APPENDICES

Appendix A.

Health and Safety Plan

Health and Safety Plan
2015 Removal Action

Monte Cristo Mining Area
Mt. Baker-Snoqualmie National Forest
Snohomish County, Washington

April 2015

CES

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2015 Removal Action
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Snohomish County, Washington

EMERGENCY PHONE NUMBERS

Medical Emergency/Ambulance 911

Police 911

Fire 911

National Poison Control Center ..... (800) 222-1222

CES Corporate Safety Officer (Ellen Crawford) ..... (541) 812-6620

US Forest Service, Snoqualmie National Forest-Everett ..... (800) 627-0062

US Forest Service, Darrington Ranger District-Darrington ..... (360) 436-1155

US Forest Service, Verlot Service Center-Verlot ..... (360) 691-7791

Granite Falls Police Department ..... (360) 691-6611

Snohomish County Sheriff's Office, Everett. ..... (425) 388-3393

Snohomish County Sheriff's Office Emergency ..... (425) 407-3970

Ramond Huffman, Law Enforcement Officer 360-913-0163

Granite Falls Fire Dept ..... (360) 691-5553

Hi-Line Helicopters, Inc. (Darrington) ..... (360) 436-1302

WA Dept. of Natural Resources (fires) ..... (800) 562-6010

Snohomish Search and Rescue ..... (425) 388-3328

Dep. Tom Dalton, Charboneau, Granite Falls Police Department ..... (360) 691-6611

Cascade Valley-Granite Falls Clinic ..... (360) 691-2419
405 W. Stanley
Granite Falls, WA 98252

Cascade Valley Hospital ..... (360) 435-2133
330 S. Stillaguamish
Arlington, WA 98223

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Health and Safety Plan
2015 Removal Action
Monte Cristo Mining Area
Mt. Baker-Snoqualmie National Forest
Snohomish County, Washington

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Report Date:	April 2015
Project Number:	2013230047
Submitted By:	Ryan Tobias, Senior Biologist

CONTENTS

FIGURE

ATTACHMENTS

1.0 INTRODUCTION

The United States Department of Agriculture, Forest Service (Forest Service) retained Cascade Earth Sciences (CES) to complete a design for the Non-Time-Critical Removal Action (RA) at the Monte Cristo Mining Area (MCMA) located in the Mt. Baker-Snoqualmie National Forest of Washington. This Health and Safety Plan (HASP) has been prepared to protect employees during five primary field activities expected to occur in 2015. These include:

- **Repository Construction:** An approximate three-acre repository will be opened for consolidation of waste rock and tailings from the MCMA.
- **Glacier Creek Crossing:** A log-stringer crossing will also be installed across Glacier Creek at milepost (MP) 5.0 at the Concentrator. The crossing will be removed by August 31, 2015.
- **Rainy Mine Access:** Construct approximately 2,700 feet of access route from the Monte Cristo Campground to the Rainy Mine north of Glacier Creek.
- **Removal Action:** Consolidation of waste rock and tailings from the Concentrator, Ore Collector, Assay Shack, Haulage Ways, Comet Mine Tram, Pride of the Woods Mine, and Rainy Mine in an onsite repository.

The purpose of this HASP is to identify, evaluate, and minimize potential health and safety hazards, as well as to provide emergency response to accidents during field operations at the MCMA. The objectives of this HASP include the following:

- Identification and evaluation of potential hazards;
- Definition of levels of protection required for the activities ;
- Formulation of emergency action plans;
- Requirements for medical monitoring (as needed);
- Requirements for appropriate personnel receiving hazardous waste operations and emergency response (HAZWOPER) training; and
- Implementation of appropriate record keeping.

This HASP covers CES personnel working in the MCMA who have the potential for exposure to hazardous waste, hazardous substances, physical hazards, or a combination of these materials/activities. It also provides guidance for any CES subcontractors who will be performing support activities. Project Managers will perform a post-job safety performance review on all subcontractors. A Subcontractor Post-Job Safety Performance Review Form (Attachment A) should be completed. This HASP is intended to comply with the requirements of the Occupational Safety and Health Administration (OSHA) Standards as stated in 29 Code of Federal Regulations (CFR) 1910.120 (HAZWOPER), as well as other applicable OSHA requirements. Amendments to this HASP may be made as the contaminant profile is updated; a change in the work status or tasks is made, or as regulatory requirements dictate. Any changes will be brought to the attention of those covered under the plan through additional training.

This HASP addresses the procedures to be followed during the placement of the stream crossing, RA fieldwork, and helicopter operations. All personnel working at the MCMA will follow the safety provisions outlined in this plan. The CES Project Manager for this project, Ryan Tobias, is responsible for the implementation of this HASP, and all questions or concerns regarding site safety should be directed to him.

2.0 SCHEDULE

Fieldwork is tentatively scheduled to begin May 1, 2015, and is expected to occur through October 2015. Stream crossing placement in Glacier Creek and RA activities south of Glacier Creek will be completed by August 31, 2015. Fieldwork will be dependent upon weather and snowpack, which could alter the start and finish dates.

3.0 HAZARD ASSESSMENT

The Hazard Assessment provides an outline of potential chemical, physical, and biological hazards that may be encountered during field activities.

3.1 Chemical Hazards

The Site Inspection (SI) (CES, 2008) and Engineering Evaluation/Cost Analysis (EE/CA) (CES, 2010) identified 10 hazardous substances - antimony, arsenic, cadmium, copper, iron, lead, manganese, mercury, selenium, and silver - with concentrations above screening levels in one or more media at many locations in the MCMA. The Agency for Toxic Substances and Disease Registry (ATSDR) includes arsenic, lead, and mercury in its list of the *Top 20 Hazardous Substances from the 2005 CERCLA Priority List of Hazardous Substances*. Chemical hazards will primarily be present from mine adit water and seeps from waste rock dumps, mine waste rock, and materials associated with the Ore Haulage Ways and Ore Collector, the Concentrator, and the Assay Lab. These materials may be encountered during RA work in the MCMA. A summary of the potential hazards of metals and associated elements considered to pose a potential risk of exposure to CES and subcontractors is presented below.

3.1.1 Antimony

Prolonged exposure to antimony can irritate your eyes, skin, and lungs. Breathing 2 milligrams per cubic meter (mg/m^3) of antimony for an extended period can cause problems with the lungs (pneumoconiosis), heart problems (altered electrocardiograms), stomach pain, diarrhea, vomiting, and stomach ulcers. The principal risk for antimony exposure to personnel in the MCMA is through inhalation of antimony-bearing dust and ingestion of contaminated soil if proper hygiene is not practiced..

3.1.2 Arsenic

Arsenic is carcinogenic to humans. Arsenic III is the most toxic form of arsenic and may be present in the MCMA. Arsenic ingestion is associated with skin cancer and may cause cancers of the lung, liver, bladder, kidney, and colon. Chronic inhalation of arsenicals is closely linked with lung cancer. Breathing high concentrations of inorganic arsenic can give you a sore throat or irritated lungs. **Ingesting high concentrations of inorganic arsenic can result in death.** Lower concentrations of arsenic can cause nausea and vomiting, decreased production of red and white blood cells, abnormal heart rhythm, damage to blood vessels, and a sensation of "pins and needles" in hands.

The principal risk for arsenic exposure to personnel in the MCMA is through inhalation of arsenic-bearing dust and ingestion of contaminated soil or water, if proper hygiene is not practiced.

3.1.3 Cadmium

Cadmium binds strongly to soil particles, dissolves in water, and does not break down in the environment, but can change forms. Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Other potential long-term effects are lung damage and

fragile bones. Breathing high levels of cadmium severely damages the lungs and can cause death. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea. The principal risk for cadmium exposure to personnel in the MCMA is through inhalation of cadmium-bearing dust and ingestion of contaminated water.

3.1.4 Copper

Concentrations of copper, such as those observed in the MCMA, can have an adverse effect on human health. Chronic exposure to copper can discolor and irritate the skin, cause mild dermatitis, runny nose, and irritation of the mucous membranes. Repeated ingestion of copper can damage the liver and kidneys. Copper is present in contaminated water and soils.

The principal risk for copper exposure to personnel in the MCMA is through inhalation of copper-bearing dust and ingestion of contaminated water.

3.1.5 Iron

Iron can be absorbed in the soluble reduced (ferrous) state by cells of the intestinal mucous. However, the ferrous form is easily converted to the insoluble oxidized iron (ferric) in surface waters. Hence, the ferrous form of iron should not be present in large quantities in surface water in the MCMA. As such, incidental ingestion of iron-contaminated surface water should not pose a major health risk to personnel in the MCMA.

The principal risk for iron exposure to personnel in the MCMA is inhalation of iron-bearing dust or ingestion of contaminated soil if proper hygiene is not practiced. Overexposure to iron-bearing dust can create a buildup in the body and eventually cause such diseases as Hemochromatosis and Siderosis. In addition, complications such as damaged blood vessels, bloody vomitus and stools, damage to the liver and kidneys, and eventual death can occur.

3.1.6 Lead

Although children under the age of six are most susceptible to lead exposure, adults can also experience adverse effects. In adults, overexposure to lead can cause increased blood pressure, fertility issues, nerve disorders, muscle pain, and memory and concentration problems. Damage to adult kidneys from ingested or inhaled lead can occur at 40 micrograms per deciliter (µg/dL), while nerve damage and anemia can occur at a concentration of 60 µg/dL. Ingestion or inhalation of high levels of lead can lead to convulsions, paralysis, and even death.

The principal risk for lead exposure to personnel in the MCMA is through incidental ingestion of lead-contaminated surface water or soil.

3.1.7 Manganese

Some individuals exposed to very high levels of manganese for long periods of time (months or years) in their work may develop a disease called "manganism" characterized by mental and emotional disturbances and slow and clumsy body movements. Manganism occurs because too much manganese injures a part of the brain that helps control body movements. Exposure to high levels of airborne manganese can affect motor skills such as holding one's hand steady, performing fast hand movements, and maintaining balance. Exposure to high levels of the metal may also cause respiratory problems and sexual dysfunction. The Environmental Protection Agency (EPA) has set a non-enforceable guideline for the level of manganese in drinking water at 0.05 milligrams per liter (mg/L).

The principal risk for manganese exposure to personnel in the MCMA is through incidental ingestion of manganese-contaminated surface water or inhalation of manganese-bearing dust.

3.1.8 Mercury

Mercury is a toxic element to humans and many higher-order animals. All chemical compounds containing mercury are toxic to humans. Inorganic mercury salts show a high acute toxicity with a variety of symptoms and damages. Organic mercury compounds, such as methyl mercury, are considered even more hazardous to humans because of their high chronic toxicity with respect to the nervous system. Methyl mercury is typically the dominant toxic mercury species in sediments.

Cinnabar, mercuric sulfide (HgS), a stable, non-reactive naturally occurring mercury compound, has not been identified in the MCMA and is most common in epithermal deposits rather than mesothermal deposits, such as those that occur in the MCMA. It is resistant to oxidation and weathering and is extremely insoluble in water. Therefore, it enters the environment mainly in the form of mechanically degraded particulate matter. Elevated mercury has been verified near the Concentrator. This occurrence probably indicates use of mercury amalgamation gold recovery. The residual mercury may be in elemental form in microscopic amounts.

The principal risk for mercury exposure to personnel in the MCMA is through inhalation of mercury-bearing dust, particularly near the Concentrator.

3.1.9 Selenium

Much of the selenium in rocks is combined with sulfide minerals or with silver, copper, lead, and nickel minerals. Selenium compounds that dissolve in water are sometimes very mobile, thus, there is an increased chance of exposure to these compounds. Although selenium is an essential nutrient for humans and animals, it can be harmful when regularly taken in amounts higher than those needed for good health. Dizziness, fatigue, and irritation of mucous membranes have been reported in people exposed to selenium in workplace air at concentrations higher than legal levels. In extreme cases, collection of fluid in the lungs (pulmonary edema) and severe bronchitis have been reported. The exact exposure levels at which these effects might occur are not known, but they become more likely with increasing amounts of selenium and with increasing frequency of exposure. The EPA Office of Drinking Water regulates the amount of selenium allowed in drinking water. Public water supplies are not allowed to exceed 50 parts per billion total selenium.

The principal risk for selenium exposure to personnel in the MCMA is through incidental ingestion of selenium-contaminated surface water or soil.

3.1.10 Silver

Many silver compounds dissolve in water and do not evaporate; therefore, the most common way that silver may enter the body of a person near a hazardous waste site is by drinking water that contains silver. If silver compounds are consumed or breathed over a long period (several months to many years), some areas of the skin and other body tissues can turn gray or blue-gray, a condition called "argyria." Argyria occurs in people who eat or breathe in silver compounds. Although a single exposure to a silver compound may cause silver to be deposited in the skin and in other parts of the body; this is not known to be harmful. Once you have argyria it is permanent. However, most doctors and scientists believe that the discoloration of the skin seen in argyria is the most serious health effect of silver. Skin contact with silver compounds has been found to cause mild allergic reactions, such as rash, swelling, and inflammation, in some people. For short-term exposures (l-10 days), the EPA suggests that drinking water levels of silver not be more than 1.142 mg/L (1.142 parts per million).

The principal risk for silver exposure to personnel in the MCMA is through incidental ingestion of silver-contaminated surface water or soil.

3.2 Physical Hazards

The MCMA is situated in a remote area with steep terrain, actively-flowing streams, potentially severe weather conditions, old mine workings, and abandoned processing equipment and related structures. As shown in the checklist below, physical hazards in the MCMA are primarily due to steep and irregular slopes in the mountainous terrain, weather conditions, and mine openings. In addition, physical hazards will be present during turbidity monitoring activities and heavy equipment operations.

Mining areas often contain a variety of unknown hazards within the workings, structures, and debris piles. Overall hazards include operating a field vehicle in steep terrain with poor roads, twisting an ankle while traversing the slopes, slipping or tripping on obstructions, falls into open mine workings, and exposure to the heat or cold. Precautions should be taken to recognize and avoid hazards such as steep banks, slippery rocks, and fast-flowing cold water. All field activities will follow standard operating procedures to minimize the chance of human error and will be conducted in a safe and prudent manner.

Helicopter operations at the Pride of the Woods, Mystery, and Justice Mines present additional physical hazards. These include potential accidents associated with entry/exit from the helicopter, fueling operations, fatigue, downwash/turbulence, spillage, and special communications.

Physical Hazard Description	Hazard		Comments
	Yes	No	
Overhead Power Lines		X	None present at MCMA.
Heavy Equipment	X		Excavators, bulldozers, and haul trucks will be used during installation of stream crossings and RA activities.
Pinch Points on Rigs	X		Excavators and bulldozers will be used – personnel should approach with caution.
Buried Conduit		X	None present in the MCMA.
Tree Snags	X		Present at the MCMA. Will work with the On-Scene Coordinator (OSC) to determine methods for removal.
Fuel (gas and diesel)	X		Generator and equipment fuel may be transported in and stored on-site. Appropriate precautions including transport safety, selection of safe storage locations, safe dispensing procedures, and fire safety equipment will be employed.
Fatigue	X		Sleeping in onsite trailer. Personnel will monitor each other for alertness and the Site Safety Officer (SSO) will require fatigued personnel to leave the work area and rest. A two-week work rotation limit will be employed.
Illness	X		Diarrhea and other gastro-intestinal tract illnesses can be a hazard due to poor hygiene. Personnel will wash their hands with soap after visiting the toilet and before eating.
Uneven Ground	X		Appropriate precautions will be taken while traversing the area.
Fall Hazards	X		Appropriate precautions will be taken while traversing the area. Fall protection is required on surfaces without guard rails in excess of four feet above the fall surface.
Steep Slopes	X		Appropriate precautions will be taken while traversing the area.

Physical Hazard Description	Hazard		Comments
	Yes	No	
Ice	X		Ice may be present IN EARLY MORNING HOURS depending on weather conditions. In addition, the MCMA may contain lingering snow. Appropriate precautions will be taken.
Extreme Temperatures	X		Field activities are scheduled for late spring through the fall months and extreme temperatures could occur.
Slippery Conditions	X		Slippery conditions may be present depending on weather conditions, or remaining snowpack in the higher elevations. Appropriate precautions will be taken while traversing the areas.
Rain	X		Rain may exacerbate hazardous conditions.
Confined Space	X		No personnel will enter adits or stopes in the MCMA during 2015 field activities.
Open Stopes	X		Appropriate precautions will be taken while traversing the MCMA and no personnel will knowingly go near stopes open to the surface.
Potential Adit Collapse	X		There is the potential for adits to collapse, especially near the portal. Caution should be taken by the selected trained personnel.. Underground workings will not be entered, and untrained personnel will not knowingly go near the vicinity of any working.
Abandoned Structures	X		Abandoned processing equipment and structures are present in the MCMA. Such structures are known to host rodents and yellow jackets. CES and subcontractors will not enter any structures during field activities.
Helicopter entry/exit	X		Work within the pilot's line of vision. No personnel shall move toward the back of the helicopter, especially near the tail rotor. Personnel shall Walk in a crouched position when approaching or leaving a helicopter. No personnel shall approaching a helicopter from an uphill position. Objects carried by site personnel will not extend above body height to avoid collision with the rotors.
Helicopter Communications	X		Radio, hand signals, emergency signals, and warning signals will be arranged with the crew. All emergency signals will be confirmed in the pre-flight briefing.. Ground crew will wear high-visibility clothing, hard hat, boots, gloves, eye and ear protection, as necessary
Helicopter refueling	X		Prior to fueling, all equipment and the helicopter must be grounded. All grounding and bonding connections must be electrically and mechanically touching clean unpainted metal parts
Helicopter pilot fatigue	X		2-hour flight shifts will be employed with ½ hour breaks and a one-hour break for lunch each day.
Helicopter Downwash and Turbulence	X		During waste rock transport, coverings will need to be securely lashed or removed altogether. Care will be taken to avoid downwash that may produce dust, dirt, and loose objects that could become airborne projectiles
Logging Operations	X		A separate HASP has been developed for timber felling operations. Please refer to this document for a description of physical hazards.
Surface Water	X		The potential for drowning exists while traversing near, crossing, or working over actively-flowing streams. Appropriate precautions should be taken to avoid falling into streams.

3.3 Remote Location

In addition to the abovementioned hazards, additional physical hazards will be created due to the extended work (several months) in a remote location. A remote camp will be set up, which will include generators, tents, camp trailers, camp staff, cooking, and poor communication. Hazards associated with the above include fatigue from poor sleeping conditions, gastro-intestinal illnesses from poor hygiene, burns, and injury. Personnel will be expected to monitor each other for fatigue, practice good hygiene, and be current in first aid and cardiopulmonary resuscitation (CPR). Personnel will be restricted to a maximum two-week rotation to reduce chances for fatigue and injury.

3.4 Biological Hazards

Biological hazards can include encounters with wildlife species, especially rodents in old buildings, insects, poisonous plants, and/or exposure to disease-causing bacterial and viral pathogens. Exposure to the most dangerous of these biological hazards is unlikely and will probably not occur during RA activities. However, biological hazards can be dangerous, even deadly, and should be recognized to prevent exposure during investigative field activities.

3.4.1 Black Bears

Black bears have a natural fear of humans and tend to avoid people or developed areas. However, bears should be considered unpredictable and potentially dangerous. A bear will usually detect the presence of humans and flee an area unless the bear has been conditioned to people and their foods. The best way to avoid a bear encounter is to make your presence known by shouting or making loud noises and watching for bear signs such as scat, claw marks, diggings, and logs or stumps torn apart. The following steps should be taken in the event of an encounter with a bear:

- If a bear is visible, but not close, alter your route to move away from the bear's area.
- If a bear approaches, *do not* run. Remain calm, continue facing the bear, and slowly back away. If the bear continues to approach, attempt to scare the bear away by shouting and acting aggressively.
- If a bear attacks, fight back using fists, sticks, rocks, and EPA registered bear pepper spray (if available).

3.4.2 Cougars

Cougar sightings in Washington are rare. Cougars are active mainly at dusk and dawn, although they will roam and hunt at any time of the day or night in all seasons. During late spring and summer, one and two-year old cougars become independent of their mothers and roam vast areas in search of a home range. It is during this time that cougars are most dangerous and most likely to come into contact with humans.

Cougars are predators, and their actions are unpredictable. Any cougar that approaches, follows, disappears then reappears, or displays other stalking behavior is acting in a predatory manner. The best way to prevent a cougar encounter is to avoid startling any cougar by making noise and traveling in groups. However, the following steps should be taken in the event of an encounter with a cougar:

- *Never* approach a cougar. Although most cougars will avoid a confrontation, all cougars are unpredictable.
- Always give a cougar an avenue of escape.
- Stay calm. Talk to the cougar in a confident voice.

- *Do not* run. Back away from the cougar slowly and always keep eye contact. Sudden movement may trigger an attack.
- Make yourself appear as large as possible with arms extended. *Do not* crouch or attempt to hide. If possible, pick up sticks or branches and wave them around.
- If a cougar attacks, fight back. Use rocks, sticks, fists, etc. to defend yourself.

3.4.3 Yellow Jackets

Yellow jackets are members of the wasp family and are recognizable by the distinct alternating yellow and black markings on the abdomen. They are not bees, which are somewhat less aggressive. Yellow jackets are social insects and will fiercely defend nests if threatened. Encounters with yellow jackets are difficult to avoid since they are small, extremely mobile, and numerous. Individuals can minimize encounters by not wearing perfumes, hair tonic, suntan lotion, aftershave lotion, shiny buckles, bright colored clothing (yellow, light blue, orange, fluorescent red), or flowered prints on clothing. Nevertheless, there is a possibility yellow jackets will be present during RA activities. The following steps should be taken in the event of an encounter with yellow jackets:

- *Never* swing or strike at yellow jackets, since rapid movements often provoke painful stings.
- If a yellow jacket is nearby, slowly raise your hand to protect your face remaining calm and stationary and then move slowly (avoiding nests located in the ground).
- Yellow jackets fly about seven to eight miles per hour, which is slower than the average running speed for humans. However, running should be a last alternative since yellow jackets can produce up to a dozen stings before a human reaches full speed.
- *Never* strike or crush a yellow jacket against your body. Wasp venom contains chemical "alarm pheromones", which, when released into the air, signals guard wasps to sting the perceived threat.

Despite peoples' best efforts, yellow jacket stings are often difficult to avoid. Insect sting kits should be carried when conducting field activities. In addition, antihistamines can be effective in reducing the pain and swelling caused from the biogenic amines released during a sting.

3.4.4 Spiders

Approximately 760 species of spiders occur in Washington State. All spiders are technically "venomous", however; the Black Widow and Hobo spiders are the only species in Washington considered as being dangerously venomous to humans. Black Widows occur only sporadically throughout Snohomish County and Hobo spiders have been documented in the Puget Sound area. The likelihood of encountering these two spiders is considered extremely low and the possibility of a bite resulting from an encounter is even lower. Spiders will often occupy dark, dry spaces such as firewood piles, old lumber, dry crawl spaces, barns, and sheds. Around mines, Black Widows are often found around adit portals. Care should be taken in these environments not to disturb or agitate spiders located in these habitats.

3.4.5 Ticks

Ticks are obligate vertebrate parasites, which are closely related to spiders. Lyme disease is a tick-borne illness known to cause muscle pain, arthritis, and neurological symptoms. In addition, ticks can cause relapsing fever and tick paralysis. Occurrences of these diseases in Washington are low, however; exposure to Lyme disease occurs primarily west of the Cascade Mountains. The only suspected carrier of Lyme disease in Washington is the Western Black-Legged Tick.

The risk of contracting Lyme disease can be reduced by the following appropriate preventative measures:

- Wear light colored, long-sleeved shirts and long sleeved pants so ticks are easy to spot.
- Pants should be tucked into socks and wear closed-toed boots.
- Check periodically for ticks on the body.
- Attempt to avoid grassy or brushy areas that may harbor ticks.
- Tick repellents such as N, N diethylmeta-toluamide (DEET) can be an effective deterrent.

If a tick is found on the body, the following measures should be taken:

- Ticks can be removed with forceps or tweezers by grasping the tick's body as close to the skin as possible.
- Apply gentle, steady pressure to the tick and pull the tick directly away from the skin. Care should be taken not to apply too much pressure to the tick's body because an engorged tick can release spirochetes into the skin.
- *Do not* twist or jerk the tick because mouthparts may break off in the skin.
- *Do not* apply a match or hot stick to the tick's body.
- *Do not* apply Vaseline in an attempt to suffocate the tick.

3.4.6 Hantavirus

Hantavirus is a virus that causes Hantavirus Pulmonary Syndrome (HPS), a form of adult respiratory disease syndrome. The infection caused by Hantavirus is a serious illness, with 38% of those infected dying from acute respiratory failure. Deer mice are the primary carriers of the Hantavirus observed in the northwest United States. They can carry the disease without showing any outward signs of sickness. Deer mice can shed the virus via urine, saliva, and droppings. Transmission of the disease can occur when fresh or dried materials contaminated with rodent excreta are disturbed and dust particles are breathed. In addition, direct introduction into broken skin, introduction into the eyes, ingestion, and bites from deer mice are believed to cause infection. The following steps can be taken to avoid exposure:

- Avoid contact with rodents or rodent nests.
- Avoid cabins and shelters unless they have been aired and disinfected.
- Avoid areas where burrows or droppings are present.
- Wear a HEPA filter mask (if available) when working in areas assumed to be infested with rodents.

3.4.7 Poison Oak

Poison oak is a deciduous shrub native to Western Washington. The easiest way to identify poison oak is by the leaflets that grow alternately in threes from the plant's stem. Leaflets often times appear glossy, and in autumn, they usually have a brilliant red coloration. Poison oak can be found in a wide range of temperatures, elevations, soil types, moisture conditions, and light intensities. However, it is commonly found on hillsides with shallow soils. In addition, it can be found in fencerows, waste areas, cut over forests, stream banks, and rocky canyons.

All parts of the poison oak plant, except the pollen, contain a poisonous, oily substance called urushiol. The only methods of contraction are direct contact with the plant and skin or indirect contact with other objects

that have come into direct contact with the plant. Exposure to poison oak can be prevented by avoiding the plant or by wearing protective clothing such as gloves and long sleeved shirts.

In the event of exposure, the following steps should be taken:

- Wash the affected area with cold water, followed with isopropyl (rubbing) alcohol or equal parts alcohol and water or Technu (follow directions) to dissolve the unabsorbed poison.
- Take a regular shower with soap and warm water. *Do not* use soap before this point because soap can pick up urushiol and distribute it over a larger area of the body.
- Clothes, shoes, tools, and any other objects that may have come into contact with the poison Oak should be wiped with alcohol and water or Technu. Wear gloves while cleaning equipment and clothes and discard immediately after use.

Often times when a person is exposed to poison oak, there is not enough time to properly cleanse the body of the urushiol (Technu can be effective up to eight hours after exposure). The resulting rash or blisters can be relieved with Calamine Lotion and/or a cool compress. Moreover, over-the-counter corticosteroids can be effective in temporarily relieving symptoms.

3.5 Weather Hazards

Weather conditions at the MCMA can be extreme and unpredictable. The following sections provide a brief outline of potential hazards and prevention measures.

3.5.1 Wind

Wind is the most likely meteorological event to create a hazard by generating dust clouds. This allows an exposure pathway to personnel through possible inhalation of contaminated airborne particulates. If winds are strong enough to cause significant dust to rise from contaminated areas, all field personnel in the vicinity will don HEPA filters for the duration of the event. This will prevent exposure of potentially high levels of metal bearing dust.

3.5.2 Hot Weather

Heat is a potential concern at this location during the summer months. In hot weather, heat stress can be a serious hazard for workers. Heat stress usually is a result of protective clothing decreasing natural body ventilation, although it may occur at any time work is being performed at elevated temperatures.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. These reactions range from mild (fatigue, irritability, anxiety, and decreased dexterity) to fatal. Because heat stress is one of the most common and potentially serious illnesses that workers face, regular monitoring and other preventative measures are vital.

Heat Stroke

Heat stroke is an acute and dangerous reaction to heat stress caused by failure of heat regulating mechanisms of the body (i.e., the individual's temperature control system that causes sweating stops working correctly). If the victim is not cooled quickly, the body temperature will rise to a point at which brain damage and/or death may occur.

Symptoms – Red, hot, dry skin, although the person may have been sweating earlier; nausea, dizziness, confusion, extremely high body temperature, rapid respiratory and pulse rates, unconsciousness or coma.

Treatment – Cool the victim quickly. This can be done by soaking the victim in an ice water bath, to reduce the temperature to a safe level (102 °F). If cell phone transmission is possible, call 911 and advise them of the situation. Follow their instructions about where to meet an ambulance.

Heat Exhaustion

Heat exhaustion is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. This condition is much less dangerous than heat stroke, but it must be treated.

Symptoms – Pale, clammy, moist skin, profuse perspiration, and extreme weakness. Body temperature is normal, pulse is weak and rapid, and breathing is shallow. The person may have a headache, may vomit, and may be dizzy.

Treatment – Remove the person to a cool place, loosen clothing, place in a head-low position, and provide bed rest. Consult a physician by cell phone, especially in severe cases. The normal thirst mechanism is not sensitive enough to ensure body fluid replacement. Have patient drink 1 to 2 cups of water immediately, and every 20 minutes thereafter, until symptoms subside. Total water consumption should be 1 to 2 gallons per day.

3.5.3 Cold Weather

Field activities may occur during cold weather events in the late spring and early fall. If snow coverage makes it difficult to complete work, field activities will be rescheduled as appropriate. Because weather conditions in the area can be unpredictable, preventative measures are included in this HASP, and all personnel should bring limited cold weather clothing.

The conditions that promote cold-related illnesses are not always apparent. Therefore, it is essential that personnel wear appropriate clothing to protect against the elements. During extreme cold (<45 °F), raining or chilly wind conditions, personnel should wear appropriate clothing to protect hands, feet, and exposed body extremities, as well as the head and neck areas. If an employee becomes over-exhausted due to exertion during extreme weather conditions, curtailing of activities should be considered rather than shedding protective clothing. All indications of cold-related illnesses will be treated immediately by the designated on-site first aid responder. The physical health of all on-site personnel will be monitored closely throughout all remedial activities.

Frostnip

Frostnip occurs when cooling occurs in the tissues, cheeks, chin, fingers, toes, and ears.

Symptoms – Pale, white, grayish, glassy patches and tissues are soft and resilient.

Treatment – Use steady, firm pressure on the cooled area with a warm body part (e.g., put fingers in armpit, put toes against a friend's abdomen).

Frostbite

Frostbite occurs when there is freezing of body tissues and is unlikely during fieldwork. Frostbite most commonly affects the hands and feet.

Symptoms – Tissues pale, cold, solid; feels wood-like; tissues not resilient; grayish patches.

Treatment – Check breathing, airway, circulation. Protect frozen areas from further damage, but DO NOT thaw. If feet are frozen, they can be walked on if necessary. However, once they begin to thaw, DO NOT walk on them. Seek professional medical aid for re-warming. WARNING: Improper warming can increase tissue loss.

Hypothermia

Hypothermia is the lowering of body temperature to below normal levels. Hypothermia can occur in cool and wet or cold environments. Water, wet clothing, and wind accelerate heat loss.

Symptoms – Shivering, weakness, loss of coordination, difficulty performing tasks and making decisions, loss of consciousness, slow or absent breathing and heartbeat.

Treatment – Check breathing, airway, circulation. Protect from further heat loss by sheltering patient from wind and water. Replace wet clothing with dry attire if possible. Cover patient's head. WARNING: Jarring the patient can cause an abnormal heart rhythm. If mild signs/symptoms, add heat to the neck, armpits, and groin. If moderate to severe signs and symptoms, prevent further heat loss and seek additional medical aid for re-warming.

3.5.4 Storms

Storms strong enough to endanger operations may require termination of RA activities until the storm has passed. Storms are hazardous due to the potential for lightning strikes and falling trees. The possibility for being struck by lightning during a thunderstorm does exist. In order to minimize the possibility of this happening the following should be observed during storms:

- *Do not* make a human lightning rod of yourself by being the highest point around.
- *Do not* stand under solitary trees or other isolated objects in field.
- *Do not* hold metal objects in your hands, which may attract a strike.
- *Do not* take refuge near wire fences or above ground pipes that could carry lightning currents to you from a strike, which has hit some distance away.
- Do get inside if possible, (but not in an isolated building in the middle of a field). Once you are inside, avoid open doors and windows.
- Do crouch or lie down if you are in an open field.
- Do stay away from open water.
- Do stay in your car with the windows rolled up. The car will provide a path around you for the current of the lightning bolt.

If lightning is identified within five miles of the project site, work will stop and will not resume until at least 30 minutes following the final strike in the area.

4.0 PERSONNEL

The CES Project Manager for this project is Ryan Tobias. In this capacity, Mr. Tobias will oversee compliance with all applicable health and safety regulations. The designated MCMA SSO, Tim Otis, will oversee day-to-day safety activities. Safety is affected by all involved parties or organizations. For this reason, the following key personnel and their organization have been identified:

Ryan Tobias – CES	Project Manager	(503) 931-3157
Tim Otis, PE – CES	Senior Engineer	(541) 619-4918
Jay Williams, PE – CES	Senior Engineer	(208) 724-2261
BJ Kronschnabel, PE – CES	Senior Engineer	(402) 613-8793
Dave Iversen – ASM Affiliates	Senior Archaeologist	(360) 572-4870
Subcontractor – TBD		
Joseph Gibbens - Forest Service	On-Scene Coordinator	(360) 956-2352

All personnel will receive copies of the HASP for review prior to the start of activities. After review, each person will sign the Acknowledgement Form included as Attachment B. The signed Acknowledgment Form and copies of hazardous waste training certificates will be attached to the HASP or otherwise available for inspection of the MCMA.

4.1 Communications

Due to the remote nature of the MCMA, CES will utilize three levels of communications to keep in contact with Principal-in-Charge and local Forest Service staff.

1. Communications with Forest Service staff through the Darrington Ranger District or Verlot Public Service Center will be available via a Forest Service-supplied radio station operated at the project campsite, or hand held Bendix/King radios. Radio communications will be transmitted through the local repeater at Barlow Pass on the selected frequency. The transmitter frequency will be included in the RA Work Plan.
2. A satellite phone will be used as a backup for the radio station at the campsite. The SSO or PM will check in with Principal-in-Charge or other designee (to be arranged prior to commencement of field operations) twice per week with the satellite phone. Check-in times will generally be Monday morning and Friday afternoon. In the event that check-in is not performed, the appropriate authorities, including the Forest Service will be notified of a potential problem.
3. E-mail communications will also be available onsite using a satellite internet connection at the temporary field camp. Although e-mail will not provide instantaneous communication in the event of an emergency, it will allow another form of communication in the event satellite telephone or radio communications are unusable.

In the event an emergency evacuation is required or a life threating injury occurs, CES will utilize the Forest Service-supplied radio station, or hand held radios at the temporary campsite to contact Hi-Line Helicopters in Darrington, Washington. If the injured person can be transported to the Townsite, the Forest Service helipad will be used to land for airlift. The Darrington Ranger District office and Verlot Public Service Center will be contacted if personnel are not available at Hi-Line Helicopters. In the event of a failure of the radio station (or hand held radios), CES will use the satellite phone as a backup form of communication. If both systems are unavailable, or an injury occurs at night and helicopter access is not feasible, an e-mail will be sent notifying the Principal-in-Charge and local Forest Service staff of the emergency and the injured person(s) will be evacuated by vehicle to the Cascade Valley Hospital in Arlington, Washington. The flow chart in Attachment C provides a diagram of the communications and notification plans in the event of an emergency.

CES internal team communications with staff and subcontractors will be conducted with standard hand-held radios to communicate work details, with agreed-upon channel selection and radio protocol discussed at weekly health and safety meetings.

5.0 PERSONAL PROTECTIVE EQUIPMENT AND OTHER REQUIRED EQUIPMENT

The following basic Level D safety equipment and other personal protective equipment (PPE) are required to be available for activities in the MCMA. PPE will be used as appropriate and as directed by the CES SSO.

5.1 Summary of Safety Equipment Required for this Project

- First aid kit
- 1 – A, B, C Fire extinguisher
- Cellular telephone – cellular coverage may not be available at remote locations
- Hand-held radios
- Forest Service-supplied Bendix King radios
- Satellite telephone – available with the CES SSO
- Wash station to rinse dust and dirt from exposed skin
- Insect bite kit
- Personal flotation device for use with the modified pontoon boat.

5.2 Personal Protective Equipment – Level D (modified)

- Work uniform with long pants and appropriate cold-weather gear (including rain protection)
- Steel-toed boots, leather or PVC (optional)
- Outer gloves, green Viton or equivalent (optional)
- Inner gloves, latex/nitrile disposable for confirmation sampling
- Safety glasses
- Splash goggles (for use during decontamination with acid)
- Disposable Tyvek coveralls (optional)
- Hard hat (used near heavy equipment and where the possibility of objects falling from overhead)

5.2.1 Fall Protection

Fall protection will be employed at the Site in accordance with Washington Administrative Code (WAC) 296-155, Part C-1, Fall Restraint and Fall Arrest. Personnel conducting work on log-stringer bridges without guardrail protection higher than four feet above the working surface will be required to wear and deploy personal fall arrest equipment. Fall body harnesses will be worn to contain the torso and distribute force during a fall. The following components of the full body harness are necessary:

- Back D-ring is the only attachment for connecting to the arrest system.
- The front D-ring is only for controlled lifting and lowering. The front D ring may be used for rescue or retrieval.
- Hip D-rings are only to be used for restraint or work positioning. When using hip D-rings for work positioning, both D-rings must be used.
- Shoulder D-rings are only used for rescue purposes.

6.0 OPERATIONAL PROCEDURES

Invasive activities involving heavy equipment require Level D PPE. These guidelines are primarily intended to address work involving equipment operation. Such activities will initially be approached under Level D conditions, and will incorporate three designated zones (Figure 1).

- The exclusion zone (EZ), or hot zone, includes all areas with contaminated material. The Concentrator, Ore Collector, Assay Shack, Haulage Ways, Comet Tram/Terminal, Rainy Mine,, and repository are included in the EZ. Personnel at the MCMA that are not HAZWOPER-certified will not be allowed access to the EZ.
- The support zone (cold zone) is the area of the Site that is free from contamination and that may be safely used as a planning and staging area. The temporary campsite and lower Townsite/Forest Service helipad are situated in the support zone.
- The contamination reduction zone (warm zone) is the transition area between the exclusion and support zones. This area is where responders enter and exit the exclusion zone and where decontamination activities take place. The access area to the repository and ingress/egress areas to the contaminated areas at the Townsite are part of the contamination reduction zone.

Other activities such as confirmation sampling will be performed using appropriate PPE. The use of a hard hat, steel-toed boots, and safety glasses may not be necessary for many types of sampling. A formal exclusion area also may not be required for such routine monitoring. However, reasonable effort should be made to keep non-essential personnel away from sampling activities.

6.1 Chemical Hazards

Due to concentrations of total arsenic in excess of state and federal drinking water standards, no ingestion of surface water will be allowed from streams at the MCMA. Potable water will be imported to the Site from offsite drinking water supplies during the RA.

6.2 Physical Hazards

The physical hazards associated with the MCMA include traversing steep terrain, working in and around flowing water, working around heavy equipment, fatigue, GI-tract illness, and injury in a remote location. Equipment will need to be carried near the creeks; waders and non-slip soled boots will be necessary for any work performed in the creeks (e.g., turbidity monitoring). Precaution will be needed in traversing the MCMA due to steep terrain. Very steep terrain will be avoided when slick from rain, as the slip and fall hazard is greatly increased. The SSO will hold a safety team meeting at the beginning of the project to set up hand or horn signals to be used for communication with equipment operators, and to establish working procedures around the equipment.

6.3 Logging Operations

A separate HASP has been developed to identify specific hazards associated with logging activities during the RA. All personnel involved with tree felling, limbing, bucking, and/or transport of downed timber will be expected to read and sign that HASP before any involvement with logging at the MCMA.

6.4 Helicopter Operations

Waste rock transport from the Pride of the Woods Mine will necessitate the use of a 10,000 pound payload capacity helicopter. In addition, equipment needed to excavate waste rock will need to be transported using

an equivalent heavy load capacity helicopter. Adit diversions at the Mystery and Justice Mines will also require access and equipment transport with a helicopter.

During transport work, all ground activity will be under the control of the signaler and the pilot. Prior to any lifting operations, radio, hand signals, emergency signals, and warning signals will be arranged with the crew. All emergency signals will be confirmed in the pre-flight briefing. Safety meetings will be conducted daily between the pilots, ground crew, supervisor, and subcontractors. Ground crew will wear high-visibility clothing, hard hat, boots, gloves, eye and ear protection, as necessary. Unnecessary personnel will not be allowed near staging areas, work areas, or drop off areas at the repository.

All personnel working near helicopters will need to be briefed regarding hazardous conditions. These may include:

- Working within the pilot's line of vision, and not moving toward the back of the helicopter, especially near the tail rotor.
- Walking in a crouched position when approaching or leaving a helicopter.
- Never approaching a helicopter from an uphill position.
- Not carrying objects extending above body height.
- Handling long lines after they have been grounded to avoid shock potential.

No unauthorized employees are allowed near the refueling site at the borrow area. Prior to fueling, all equipment and the helicopter must be grounded. All grounding and bonding connections must be electrically and mechanically touching clean unpainted metal parts.

Downwash and turbulence can result in spillage of waste rock to the ground and waterways. During waste rock transport, coverings will need to be securely lashed or removed altogether. Moreover, care will also be taken to avoid downwash that may produce dust, dirt, and loose objects that could become airborne projectiles.

To avoid pilot fatigue, 2-hour shifts will be employed, with ½-hour breaks and a one-hour break for lunch each day. Refueling will occur during breaks and a ½-hour maintenance check will be performed following flight operations at the end of each work day.

7.0 DECONTAMINATION / DISPOSAL PROCEDURES

Extensive decontamination procedures have been determined to be unnecessary for this phase of the project. However, should comprehensive decontamination become necessary due to PPE Level upgrade, the SSO will devise a decontamination plan according to the following table.

Personnel and equipment leaving the EZ shall be decontaminated. Level **D** decontamination protocol shall be used with the following decontamination stations:

LEVEL C DECONTAMINATION STEPS		LEVEL D DECONTAMINATION STEPS	
1	Equipment Drop	1	Equipment Drop
2	Outer Garment, Boots, and Glove Wash and Rinse	2	Outer Glove Disposal and Boot Wash and Rinse
3	Disposable Garment, Boots, and Glove Removal	3	Outer Boot and Inner Glove Removal, as necessary
4	Cartridge Change (if necessary)	4	Field Wash
5	Remove Respiratory Protection		
6	Field Wash		

The following decontamination equipment is required at a boring location (Not applicable in the MCMA.).

DECONTAMINATION EQUIPMENT CHECKLIST			
X	Scrub Brushes	X	Garbage Bags
X	Waste Containers	X	Paper Towels
X	Soap	X	Isopropyl Alcohol
X	Plastic Tubs	X	Pump Spray Bottles
X	Plastic Drop Cloths	X	Pump Spray Bottles (DI water)
X	De-Ionized (DI) or distilled water	X	Pump Spray Bottle (HNO_3 solution)

8.0 DISPOSAL OF DECONTAMINATION WASTES

All equipment and liquids used for decontamination shall be disposed of properly according to local, state, and federal regulations. Whenever field clothing is sent to commercial laundries or cleaning establishments that decontaminate protective clothing or equipment shall be informed of the potentially harmful effects of exposures. Skin exposed to MCMA dust will be washed periodically with soap and water or waterless hand cleaner.

8.1 Standard Operating Procedures

The major pathways for the exposure to chemicals in the MCMA are through inhalation of dust particles and ingestion of contaminated surface water. Therefore, all activities should be performed with minimal disruption of the soils and sediments. As discussed, no ingestion of surface water will be allowed from streams at the MCMA. No eating, drinking, smoking, gum or tobacco chewing, or application of cosmetics will occur in the field while investigative activities are conducted. Skin exposed to MCMA dust will be washed periodically with soap and water, and always before ingesting food or drink. In addition, activities in the MCMA will include wearing gloves, which should minimize exposure to contaminated surface water. If personnel are exposed to surface water in areas identified in the on-going studies (e.g., Removal Action) as having detectable levels of contaminants, skin will be washed immediately following completion of confirmation sampling activities with soap and water or waterless hand cleaner.

- The instructions of the SSO will be followed.
- No horseplay will be tolerated.
- Work practices that minimize airborne release of contaminants will be used.
- Contact with waste material will be minimized.
- The hands and face of personnel must be thoroughly washed as soon as possible upon leaving the work area and before eating, drinking, or other non-work related activities.

All involved personnel are responsible for reading and understanding the provisions of this HASP and will agree to abide by it. Their signature at the end of the HASP signifies their personal review and acceptance of this plan.

9.0 HAZWOPER TRAINING

All persons involved with fieldwork in the MCMA must have at least 40 hours of hazardous waste operations training plus three (3) days of field experience, or be under the direct supervision of a trained experienced supervisor, pursuant to 29 CFR 1920.120. If initial training took place more than 12 months prior to the job, an 8-hour refresher course must be taken.

Copies of training certificates documenting the required training must be available in the MCMA. The SSO is responsible for inspecting documentation to ensure the requirements of this section are met.

10.0 FIRST AID/CPR TRAINING

All persons working at the MCMA must be current in an accredited (e.g., American Red Cross) first aid and CPR certification. Copies of training certificates documenting the required training must be available at the MCMA. The SSO is responsible for inspecting documentation to ensure the requirements of this section are met.

11.0 MEDICAL MONITORING

Employees are required by OSHA to have a full hazardous materials physical if exposed to concentrations of toxic substances above permissible exposure limits (PEL) for 30 or more days per year. It is the policy of CES that any person exposed at or above the toxic exposure limit (TEL) of a toxic substance will receive a full physical following exposure. The TEL for arsenic is 0.002 mg/m^3 as dust particles in a 15-minute interval; TEL for antimony is 0.5 mg/m^3. The TEL for copper is 1.0 mg/m^3, while the TEL for iron is 10 mg/m^3 during a standard 8-hour workday. The TEL for lead is 0.050 mg/m^3 during a standard 8-hour workday. Mercury TEL is 0.025 mg/m^3. Confirmation sampling activities are not anticipated to disturb soils to the extent that wind-borne dust concentrations approaching the TEL will be of concern for field personnel. Medical monitoring for activities during the implementation of the Work Plan will not be required, although CES field staff are routinely managed under our medical monitoring program.

12.0 EMERGENCY RESPONSE PLAN AND SERVICES

In the unlikely event of a fire or explosion, proper action is required to safeguard personnel and the environment. A copy of the Forest Service Fire Protection and Suppression specifications are included in Attachment D. In the event of a fire, emergency services will be immediately contacted (fire, police, etc.) by calling 911 and/or the local fire departments, or by whatever means is practical when working in remote areas. In addition, CES will contact the Forest Service Darrington Ranger District office in Darrington, Washington, as well as Department of Natural Resources office in Sedro Woolley, Washington. MCMA personnel will be notified of the problem. Only small fires may be extinguished by workers in the MCMA. If the fire is too large, or if in doubt, the area will be evacuated. In the event of an accident or emergency during MCMA work, the following services are available:

Monte Cristo Mining Area Work Plan – 2015 RA

Medical Emergency/Ambulance.....911
Police 911
Fire 911
National Poison Control Center ..... (800) 222-1222
CES Corporate Safety Officer (Ellen Crawford)..... (541) 812-6620
US Forest Service, Snoqualmie National Forest-Everett..... (800) 627-0062
US Forest Service, Darrington Ranger District-Darrington..... (360) 436-1155
US Forest Service, Verlot Service Center-Verlot..... (360) 691-7791
Granite Falls Police Department..... (360) 691-6611
Snohomish County Sheriff's Office, Everett..... (425) 388-3393
Snohomish County Sheriff's Office Emergency ..... (425) 407-3970
Ramond Huffman, Law Enforcement Officer 360-913-0163
Granite Falls Fire Dept..... (360) 691-5553
Hi-Line Helicopters, Inc. (Darrington) ..... (360) 436-1302
WA Dept. of Natural Resources (fires) ..... (800) 562-6010
Snohomish Search and Rescue ..... (425) 388-3328
Dep. Tom Dalton, Charboneau, Granite Falls Police Department .... (360) 691-6611
Cascade Valley-Granite Falls Clinic..... (360) 691-2419
405 W. Stanley
Granite Falls, WA 98252
Cascade Valley Hospital ..... (360) 435-2133
330 S. Stillaguamish
Arlington, WA 98223

Standard hand-held radios, Forest Service supplied radios, and a satellite telephone will be made available to field personnel. Radio or telephone contact will be made to the Forest Service office in Darrington or at the Verlot Public Service Center in the event of an emergency or forest fire. Arrangements will be made for helicopter transport via Hi-Line Helicopters in Darrington in the event that CES field staff experience a life-threatening injury or condition.

In areas where 911 is not available, the telephone numbers of the physicians, hospitals, or ambulances shall be conspicuously posted.

12.1 Emergency Procedures – Immediate

1. **ASSESS SITUATION:** Can the site be entered? Does the hazard still exist?
2. **MAKE THE SITE SAFE:** Safe for others to enter?
3. **ASSESS THE VICTIM:** 1) Breathing? 2) Heartbeat? 3) Other life threatening?
4. **CALL 911:** Follow Oral Reporting Procedures below. If life threatening, request instructions from dispatcher; if not life threatening remove from contamination zone and consider the need for decontamination prior to transport.
    - Name, location, and phone number of person reporting;
    - Location of accident/incident, i.e., building number, facility name, etc.;
    - How many persons need help;
    - Description of injuries;
    - Details of any chemicals or other contamination involved;
    - Summary of the accident including its suspected cause and the time it occurred;
    - Summary of what is being done for the victim(s);
    - Depending on severity of the accident you may want to suggest helicopter transport, or meeting the ambulance somewhere along the transport route;
    - Do not hang up until the other party has done so.
5. **APPLY EMERGENCY FIRST AID:** In the absence of an infirmary, clinic, or hospital in near proximity to the workplace which is used for the treatment of all injured employees, a person or persons shall be adequately trained to render first aid. Adequate first aid supplies shall be readily available and easily accessible. All persons administering first aid shall have a valid certificate in first aid training by the American Red Cross or equivalent. The injured party should be removed from the contaminated area or other unsafe zone, if possible without incurring additional injuries. Ensure breathing, heartbeat, and reduce immediate threat to life.
6. **FIRST AID KITS:** The contents of the first aid kits shall be placed in a weatherproof container with individual sealed packages for each type of item, and shall be checked by the employer before being sent out on each job and at least weekly on each job to ensure that the expended items are replaced.

12.2 Emergency Procedures - Secondary

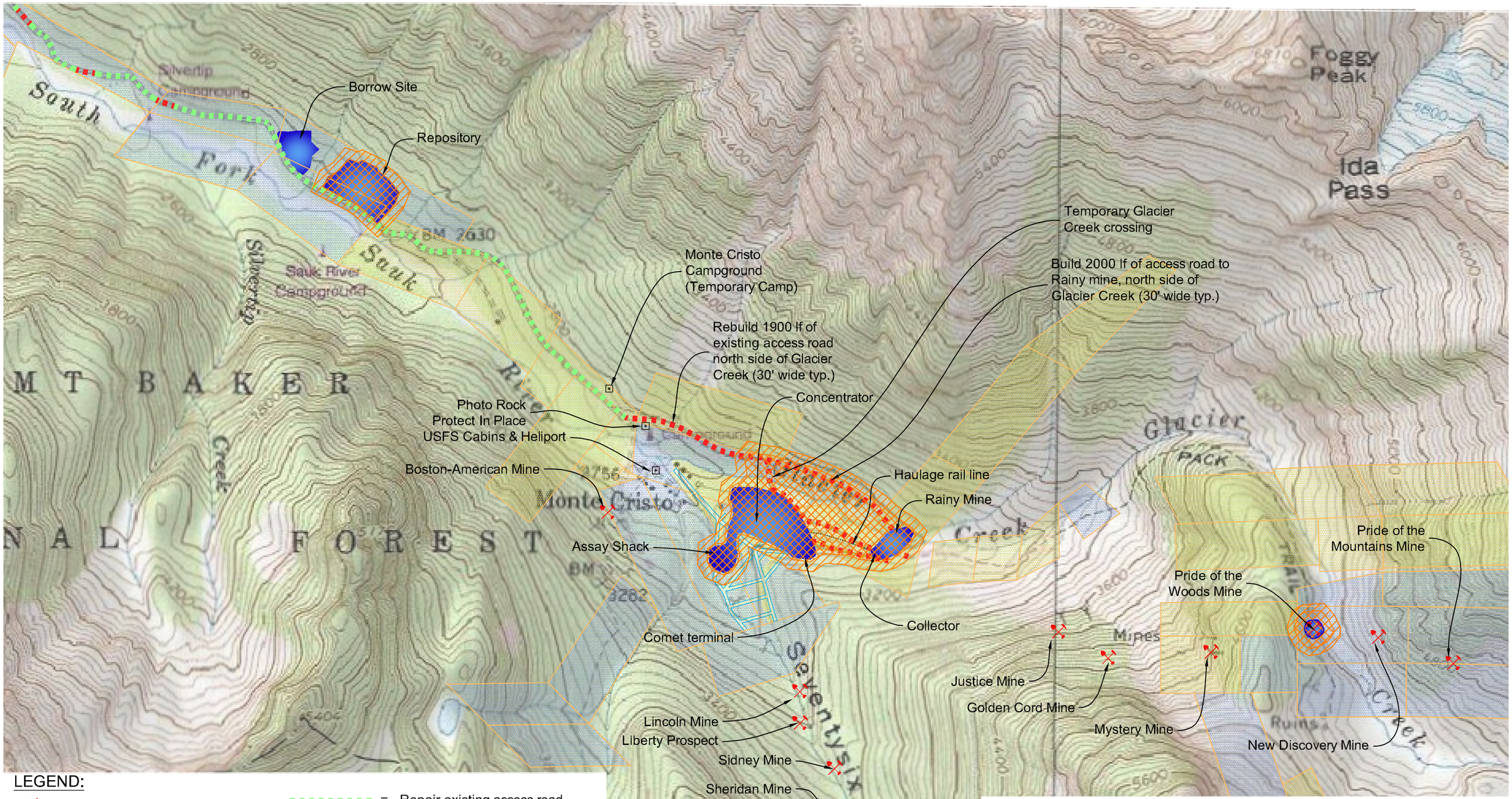
1. Transport to hospital if possible, otherwise call ambulance (911).
2. Notify CES and the Forest Service and other key personnel.
3. Complete written accident/incident report using attached form (Attachment E). Send copies to CES Project Manager, Operations Manager (Health and Safety Advisor), and Human Resources.

12.3 Hospital Route

Maps and directions to clinics in Granite Falls, Washington and the Cascade Valley Hospital in Arlington, Washington are included in Attachment F.

FIGURE

Figure 1. Designated Work Zones



LEGEND:

- = Reference Sites
- = Facility Sites
- = Reference Sites
- = USFS Claims
- = Private Claims
- = Areas of Potential Disturbance
- = Repair existing access road (Area of Potential Disturbance)
- = Rebuild/Build access route (Area of Potential Disturbance)
- = Exclusion Zone
- = Contamination Reduction Zone

(SOURCE: NRCS Web Soil Survey)

0 1000'

1" = 1000'

Figure 1. Designated Work Zones

PROJECT NUMBER: 2013230047	Monte Cristo Mining Area
DATE: 1/14/2015	
DWG NO: 2013230047 HASP F1.dwg	USDA Forest Service Mt. Baker - Snoqualmie National Forest Monte Cristo, Washington
DWG BY: 6RKB / PROJECT MANAGER: 6DGW	
REVISED:	CASCADE EARTH SCIENCES A Valmont Industries Company

ATTACHMENTS

Attachment A. **Subcontractor Post-Job Safety Performance Review Form**
Attachment B. **Acknowledgement Form**
Attachment C. **Emergency Notification and Evacuation Procedures**
Attachment D. **Supplemental Forest Fire Precautions**
Attachment E. **Loss Report and Diagnosis Form**
Attachment F. **Hospital Route Map**

Attachment A.

Subcontractor Post-Job Safety Performance Review Form

Subcontractor Post Job Safety Performance Review Form

Person Completing Review: _____ Date: _____

Project Name: _____

Subcontractor Name: _____

1. Was the Subcontractor an engaged and willing participant in all safety briefings/activities?
   - ☐ Yes
   - ☐ No

     If No, explain: _____
2. Did the Subcontractor adhere to the CES Health and Safety Plan?
   - ☐ Yes
   - ☐ No

     If No, explain: _____
3. When you had a safety concern, did the Subcontractor follow your direction?
   - ☐ Yes
   - ☐ No

     If No, explain: _____
4. Did the Subcontractor wear appropriate PPE at all times?
   - ☐ Yes
   - ☐ No

     If No, explain: _____
5. Were there any near misses?
   - ☐ Yes

     If Yes, explain: _____
   - ☐ No
6. Were there any safety incidents to report?
   - ☐ Yes

     If Yes, explain: _____
   - ☐ No

Attachment B.

Acknowledgement Form

ACKNOWLEDGEMENT

To Be Signed and Returned To

Cascade Earth Sciences (CES) Health and Safety Officer

I have received and carefully read the Site Health and Safety Plan (HASP) for the Removal Action at the MCMA project area. I agree to abide by these safety rules, regulations, and guidelines while working at the MCMA. I understand that any violation of these rules may result in my removal from the work area.

I have had a 40-Hour Health and Safety Training course and an annual refresher course(s), and I have provided certificates of these courses to the Site Safety Officer.

Signature _____ Date _____

Print Name _____

Signature _____ Date _____

Print Name _____

Signature _____ Date _____

Print Name _____

Signature _____ Date _____

Print Name _____

Signature _____ Date _____

Print Name _____

Signature _____ Date _____

Print Name _____

Safety Officer

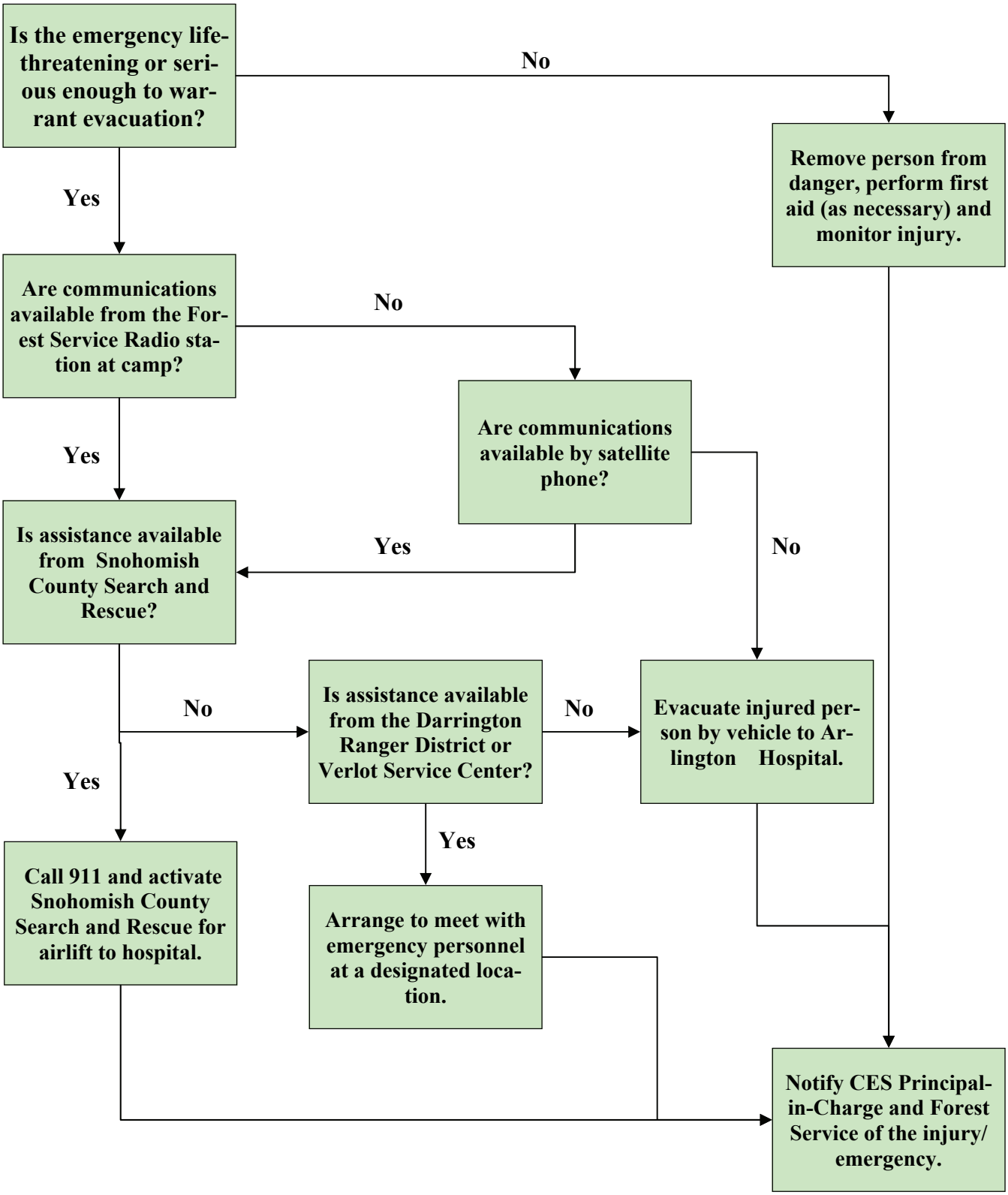
Signature _____ Date _____

Print Name _____

Attachment C.

Emergency Notification and Evacuation Procedures

Emergency Notification and Evacuation Procedures



Emergency Numbers:

- Hi-Line Helicopters, Inc. - (360) 436-1302
- Snohomish Search and Rescue—(425) 388-3328
- Forest Service, Darrington Ranger District - (360) 436-1155
- Forest Service, Verlot Service Center - (360) 691-7791
- Cascade Valley Hospital - (360) 435-2133
- Cascade Valley Hospital-Granite Falls Clinic - (360) 691-2419

Attachment D.

Supplemental Forest Fire Precautions
(U.S. Forest Service, Region 6)

Because of the potential for elevated forest fire danger the following precautions will be adhered to.

1. Fire Period and Closed Season

   Specific fire prevention measures are listed below and shall be effective for the period April 1 to October 31 of each year. The Forest Service may change the dates of said period by advance written notice if justified by unusual weather or other conditions. Required tools and equipment shall be kept currently in serviceable condition and immediately available for initial attack on fires.

2. Fire Plan

   Before starting any operations on the project, the Contractor, Permittee, Licensee, or Purchaser, hereinafter referred to as the "Contractor," shall prepare a fire plan in cooperation with the Engineer providing for the prevention and control of fires in the project area.The Contractor shall certify compliance with fire protection and suppression requirements before beginning operations during the fire period and closed season, and shall update such certification when operations change.

3. Substitute Measures

   The Engineer may by written notice authorize substitute measures or equipment or may waive specific requirements during periods of low fire danger.

4. Emergency Measures

   The Forest Service may require emergency measures, including the necessary shutting down of equipment or portions of operations in the project area during periods of fire emergency created by hazardous climatic conditions.

5. Fire Control

   The Contractor shall, independently and in cooperation with the Forest Service, take all reasonable action to prevent and suppress fires in the project area. Independent initial action shall be prompt and shall include the use of all personnel and equipment available in the project area.

   For the purpose of fighting forest fires on or in the vicinity of the project which are not caused by the Contractor's operations, the Contractor shall place employees and equipment temporarily at the disposal of the Forest Service. Any individual hired by the Forest Service will be employed in accordance with the Interagency Pay Plan for Emergency Firefighters. The Forest Service will compensate the Contractor for equipment rented at fire fighting equipment rates common in the area, or at prior agreed to rates.

6. Compliance with State Forest Laws

Listing of specific fire precautionary measures herein is not intended to relieve the Contractor in any way from compliance with the State Fire Laws covering fire prevention and suppression equipment, applicable to operations under this contract, permit or license.

7. Fire Precautions

Specific fire precautionary measures are as follows:

a. Smoking and Open Fires

Smoking and fires shall be permitted only at the option of the Contractor. The Contractor shall not allow open fires on the project area without advance permission in writing from Forest Service.

Unless restricted by State Law or Federal Regulation, smoking shall be permitted only in such portions of the project area that are free of flammable material. Smokers shall sit down to smoke in such a position that any burning material will fall within a cleared area, and shall extinguish and press out in mineral soil all burning material before leaving the cleared area.

b. Fire Extinguishers and Equipment on Trucks, Tractors, etc.

All power-driven equipment operated by the Contractor on National Forest land, except portable fire pumps, shall be equipped with one fire extinguisher having a UL rating of at least 5 BC, and one "D" handled or long handled round point shovel, size "0" or larger. In addition, each motor patrol, truck and passenger-carrying vehicle shall be equipped with a double-bit axe or Pulaski, 3-1/2 pounds or larger.

Equipment shall be kept in a serviceable condition and shall be readily available.

c. Power Saws

Each gasoline power saw operator shall be equipped with a pressurized chemical fire extinguisher of not less than 8-ounce capacity by weight, and one long-handled round point shovel, size "0" or larger. The extinguisher shall be kept in possession of the saw operator at all times. The shovel shall be accessible to the operator within 1 minute.

d. Extinguishers

One refill for each type or one extra extinguisher sufficient to replace each size extinguisher required on equipment shall be safely stored in the fire tool box or other agreed upon place on the project area that is protected and readily available.

e. Spark Arresters and Mufflers

Each internal combustion engine shall be equipped with a spark arrester meeting either (1) USDA Forest Service Standard 5100-1a, or (2) appropriate Society of Automotive Engineers (SAE) recommended practice J335(b) and J350(a) as now or hereafter amended unless it is:

(1) Equipped with a turbine-driven exhaust supercharger such as the turbocharger. There shall be no exhaust bypass.

(2) A passenger-carrying vehicle or light truck, or medium truck up to 40,000 GVW, used on roads and equipped with a factory-designed muffler complete with baffles and an exhaust system in good working condition.

(3) A heavy duty truck, such as a dump or log truck, or other vehicle used for commercial hauling, used only on roads and equipped with a factory designed muffler and with a vertical stack exhaust system extending above the cab.

Exhaust equipment described in this subsection, including spark arresters and mufflers, shall be properly installed and constantly maintained in serviceable condition.

f. Emergency Fire Precautions

The Contractor shall restrict operations in accordance with the Industrial Fire Precaution Levels listed below. The Forest Service may change the Industrial Fire Precaution Levels to other values upon revision of the National Fire Danger Rating System and may change the specific Industrial Fire Precaution Levels when such changes are necessary for the protection of the National Forest. When sent to the Contractor, the revised Industrial Fire Precaution Levels will supersede the attached levels.

INDUSTRIAL FIRE PRECAUTIONS SCHEDULE

INDUSTRIAL FIRE PRECAUTION LEVEL (IFPL)

I. Closed season - Fire precaution requirements are in effect. A fire watch/security is required at this and all higher levels unless otherwise waived.

II. Partial hootowl - The following may operate only between the hours of 8 p.m. and 1 p.m., local time:

a. power saws, except at loading sites;
b. cable yarding;
c. blasting;
d. welding or cutting of metal.

III. Partial shutdown - The following shall be prohibited except as indicated:

Cable yarding - except that gravity operated logging systems employing non-motorized carriages may be operated between the hours of 8 p.m. and 1 p.m., local time, when all block and moving lines, except the line between the carriage and the chokers, are suspended 10 feet above the ground;

Power saws - except power saws may be used at loading sites and on tractor/skidder operations between the hours of 8 p.m. and 1 p.m., local time.

In addition, the following are permitted between the hours of 8 p.m. and 1 p.m., local time:

a. tractor/skidder operations;
b. mechanized loading and hauling of any product or material;
c. blasting;
d. welding or cutting of metal;
e. any other spark-emitting operation not specifically mentioned.

IV. General shutdown - All operations are prohibited.

The following definitions shall apply to these Industrial Fire Precaution Levels:

Cable yarding systems: A yarding system employing cables and winches in a fixed position.

Closed season (Fire Precautionary Period): That season of the year when a fire hazard exists as declared by the responsible agency official.

Engineer: The person executing the contract, permit or license on behalf of the Government and includes that person's designated representative, acting within the limits of their authority or the duly appointed successor to the individuals.

Loading sites/woods site/project area: A place where any product or material (including but not limited to logs, firewood, slash, soil, rock, poles, posts, etc.) is placed in or upon a truck or other vehicle.

Low hazard area: Means any area where the responsible agency representative (WDNR, ORF, BIA, BLM) determines the combination of elements reduces the probability of fire starting and/or spreading.

Tractor/skidder operations: include a harvesting operation, or portion of a harvesting operation, where tractors, skidders, or other harvesting equipment capable of constructing fireline, are actively yarding forest products and can quickly reach and effectively attack a fire start.

Waivers, written in advance, may be used for any and all activities. Activities for which waivers may be issued include, but are not limited to:

a. mechanized loading and hauling;
b. road maintenance such as sprinkling, graveling, grading and paving;
c. cable yarding using gravity systems or suspended lines and blocks, or other yarding systems where extra prevention measures will significantly reduce the risk of fire;
d. powers saws at loading sites or in felling and bucking where extra prevention measures will significantly reduce the risk of fire;
e. maintenance of equipment (other than metal cutting and welding) or improvements such as structures, fences and powerlines.

Such waiver, or substitute precautions will prescribe measures to be taken by the Contractor to reduce the risk of ignition, and/or the spread of fire. The Engineer shall consider Site specific weather factors, fuel conditions, and specific operations that result in less risk of fire ignition and/or spread than contemplated when precaution level was predicted. Consideration shall also be given to measures that reduce the precaution levels above. The Contractor shall assure that all conditions of such waivers or substitute precautions are met.

The Contractor shall obtain the predicted Industrial Fire Precaution Level daily, prior to the start of work, from the appropriate Ranger District headquarters. If predictions made after 6:00 p.m., local time, are significantly different than the original prediction, the Forest Service will inform the Contractor when changes in restrictions or industrial precautions are made.

NOTE: The IFPL system does not apply on lands protected by ODF east of the summit of the Cascades.

Where hauling involves transit through more than one shutdown/regulated use area, the precaution level at the woods loading site shall govern the level of haul restriction, unless otherwise prohibited by other than industrial precaution level system.

8. Fire Tools

The Contractor shall furnish serviceable fire fighting tools in a readily accessible fire tool box or compartment of sound construction with a hinged lid and hasp so arranged that the box can be secured or sealed. The box shall be red and marked "Fire Tools" in letters one inch high. It shall contain a minimum of:

a. 2 axes or Pulaskis with a 32-inch handle;
b. 3 adze eye hoes. One Pulaski may be substituted for 1 adze eye hoe;
c. 3 long-handled, round point shovels, size "0" or larger.

9. Fire Security

When the Industrial Fire Precautions Level is "I" or higher, unless a waiver is granted, the Contractor shall designate a person who shall perform fire security services listed below on the project area and vicinity. The designated person shall be capable of operating the Contractor's communications and fire fighting equipment specified in the contract, excluding helicopters, and of directing the activities of the Contractor's personnel on forest fires. In lieu of having the designated person perform the required supervisory duties, the Contractor may provide another person meeting the qualifications stated above to direct the activities of Contractor's personnel and equipment during all fire fighting activities.

Services described shall be for at least 1 hour from the time the Contractor's operations are shut down. For the purposes of this provision, personnel servicing equipment, and their vehicles, who are not engaged in cutting or welding metal are excluded.

Fire security services shall consist of moving throughout the operation area or areas constantly looking, reporting, and taking suppression action on any fires detected. Where possible, the designated person shall observe inaccessible portions of helicopter operating areas from vantage points within or adjacent to project area.

10. Blasting

Whenever the Industrial Fire Precaution Level is "II" or greater, a fire security person equipped with a long-handled, round point, No. "0" or larger, shovel, and a five-gallon backpack pump can filled with water will stay at location of blast for 1 hour after blasting is done. Blasting may be suspended by Forest Service in writing, in an area of high rate of spread and resistance to control.

Fuses shall not be used for blasting. Explosive cords shall not be used without written permission of Forest Service, which may specify conditions under which such explosives may be used and precautions to be taken.

USDA Forest Service - Pacific Northwest Region
Fire Protection and Suppression

Additional Fire Precautionary Measure 1 - Tank Truck

The Contractor shall provide a tank truck or trailer containing not less than 300 gallons of water during yarding, loading, land clearing, right of way clearing, and mechanical treatment of slash. A tank truck or trailer will not be required if power saw falling and bucking is the only operation. Such tank truck or trailer shall be maintained in a serviceable condition and located within 10 minutes, round trip, from each project area during fire period and closed season.

The tank truck or trailer shall be equipped with a pump capable of discharging 20 gallons of water per minute, using a ¼ inch nozzle tip, through a 50-foot length of rubber lined hose. In addition, 500 feet of serviceable fabric jacket rubber lined hose of not less than 1 inch outside diameter, fitted with a nozzle capable of discharging a straight stream of ¼ inch diameter and a spray pattern shall be immediately available for use. The tank, pump, and at least 250 feet of hose and nozzle shall be connected and ready for use at all times.

If a trailer is used, it shall be equipped with a hitch to facilitate prompt movement. A serviceable tow vehicle shall be immediately available for attachment to the trailer and must meet the time requirements stated above. Such truck or trailer shall be equipped to operate for a minimum of 8 hours. Tank truck or trailer shall be available from the start of work to the end of the Fire Watch/Fire Security service.

Additional Fire Precautionary Measure 2 - Communications

The Contractor shall provide adequate two-way communication facilities to report a fire to the Forest Service within 15 minutes of detection. FCC regulations prohibit commercial use of Citizen Band (CB) radios. CB's are not considered adequate two-way communications.

Such communications shall be operable during periods of operation of power driven equipment, including the time fire security is required.

Attachment E.

Loss Report and Diagnosis Form

LOSS REPORT & DIAGNOSIS

valmont

Location _____ **Section I – WHAT HAPPENED** **Incident #** _____ **OSHA Claim #** _____

Part I contains basic, standard information which must be filled out for every report. ***Part II must be filled out for every injury loss, and the front page of this report must be turned into Safety & Health within 24 hours of the incident****.* ***A report must be made to the Workers Compensation Insurer within 3-days.*** *Part III is for recording losses involving property damage. Part IV is a description of all events. Complete Parts I, II, and IV for injury events. Complete Parts I, III, and IV for property damage events.* ***Section II on the backside of this form must be completed for every loss*** *during the diagnosis review. Also, have the employee note the location of the pain on the Workers' Compensation* ***Pain Drawing*** *form.*

PART I BASIC INFO

Employee Name _____ ☐ Male ☐ Female SSN _____ DOB _____

Address _____ City & Zip _____ Clock # _____

(Optional) Marital Status_____ Spouse's Name_____ # of Dependant Children _____

Date of Event _____ Time _____ ☐ AM ☐ PM Report Date _____ Time _____ ☐ AM ☐ PM

Department # _____Exact Location _____ Home Phone # _____

Originated By _____Title _____ Date Hired _____ Wage _____

PART II INJURY

Title _____ Job at Time of Incident _____ Time on this Job _____

Time Began Work _____ Nature of Injury-(cut, burn, puncture) _____ Body Part _____

What Harmed Employee (pipe, hammer, etc.) _____ Date expected back _____

PART III PROPERTY

Property Damaged _____

Nature of Damage _____ Work Order # _____

Repair/Replacement Cost: Estimated _____ Actual _____

PART IV DESCRIPTION OF INCIDENT

DESCRIBE IN YOUR OWN WORDS HOW THE LOSS OCCURRED. (Must be completed by employee)

_____

_____

_____

_____

_____

_____

TO BE COMPLETED BY SAFETY & HEALTH DEPARTMENT OR RESPONDING MEDICAL PERSONNEL

DESCRIBE FIRST AID GIVEN _____

_____

☐ First Aid – On-Site ☐ First Aid – Off-Site Treated in Emergency Room? ☐ Yes ☐ No Hospitalized Overnight? ☐ Yes ☐ No

☐ Sutures ☐ Fracture Medication(s) _____

NAME OF TREATING PHYSICIAN AND/OR MEDICAL CENTER _____

TO BE COMPLETED BY PERSON RESPONSIBLE FOR OSHA RECORDKEEPING

☐ INJURY ☐ ILLNESS OSHA RECORDABLE? ☐ Yes ☐ No Why _____

☐ Lost Workday ☐ Restricted Duty ☐ Report Only Fatality? ☐ Yes ☐ No If yes, Date of Death _____

SEND TOP COPY OF FRONT TO SAFETY & HEALTH. Retain second copy of front and complete back. Return completed report to Safety & Health.

Section II – BEHAVIORAL ANALYSIS

Department Supervisors are to complete this section by conducting an interview with the employee involved in the incident. Each supervisor must record responses to each question in the space provided. Answers to the questions will most likely call for follow-up questions to obtain a better understanding of the response. (See instructions for completing this form in the file entitled "Loss Report & Diagnosis – Guidelines" in the Safety Cyber Library). ***THE FISHBONE ANALYSIS IS TO BE USED WITH THIS SECTION.***

1. ARE THERE WORK/JOB INSTRUCTIONS FOR THIS JOB/TASK?
Responses to Question: _____

2. WERE YOU DOING THE TASK AS YOU WERE TRAINED? PLEASE DESCRIBE TRAINING
Responses to Question: _____

3. WHAT WERE THE POSITIVE RESULTS FOR THE METHOD YOU CHOSE?
Responses to Question: _____

4. DID YOU THINK THERE WAS A BETTER WAY TO PERFORM THE TASK?
Responses to Question: _____

5. IS THERE ANYTHING ABOUT THE TASK THAT MAKES IT DIFFICULT FOR ANYONE TO COMPLETE CORRECTLY?
Responses to Question: _____

6. SHOULD A HAZARD REPORT BE FILLED OUT?
Responses to Question: _____

7. WERE THERE OTHER PRESSURES AT THE TIME THAT CAUSED SAFETY TO BE COMPROMISED?
Responses to Question: _____

Section III – ADMINISTRATIVE DETAILS

WHAT TYPE OF EVENTS CONTRIBUTED THE MOST TO THE INJURY?

_____ Factors away from work _____ Non-Production tasks _____ Production tasks

ASSESSMENT OF RISK

Loss Severity Potential:	__ minor	__ major	__ serious	__ catastrophic
Probable Occurrence Rate:	__ negligible	__ low	__ moderate	__ high
Cost of Control:	__ minor	__ low	__ medium	__ high
Degree of Control Achieved:	__ low	__ moderate	__ substantial	__ complete

Names of persons participating in the Incident Diagnosis. These persons are responsible for assuring that the "Actions to Prevent a Recurrence" are completed. (All Positions must sign)

Employee _____ Date _____ Supervisor _____ Date _____

Manager _____ Date _____ Safety Coor._____ Date _____

Other _____ Title _____ Date _____

Other _____ Title _____ Date _____

ACTIONS TO PREVENT A RECURRENCE

ACTION #1: _____ **PERSON RESPONSIBLE:** _____ **PROJECTED COMP. DATE**_____

ACTION #2: _____ **PERSON RESPONSIBLE:** _____ **PROJECTED COMP. DATE**_____

ACTION #3: _____ **PERSON RESPONSIBLE:** _____ **PROJECTED COMP. DATE**_____

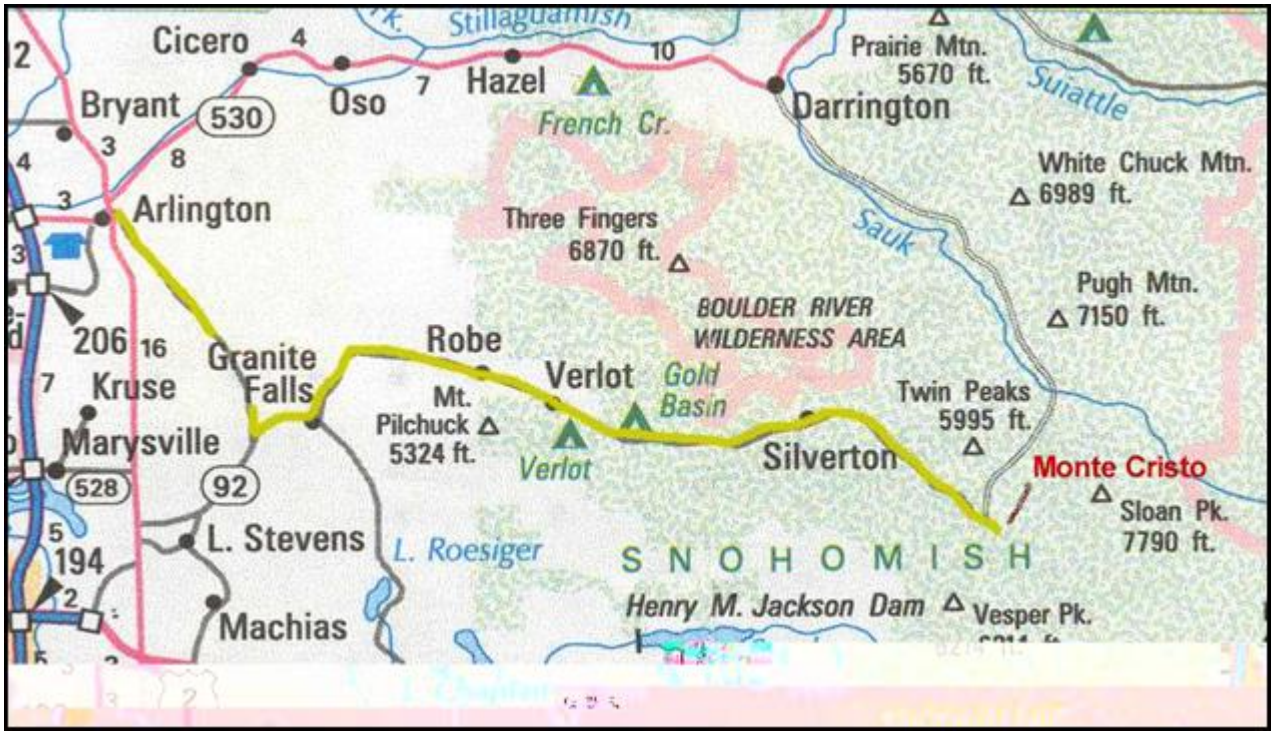
<u>This Diagnosis must be reviewed and signed by the site manager</u>

_____ Date: _____

Attachment F.

Hospital Route Map

MAP: Monte Cristo Townsite to the Cascade Valley-Granite Falls Clinic in Granite Falls, WA and Cascade Valley Hospital in Arlington, WA



Emergency Evacuation Directions	Distance
1: Depart MCMA and travel northwest to Barlow Summit intersection	3 miles
2: Turn LEFT and follow Mountain Loop Highway to Granite Falls	30 miles
3: Turn RIGHT at Highway 92 to Burn Rd. intersection	1 miles
4: Turn right on Burn Rd. to Arlington	14 miles
Note: Helipad is available at Granite Falls Clinic!	
Road from Granite Falls to Arlington is slow, winding, and narrow!	

Total Distance:	About 50 miles
Estimated Time:	1 hour, 30 minutes

Appendix B.

Updated HELP Model Simulations

TECHNICAL MEMORANDUM

DATE: January 21, 2015

TO: Jay Williams, PE – Cascade Earth Sciences

FROM: Bernard Kronschnabel, PE – Cascade Earth Sciences

SUBJECT: Updated HELP Model Simulations of the Monte Cristo Mining Area Repository

INTRODUCTION

This memorandum summarizes the results of hydrologic simulations of the Monte Cristo Mining Area (MCMA) tailings repository as modeled by the Hydrologic Evaluation of Landfill Performance (HELP) Model, Version 3.95D. This memorandum updates the original July 14, 2014 memorandum with additional simulations using precipitation data from the Big Four weather station located at the Big Four Ice Caves – approximately five miles from the repository location. The updated simulations are discussed at the end of this memorandum.

THE HELP MODEL

The HELP Model "was developed to conduct water balance analysis of landfills, cover systems, and solid waste disposal and containment facilities. As such, the model facilitates rapid estimation of the amounts of runoff, evapotranspiration, drainage, leachate collection, and liner leakage that may be expected to result from the operation of a wide variety of landfill designs. The primary purpose of the model is to assist in the comparison of design alternatives as judged by their water balances (Berger and Schroeder, 2013)." The HELP Model is not used to make absolute quantitative predictions of percolation and leachate volumes, but rather is a tool that compares relative amounts of percolation associated with different designs and initial conditions.

REPOSITORY DESIGN

The repository design (summarized in Table 1) consists of five layers which are utilized in the HELP Model simulation, and three additional geotextile layers that do not significantly affect hydrologic performance of the repository.

Starting at the bottom, the repository will be constructed of 12 inches of compacted native fill from the excavation of the repository, overlain by 20 feet of mine tailings, a 60-mil high density polyethylene (HDPE) geomembrane liner, 6 inches of gravel, and 36 inches of native fill. A vegetative cover consisting of native grasses will be established upon closure of the repository. The additional geotextile layers that are not included in the HELP Model consist of two 8-ounce non-woven geotextile layers (one above and one below the HDPE liner) and a filter fabric layer located between the 36-inch native fill layer and the 6-inch gravel layer on top of the HDPE liner.

MODEL PARAMETERS

The parameters used in the simulation are described below.

Base Parameters

Several parameters in the model remain the same for all simulations. All precipitation, temperature, solar radiation, and evapotranspiration (ET) files were generated by the HELP Model using Stampede Pass, Washington as the location. For Year 1 of each simulation, the repository cover is modeled as having Bare Grass for ET and for calculation of the Runoff Curve. In Year 2, the cover is modeled as having Fair Grass for the ET and Runoff Curve calculations. For the remaining years, ET and Runoff Curves are calculated using Excellent Grass as a vegetative cover. The repository footprint of 1.79 acres (78,033 square feet) is used for determination of precipitation inputs, runoff area, and for calculation of layer volumes.

Repository Layer Parameters

The repository layers and physical properties, as presented in Table 1, are the same across all simulations. However, assumptions for the number of liner pinholes and installation defects are varied between simulations to assess the effect these properties will have on the repository performance. The assumptions made regarding the physical properties for each layer are described in detail below. The values shown in Table 1 were generated by the HELP Model unless noted otherwise.

Layer 1 – Native Fill

The properties of the native fill were estimated based on the Preliminary Geotechnical Site Characterization prepared by GeoEngineers in October 2013 (GeoEngineers, 2013). The test pits evaluated in this report classified the native fill as "SM" according to the Unified Soil Classification System (USCS) corresponding to a silty sand. Classification #5 was selected for the HELP Model classification. Layer 1 was designated as a Vertical Percolation Layer within the model.

Layer 2- Gravel

The HELP Model has two choices for gravel layers – classifications #21 and #50. Classification #21 corresponds to a finer gravel and was selected for Layer 2. Layer 2 was designated as a Lateral Drainage Layer.

Layer 3 – HDPE Liner

Classification #35 represents an HDPE liner. Layer 3 was designated as a Geomembrane Layer.

Layer 4 – Tailings

The tailings were approximated as a 48:52 (tailings:gravel) ratio of a mixture of tailings from a gold mine in central Washington and gravel (classification #21) of the HELP Model. This ratio was selected based on the estimated tailings and waste rock volumes that will be placed in the repository (CES, 2012). Table 2 summarizes the estimated volumes of each contributing source to the repository and classifies the source as primarily waste rock or tailings. The waste rock component is modeled by gravel (classification #21) and the tailings component is modeled by tailings as characterized by test pits from the aforementioned gold mine tailings pile to compute the properties of Layer 4 for the HELP Model (Table 3). Layer 4 was designated as a Vertical Percolation Layer.

Layer 5 – Compacted Native Fill

The HELP Model estimates pore volume, field capacity, wilting point, and Ksat for some soils defined as moderately compacted soil layers, but does not estimate these properties for the classification #5 (corresponding to the native fill). Based on the relations of these properties between soil layers and their compacted counterparts in the HELP Model estimates, the properties for the compacted native fill layer were estimated as 90% of the native fill for all values except Ksat. The value for Ksat of the compacted native fill

layer was estimated as 10% of the Ksat for the native fill layer. Layer 5 was designated as a Barrier Soil Layer.

Samples of the tailings, waste rock, and native fill will be collected during the 2015 field activities for laboratory characterization of the tailings/waste rock mix and compacted native fill. If measured properties differ from the estimates in this memorandum by greater than 10%, the HELP Model simulations will be updated with the new data and summarized in a future memorandum.

Initial Moisture Content

In order to determine initial moisture content of each layer, assumptions based on probable field conditions during the removal action are required. In addition to estimating the moisture content of each layer, an estimation of the amount of precipitation that will infiltrate into the open repository during the removal action is also required. Starting with precipitation, a range of precipitation amounts that will occur during the removal action was computed based on HELP Model precipitation models and using data for Startup, Washington available from the Western Regional Climate Center. Assumptions were then made based on the amount of this precipitation that would enter the open repository in spite of engineering controls during the removal action. Volumes were calculated based on 10, 20, and 30% of precipitation modeled to occur during the removal action and on the footprint of the repository. This volume was then translated to a moisture content based on the porosity of the tailings layer.

Assumptions based on the moisture content of the layers as the materials are placed were made based on available water holding capacity (AWHC). The AWHC represents a volume fraction of each layer equal to the field capacity minus the wilting point. Moisture contents were computed for 25, 50, and 75% of AWHC for the tailings layer (Layer 4) at the time of placement. The combined moisture content of the precipitation inputs and the AWHC were used to calculate a range of initial moisture contents for layer 4. HELP Model simulations were then analyzed for the minimum, maximum, and average initial moisture contents of this range. All other layers were assumed to be placed at a moisture content corresponding to 75% AWHC. It is assumed that removal action controls will be implemented to keep fill materials covered until time of placement, and material will not be placed during significant precipitation events.

Liner Variables

The HELP Model has three variables that can be adjusted with regard to HDPE liners: Pinhole Density, Installation Defects, and Placement Quality. Based on HELP Model guidelines, a Placement Quality of "Good" was selected as representative of the best that can be achieved in field conditions. This selection was used in all simulations.

Pinhole Density and Installation Defects (in units of number per acre) are discussed in the HELP Model documentation. Ranges are given for Defect densities based upon placement quality. These ranges do not take into account the testing of the liner integrity prior to the filling of the repository. Electronic leak detection and location services are available that can test the entire liner surface, allowing identification, repair, and verification of any detected pinholes and installation defects. Therefore, an assumption of 1 Pinhole per acre and 1 Installation Defect per acre was used as a "base case" simulation. Simulations were run using 1 Pinhole and 2 Installation Defects per acre, and using 2 Pinholes and 2 Installation Defects per acre to assess the sensitivity of liner integrity.

RESULTS

Percolation through the HDPE liner is presented in Chart 1. The closure of the repository is assumed to occur on September 30, so the first year after closure in the HELP Model only covers three months. The HELP

Model indicates that percolation through the liner will generally be between 1,000 and 1,500 gallons per year for 40 years after repository closure in the base case simulation (Chart 1). Increasing the number of installation defects to two defects per acre results in an increase in percolation through the liner. The additional liner defect per acre results in a percolation range of approximately 2,000 to 3,000 gallons per year. Increasing the number of pinhole defects per acre to two per acre does not significantly contribute to percolation.

Chart 2 shows the percolation through the compacted native soil layer below the tailings layer. When placed at maximum initial moisture content, approximately 3,600 gallons will percolate through the compacted native fill during October – December of the year of closure. In Year 2, approximately 14,500 gallons will percolate through the compacted native fill layer. Percolation steadily decreases to approximately 3,000 gallons in Year 40. Comparisons of percolation through the compacted native fill layer at average initial moisture content between the base case scenario to scenarios with one pinhole defect and two installation defects and to two pinhole defects and two installation defects are shown in Chart 2. All three scenarios result in less than 300 gallons of percolation initially and less than 100 gallons per year by Year 4.

Table 4 tabulates the percolation through the compacted native fill layer in the case of maximum initial moisture content along with the average head on top of the compacted native soil layer. Average head on top of the compacted native fill is negligible at 0.0003 inches or less during any year.

Table 5 tabulates the annual outflow from the gravel drainage layer on top of the liner and the average head on top of the liner in the base case simulation. Starting in Year 2, the annual outflow from the gravel drainage layer is predicted to range between 2.5 to 4.8 million gallons, corresponding to annual precipitation predictions. There will be less than 0.2 inches of head on top of the HDPE liner under these conditions.

Summary

The HELP Model simulations highlight the importance of keeping the repository and tailings as dry as possible during the removal action. If the tailings are maintained sufficiently below field capacity, there will be negligible percolation through the compacted native soil layer. The maximum predicted moisture content of the tailings at the time of placement will result in less than 15,000 gallons per year of percolation through the compacted native soil layer. The head on top of the compacted native fill layer will be negligible under these conditions. If the tailings are placed at the average of the predicted range of moisture contents (approximately 110% of field capacity), percolation through the compacted native soil will be approximately 300 gallons per year for the first full year after closure, equilibrating to less than 100 gallons per year by Year 4.

The HELP Model indicates that a typical installation defect per acre will result in approximately 1,000 to 1,500 gallons per year of additional percolation through the liner and a negligible increase in percolation through the compacted native soil. The HELP Model also indicates that pinhole defects have a negligible effect on percolation.

Recommendations

The HELP Model simulations highlight the importance of minimizing the moisture content of the tailings during removal action activities. Engineering controls to keep waste rock and tailings covered during the removal action and to prohibit placement of waste rock and tailings during precipitation events are recommended. Strict oversight of the placement of the HDPE liner followed by electronic leak location and repair of detected defects and leaks is also recommended.

Supplemental Simulations

Precipitation and temperature data from the Big Four, Washington weather station was obtained from the National Oceanic and Atmospheric Administration website for the years 1931-1942 (Table 6). The Big Four station is presumed to be located at the Big Four Ice Caves which are approximately 7 miles northwest of the repository location. The Big Four Ice Caves are located immediately to the north of Big Four Mountain which is in turn is approximately 6 miles northeast of Spada Lake. Precipitation in the vicinity of Spada Lake is higher than the precipitation in the surrounding Cascades, and has been named the Spada Lake anomaly (Mass, 2012). The Spada Lake anomaly results in higher precipitation measurements at Big Four and at several weather stations to the west and south of Spada Lake. It is uncertain whether the anomaly affects precipitation as far east as Monte Cristo and the repository. However, supplemental HELP Model simulations were performed using the precipitation data from the Big Four station to assess the effect of increased precipitation.

The repository design and layers remained the same in the supplemental simulations as in the original. The monthly average precipitation and temperature data from Table 6 was used for the HELP Model. The HELP Model files for solar radiation and evapotranspiration are generated based on the precipitation and temperature files. The revised precipitation data was then used to revise the amount of precipitation modeled to enter the repository during removal action operations. This, in turn, was used to revise the initial moisture content of the placed tailings. As with the original simulations, simulations were performed using maximum initial moisture content and average initial moisture content of placed tailings in the "Base Case" scenario consisting of 1 Pinhole and 1 Installation Defect per acre. The average initial moisture content was then simulated for 1 Pinhole and 2 Installation Defects per acre, and for 2 Pinholes and 2 Installation Defects per acre.

Chart 3 compares percolation through the HDPE liner in the Base Case to 1 Pinhole and 2 Installation Defects per acre and to 2 Pinholes and 2 Installation Defects per acre. In the Base Case, percolation through the HDPE liner will be between 1,500 and 2,000 gallons per year for most years, with a maximum of 2,272 gallons in Year 3. By increasing the number of Installation Defects to 2 per acre, the percolation through the HDPE approximately doubles – ranging from 3,000 – 4,000 gallons per year for most years with a maximum of 4,486 gallons in Year 3. The addition of a second Pinhole per acre has no significant effect on percolation through the HDPE liner.

Chart 4 compares the percolation through the compacted native soil among the following scenarios:

- Base Case – average initial moisture content
- 1 Pinhole and 2 Installation Defects per acre – average initial moisture content
- 2 Pinholes and 2 Installation Defects per acre – average initial moisture content
- Base Case – maximum initial moisture content

For all scenarios with average initial moisture content of placed tailings, approximately 6,000 gallons will percolate through the compacted native soil in the first year after closure (Chart 4). Percolation will then fluctuate from approximately 50 to 200 gallons per year for the remaining 39 years of the simulation. If the tailings are placed at the maximum initial moisture content, 40,000 gallons would percolate through the compacted native soil during the first year after closure. In Year 2, approximately 22,000 gallons would percolate through the compacted native soil, followed by 21,000 gallons in Year 3, 18,000 gallons in Year 4, and 16,000 gallons in Year 5. Percolation through the compacted native soil is modeled to drop below 10,000 gallons in Year 11, below 5,000 gallons in Year 24, and 3,000 to 4,000 gallons from Year 30 onward. This data is also tabulated in Table 7

Table 7 tabulates the volume of percolate through the compacted native soil layer in the case of maximum initial moisture content of placed tailings, and the associated head on the layer. The average head in Year 1 will be 0.0018 inches, decereasing to less than 0.0010 inches for all remaining years.

Table 8 tabulates the outflow from the gravel drainage layer above the HDPE liner and associated head on the liner for the Base Case simulations (1 Pinhole and 1 Installation Defect per acre). Outflow volumes are consistent with precipitation data. The average head on the HDPE liner ranges from 0.2 to 0.3 inches for most years, with a maximum of 0.295 inches.

SUMMARY

The simulations using the higher precipitation data from Big Four, Washington do not indicate structural problems for the repository design. The head on the HDPE liner is less than 0.3 inches in all years of the simulation. The head on the compacted native soil layer is less than 0.002 inches in all years of the simulation. As with the original simulations, the HELP Model highlights the importance of keeping water out of the repository and tailings during the removal action. The results of the supplemental simulations with increased precipitation data does not change the conclusions of the original July 2014 memorandum.

BJK/sjr

Att: Table 1. Repository Layers
Table 2. Sources of Repository Material
Table 3. Layer 4 Composition for HELP Model
Table 4. Compacted Native Soil Layer – Maximum Initial Moisture
Table 5. Outflow From Gravel Drainage Layer – All Base Case Simulations
Table 6a. Precipitation Data – Big Four, Washington for 1931-1942
Table 6b. Temperature Data – Big Four, Washington for 1931-1942
Table 7. Compacted Native Soil Layer – Maximum Initial Moisture – Big Four Precipitation
Table 8. Outflow From Gravel Drainage Layer – All Base Case Simulations – Big Four Precipitation
Chart 1. Percolation Through HDPE Liner
Chart 2. Percolation Through Compacted Native Soil
Chart 3. Percolation Through HDPE Liner – Big Four Precipitation Data
Chart 4. Percolation Through Compacted Native Soil – Big Four Precipitation Data

c: Ryan Tobias – Cascade Earth Sciences
PN: 2013230047
Doc: App B 2015 HELP Simulations.docx

Ref: Berger and Schroeder, 2013. The Hydrologic Evaluation of Landfill Performance (HELP) Model – User's Guide for HELP-D (Version 3.95D), 6th revised edition. Klaus Berger and Paul R. Schroeder. 2013. University of Hamburg, Germany.

CES, 2012. Removal Action Memorandum - Non-Time Critical Removal Action - Monte Cristo Mining Area Site, Cascade Earth Sciences, Spokane, Washington.

GeoEngineers, 2013. Preliminary Geotechnical Site Characterization – Monte Cristo Mining Area – Proposed Repository. Snohomish County, Washington. GeoEngineers, Spokane, Washington.

Mass, 2012. The Spada Lake Anomaly. The Cliff Mass Weather Blog. February 23, 2012. http://cliffmass.blogspot.com/2012/02/spada-lake-anomaly.html.

Table 1. Repository Layers

Layer	Thickness	Characteristics	HELP Model Soil #	Pore Volume	Field Capacity	Wilting Point	Ksat	Pore Volume
	inches			Volume Fraction			cm/s	gallons
1	36	Native Fill	5	0.457	0.131	0.058	0.001	800,342
2	6	Gravel [1]	21	0.397	0.032	0.013	1.00	115,877
3	0.06	HDPE Liner	35	--	--	--	2.00E-13	--
4	240	Tailings [2]	--	0.410	0.070	0.030	0.00072	4,792,009
5	12	Compacted Native Fill [3]	--	0.411	0.118	0.052	0.0001	240,102

NOTES:

Values for Pore Volume, Feld Capacity, Wilting Point, and Ksat are Hydrologic Evaluation of Landfill Performance Model (Version 3.95D) defaults unless otherwise noted.

Abbreviations: # = number, cm/s = centimeters per second, HELP = Hydrologic Evaluation of Landfill Performance Model, Version 3.95D, Ksat = saturated hydraulic conductivity.

1 Ksat of clean gravel used for gravel layer. Source: Chiu and Evett, 1992. Soils and Foundations, 3rd Edition. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

2 Values for Tailings layer estimated based on characterization of central Washington gold mine tailings pile test pits and estimated contributions of tailings and waste rock to repository.

3 Pore Volume, Field Capacity, and Wilting Point values for compacted native fill estimated at 90% of native fill. Ksat value for compacted native fill estimated at 10% of native fill.

Table 2. Sources of Repository Material

Source	Volume cubic yards	Composition	Percent of Total
Pride of the Woods	2,000	waste rock (gravel)	12%
Rainy Mine	3,300	waste rock (gravel)	19%
Ore Collector/Comet Terminal/Haulage	3,700	waste rock (gravel)	21%
Concentrator	8,100	tailings	47%
Assay Shack	200	tailings	1%
Total	**17,300**	**Waste Rock/ Tailings Mix**	**100%**
Gravel Subtotal	**9,000**	**--**	**52%**
Tailings Subtotal	**8,300**	**--**	**48%**

Table 3. Layer 4 Composition for HELP Model

Tailings Component	Pore Volume	Field Capacity	Wilting Point	Ksat
	Volume Fraction			cm/s
Tailings [1]	0.425	0.111	0.049	0.00072
Gravel [2]	0.397	0.032	0.013	0.1
Average [3]	**0.410**	**0.070**	**0.030**	**0.00072**

NOTES:

Abbreviations: HELP = Hydrologic Evaluation of Landfill Performance Model (Version 3.95D), Ksat = saturated hydraulic conductivity.

1 As characterized by test pits in a central Washington gold mine tailings pile.

2 Pore Volume, Field Capacity, and Wilting Point corresponding to HELP Model layer #21. Lowest Ksat for gravel used for gravel layer to account for 'dirtiness' of waste rock. Source: Chiu and Evett, 1992. Soils and Foundations, 3rd Edition. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

3 The Ksat of Layer 4 is assumed equal to the Ksat of the tailings component. The waste rock components (gravel) will be surrounded by tailings, therefore the Ksat of the tailings will be limiting. Pore Volume, Field Capacity, and Wilting Point are weighted averages based estimated tailings and waste rock contributions to Layer 4.

Table 4. Compacted Native Soil Layer - Maximum Initial Moisture

Year	Percolation Through Compacted Native Soil		Average Head on Compacted Native Soil	Year	Percolation Through Compacted Native Soil		Average Head on Compacted Native Soil
	inches	gallons	inches		inches	gallons	inches
1	0.073	3,568	0.0000	**21**	0.105	5,126	0.0001
2	0.297	14,452	0.0003	**22**	0.099	4,831	0.0001
3	0.286	13,921	0.0003	**23**	0.095	4,613	0.0001
4	0.269	13,063	0.0003	**24**	0.091	4,444	0.0001
5	0.254	12,328	0.0003	**25**	0.091	4,413	0.0001
6	0.232	11,285	0.0002	**26**	0.089	4,329	0.0001
7	0.220	10,716	0.0002	**27**	0.084	4,075	0.0001
8	0.202	9,815	0.0002	**28**	0.077	3,732	0.0001
9	0.189	9,187	0.0002	**29**	0.076	3,678	0.0001
10	0.180	8,749	0.0002	**30**	0.075	3,659	0.0001
11	0.170	8,272	0.0002	**31**	0.074	3,578	0.0001
12	0.159	7,723	0.0002	**32**	0.069	3,348	0.0001
13	0.150	7,310	0.0002	**33**	0.065	3,175	0.0001
14	0.142	6,889	0.0001	**34**	0.072	3,503	0.0001
15	0.134	6,532	0.0001	**35**	0.067	3,239	0.0001
16	0.126	6,137	0.0001	**36**	0.065	3,140	0.0001
17	0.119	5,800	0.0001	**37**	0.065	3,177	0.0001
18	0.119	5,773	0.0001	**38**	0.062	2,995	0.0001
19	0.111	5,419	0.0001	**39**	0.061	2,944	0.0001
20	0.105	5,123	0.0001	**40**	0.061	2,978	0.0001

Table 5. Outflow From Gravel Drainage Layer - All Base Case Simulations

Year	Outflow From Gravel Drainage Layer		Average Head on Liner	Year	Outflow From Gravel Drainage Layer		Average Head on Liner
	inches	gallons	inches		inches	gallons	inches
1	18.178	883,529	0.140	**21**	70.508	3,427,078	0.136
2	88.969	4,324,382	0.173	**22**	68.220	3,315,898	0.132
3	95.634	4,648,349	0.186	**23**	69.661	3,385,924	0.134
4	66.322	3,223,605	0.128	**24**	68.444	3,326,741	0.132
5	89.739	4,361,809	0.174	**25**	70.563	3,429,761	0.137
6	69.992	3,402,017	0.136	**26**	91.341	4,439,699	0.179
7	90.755	4,411,187	0.176	**27**	93.004	4,520,496	0.180
8	60.462	2,938,800	0.118	**28**	70.918	3,447,006	0.137
9	51.580	2,507,075	0.100	**29**	95.868	4,659,708	0.185
10	67.868	3,298,788	0.132	**30**	88.566	4,304,828	0.171
11	84.362	4,100,485	0.163	**31**	72.127	3,505,771	0.139
12	83.688	4,067,686	0.161	**32**	76.984	3,741,863	0.149
13	88.688	4,310,748	0.171	**33**	50.879	2,473,012	0.099
14	58.935	2,864,584	0.115	**34**	88.172	4,285,653	0.171
15	90.973	4,421,793	0.176	**35**	80.696	3,922,258	0.157
16	73.136	3,554,819	0.142	**36**	64.056	3,113,474	0.124
17	64.166	3,118,845	0.124	**37**	86.111	4,185,497	0.167
18	98.824	4,803,411	0.190	**38**	71.130	3,457,325	0.138
19	70.968	3,449,432	0.138	**39**	81.509	3,961,813	0.157
20	69.670	3,386,356	0.136	**40**	99.658	4,843,943	0.193

Table 6a. Precipitation Data - Big Four, Washington for 1931-1942

Month	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	Min	Max	Avg [1]
	inches														
Jan	25.31	22.21	--	--	38.03	26.27	7.39	9.29	--	--	15.88	4.64	4.64	38.03	18.63
Feb	15.75	31.29	--	--	8.32	14.91	13.63	4.71	--	--	6.22	8.78	4.71	31.29	12.95
Mar	29.94	29.63	--	--	17.44	14.65	7.24	15.00	--	--	5.40	13.03	5.40	29.94	16.54
Apr	11.19	13.91	--	--	3.98	2.43	19.68	10.49	--	--	3.82	8.05	2.43	19.68	9.19
May	6.91	3.80	--	--	2.45	13.43	6.64	--	--	--	15.15	--	2.45	15.15	8.06
Jun	16.39	1.75	--	--	7.72	10.25	13.98	--	--	2.59	5.00	--	1.75	16.39	8.24
Jul	1.49	10.86	--	--	--	4.10	0.36	--	--	2.72	0.26	--	0.26	10.86	3.30
Aug	0.64	1.57	--	--	--	1.94	5.15	--	--	3.29	5.30	--	0.64	5.30	2.98
Sep	16.32	4.11	--	--	--	5.23	1.79	4.21	--	--	19.30	--	1.79	19.30	8.49
Oct	12.67	16.58	--	--	8.86	2.06	13.75	--	--	--	19.05	--	2.06	19.05	12.16
Nov	22.99	37.15	--	--	6.92	2.35	34.56	--	--	15.99	18.62	--	2.35	37.15	19.80
Dec	20.68	--	--	24.52	14.75	29.57	25.32	--	--	16.19	23.85	--	14.75	29.57	22.13
Total	**180.28**	**172.86**	**--**	**24.52**	**108.47**	**127.19**	**149.49**	**43.7**	**--**	**40.78**	**137.85**	**34.5**	**43.23**	**271.71**	**142.47**

NOTES:

Abbreviations: -- = indicates no data available, Avg = average, Max = maximum, Min = minimum.

Data obtained from National Oceanic and Atmospheric Administration website.

1 Monthly precipitation used for Hydrologic Evaluation of Landfill Performance (HELP) Model simulations calculated from average of months in which data is available.

Table 6b. Temperature Data - Big Four, Washington for 1931-1942

Month	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	Min	Max	Avg [1]
	degrees Fahrenheit														
Jan	35.2	28.0	--	--	27.9	33.0	--	32.0	--	--	--	--	27.9	35.2	31.2
Feb	34.6	27.0	--	--	32.8	25.8	--	34.6	--	--	--	--	25.8	34.6	31.0
Mar	37.1	34.0	--	--	32.8	36.6	39.6	38.2	--	--	--	--	32.8	39.6	36.4
Apr	43.6	40.2	--	--	38.0	--	38.3	43.8	--	--	--	--	38.0	43.8	40.8
May	51.6	45.6	--	--	46.4	50.8	--	--	--	--	--	--	45.6	51.6	48.6
Jun	55.6	55.0	--	--	54.6	57.4	57.4	--	--	--	--	--	54.6	57.4	56.0
Jul	60.7	56.0	--	--	--	61.0	60.2	--	--	--	--	--	56.0	61.0	59.5
Aug	57.8	58.0	--	--	--	60.9	58.4	--	--	--	--	--	57.8	60.9	58.8
Sep	53	54.8	--	--	--	54.4	56.6	59.8	--	--	--	--	53.0	59.8	55.7
Oct	45.6	47.2	--	--	45.2	48.8	50.8	--	--	--	--	--	45.2	50.8	47.5
Nov	34.4	40.1	--	--	32.2	35.8	38.9	--	--	--	--	--	32.2	40.1	36.3
Dec	31.2		--	--	34.6	32.6	33.9	--	--	--	--	--	31.2	34.6	33.1
Average	**45.0**	**44.2**	**--**	**--**	**38.3**	**45.2**	**48.2**	**41.7**	**--**	**--**	**--**	**--**	**41.7**	**47.5**	**44.6**

NOTES:

Abbreviations: -- = indicates no data available, Avg = average, Max = maximum, Min = minimum.

Data obtained from National Oceanic and Atmospheric Administration website.

1 Monthly temperature used for Hydrologic Evaluation of Landfill Performance (HELP) Model simulations calculated from average of months in which data is available.

Table 7. Compacted Native Soil Layer - Maximum Initial Moisture - Big Four Precipitation

Year	Percolation Through Compacted Native Soil		Average Head on Compacted Native Soil	Year	Percolation Through Compacted Native Soil		Average Head on Compacted Native Soil
	inches	gallons	inches		inches	gallons	inches
1	0.810	39,366	0.0018	**21**	0.117	5,693	0.0001
2	0.461	22,393	0.0005	**22**	0.111	5,398	0.0001
3	0.422	20,489	0.0004	**23**	0.107	5,205	0.0001
4	0.376	18,278	0.0004	**24**	0.105	5,113	0.0001
5	0.337	16,370	0.0003	**25**	0.100	4,856	0.0001
6	0.305	14,833	0.0003	**26**	0.101	4,924	0.0001
7	0.279	13,543	0.0003	**27**	0.094	4,549	0.0001
8	0.253	12,274	0.0003	**28**	0.086	4,168	0.0001
9	0.231	11,251	0.0002	**29**	0.084	4,106	0.0001
10	0.218	10,618	0.0002	**30**	0.081	3,943	0.0001
11	0.200	9,728	0.0002	**31**	0.082	4,002	0.0001
12	0.189	9,173	0.0002	**32**	0.075	3,628	0.0001
13	0.176	8,545	0.0002	**33**	0.075	3,658	0.0001
14	0.167	8,118	0.0002	**34**	0.084	4,068	0.0001
15	0.154	7,472	0.0002	**35**	0.074	3,583	0.0001
16	0.145	7,056	0.0001	**36**	0.073	3,554	0.0001
17	0.137	6,648	0.0001	**37**	0.072	3,516	0.0001
18	0.132	6,408	0.0001	**38**	0.070	3,413	0.0001
19	0.126	6,114	0.0001	**39**	0.072	3,477	0.0001
20	0.119	5,788	0.0001	**40**	0.067	3,235	0.0001

Table 8. Outflow From Gravel Drainage Layer - All Base Case Simulations - Big Four Precipitation

Year	Outflow From Gravel Drainage Layer		Average Head on Liner	Year	Outflow From Gravel Drainage Layer		Average Head on Liner
	inches	gallons	inches		inches	gallons	inches
1	34.763	1,689,688	0.267	**21**	108.646	5,280,815	0.210
2	115.377	5,607,970	0.224	**22**	108.894	5,292,840	0.209
3	151.615	7,369,352	0.295	**23**	98.208	4,773,445	0.192
4	118.299	5,749,986	0.229	**24**	103.982	5,054,114	0.201
5	119.639	5,815,147	0.233	**25**	107.076	5,204,509	0.208
6	129.199	6,279,778	0.251	**26**	145.396	7,067,044	0.284
7	125.798	6,114,505	0.244	**27**	142.259	6,914,612	0.275
8	96.448	4,687,924	0.187	**28**	119.654	5,815,881	0.233
9	93.496	4,544,410	0.181	**29**	150.957	7,337,355	0.292
10	110.164	5,354,613	0.214	**30**	123.880	6,021,289	0.239
11	118.968	5,782,518	0.228	**31**	113.115	5,498,044	0.220
12	133.503	6,488,987	0.258	**32**	115.188	5,598,774	0.222
13	127.046	6,175,140	0.244	**33**	75.319	3,660,944	0.147
14	109.619	5,328,123	0.214	**34**	151.928	7,384,546	0.295
15	130.592	6,347,525	0.252	**35**	114.263	5,553,843	0.222
16	116.781	5,676,227	0.225	**36**	106.689	5,185,694	0.205
17	116.966	5,685,229	0.226	**37**	119.744	5,820,241	0.233
18	144.254	7,011,541	0.277	**38**	123.892	6,021,828	0.239
19	113.598	5,521,515	0.219	**39**	131.929	6,412,482	0.255
20	117.676	5,719,695	0.228	**40**	133.418	6,484,870	0.258

Chart 1. Percolation Through HDPE Liner

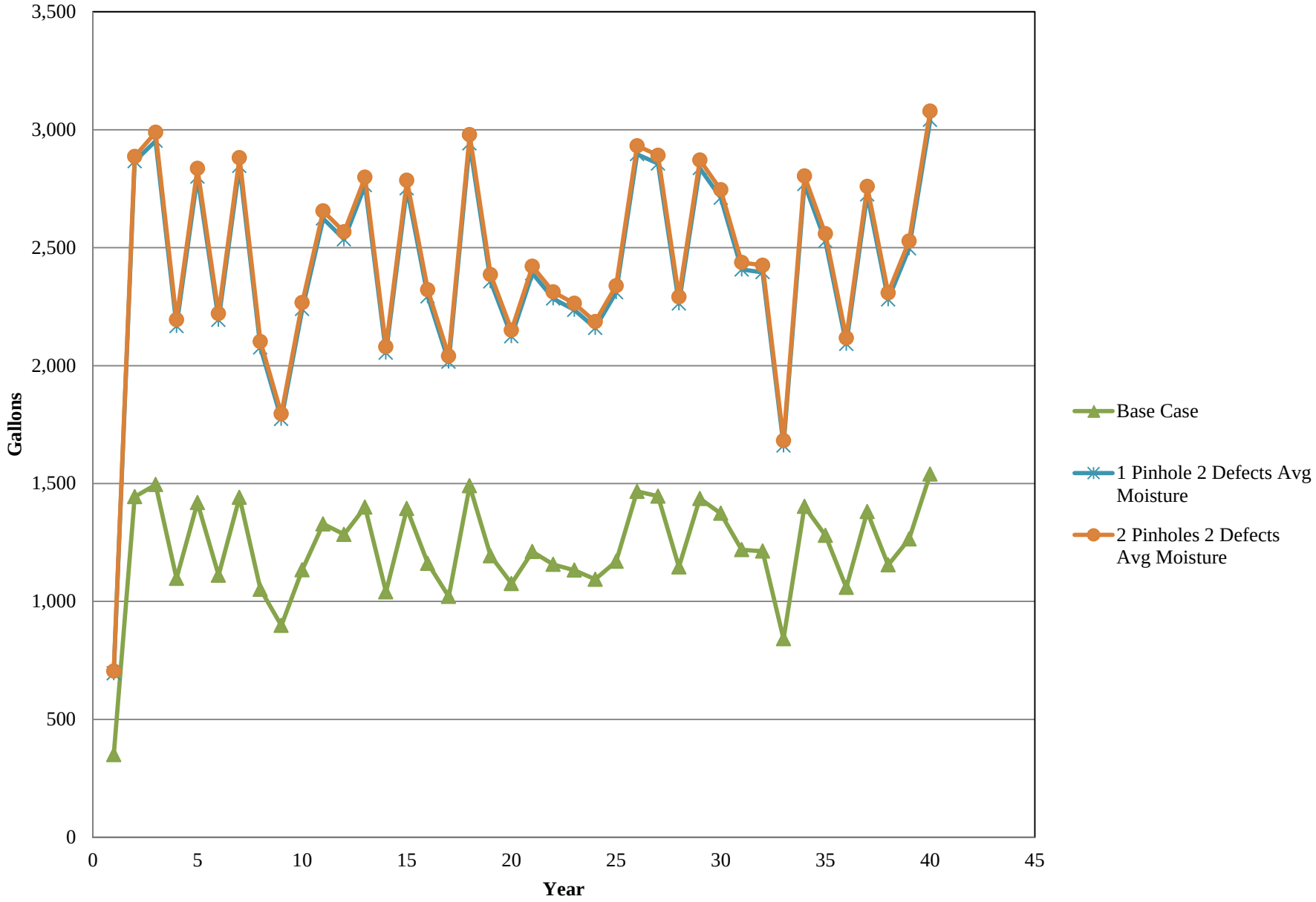


Chart 2. Percolation Through Compacted Native Soil

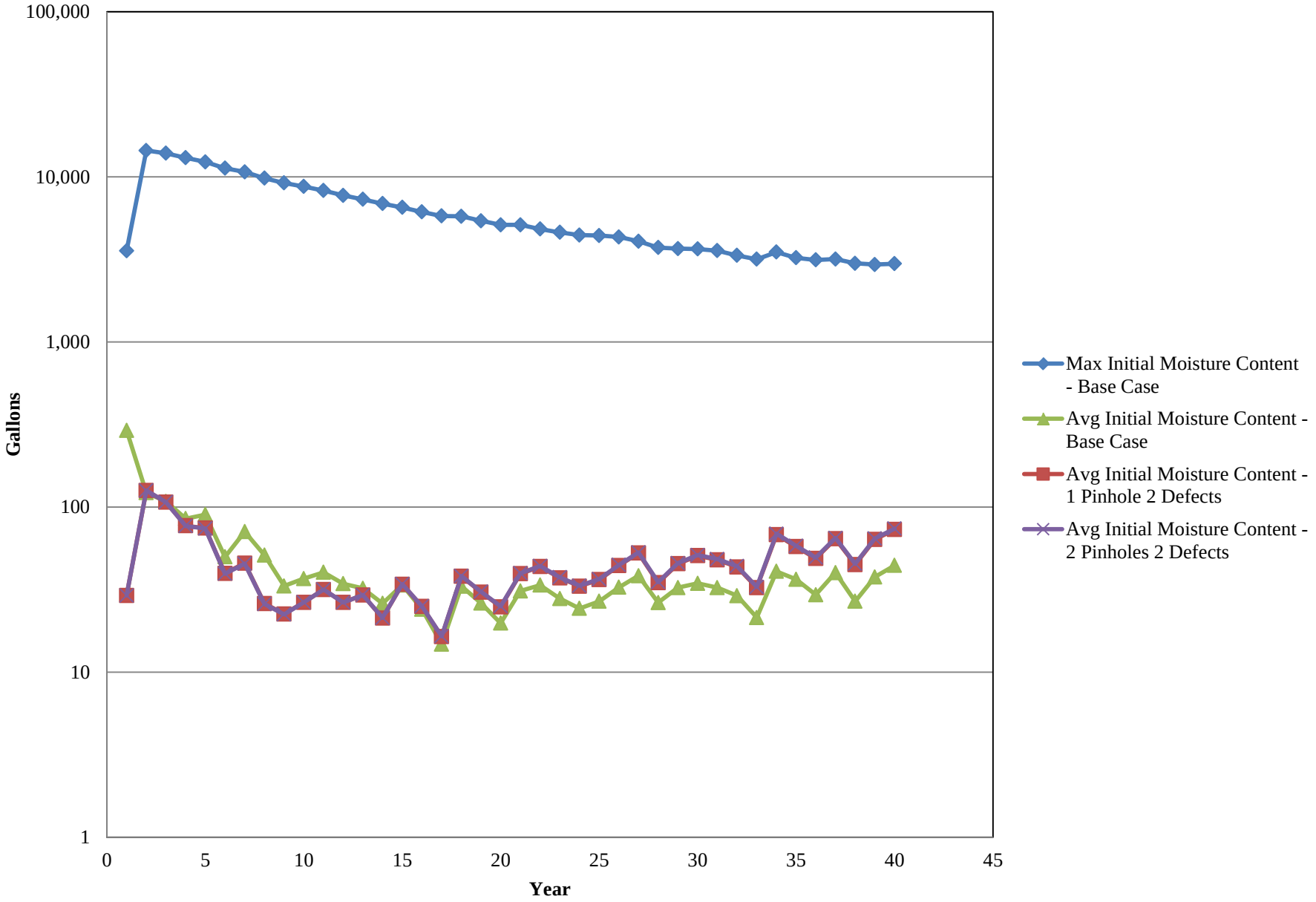


Chart 3. Percolation Through HDPE Liner - Big Four Precipitation Data

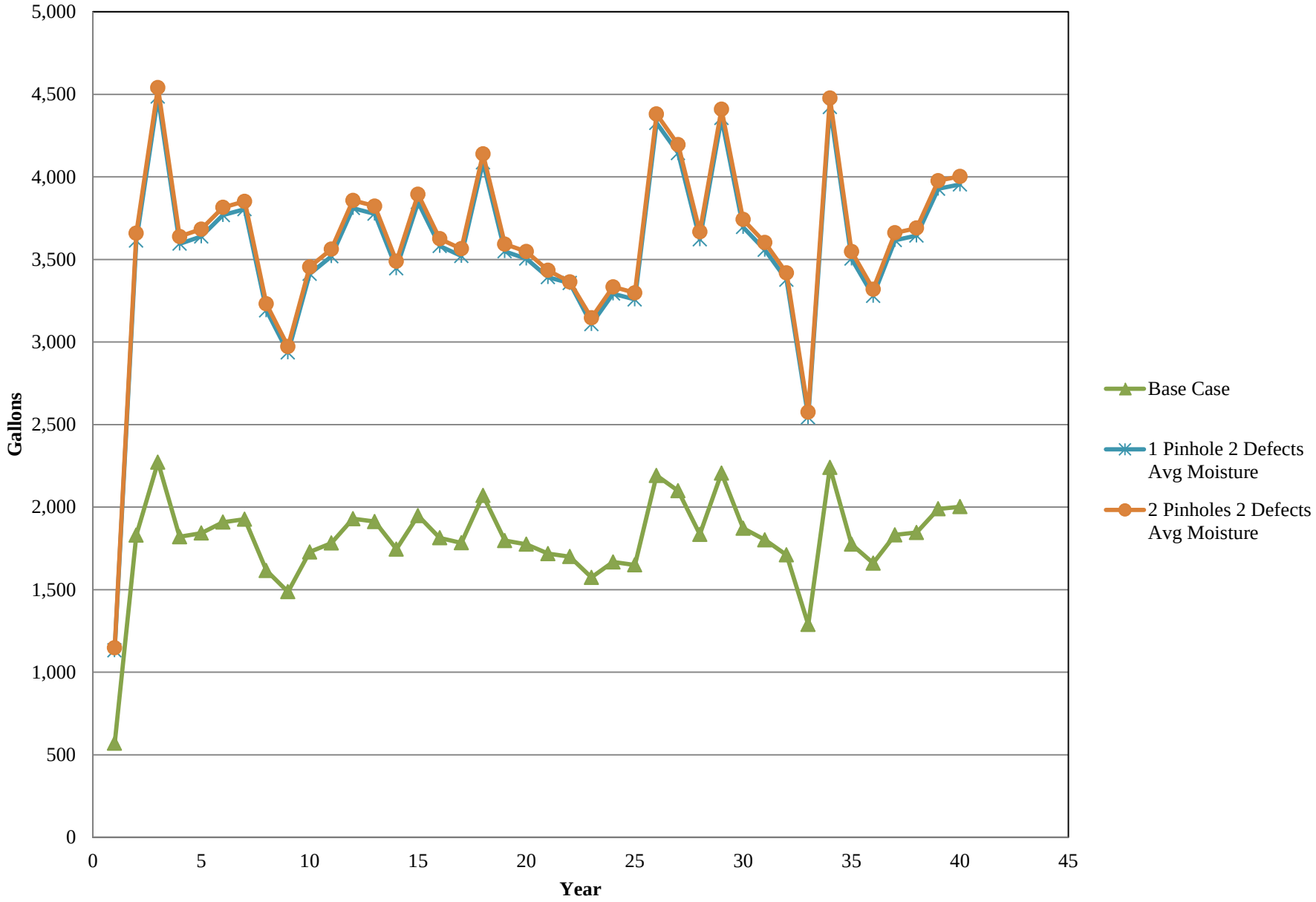
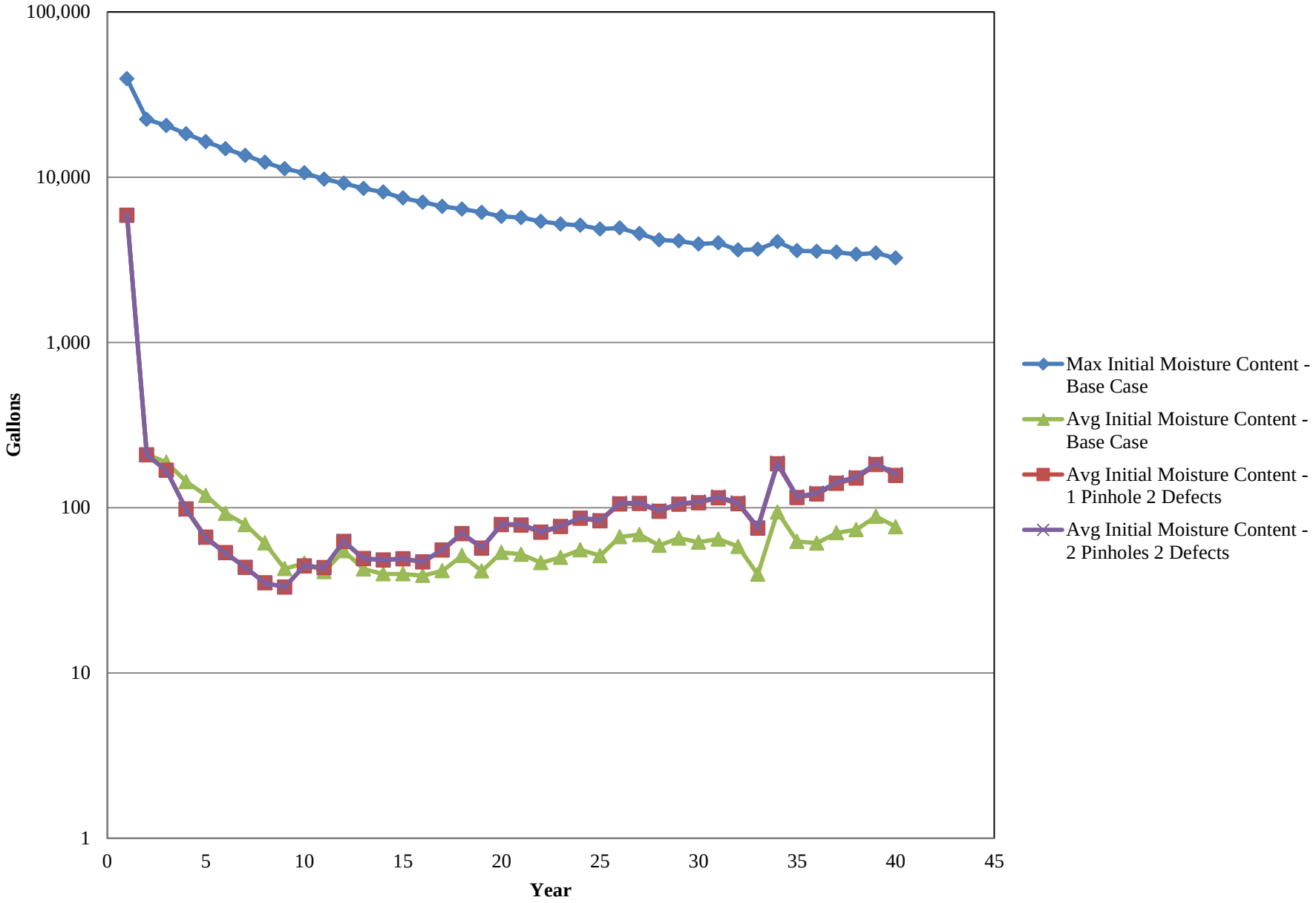


Chart 4. Percolation Through Compacted Native Soil - Big Four precipitation Data



Appendix C.

MCMA Repository Run-on Control Drain

TECHNICAL MEMORANDUM

CES A valmont COMPANY
Conserving Resources. Improving Life.

DATE: July 1, 2014 (Revised December 10, 2014)

TO: Joseph Gibbens, PE – USDA Forest Service

FROM: Jay Williams, PE – Cascade Earth Sciences

SUBJECT: MCMA Repository Run-On Control Drain

The proposed repository site is bounded on the upslope end by an abandoned railroad grade and on the downslope end by another abandoned railroad grade and a road. The railroad grade on the high (northeast) end has a ponding area that could potentially raise the groundwater elevation locally in the repository area, which subsequently drains towards the northwest and could potentially flow onto the repository cover. To mitigate this potential, CES has evaluated how best to drain the ponding area. We concluded that enhancing the drainage flowing to the northwest was the best alternative. An interceptor ditch would route flows away before they would reach the repository. The proposed grades, ditch alignment, and drainage area boundary should be field-verified.

The ponding area has a narrow watershed bounded on either side by natural drainage ways (Attachment A). The contributing drainage area is approximately 54 acres and has a time of concentration of 5 minutes. Rainfall intensity was determined using Dam Safety Guidelines Technical Note 3 – Design Storm Construction by the Washington Department of Ecology (Attachment B). Annual Exceedance Probability for the design storm was estimated using Technical Note 2.

Failure of the drainage ditch would be unlikely to cause either loss of life or significant property damage downstream. However, in a catastrophic storm a ditch failure could potentially cause contaminants to wash down into the Sauk River.

To determine the peak flow generated by the rainfall intensity of X inches per hour, we used the rational formula since the watershed area is so small. The rational formula is:

$$Q = CIA$$

Where:

- Q = peak flow rate in cubic feet per second
- C = a factor indicating runoff potential from the rainfall on the terrain (0.2 for forest)
- I = peak rainfall intensity in inches per hour
- A = watershed drainage area in acres

Therefore, Q = 0.2 (forest) x I x 54.

The table below shows the peak rainfall intensity, peak flow rate, flow depth, and flow velocity for several representative storms.

Storm	Peak		Ditch Flow	
	Intensity	Flow	Depth	Velocity
	inches per hour	cubic feet per second	feet	feet per second
Tr = 100 year	5.52	60	1.9	3.05
Tr = 500 year Design Step 1	6.63	72	2.1	3.22
Design Step 5 (10,000 < Tr <100,000)	9.93	107	2.5	3.55
Probably Maximum Precipitation	18.04	195	3.3	4.16

NOTE:
Flow calculations based on a channel with:

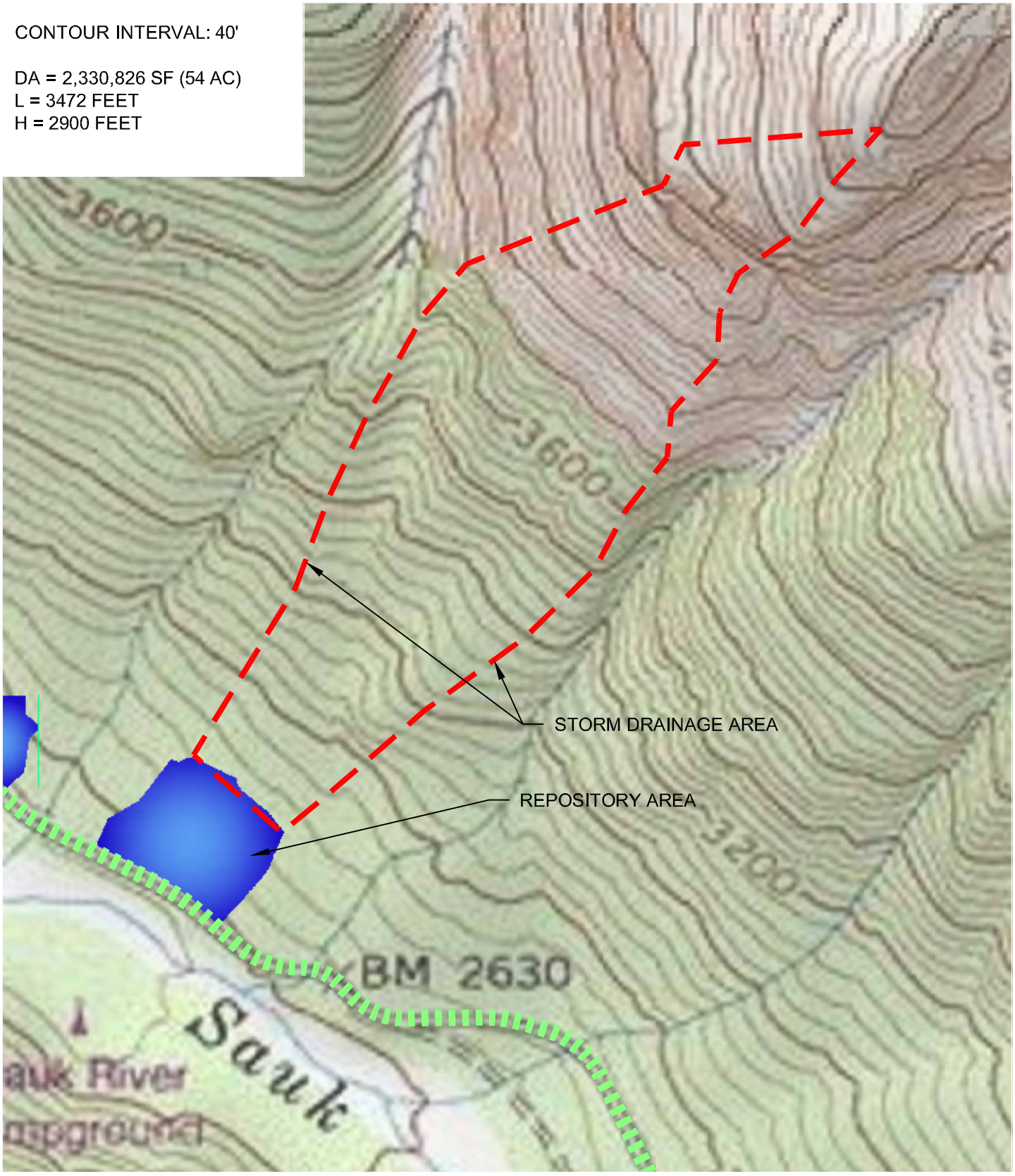
- Bottom width = 5 feet
- Side Slope = 3H:1V
- Manning's 'n' = 0.055
- Channel Slope = 0.01
- Tr = return period (e.g., a 100 year Tr has an annual chance of occurance of 1%)

Due to the potential for contamination downstream, a Design Step of 1 to 6, as defined in Technical Note 2 could be warranted. We chose Design Step 5, which has a probability of exceedance of 0.0001 to 0.00001 in any given year (Tr of 10,000 to 100,000 year) to size the ditch flowing bankfull. During the 100 year return period storm, this ditch would have 0.6 feet of freeboard during peak flow.

Preliminary information indicates that a channel to the northwest having a slope of 0.01 is manageable. Flow in a channel 2.5 feet deep, with a bottom width of 5 feet and a side slope of 3H:1V, with a Manning's 'n' value of 0.055 (channel in poor repair) would flow approximately 110 cubic feet per second and would be adequate for this channel. Channel velocities during this extreme event would be about 3.5 feet per second, which could cause scouring and would require repair after the event. Lower flows that could be expected in more normal circumstances (Tr = 10 year or less) would be slightly over 2 feet per second and could be safely passed in an adequately vegetated channel or in a gravel armored channel.

In addition to water run-on flow, field evaluation of the site and of geologic mapping shows that landscape-forming debris avalanches have deposited the present rocky substrate of the repository site. Another of these events would likely be depositional rather than erosional, based on the current landform and given the grade break to steeper slope above the repository. Should a debris avalanche occur at this location, the resulting deposition could cover a portion of the repository with rock and organic matter. In that eventuality, further geotechnical evaluation would be needed to evaluate whether the deposited material should be removed or left in place.

JEW/sjr
Att: Att A. Repository Drainage Basin R1
Att B. Design Storm
c: Tim Otis, Ryan Tobias – Cascade Earth Sciences
PN: 2013230047
Doc: App C MCMA Repository Run-On Control Drain Memo.docx



Attachement A. Repository Drainage Basin R1

PROJECT NUMBER: 2013230036	Monte Cristo Mining Area Removal Action
DATE: 6/30/2014	
DWG NO: 2013230022 Attachment A.dwg	USDA Forest Service Mt. Baker - Snoqualmie National Forest Darrington Ranger District
DWG BY: 6RKB / PROJECT MANAGER: 2013230022	
REVISED:	CES CASCADE EARTH SCIENCES A Valmont Industries Company

S:\[Working Drafting]\2013230022 MCMA Removal Action\Drawings\Misc Figs\2013230022 Attachment A.dwg June 30, 2014 RKB

Monte Cristo Repository; USFS

Worksheet for Computation of **Short Duration** Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision
Monte Cristo Repository; 04/25/2014 page 1 of 2

Project data:		*Input*		*Input*	
	Dam location:	T __ N, R __ E/W, Section ___; ___ miles N/S/E/W of [nearest town/city]			
	Watershed Lat/Long:	47.9900	deg. N	121.4100 deg. W	(> 3 decimal places)
	Watershed elevation:	5000	feet		(Lat/Long and elev for centroid of watershed)
	Climatic Region:	15			(MGS Look-up Calculator)
	Mean Annual Precip:	122.5	inches		(MGS Look-up Calculator)
	Duration of interest:	2	hours		(Index for short duration storm)
	Design Step:	5			(Worksheet from Tech Note 2)
	Drainage area:	0.08	sq.miles.		(Compare to small watershed < 1 sq.mile.)
		Input			

Key equations :

Precipitation estimates are calculated from gridded data set files by the MGS Look-up Calculator (the "Calculator" tab in this workbook) using the four-parameter Kappa probablility distribution. The specific equations are described in more detail in the following references :

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Western Washington, prepared for Washington State Department of Transportation, Report WA-RD 544.1, MGS Engineering Consultants, March 2002.

Schaefer MG, Barker BL, Taylor GH and Wallis JR, Regional Precipitation-Frequency Analysis and Spatial Mapping of Precipitation for 24-Hour and 2-Hour Durations in Eastern Washington, prepared for Washington State Department of Transportation, MGS Engineering Consultants, January 2006.

The calculations were extended to the Dam Safety storms by the update to Technical Note 3.
The gridded data sets are provided by Ecology along with this spreadsheet and look-up calculator.

Scaling precipitation, P_{sd} = DF * P_{gds} Use design factor = 1.15 *Input*

where: P_{gds} = estimated 2-hr precip for selected frequency, inches
DF = design factor; DF = 1.15 for new dams
P_{sd} = scaling precip for 2-hr index period, inches

Total storm precip = (scaling precip for 2-hr index) x (multiplier from mass curve for 4-hr storm)
multiplier for 4-hr storm = 1.2050 for Climatic Region 15
*(from **Multipliers** worksheet)* Hyetograph no. 5

This project :

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Precip estimate, P_{gds} (in.) :	1.32	1.50	1.79	2.14	2.31	2.59
Scaling precipitation, P_{sd} (in.) :	1.51	1.72	2.05	2.47	2.65	2.98
Total precip for design storm :	1.82	2.07	2.47	2.97	3.20	3.59

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Precip estimate, P_{gds} (in.) :	2.89	3.21	3.55	3.91	4.29	6.71
Scaling precipitation, P_{sd} (in.) :	3.33	3.70	4.09	4.50	4.94	6.71
Total precip for design storm :	4.01	4.45	4.92	5.42	5.95	8.09

Monte Cristo Repository; USFS

Worksheet for Computation of Short Duration Precipitation Magnitude-Frequency Curve
Reference: Technical Note 3, Oct 2009 revision
Monte Cristo Repository; 04/25/2014 page 2 of 2

Comparison to PMP for local storm (thunderstorm). Ref: HMR-57, Fig. 11.19 and 11.12, Table 11.4.

	Input	
Local storm, 1-hour PMP =	6.1	in.
2-hour PMP = 110% x 1-hr =	6.7	in.

Frequency / design step :	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
Scaling precipitation, Psd (in.) :	2.98	3.33	3.70	4.09	4.50	4.94
Percentage of 2-hr PMP (%) :	44.4	49.6	55.1	60.9	67.1	73.6

Note: Per Tech Note 3, page 10: For IDF = PMF, use PMP > Step 6.

Basin average precipitation for large watershed.

Drainage area = 0.08 sq.miles. (Compare to small watershed < 1 sq.mile.)

Basin avg. precip = 100 % of total storm point precip.
*(from **Multipliers** worksheet)*

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Total storm point precip :	1.82	2.07	2.47	2.97	3.20	3.59
Basin avg total storm precip :	1.82	2.07	2.47	2.97	3.20	3.59

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Total storm point precip :	4.01	4.45	4.92	5.42	5.95	8.09
Basin avg total storm precip :	4.01	4.45	4.92	5.42	5.95	8.09

Peak rainfall intensity for design storm.

Peak rainfall intensity (in/hr) = (total storm precip) x (peak intensity factor)
peak intensity factor = 2.23068 for Climatic Region 15
*(from **Multipliers** worksheet)* Hyetograph no. 5

Frequency / design step :	10 yr	25 yr	100 yr	Step 1	Step 2	Step 3
Basin avg total storm precip :	1.82	2.07	2.47	2.97	3.20	3.59
Peak storm intensity (in/hr) :	4.07	4.63	5.52	6.63	7.13	8.01

Frequency / design step :	Step 4	Step 5	Step 6	Step 7	Step 8	PMP
Basin avg total storm precip :	4.01	4.45	4.92	5.42	5.95	8.09
Peak storm intensity (in/hr) :	8.94	9.93	10.98	12.10	13.28	18.04