medium for alkaline recharge trenches. Slags are produced by a number of processes so care is needed to ensure that candidate slags are not prone to leaching metal ions such as chromium, magnesium, nickel, or lead. Slag leach beds have been successfully used to improve the buffering capacity of clean surface water or groundwater prior to commingling with mine drainage. SLBs operate best when charged with fresh (non-metalliferous water) and kept saturated with constant flow to avoid wetting and drying cycles and prevent metals from precipitating and plugging the bed. Ore Hill lacks a steady source of fresh water and water at the main pond is already near neutral; therefore, SLBs were screened out.

Surface Water Diversion:
Diverting surface water upstream of AMD sites to decrease the amount of water entering mined or impacted areas is highly recommended in acid-producing areas. Channeling surface waters or mine waters to control volume, direction, and contact time can be used to minimize the effects of AMD on receiving streams and improve the retention time of impacted waters in treatment areas. The diversion of water from mining areas and from acid-producing materials is an abatement technique used in both surface and underground mines. Surface diversion of runoff involves the construction of drainage ditches to move surface water quickly off the Site before infiltration or commingling occurs, or to limit its movement into impacted areas to minimize flushing. The diversion is accomplished either by excavating a channel on the uphill side of surface mines or by diking to separate impacted water from storm water. Diversion methods are currently in use at the Site; therefore, surface water diversion was retained as a candidate technology.

Inundation (Saturation)
Inundation by physically restricting surface flows or constructing impoundments within an isolated area of a surface mine has been used to minimize or eliminate pyrite oxidation. Inundation of acid-producing materials, such as flooding underground workings may be less expensive than traditional reclamation by backfilling and planting. However, the quality of impounded waters flowing from acidic areas has not always improved following inundation. In general, while pH has not always shown marked improvement, some reduction in total acid and iron concentrations typically occurs. At the Ore Hill Mine, the ore body dipped rather steeply and the workings are almost entirely lower in elevation than the discharge point at the adit. Therefore, the underground workings may be already

inundated and the adit may be the spill point and the workings may be inundated; however, this fact could not be verified with the existing information. Inundation was screened out.

Underground Mine Sealing

Deep mine sealing is defined as closure of mine entries, drifts, stopes, shafts, boreholes, barriers, outcrops, subsidence holes, fractures, and other openings into underground mine complexes. Deep mine seals are constructed to achieve one or more functional design goals including: (1) eliminating potential access to the abandoned mine works following closure, (2) minimizing AMD production by limiting infiltration of air and water into underground workings, (3) minimizing AMD production by maximizing inundation of the underground workings, (4) minimizing AMD exfiltration through periphery barriers to surface water systems, and (5) developing staged internal mine ponds to regulate maximum hydraulic head and pressure. Underground mine sealing was screened out because of limited access to underground workings.

Low Head Dam (LHD)

The purpose of a LHD is to aerate the stream and ensure that most, if not all, of the iron in the stream is in the ferric oxidation state. The limestone, or any other non-acid producing rock, used to build these dams should be sized according to expected peaks in hydraulic load. LHDs can be incorporated into several hydraulic control and treatment measures. LHDs can be used to create a treatment pond at the mine discharge source, as well as along the drainage and in the wetlands to maintain positive hydraulic control and distribute flows. LHDs were retained as a candidate technology.

Permeable Reactive Barrier (PRB)

Treatment of AMD by a PRB typically consists of installing a mass of reactive, permeable media in the path of groundwater flow. As water "passively" flows through the barrier, metals are removed or altered using a combination of physical, chemical, or biological processes. PRB media includes the proprietary materials ViroMine™ and Apatite II™. ViroMine™ utilizes a material processed from aluminum mining "red mud." This non-hazardous material removes/sequesters metals from AMD and is processed in different "reagent" formulations, depending on the pH and form of the mine wastes. The custom blend of reagents works by forming strong bonds with metals ions and converting them into insoluble, nonreactive sediment. ViroMine™ can be applied in liquid or solid form, depending on the media being treated. Another option involves placing the pelletized media in gabion structures and funneling the AMD through them for treatment.

PIMS™ is a remediation technology that uses a proprietary form of the mineral apatite, called Apatite II™, to stabilize dissolved metals in AMD by chemically binding them into insoluble phosphate minerals. Additionally, this media has strong non-specific adsorption properties and has been shown to provide buffering capacity and nutrients to stimulate microbial growth. Like Viromine™, Apatite II™ can be applied to contaminated water in a variety of ways, including emplacement as a PRB downgradient of the source.

Both the Viromine™ and PIMS™ have limited track records and their long-term effectiveness has not been determined. In addition, a pilot study is typically required with these systems to develop the optimum mixtures and application rates and methods. Because both Viromine™ and PIMS™ have shown promising results at other AMD sites, two small-scale pilot tests could be considered for Ore Hill. Viromine™ and PIMS™ were retained as potential candidate technologies.

The treatment technologies were assessed relative to others in the same sub-category based on effectiveness, implementability, and cost. This allowed each technology to be assigned a relative ranking of high, medium, or low for each evaluation criterion. Table 4 summarizes the results of the removal action technology screening process, including the technologies retained for incorporation into removal action alternatives.

The landscape characteristics that exist at the Site affect the applicability of these technologies. There are three key areas in the Ore Hill drainage with different physical characteristics and suitability for the various treatment technologies. Area 1 consists of concentrated AMD discharge at the Ore Hill adit and extends about 200 feet downstream to the main pond. Area 2 consists of the main pond where flows converge downstream of Area 1, and extends for approximately 100 feet. Area 3 continues downstream to the old road crossing just upstream of the confluence with the west drainage and AS05. Flows from Area 3 combine with flow from adjacent drainages at the confluence to form the Ore Hill Mine Tributary, which discharges to Ore Hill Brook. These areas are further described below:

Area 1: Concentrated Discharge at Adit (AS01, AS02 and AS03)
Concentrated AMD is present at the Ore Hill adit as groundwater upwelling from the underground mine workings in a localized area. The area is accessible from the existing access road and features a steep area with an excavation into the former adit. The adit discharge flow is expected to range from 0.5 to 2.0 gpm. The discharge flows through a channel in the bedrock for about 200 feet before converging with flow from the upper west area of the Site at the main pond. While the adit discharge has low pH and contains high concentrations of several metals at AS01, pH increases and metals concentrations significantly decrease by the time the flow reaches AS02. This natural process should not be disrupted but could be augmented with additional alkalinity treatment between the adit portal and main pond. Alkaline material could be placed in the existing bedrock channel to raise pH, increase alkalinity, and augment the existing natural processes. Area 1 also includes flow from the upper west area of the Site that converges with the adit discharge in the main pond. This flow is already neutral and would not benefit from alkalinity adjustment.

Area 2: Converging Flows at the Main Pond
Area 2 is located approximately 200 feet below the adit discharge, where the adit discharge mixes with surface flow from the upper west area of the Site in the main pond. The pond is approximately 100 feet long and 50 feet wide, and is contained by a small check dam installed during the previous removal action. This large, relatively level area is in bedrock and is ideal for increasing the hydraulic residence time in the watershed, extending the flow path, and controlling the hydraulic grade. The area is well suited for the application of a sedimentation basin and a constructed aerobic wetland. The objective of treatment in this area would be to promote settling and metals removal via a settling pond and engineered wetland or SRB.

Area 3: Channelized Flow and Small Ponds Between the Main Pond and Ore Hill Brook (AS04 and AS05)
Area 3 consists of the lower 150 feet of drainage and is closest to the culvert discharge. The existing check dams could be enlarged to provide additional retention and polishing to increase precipitation and metals removal. This area can be utilized for a final polishing step for additional metals removal by incorporating multiple stepped treatment cells (wetlands) or a passive flow through treatment system such as ViroMine™.

6.2 Identification of Removal Action Alternatives

Based on results of the removal action technology screening process, two conceptual removal action alternatives with multiple options were developed for detailed analysis, along with a No Action alternative for comparative purposes. The removal action alternatives include:

- **ALTERNATIVE 1 – NO ACTION**
- **ALTERNATIVE 2 – PARTIAL STAGED PASSIVE TREATMENT**
  - Option A – Anaerobic Wetlands
  - Option B – SRB
- **ALTERNATIVE 3 – COMPLETE STAGED PASSIVE TREATMENT**
  Alternative 2 plus:
  - Option A – ViroMine™ Media
  - Option B – Aerobic Wetlands

Each alternative and removal action elements that are common to all action alternatives are discussed below. All designs are conceptual only and subject to modification during final engineering design. The material quantities and flow rates provided in this section are estimates only and not intended for construction.

<u>Removal Action Elements to be Implemented for Both Action Alternatives</u>

- **Best Management Practices.** During removal activities, best management practices (BMP) will be employed to contain run-off, minimize erosion, and prevent sedimentation of the stream during the removal action. Specific BMPs will depend on the removal action selected and may include, but not be limited to: silt fencing, straw bales, check dams, temporary surface water diversions, sediment retention, and dust suppression.
- **Staging Area.** A temporary staging area will be developed at the Site to stage equipment and materials for the removal action. Upon completion of the removal action, the area will be reclaimed and re-seeded.
- **Temporary Dewatering and Bypass.** A temporary bypass will be constructed to convey the adit discharge and drainage from the upper west area of the Site around the main pond and working areas during construction. The bypass will consist of a small earthen channel and berms, as needed, to direct flows around the working areas and back into the natural drainage below the construction area.

<u>ALTERNATIVE 1 – NO ACTION</u>

This alternative consists of no further action and leaving the Site as is. The adit discharge and surface water would remain untreated.

<u>ALTERNATIVE 2 – PARTIAL STAGED PASSIVE TREATMENT</u>

This alternative involves initial passive treatment of the primary AMD discharge at the adit in Area 1 and staged passive treatment at the main pond in Area 2. Area 3 would remain as is. Treatment technologies include:

1) An OLC constructed in the existing channel from the adit to the main pond;
2) A settling pond in the upper portion of the main pond area; and
3) An anaerobic wetland or an SRB constructed in the lower portion of the main pond area.

The treatment technologies to be implemented under this alternative are discussed below and shown in Figures 3, 6 and 7.

Area 1: Adit Discharge
The primary source of AMD is discharge from the mine adit at AS01. The area is easily accessible from the existing access road and features a defined channel approximately 180 feet long, 4 feet wide, and ranging from 2 to 5 feet deep. Observed flows discharging from the adit have ranged from 0.5 to 1.2 gpm. A series of small rock check dams that were installed in the channel after the previous removal action have created two small ponds, approximately 60 feet apart. The initial treatment at AS01 would increase alkalinity and provide aeration for subsequent metal precipitation in the main pond.

The removal action tasks specific to Area 1 include:

- Constructing an OLC from the adit to the main pond.
  - Placing ~30 cy of coarse limestone aggregate (2 to 4-inch top-size) in a 12-inch layer in the bottom of the existing channel from the adit portal to the main pond (~180 feet). The existing check dams would be left in place.

Area 2: Main Pond
Area 2 consists of the main pond area where AMD from the adit and surface water drainage from the upper west area of the Site converge. About 100 feet downstream of the main pond at sampling location AS04, the pH is near neutral and the metal load has been greatly reduced compared to the adit discharge at AS01, presumably through a combination of settling, precipitation, and adsorption. Treatment in Area 2 would consist of slowing the flow down and promoting metals removal through precipitation and oxidation. Two options were considered for Area 2: (1) Option A – anaerobic wetlands, and (2) Option B – SRB. Both options include pre-treating with a settling pond.

The removal action tasks specific to both options include:

- **Settling Pond:**
  - Constructing a settling pond in the upper portion of the main pond area (Figure 3) by dividing the main pond into two ponds with an LHD about 60 feet upstream of the existing check dam that forms the main pond area. The upper pond formed by the new LHD will act as a large settling basin.
  - The LHD would be 6 feet high and about 40 feet long with a 6-foot top width and 2H: 1V side slopes.
  - The LHD would be constructed of ~200 cy of well-graded, coarse aggregate rock (6 to 8-inch top-size or New Hampshire Department of Transportation (NHDOT) Type C Rock Channel Protection).
  - A layer of filter fabric (~80 square yards [sy]) would be installed over the inside dam face and covered with a 6- to 12-inch-thick layer (~20 cy) of clean soil to increase retention time.
  - The settling pond would provide an estimated retention time of more than 30 days during low flow (~1 gpm) conditions in the winter to approximately 3.5 days during a peak flow of 10 gpm.
- **Option A – Anaerobic Wetland:**
  - Constructing an anaerobic wetland in the main pond area immediately downstream of the settling pond described above (Figure 3) by enlarging the existing check dam to create a LHD at the lower end of the main pond. Approximately 160 cy of well-graded, coarse aggregate rock (6 to 8-inch top-size or NHDOT Type C Rock Channel Protection) would be added to the existing check dam.
  - The LHD would be 6 feet high and about 50 feet long with a 6-foot top width and 2H:1V side slopes.

  - A spillway would be incorporated to direct the outflow and limit flow depth in the wetland to about 1 foot.
  - A layer of filter fabric (~80 sy) would be installed over the inside dam face to increase retention time, thereby allowing more precipitates to settle and increasing plant soil interaction.
  - A 6-inch deep layer of crushed limestone (~40 cy) would be placed over the wetland bottom in one loose lift.
  - An organic and gravel substrate mix (~270 cy) would be placed on the LHD face and wetland bottom and banks to the wetted perimeter. The media would be loosely placed to a minimum depth of 3 feet and consist of a 40 percent gravel and 60 percent organic material (e.g. sawdust, alfalfa hay, mushroom compost or manure). Baffles would be installed to lengthen the flow path and prevent short circuiting the system.
  - Wetland vegetation would be harvested from local sources and be compatible with local climate. Local wetland vegetation species tolerant to cold climates and heavy metals are preferred, if available.
  - Assuming a flow depth of 1 foot, the wetlands would provide an additional 11.6 days of retention time during low flow (~1 gpm) conditions and 1.2 days during a peak flow of 10 gpm.
- **Option B – SRB:**
  - Conducting a small-scale pilot study and batch testing to determine the optimal organic substrate mix and system configuration.
  - Constructing an SRB in the main pond area immediately downstream of the settling pond described above (Figure 3) by enlarging the existing check dam to create a LHD at the lower end of the main pond. Approximately 160 cy of well-graded, coarse aggregate rock (6 to 8-inch top-size or NHDOT Type C Rock Channel Protection) would be added to the existing check dam.
  - The LHD would be 6 feet high and about 50 feet long with a 6-foot top width and 2H:1V side slopes.
  - A layer of high density polyethylene (HDPE) or polyvinyl chloride (PVC) liner (~120 sy) would be installed over the inside dam face and extend about 20 feet onto the exposed bedrock bottom to increase retention time. Because the area is on exposed bedrock and infiltration losses are expected to be minimal, a liner should not be required for the entire bottom or sides.
  - A 12-inch deep layer of coarse drain rock (~90 cy) would be placed on the pond bottom. A network of perforated collection pipes would be installed in the drain rock to collect and convey the flow to a riser pipe that discharges to the downstream face of the LHD. A layer of geotextile filter fabric (~270 sy) would be placed over the drain rock and collection pipes to prevent plugging.
  - An organic substrate mix (~450 cy) would be placed on the LHD face and wetland bottom and banks to the wetted perimeter. The media would be loosely placed in layers to a minimum depth of 5 feet and consist of a mix of limestone or gravel and organic material that may include sawdust, wood chips, alfalfa hay, mushroom compost, manure or similar materials. The exact mix and ratio of materials would be determined during the pilot study and batch testing.
  - Installing inspection ports or other means of inspecting the organic strata and collection pipes for plugging.

ALTERNATIVE 3 – COMPLETE STAGED PASSIVE TREATMENT

This alternative combines the treatment technologies and tasks outlined in Alternative 2 with additional passive treatment at the southern edge of Area 3 to promote manganese removal and provide a final polishing step. Area 3 consists of the lower 300 to 400 feet of drainage closest to Ore Hill Brook.

Downstream of the main pond, the flow combines with groundwater discharges in braided channels over multiple "benches" formed from sediment deposition (after the removal action in 2006) and/or the initial (2006) removal activities (excavations to bedrock). Two check dams installed after the previous removal action have created two small ponds in the main channel. Flow from the last pond discharges through a culvert under the old road and converges with Ore Hill Brook below the excavated area.

Two options were considered for Area 3: (1) Option A – ViroMine™ media, and (2) Option B – aerobic wetlands. Under Option A, the flow would be passed through three gabion filtration baskets placed in series in an HDPE-lined channel. The gabions would be filled with a mixture of riprap and ViroMine™ pelletized media, essentially creating a partially aboveground PRB. The gabions would provide a flow-through structure that would allow the ViroMine™ media to react with dissolved metals in the water. ViroMine™ utilizes a material processed from aluminum mining "red mud." It is believed that this non-hazardous material would remove and/or sequester the remaining dissolved metals not treated by the methods described in Alternative 2. The custom blend of reagents would form strong bonds with the metals ions and convert them into an insoluble, nonreactive sediment. Placing three gabions in series would provide extended contact with the reactive media and slow the flow down to promote metals precipitation. Because the ViroMine™ technology is proprietary, available design information or guidance is very limited. Therefore, the design presented below is conceptual based on the available information and the material quantities are estimates only and should be more accurately quantified for final design of the selected removal action alternative. More detailed design information will be required for the final engineering design and a pilot-study is typically required to develop the optimum reagent mixture and application rate.

Under Option B, a series of two aerobic wetlands would be installed in the existing ponds upstream of the two check dams installed after the previous removal action. The check dams would be enlarged to create LHDs and the upstream areas would be augmented with wetland soil and vegetation to create aerobic wetlands. The wetlands would increase hydraulic retention and soil and plant interaction to promote additional metals removal and provide a final polishing step. Based on a flow depth of 1 foot, the two wetlands would provide a combined retention time of about 4.9 days during low flow (~3 gpm) conditions in the winter and 0.5 days during a peak flow of 30 gpm.

The treatment technologies to be implemented under this alternative are discussed below and shown in Figures 4 and 8.

Areas 1 and 2:
The removal action tasks specific to Areas 1 and 2 are the same as those proposed in Alternative 2.

Area 3: Channelized Flow and Minor Ponds Downstream of the Main Pond
The removal action tasks specific to Area 3 include:

- **Option A – ViroMine™ media:**
    - Conducting a pilot study to optimize the ViroMine™ media mix and system configuration.
    - Constructing a rectangular channel with three gabions across the drainage at the southern end of Area 3 and breaching the existing check dam to funnel flow into the channel (Figure 5).
    - Constructing (~20 cy) a 30-foot long rectangular channel with a 3-foot bottom width and 3-foot depth, and 2H: 1V side slopes.
    - Installing a 60-mil HDPE liner along the bottom and sides of the channel with excess top place over top of trench and anchor (~50 sy).
    - Installing three 3-foot wide by 3-foot long by 3-feet high gabions, each containing a mixture of riprap and 1 ton of ViroMine™ pelletized product.

- Placing the HDPE liner over the completed trench, covering with 1 foot of soil (~20 cy), and lightly compacting.
  - Placing the residual excavated soil along the up slope sides of the trench to prevent the intrusion of storm water run on.
- **Option B – Aerobic Wetlands:**
  - Constructing two aerobic wetlands by enlarging the two existing check dams to create LHDs.
  - Each LHD would be 4 feet high and 50 feet long. The LHDs would have 2H:1V side slopes and a 4-foot top width.
  - Each LHD would be constructed of ~50 cy of well-graded, coarse aggregate rock (6 to 8-inch top-size or NHDOT Type C Rock Channel Protection).
  - Spillways would be incorporated to direct the outflow and limit flow depth in the wetlands to about 1 foot.
  - Filter fabric (~80 sy each) would be installed over the inside dam faces to increase retention time, thereby allowing more precipitates to settle and increasing plant soil interaction.
  - Wetland growth media (~230 cy total) would be hauled to the Site and placed on the LHD face and wetland bottom and banks to the wetted perimeter. The media would be placed in one 2-foot layer and consist of a 40 percent gravel and 60 percent loam mixture.
  - Wetland vegetation would be harvested from local sources and be compatible with local climate. Local wetland vegetation species tolerant to cold climates and heavy metals are preferred, if available.

6.3 Analysis of Selected Removal Action Alternatives

The removal action alternatives were evaluated based on the following criteria:

- Effectiveness
- Implementability
- Relative cost

Effectiveness is defined as the ability of an alternative (relative to other options in the same technology sub-category) to:

- Protect public health and the community, protect workers during implementation, and protect the environment – addresses whether or not the remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls; and
- Comply with ARARs – addresses whether or not a remedy will meet all ARARs or other federal and state environmental statutes and/or provide grounds for invoking a waiver.

Implementability encompasses the technical and administrative feasibility of implementing a removal action and the availability of resources needed to implement the removal action. It also takes into account legal considerations. Factors of particular consideration include removal action and operational feasibility; availability of equipment, personnel, and treatment capacity; community acceptance; and the ability to obtain necessary permits for off-site actions.

- Technical feasibility – refers to construction and operational considerations, the demonstrated performance and useful life, adaptability to site-specific environmental conditions, whether it contributes to remedial performance, and whether it can be implemented within 1 year.

- Administrative feasibility – refers to the permits required, easements or right-of-ways required, impacts on adjoining properties, the ability to implement institutional controls, and the likelihood of obtaining an exemption from statutory limits, if needed.
- Availability – includes the availability of equipment, personnel and services, outside laboratory testing services (if needed), off-site treatment and disposal capacity (if needed).

The relative cost of each alternative was evaluated based on professional experience, engineering judgment, and standard cost estimating tools. Primary cost considerations include:

- Capital costs,
- Engineering and design costs, and
- O&M costs.

The estimated costs for each task are summarized in Table 5. Costs are based on experience at similar sites, on published data and reports, and on inquiries to possible vendors. Many removal action unit costs were obtained from R.S. Means (2004) data, and include overhead and profit. The unit costs were adjusted to represent 2008 values. Estimated costs relied on several significant assumptions regarding site conditions. The estimated costs are intended for alternative comparison only and are not suitable for removal action construction planning. O&M costs were estimated using a combination of (1) the anticipated life expectancies for key features that will require replenishment/reconstruction (e.g. OLCs, SRB, ViroMine™), and (2) a percentage (4 percent) of the capital construction costs for the wetlands. The estimated costs represent the long-term average annual O&M costs; actual costs will vary from year to year. All costs are presented in terms of present value. A detailed breakdown of the estimated O&M costs is provided in Appendix D.

Assumptions made in preparing the cost estimate include:

- All removal actions can be completed in one field season using standard removal action equipment.
- All materials will be purchased and transported from an off-site source. Assumed available source within 50 miles of the Site.
- The Site is easily accessible from the existing access road; improvements to the road are not expected.
- The Site does not contain any other hazardous materials.
- Monitoring costs are based on biannual site visits for a 3-year period following completion of removal action.
- Fees based on removal action costs included 25 percent for construction management, plus a 20 percent contingency on total project costs.
- Present value corrections were not calculated because of the short duration of the removal action and monitoring.

A detailed analysis of each alternative is provided below.

ALTERNATIVE 1 – NO ACTION

This alternative involves leaving the Site in its current condition.

Effectiveness

The overall effectiveness of the No Action alternative is low. Under the existing conditions, AMD discharging from the adit would continue to contribute metals loading to Ore Hill Brook. Surface water impacts would not be addressed and no controls on contaminant migration would be provided. There would not be any reduction in contaminant toxicity, mobility or volume. No protection of human health or the environment would be achieved. This alternative would not achieve any of the RAOs or comply with ARARs.

Implementability
This alternative is both technically and administratively feasible, and the availability of resources would not be an issue. However, agency and public acceptance is not likely.

Cost
There are no capital or O&M costs associated with this alternative. However, there may be significant long-term costs associated with future impacts or releases. There may also be non-monetary costs associated with ecological impacts to wildlife and the aquatic community.

ALTERNATIVE 2 – PARTIAL STAGED PASSIVE TREATMENT
This alternative involves initial passive treatment of the primary AMD discharge at the adit in Area 1 and staged passive treatment at the main pond in Area 2.

Effectiveness
Both treatment technologies in this alternative should significantly reduce metal loads to Ore Hill Brook but the SRB (Option B) should have a higher removal efficiency than the anaerobic wetland (Option A) because of greater microbial action and extended contact with the organic media. The improvement in surface water quality would reduce risks to human health and the environment from exposure to high concentrations of metal. This alternative would achieve the RAOs and comply with ARARs to the extent practical. Short–term effectiveness for the anaerobic wetland is expected to be better than the SRB because a pilot study is not required. The short-term effectiveness of both options will also depend on the time of year constructed and both may require one or more field seasons for bacterial development and to become fully efficient. Long-term effectiveness should be high for both options based on a significant improvement to surface water. Periodic O&M will be required to monitor surface water quality, repair erosive areas, replenish limestone components, and remove accumulated metals-laden precipitates. O&M is expected to be significantly higher for the SRB to monitor the pipes and substrate for plugging.

Implementability
Both options are technically and administratively feasible. The proposed technologies are implementable using standard construction methods and equipment, and the required resources are readily available.

Cost
[redacted] Biannual surface water quality monitoring for 3 years would cost approximately **$12,000** for either option.

ALTERNATIVE 3 – COMPLETE PASSIVE TREATMENT
This alternative combines the treatment technologies and tasks outlined in Alternative 2 with additional passive treatment at the southern edge of Area 3.

Effectiveness
The combined treatment technologies in this alternative would result in high removal of metals from the surface water. Both options should reduce the contaminant volume and improve surface water quality, which would reduce risks to human health and the environment from exposure to high concentrations of metals. Based on case studies at other mine sites, treatment with ViroMine™ media (Option A) can significantly remove metals but the efficiency is speculative and a pilot study would be required. Both

options, when combined with Site improvement from Alternative 2, would achieve the RAOs and comply with ARARs to the extent practical. Short-term effectiveness of the aerobic wetlands (Option B) would be high based on an immediate improvement to surface water. Short-term effectiveness of the ViroMine™ system should also be high once the pilot study has been completed and a full-scale system constructed; however, the long-term effectiveness will depend on the longevity of the media. O&M requirements will be similar to Alternative 2 for the wetlands. The ViroMine™ system will require periodic replacement of the ViroMine™ media.

<u>Implementability</u>
Both options are technically and administratively feasible. The proposed technologies are implementable using standard construction methods and equipment. The ViroMine™ media would need to be purchased and shipped to the Site and installed. This media would have to be replaced approximately every 5 to 10 years. Limited information is available on ViroMine™; therefore, a pilot study is needed to optimize the system for maximum removal efficiency, as well as determine placement of the product based on stream characteristics.

<u>Cost</u>
[redacted]

[redacted] Biannual surface water quality monitoring for 3 years would cost approximately **$12,000** for either option.

6.4 Identification of Data Gaps

Data gaps identified during the preparation of this Supplemental EE/CA include:

- Potential borrow sources not identified and characterized; and
- Size of the existing check dams.

Broad assumptions regarding the data gaps above were used in the development of designs presented in this Supplemental EE/CA. The data gaps, potential issues, and recommended actions are discussed below.

Data Gap	Potential Issues	Recommended Action
• Potential borrow sources not identified and characterized	• Cannot determine the distance the borrow will have to be hauled.	• It is assumed that an acceptable borrow source will be available within 50 miles from the Site. At the time of the removal action closer sources can be evaluated.
• Size and geometry of the existing check dams is unknown	• Cannot accurately determine the amount of rock that will need to be added to the existing check dams.	• During the removal action final design, the check dams should be measured to determine the volume of additional rock needed to achieve the desired configuration.

7.0 COMPARATIVE ANALYSIS OF REMOVAL ACTION ALTERNATIVES

The removal action alternatives were compared based on the following criteria:

- **Effectiveness**
  - Achieves RAOs
  - Protective of human health (including public health and safety) and the environment
  - Complies with ARARs
  - Long-term effectiveness and permanence
  - Reduction of toxicity, mobility and volume
  - Short-term effectiveness
- **Implementability**
  - Technical feasibility
  - Administrative feasibility (including State and Federal Agency and Community acceptance)
  - Availability of resources
- **Cost** (including Removal Cost and future O&M cost)

The comparative analysis of removal action alternatives is summarized in Table 6.

Alternative 1 is the least effective and does not achieve RAOs, does not provide protection to human health or the environment, and does not comply with ARARs. Alternative 1 is the easiest to implement from a technical standpoint and requires the least resources; however, due to lack of effectiveness, it probably would not meet with State Agency, USDA-FS, or Community acceptance. This Alternative is the least expensive.

Alternative 2 Option A exceeds Alternative 1 for all the criteria listed under effectiveness. This alternative would be readily implementable with available resources, and should be at least minimally acceptable to interested parties. This alternative is the least costly of those likely to be deemed acceptable.

Compared to Alternative 2 Option A, Alternative 2 Option B (the SRB) appears to have more advantages in terms of most of the effectiveness criteria. Alternative 2 Option B should provide better water quality, a higher level of human health and ecological protection, and greater compliance with ARARs, although it would require a pilot study, delaying implementation and thereby reducing short-term effectiveness. Option B is expected to provide a higher level of metals removal efficiency but may be prone to plugging. Though technically and administratively feasible, this alternative would be less easily implemented than Alternative 2 Option A. This option would require a significantly greater commitment of funds than

Alternative 2 Option A (both construction and O&M costs are approximately 40 percent higher for Option B), and a greater long-term improvement in water quality would be anticipated compared to Alternative 2 Option A.

Alternative 3 is essentially a water quality “polishing” alternative, and assumes that either Alternative 2 Option A or Alternative 2 Option B is selected. Alternative 3 has two options, and either option would provide additional advantages in terms of most of the effectiveness criteria compared to either Alternative 2 option selected. Alternative 3 options are believed to be acceptable in terms of implementability, and either Alternative 3 option increases the cost over Alternative 2 alone.

Alternative 3 Option A (the ViroMine^{TM} system) offers potentially greater effectiveness than Alternative 3 Option B as the ViroMine^{TM} system reportedly can be more efficient at metals removal than aerobic wetlands. The limited information available on ViroMine^{TM} system performance is impressive. A ViroMine^{TM} system would require a pilot study to optimize and configure, and could require relatively frequent replacement of the treatment media. The cost information available indicates that the ViroMine^{TM} system (Option A) costs significantly less than the aerobic wetlands (Option B); information on system lifespan and costs is very limited; however, and claims by the company regarding these factors lack significant case study documentation

All alternatives are relatively easy to implement and technically and administratively feasible. The long-term effectiveness for all alternatives is speculative and will need to be evaluated through periodic surface water quality monitoring. In addition, long-term maintenance will be required to ensure continued effectiveness and permanence.

8.0 RECOMMENDED REMOVAL ACTION ALTERNATIVE

Key features of the recommended alternative are discussed below. Details are provided in Section 6.2 and on Figure 5 through 7. The recommendation expressed here is based on the analysis discussed in Sections 6.3 and 7.0, and 8.0 and summarized in Table 6.

The recommend alternative is a combination of Alternatives 2 and 3, and consists of:

- **ALTERNATIVE 2 – PARTIAL STAGED PASSIVE TREATMENT**
  - Option B – SRB
- **ALTERNATIVE 3 – COMPLETE STAGED PASSIVE TREATMENT**
  - Option B – Aerobic Wetlands

An OLC would be installed from the Ore Hill adit to the main pond by placing a 12-inch deep layer of limestone in the existing channel. The OLC would provide additional alkalinity and aeration to the adit discharge. A settling pond and SRB would be installed in the main pond area to increase hydraulic retention and promote the oxidation and precipitation of metal hydroxides and sulfides. Two aerobic wetlands would be installed in Area 3 to further increase retention time, promote removal of manganese and other metals, and provide a final polishing step. The aerobic wetlands were selected over the ViroMine^{TM} system because the wetlands are a proven technology that should work well at the site. There is very little available information regarding ViroMine^{TM} and the reported removal efficiencies, maintenance requirements, and costs are not well documented.

Periodic O&M will be required to monitor surface water quality, monitor the SRB pipes and substrate for plugging, repair erosive areas and replenish limestone and organic media. Metal-laden precipitate will be a by-product of the proposed passive water treatment system and will be captured and addressed periodically, as needed, by the USDA-FS.

The recommended alternative would treat an average of ~14,400 gallons of AMD per day at an average flow of 10 gpm. The recommended alternative should achieve a considerable reduction in metal loading to Ore Hill Brook. [redacted] and the estimated average annual O&M cost is **$5,968** including the periodic replacement of lime-based and organic components. Biannual surface water quality monitoring for 3 years would total approximately **$12,000.**

The proposed alternative will satisfy the eight factors in 40 CFR 300.415(b) as described below.

Factor	Site Condition	Satisfied?
(1) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances, pollutants, or contaminants.	Overall surface water quality at the Site should improve significantly reducing the human health and ecological risks.	Yes
(2) Actual or potential contamination of drinking water supplies or sensitive ecosystems.	There is no public water supply at the Site and surface water will be treated to the extent practical based on ARAR-based criteria. Potential ecological impacts should be minimized by improving water quality. Ground water is beyond the scope of this removal action.	Yes
(3) Hazardous substances, pollutants, or contaminants in drums, barrels, tanks, or other bulk storage containers that may pose a threat of release.	No drums, barrels, tanks, or bulk storage containers on the Site.	Yes
(4) High levels of hazardous substances, pollutants, or contaminants in soils largely at, or near, the surface that may migrate.	Sediment will be contained within a subaqueous environment and transport potential will be minimized.	Yes
(5) Weather conditions that may cause hazardous substances, pollutants, or contaminants to migrate or be released.	Storm water will be diverted around the treatment areas, which will minimize the potential for erosion and contaminant migration.	Yes
(6) Threat of fire or explosion.	No flammable materials on the Site.	Yes
(7) The availability of other appropriate federal or state response mechanisms to respond to the release.	The site is on USDA-FS land and is being addressed by the USDA-FS.	Yes
(8) Other situations or factors that may pose threats to public health or the environment.	None.	Yes

The proposed removal action designs presented in this Supplemental EE/CA are conceptual. All material quantities are estimates only and should be verified for construction.

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Tables

TABLE 1
Plymouth State University Surface Water Sample Results Summary
Ore Hill Mine Supplemental EE/CA

Sample Date	Sample ID	Flow (gpm)	pH	Hard	Total Analyte Concentration (mg/L)																	
					Ag	Al	As	Ba	Be	Cd	Cr	Cu	Fe	Hg*	Mn	Ni	Pb	Sb	Se	Ti	V	Zn
6/26/2007	OHB1 (background)	--	6.70	10	ND	0.025	ND	ND	ND	0.0001	ND	0.0020	0.01	ND	ND	ND	ND	ND	0.01	ND	ND	0.03
	AS01	0.54	4.18	105	ND	3.623	0.01	0.44	0.0012	0.041	ND	0.5314	0.02	0.69*	0.37	0.01	1.95	0.01	0.01	ND	0.01	14.35
	AS02	0.48	6.93	264	ND	0.026	ND	0.59	ND	0.016	ND	0.0420	0.19	ND	0.26	0.01	0.06	0.01	ND	ND	ND	4.31
	AS03	3.96	7.38	156	ND	0.046	ND	1.05	ND	0.008	ND	0.0560	0.03	ND	0.10	ND	0.05	0.01	ND	ND	ND	1.03
	AS04	6.18	7.14	201	ND	0.044	ND	0.80	ND	0.021	ND	0.0489	0.37	ND	0.22	ND	0.15	ND	0.01	ND	ND	3.42
	AS05	9.51	7.26	210	ND	0.030	ND	0.63	ND	0.014	ND	0.0321	0.16	ND	0.22	ND	0.04	ND	ND	ND	0.01	2.16
	AS06	9.03	6.82	150	ND	0.038	ND	0.97	ND	0.009	ND	0.0268	0.04	ND	0.08	ND	0.05	ND	ND	ND	ND	1.98
7/31/2007	OHB1 (background)	--	6.13	10	ND	0.034	ND	ND	ND	0.0001	ND	0.0040	ND	ND	ND	ND	ND	0.05	ND	ND	ND	0.06
	AS01	0.68	5.02	117	0.05	4.067	ND	0.48	ND	0.042	ND	0.5941	0.07	ND	0.40	0.01	1.93	ND	ND	ND	ND	15.21
	AS02	0.73	6.59	260	0.05	0.026	ND	0.75	ND	0.024	ND	0.0403	0.09	ND	0.36	0.01	0.07	0.01	0.01	ND	ND	8.84
	AS03	0.78	7.42	169	0.05	0.062	ND	0.76	ND	0.003	ND	0.0486	0.04	ND	0.06	ND	0.09	0.01	ND	ND	ND	0.71
	AS04	1.9	7.09	325	0.05	0.048	ND	0.76	ND	0.012	ND	0.0413	1.29	ND	0.32	ND	0.20	0.01	ND	ND	ND	2.98
	AS05	NA	7.17	326	0.05	0.030	ND	0.70	ND	0.009	ND	0.0294	0.41	0.51*	0.32	ND	0.08	0.01	0.01	ND	ND	1.47
	AS06	6.82	6.84	185	0.05	0.062	ND	0.97	ND	0.006	ND	0.0288	0.03	ND	0.13	ND	0.10	0.01	ND	ND	ND	1.74
10/15/2007	OHB1 (background)	--	5.66	12	ND	0.062	0.01	ND	ND	ND	ND	ND	0.03	ND	ND	ND	ND	ND	ND	ND	ND	0.04
	AS01	1.16	4.40	138	ND	4.653	0.02	0.49	ND	0.052	ND	0.87	0.08	ND	0.45	0.01	2.17	0.01	ND	ND	ND	18.25
	AS02	1.65	6.45	244	ND	0.01	0.01	0.62	ND	0.038	ND	0.10	0.05	ND	0.42	0.01	0.04	ND	ND	ND	ND	14.97
	AS03	4.12	7.51	261	ND	0.05	0.01	0.87	ND	0.015	ND	0.14	0.06	ND	0.17	ND	0.07	ND	ND	ND	ND	1.55
	AS04	9.03	7.72	331	ND	0.05	0.01	0.77	ND	0.020	ND	0.12	0.28	ND	0.25	ND	0.10	0.01	ND	ND	ND	3.65
	AS05	11.89	7.24	359	ND	0.05	0.01	0.63	ND	0.017	ND	0.12	0.26	ND	0.32	ND	0.07	0.01	ND	ND	ND	3.08
	AS06	42.48	7.71	125	ND	0.05	ND	0.66	ND	0.008	ND	0.05	0.12	ND	0.16	ND	0.05	ND	ND	ND	ND	1.88
minimum (excluding background) =			4.18	10	ND	0.01	ND	ND	ND	ND	ND	0.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.04
maximum (excluding background) =			**7.72**	**359**	**0.05**	**4.65**	**0.02**	**1.05**	**0.0012**	**0.05**	**ND**	**0.87**	**1.29**	**0.69**	**0.45**	**0.01**	**2.17**	**0.01**	**0.01**	**ND**	**0.01**	**18.25**
average (excluding background)=			6.63	197	0.05	0.65	0.01	0.72	0.0012	0.02	ND	0.15	0.19	0.60	0.26	0.01	0.40	0.01	0.01	ND	0.01	5.08
Human Health Screening Criteria:																						
NH Water Quality Criteria, protection of human health, water and fish consumption, Table 1703.1 (2007)			6-9	NS	0.105	NS	0.000018	1	0.001	NS	0.001 (Cr^6)	1.0	0.3	0.00005	0.05	0.61	NS	0.014	0.17	NS	NS	5
EPA Recommended chronic ambient water quality criteria for human consumption of water and fish (2006)			5-9	NS	NS	NS	0.000018	1	NS	NS	NS	1.3	0.3	NS	0.05	0.61	NS	0.0056	0.17	NS	NS	7.4
Ecological Screening Criteria:																						
NH Water Quality Criteria, protection of aquatic life, Table 1703.1 (2008)			6.5-9	NS	NS	0.087	NS	NS	0.0053	0.0004	0.011 (Cr^6)	0.0013	1	0.00077	NS	0.007	0.0002	1.6	0.005	NS	NS	0.017
EPA Recommended chronic (CCC) ambient water quality criteria for freshwater aquatic life (2006)			6.5-9	NS	NS	NS	0.15	NS	NS	0.00005	0.011 (Cr^6)	0.0013	1	0.00077	0.12	0.007	0.0002	NS	0.005	NS	NS	0.017

Notes:

*Laboratory analysis of mercury using an ICP is generally not recommended and may provide falsely high results.

(pink) Human health screening criteria exceeded.

(green) Ecological screening criteria exceeded.

Screening criteria for hardness dependent metals are based on a receiving stream hardness of 10 and were converted to total concentrations where applicable.

EPA = U.S. Environmental Protection Agency

ND = Not detected

NH = New Hampshire

NS = No standard

gpm = Gallon per minute

TABLE 2
Human Health and Ecological Risk Evaluation Summary
Ore Hill Mine Supplemental EE/CA

Analyte	Maximum Detected Concentration	Sample Location	Units	Screening Criteria			Potential Risk	
				Aquatic Life[a]	Human Health[b]	BLM RMC[c]	Ecological	Human Health
Aluminum	**4.65**	AS01[f]	mg/L	0.087	NS	NS	53	—
Antimony	**0.01**	OHB1	mg/L	1.6	0.0056	0.124	<1	2
Arsenic[d]	**0.02**	AS01[f]	mg/L	0.15	0.000018	0.093	<1	850
Barium	**1.05**	AS03	mg/L	NS	1	NS	—	1.1
Beryllium	**0.0012**	AS01[f]	mg/L	0.0053	0.001	NS	<1	1.2
Cadmium	**0.05**	AS01[f]	mg/L	0.00005	NS	0.155	1040	<1
Chromium	ND	—	mg/L	0.011	0.001	NS	—	<1
Copper	**0.87**	AS01[f]	mg/L	0.0013	1	11.49	669	<1
Iron	**1.29**	AS04	mg/L	1	0.3	NS	1.3	4
Lead	**2.17**	AS01[f]	mg/L	0.0002	NS	0.05	10860	43
Manganese	**0.45**	AS01[f]	mg/L	0.12	0.05	1.548	4	9
Mercury[e]	**0.69[e]**	AS01[f]	mg/L	0.00077	0.00005	0.093	896[e]	13800[e]
Nickel	**0.01**	AS01[f]	mg/L	0.007	0.61	6.194	2	<1
Selenium	**0.01**	AS05	mg/L	0.005	0.17	1.548	2	<1
Silver	0.05	AS05	mg/L	NS	0.105	1.548	—	<1
Titanium	ND	—	mg/L	NS	NS	NS	—	—
Vanadium	0.01	AS01[f]	mg/L	NS	NS	NS	—	—
Zinc	**18.25**	AS01[f]	mg/L	0.017	5	92.909	1074	4

NOTES:

Screening criteria for hardness dependent metals (cadmium, copper, nickel, lead, and zinc) based on a hardness of 10.

a. Lower of EPA and NH Ambient Water Quality Criteria (AWQC) for Protection of Freshwater Aquatic Life, Criteria Continuous Concentration (CCC).

b. Lower of EPA and NH AWQC for Protection of Human Health, water and organism ingestion.

c. Values based on camper scenario (Ford 2004).

d. Arsenic criterion currently under consideration by EPA.

e. Mercury concentration measured using an ICP which is generally not recommended and may provide falsely high results.

f. Sample location AS01 represents less than 10 percent of the flow within the excavated area on Site and the water quality improves significantly by sample location AS02, approximately 200 feet downstream.

mg/L = Milligram per liter

BLM = U.S. Bureau of Land Management

ND = Not detected

NS = No standard

RMC = Risk Management Criteria

Bold values exceed screening criteria

Relative Risks	
Concentration Range	**Relative Risk**
≤ Criteria or RMC	Low
1–10× Criteria or RMC	Moderate
10–100× Criteria or RMC	High
>100× Criteria or RMC	Extremely high

TABLE 3
Surface Water Quality ARARs and Proposed Cleanup Criteria
Ore Hill Mine Supplemental EE/CA

Analyte	Units	Apparent Background Concentration[a]	Maximum Detected Concentration[b]	State of New Hampshire: Protection of Aquatic Life Chronic[c]	State of New Hampshire: Protection of Human Health, Water & Fish Consumption[d]	Federal – Clean Water Act Section 304: Freshwater Aquatic Life Chronic[e]	Federal – Clean Water Act Section 304: Human Health Consumption of Water+Organism[f]	Proposed Surface Water Cleanup Criteria[g]
Aluminum	mg/L	0.04	**4.65**	0.087	NS	NS	NS	0.087
Antimony	mg/L	0.05	**0.01**	1.6	0.014	NS	0.0056	BG
Arsenic	mg/L	0.01	**0.02**	NS	0.000018	0.15	0.000018	BG
Barium	mg/L	ND	**1.05**	NS	1	NS	1	1
Beryllium	mg/L	ND	**0.0012**	0.0053	0.001	NS	NS	0.001
Cadmium	mg/L	0.0001	**0.05**	0.0004	NS	0.00005	NS	0.0004
Chromium	mg/L	ND	ND	0.011 (Cr6)	0.001 (Cr6)	0.011 (Cr6)	NS	BG
Copper	mg/L	0.0030	**0.87**	0.0013	1	0.0013	NS	BG
Iron	mg/L	0.02	**1.29**	1	0.3	1	0.3	0.3
Lead	mg/L	ND	**2.17**	0.0002	NS	0.0002	NS	BG
Manganese	mg/L	ND	**0.45**	NS	0.05	0.12	0.05	0.05
Mercury[h]	mg/L	ND	**0.69**[h]	0.00077	0.00005	0.00077	NS	BG
Nickel	mg/L	ND	**0.01**	0.007	0.61	0.007	0.61	0.007
Selenium	mg/L	0.01	**0.01**	0.005	0.17	0.005	0.17	BG
Silver	mg/L	ND	0.05	NS	0.105	NS	NS	0.105
Titanium	mg/L	ND	ND	NS	NS	NS	NS	BG
Vanadium	mg/L	ND	0.01	NS	NS	NS	NS	BG
Zinc	mg/L	0.04	**18.25**	0.017	5	0.017	7.4	BG

Notes:
a. Based on three surface water samples from location OHB1 on Ore Hill Brook.
b. Maximum detected concentation in surface water samples collected from the Site.
c. New Hampshire Water Quality Criteria, protection of aquatic life, Table 1703.1 (2007)
d. New Hampshire Water Quality Criteria, protection of human health, water and fish ingestion, Table 1703.1 (2007)
e. EPA Recommended chronic water quality criteria for freshwater aquatic life (2006).
f. EPA Recommended chronic water quality criteria for human consumption of water and fish (2006).
g. Long-term water quality goal for water leaving the site.
h. Mercury concentration measured using an ICP which is generally not recommended and may provide falsely high results.
Hardness dependent criteria adjusted based on an apparent background hardness of 10; also converted to total concentrations where applicable.
BG = Background
ND = Not detected
NS = No standard
Bold values exceed the proposed cleanup criteria.

TABLE 4
Removal Action Technology Screening Matrix
Ore Hill Mine Supplemental EE/CA

Technology Class	Process Option	Description	Effective–ness	Implemen–tability	Cost	O&M	Land Impact	Pros	Cons	Retained?
Active Treatment	Active Limestone Dosing	Mechanically introduce limestone product into stream incrementally	High -adjusting initial alkalinity	Low-lack of utilities	High	High - requires monthly-quarterly replacement	Minimal	pH adjustment	Requires frequent O&M	No
	Active Limestone Dumping	Same as Limestone Dosing, except loads of limestone are dumped in large portions rather than incrementally	High -adjusting initial alkalinity	Medium - requires replacement	Low	Medium - requires replacement of limestone 2-5 yrs	Minimal	pH adjustment	Requires some O&M	No
Passive Treatment	Anoxic Limestone Drain (ALD)	Buried channel containing limestone, often used in conjuction with aeration and wetland system	Low with high DO	Medium	Low	High - requires periodic flushing and limestone replacement	Mininal	pH adjustment	High concentrations of metals and DO promote plugging	No
	Permeable Reactive Barrier (PRB)	Mass of reactive, permeable media in the path of groundwater flow	High for specific metals	Medium-requires pilot study	Medium	High-requires periodic replacement of media	Minimal	Provides effective metals removal	Requires costly O&M	**Yes**
	ViroMine™	Custom blend of reagents applied via a flow through structure such as a permeable reactive barrier or gabion	High for select metals	Medium - requires pilot study	Low	Remove clogging sediment and reapply reagents	Unknown	High metal removal efficiency, potentially low maintenace	More suitable for low flow conditions, requires pilot study, may require large area because of high flows	**Yes**
	Anaerobic Wetland	Compost wetland generates alkalinity through bacterial activity and limestone dissolution	High -if followed by additional treatment	Medium - requires water depth >3 ft	Low	Low	Moderate - High	Provides metals removal	Requires aerobic polishing and significant depth and area	**Yes**
	Settling pond	Construct settling pond to remove fines	Medium	High	Low	Medium—excavate and dispose of sediments every few years	<0.1 ac at 4 ft deep	Reduce sediment load to stream; use as pretreatment	Only reduces sediments and precipitates formed on air contact	**Yes**
	Aerobic Wetland	Wetland with fine grained sediments, typically designed to promote precipitation of iron hydroxide	High with pretreatment	Medium - requires flat topography and saturated conditions	Low	Low-Medium depends on metals accumulation and flooding	Low	Provides effective metals removal	Needs protection from flooding, requires upstream pH adjustment	**Yes**

TABLE 4
Removal Action Technology Screening Matrix
Ore Hill Mine Supplemental EE/CA

Technology Class	Process Option	Description	Effective–ness	Implemen–tability	Cost	O&M	Land Impact	Pros	Cons	Retained?
Passive Treatment	**Open Limestone Channel (OLC)**	Open channel containing large limestone that carries and treats the mine discharge	High - adjusting pH below 4.5	Medium- requires sufficient slope (10%)	Low	Low	Minimal	Effective at initially increasing alkalinity	Requires subsequent metals precipitation	**Yes**
	Successive Alkalinity Producing System (APS or SAPS)	Combine the use of an ALD and an anaerobic wetland	Medium - limited by high DO	Medium	Medium	Medium - requires periodic flushing	Moderate - requires some area	Removes metals and acidity	Requires maintenance of an underdrain and requires significant depth of water and area, subject to plugging	No
	Limestone Pond	Pond is constructed at the upwelling of an AMD seep or underground water discharge point, with limestone placed in botton of pond	High - initial pH adjustment	Medium - possible at Coe B	Low	Medium - requires periodic replacement of limestone	Minimal	Provides intitial pH adjustment and applicable at Coe B	Requires further pH adjustment and precipitation	No
	Limestone Leach Bed (LLB)	Buried cells or trenches of limestone with subsurface drains which water flows through; limestone dissolves, adds alkalinity	High - initial pH adjustment	High - near mine discharges	Low	Low - requires periodic flushing	Minimal	Effectively adjusts alkalinity and pH	Requires further pH adjustment and precipitation, subsurface drainage maintenance	No
	Slag Leach Bed (SLB):	Columns of steel slag maintain constant hydraulic conductivity over time and produce highly alkaline leachate	Medium - requires constant source of recharge	Low - limited by lack of recharge	Medium	Medium - requires periodic flushing of drains	Minimal	Adjusts alkalinity	Requires recharge, some area, and periodic flushing	No
	Surface Water Diversion	Diversion of runoff by constructing of drainage ditches to move surface water quickly off the site before infiltration or commingling occurs	Medium - limits interation of surface water and impacted waters	Medium - depends on topography and mine drainage	Medium	Low	Moderate	Limits commingling of impacted waters, improves water quality of receiving stream, already in place at Ore Hill	Requires periodic maintenance	**Yes**
	Inundation (Saturation)	Physical restriction of waters by constructing impoundments within an isolated area of a surface mine	Low	Low	None	None	High	Limits oxidation and contaminant migration	Site workings may already be inundated; cannot verify with existing information.	No

TABLE 4
Removal Action Technology Screening Matrix
Ore Hill Mine Supplemental EE/CA

Technology Class	Process Option	Description	Effective–ness	Implemen–tability	Cost	O&M	Land Impact	Pros	Cons	Retained?
Passive Treatment	Underground Mine Sealing	Closure of all openings into underground mine complexes	Medium	Low	Low	None	Minimal	Can eliminate adit discharge	Potential for leaking or failure, no metals removal or increased alkalinity	No
	Sulfate Reducing Bioreactor (SRB)	Series of buried trenches or tanks containing cobbles and organic matter, may also be in wetland form	High	Low	Medium	Requires carbon source replenishment	<0.1ac	No pumps/motors; subsurface; not as prone to vandalism	Subject to freezing or plugging, requires pilot study	**Yes**
	Low Head Dam	Dams built of rock or limestone; aerates the stream, maintains positive hydraulic control, distributes flow	Medium	Medium	Low	Low	Minimal	Provides positive hydraulic control, distributes flows, compatible with other passive treatment technnologies	Needs to be augmented with metals precipitation and/or other treatments	**Yes**

[redacted]

[redacted]	[redacted]	Alternative 2		Alternative 3		[redacted]
		[redacted]	[redacted]	[redacted]	[redacted]	
OLC	[redacted]	[redacted]	[redacted]			[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Settling Pond	[redacted]	[redacted]	[redacted]			[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Anaerobic Wetland Construction	[redacted]	[redacted]				
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
SRB	[redacted]		[redacted]			[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
ViroMine™	[redacted]			[redacted]		
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Aerobic Wetlands	[redacted]				[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Miscellaneous	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Removal Action Subtotal =	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Design and Oversight	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	TOTAL REMOVAL ACTION COST =	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Monitoring	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
O&M	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	TOTAL ANNUAL MONITORING AND 0&M COST =	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

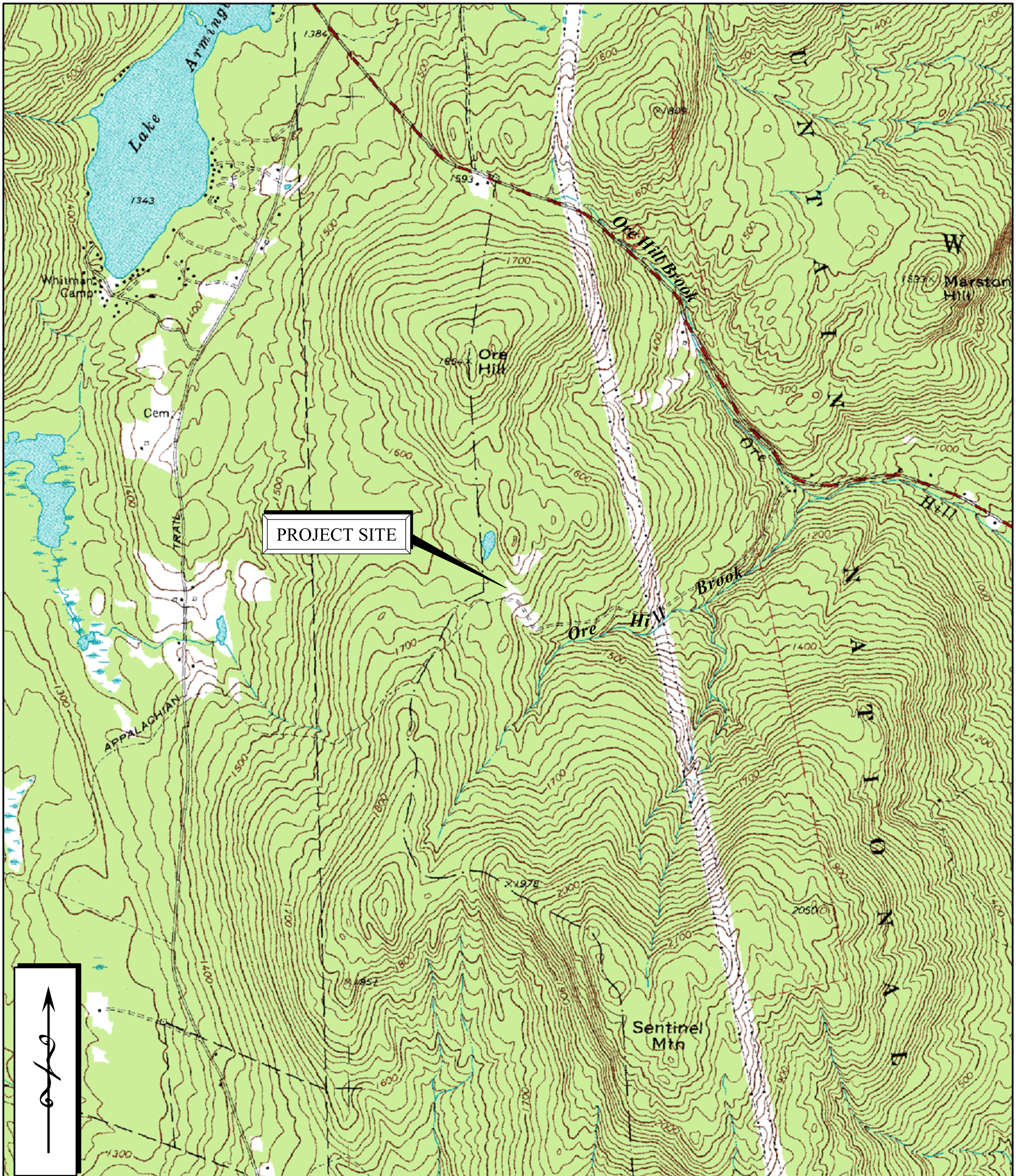
TABLE 6
Comparative Analysis of Removal Action Alternatives
Ore Hill Mine Supplemental EE/CA

Assessment Criteria	Alternative 1 No Action	Alternative 2 - Partial Staged Passive Treatment: Option A - Anaerobic Wetlands	Alternative 2 - Partial Staged Passive Treatment: Option B - SRB	Alternative 3 - Complete Staged Passive Treatment: Option A - ViroMine™ System	Alternative 3 - Complete Staged Passive Treatment: Option B - Aerobic Wetlands
Compliance with Removal Action Goals and Objectives					
Attributes:	Does not comply	Basic treatment focused on primary source	Higher level of treatment with SRB	Polishing with ViroMine™	Polishing with aerobic wetlands
Advantages:	None	+Improves water quality	**+Better improvement in water quality**	**+Potential highest water quality improvement**	+Significant water quality improvement
Overall Protectiveness of Public Health, Safety and Welfare					
Attributes:	No protection	Improved water quality reduces human health risk	Water treated to significantly reduce risk to human health	Water treated to eliminate human health risk to the extent possible	Water treated to significantly reduce risk to human health
Advantages:	None	+Some level of human protection	**+Higher level of human protection**	**+Potential highest level of human protection**	+High level of human protection
Environmental Protectiveness					
Attributes:	No protection	Improved water quality reduces ecological risk	Water treated to significantly reduce ecolgoical risk	Water treated to eliminate ecological risk to the extent possible	Water treated to significantly reduce ecological risk
Advantages:	None	+Some level of ecological protection	**+Higher level of ecological protection**	**+Potential highest level of environmental protectiveness**	+High level of environmental protectiveness
Compliance with ARARs					
Attributes:	Does not comply	Complies to practical extent	Complies to practical extent	Complies to practical extent	Complies to practical extent
Advantages:	None	+Improves surface water quality compliance	**+More compliant**	**+Potential most compliant**	+Very compliant
Long-term Effectiveness and Permanence					
Attributes:	No action	Requires long-term monitoring and maintenance to ensure effectiveness	Will require more maintenance to replensih organic media and prevent plugging	Will require high maintenance for monitoring and to replenish the ViroMine™ media	Will require more maintenance because of the additional treatment features
Advantages:	None	+Effective and provides long-term permanence	**+More effective and provides long-term permanence**	**+Potential most effective and provide long-term permanence**	+Highly effective and provides long-term permanence
Reduction of Toxicity, Mobility and Volume					
Attributes:	No action	Improves surface water quality but may generate sludge with high concentrations of metals	Improves surface water quality but may generate sludge with high concentrations of metals	Generates sludge that will require periodic removal	Will generate a small amount of metals-laden sludge
Advantages:	None	+High reduction in metals loading to Ore Hill Brook	**+Greater reduction in metals loading to Ore Hill Brook**	**+ViroMine sludge should be non-hazardous +High reduction in metals loading to Ore Hill Brook**	+High reduction in metals loading to Ore Hill Brook

TABLE 6
Comparative Analysis of Removal Action Alternatives
Ore Hill Mine Supplemental EE/CA

Assessment Criteria	Alternative 1	Alternative 2 - Partial Staged Passive Treatment		Alternative 3 - Complete Staged Passive Treatment	
	No Action	Option A - Anaerobic Wetlands	Option B - SRB	Option A - ViroMine™ System	Option B - Aerobic Wetlands
Short-Term Effectiveness					
Attributes:	No action	Constructable within one field season	Constructable within one field season but will require SRB pilot study	Constructable within one field season but will require ViroMine™ pilot study	Constructable within one field season
Advantages:	None	**+Most easily constructed** +Immediately effective and should improve as wetlands develop	+Easily constructed **+Immediately effective and should improve as bacteria establish**	+Easily constructed +Immediately effective but may decrease	+Easily constructed **+Immediately effective and should improve as wetlands develop**
Implementability					
Attributes:	Not applicable	Contructable using standard construction equipment and methods.	Constructable using standard construction equipment and methods; may require more effort because of greater depth and complexity of material	Constructable using standard construction equipment and methods; may require more effort to construct ViroMine™ gabions	Constructable using standard construction equipment and methods
Advantages:	None	**+Easy to implement; technically and administratively feasible**	+Implementable; technically and administratively feasible	+Implementable; technically and administratively feasible	**+Easily implementable; technically and administratively feasible**
State and Federal Agency, and Community Acceptance					
Attributes:	Not acceptable	Reasonable effort to improve water quality and reduce metals loading to Ore Hill Brook	Better effort to improve water quality and reduce metals loading to Ore Hill Brook	Better effort to improve water quality and reduce metals loading to Ore Hill Brook	Reasonable effort to improve water quality and reduce metals loading to Ore Hill Brook
Advantages:	None	+Minimally acceptable	**+Depends on pilot study results**	+Depends on pilot study results	**+Acceptable**
[redacted]					
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Figures



0 500 1,000 2,000 3,000 4,000 Feet

SCALE: 1 inch equals 2,000 feet

REFERENCE: U.S.G.S. 7.5 MINUTE QUADRANGLE, WARREN, NEW HAMPSHIRE 1973

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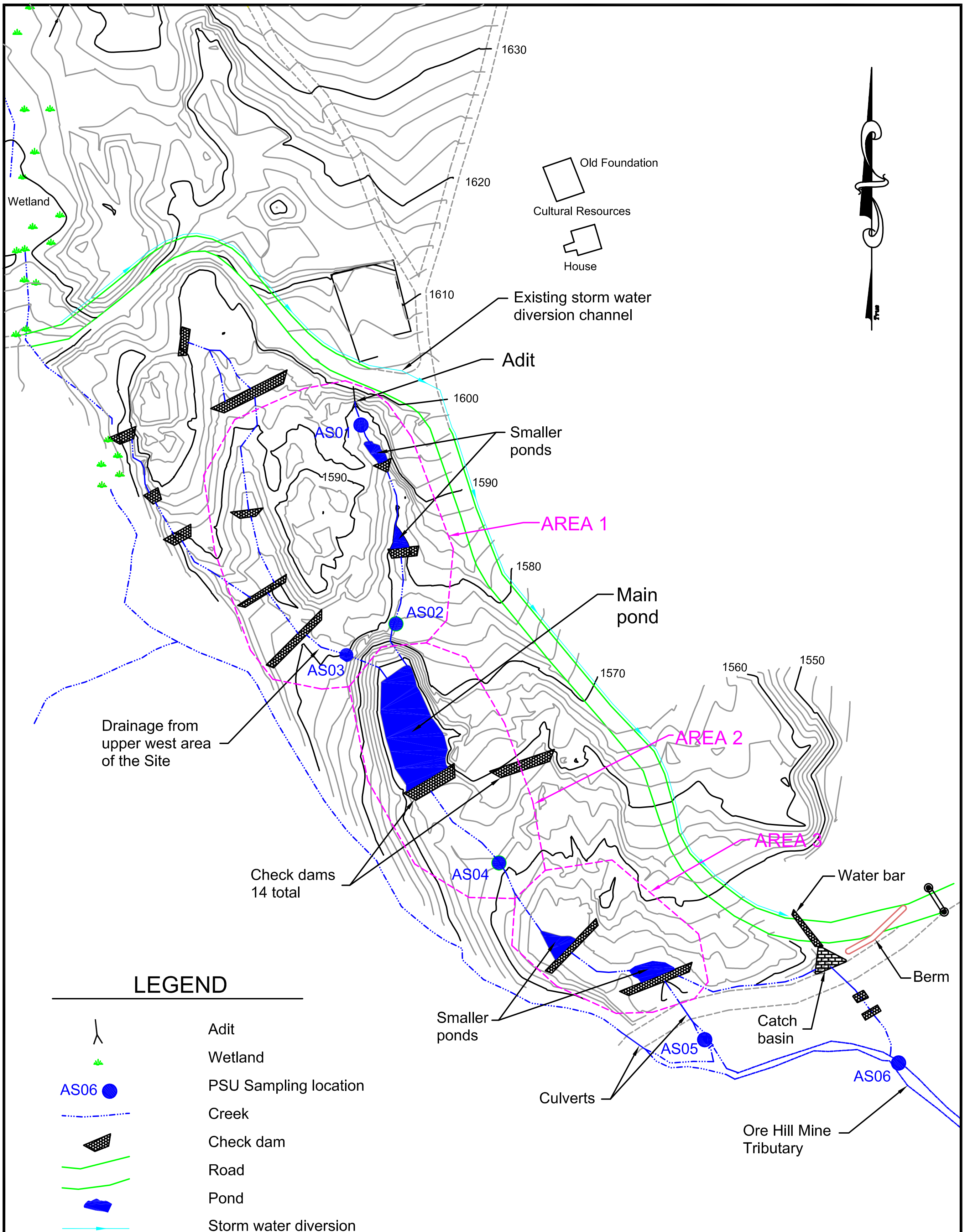
Ore Hill Mine
Vicinity Map

B2473.I	vicinitymap.mxd	3/17/08	Figure 1

:MSE\ore_hill\vicinity_map.mxd 3.17.08



100 0 100

SCALE: 1 inch = 100 feet

Source: As-built Survey by SK & JT, 7/12/07

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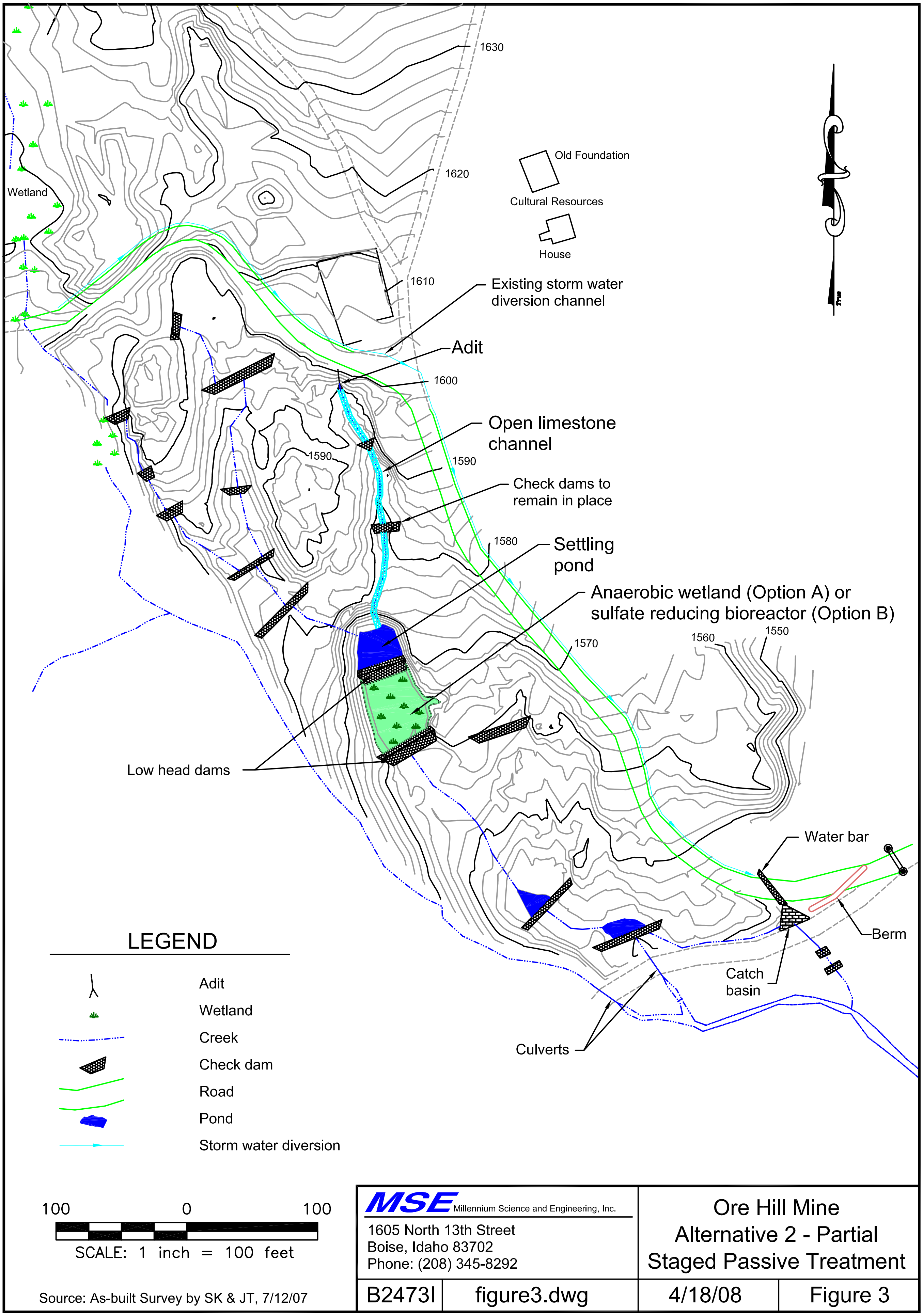
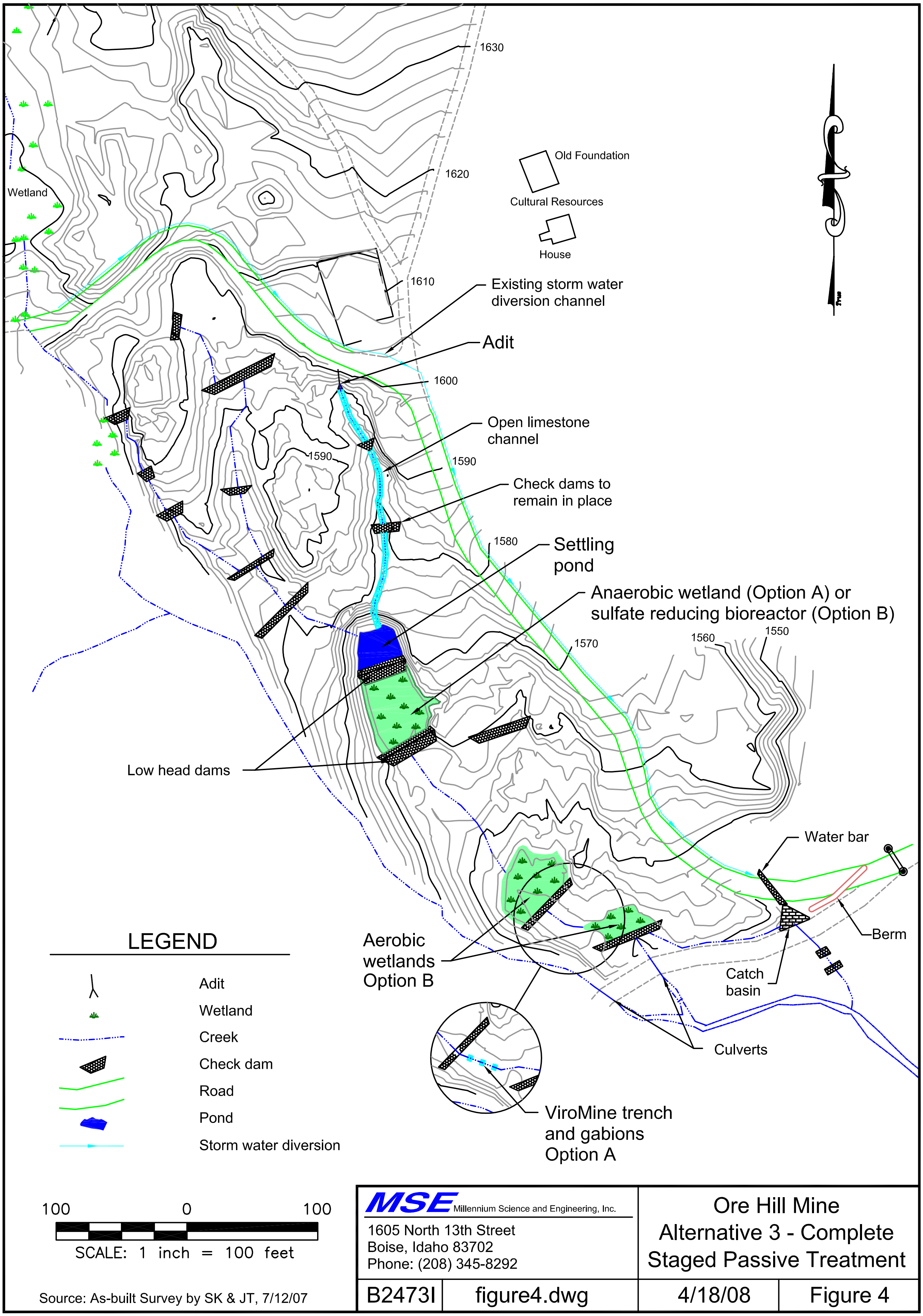
Ore Hill Mine
Overall Site Map

B2473I	sitemap.dwg	4/18/08	Figure 2

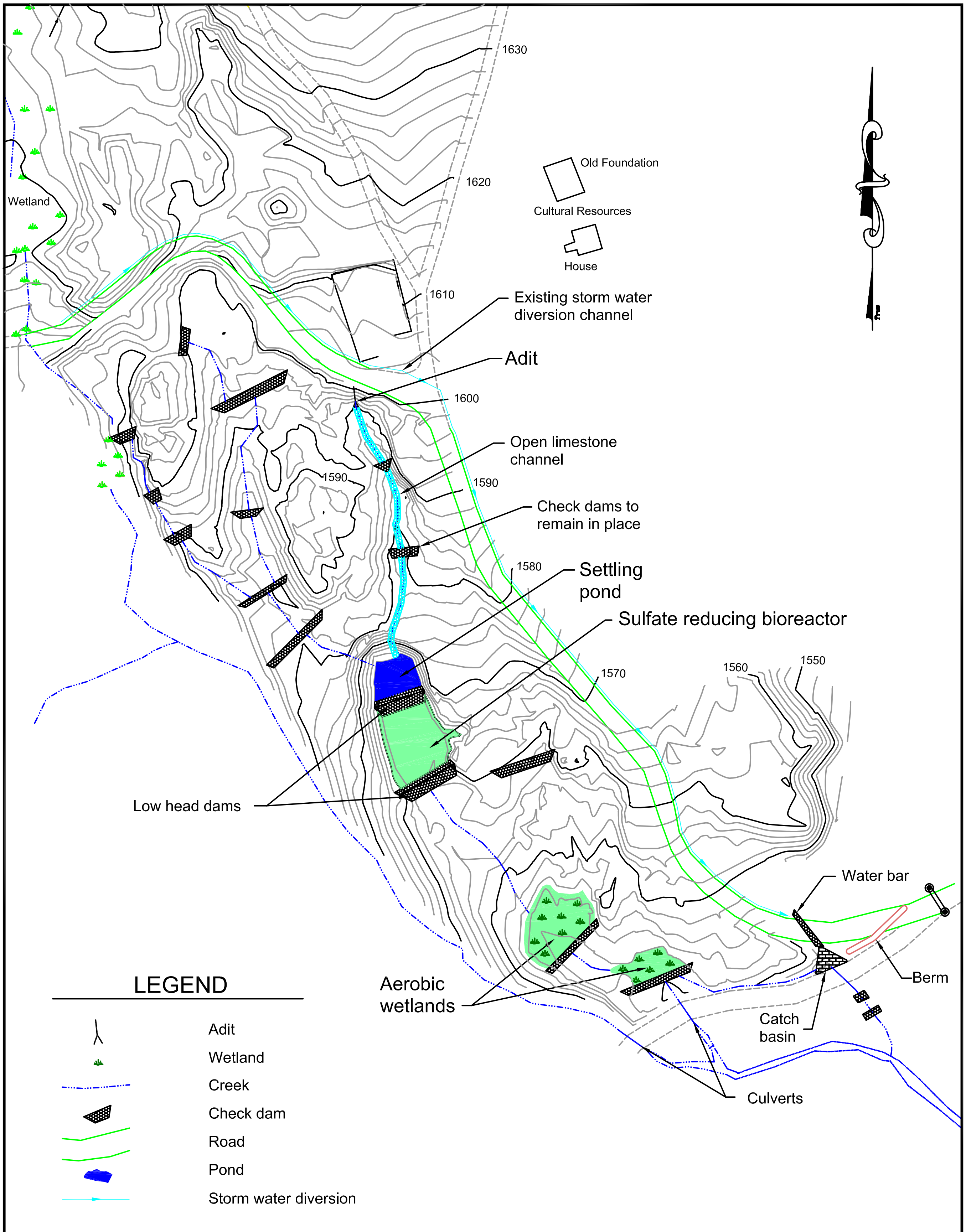


MSE Millennium Science and Engineering, Inc. 1605 North 13th Street Boise, Idaho 83702 Phone: (208) 345-8292		Ore Hill Mine Alternative 2 - Partial Staged Passive Treatment	
B2473I	figure3.dwg	4/18/08	Figure 3



MSE Millennium Science and Engineering, Inc. 1605 North 13th Street Boise, Idaho 83702 Phone: (208) 345-8292	Ore Hill Mine Alternative 3 - Complete Staged Passive Treatment

B24731	figure4.dwg	4/18/08	Figure 4



100 0 100

SCALE: 1 inch = 100 feet

Source: As-built Survey by SK & JT, 7/12/07

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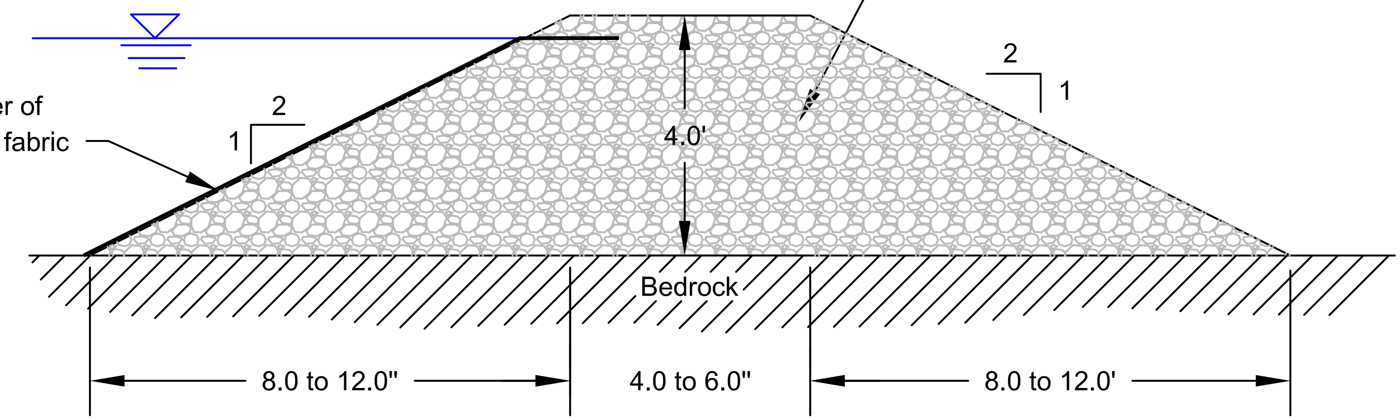
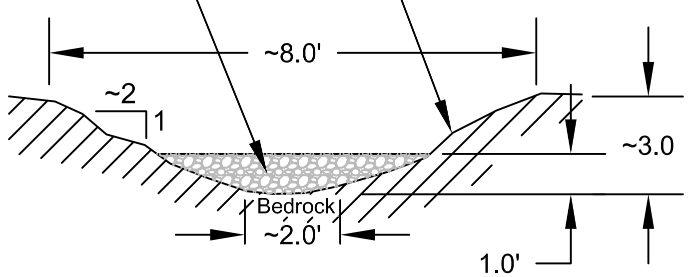
Ore Hill Mine
Recommended
Alternative

B2473I	figure5.dwg	4/18/08	Figure 5



LOW HEAD DAM TYPICAL CROSS SECTION

Not to Scale



OPEN LIMESTONE CHANNEL

Typical Cross Section Not to Scale

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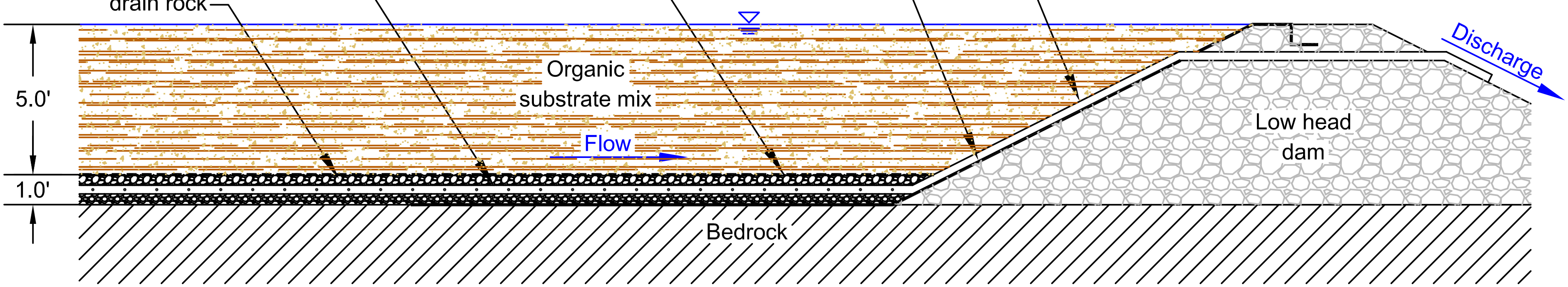
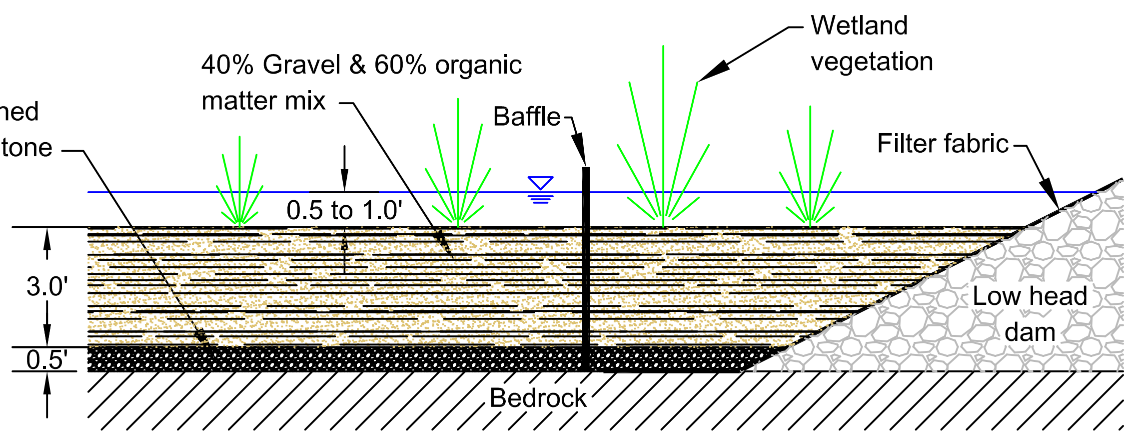
Ore Hill Mine
Low Head Dam &
Open Limestone Channel

B2473I	figure6.dwg	4/18/08	Figure 6



SULFATE REDUCING BIOREACTOR

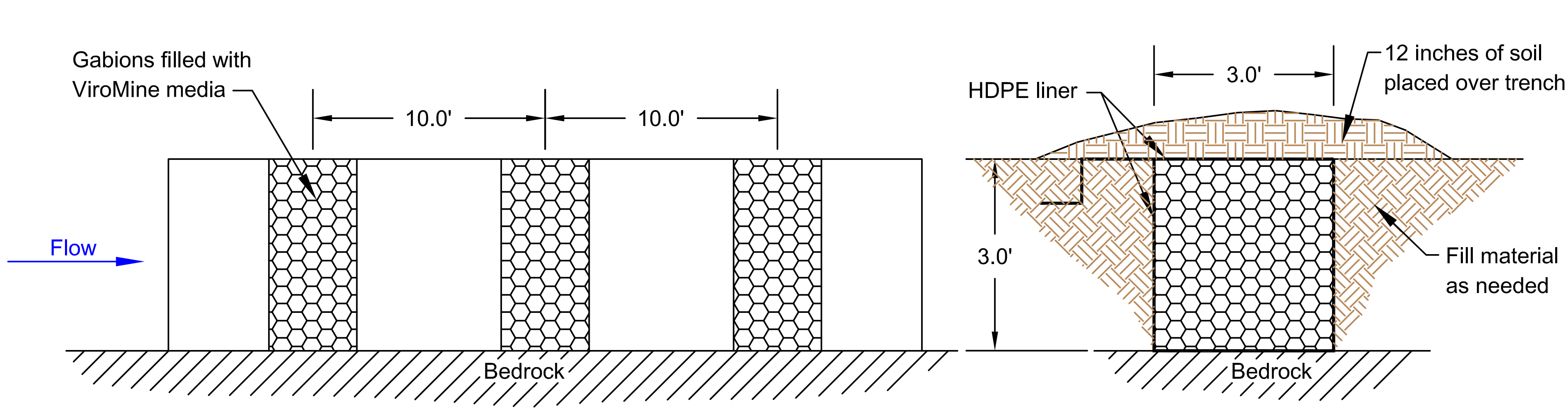
Typical Cross Section Not to Scale



ANAEROBIC WETLANDS

Typical Cross Section Not to Scale

MSE Millennium Science and Engineering, Inc. 1605 North 13th Street Boise, Idaho 83702 Phone: (208) 345-8292		Ore Hill Mine SRB and Anaerobic Wetland	
B2473I	figure7.dwg	4/18/08	Figure 7

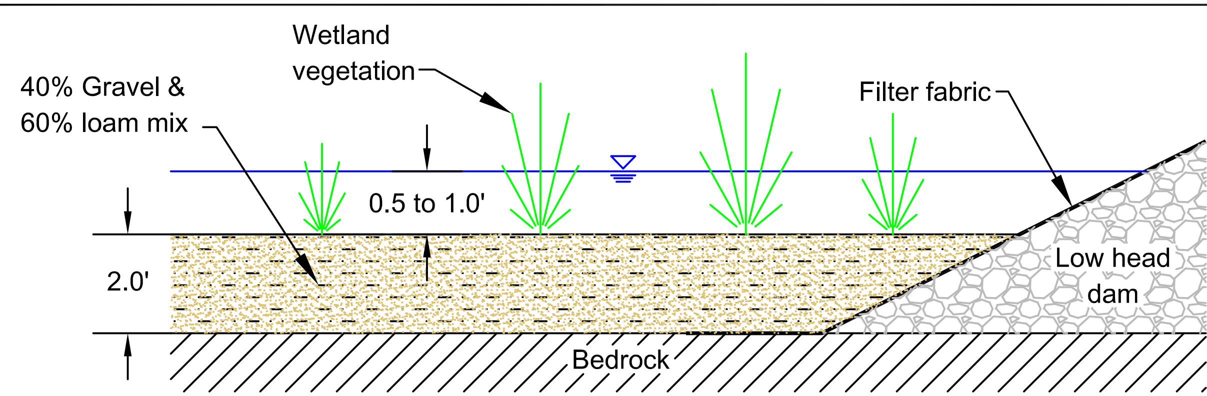


VIROMINE - SIDE VIEW

Typical Cross Section Not to Scale

VIROMINE - FRONT VIEW

Typical Cross Section Not to Scale



AEROBIC WETLANDS

Typical Cross Section Not to Scale

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Ore Hill Mine
ViroMine™ Sytem and
Aerobic Wetland

B2473I	figure8.dwg	4/18/08	Figure 8

APPENDIX A

Plymouth State University
Ore Hill Adit Water Quality Monitoring 2008 Report

Ore Hill Adit Water Quality Monitoring
2008 Report

Prepared by
Christian Doogan
Kevin McGuire

Plymouth State University
Center for the Environment

Introduction

Plymouth State University (PSU) and the US Forest Service have partnered to monitor the water quality of Ore Hill Brook as part of the Ore Hill Mine Reclamation project in the White Mountain National Forest in Warren, NH. This report documents the results of a pilot study that was proposed after seepage from an adit was discovered on-site in the fall of 2006. *The objective of the study* was to determine if seepage from the adit was the major source of metals in surface waters draining the reclamation area. The project included three rounds of water sampling and discharge measurements at six sampling locations in the reclamation area that were established in early June of 2007 (see Figure 1). Ths sample collection was designed to capture baseflow conditions during the summer and fall of 2007. The six locations were selected to estimate inputs from groundwater emanating from the mine adit and from groundwater that contributes to surface water flows within the reclamation area. Figure 1 shows the locations of these sampling sites with four located in the reclamation area and two located on the Ore Hill Mine Tributary. Three of the sample locations (AS01, AS05, and AS06) in this study are the same sites as those identified as Adit, Seep, and OHMT, respectively, in the ongoing monitoring work being conducted by Janet Towse and Kevin McGuire (PSU) (USFS Agreement 06-CS-11092200-021).

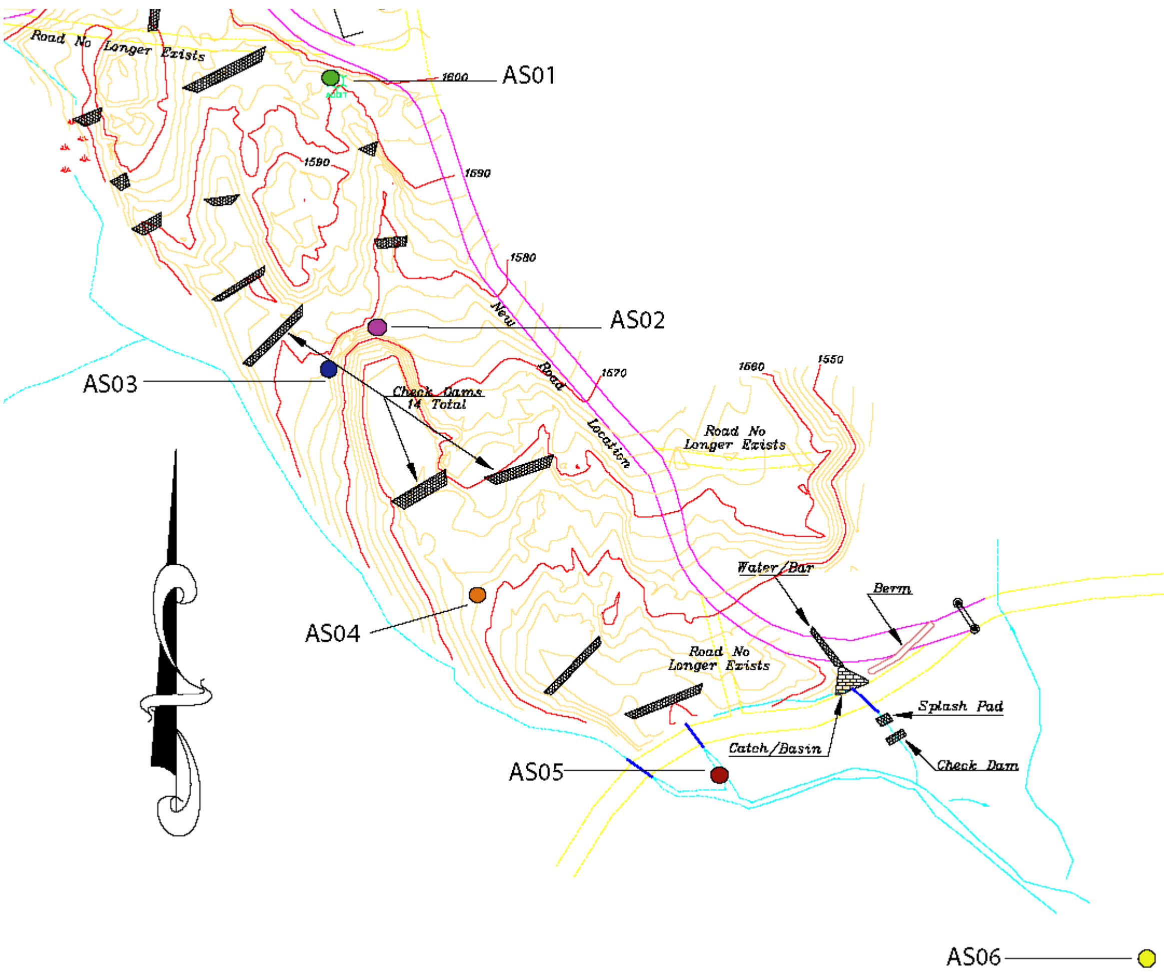

Figure 1. Surface water sampling locations (AS01-AS06) for the Ore Hill Adit Study. Original by SK&JT July 12, 2007. Altered by Plymouth State University Oct. 2007.

Methods

Water Chemistry

Water samples were collected using a standard procedure of triple rinsing a 125mL acid-washed bottle with sample water before taking a final sample for analysis. Water samples were taken at each of the six locations for the three rounds before discharge measurements were made. All samples were sent to the US Forest Service laboratory in Durham, New Hampshire for analysis on a Varian ICP (inductively-coupled plasma) emission spectrometer that detects concentrations in the 0-200 mg/L (ppm) range. Results are reported for the six metals of greatest concern at Ore Hill: aluminum, cadmium, copper, lead, zinc, and magnesium (i.e., a chemical component of the treatment).

Discharge Measurement

Two methods were used to estimate discharge: volumetric measurement (i.e., the time taken to fill a container of known volume) and salt dilution. Volumetric gaging was used at AS01 and AS02 because flow was too low for salt dilution. Salt dilution gaging involves injecting a "slug" of NaCl tracer into the stream and monitoring electrical conductivity (EC) downstream for changes (Webster and Valett, 2006). The slug was added to an upstream location that would provide complete mixing of tracer with stream water. The general method for computing discharge (Q) via salt dilution uses the following mass balance equation:

$$Q = \frac{Vc_t}{\int_{t_1}^{t_2} c(t) - c_0 dt}$$

where V is a known volume of tracer (L^3), c_t is the concentration of NaCl in the introduced solution (M/L^3), c_0 is the background NaCl concentration, c is the time-varying concentration of NaCl measured downstream, and t_1 and t_2 are the initial and final times of measurement. A calibration relationship was developed between the NaCl concentrations and EC, which allows for accurate low flow discharge measurements using relative EC changes instead of actual concentrations of the salt (Moore, 2004).

Data Analyses

Raw EC data were analyzed to compute discharge using the method described by Moore (2004). The discharge data along with the element concentrations from the water samples were used to compute loads in grams per day. Comparative analyses of samples from AS02 and AS03 that drain different sides (east and west) of the reclamation area were used to evaluate the relative importance of the adit seepage compared to ambient groundwater inflows of the effluent stream network.

Table 1. The discharge in gallons per minute of all six locations for the three rounds of sampling.

Site	6/26/2007	7/31/2007	10/15/2007
AS01	0.54	0.68	1.16
AS02	0.48	0.73	1.65
AS03	3.96	0.78	4.12
AS04	6.18	1.90	9.03
AS05	9.51	NA	11.89
AS06	9.03	6.82	42.48

Results and Discussion

Discharge generally increased downstream from AS01 to AS06. Table 1 and Figure 2 show the trends in discharge between each sampling location and each round of sampling. The samples that were collected in July had the lowest discharge while those collected in October had the highest dicharge. It should be noted that the high flow on October 15 at AS06 included additional drainage from the western side of the reclamation area which has a confluence just below sample point AS05. The western drainage was dry all summer and did not flow until October after precipitation increased. The calculation of discharge for AS05 during the July round of sampling was not possible due to problems with the EC datalogger.

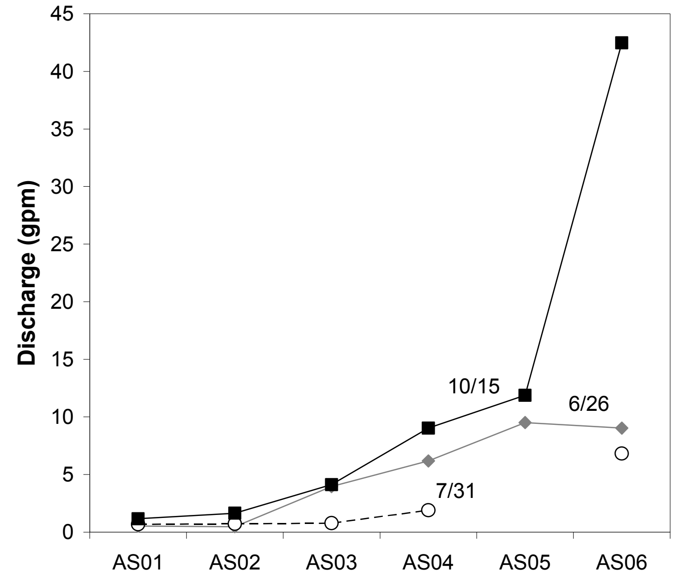

Figure 2. Discharge (Q) for all six locations during each round of sampling.

Discharge was always greater at AS03 (drainage from the west side of the site) compared to AS02. Also, mass balances of discharge between the measured locations suggest significant inflows from groundwater or unmeasured surface water throughout the site. For example, the difference between the sum of flows from AS02 and AS03 from AS04, suggests an additional 20 to 35% contribution from groundwater seepage or surface water at the location of the large pit (i.e., immediately upstream of AS04). Between AS04 and AS05 where no additional channels were observed entering the drainage, discharge increases due to groundwater inflow approximately 24 to 35%.

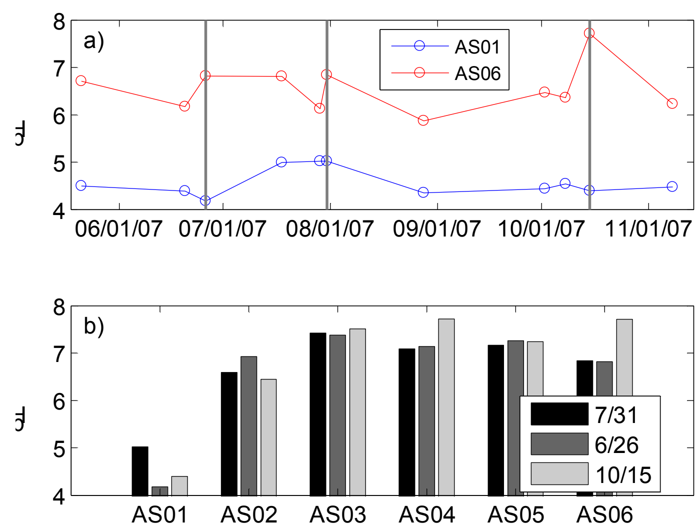

Figure 3. a) The pH for AS01 and AS06 from May to October 2007. Gray lines indicate sample dates from this study, all other samples taken by Janet Towse. **b)** The pH of all six sites shown for all rounds of sampling.

Surface water pH dramatically increased between AS01 and AS02 and appeared to remain constant downstream of AS03 (Figure 3). This suggests that west side of the reclamation area is slightly more buffered than the adit drainage. Also, with pH increases, many metals including Al, Zn, and Pb, begin to precipitate and form complexes. The pH for AS01 and AS06 remained fairly constant between late spring and fall even though discharge changes were rather significant over this period (Figures 2 and 3).

Zinc concentrations for the three sample collections were representative of the range of variation over the summer (Figure 4). Other metals showed similar behavior (concentration data are given Appendix A). Concentrations of zinc were approximately an order of magnitude higher at the adit compared to other sample locations. During the last round of sampling on October 15, 2007, duplicates were taken at sites AS02 and AS03 for comparison and 125 quality control.

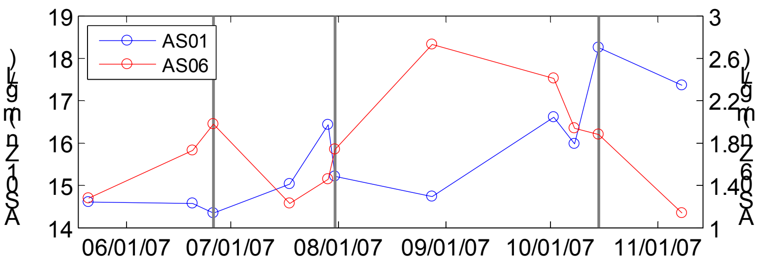

Figure 4. Zinc concentrations for AS01 and AS06 from May to October 2007. AS06 corresponds to the right axis. Gray lines indicate sample dates from this study, all other samples taken by Janet Towse.

Metal loads for Zn, Cu, Cd, and Pb all decreased during low flow conditions from the adit (AS01) to the first downstream sample location (AS02) even though discharge increased (see Appendix B for load data). This suggests some loss (adsorption or precipitation) of heavy metal mass after the adit discharge. During higher flows, this pattern was not as evident for all metals (e.g., Zn and Cd). Under high flow conditions, precipitation is less likely because velocities are higher and the channels are more likely to be flushed as more sediment becomes entrained and erodes downstream. Aluminum appeared to drop out significantly approaching background levels (i.e., similar to Ore Hill Brook [OHB1] above the mine tributary) before reaching AS02 whereas zinc and the other metals generally increased downstream (see Figure 5). The pattern of magnesium loading was quite different. Magnesium, a byproduct of the remediation treatment, increased downstream (Figure 5). Load patterns for Cd, Cu, and Pb are shown in Appendix C.

When comparing the loads from the east (AS02) and west (AS03) drainages that enter the large pit above AS04, it is clear that the concentrated zinc load from the adit had an impact on the total load. The adit zinc load represented approximately 35 to 180% of the zinc load at AS04, even though it was generally less than 10% of the flow. Zinc loads generally decreased

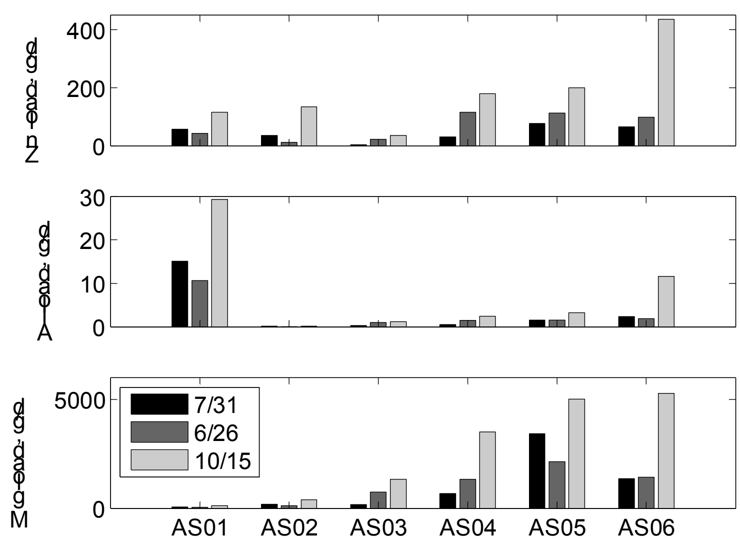

Figure 5. Aluminum, zinc, magnesium loads (grams per day) of all six sites for each round of sampling. Dates are arranged in order of hydrologic intensity with 7/31 being driest period sampled.

by the bottom of the watershed (AS06), except under high flow conditions. During the high flow event, some zinc loading may be coming from the tributary that became hydraulically connected in the wettest conditions.

Summary

Aluminum loads and low pH that originate from the adit do not appear at levels of concern below the large pit above site AS04. The pH levels approach neutrality shortly after emanating from the adit. However, zinc loads observed at the adit are a significant percentage of the loads observed just below the large pit (AS04) and at the bottom of the watershed (AS05). Zinc loads generally decrease below AS05 except under high flow conditions and some additional zinc loading appears to coming from groundwater inflows throughout the surface water drainage network.

Recommendations

Additional sampling of the three new locations in the adit region (AS02, AS03, AS04) may not yield further information relative to future treatment possibilities. However, continuing to monitor sites AS01-AS06 before and after treatment is strongly recommended to document changes related to the treatment process. AS01, AS05, and AS06 are currently being sampled for water quality (Janet Towse) but adding AS02-AS04 would be beneficial. The data in this report suggest that treatment in the drainage between AS01 and AS02 and in the large pit (above AS04) would provide the best opportunity for reducing metal loading at this site. Depending on treatment plans, monitoring sites could be altered accordingly.

Lastly, to develop the best possible treatment method, geochemical and physical processes that are currently taking place should be quantified to evaluate the stability, type, and quality of precipitation/adsorption metal reactions. The results from this study show that aluminum and pH levels were significantly improved within the 200-foot channel between AS01 and AS02; however, it is not clear what geochemical reactions led to this decrease. Moreover, zinc loadings patterns appear to be fairly complex. Both physical (groundwater inflow and high flow flushing) and chemical processes (precipitation or complexing reactions and metal dissolution during storm pH depressions) controlling metal solubility likely occur under different hydrologic conditions. Treatment methods selected to control the adit metal chemistry should be compatible with processes that lead to stable retention of metals on-site. Geochemical and physical processes should be studied to develop the most efficient and cost effective remediation technology possible.

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Moore, R.D. 2005. Slug injection using salt in solution. Streamline. 8:1-6

Webster, J.R., and Valett, H.M. 2006. Solute dynamics. In: F.R. Hauer and G.A. Lambert (Editors), Methods in stream ecology. Academic Press, Amsterdam, pp. 169-185

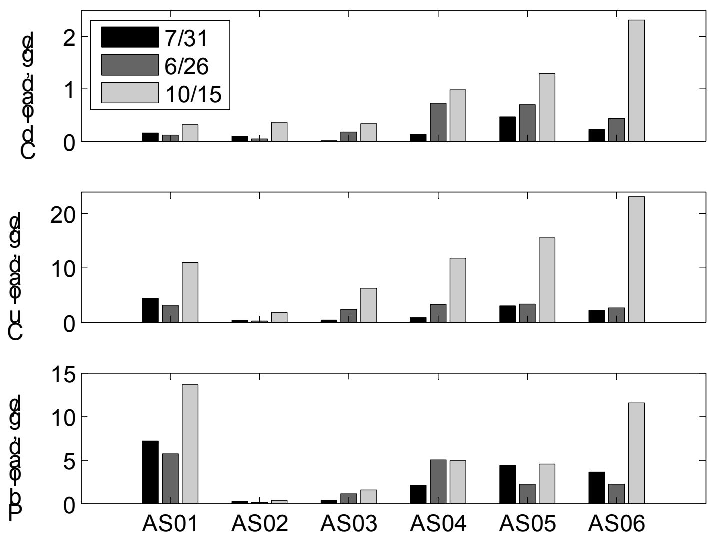
Appendix A. The concentrations of elements of interest and pH for all six locations during the three rounds of sampling. The New Hampshire water quality standards are listed in parenthesizes and all concentrations are in mg/L. Asterisks indicate duplicates taken for comparison.

Site	Date	pH	Al (mg/L) (0.087)	Cd (mg/L) (0.0008)	Cu (mg/L) (0.0027)	Pb (mg/L) (0.00054)	Zn (mg/L) (0.0365)	Mg (mg/L)
AS01	6/26/2007	4.18	3.623	0.0405	0.5314	1.95	14.35	10.88
AS02	6/26/2007	6.93	0.026	0.0161	0.042	0.06	4.31	47.96
AS03	6/26/2007	7.38	0.046	0.0083	0.056	0.05	1.03	34.34
AS04	6/26/2007	7.14	0.044	0.0214	0.0489	0.15	3.42	39.31
AS05	6/26/2007	7.26	0.03	0.0135	0.0321	0.04	2.16	41.05
AS06	6/26/2007	6.82	0.038	0.0087	0.0268	0.05	1.98	28.78
AS01	7/31/2007	5.02	4.067	0.0417	0.5941	1.93	15.21	13.22
AS02	7/31/2007	6.59	0.026	0.0244	0.0403	0.07	8.84	46.05
AS03	7/31/2007	7.42	0.062	0.0025	0.0486	0.09	0.71	37.52
AS04	7/31/2007	7.09	0.048	0.0122	0.0413	0.2	2.98	64.96
AS05	7/31/2007	7.17	0.03	0.009	0.0294	0.08	1.47	65.9
AS06	7/31/2007	6.84	0.062	0.006	0.0288	0.1	1.74	36.44
AS01	10/15/2007	4.4	4.65	0.05	0.87	2.17	18.25	18.39
AS02	10/15/2007	6.38	0.01	0.04	0.1	0.04	15.28	43.79
AS02 *	10/15/2007	6.51	0.01	0.04	0.1	0.04	14.66	41.4
AS03	10/15/2007	7.3	0.06	0.01	0.14	0.07	1.57	60.23
AS03 *	10/15/2007	7.72	0.04	0.02	0.14	0.07	1.53	57.61
AS04	10/15/2007	7.72	0.05	0.02	0.12	0.1	3.65	71.22
AS05	10/15/2007	7.24	0.05	0.02	0.12	0.07	3.08	77.36
AS06	10/15/2007	7.71	0.05	0.01	0.05	0.05	1.88	25.82

Appendix B. Stream metal loads in grams per day of all six locations for the three rounds of sampling.

Site	Date	Al g/d	Cd g/d	Cu g/d	Pb g/d	Zn g/d	Mg g/d
AS01	6/26/2007	10.64	0.12	1.56	5.72	42.15	31.97
AS02	6/26/2007	0.07	0.04	0.11	0.14	11.18	124.33
AS03	6/26/2007	0.99	0.18	1.21	1.12	22.32	741.73
AS04	6/26/2007	1.47	0.72	1.65	5.02	115.25	1324.66
AS05	6/26/2007	1.58	0.70	1.66	2.22	112.03	2127.96
AS06	6/26/2007	1.87	0.43	1.32	2.23	97.66	1417.47
AS01	7/31/2007	15.11	0.15	2.21	7.18	56.51	49.12
AS02	7/31/2007	0.10	0.10	0.16	0.29	35.14	183.04
AS03	7/31/2007	0.26	0.01	0.21	0.38	3.00	158.85
AS04	7/31/2007	0.50	0.13	0.43	2.11	30.87	673.45
AS05	7/31/2007	1.56	0.47	1.52	4.39	76.24	3416.11
AS06	7/31/2007	2.31	0.22	1.07	3.64	64.51	1353.70
AS01	10/15/2007	29.33	0.32	5.49	13.69	115.11	115.99
AS02	10/15/2007	0.09	0.36	0.90	0.36	134.51	382.74
AS03	10/15/2007	1.12	0.34	3.14	1.57	34.82	1328.07
AS04	10/15/2007	2.46	0.98	5.91	4.92	179.76	3507.44
AS05	10/15/2007	3.24	1.30	7.78	4.54	199.58	5012.93
AS06	10/15/2007	11.58	2.32	11.58	11.58	435.32	5284.02

Appendix C. Cadmium, copper, lead loads (grams per day) of all six sites for each round of sampling. Dates are arranged in order of hydrologic intensity with 7/31 being driest period sampled.



APPENDIX B
Site Photographs


Photo 1: Adit (AS01)


Photo 2: Looking downstream from adit

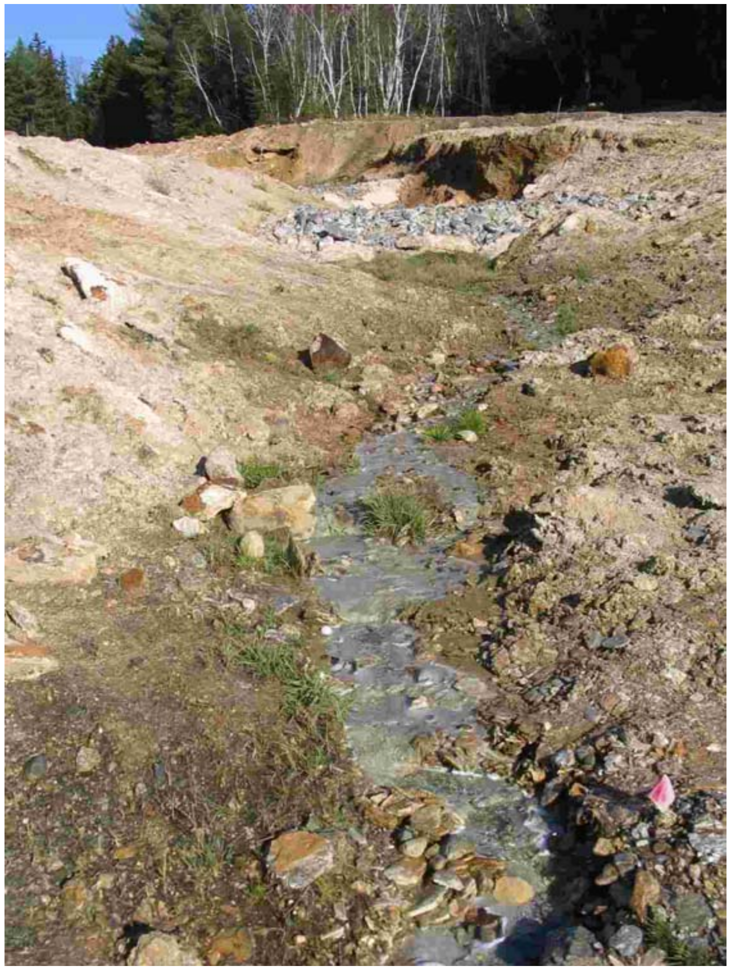


Photo 3: Looking upstream from AS02


Photo 4: Main Pond

Photo 5: Looking upstream from AS04

Photo 6: Looking upstream from AS05

APPENDIX C
Applicable or Relevant and Appropriate Requirements

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

(ARARs)

Ore Hill Mine Site
White Mountain National Forest, New Hampshire
April 29, 2008

Table C-1
Chemical-Specific ARARs and To Be Considered (TBC) Information

Media Requir	**eme nt**	**Requirement Synopsis Status**	**and Rationale**
Surface Water F1	FEDERAL – Clean Water Act (CWA) Title 33 US Code Section 1314 (33 USC 1314) Ambient Water Quality Criteria (AWQC) 40 Code of Federal Regulations (CFR) 131.36(b)(1)	National recommended, but non-enforceable, criteria for surface water quality established by EPA for evaluating toxic effects on human health and aquatic organisms. AWQC are used by states in setting their water quality standards. Surface water runoff from the site exceeds the Ambient Water Quality Criteria for several metals, including Aluminum, Lead and Zinc	Not Applicable or Relevant and Appropriate. New Hampshire is an authorized state and the Forest Service will work with State of New Hampshire water quality standards.
Groundwater F2	FEDERAL Safe Drinking Water Act (SDWA) 42 USC 300f et seq., 40 CFR 142.40, 142.50 40 CFR 143 40 CFR 141	EPA has established regulations to protect the public from contaminants in drinking water. Primary and Secondary drinking water regulations and standards have been established. National primary drinking water standards (NPDWS), expressed as maximum contaminant levels (MCL), are not to be exceeded in public water supplies. National Secondary drinking water standards (NSDWS) should not be exceeded in public water supplies. These are nonenforceable, aesthetic-based guidelines that consider available treatment technologies and the cost of treatment. The EPA has also established maximum contaminant level goals, (MCLG). These are nonenforceable guidelines based on human health considerations without regard to available treatment technologies and/or the cost of treatment.	Not Applicable or Relevant and Appropriate. Treating groundwater is beyond the scope of this Removal Action, which is intended to improve surface water quality. However, the selected Removal Action may reduce contaminant loading and prevent further degradation of groundwater. Removal Action does not involve a public water supply.
Hazardous Wastes F3	FEDERAL Resource Conservation and Recovery Act (RCRA) Subtitle C – Hazardous Wastes 42 USC 6901-6992k 40 CFR Parts 260 - 270 RCRA Subtitle C 40 CFR 261.4(b)(7)	RCRA Subtitle C established "cradle-to-grave" control of hazardous waste. 40 CFR Part 261 provides identification and listing of hazardous waste; Parts 262 - 270 sets standards for the transportation, treatment, storage, and disposal of hazardous wastes. RCRA Subtitle C includes an exemption for certain mine site wastes (Bevill Exclusion).	Generally, RCRA Subtitle C is Not Applicable or Relevant and Appropriate. Removal Action does not involve RCRA hazardous wastes. Mine wastes present at the Ore Hill Mine Site are exempt from RCRA Subtitle C under the Bevill Exclusion, which is Applicable.

Table C-1
Chemical-Specific ARARs and TBC Information (Continued)

Media Requireme	nt	Requirement Synopsis Status	and Rationale
Solid Waste F4	FEDERAL RCRA Subtitle D Nonhazardous Wastes 42 USC 6901 et seq. 40 CFR Part 258 40 CFR Part 261.2	RCRA Subtitle D establishes a framework for the management of non-hazardous wastes. 40 CFR Part 258 sets requirements for the storage and disposal of non-hazardous solid wastes. 40 CFR 261.2 defines solid waste as any discarded (i.e., abandoned, recycled, or inherently waste-like) materials. The definition of solid waste includes wastes from the extraction, beneficiation, or processing or ores and minerals. These wastes are subject to RCRA Subtitle D, unless subject to regulation under RCRA Subtitle C.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste. Point source discharges such as Ore Hill adit seep are excluded from the definition of solid waste per 40 CFR261.4(a)(2).
Air F5	FEDERAL Clean Air Act (CAA) 42 USC s/s 7401 et seq.	Establishes National Ambient Air Quality Standards (NAAQS) to protect public health and welfare.	Not Applicable or Relevant and Appropriate. Only “major” sources are subject to requirements related to NAAQS. Substantive portions of state regulations for air quality may be Applicable.
Sediment F6	FEDERAL National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NOS OMA 52	Recommends reference doses for various contaminants in stream sediments and their potential effects on biota exposed to the contaminants.	Recommended reference doses are To Be Considered (TBC), not Applicable or Relevant and Appropriate. Removal Action does not involve sediment.
Soil, Groundwater, Surface Water, and Sediment F7	FEDERAL EPA Risk Assessment Guidance (RAGS) EPA Risk Reference Doses (RfD)	Guidance: RfDs are estimates of daily exposure levels that are unlikely to cause significant adverse health effects over a lifetime. The doses levels are developed based on the noncarcinogenic effects and are used to develop hazard indices. A hazard index of less than or equal to 1 is considered acceptable.	TBC, not Applicable or Relevant and Appropriate.
Soil F8	FEDERAL EPA Region 9 Preliminary Remediation Goals (PRG)	PRGs provide criteria for evaluation of soil contaminant concentrations in residential and industrial exposure settings.	PRGs are TBC, not Applicable or Relevant and Appropriate as treatment of soil is beyond the scope of the proposed Removal Actions.

Table C-1
Chemical-Specific ARARs and TBC Information (Continued)

Media Requireme	nt	Requirement Synopsis Status	and Rationale
Surface Water S1	STATE New Hampshire Code of Administrative Rules (NHCAR) Revised Statutes Annotated (RSA) 485-A:8 Surface Water Classification Standards and NHCAR Env-Ws 1700 Interim Surface Water Quality Standards	RSA 485-A:8. Surface Water quality standards have been promulgated to address public health and welfare, enhance water quality and serve the purposes of the Clean Water Act. Identifies standards that Class A and B waters must satisfy. Establishes standards for physical, chemical and bacteriological characteristics. These standards are also used to determine compliance with the state's nondegredation policy. Part Env-Ws 1703 Interim Water Quality Standards and Env-Ws 1704 Interim Alternative Site-specific Criteria. The purpose of these rules is to establish water quality standards for the state's surface waters. Water quality criteria for toxic substances are established. Env-Ws 1705 Interim Flow Standards and Env-Ws 1707 Interim Mixing Zones establish criteria to determine compliance with standards. These rules are applicable to point or non-point discharge(s) of pollutants to surface waters. Interim Env-Ws 1703.19 establish criteria for non-degradation of aquatic ecosystems. Interim Env-Ws 1708.05 establishes all surface waters in the National Forest are Outstanding Resource Waters and that there shall be no degradation of Outstanding Resource Waters.	Substantive portions are Applicable, and will be met to the extent practical given the scope of the Removal Action.
Soil S2	STATE New Hampshire Solid Waste Management Act RSA Ch. 149-M, NHCAR Env-Sw 100-2000 et seq.	RSA Ch. 149-M: Establish standards applicable to the treatment, storage and disposal of solid waste and the closure of solid waste facilities. NHCAR Env-Sw 100-300: These provisions establish standards applicable to the treatment, storage and disposal of solid waste and the closure of solid waste facilities.	Not Applicable or Relevant and Appropriate. Removal Action does not involve any solid waste facilities or the treatment, storage, or disposal of solid waste.
Soil & Groundwater S3	New Hampshire Department of Environmental Services Contaminated Sites Risk Characterization and Management Policy (RCMP), 1/98, as amended.	The RCMP establishes policies, procedures and screening levels for risk-based characterization of contaminated sites.	TBC for surface water.

Table C-1
Chemical-Specific ARARs and TBC Information (Continued)

Media Requireme	nt	Requirement Synopsis Status	and Rationale
Groundwater S4	STATE Nondegradation of Groundwater to Protect Surface Water NHCAR Env-Or 603.01 (c)	Env-Or 603.01 provides that, unless naturally occurring, groundwater shall not contain any contaminants at concentrations such that groundwater discharge to surface water results in a violation of surface water standards in any surface water body within or adjacent to the site unless the groundwater discharge is exempted under Env-Or 603.02. Env-Or 603.01 (c) incorporates surface water standards set forth at RSA 485-A:8 and Interim Env-Ws 1703. Ore Hill Brook, its tributaries and all other surface watersheds thereof, are considered "Outstanding Resource Waters" per Interim Env-Ws 1708.05. Only limited and temporary degradation is allowed in waters classified as such. Discharge of inadequately treated wastes into "Outstanding Resource Waters" is prohibited.	Not Applicable or Relevant and Appropriate as treatment of groundwater is beyond the scope of the proposed source control Removal Actions. However, Removal Action is expected to improve groundwater quality. Removal Action does not involve creation of a new source of groundwater contamination or new source of degradation.
Groundwater S5	STATE Health-based Ambient Groundwater Quality Standards: NHCAR Env-Or 603.01(a) and (b)	Env-Or 603.01(a) and (b) provide that groundwater shall be suitable for use as drinking water without treatment and shall not contain any regulated contaminant in concentrations greater than ambient groundwater quality standards established in Env-Or 603.03.	Not Applicable or Relevant and Appropriate as treatment of groundwater is beyond the scope of the proposed Removal Actions. See S4.
Groundwater S6	STATE Groundwater Discharge Criteria NHCAR Env-Or 603.03	Establishes groundwater d ischarge criteri a th at in clude th e MCLs (and MCLGs) adopted by the Water Division.	Not Applicable or Relevant and Appropriate as treatment of groundwater is beyond the scope of the proposed source control Removal Actions. However, Removal Action is expected to improve groundwater quality. Removal Action does not involve creation of a new source of groundwater contamination or new source of degradation.
Air Emissions S7	STATE Air Pollution Control RSA Ch.125-C Ambient Air Quality Standards NHCAR Env-A Part 303	These regulations set primary and secondary ambient air quality standards (equivalent to federal standards). The standards do not allow significant deterioration of existing air quality in any portion of the state for: particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone, and lead.	Control requirements for particulate emissions/fugitive dust are Applicable. The Removal Action will not create a significant deterioration in air quality.

Table C-1
Chemical-Specific ARARs and TBC Information (Continued)

Media Requireme	nt	Requirement Synopsis Status	and Rationale
Air S8	STATE Air Pollution Control RSA Ch. 125-C NHCAR Env-A Part 1400 Regulated Toxic Air Pollutants	Identifies toxic air pollutants to be regulated (pollutants also listed in 40 CFR 261). High, moderate and low toxicity classifications are established. Air toxics in these classifications are regulated when they occur in concentrations that cause adverse health effects including increased cancer risk.	Not Applicable or Relevant and Appropriate as the Removal Action will not result in a release of air pollutants that would be regulated under this rule.
Groundwater S9	STATE Drinking Water Quality Standards NHCAR Env-Ws 314 and Env–Ws 316	Env-Ws 314 and 315 establish MCLs for inorganics and organics in drinking water, respectively. Env–Ws 316 established secondary MCLs for drinking water. Remedial activities that provide drinking water to the public will have to comply with MCLs and secondary MCLs in these chapters.	Not Applicable or Relevant and Appropriate, as Removal Action does not involve a public drinking water source. See S4.
Treatment Discharge S10	STATE Standards for Pre-treatment of Industrial Wastewater NHCAR Env– Ws 904.	Env–Ws 904 establishes guidelines for those wastes that are prohibited from being introduced to publicly owned treatment works (POTW).	Not Applicable or Relevant and Appropriate, Removal Action does not involve discharge to local POTW.

Table C-2
Location-Specific ARARs and TBC Information

Location Requireme	nt	Requirement Synopsis Status	and Rationale
Surface Water & Wetlands F9	FEDERAL CWA (33 USC 1314) 33 USCA 1251 et seq 33 CFR Parts 320-323, and 40 CFR 230	For discharge of dredged or fill material into water bodies or wetlands, there must be no practical alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standard or toxic effluent standard or jeopardize threatened or endangered (T&E) species; discharge cannot significantly degrade waters of U.S.; must take practicable steps to minimize and mitigate adverse impacts; must evaluate impacts on flood level, flood velocity, and flood storage capacity.	Not Applicable or Relevant and Appropriate. The Removal Action will not involve discharge of dredge or fill material into a designated federal wetland. The Removal Action will be designed to minimize adverse impacts to resources. 33CFR 321- Permits are not required under CERCLA, not Applicable or Relevant and Appropriate.
Wetlands and Floodplains F10	FEDERAL CWA 33 USC 1314 Procedures on Floodplain Management and Wetlands Protection 40 CFR 6, Appendix A 40 CFR 300 Executive Order (EO) 11990 Protection of Wetlands, 5/77 EO 11988 Floodplain Management, 5/77	Federal agencies will avoid, whenever possible, the long- and short-term impacts associated with the destruction of wetlands and the occupancy and modifications of floodplains and wetlands development wherever there is a practicable alternative in accordance with EOs 11990 and 11988. The agency will promote the preservation and restoration of floodplains so that their natural and beneficial values can be realized. Any plans for actions in wetlands or floodplains must be submitted for public review.	Applicable since portions of the site may be located within a 100-year floodplain or within a federally designated wetland. All practicable means will be used to minimize harm to seasonally wet areas.
Wetlands F11	FEDERAL Fish and Wildlife Coordination Act (FWCA) 16 USC Chapter 49, §§ 2901-2912; 40 CFR Part 6.302(g)	Requires federal agencies to take into consideration the effect that water-related projects will have on fish and wildlife. Requires consultation with U.S. Fish and Wildlife Service (USFWS) and the state to develop measures to prevent, mitigate, or compensate for project-related losses to fish and wildlife.	Substantive portions Applicable and will be met to the extent practicable given the scope of the Removal Action. However, Removal Action does not involve “project related losses” to fish and wildlife; project will benefit fish and wildlife.

Table C-2
Location-Specific ARARs and TBC Information (Continued)

Location Requ	ireme nt	Requirement Synopsis Status	and Rationale
Mine Sites F12	FEDERAL Surface Mining Control and Reclamation Act (SMCRA) 30 USC §§ 1201-1328	Provides closure guidelines for active coal sites. Design criteria for the closure of tailings at coal sites.	Not Applicable or Relevant and Appropriate. Removal Action does not involve the closing of an active coal mine site.
Mine Sites F13	FEDERAL Federal Water Pollution Control Act 33 USC 1251 Effluent Guidelines and Standards 40 CFR Part 440.100	Establishes discharge standards for mines producing and/or processing copper, lead, zinc, gold, silver, and molybdenum ores.	Not Applicable as Removal Action does not involve an active mine producing and/or processing copper, lead, zinc, gold, silver, or molybdenum ore.
Cultural F14	FEDERAL National Historic Preservation Act (NHPA) 16 USC § 470; 36 CFR Part 800 40 CFR 6.301(b)	NHPA requires Federal Agencies to take into account the effect of any Federally assisted undertaking or licensing on any property with historic, architectural, archeological, or cultural value that is included in or eligible for inclusion in the National Register of Historic Places (NRHP). New Hampshire follows this Act. Federal agencies are required to locate, inventory and nominate all sites, buildings, districts, and objects under their jurisdiction or control for listing on the NRHP. Federal Agencies must also provide the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity to comment on activities that may affect properties on or eligible for listing on the NRHP. The State Historic Preservation Officer will act as a liaison between the Actions that will have adverse effects on such a feature must be avoided, minimized, or mitigated.	Substantive portions Applicable, however the USDA-FS already conducted a cultural resource survey to identify significant cultural features in the project area.
Cultural F15	FEDERAL Archaeological and Historical Data Preservation Act 16 USC § 469 40 CFR 6.301(c)	Establishes procedures to provide for preservation of significant scientific, prehistoric, historic, and archeological data that might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program.	Substantive portions Applicable, however the USDA-FS already conducted a cultural resource survey of the Site.

Table C-2
Location-Specific ARARs and TBC Information (Continued)

Location Requireme	nt	Requirement Synopsis Status	and Rationale
Cultural F16	FEDERAL Historic Sites Act 16 USC §§ 461-467 40 CFR 6.301(a)	Requires Federal agencies to consider the existence and location of potential and existing National Natural Landmarks to avoid undesirable impacts on them.	Not Applicable or Relevant and Appropriate. Removal Action does not involve potential or existing National Natural Landmarks.
Wilderness F17	FEDERAL Wilderness Act 16 USC 1131	This act requires that action be taken to establish non-degradation, maximum restoration, and protection of wilderness areas as primary management principles.	Not Applicable or Relevant and Appropriate. Removal Action does not involve a federally designated wilderness area.
Endangered Species & Habitat F18	FEDERAL Endangered Species Act 16 USC 1531, et. Seq. 50 CFR Part 402 50 CFR Part 17.11-17.12 40 CFR Part 6.302(h)	Requires that action be performed to conserve endangered or threatened species. Activities must not destroy or adversely modify the critical habitat upon which endangered or threatened species depend. May need to consult with the Department of Interior (DOI).	Substantive portions Applicable; however, no endangered or threatened plant or animal species were identified by USDA-FS to be present at the Site.
Wetlands S11	STATE Criteria and Conditions for Fill and Dredge In Wetlands RSA Ch. 482-A and NHCAR Env-Wt Parts 300-400, 600 and 700	RSA 482-A and Env-Wt Parts 300-400, 600 and 700 regulate filling and other activities in or adjacent to wetlands, and establish criteria for the protection of wetlands from adverse impacts on fish, wildlife, commerce and public recreation.	Substantive portions Applicable. Any Removal Actions performed in wetlands located in or adjacent to the site will comply with the substantive portions of the wetlands protection requirements to the extent practicable. See F10.
Wetlands S12	STATE Permits for Significant Alteration of Terrain RSA485-A:17 Activities NHCAR Env-Ws 415 485:17	RSA 485-A:17 and NHCAR Env-Ws Part 415 establishes criteria for conducting any activity in or near state surface waters which significantly alters terrain or may otherwise adversely affect water quality, impede natural runoff or create unnatural runoff activities within the scope of these provisions include excavation, dredging, filling, mining and grading of topsoil in or near wetland areas. Establishes criteria to control erosion and run-off for any activity that significantly alters the terrain.	Substantive portions Applicable or Relevant and Appropriate. Removal Action will comply with substantive portions to the extent practicable. Note: permits are not required for CERCLA actions.

Table C-2
Location-Specific ARARs and TBC Information (Continued)

Location Requireme	nt	Requirement Synopsis Status	and Rationale
Cultural S13	STATE New Hampshire Historic Preservation Act (NHHPA) RSA 227-C	Governs the identification and protection of state historic resources and properties. The removal activities that affect any historic property must comply with the relevant provisions of this act. The NHHPA authorizes municipalities to establish local historic districts and to regulate construction, alteration, and other activities affecting historical properties and districts [RSA 31:89(a) to 31:89(k)]. Any work, within or that may affect historic properties or districts, should take local historical preservation provisions into consideration.	Substantive portions Applicable. Removal Action will comply with substantive portions to the extent practicable. The Ore Hill Mine site is not a designated local historic district; however, historic resources have been evaluated and appropriate actions taken. See F15 and F16.
Native Plants S14	STATE New Hampshire Native Plant Protection Act RSA 217-A, Res-N 100-300	Protects native species that are endangered, threatened, or are otherwise reduced in number in order to maintain and enhance their numbers. DRED has authority to determine which species will be protected. DRED is authorized to establish a protection program. Private property owners are exempt from this chapter with respect to their own property. (See RSA 217-A:7 for Cooperation with Other State Agencies).	Applicable; however, USDA-FS did not identify protected plant species that would be jeopardized by Removal Action at the Site.
Rivers Protections S15	STATE New Hampshire Rivers Management and Protection Program RSA 483	This statute establishes a program to protect certain rivers or segments of rivers that possess characteristics valued by the people of New Hampshire. Rivers are nominated for protection. The statute further states that the scenic beauty and recreational potential of such rivers shall be restored and maintained, and that riparian interests shall be respected. Additionally, water quality shall not be degraded form existing water quality standards established under RSA 485-A.	Not Applicable or Relevant and Appropriate. Ore Hill Brook is not a designated protected river.
Endangered Species S16	STATE Endangered Species Conservation Act Fis 1000 Conservation of Endangered Species RSA 212-A	This chapter contains a list of all species of wildlife normally occurring within this state that are considered endangered or threatened. The executive director of New Hampshire Fish and Game has authority to determine which species will be listed. Fish and Game is authorized to establish a protection program. Private property owners are exempt from this chapter with respect to their own property. (See RSA 212-A:9 for Cooperation with Other State Agencies).	Substantive portions Applicable and will be met to the extent practicable given the scope of the Removal Action. However, USDA-FS conducted a survey for Threatened & Endangered species as well as state special-listed species and found none at the site. See F18.

Table C-2
Location-Specific ARARs and TBC Information (Continued)

Location Requireme	nt	Requirement Synopsis Status	and Rationale
On-site disposal S17	STATE Solid Waste Landfills - Surface Water Protection Env-Sw 804.03	Establishes surface water protection standards relative to landfill siting. Identification of the area must be based on a hydrogeological investigation; the footprint of the landfill shall not be located within 200 feet of any perennial surface water body, measured from the closest bank of a stream and closest shore of a lake, as applicable; the footprint of a landfill shall not be located within 200 feet upgradient and 100 feet down gradient of a wetland within the jurisdiction of RSA 482-A, excluding any drainage appurtenances related to the site, that is not allowed to be filled under the authority of RSA 482-A.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S18	STATE Solid Waste Landfills - Set-back Requirements Env-Sw 804.04	Setback requirements: a 100-foot buffer strip is required between the property line and the footprint of the landfill.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S19	STATE Hazardous Waste Landfill Siting Criteria Env-Hw 353.09	Owners and operators of hazardous waste facilities are required to identify whether the facility is, or will be, located within a 100-year floodplain. Owners of land disposal facilities must show whether the facility is, or will be, located within a 500-year floodplain. Furthermore flood control measures also must be identified. Similarly, new facilities or new land disposal facilities located within 3,000 feet of faults displaced in Holocene time must show that no faults pass within 200 feet of the facility. Sitting requirements of this provision must be considered when deciding whether to build a hazardous waste facility or hazardous waste land disposal facility onsite.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste or the siting of a hazardous waste landfill. See F3.

Table C-2
Location-Specific ARARs and TBC Information (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
On-site disposal; on-site diversion F19	FEDERAL RCRA Subtitle C 42 USCA 6901-6992k 40 CFR 260 - 270	RCRA Subtitle C establishes requirements for hazardous waste treatment, storage, and disposal of hazardous wastes.	Not Applicable or Relevant and Appropriate. Removal Action does not include hazardous wastes. See F3.
On-site disposal; on-site diversion F20	FEDERAL RCRA Subtitle D 42 USCA 6901 et seq 40 CFR Parts 258 and 261.2	RCRA Subtitle D establishes definitions of solid wastes and establishes requirements for municipal solid waste landfills.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
Off-site disposal F21	FEDERAL 40 CFR 300.440 (preamble to final OSR, 58 FR 49200, 49201, September 22, 1993)	Establishes criteria and procedures for determining whether facilities are acceptable for the receipt of CERCLA wastes from response actions authorized or funded under CERCLA. OSR applies to any remedial or Removal Action involving the off-site transfer of any hazardous substance, or pollutant or contaminant that is conducted pursuant to any CERCLA legal authority. The purpose of OSR is to avoid having CERCLA wastes from response actions contribute to present or future environmental problems by directing these wastes to environmentally sound management units.	Not Applicable or Relevant and Appropriate. Removal Action does not involve off site transportation of wastes.
Off-site disposal F22	FEDERAL Hazardous Materials Transportation Act (49 USC §§ 1801-1813) 49 CFR Parts 10, 171-177	Regulates transportation of hazardous materials.	Not Applicable or Relevant and Appropriate. See F3 and F12. Additionally, the Removal Action alternatives do not involve off site transportation of hazardous materials.
General F23	FEDERAL Safe Drinking Water Act (SDWA) 42 USC 300f et seq., 40 CFR 141; 142.40, 142.50, 143	Applies to sites that will have discharges to drinking water supplies. Drinking water regulations apply where certain contaminants are found in drinking water that is directly provided to 25 or more people or supplied to 15 or more service connections.	Not Applicable or Relevant and Appropriate. See F2. Site does not provide drinking water to 25 or more people or 15 or more service connections.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
General F24	FEDERAL CWA 33 USC 1314 40 CFR 230 33CFR 321	No discharge of dredged or fill material will be permitted if there is a practicable alternative to the discharge that would have a less adverse impact on the aquatic ecosystem, as long as the alternative does not have other significant adverse environmental consequences. Appropriate and practicable steps must be taken that will minimize potential adverse impacts of the discharge of the dredged material on the aquatic ecosystem.	Not Applicable or Relevant and Appropriate. Removal Action will not involve discharge of dredge or fill material into a designated federal wetland. The Removal Action will be designed to minimize adverse impacts to resources. Removal Action should improve wetland/aquatic habitat due to improved surface water quality. 33CFR 321- Permits are not required under CERCLA, not Applicable or Relevant and Appropriate.
On-site diversion F25	FEDERAL CWA 33 USC 1314 National Pollution Discharge Elimination System (NPDES) 40 CFR 122 – 125, 131	Regulates the discharge of water into public surface water.	Substantive portions Applicable and will be met to the extent practicable. Note: permits are not required for CERCLA activities.
General F26	FEDERAL CWA 33 USC 1314 Procedures on Floodplain Management and Wetlands Protection 40 CFR 6, Appendix A Executive Order (EO) 11990 Protection of Wetlands, 5/77 EO 11988 Floodplain Management, 5/77	Federal agencies will avoid, whenever possible, the long- and short-term impacts associated with the destruction of wetlands and the occupancy and modifications of floodplains and wetlands development wherever there is a practicable alternative in accordance with Executive Orders 11990 and 11988. The agency will promote the preservation and restoration of floodplains so that their natural and beneficial values can be realized.	Substantive portions Applicable and will be complied with to the extent practicable.
Surface Water F27	FEDERAL Rivers and Harbors Act of 1899 Dredge and Fill Requirements 33 USC 403 et seq. 33 CFR Parts 320-323	Any excavation from, deposition of material in, or any obstruction or alteration of any “navigable water of the US” must comply with these requirements.	Substantive portions Applicable and will be complied with to the extent practicable.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
General F28	FEDERAL Fish and Wildlife Coordination Act 16 U.S.C 166 et seq	Any modification of a body of water requires prior consultation with the USFWS to develop measures to prevent, mitigate, or compensate for losses to fish and wildlife.	Substantive portions are Applicable and will be complied with to the extent practicable. Removal Action should improve water quality and fish habitat. See F11.
General F29	FEDERAL Clean Air Act (CAA) 40 CFR 50.6 National Ambient Air Quality Standards (NAAQS)	Air quality regions must maintain maximum primary and secondary 24-hr NAAQS concentrations for particulate emissions below 150 $\mu g/m^3$, with 24-hour average for particulates having a mean diameter of 10 micrometers or less. The annual standard is 50 $\mu g/m^3$, (annual arithmetic mean). Lead is regulated at 1.5ug/m^3, as a quarterly average.	Not Applicable or Relevant and Appropriate. See F5.
General F30	FEDERAL Noise Control Act 40 CFR 204, 205, 211	Regulates construction and transportation equipment noise, process equipment and noise levels, and noise levels at the property boundaries of the project.	Substantive portions Applicable during construction. Site noise levels will be in accordance with federal requirements.
On-site disposal S20	STATE New Hampshire Solid Waste Management Act RSA Ch. 149-M Env-Sw 100-2000 et seq.	These provisions establish standards applicable to the treatment, storage and disposal of solid waste and the closure of solid waste facilities.	Not Applicable or Relevant and Appropriate. Removal Action does not involve the treatment, storage, or disposal of solid waste or any solid waste facilities.
On-site disposal S21	STATE Requirements for Collection, Storage, and Transfer Facilities Setback Env-Sw 403.02.2 (b)	A collection, storage and transfer facility (C/S/T) shall be sited no less than 50 feet from any property line. Siting requirements applicable to all landfills, unless *permit exempt.* C/S/T facility defined at Env-Sw 102.35 – includes (undefined term) "stockpiles of waste."	Not Applicable or Relevant and Appropriate. Removal Action does not involve a C/S/T facility. Permits are not required for CERCLA activities. See S17, S18, and S19.
On-site disposal S22	STATE Solid Waste Landfills - Groundwater Protection Env-Sw 804.02	Groundwater protection standards are identified with respect to landfill siting. Establishes requirements for hydrogeologic characterization of landfill sites; pre- and post-construction scenario modeling of the groundwater and surface water regimen. Establishes requirements for base of facility height above seasonal high groundwater table and confirmed bedrock surface; establishes requirements for groundwater monitoring.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill. See S17.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
On-site disposal S23	STATE Solid Waste Landfills - Design and Construction Requirements Env-Sw 805.02,	If lined, the design shall incorporate a foundation and leak detection system, a groundwater monitoring system, a Stormwater management system, a decomposition gas control system, and a final capping system. If unlined, the design shall incorporate a groundwater and surface water monitoring system, and a Stormwater management system pursuant to Env-Sw 805.10.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S24	STATE Solid Waste Landfills - Subgrade and Base Grade Standards Env. Sw 805.03	The landfill subgrade shall be graded and prepared for landfill construction; subgrade characteristics and materials are defined, including that the subgrade material shall have a saturated hydraulic conductivity of 1×10^{-4} cm/sec or less.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S25	STATE Solid Waste Landfills - Liner Material and Construction Requirements Env. Sw 805.04	Defines the requirements for soil, geomembrane and composite liners, as well as quality control procedures pertaining to liners.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S26	STATE Solid Waste Landfills - Liner System Design Standards Env. Sw 805.05	Defines requirements for double lined facilities, including drainage layers, loading conditions, and leachate transmission.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S27	STATE Solid Waste Landfills - Leachate Collection and Removal System Design Standards Env. Sw 805.06	Defines standards for leachate collection, including separation of leachate collection from stormwater management systems, and leachate management systems that are directly connected to a permitted wastewater treatment facility.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S28	STATE Solid Waste Landfills - Leak Detection and Location System Design Standards Env. Sw 805.07	Required for lined landfills.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
On-site disposal S29	STATE Solid Waste Landfills Groundwater and Surface Water Monitoring System Design Standards Env. Sw 805.08	At least one groundwater monitoring well shall be installed hydraulically upgradient from the landfill and at least 3 monitoring wells shall be installed in each down-gradient direction; the location, materials and specifications of the groundwater and surface water monitoring system shall comply with the requirements of RSA 485-A.	Not Applicable or Relevant and Appropriate. Removal Action does not involve solid waste or the siting of a solid waste landfill.
On-site disposal S24	STATE Collection, Storage, and Transfer Facilities - Design Features and Appurtenances Env. Sw 404.03 (a)	Defines the features and appurtenances required for a Collection, Storage, and Transfer (C/S/T) facility	Not Applicable or Relevant and Appropriate. Removal Action does not involve design or construction of a C/S/T facility.
On-site disposal S31	STATE Waste Handling and Storage Area Requirements Env. Sw 404.04 (a), (d)	Establishes requirements for waste handling and storage areas.	Not Applicable or Relevant and Appropriate. Removal Action does not involve design or construction of waste handling and storage areas.
On-site disposal S32	STATE Waste Stockpiles Env- Sw 404.05	Establishes requirements that pertain to the location, configuration and size of stockpiles, and protection of the environment.	Not Applicable or Relevant and Appropriate. Removal Action does not involve waste stockpiles.
On-site diversion; off-site disposal S33	STATE Standards for Generators Env-Hw 500	Establishes requirements applicable to generators, including persons transporting hazardous wastes or treatment residues off-site.	Not Applicable or Relevant and Appropriate. Removal Action does not involve generation of hazardous waste, or off-site transportation of hazardous waste or treatment residues.
Off-site disposal S34	STATE Requirements for Hazardous Waste Transporters Env-Hw 600	These provisions apply to all persons transporting hazardous wastes within or through New Hampshire, including hazardous waste destined for recycling.	Not Applicable or Relevant and Appropriate. Removal Action does not involve the transportation of hazardous wastes.
Off-site disposal S35	STATE Packaging, Labeling and Placarding Env-Sw 603.05, incorporating by reference Saf-C-600 and 49 CFR 171, 172, 173, 178,and 179	Hazardous wastes transported off-site must be packaged and labeled in accordance with New Hampshire Department of Safety rules and federal transportation requirements. Federal regulations establish specifications for shipping containers and tank cars as well as labeling and identification requirements for hazardous constituents.	Not Applicable or Relevant and Appropriate. See S34.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
Off-site disposal S36	STATE Hazardous Waste Management Act RSA Ch. 147A-NH and Hazardous Waste Rules Env-Sw 100-1000	Standards for management of hazardous waste facilities. Operate in lieu of federal RCRA Subtitle C requirements.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste.
Off-site disposal S37	STATE Requirements for Owners and Operators of Hazardous Waste Facilities Env-Hw 700	These provisions establish operating and monitoring requirements for owners and operations of hazardous waste facilities, as well as general, environmental, health and design requirements.	Not Applicable or Relevant and Appropriate. See S36.
Off-site disposal S38	STATE General Design Requirements for Facilities Env-Hw 702.09	This provision establishes general facility design standards to prevent release of hazardous constituents.	Not Applicable or Relevant and Appropriate. See S36.
Off-site disposal S39	STATE Monitoring of Hazardous Waste Treatment Facilities Env-Hw 702.10 - 702.14	These provisions establish groundwater-monitoring requirements and authorize the Division to require other appropriate environmental monitoring.	Not Applicable or Relevant and Appropriate. See S36.
On-site options S40	STATE Public Notification Plan Env-Hw 702.06	This provision authorizes the Division to require development of a program to inform the public of the status of facility activities. A public notification plan is appropriate to ensure that the public will receive on going information as to the implementation of the selected remedy and the status of site closure.	Not Applicable or Relevant and Appropriate as this is an administrative rather than substantive requirement. Further, the Removal Action does not involve RCRA hazardous waste. A Community Relations Plan will be developed per the National Contingency Plan [40 CFR 300.415(n)] and state participation is expected.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
On-site options S41	STATE Environmental & Health Requirements Env-Hw 702.08	This provision requires facilities to comply with specified state and federal environmental standards & federal occupational health and safety requirements. Applicable environmental standards include surface water standards specified in the Federal Clean Water Act NH RSA 485-A groundwater criteria established by the Federal Safe Drinking Water Act, state groundwater rules promulgated pursuant to RSA 485-A, air emission limits specified in Federal Clean Air Act and state implementation plans. Applicable occupational standards Include 29 CFR Ch. 1910 (industry standards); 29 CFR Ch. 1926 (safety and health standards); NH RSA Ch. 277-A (Workers Right to Know Act); NH Admin. Rules He-P Ch. 1800, Part 1803 (Toxic Substances in the workplace).	Relevant and Appropriate. Will comply to extent practicable given scope of Removal Action. Further, the Removal Action will comply with appropriate environmental and occupational safety requirements. .
On-site options S42	STATE Record keeping and Reporting Env-Hw 705	This provision establishes record keeping and reporting requirements. Federal requirements are included by Reference 40 CFR 264.74 and 264.77. The owner or operator is responsible for reporting environmental or public health-threatening events	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste. Candidate ARAR is administrative rather than substantive. However, if a situation constituting an environmental and or public health-threatening event occurs, the state and other appropriate response personnel will be notified.
General S43	STATE General Waste Analysis Env-Hw 708.02(b) incorporating by reference 40 CFR Section 264.13	This provision requires that general waste analyses be performed before an owner or operator either treats, stores, or disposes of hazardous waste. The analysis may include data developed under Part 261 (identification and listing of hazardous waste).	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste.
General S44	STATE Hazardous Waste Facility Security Requirements Env-Hw 708.02 (c), incorporating by reference 40 CFR 264.14	This provision incorporates federal RCRA requirements for the adoption of security measures to protect the public from exposure to hazardous waste.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste.
General S45	STATE General Inspection Requirements Env-Hw 708.02(d), incorporating by reference 40 CFR 264.15	This provision incorporates federal RCRA requirements for regular inspection of hazardous waste facilities.	Not Applicable or Relevant and Appropriate. Removal Action does not involve a hazardous waste facility.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
General S46	STATE Personnel Training Env-Hw 708.02 (e) incorporating by reference 40 CFR 264.16	This provision incorporates federal RCRA requirements for the training of hazardous waste facility personnel to ensure compliance with applicable standards and effective emergency response.	Not Applicable or Relevant and Appropriate. Removal Action does not involve a hazardous waste facility. However, a Safety Plan will be in place during the Removal Action.
General S47	STATE Preparedness and Prevention Requirements, Env- Hw 708.02(h), incorporating by reference 40 CFR 264, Subpart C	This provision incorporates federal RCRA requirements for prevention and response to releases of hazardous waste.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste. However, a safety plan will be in place during Removal Action.
General S48	STATE Contingency Plan Env-Hw 708.02 (i), incorporating by reference 40 CFR 264, Subpart D	This provision incorporates federal RCRA requirements for contingency plans and emergency procedures.	Not Applicable or Relevant and Appropriate. Removal Action does not involve a hazardous waste facility with a standard permit and/or a transfer facility permit. Emergency response plans will be included in safety plan for Removal Action, as appropriate.
General S49	STATE Releases from Solid Waste Management Units Env-Hw 708.02(j), incorporating by reference 40 CFR 264, Subpart F	This provision, which incorporates federal RCRA standards, supplements NH Admin. Code Ws Ch 410 by establishing additional standards for groundwater monitoring and appropriate remediation at hazardous waste facilities. The provision prohibits the discharge of constituents into groundwater above federal RCRA limits for such contaminants at the compliance point, which is defined as the boundary of each waste management unit under 40 CFR 264.95.	Not Applicable or Relevant and Appropriate. Removal Action does not involve waste units at hazardous waste facilities.
General S50	STATE Closure and Post-Closure, Env-Hw 708.02 (k), incorporating by reference 40 CFR 264, Subpart G	This provision, incorporating federal RCRA requirements, sets forth design and performance standards for hazardous waste facility remediation and closure.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste facilities. See F20.
General S51	STATE Technical Requirements for Use and Management of Containers Env-Hw 708.03 (d) (1), incorporating by reference 40 CFR 264 Subpart I	This provision incorporates federal RCRA requirements for facilities that store containers of hazardous waste.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste or storage of hazardous waste in containers. See F20.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
General S52	STATE Technical Requirements for Tanks Env-Hw 708.03 (d) (2), Incorporating by Reference 40 CFR 264, Subpart J	This provision incorporates federal RCRA requirements for facilities using tanks to treat or store hazardous waste.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste or storage or treatment of hazardous waste in tanks.
General S53	STATE Technical Requirements for Surface Impoundments, Env-Hw 708.03(d)(3), incorporating 40 CFR 264 Subpart K	This provision establishes design and operation monitoring and closure requirements for surface impoundments.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste or storage or treatment of hazardous waste in surface impoundments.
General S54	STATE Technical Requirements for Waste Piles Env-Hw 708.03(d) (4), incorporating by reference 40 CFR 264 Subpart L	This provision incorporates federal RCRA requirements for storage and treatment of hazardous waste in piles.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste or treatment of hazardous waste in piles.
General S55	STATE Technical Requirements for Land Treatment Env-Hw 708.03(d) (5) incorporating 40 CFR 264 Subpart M.	This provision establishes treatment zones for hazardous constituents placed on land. The owner or operator must design a program to ensure that hazardous constituents are degraded, transformed or immobilized within those zones. Treatment, design and operation requirements are also established.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste or treatment of hazardous waste on the land surface.
General S56	STATE Additional Technical Requirements for Owners and Operators of Hazardous Waste Facilities Env-Hw 708.03(a)-(c)	This provision requires owners and operators of hazardous waste facilities to treat store and dispose of wastes according to best available technology (BAT). Planned and non-planned releases of hazardous waste shall be minimized and the best available solution for managing hazardous wastes shall be utilized.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste facilities. See S36.
General S57	STATE General Manifest Requirements Env-Hw 703.01	The transport of any hazardous wastes off-site must comply with the manifesting and record keeping requirements set forth in this provision.	Not Applicable or Relevant and Appropriate. Removal Action does not involve transport of hazardous wastes or hazardous materials off-site. See also F22 and S34.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
General S58	STATE Technical Requirements for Landfills Env-Hw 708.03(d) (6), incorporating by reference 40 CFR 264, Subpart N	Env-Wm 708.03(d) (6) incorporates federal RCRA requirements for hazardous waste landfills. This provision requires landfills to have a liner and leachate collection and removal system for all portions of the landfill to prevent migration of wastes out of the landfill.	Not Applicable or Relevant and Appropriate. Removal Action does not involve hazardous waste or construction or operation of a hazardous waste landfill.
General S59	STATE NH Dept. of Safety Rules for Transport of Hazardous Materials Safety Ch. 600	These regulations govern the transport of hazardous materials and waste.	Not Applicable or Relevant and Appropriate. See F22 and S34.
On-site removal options S60	STATE Surface Water Quality Standards Interim Env-Ws 1700	The purpose of these rules is to establish water quality standards for the state's surface waters. Water quality criteria for toxic substances are established. [See Part NHCAR Env-Ws 1703 Interim Water Quality Standards and NHCAR Env-Ws 1704 Interim Alternative Site-specific Criteria]. Env-Ws 1705 Interim Flow Standards and Env-Ws 1707 Interim Mixing Zones establish criteria to determine compliance with standards. These rules are applicable to point or non-point discharge(s) of pollutants to surface waters. Interim Env-Ws 1703.19 establishes criteria for non-degradation of aquatic ecosystems. Interim Env-Ws 1708.05 establishes all surface waters in the National Forest are Outstanding Resource Waters and that there shall be no degradation of Outstanding Resource Waters.	Substantive portions are Applicable to alternatives with discharge to surface water, and will be complied with to the extent practicable. Site-specific background values will also be used as a measure of water quality, as appropriate. USDA-FS will work with State regarding standards. In general, Removal Action should result in substantial improvement to surface water quality.
General S61	STATE Standards of Design for Sewage Systems and Wastewater Treatment Systems Env-Wq 700	This chapter establishes standards for the design and construction of public or private sewerage and wastewater treatment facilities.	Not Applicable or Relevant and Appropriate. Removal Action does not at involve design or construction of sewerage or wastewater treatment facilities.
General S62	STATE Surface Water Regulations – Sampling and Analysis Interim Env-Ws 1706	Establishes the requ irements for co llecting, preserv ing an d analyzing samples.	Not Applicable or Relevant and Appropriate as is procedural; however, will be complied with to the extent practicable.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
General S63	STATE Water Pollution and Waste Disposal RSA 485-A:12	RSA 485-A:12, prohibits the disposal of wastes in such a manner as will lower the quality of any surface water below the minimum requirements of the surface water classification. Specific standards for classification of surface waters are found at RSA 485-A: 8. ("no disposal of … waste… into .. waters except those which have received adequate treatment to prevent lowering of…biological, physical, chemical or bacteriological characteristics below those given …["no objectionable physical characteristics, (75% DO), and (bacterial limits"]. No disposal … inimical to aquatic life or the maintenance of aquatic life. pH … shall be 6.5 to 8.0 except when due to natural causes.	Not Applicable as Removal Action does not involve waste disposal. See S60.
General S64	STATE Protection of State Surface Waters Env-Wq 300 Surface Water Discharge Permit Regulations Env-Ws 401	RSA 485-A:13, prohibits the disposal of wastes in such a manner as will lower the quality of any surface water below the minimum requirements for the surface water classification without first obtaining a permit. The purpose of Env Ws 400 et seq. is to describe NPDES application hearing procedures jointly followed by the state and EPA and to describe the application procedures and permit conditions and durations followed by the State in accordance with the Clean Water Act and RSA 485-A.	Not Applicable or Relevant and Appropriate as procedural rather than substantive. No permits are required for CERCLA actions. The Removal Action is intended, to the extent practicable to reduce or eliminate any discharge to surface waters in or adjacent to the Site that would lower the quality of any surface water body below the applicable classification requirements.
General S65	STATE Water Quality Certification Env-Ws 451 through 455	The purpose of the rules in Env-Ws 451 through 455 is to set forth procedures for the issuance of state certification pursuant to section 401 of the federal Clean Water Act. These rules apply to persons seeking a federal permit or license that may result in a discharge to surface waters of the state. These rules shall not apply to the certification of NPDES permits.	Not Applicable or Relevant and Appropriate. See S64.
General S66	STATE Antidegradation Interim Env-Ws 1708	This regulation protects all surface waters of the State from degradation caused by a new and increased point and non-point sources and all other activities that discharge pollutants. Limited degradation as the result of insignificant discharges is allowed by the division [see Part 437.04(a)]	Although the Removal Action does not involve new and/or increased point and non-point sources, substantive portions of the regulation are Applicable and will be complied with to the extent practicable.
On-site removal options S67	STATE Best Management Practices, Env-Wq 401	Env-Wq 401 establishes the minimum required best management practices (BMP) to be employed when performing activities that require the use of regulated substances, so that the risk of groundwater contamination is minimized.	Applicable. The Removal Action and other site work will be performed using BMPs to minimize or prevent groundwater contamination.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
On-site removal options S68	STATE Groundwater Discharge Permit and Registration Rules: RSA 485-A; Env-Wq 402	The purpose of these rules is to establish standards, criteria and procedures for regulating discharges to groundwater and provide for groundwater protection. Discharges of non-domestic wastewater that contains a substance with an MCL or MCLG are allowed provided that the discharge has been treated using best available technology, no substance discharged exceeds the standards established in Env-Wq 402.06 and the discharge is permitted in accordance with Env-Wq 402.22.	Not Applicable or Relevant and Appropriate. See S4.
On-site removal options S69	STATE Prohibited Discharges Env-Wq 402.07	Env-Wq 402.07 prohibits discharge of regulated contaminants to groundwater.	Not Applicable or Relevant and Appropriate. See S4. The Removal Action is expected to decrease or eliminate the uncontrolled discharge of regulated contaminants to the groundwater aquifer below the site.
On-site removal options S70	STATE Additional Groundwater Criteria Env-Or 603.01 (a)	Env-Or 603.01 (a) provides that groundwater shall be suitable for drinking water without treatment. (Drinking water standards applicable to the site pursuant to Env-Or 603.03 include both state and federal minimum requirements. See, e.g.; N.H. Safe Drinking Water Act, RSA Ch. 485; Env-Ws Part 310-319; 52 FR 25716 (July 8, 1987) (codified at 40 CFR 141.61(a)).)	Not Applicable or Relevant and Appropriate. See S4.
On-site removal options S71	STATE Nondegradation of Groundwater to Protect Surface Water Env-Or 603.01 (c)	Env-Or 603.01 (c) provides that groundwater shall not contain any contaminant at concentrations such that the natural discharge of that groundwater to surface water results in a violation of surface water quality standards.	Not Applicable or Relevant and Appropriate. See S4. The Removal Action is expected to eliminate or prevent any discharges to groundwater that would result in a violation of surface water quality at adjacent surface waters to the extent practicable.
On-site removal options S72	STATE Groundwater Management Zone Env-Or 607.05 and 607.06	This part sets forth the criteria for establishing a Groundwater Management Zone where contaminants in groundwater exceed groundwater quality standards and establishes the requirements to provide alternate water supplies and restrict groundwater use.	Not Applicable or Relevant and Appropriate as treatment of groundwater is beyond the scope of the proposed Removal Actions. However, Removal Action is expected to improve groundwater quality. Removal Action does not involve creation of a new source of groundwater contamination or new source of degradation. USDA-FS will restrict future land and groundwater use at the Site through administrative controls.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
On-site removal options S73	STATE Water Quality Sampling, Analysis and Reporting Env-Or 704.01	Part Env-Or 704.01 establishes the requirement and criteria for sampling and analyzing groundwater and surface water samples.	Not Applicable or Relevant and Appropriate as is procedural; however, will be complied with to extent practicable. See S62.
On-site removal options S74	STATE Groundwater Monitoring Wells Env-Or 704.02	Part Env-Or 704.02 establishes the requirement and criteria for constructing, developing, and decommissioning monitoring wells.	Not Applicable or Relevant and Appropriate. Planned Removal Action will not involve additional monitoring wells. See S4.
General S75	STATE Abatement and Control of Open Source Air Pollution NH Admin. Code 1000 Prevention.	Env-A 1002 Fugitive Dust Emission Control prohibits the emission of fugitive dust. See definition at Env-A 101.134; any particulate matter composed of soil which is uncontaminated by pollutants resulting from industrial activity.	Applicable. During the Removal Action, BMPs will be used to prevent, abate, and control fugitive dust emissions as needed. Such precautions may include wetting, covering, shielding, and vacuuming.
On-site removal options S76	STATE NH Water Well Board RSA 482-B Env-We 302 Qualifications	This regulation requires individuals and businesses performing soil exploration or other well drilling operations to be licensed.	Not Applicable or Relevant and Appropriate. Removal Action will not involve soil exploration or well drilling operations.
On-site removal options S77	STATE Abandonment of Wells Env-We 604	This provision requires that abandoned wells must be sealed to prevent the entry of contaminants into the groundwater.	Not Applicable or Relevant and Appropriate. Removal Action will not involve well drilling or abandonment operations.
On-site removal options S78	STATE - Env-We 800 Reports	Part Env-We 801 well completion reports are required to be submitted to the project manager or property owner. Part Env-We 802: Monitoring well completion reports are required to be submitted to the project manager or property owner.	Not Applicable or Relevant and Appropriate. Removal Action will not involve well drilling operations.
General S79	STATE Selection of Consulting Engineering Firms Env-Wq 600	Part Env-Wq 601.01 (a) provides consulting engineering firms with the requirements for eligibility and listing as prequalified on the roster of prequalified consulting engineering firms maintained by the department; and (b) specifies the procedures for contracting with prequalified consulting engineering firms for engineering services for water supply and water pollution control projects that receive state or federal financial assistance.	Not Applicable as this is administrative or procedural rather than substantive requirement. Consulting engineering firms contracted for water pollution control projects on the Site will meet the requirements for eligibility and listing as prequalified. USDA-FS will comply with the procedures for contracting with these firms to the extent practicable.

Table C-3
Action-Specific ARARs and TBCs (Continued)

Removal Alternative	Requirement Requireme	nt Synopsis Status	and Rationale
Low-head dams S80	STATE Dam Rules: RSA 482; Env-Wr 100-700	The purpose of these rules is to establish permitting, design, and inspection requirements of new dams.	Potentially Applicable; however, because of their small size, the proposed low head dams should be exempt.

APPENDIX D
Cost Estimate