

An aerial photograph showing a large, conical pile of orange-brown tailings material in a valley surrounded by dense evergreen forests. A stream flows through the valley floor. The text is overlaid in yellow on the image.

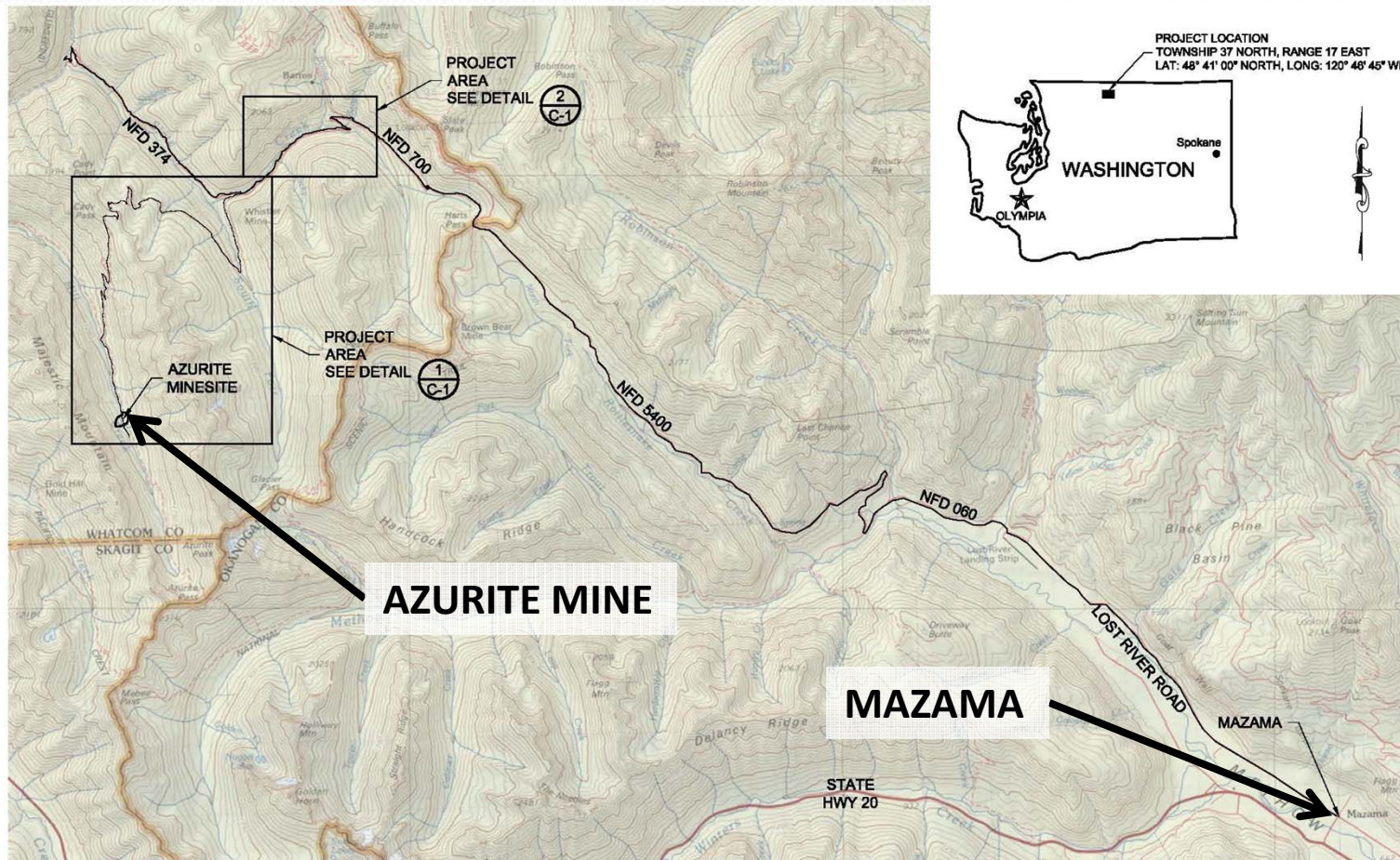
AZURITE MINE - CERCLA REMOVAL ACTION PROJECT

**2011 – Mine Design, Operation, & Closure Conference
Dustin G. Wasley, PE, Principal
Cascade Earth Sciences
May 3, 2011**

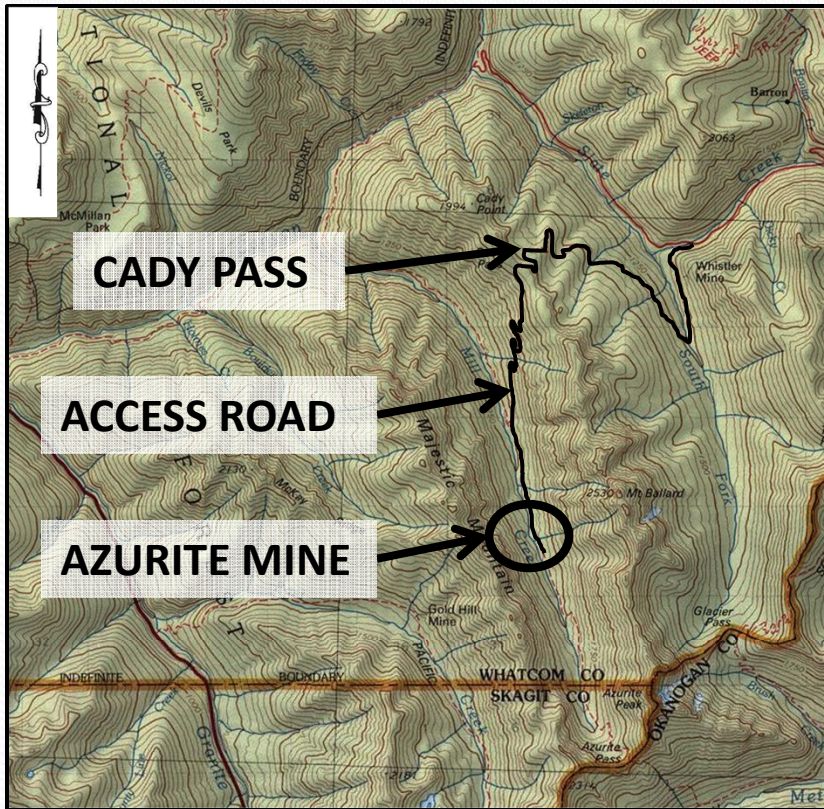
Azurite Mine Overview

- Abandoned Underground Gold Mine, Located in North-Central WA on USFS-Administered Land
- Northwest of Mazama, Near Harts Pass Recreation Area
- Remote Area, with limited vehicle access
- Moderate Recreational Use, near Pacific and Cascade Crest Trails

Azurite Mine Location

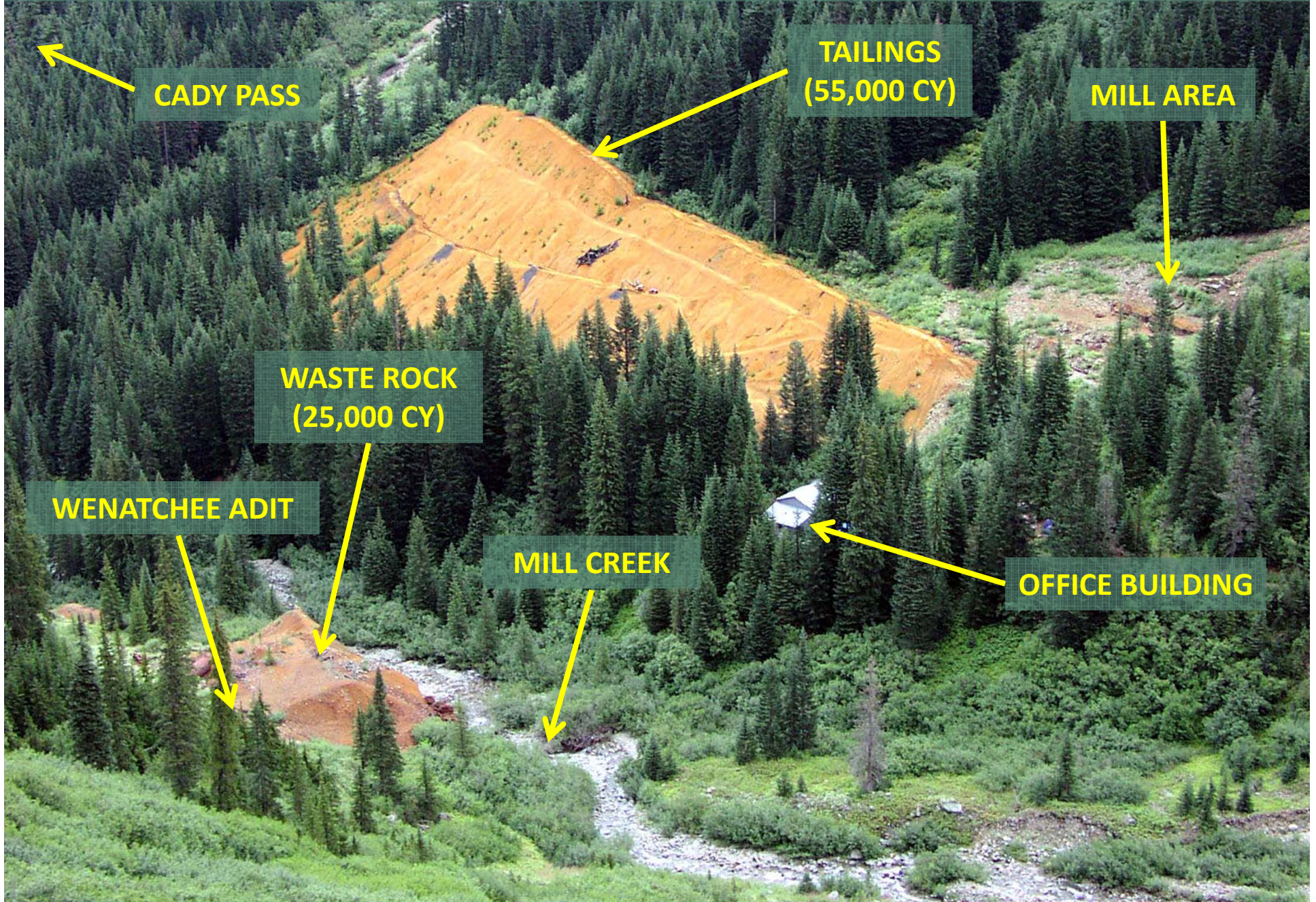


Azurite Mine Location



LOOKING SOUTH FROM CADY PASS

OVERVIEW OF AZURITE MINE FROM TINSON ADIT



Tailings Pile



Tailings Pile



Mill Area / Office Building



Waste Rock Pile



Waste Rock Pile



Upper Mill Creek



Lower Mill Creek/Canyon Creek



Azurite Mine – Early History

- 1915 – 31 Claims Staked
- 1918 – Azurite Gold Company
- 1918 to 1931 – Underground Development
- 1934 – ASARCO Leased Mine
- 1934 to 1936 – 100 TPD Mill and Infrastructure
- 1936 to 1942 – Production, Development, Exploration
- 1942 – ASARCO Removes Equipment
- Total Production – 72,000 tons (0.4 oz/ton Au)

Azurite Mine – Recent History

- 1995 – Discovery Assessment (USFS)
- 2002 – IAM Open File Report (WA DNR)
- 2004/2005 – CERCLA Site Inspection (USFS/CES)
- 2005 – Reprocessing Study (USFS/CES/Degerstrom)
- 2006 to 2008 – EE/CA & Risk Assessment (ASARCO/MFG)
- 2007 – ASARCO Settlement with USFS
- 2007 to 2010 – Data Gaps/Removal Design (USFS/CES)

CERCLA Site Inspection Review

- Surface Water Pathway
 - 8 Aquatic Stations (Surface Water, Pore Water, Sediment, & Benthic)

Aquatic Stations

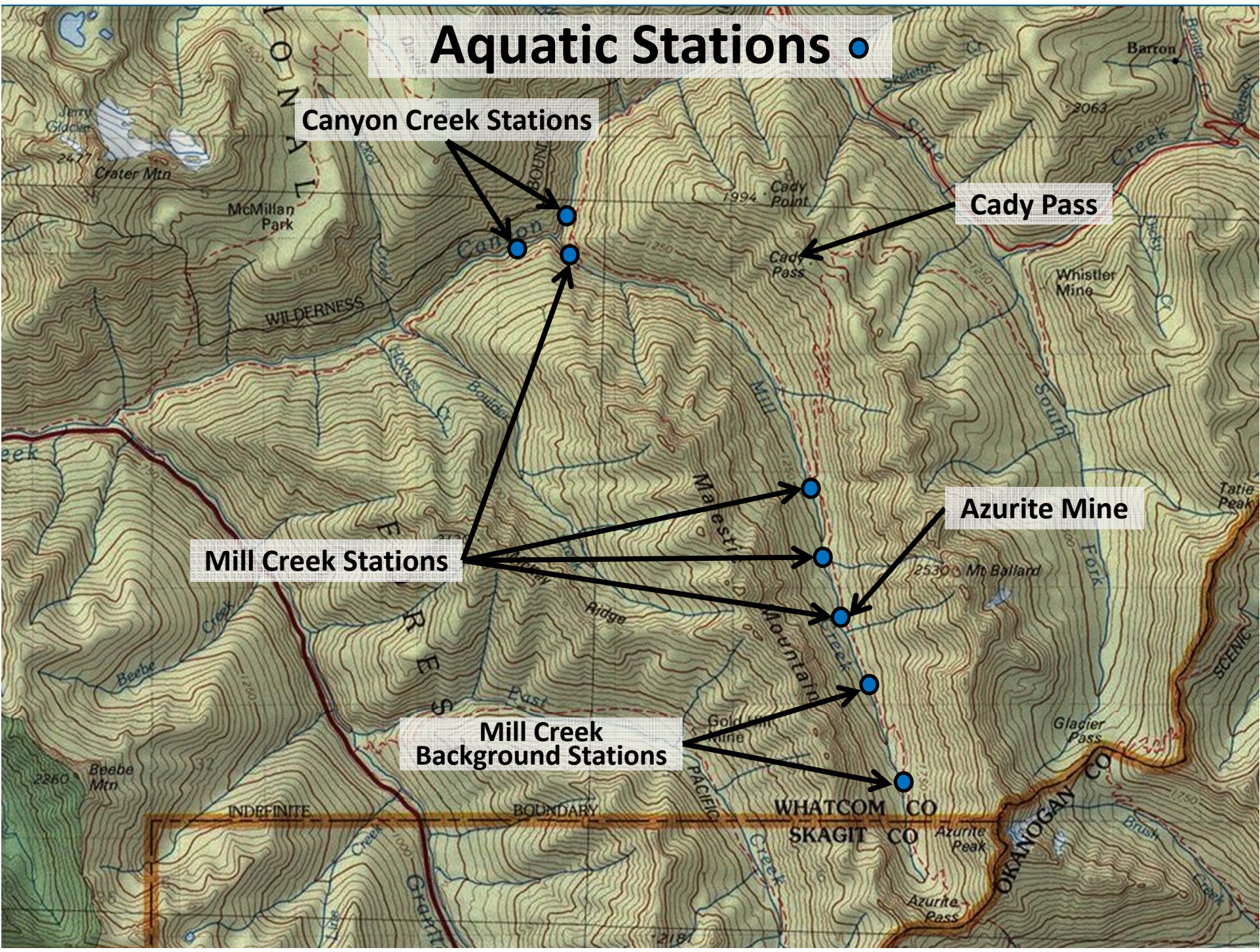
Canyon Creek Stations

Cady Pass

Mill Creek Stations

Azurite Mine

Mill Creek Background Stations



CERCLA Site Inspection Review

- Surface Water Pathway
 - 8 Aquatic Stations (Surface Water, Pore Water, Sediment, & Benthic)
 - Minimal impacts to Surface/Pore Water/Benthic
 - Sediments slightly impacted (COCs: As, Cd, Cr, Cu, Ni, Zn)
 - Complete Pathway for Receptors
- Soil Pathway
 - 17 Test Pits - 40 Tailings/WR/Soil Samples (COCs: As, Cu, Hg, and Pb)
 - Tailings/WR ARD Potential - ABP as low as -230 t CaCO₃/Kt
 - Background Soil Elevated with COCs
 - Complete Pathway for Receptors

CERCLA Site Inspection Review (cont.)

- Air Pathway
 - Complete Pathway for Receptors
- Groundwater Pathway
 - Adit discharge/seeps (3) impacted (COCs: Al, As, Cu, Mn, Zn)
 - Incomplete Pathway for Receptors
- Topographic Survey of Tailings, Mill Site, and WR
- Ecological Survey
 - RTE species expected (Bull Trout, Spotted Owl)
- Engineering Evaluation / Cost Analysis (EE/CA) Recommended

Reprocessing Study

- CES – Contracted with Degerstrom in 2005
- Four tailings samples (Two for Gravity / Two for Floatation)
- Gravity – Poor Gold/Sulfide Recovery (14-28%/29-41%)
- Floatation – Poor Gold/Sulfide Recovery (21-35%/16-27%), Excellent Recovery for As, Cu, and Zn.
- Historic Lime/ CN^- used interferes with floatation tests
 - Better gold recovery (60%) after lime/ CN^- acidification/aeration treatment
- Conclusion / Bottom Line
 - Gravity – Not economical
 - Floatation – Better recovery after pretreatment, but cons not marketable (high arsenic/base metals).

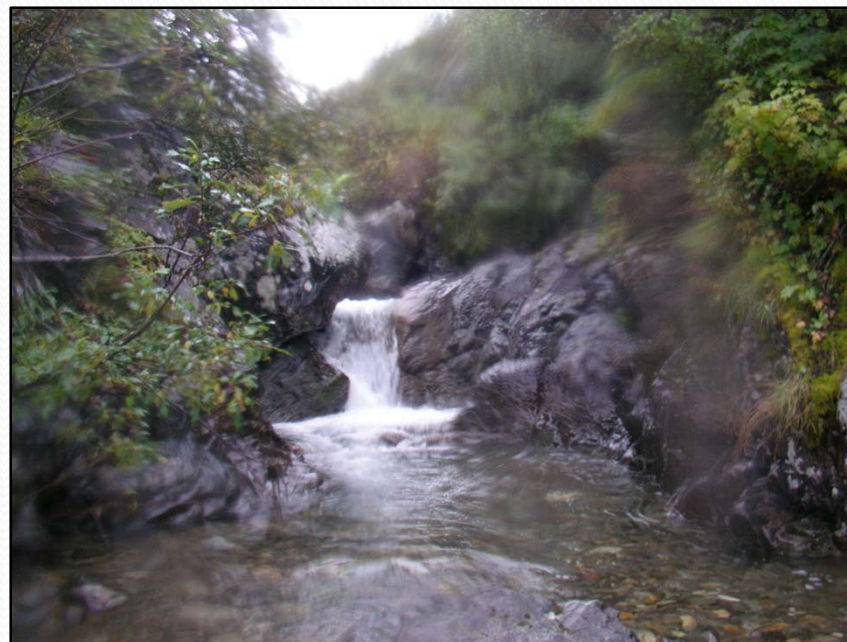
Engineering Evaluation/Cost Analysis

- Lead by ASARCO (MFG), with Input from USFS
- Additional Sampling
- Risk Assessment (Human and Ecological)
 - Human – Carcinogenic Risk for Arsenic (Cleanup Goal – 104 mg/kg)
 - Ecological – Many COCs, Source Control Will Mitigate Risks
- Preferred Alternative
 - Place Waste Rock Over Tailings Pile
 - Construct Retaining Wall at Toe of Tailings Pile
 - 1-foot Soil Cover, then 1-foot Talus/Rock Cover
 - Erosion Controls
 - Physical Hazard Mitigation

\$5.7M – 30 Yr Present Worth

Removal Action Design Data Gaps

- Mill Creek Fish Barrier Survey
 - Multiple Fish Barriers, No Fish Within 2.5 Miles



Removal Action Design Data Gaps

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- Borrow Material Assessment
 - Onsite Talus/Rock Areas



Removal Action Design Data Gaps

- Mill Creek Fish Barrier Survey
 - Multiple Fish Barriers, No Fish Within 2.5 Miles
- Borrow Material Assessment
 - Onsite Talus/Rock Areas
- Access Road Improvement Assessment
 - Bridge Replacement/Repair, Culverts, and Switchbacks
- Geotechnical Assessment
 - GeoEngineers - Slope Stability of the Recommended RA.
- Humidity Cell Testing / Batch Soil Attenuation
 - Upper WR – ↑Sulfides (-) ABPs
 - Lower WR – ↓Sulfides (+) ABPs
 - Soils Underlying Tailings ↑ attenuation of metals/acids

Design Considerations

- Weather Conditions



Design Considerations

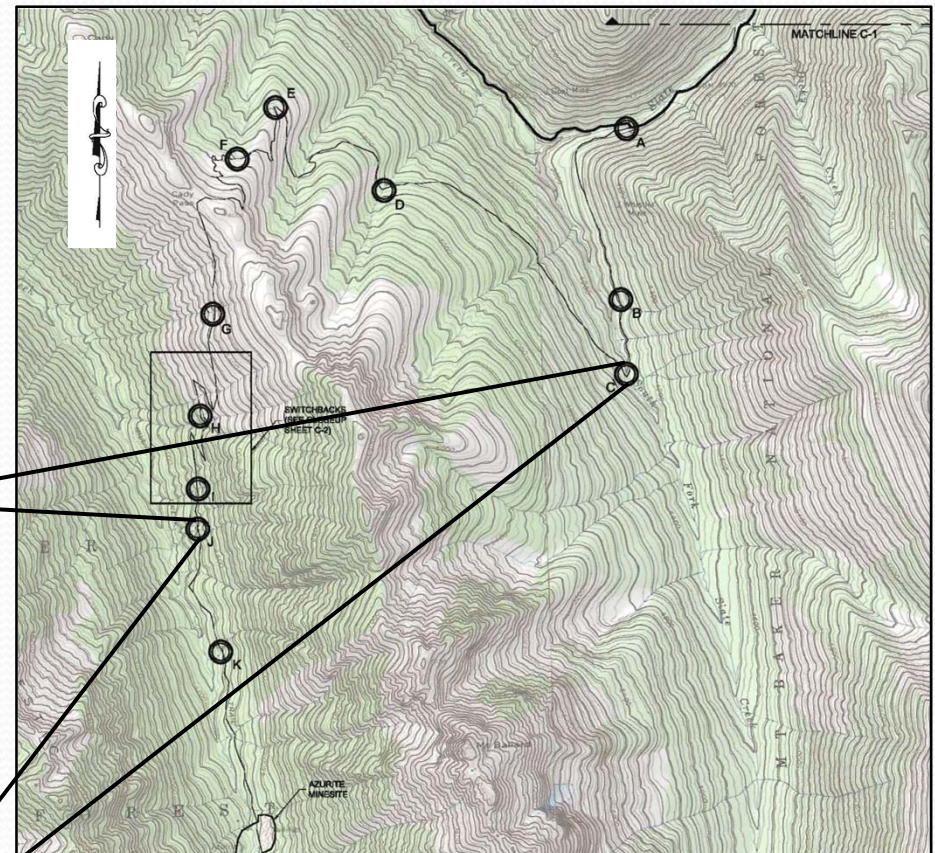
- Weather Conditions
- Construction Window (late June – early October)
- Remote Access/Logistics/Communications
- Steep Slopes / Difficult Terrain
- Limited Onsite Staging Areas / Borrow Materials

Final Removal Action Alternative

- Access Road Bridge Replacement and Road Improvements
- Temporary Access Road Across Mill Creek
- Mill Creek Diversion Away from Waste Rock Pile
- Onsite Covered Repository
 - Waste Rock over Tailings Pile/Mill Area
 - Reinforced Stabilized Slope/Repository Toe Berm
 - Multi-Layer Cover, HDPE Membrane, and Talus/Rock Cover
- Run-on/Run-off Control
- Physical Hazard Mitigation
- Revegetation (USFS)

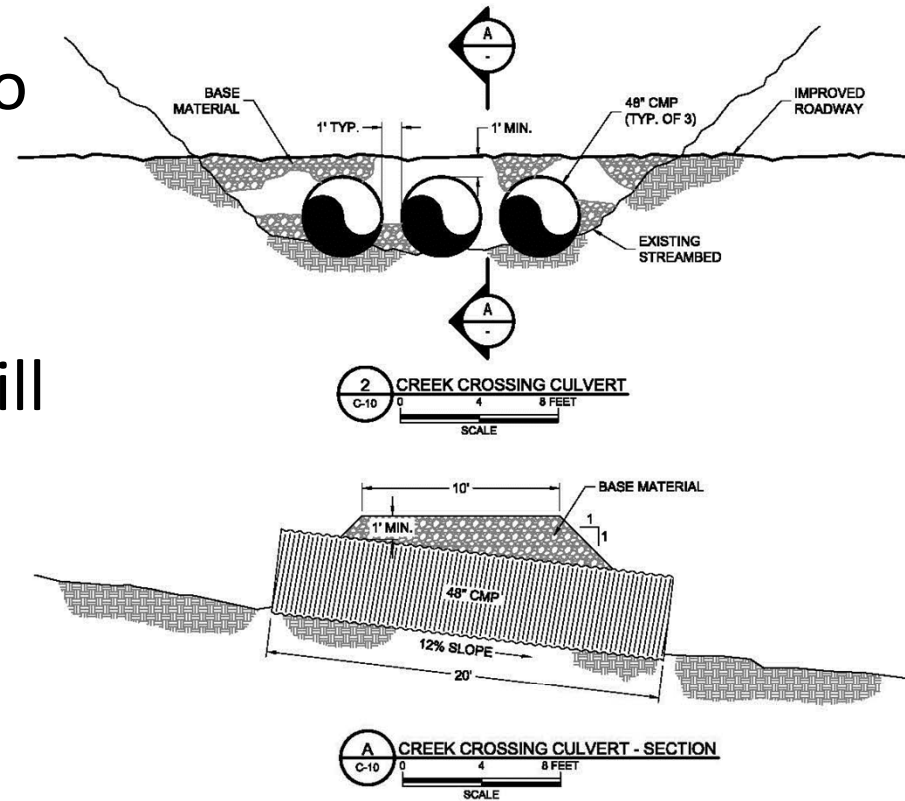
Access Road Improvements (Complete)

- Work in 2010 by Palm Construction/USFS
- Bridge Installation
- Road Widening/Grading
- Switchback Improvements
- Culvert Installation



Temp Access Road Across Mill Creek

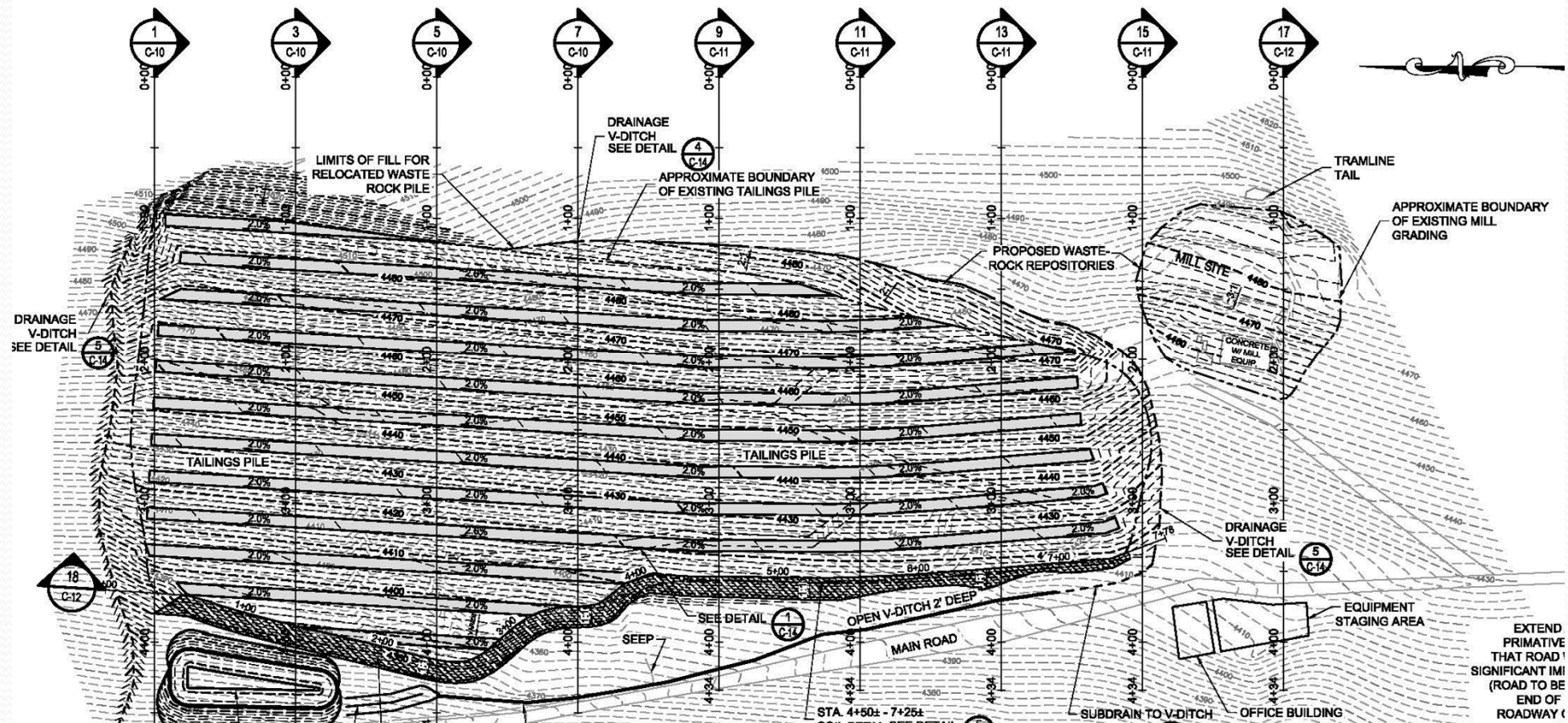
- Needed to Access Waste Rock Pile, and Transport to Repository
- Three, 48-inch CMPs
- Will Temporarily Divert Mill Creek Away From Waste Rock Pile
- Time Dependent on Mill Creek Flow Rate



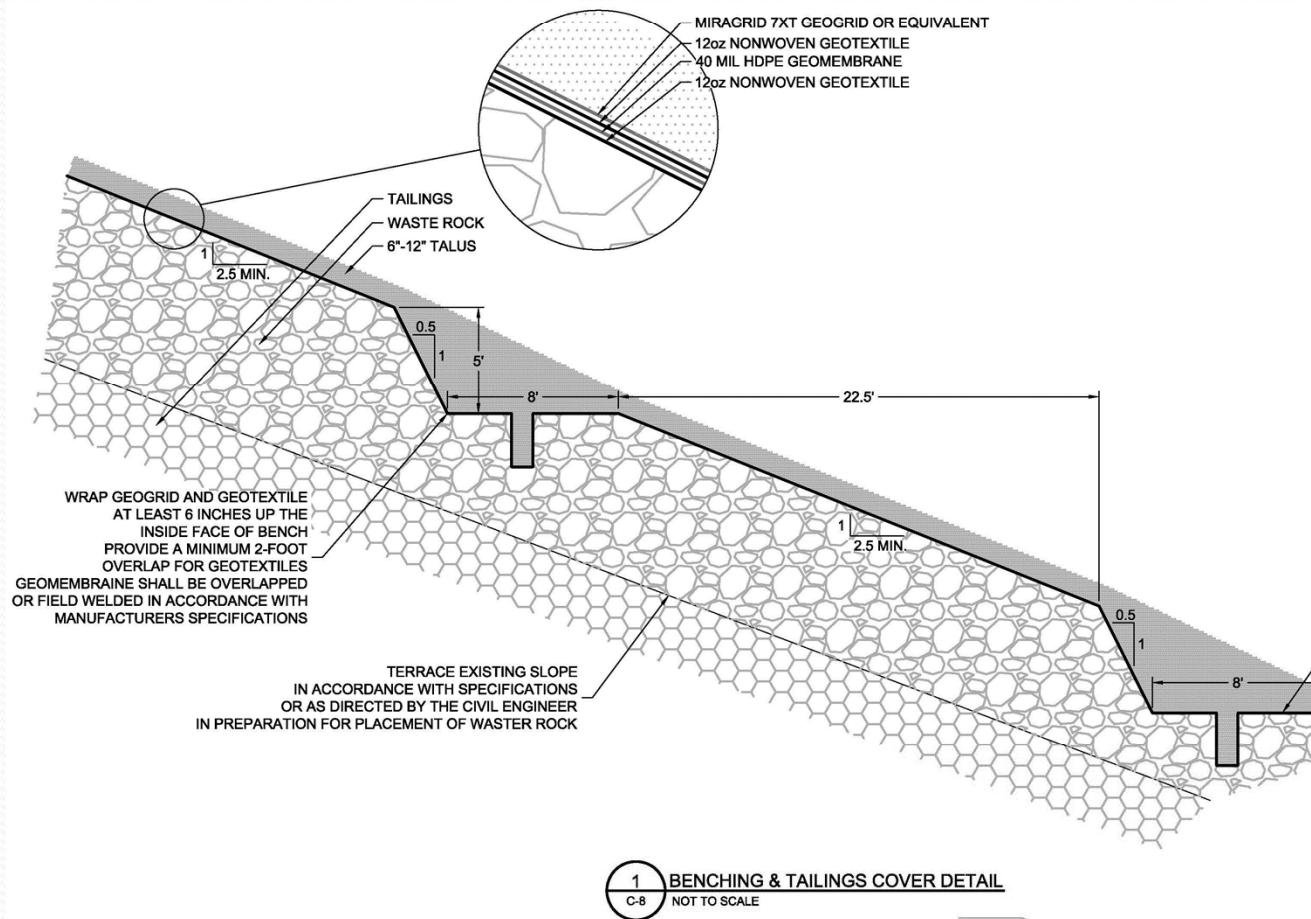
Onsite Repository

- Overall Slope 2.5:1
- Waste Rock Placed & Blended w/ Tailings to achieve slope
- In-sloped benches every 20-25 feet to relieve precip
- Reinforced Stabilized Slope/Toe Berm
- Repository Cover (multi-layer system)
 1. Talus/Rock Cover
 2. Geogrid
 3. 12-oz Nonwoven Geotextile
 4. 40-mil HDPE Membrane
 5. 12-oz Nonwoven Geotextile
 6. Waste Rock/Tailings

Repository Grading Plan



Repository Cross Section Detail



Removal Action Schedule

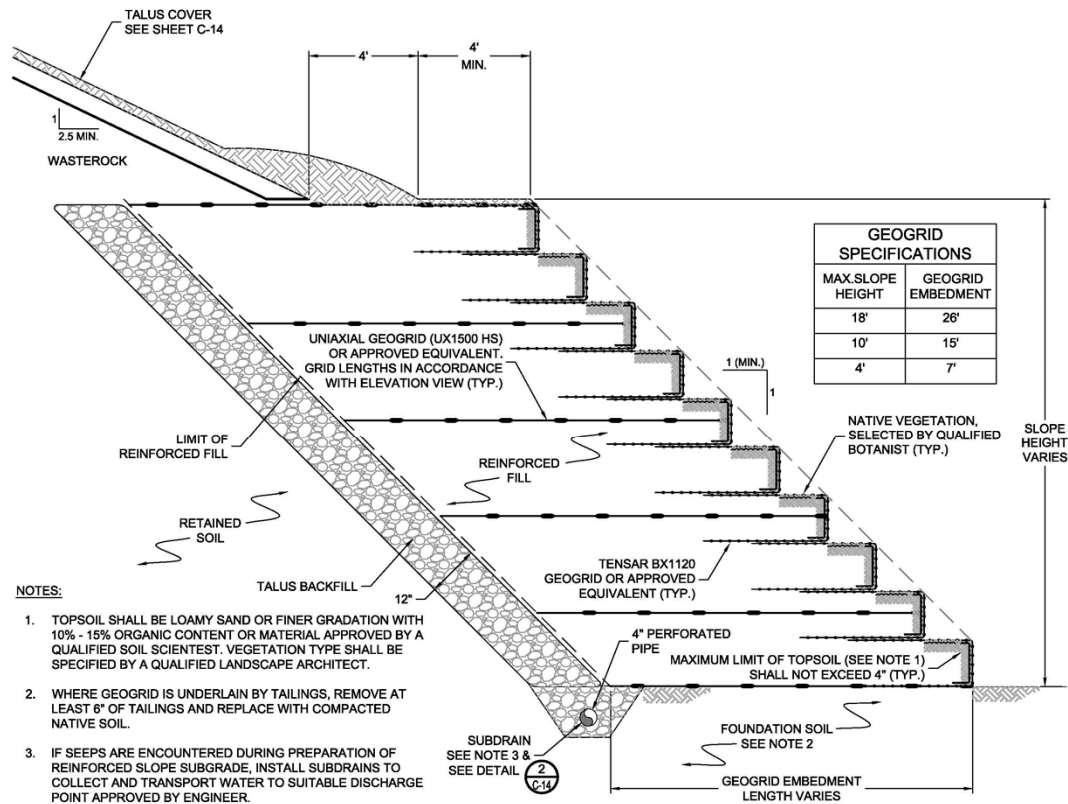
- Turnkey-Design Build Contract Structure
- Spring Baseline Aquatic Sampling – Mid-June 2011
- RA Mobilization Planned for Late-June/Early-July 2011
 - Continuous Work Schedule with Rotating Staff/CES Oversight
- Fall Aquatic Sampling – Early/Mid-October 2011
- Assess Adit/Seep Treatment Requirements – 2012
- Post RA Monitoring/O&M – 2012 to 2014 (Semi-Annual)

QUESTIONS



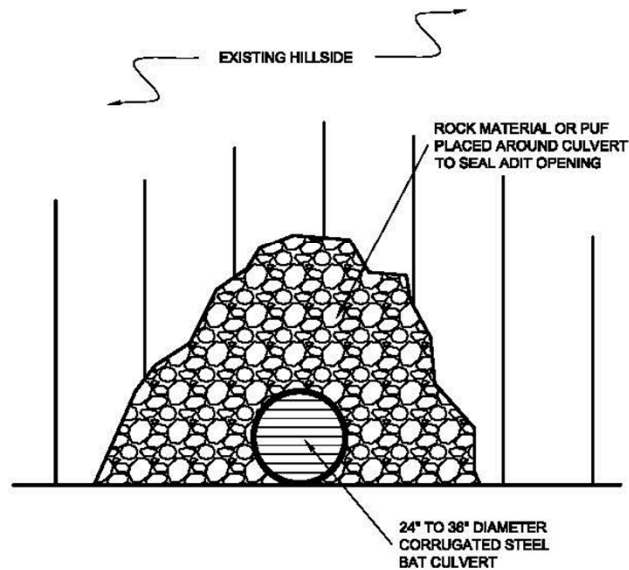
- Extra Slides

Reinforced Stabilized Slope Details

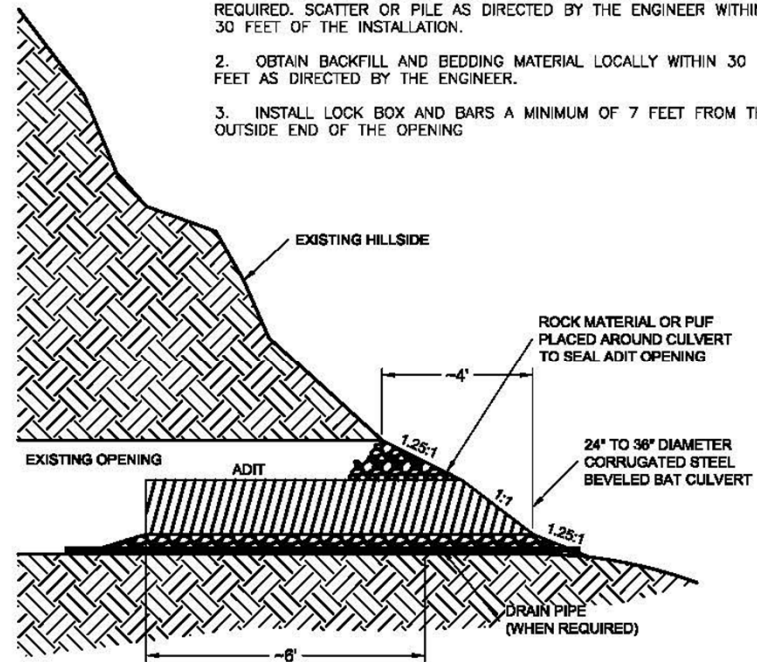


2 STABILIZED SLOPE TYP CROSS SECTION
C-8 NOT TO SCALE

Adit Closures



4 BAT CULVERT - FRONT VIEW
NOT TO SCALE



5 BAT CULVERT - PROFILE
NOT TO SCALE

NOTES

1. REMOVAL OF EXISTING PORTAL STRUCTURE AND TIMBERS MAY BE REQUIRED. SCATTER OR PILE AS DIRECTED BY THE ENGINEER WITHIN 30 FEET OF THE INSTALLATION.
2. OBTAIN BACKFILL AND BEDDING MATERIAL LOCALLY WITHIN 30 FEET AS DIRECTED BY THE ENGINEER.
3. INSTALL LOCK BOX AND BARS A MINIMUM OF 7 FEET FROM THE OUTSIDE END OF THE OPENING

Reprocessing Study

- Four tailings samples (2 for Gravity / 2 for Floatation)
- Gravity – Poor gold/sulfide recovery (14-28%/29-41%)
- Floatation – Poor gold/sulfide recovery (21-35%/16-27%), excellent recovery for As, Cu, and Zn.
- Historic Lime/ CN^- used interferes with floatation tests
- Bottom Line
 - Gravity – Not economical due to poor recovery
 - Floatation – Better recovery after lime/ CN^- pretreatment, but concentrates are not marketable (high arsenic/base metals).

Azurite Mine – Key Site Features

- 4-Acre Tailings Pile (~55,000 CY)
- Waste Rock Piles, Upper & Lower, combined (~25,000 CY)
- Mill Area – Only Foundations Remain
- Mill Creek bisects the Site
- Office Building
- 10-Mile Access Road, significant erosion issues
- Adits/Openings (Wenatchee, Tinson, Discovery, Burnham)
 - Wenatchee – Main Haulage Adit

Access Road

