Water Quality and Regulatory Issues Associated With Abandoned Mines In The Central Valley Region

Joint Workshop

State Water Resources Control Board

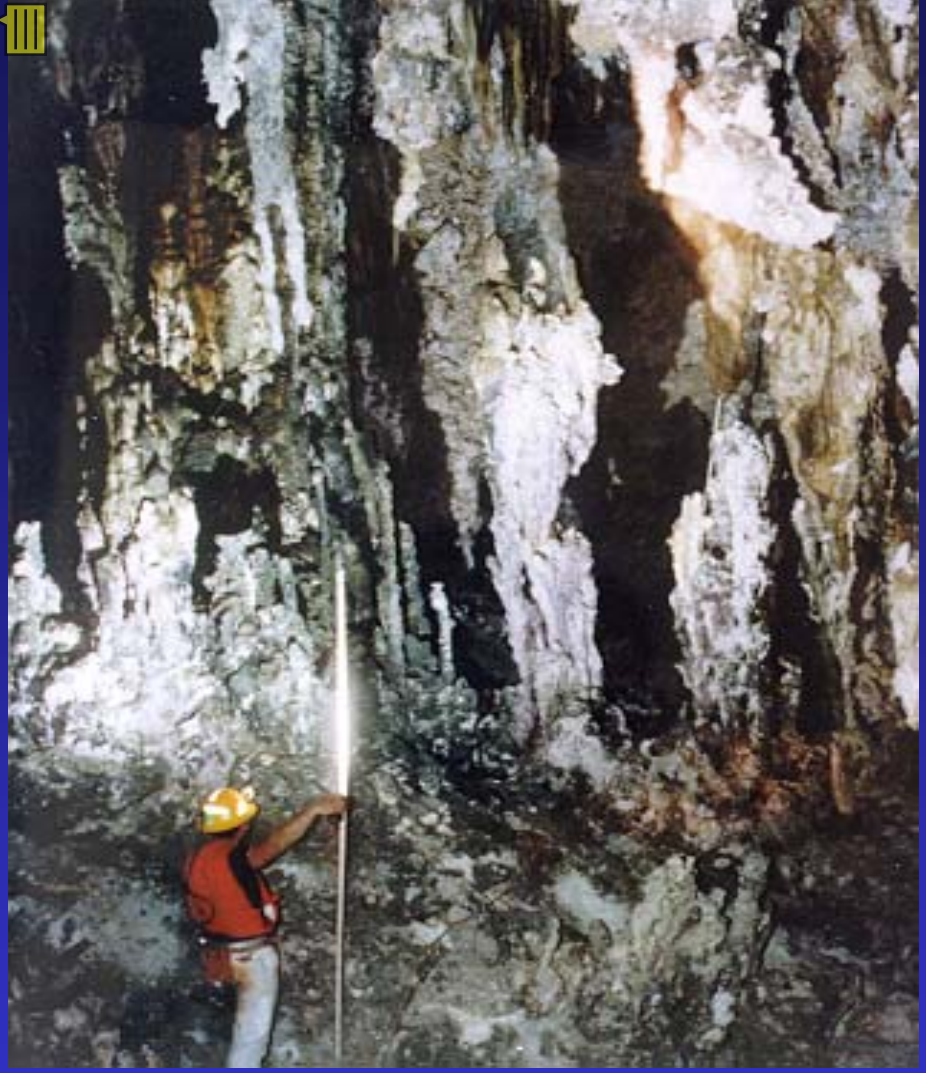
Central Valley Regional Water Quality Control Board

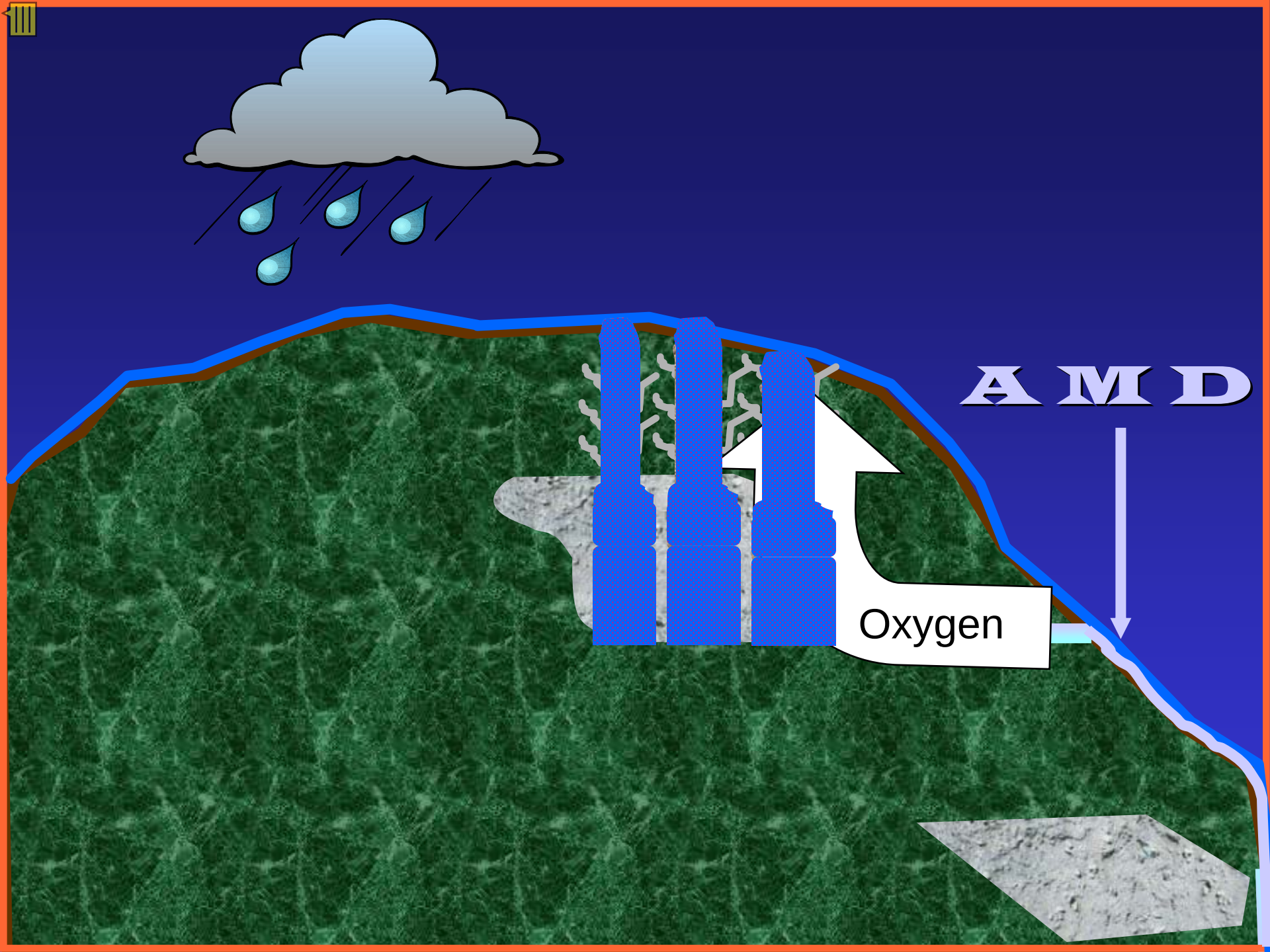
INTRODUCTION

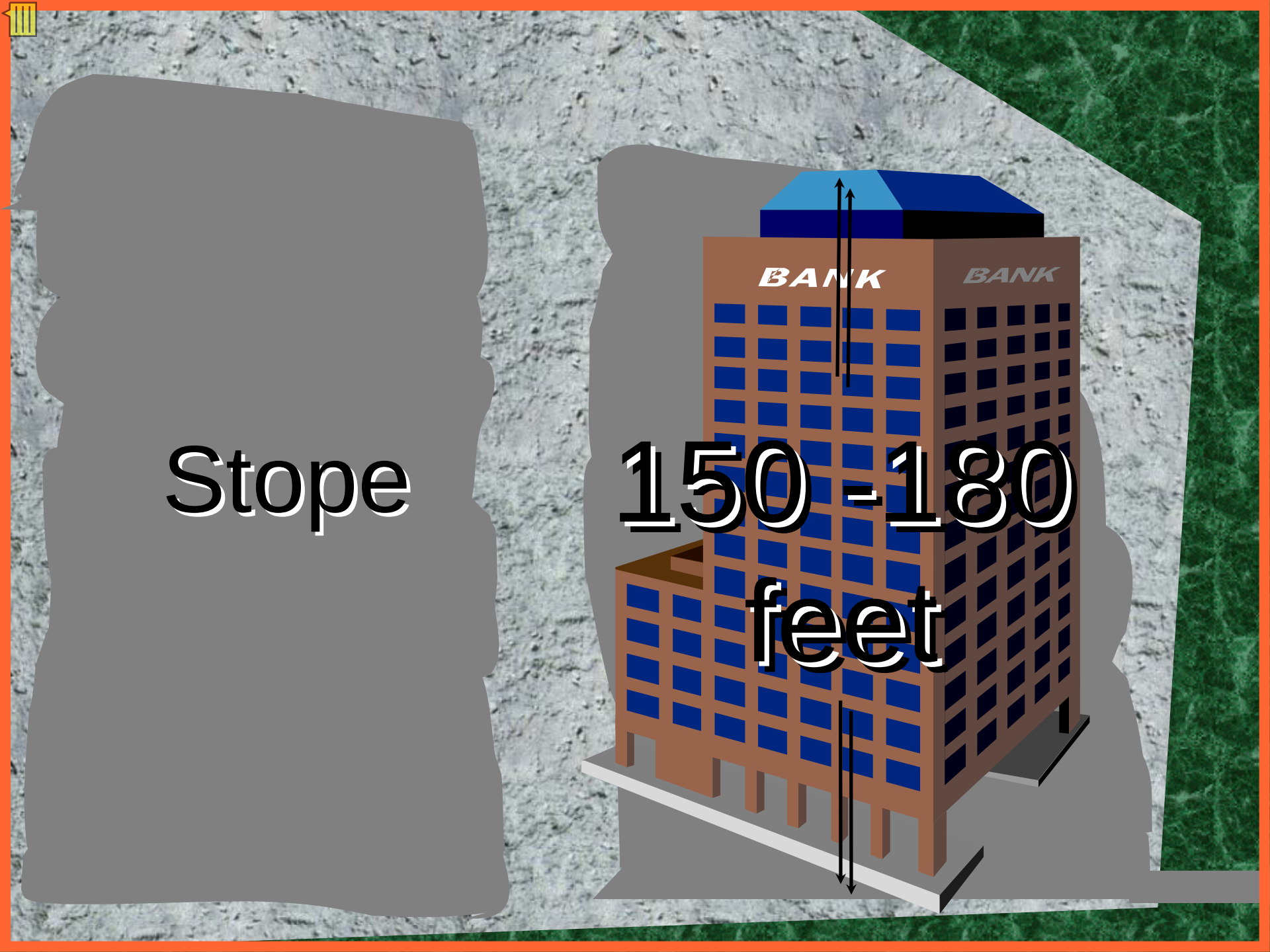
- There are thousands of abandoned mines in California & a significant portion are CV Region
- Staff started addressing pollution from abandoned mines in the early 1970s
- I started with the West Shasta mining District mines (IMM & Shasta Lake area) in 1973
- Contracted w/ USGS to do a recon survey of Redding area mines

INTRODUCTION

- **Survey showed that many large mines were discharging up to 2000 lbs of Cu & Zn into the Sacramento River & Shasta Lake each day**
- **The Central Valley Water Board initiated a regulatory program to address these mines**
- **Success has been varied – But at the 2 largest mine complexes, over 90% of the heavy metal discharges have been eliminated**




AMD
Oxygen


Stope
150 -180
feet
BANK
BANK

IMM CASE HISTORY

- **1860-90…IMM Discovered & Mined for Gold and Silver**
- **1900-20…Peak Copper Production (1000 tons/day)**
- **1930-40…Open Pit Mining(2.6 million tons gossen)**
- **1944……..Copper Cementation Plant Constructed**
- **1955-62…Stauffer Chemical Co. Purchased Mountain Copper Ltd. – Operated Cu plant**
- **1976…….Purchased by Iron Mt. Mines, Inc. RWQCB Initiated Enforcement**

Case History Cont.

- **1977-1988 - RB Litigation (Discharger IMM,Inc.)**

  -WDRs- July 1977
  -NPDES Permit-Sept. 1978
  -C&D Order-Jan. 1979
  -Referral To A.G.-July 1979
  -13305 Order-July 1981
  -Injunction (Access)-Nov.1981
  -Superior Court Fines ($16 Million)-Feb.1982
  -Stipulated Settlement ($400,000)-July 1983
  -Judgment Paid After Lien Filed-Aug. 1985
  -C&A Order Requiring IMM to Conduct Emergency Treatment-July1998
  -IMM Fails to comply
  -ACL Order adopted by RB ($250,000) Unpaid to-date
  -EPA initiates "Superfund" remedy

Abandoned Mine Presentations

- Overview, West Shasta Copper Mines, Regulatory Issues – Phil Woodward
- Sacramento Area Mines, Responsible Parties, Federal Agencies – Victor Izzo
- New Idria Mercury Mine – Ron Holcomb
- Mercury contamination from mining in the Sierra Nevada – Rick Humphreys
- Summary – Jim Pedri

Overview of Abandoned Mines

West Shasta Copper Mining District

Regulatory Issues

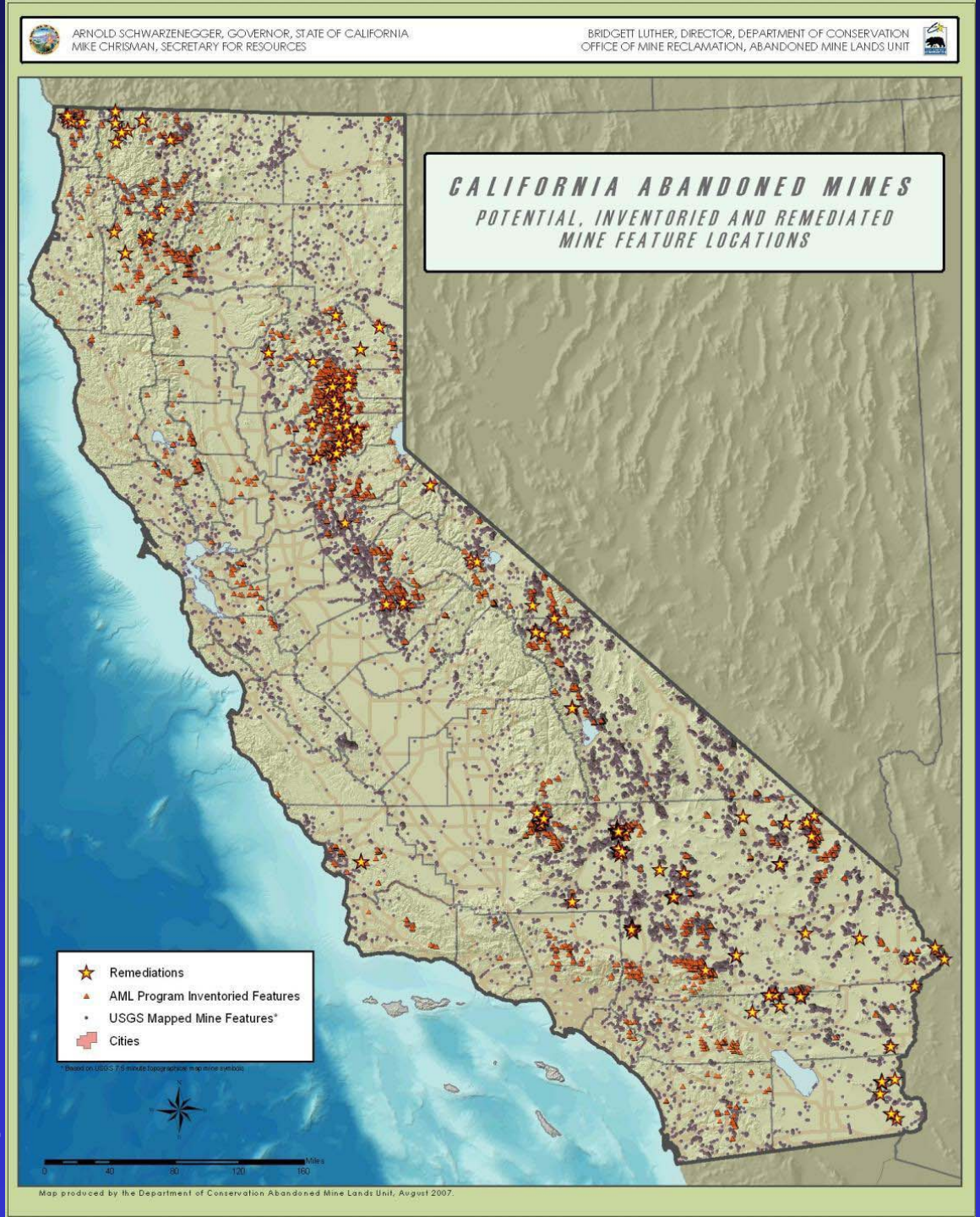
By

Philip Woodward
Senior Engineering Geologist
Central Valley Regional Water Quality Control Board

Definition Of Abandoned Mine

Surface Mining And Reclamation Act
Section 2779(h)(6)

- Mining activities have ceased for a year
- Site not reclaimed to regulatory standards
- Environmental and/or physical hazards remain
- Does NOT mean there is no identifiable property owner


ARNOLD SCHWARZENEGGER, GOVERNOR, STATE OF CALIFORNIA
MIKE CHRISMAN, SECRETARY FOR RESOURCES
BRIDGETT LUTHER, DIRECTOR, DEPARTMENT OF CONSERVATION
OFFICE OF MINE RECLAMATION, ABANDONED MINE LANDS UNIT
CALIFORNIA ABANDONED MINES
POTENTIAL, INVENTORIED AND REMEDIATED
MINE FEATURE LOCATIONS
Remediations
AML Program Inventoried Features
USGS Mapped Mine Features*
Cities
* Based on USGS 7.5-minute topographical map mine symbols
0
40
80
120
160
Miles
Map produced by the Department of Conservation Abandoned Mine Lands Unit, August 2007.

Abandoned Mines In Central Valley Region

- Includes historic copper, zinc, gold, mercury mines
- Pollutants include acid, arsenic, cadmium, copper, lead, mercury, zinc (other metals such as aluminum, iron, etc), reagents
- WQ impacted by direct discharge, storm water runoff & materials deposited in drainage courses

Abandoned Mines In Central Valley Region

- Human health problems include exposure to arsenic, cadmium & lead from exposed tailings & overburden, mercury residue from gold recovery (present in hydraulic mines and dredge tailings) & mercury from tailings at mercury mines

Abandoned Mines In Central Valley Region

(Feinstein List)

- 117 Priority Mines State Wide (Environmental Hazards)
- 86 Priority Mines in Central Valley
- 62 with water quality issues
- 8 need $10-100 million each to remediate
- 29 need $1-10 million each to remediate
- 25 need <$1 million

Abandoned Mines In Central Valley Region

- Many of the mines have not operated for decades (some over 100 years)
- Many located in remote areas with limited access
- Many located where no electrical power

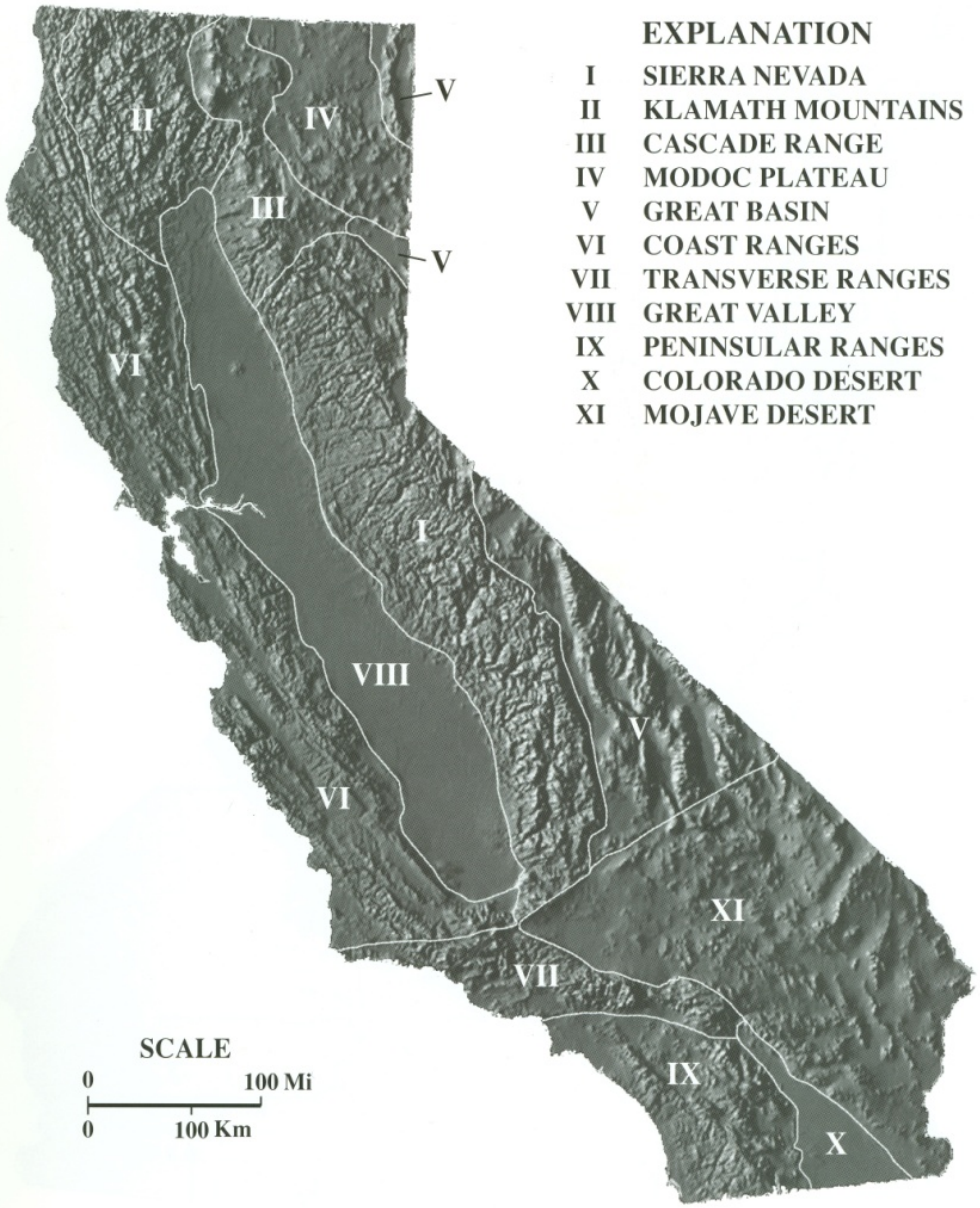


Figure A2. Physiographic provinces of California. Provinces include: I, Sierra Nevada; II, Klamath Mountains; III, Cascade Range; IV, Modoc Plateau; V, Great Basin (Basin and Range); VI, Coast Ranges; VII, Transverse Ranges; VIII, Great Valley; IX, Peninsular Ranges; X, Colorado Desert; XI, Mojave Desert. Base from Thelin, G.P., and Pike, R.J. 1991, Landforms of the conterminous United States—a digital shaded-relief portrayal: U.S. Geological Survey Miscellaneous Investigations Series Map I-2206, scale 1:2,500,000.

Physiographic provinces of California

from Ashley (1998) in DTSC Preliminary Assessment Handbook

Presented by
Dr. Charlie Alpers, U.S.G.S
Geology Symposium 2009

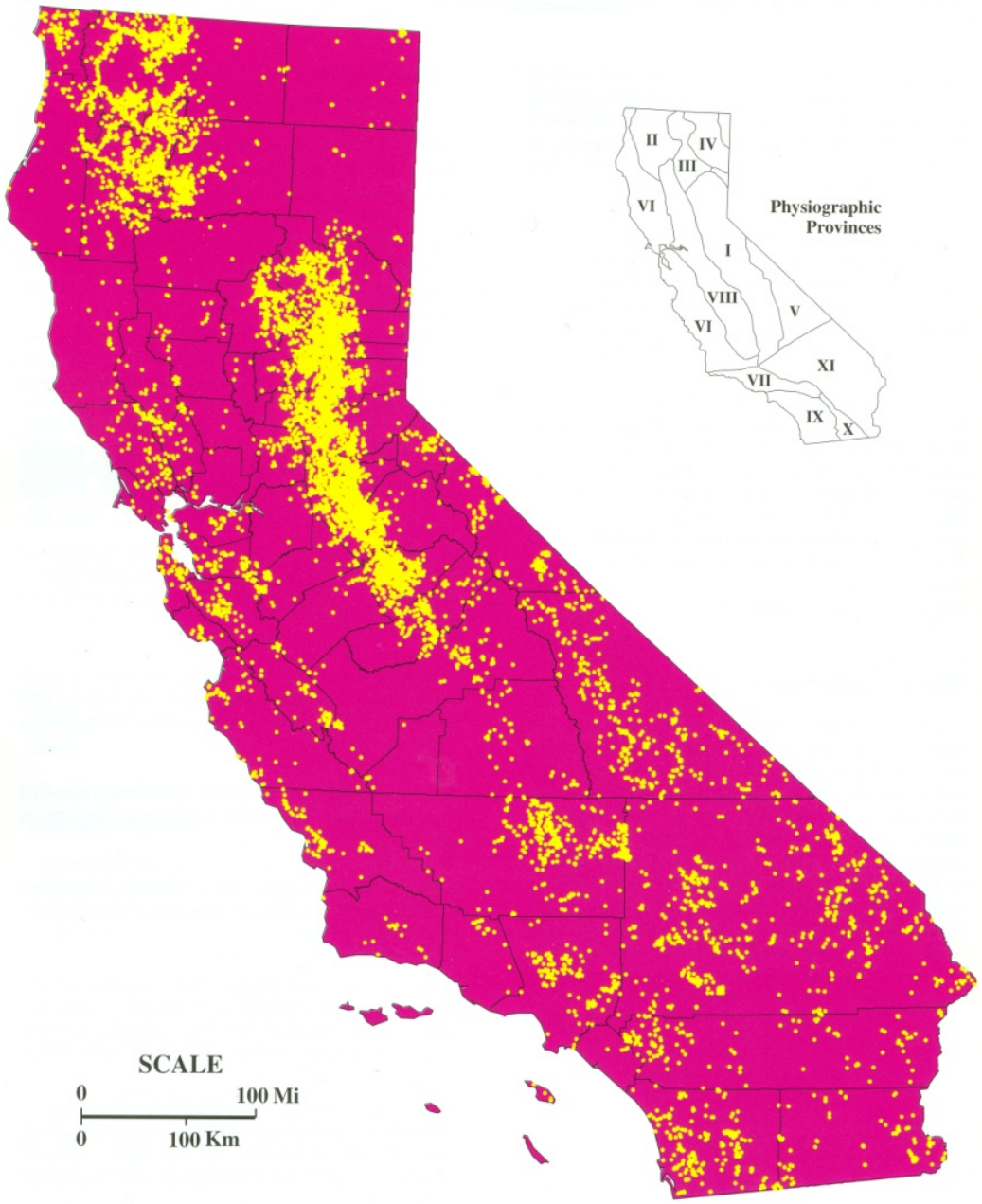


Figure A1. Map of California showing locations of past and present mines with recorded mineral production, including metallic commodities, industrial minerals, and some construction commodities. Fuel minerals are not included. Data primarily from U.S. Geological Survey, Mineral Resource Data System (MRDS) database, supplemented with selected data from Mineral Industry Location System (MILS) database (formerly maintained by U.S. Bureau of Mines, now maintained by U.S. Geological Survey). Data set depicted does not include all small and intermittent producers, and is known to be incomplete with respect to sand and gravel, aggregate, and stone.

Locations of past and present mines in California

Approx. 47,000 abandoned mines (Calif. Dept. of Conservation and USGS databases)

from Ashley (1998) in DTSC Preliminary Assessment Handbook

Presented by
Dr. Charlie Alpers, U.S.G.S
Geology Symposium 2009

Figure A5. Map of California showing locations of mines that produced mainly mercury. Data from U.S. Geological Survey, Mineral Resource Data System (MRDS) database. Data set depicted is known to be incomplete with respect to small producers.

Distribution of mercury mines

Calif. Coast Range mines account for approx. 75% of Hg production in North America (1850s -1960s) (Rytuba, 2003)

from Ashley (1998) in DTSC Preliminary Assessment Handbook

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Distribution of lode gold mines

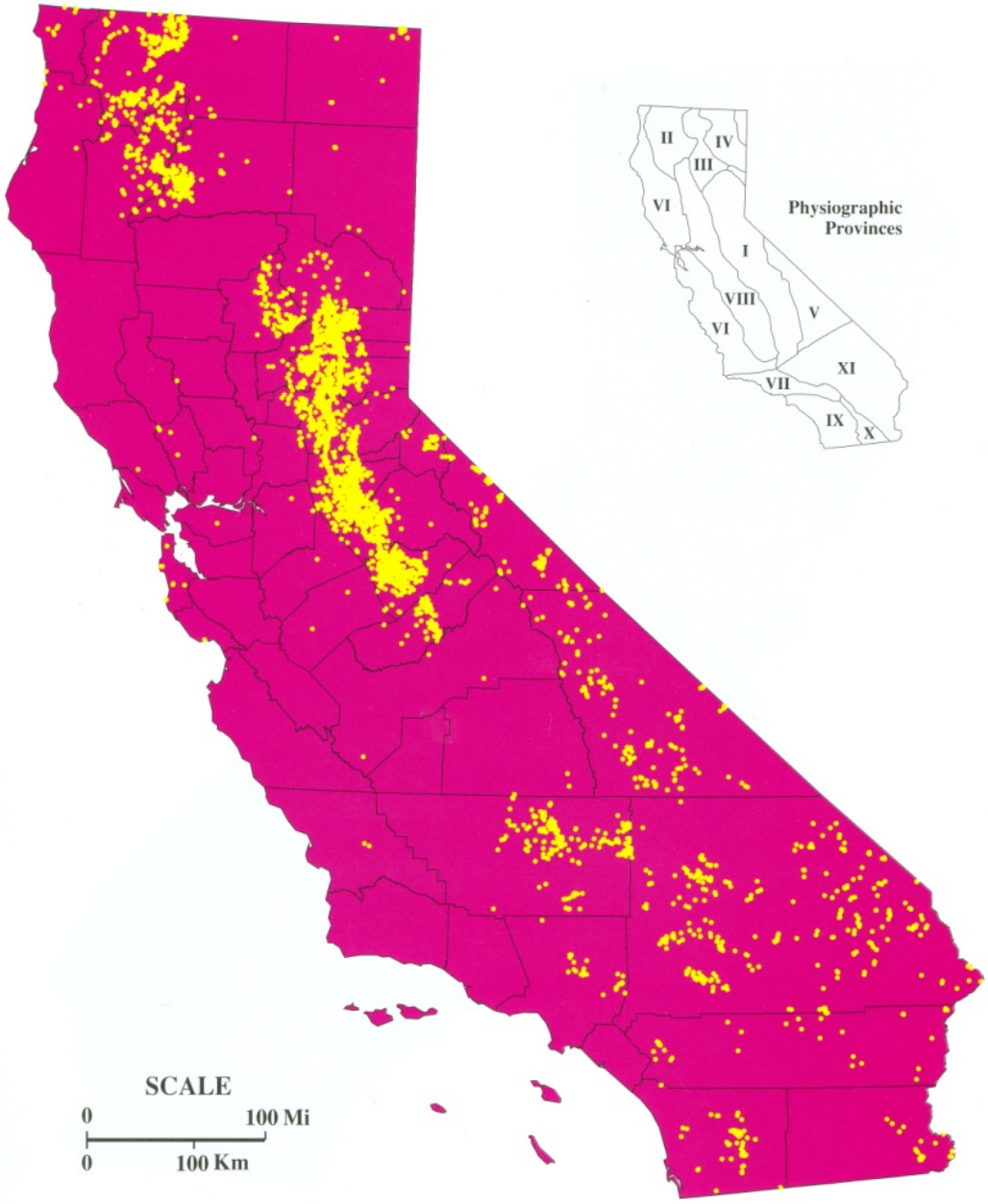

Figure A3. Map of California showing locations of lode gold mines with recorded production. Data from U.S. Geological Survey, Mineral Resource Data System (MRDS) database.

from Ashley (1998) in DTSC Preliminary Assessment Handbook

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Dr. Charlie Alpers, U.S.G.S
Geology Symposium 2009

Figure A4. Map of California showing locations of mines that produced base metals (primarily copper, lead, or zinc), with or without silver. Either base metals or silver may account for the majority of production value. Many mines shown here produced gold as a byproduct; mines in which gold value predominates, however, are shown on Figure A3. Data from U.S. Geological Survey, Mineral Resource Data System (MRDS) database.

Distribution of base metal mines (Pb, Zn, Cu)

Largest are VMS deposits in Klamath Mtns. (West Shasta mining district) and western Sierra Nevada (Foothill Zn-Cu Belt)

from Ashley (1998) in DTSC Preliminary Assessment Handbook

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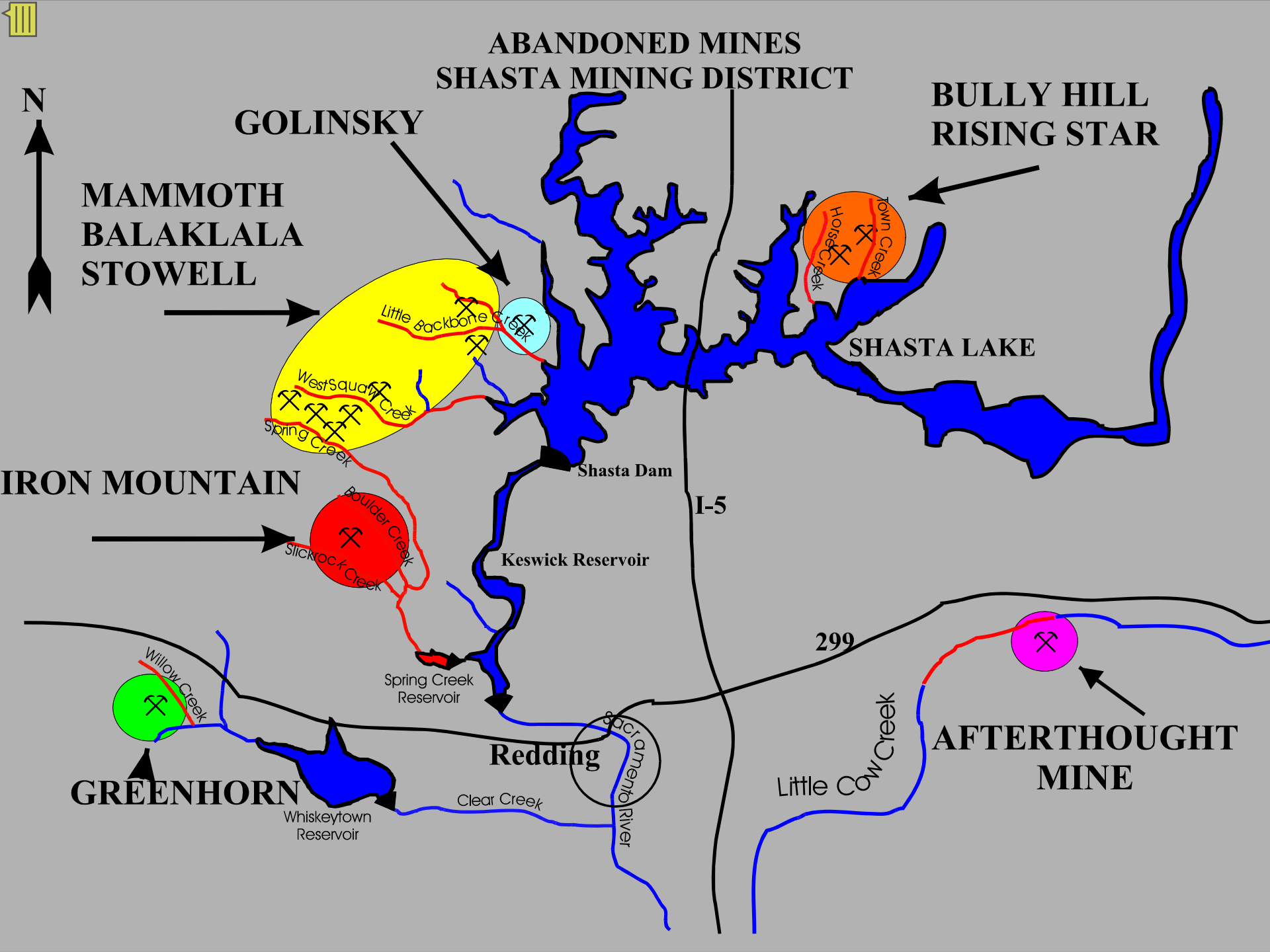
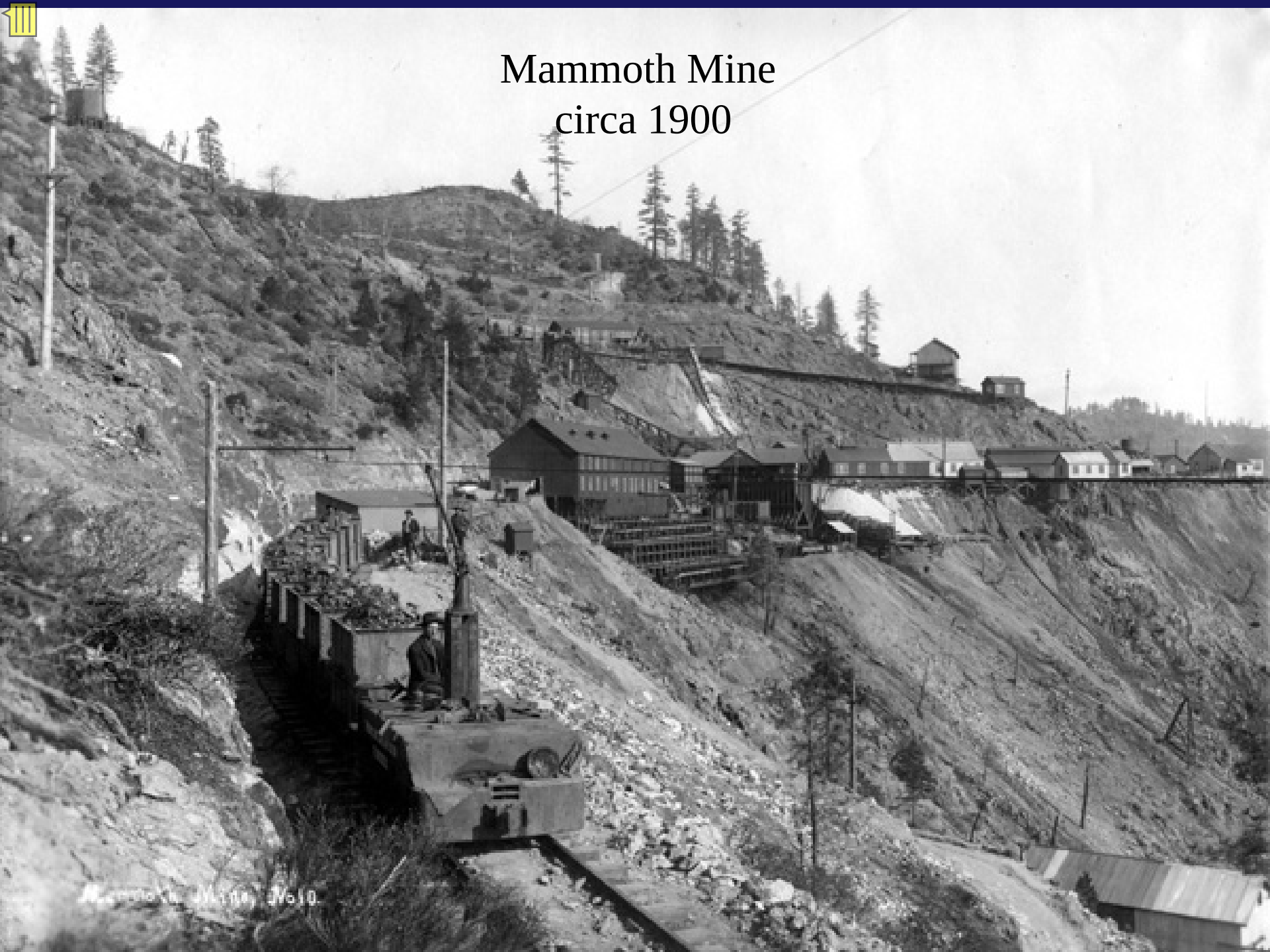
Geology Symposium 2009

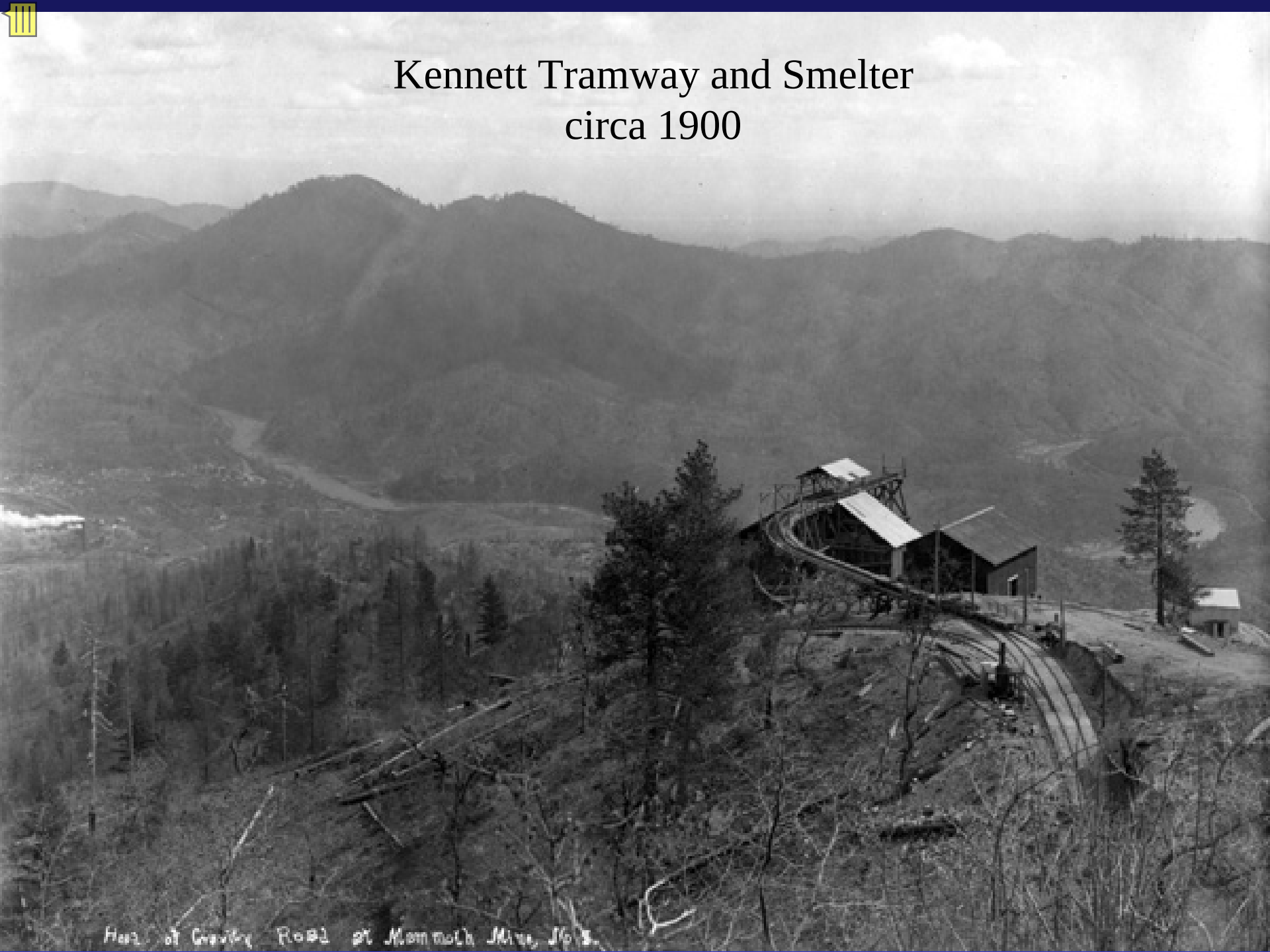

ABANDONED MINES
SHASTA MINING DISTRICT
N
GOLINSKY
BULLY HILL
RISING STAR
MAMMOTH
BALAKLALA
STOWELL
Little Backbone Creek
West Squaw Creek
Spring Creek
Horsetown Creek
SHASTA LAKE
IRON MOUNTAIN
Boulder Creek
Slickrock Creek
Shasta Dam
I-5
Keswick Reservoir
299
Willow Creek
Spring Creek
Reservoir
Redding
Sacramento River
Little Cow Creek
AFTERTHOUGHT
MINE
GREENHORN
Whiskeytown
Reservoir
Clear Creek

Mammoth Mine
circa 1900

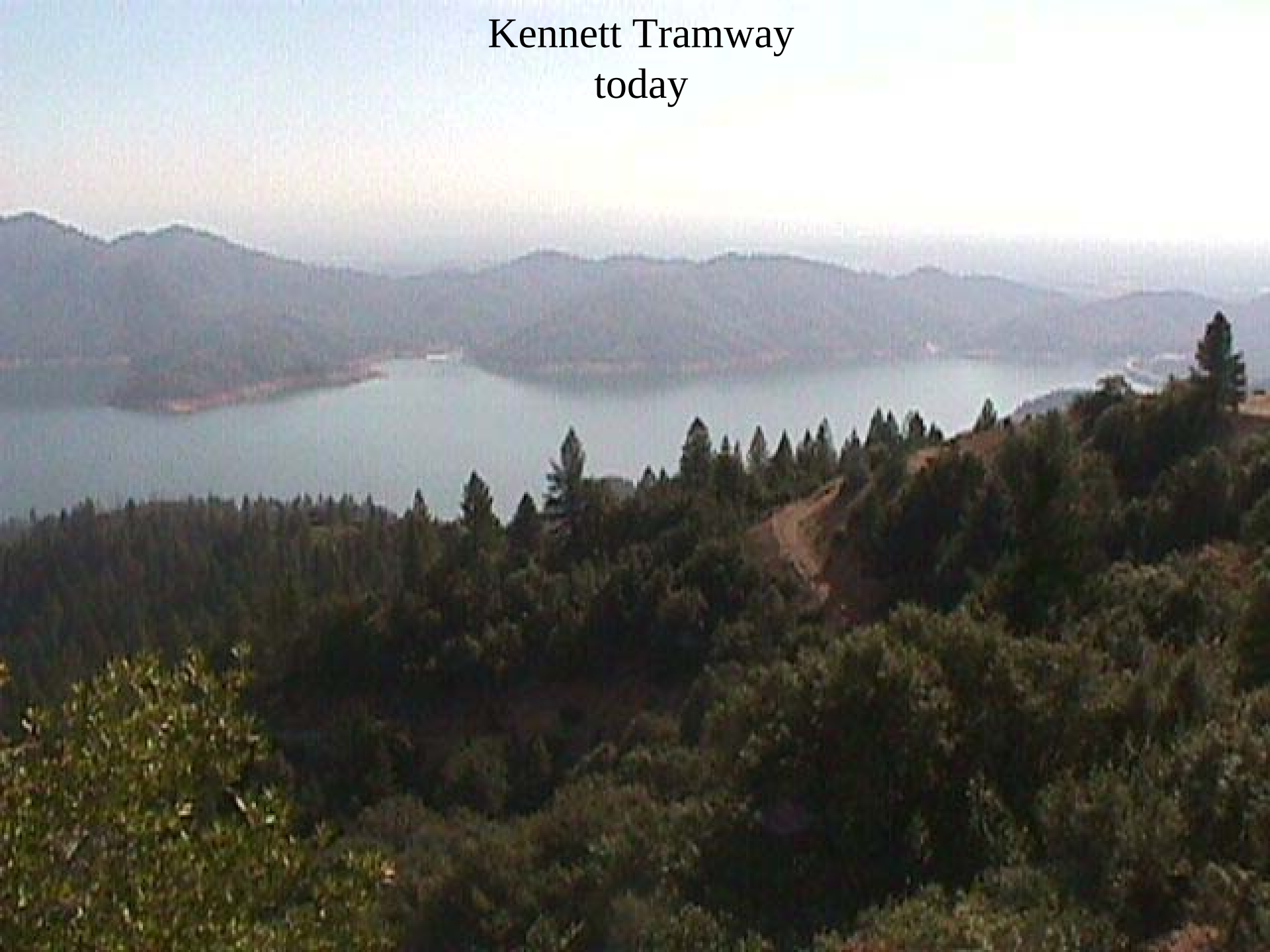



Mammoth Mine
today

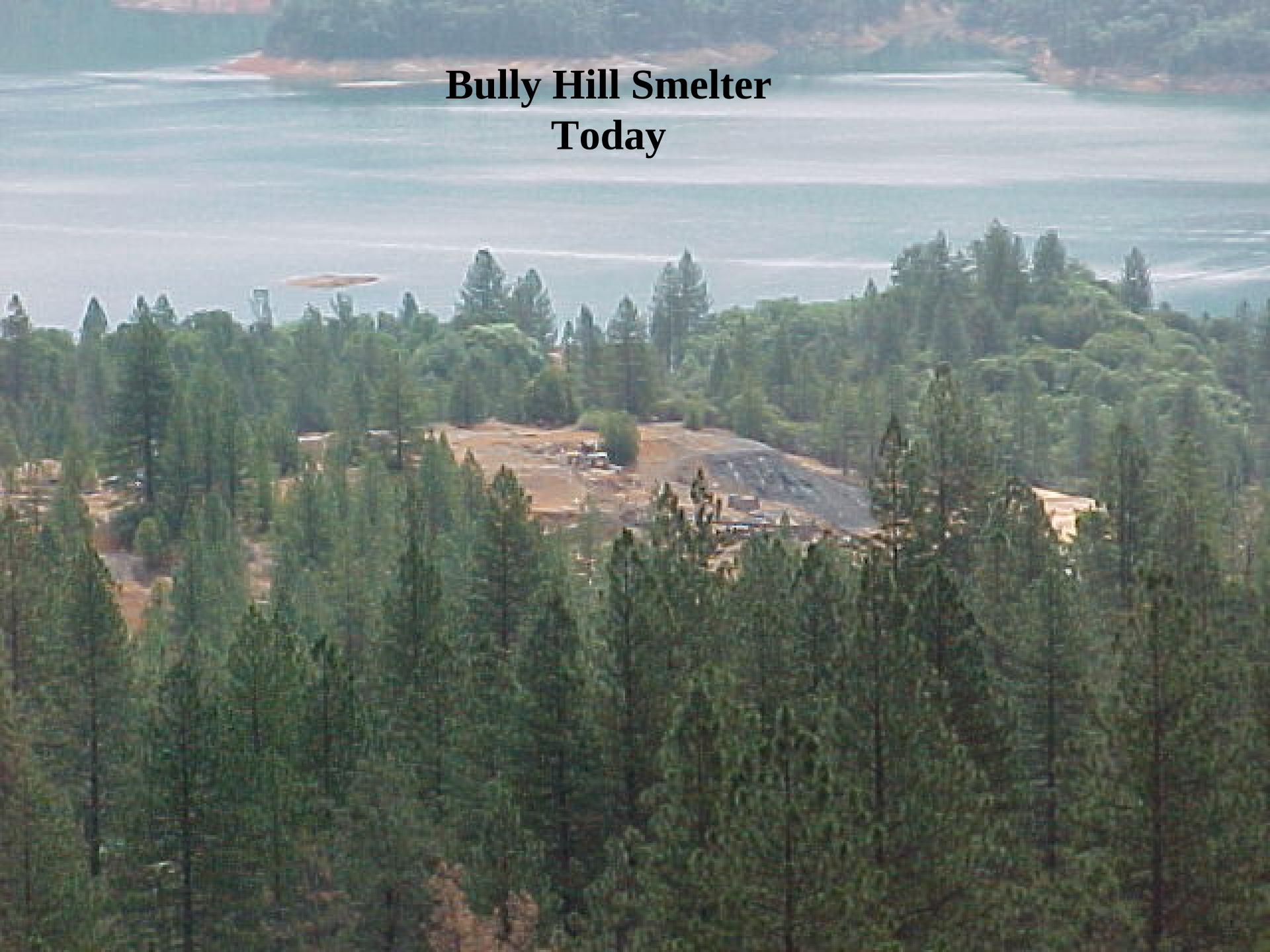
Kennett Tramway and Smelter
circa 1900



Kennett Tramway
today



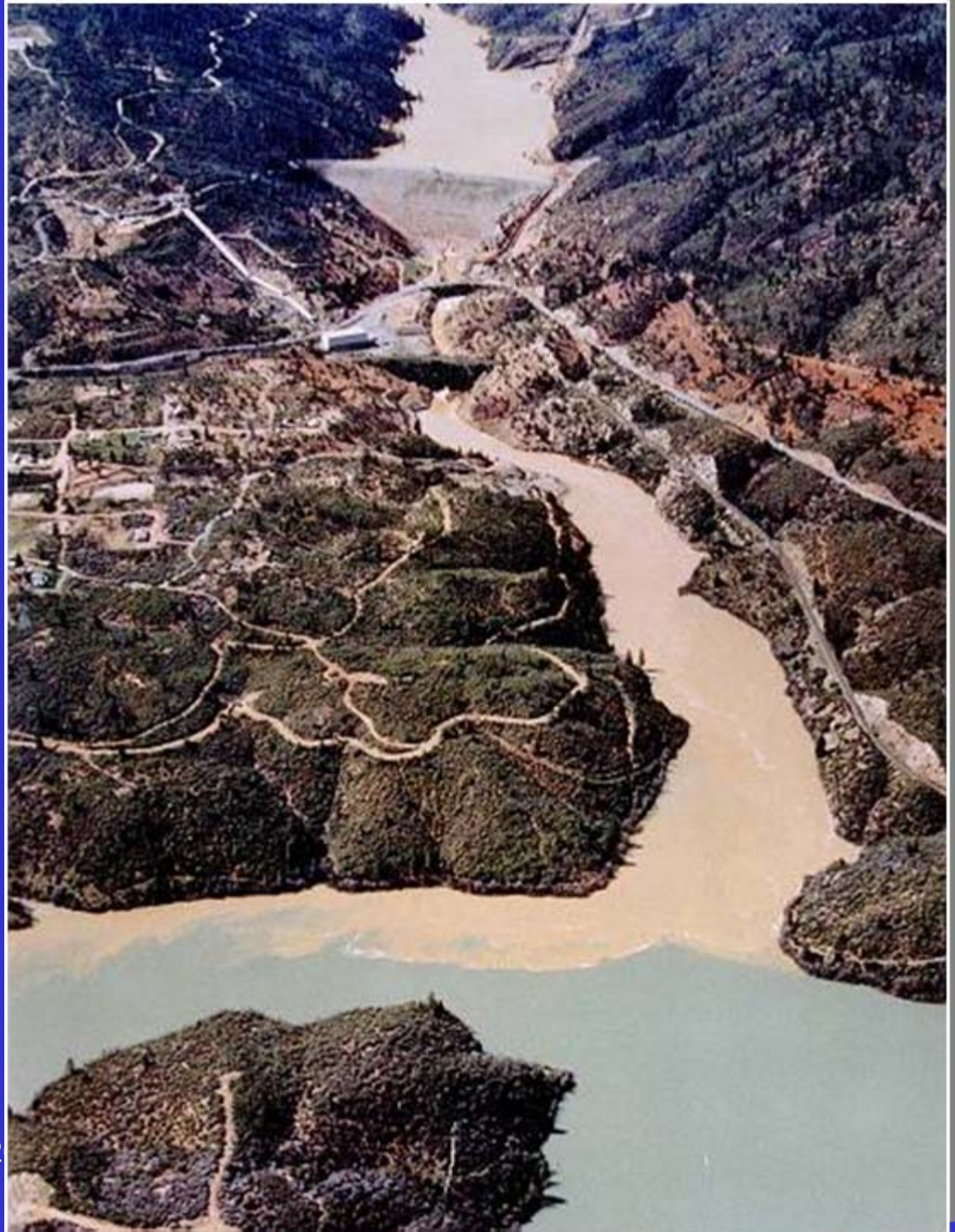

Bully Hill Smelter
Circa 1910


Bully Hill Smelter
Today

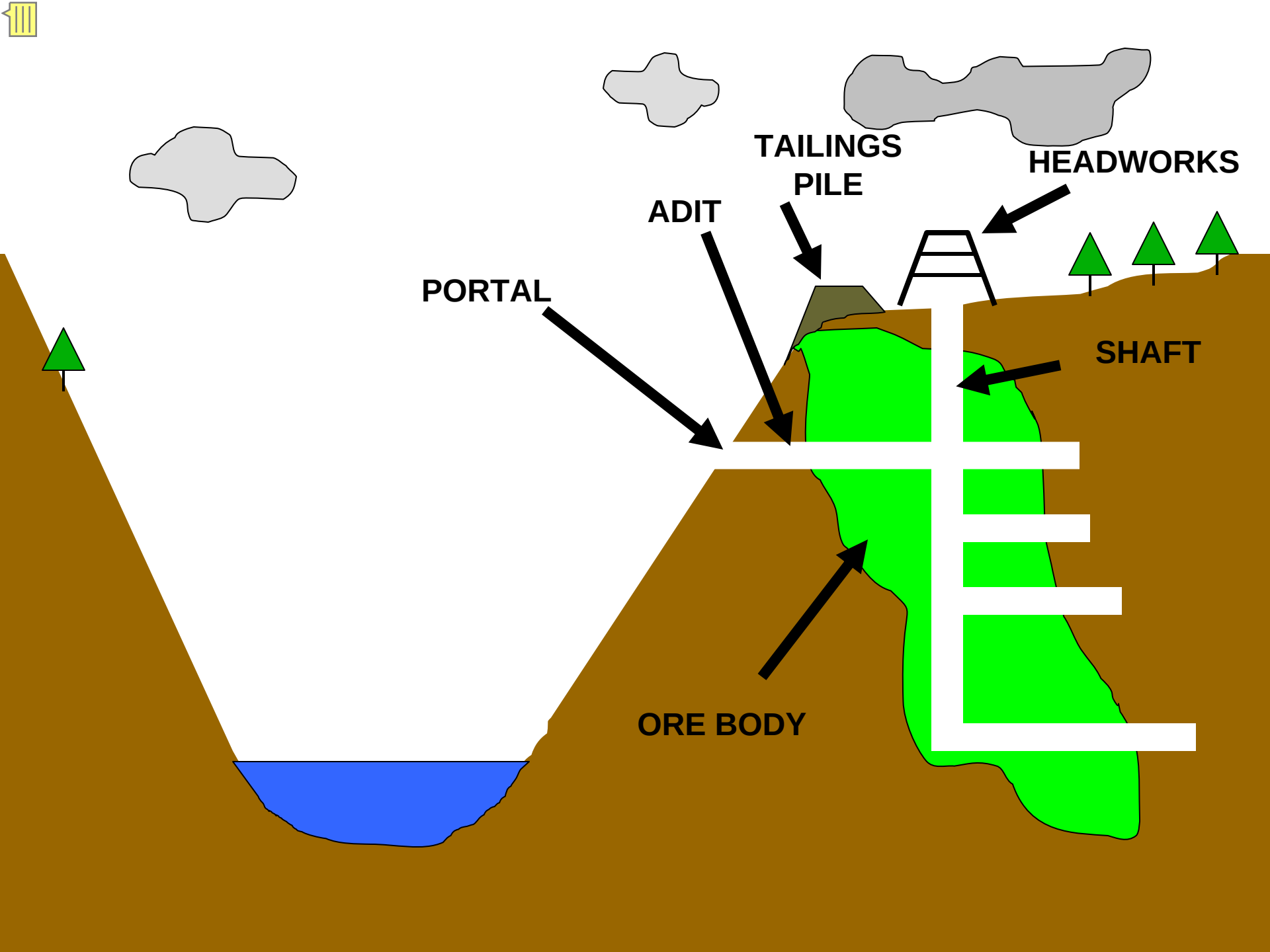
Abandoned Mines In Central Valley Region – Copper Mines

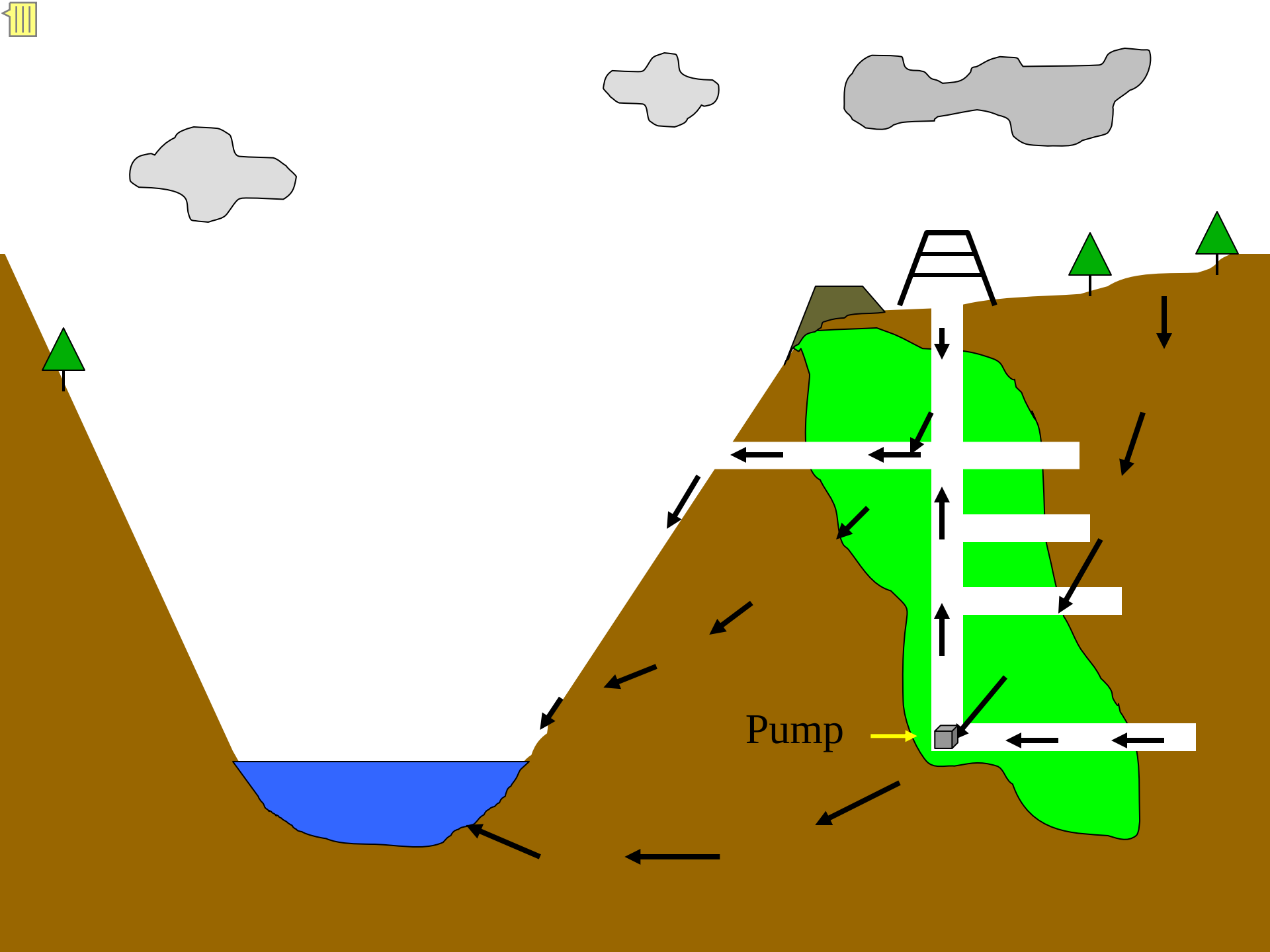
- Abandoned copper mines largest volume discharged from mines
- Generally pose greatest local impact & magnitude of discharges
- Variability in the impacts of discharges
  - Small discharges may not affect beneficial uses
  - Many discharges significantly affect beneficial uses
  - Non-point source components may significantly affect beneficial uses (even after remediation)

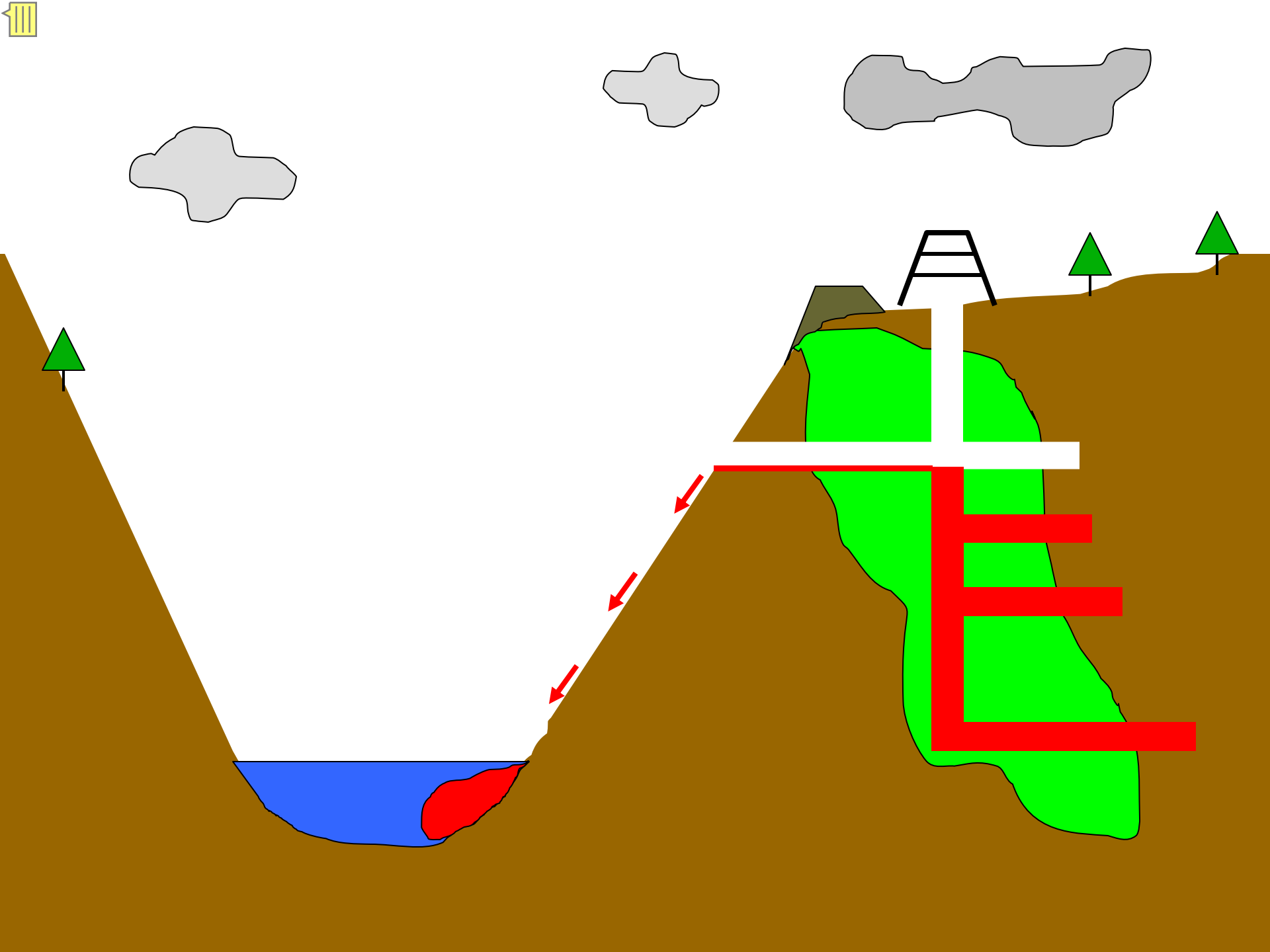
Acid Mine Discharge at IMM

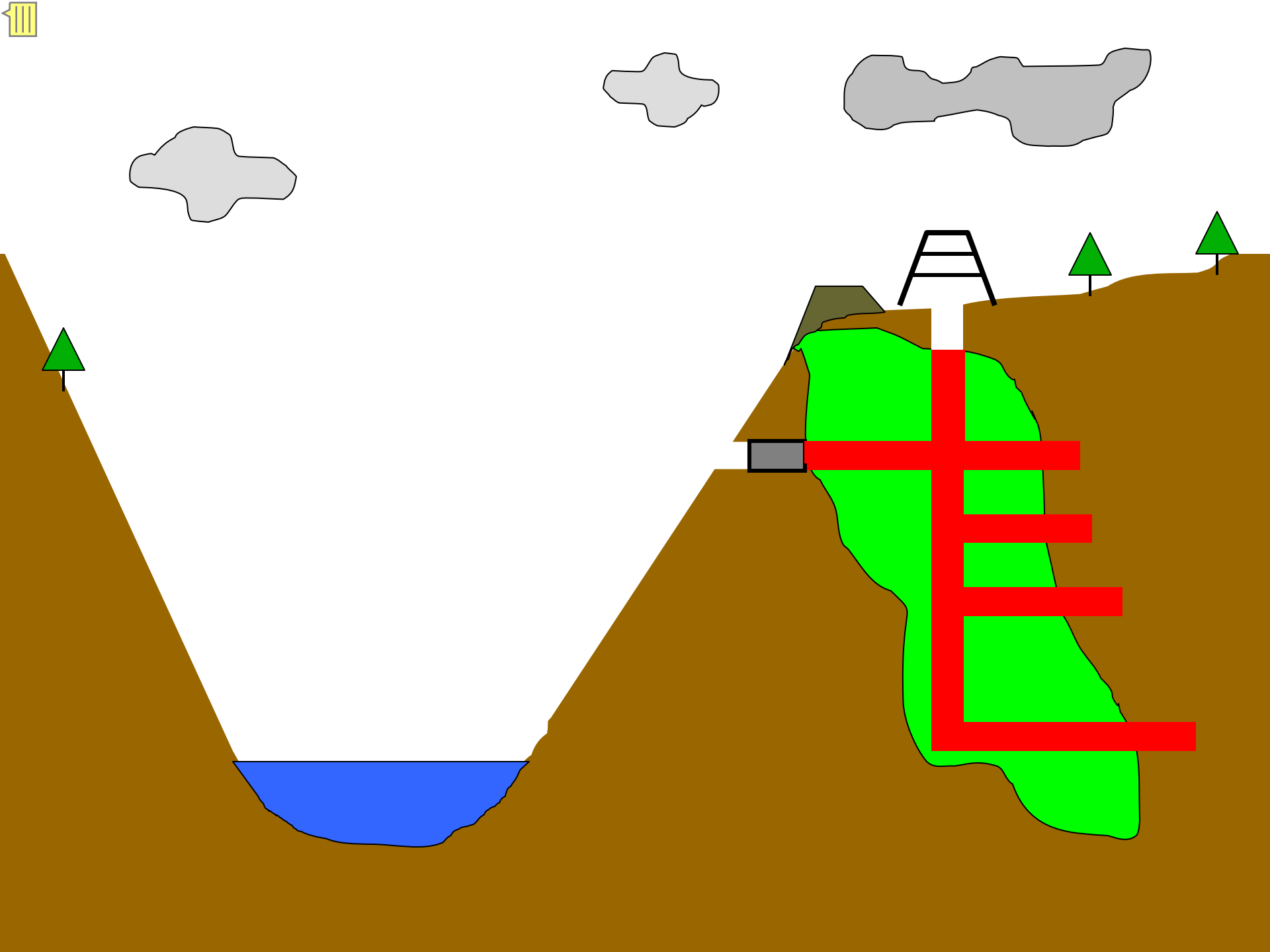


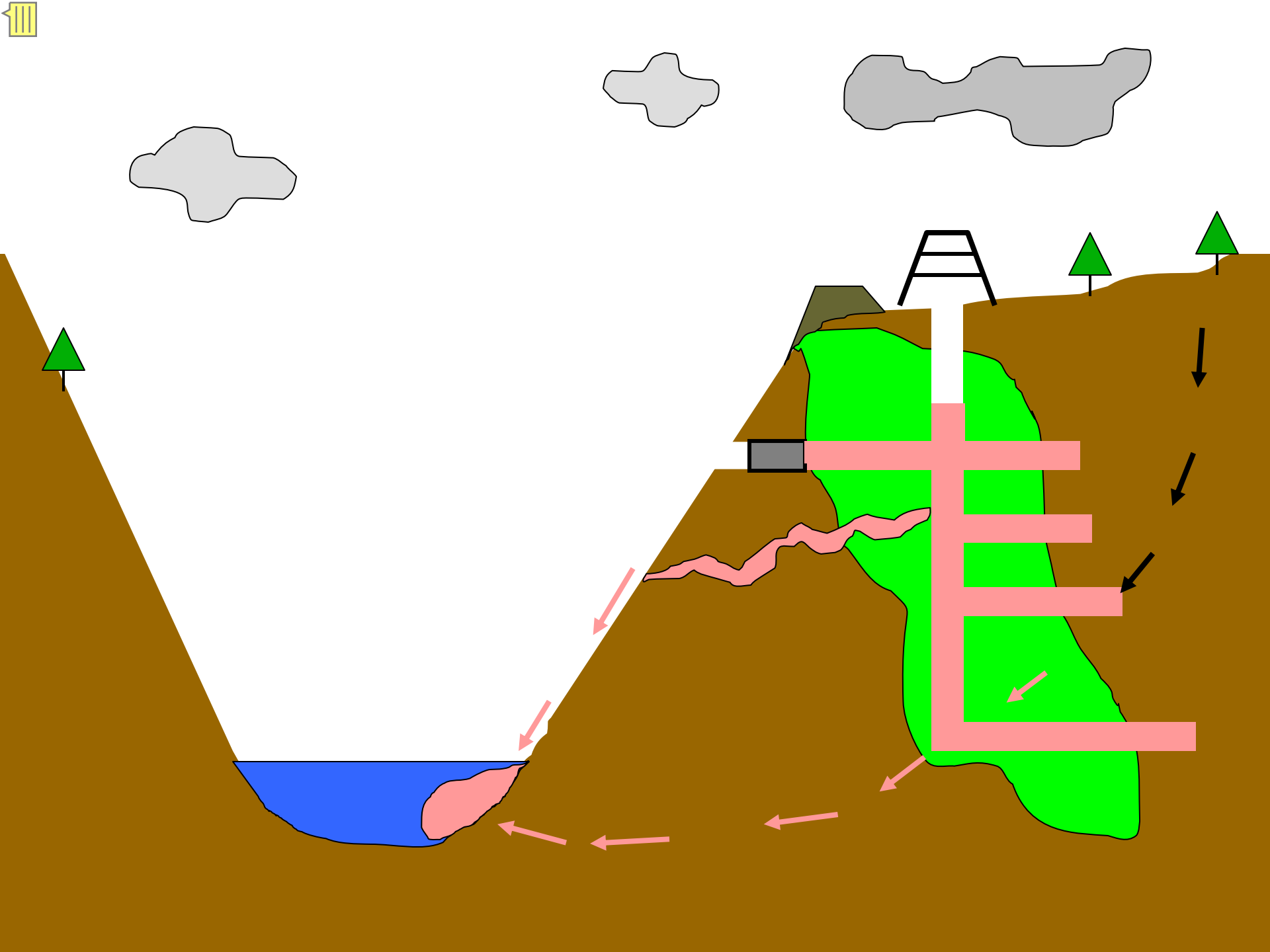
Source Of Pollutants


TAILINGS
PILE
HEADWORKS
ADIT
PORTAL
SHAFT
ORE BODY


Pump

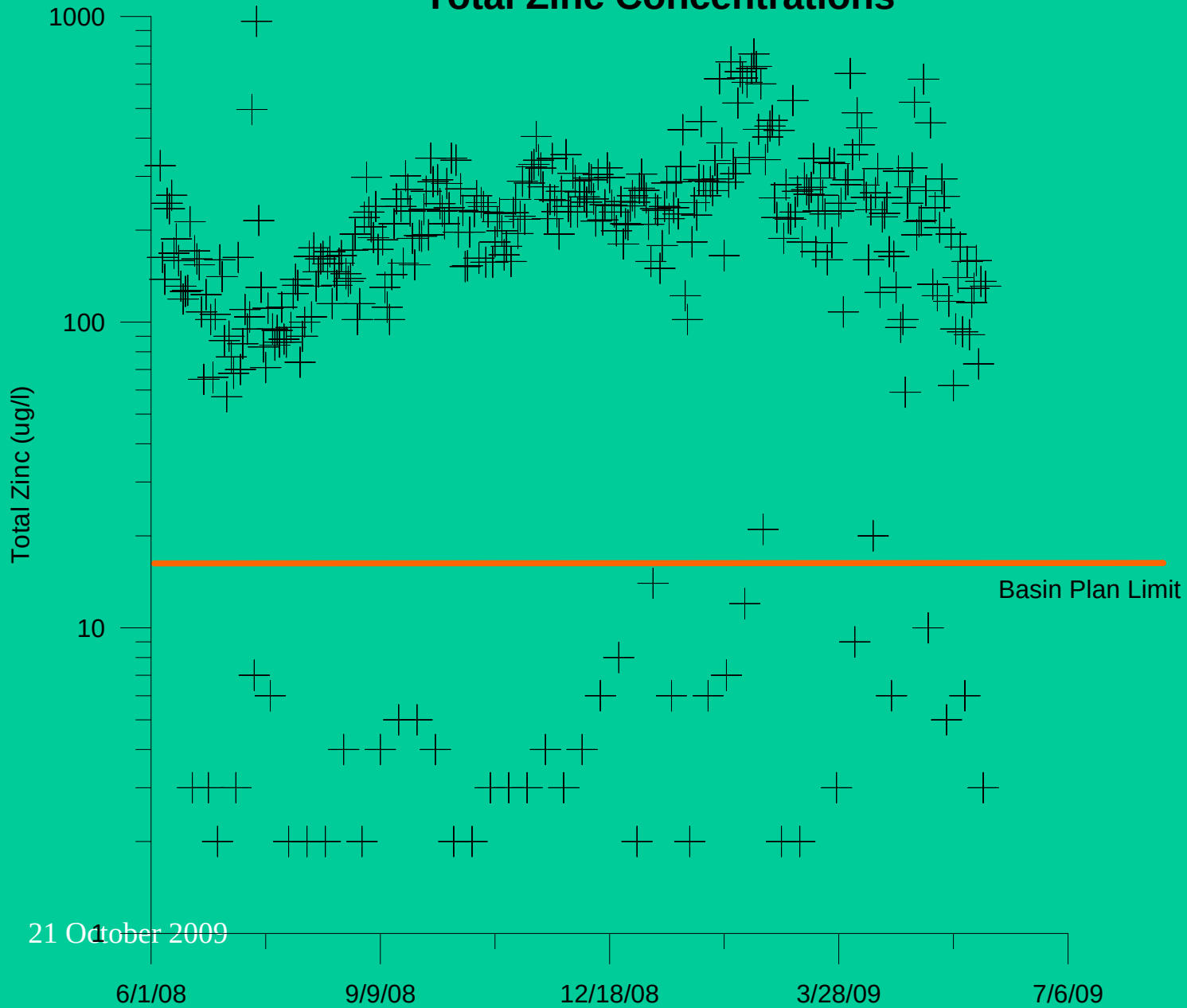


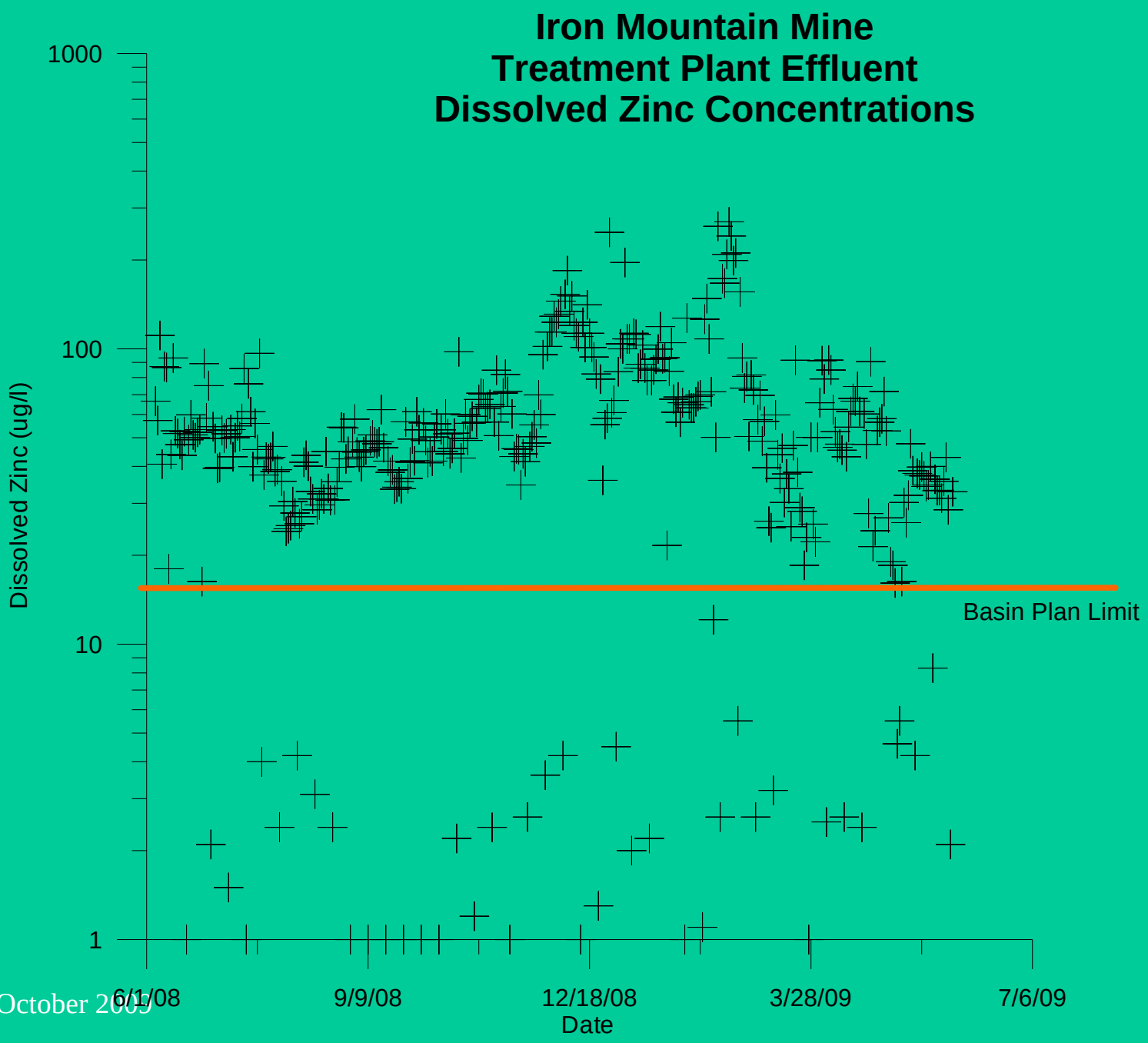




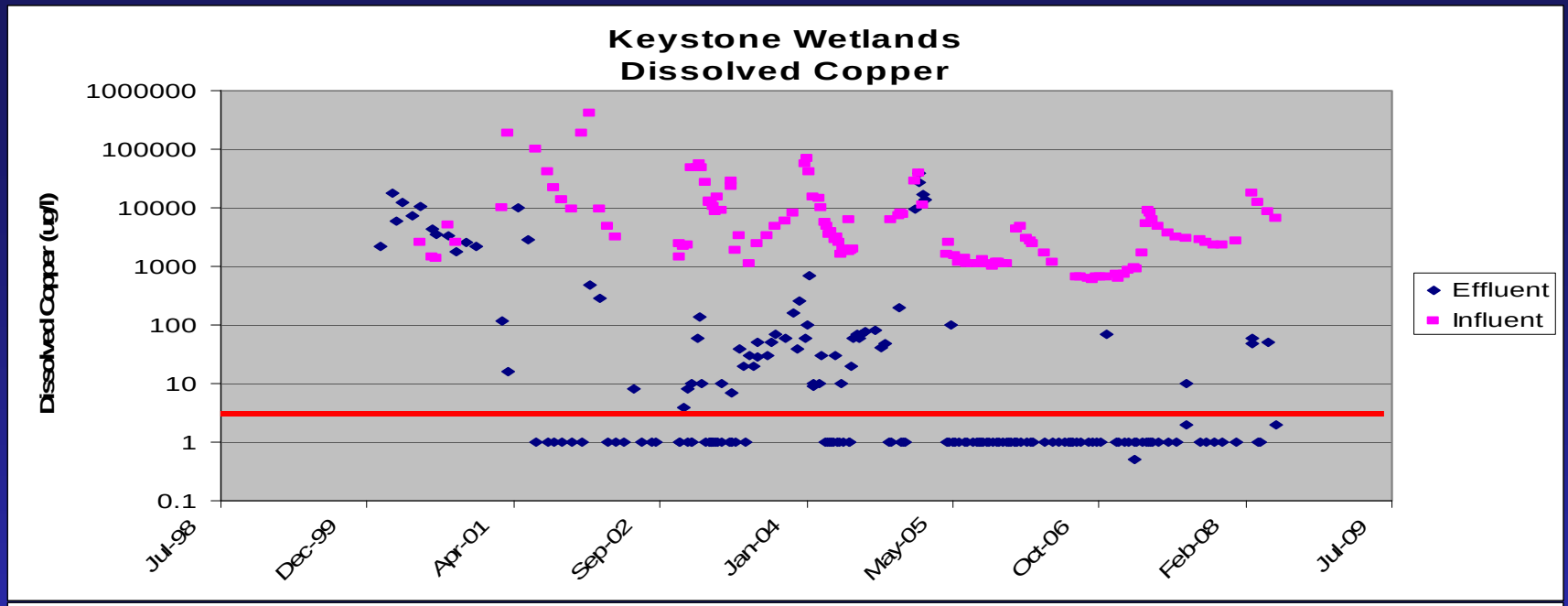
Cleanup Activities

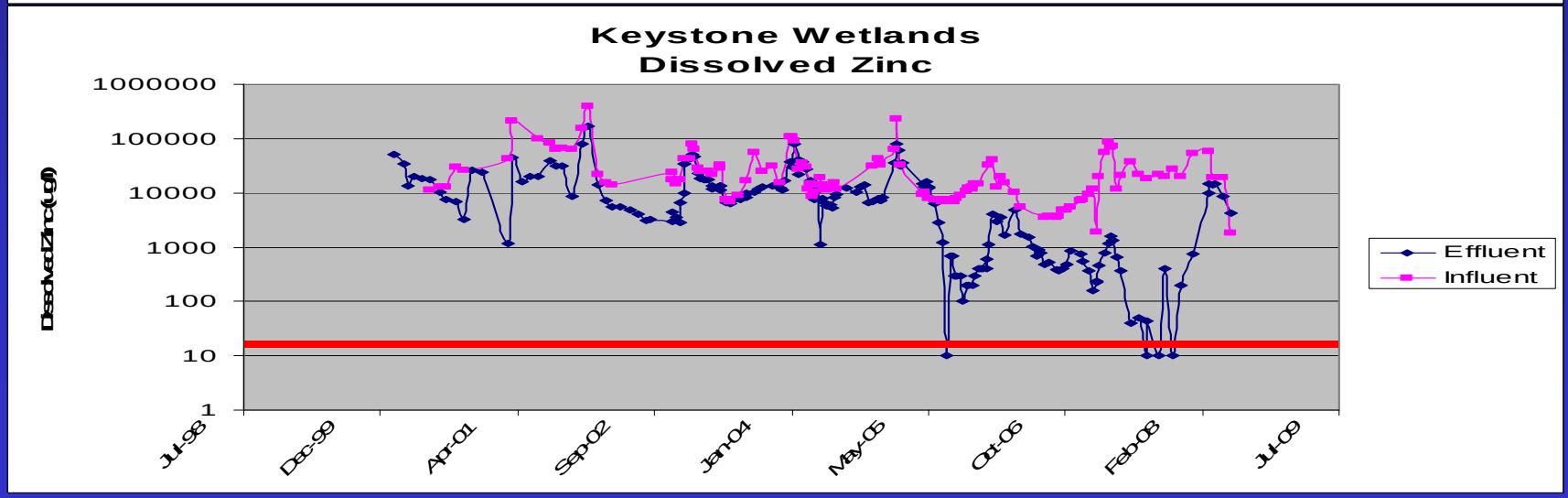
Iron Mountain Mine
Treatment Plant Effluent
Total Zinc Concentrations

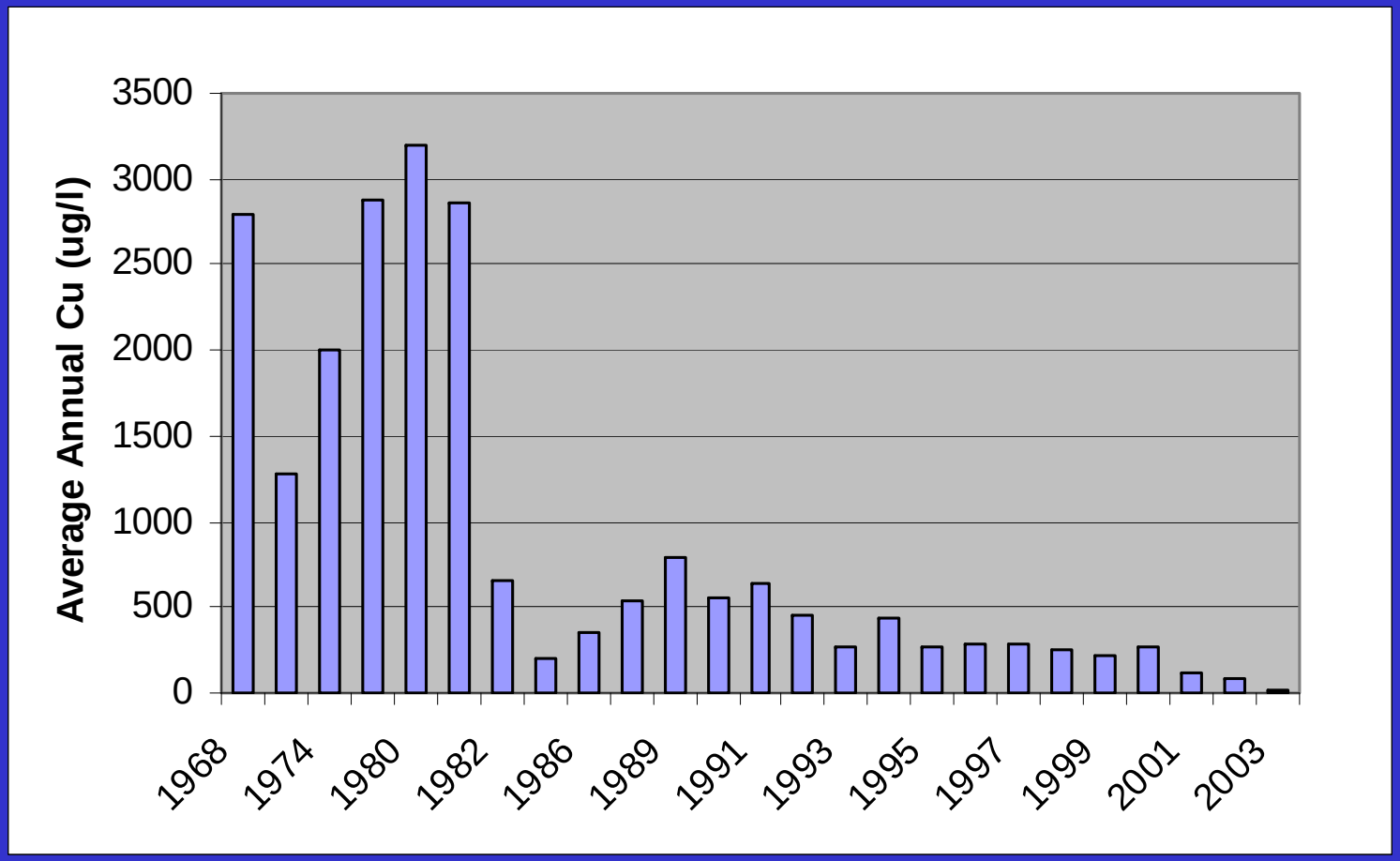



Iron Mountain Mine
Treatment Plant Effluent
Dissolved Zinc Concentrations
1000
100
10
1
Dissolved Zinc (ug/l)
Basin Plan Limit
6/1/08
9/9/08
12/18/08
3/28/09
7/6/09
Date


81 11 29


Keystone Wetlands
Dissolved Copper
Dissolved Copper (ug/l)
1000000
100000
10000
1000
100
10
1
0.1
Jul-98
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Effluent
Influent


Keystone Wetlands
Dissolved Zinc
1000000
100000
10000
1000
100
10
1
Jul-98
Dec-99
Apr-01
Sep-02
Jan-04
May-05
Oct-06
Feb-08
Jul-09
Effluent
Influent



Effectiveness of BMPs Controlling Mine Drainage in West Squaw Creek, Shasta County

Past Regulatory Approach

- 1975 to early 1980s - WDRs
- 1980s to early 1990s - NPDES permits with numeric effluent limits for active mines or a percent reduction of AMD from portals
- Late 1990s - NPDES permits with narrative effluent limits (99% removal), BMP requirements

West Squaw Creek Mines

- Successful in reducing discharges from most mine portals over 99 %
- Reduced metal loading to streams 90 %
- Eliminated fish kills in Shasta Lake
- Restored reach of West Squaw Creek to support fishery
- Most of creek cannot support fishery
- Cost $12 million

EPA Superfund Approach (Iron Mountain Mine)

- USEPA Superfund remediation
- Successful in reducing discharges from mine portals over 99 %
- Reduced metal loading to streams 98 %
- Virtually eliminates risk of toxicity in Sacramento River.
- Local streams will not support fisheries
- Cost over $300 million +

Abandoned Mine Effluent Highly Variable

- Volume and concentration of discharge and receiving waters varies widely
  - Varies with season
  - Highly influenced by precipitation events
  - Changes can be large and rapid
- Passive treatment system effectiveness varies with
  - ambient temperature
  - Influent concentration
  - Influent volume

Abandoned Mine Effluent

- Unlike traditional discharges (POTW, Industrial), abandoned mine discharges
  - Controlled by nature
  - Many in remote areas with limited access and no infrastructure making treatment challenging
  - Cannot stop waste generation process

Long Term Projects

Regional board staff and dischargers working on sites for 25 years and still cannot consistently meet effluent limits

- Iterative process
- New methodologies continually being developed (constructed wetlands, treatment systems, anoxic limestone drains, sulfate reducing bio-reactors, etc)

Impacts on Beneficial Uses

Many watercourses impacted by abandoned mines cannot meet water quality objectives or support assigned beneficial uses

- Naturally mineralized areas with non-point sources of pollutants
- Beneficial Uses assigned without full appreciation of problem
- Changing assigned Beneficial Uses to match reality is complex and time consuming
  - Perform Use Attainability Analyses
  - Develop Site Specific Water Quality Objectives
  - Adopt Basin Plan Amendment
- Started UAA and BPA 10 years ago
- Regional Board adopted UAA and BPA in 2004
- Staff still working with other agencies for final version

Differences in Regulatory Processes

- U.S. EPA Superfund Program
  - Iron Mountain Mine
    - Discharge from treatment plant cannot meet WQBELS (cadmium, zinc, etc)
    - Watercourses do not meet water quality objectives or support designated beneficial uses
    - Superfund can waive requirements
    - No permits required

Summary

- Abandoned mine discharges and remediation highly complex
- Large scale pollutant sources and impacts
- Each mine has unique problems and issues requiring individual approaches

SUMMARY

- There are thousands of abandoned mines in California & a significant portion are CV Region
- Of the 117 mines posing the greatest environmental threat, 86 are in the CV Region
- The presentations today reflect the varied impacts to WQ and human exposure
- Remediation of abandoned mines is very costly and determining responsible parties is difficult

SUMMARY

- **Enforcement actions are usually required & such actions pose a unique challenge for mines on federal lands**
- **“State of the art” remedies at mines with varied & continuous discharge cannot meet NPDES criteria**
- **Media exposure and public perception of WQ issues at some mines is sometimes greater than the real threat**

CONCLUSION

- **Cleanup of abandoned mines must be a state priority**
- **Mines posing the greatest threat to WQ and/or human exposure should be remediated first – updated priority list**
- **A ”practical” or BMP approach is best for many of the mines in remote locations – “a one size fits all” approach will not work**
- **Consider a funding source for extensive title, PRP searches & field sampling**

CONCLUSION

- **Increased coordination & cooperation with federal land management agencies to require cleanup – develop a legal strategy if coordinated approach fails**
- **Increased utilization of tools in CWA & CWC (UAAs etc.)**
- **Seek additional "Good Samaritan" legislation to assist agencies and PRPs**
- **Insufficient staff resources currently available for the task**