

Blending Historical Mapping with Lidar: Barker-Hughesville Site Example

Mine Design, Operations, and Closure Conference

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May 5, 2016



**CDM
Smith.**



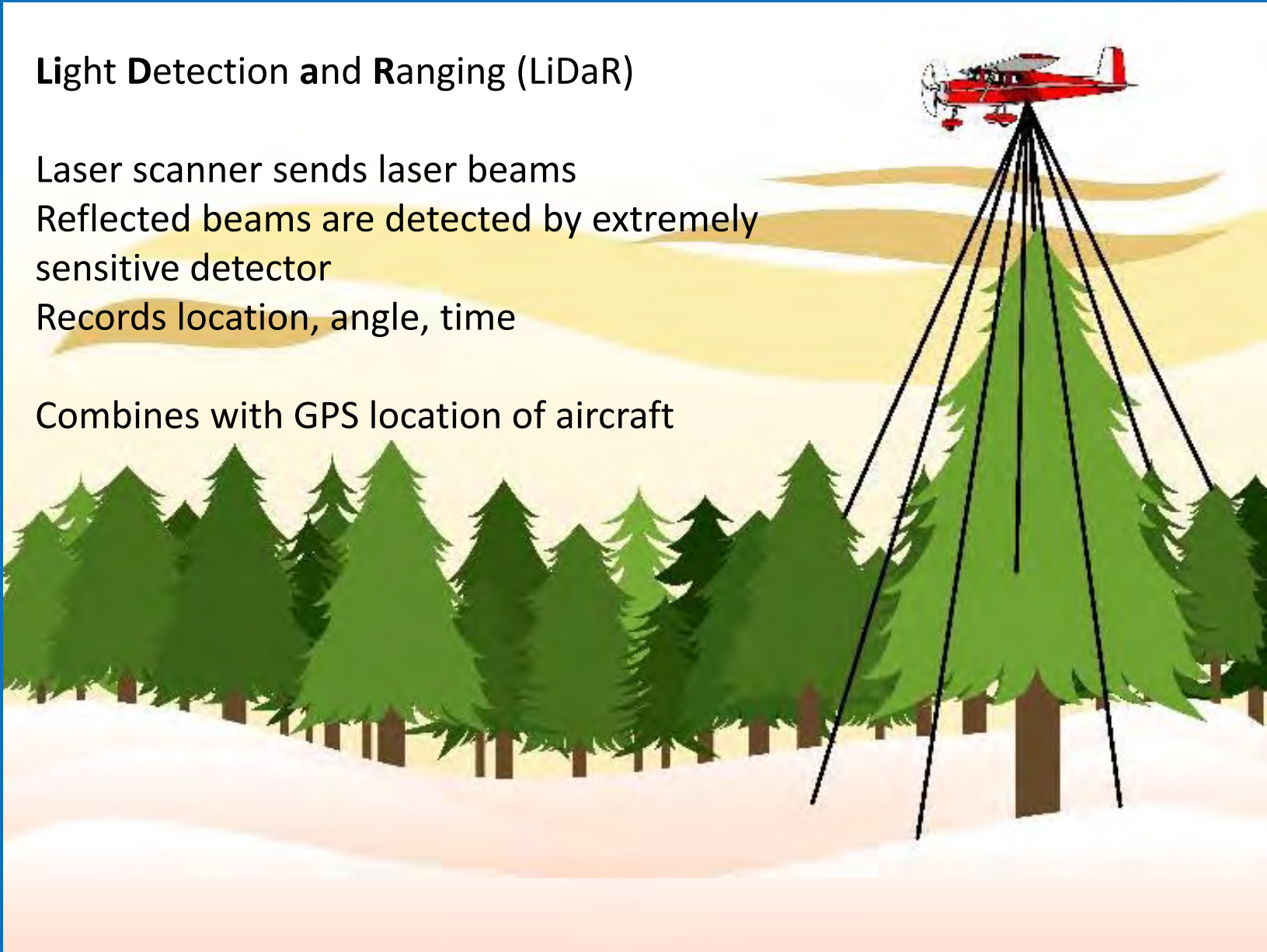
Overview of Lidar

Overview of Lidar

Light Detection and Ranging (LiDaR)

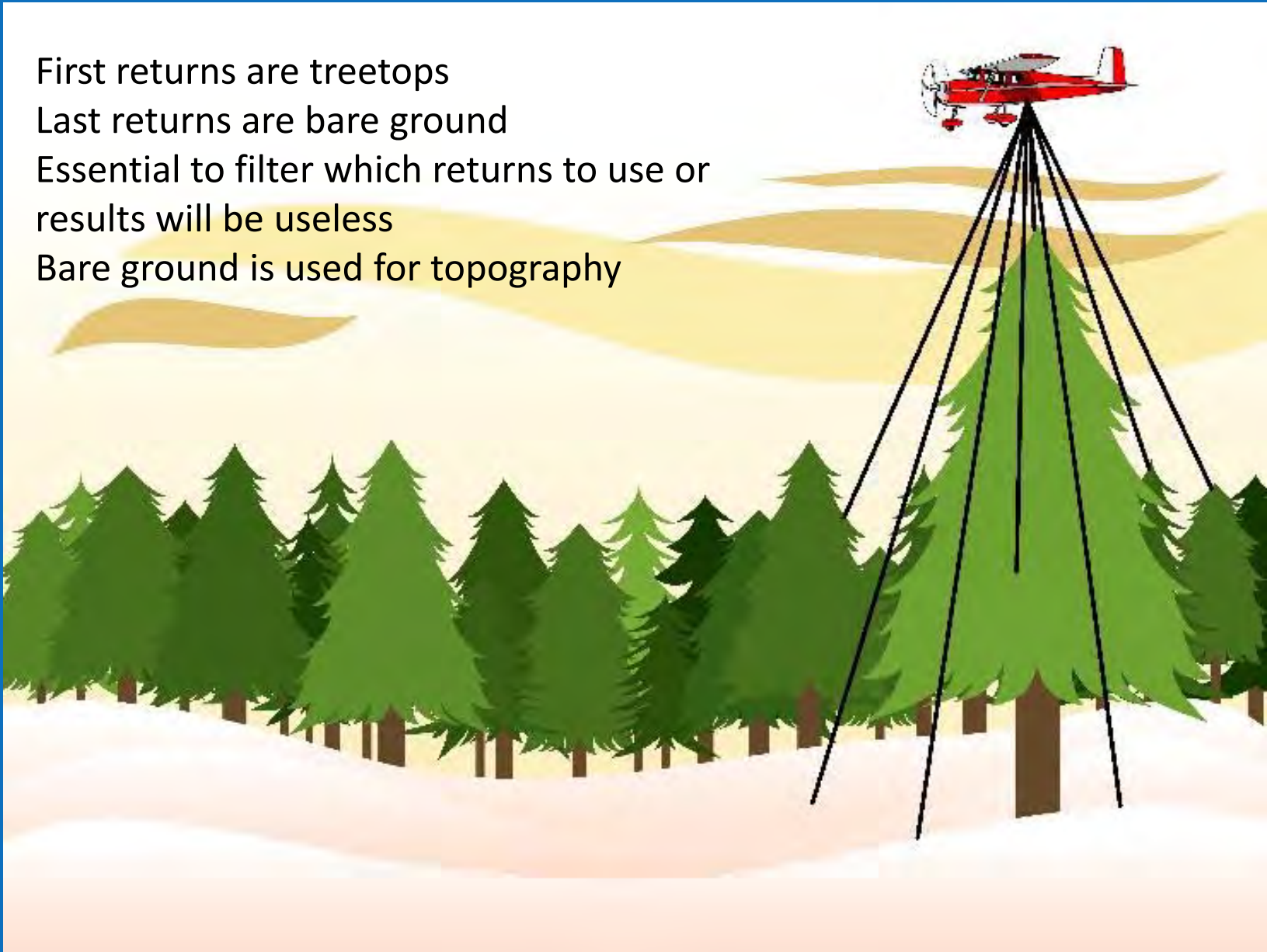
Laser scanner sends laser beams
Reflected beams are detected by extremely sensitive detector
Records location, angle, time

Combines with GPS location of aircraft



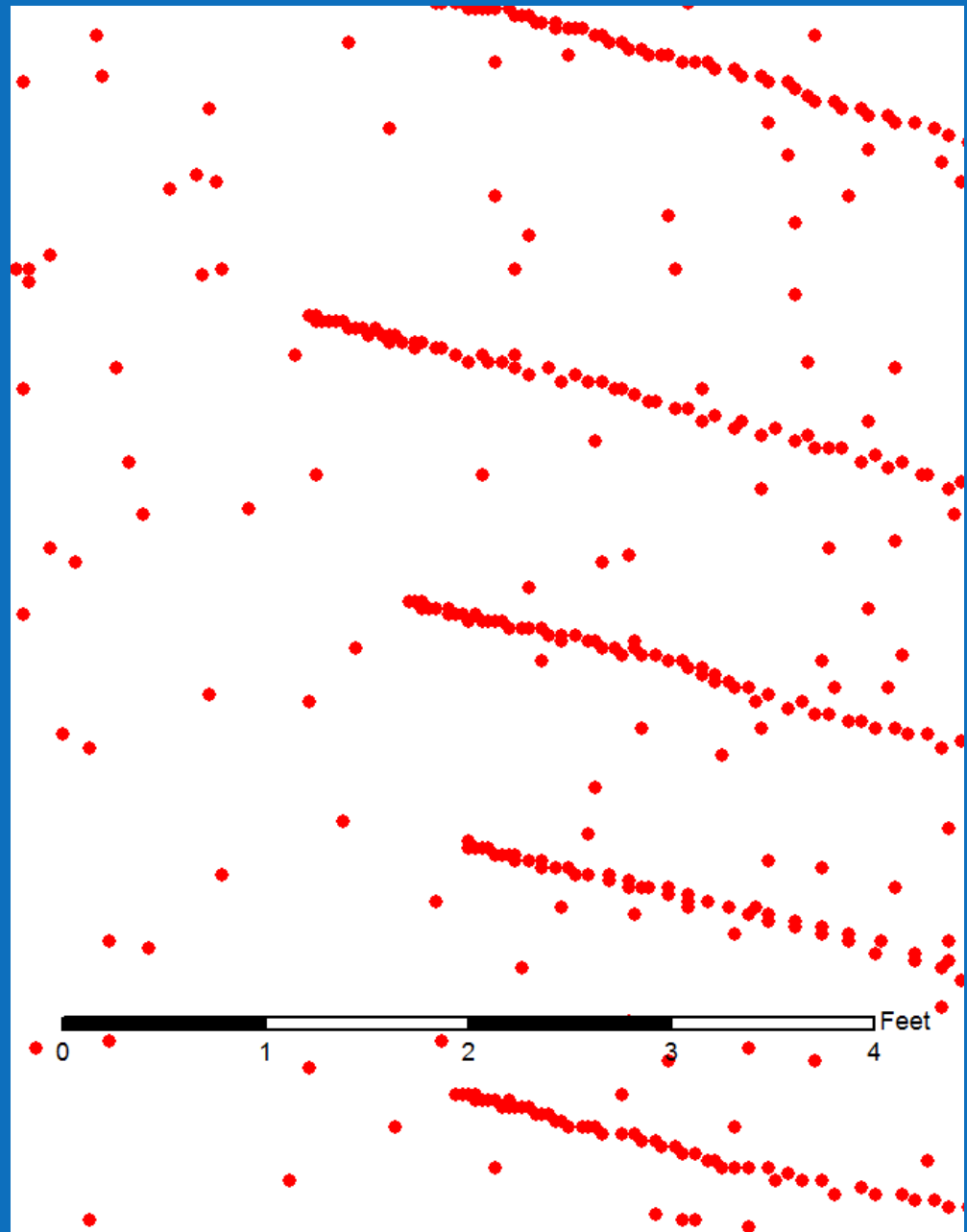
Overview of Lidar

First returns are treetops
Last returns are bare ground
Essential to filter which returns to use or
results will be useless
Bare ground is used for topography

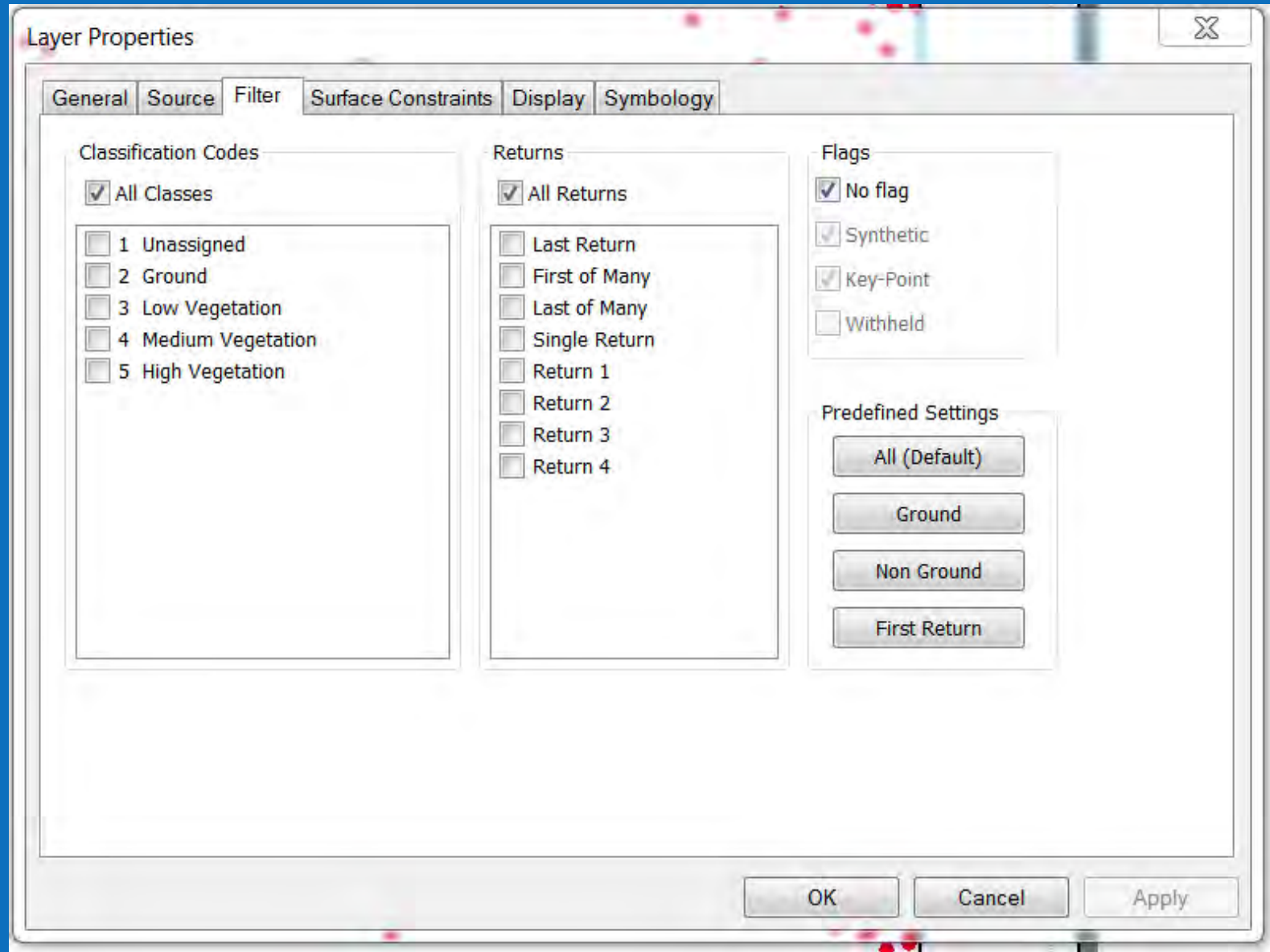


Products Delivered

- Depends on Contractor and contract
- May include point file
- Usually includes contours
- May include raw files
- .las or MKP
- Orthophotography is optional



Points, .las or MKP need analysis by GIS or CAD



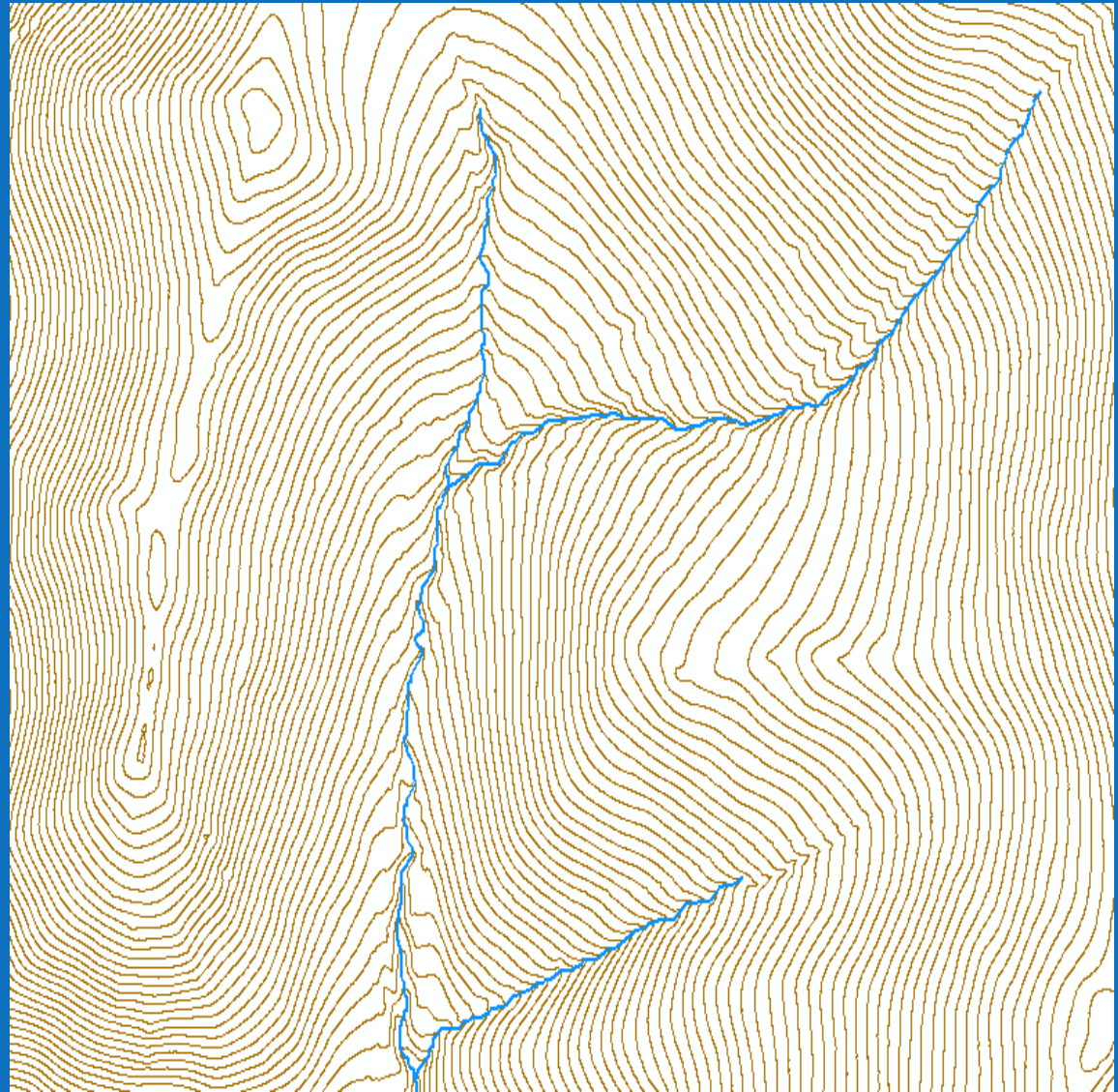
Primary product is DEM and contours

Digital Elevation Model (DEM) is used for designs, calculation of volumes, and local hydrology

Contours are for visual presentation

Heavy demands on computer and software

Lots of spinning orb time





Barker Hughesville Site

Barker Hughesville Mining District Site, Montana

Numerous abandoned underground mines

Mill and tailings pond

Open adits and shafts

Waste Rock piles

Discovery 1879 – sporadic mining through 1960s

Primarily lead and silver



Barker Hughesville Mining District Site, Montana

Steep topography
Heavy timber

Mixed ownership
Limited access



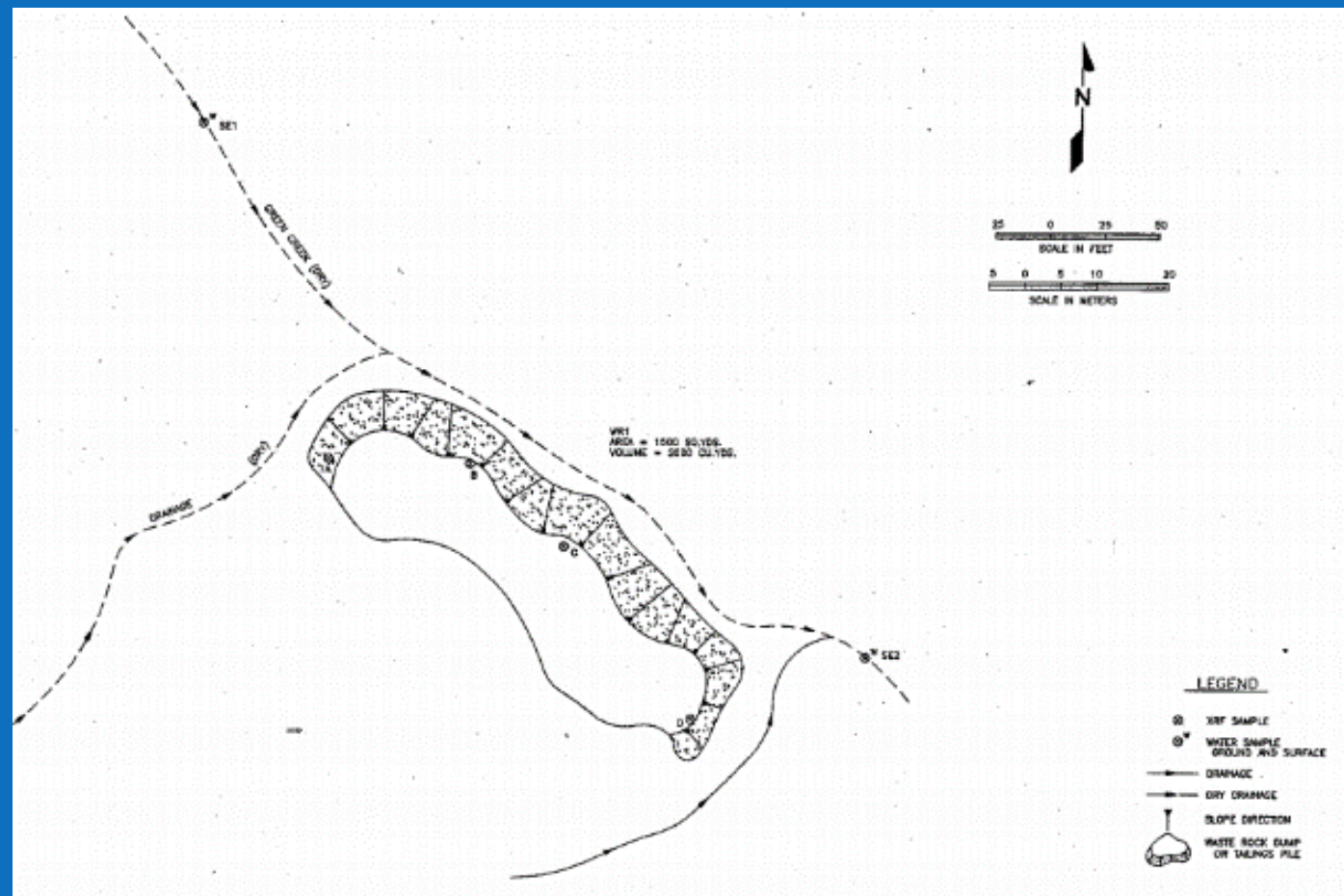
Barker Hughesville Mining District Site, Montana

Previous investigations 1990s

Mixed quality

Some incorrect sites

Very incomplete



NPL Listing and Remedial Investigation

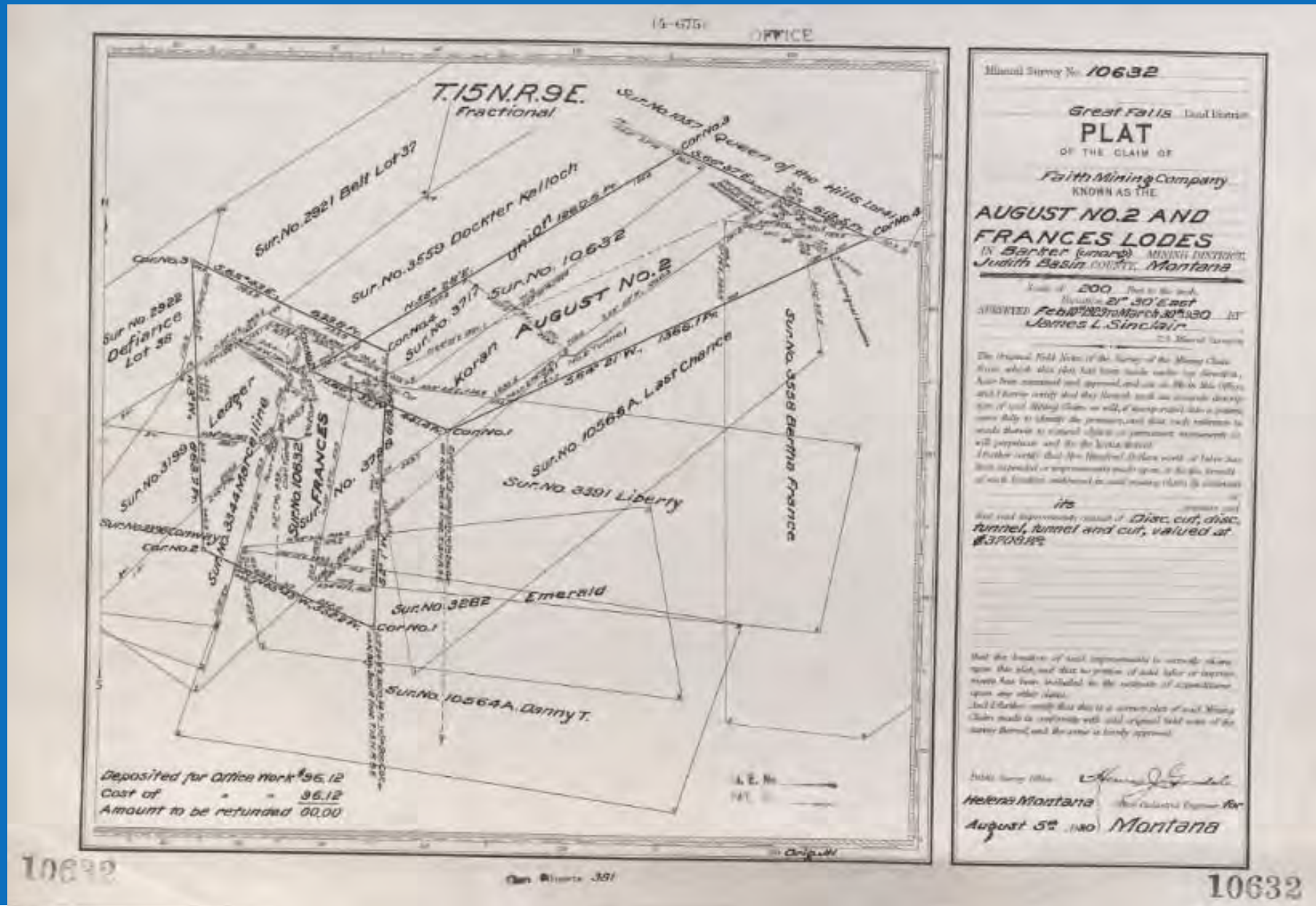
Needs

- Full inventory of sites
- Sample all significant sites
- Generate areas and volumes for FS

Research for Sites

- EPA and State files
- Geologic reports
- Historical Society library
- BLM GLO records
- Defense Minerals Agency
- National Mine Map Repository
- County records
- Aerial photography

GLO Mine Survey



Mineral Survey No. 10632

Great Falls Coal District

PLAT
OF THE CLAIM OF

Faith Mining Company
KNOWN AS THE

**AUGUST NO. 2 AND
FRANCES LODES**
IN Barter (small) MINING DISTRICT,
Judith Basin COUNTY, Montana

Scale of 200 Feet to the inch.
Bearing 27° 30' East
ADJUSTED February 20, 1930
James L. Sinclair

The original field notes of the Survey of the Mining Claims herein which this plat has been made under my direction, have been examined and approved, and in the field the office and I have verified that they furnish such an accurate description of said Mining Claims, as well of improvements thereon, as to enable me to identify the premises, and that such returns be made thereon to correct claims on permanent monuments as will perpetuate and fix the limits thereof.

I further certify that the Homestead Claims made in this Survey have been inspected or approximately made up, in the amount of such location, and found to conform to the provisions of the Act.

its

and such improvements, consist of Disc. cut, disc. tunnel, tunnel and cut, valued at \$3,500.00

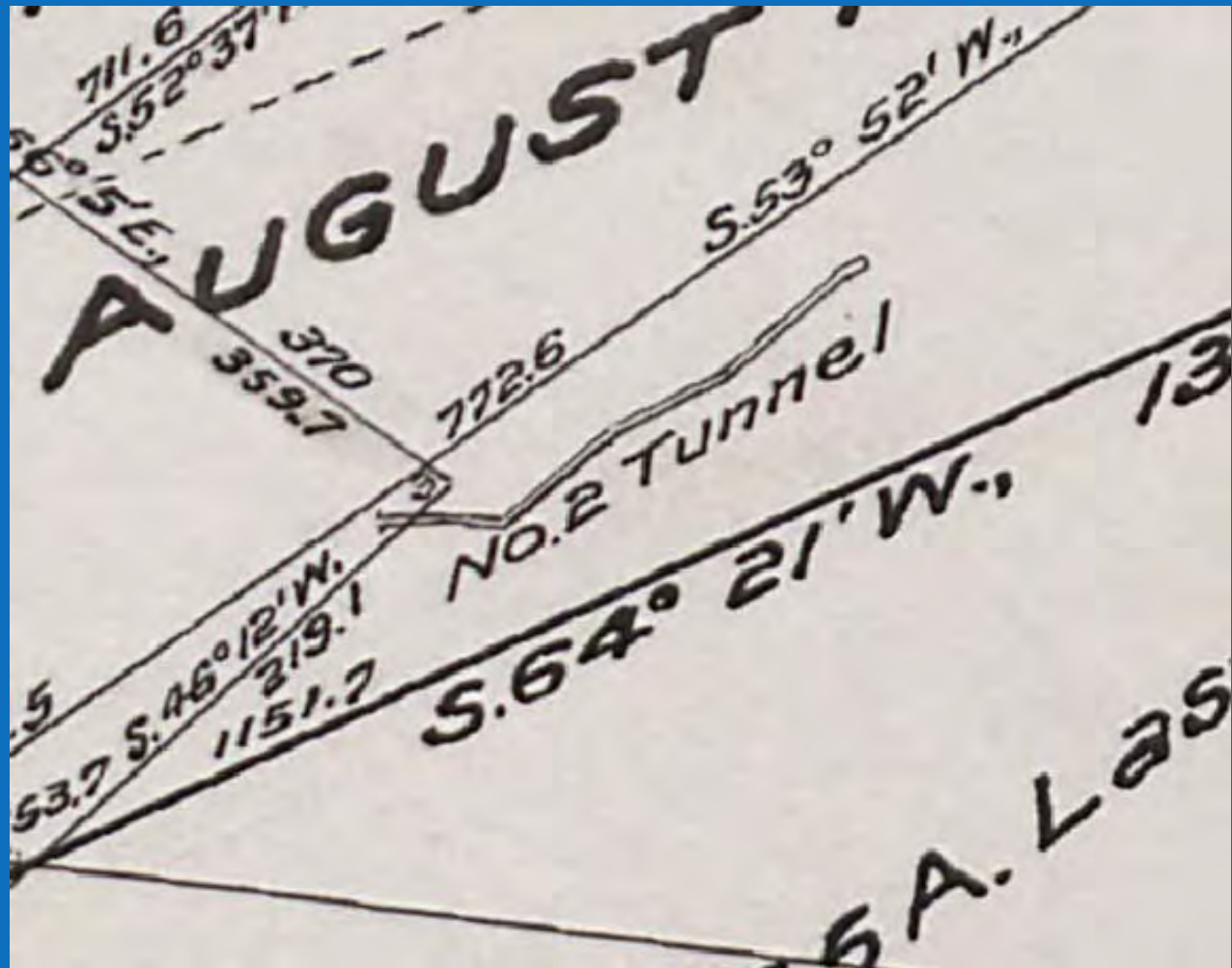
That the location of said improvements is correctly shown upon this plat, and that no portion of said plat or improvements has been included in the outside of applications upon any other claim.

And I further certify that this is a correct plat of said Mining Claims made in conformity with said original field notes of the Survey thereof, and the same is hereby approved.

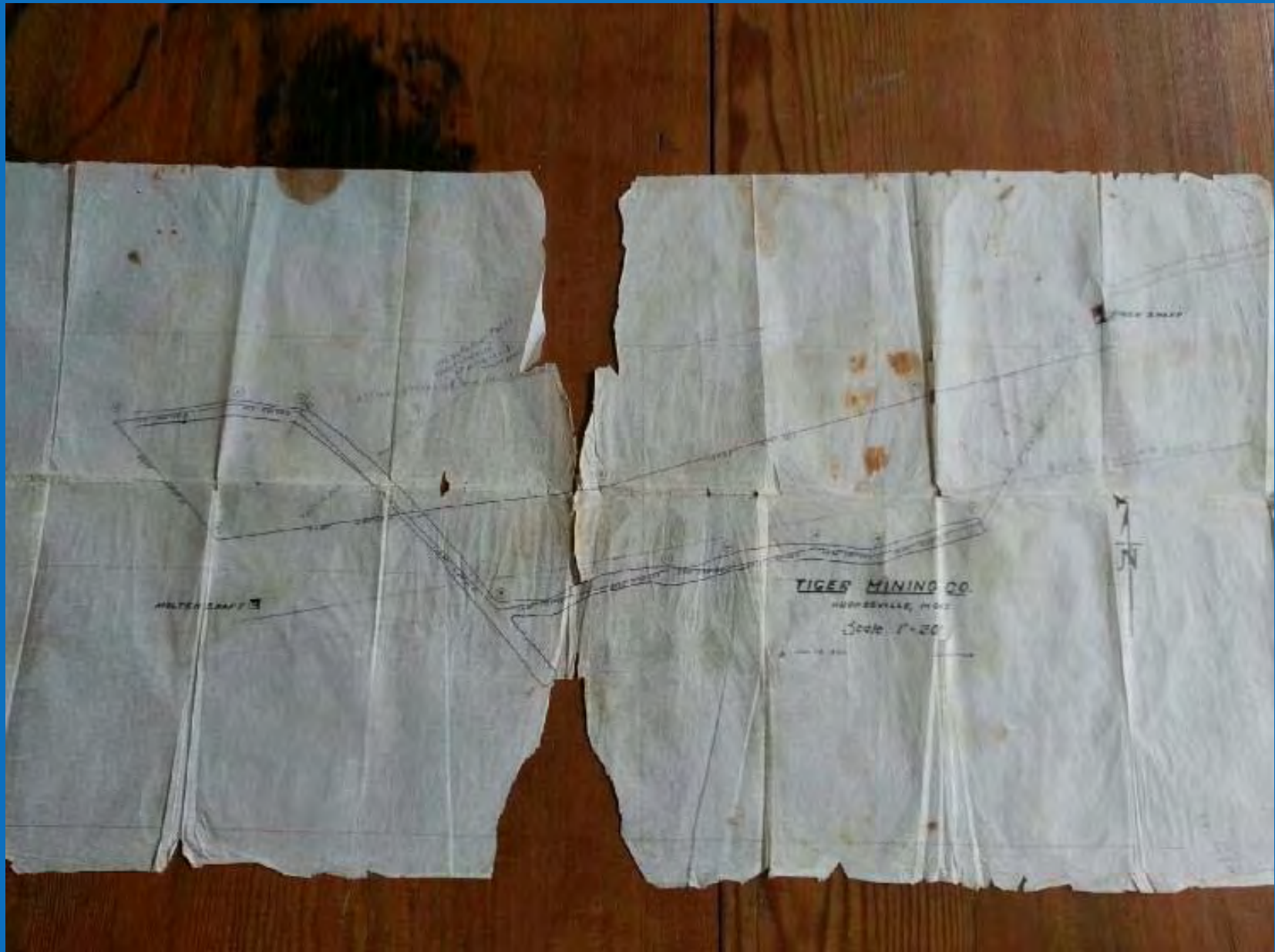
James L. Sinclair
Helena, Montana
August 5th, 1930
Montana

Some workings on Mine Surveys

- Discovery cut, shaft or tunnel
- Sometimes extent of tunnels
- Uncertain accuracy



Mine Maps of varying quality and condition



Narrative Reports from Mine Inspectors

HUGHESVILLE.

The Carter mine, at Hughesville, is worked by the Carter Mining Company. A two compartment shaft was sunk to the depth of 90 feet. Were going to cross-cut the ledge at the 100-foot level. They were putting up a hoist and were preparing to put in hoisting machinery. Employ 8 men around the mine. J. Barker, Superintendent, and David O'Neill, Foreman.

May and Edna Mine, worked by the May and Edna Mining Company. The first work was done on this property about three years ago. The lower tunnel is driven in about 700 feet, and is timbered with sets. About 195 feet in this tunnel an uprise was driven to surface, and the face of the workings was ventilated by means of a box connected with this uprise, which gives a return to the air. Above this tunnel, on the hill, two more tunnels were driven a short dis-

How to Resolve Locations?

The Good

- Claim names are mostly consistent
- Patented claims are inholdings
- Cadastral records retain claim names and outer shapes

Not So Good

- Mining companies and mine names come and go
- Mining reports are somewhat secretive and exaggerate ore and workings
- Difficult to find mining reports
- Aerial photography is just trees



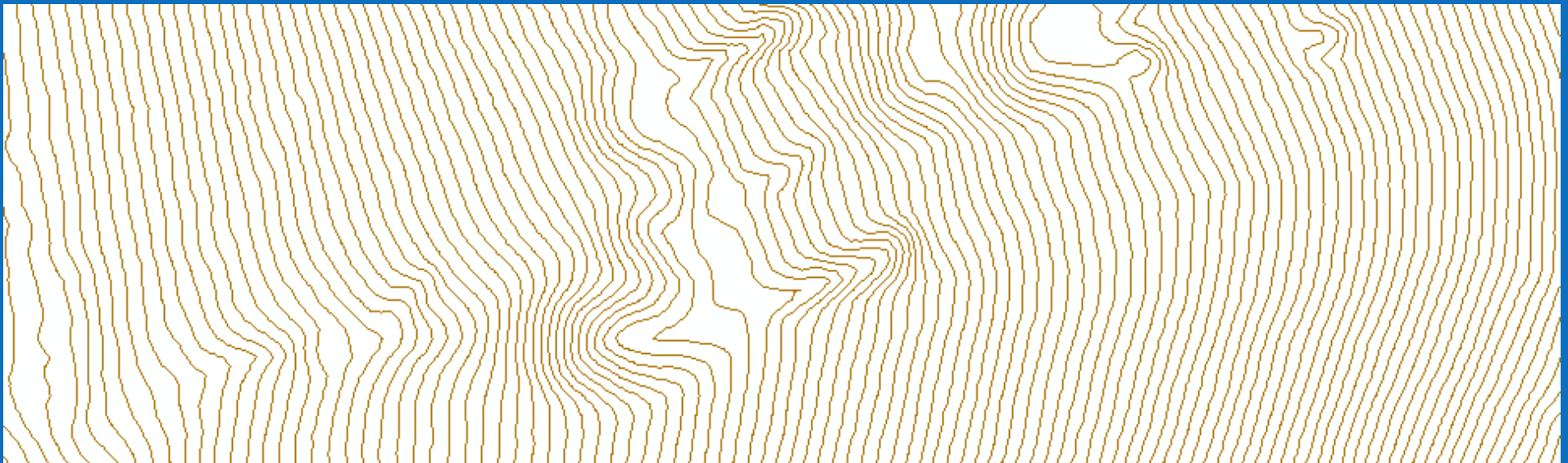
Lidar to the Rescue

High Quality Topography Illuminates Workings

Vegetation is removed and anthropogenic disturbances are easy to see

- Roads
- Waste rock piles
- Shafts

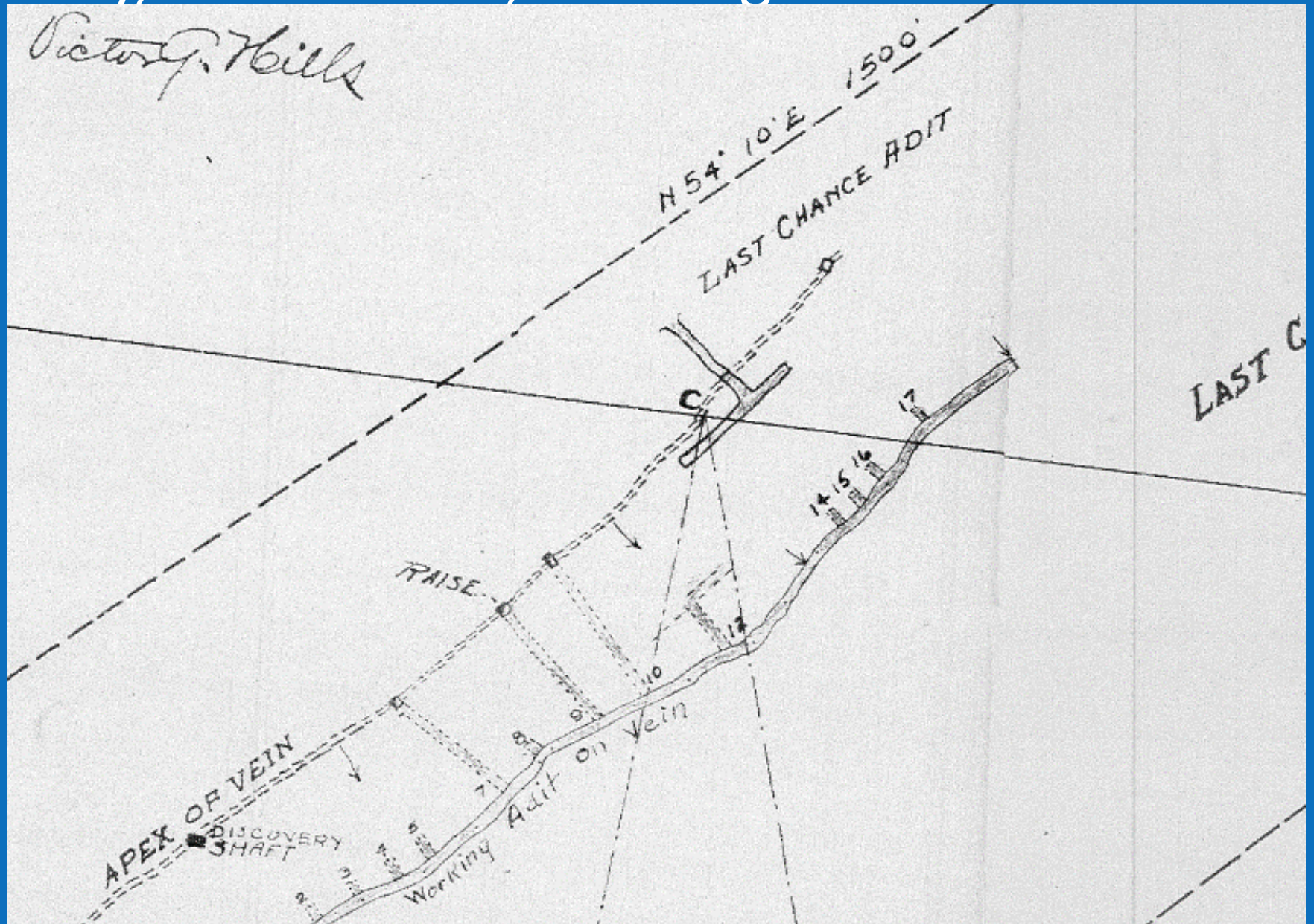
Virtual clear cut reveals adits and waste rock piles



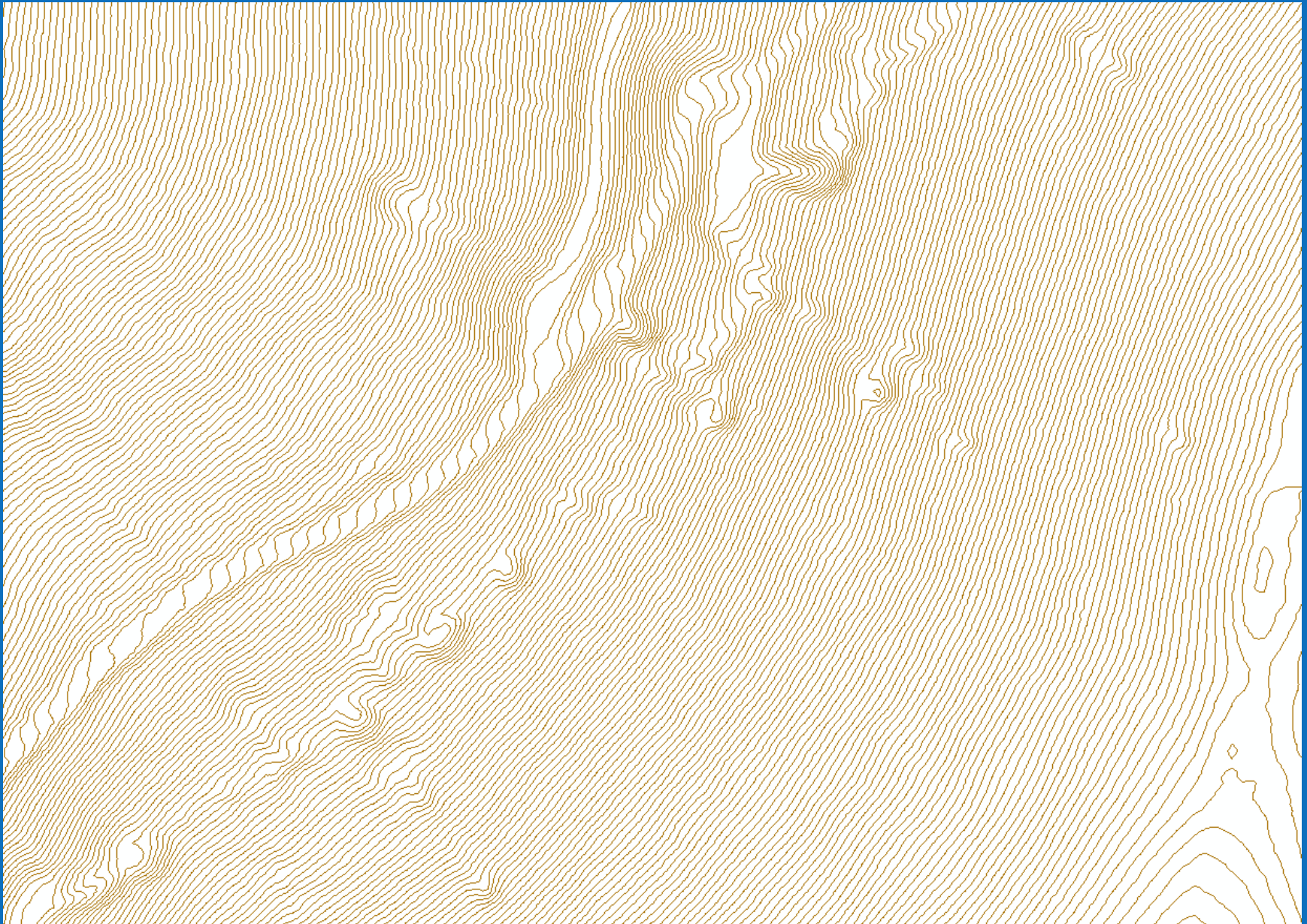
Liberty, Last Chance, and August No. 2 Mines



Liberty, Last Chance, and August No. 2 Mines



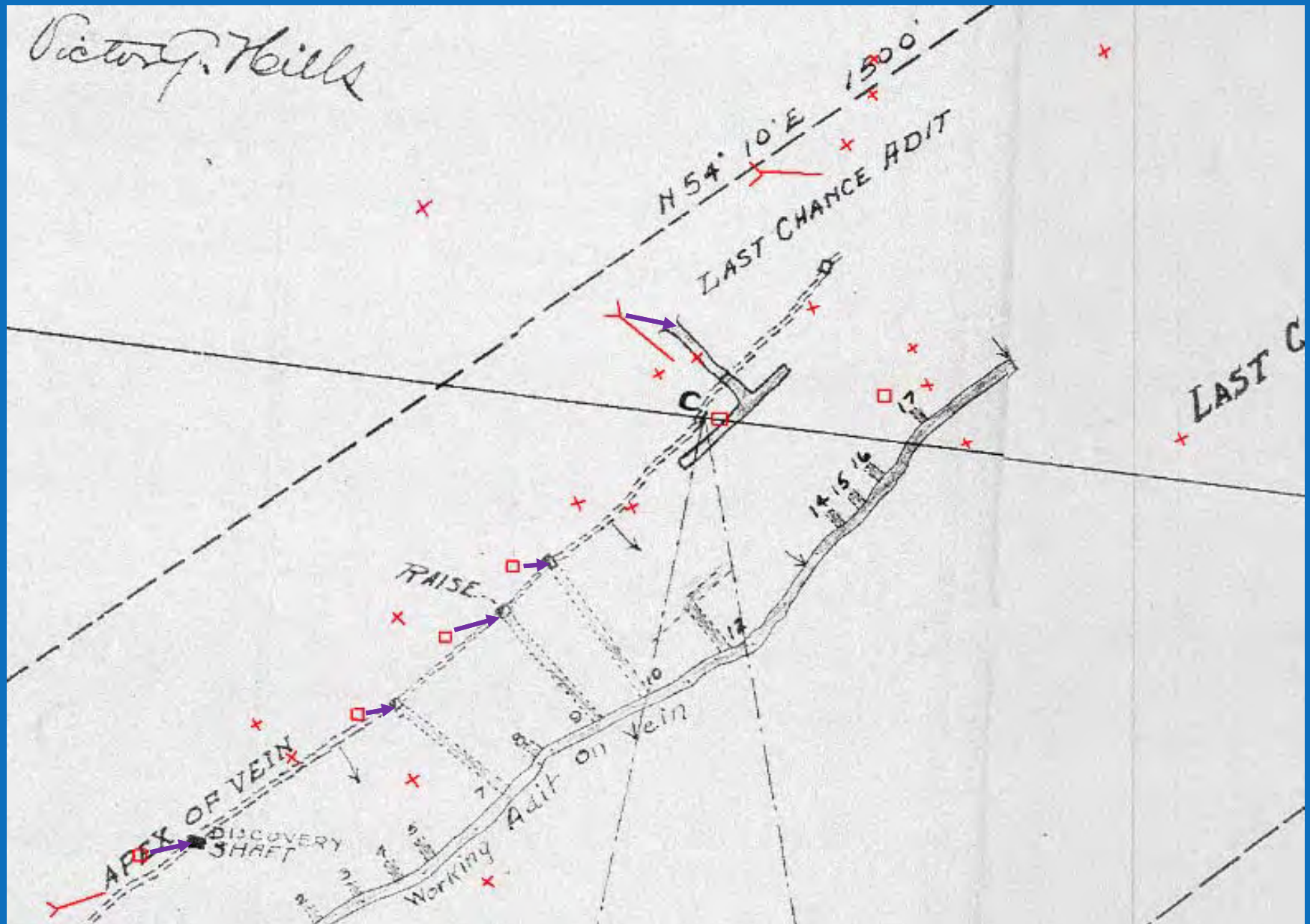
Liberty, Last Chance, and August No. 2 Mines



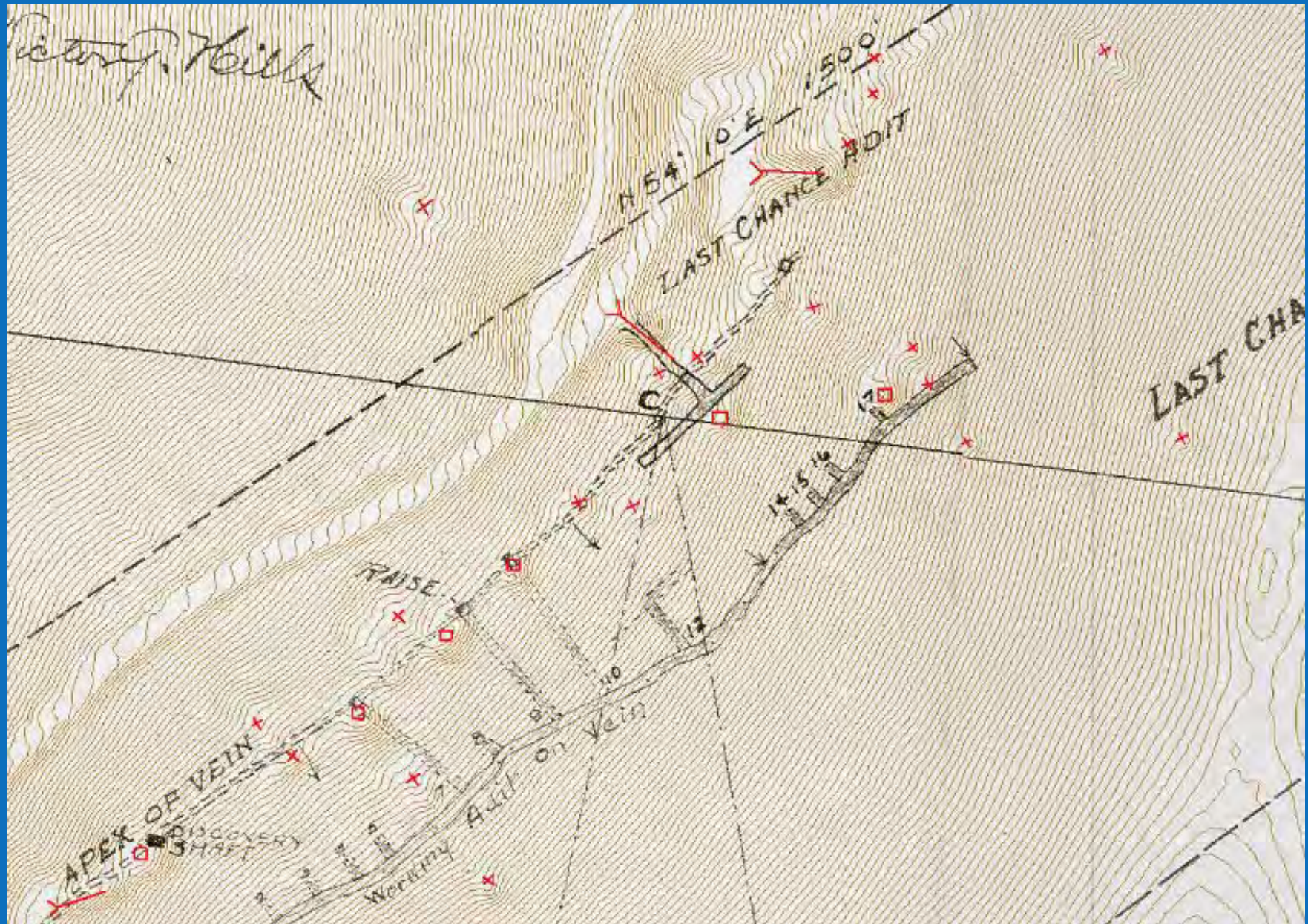
Liberty, Last Chance, and August No. 2 Mines



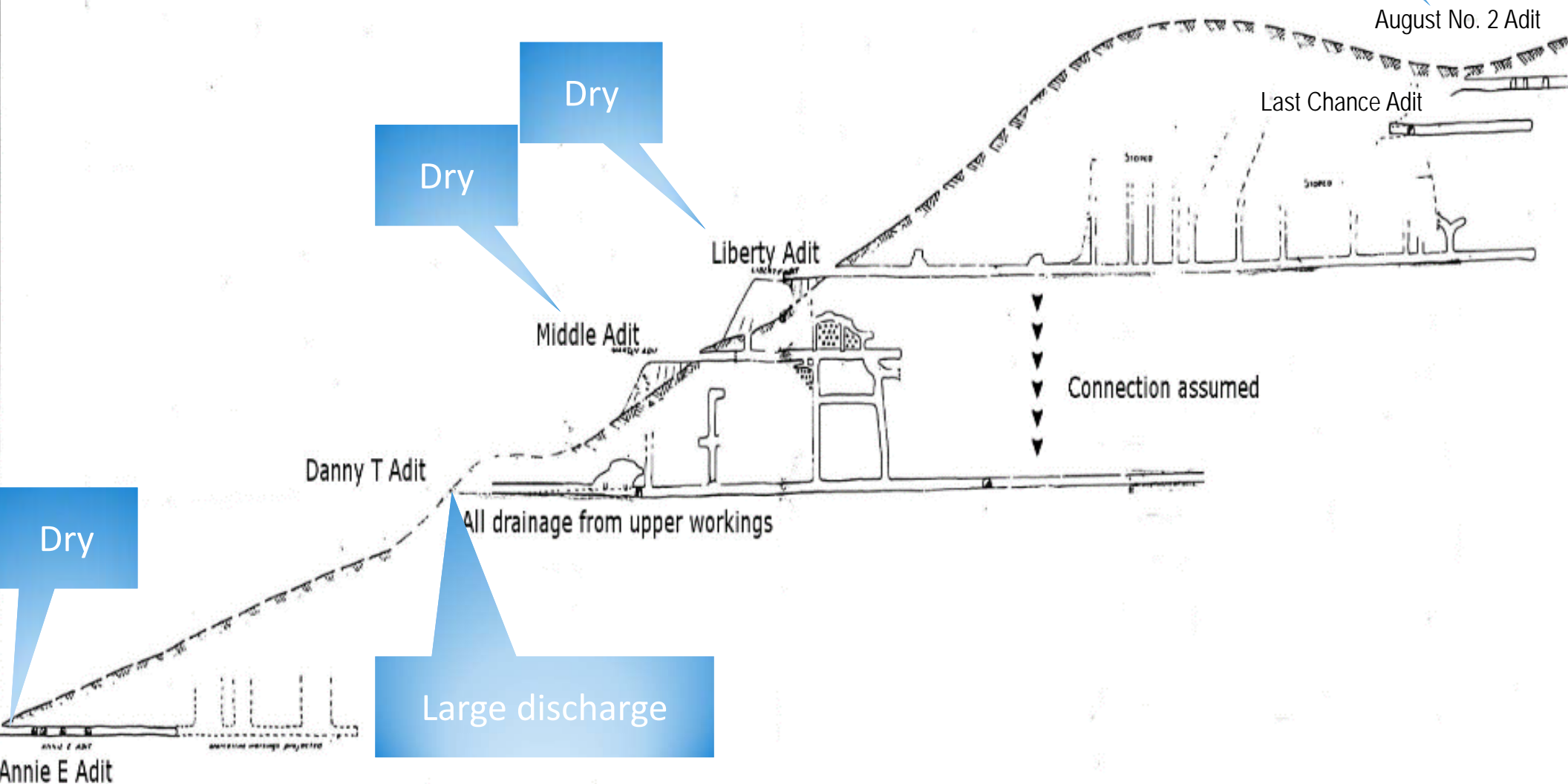
Liberty, Last Chance, and August No. 2 Mines



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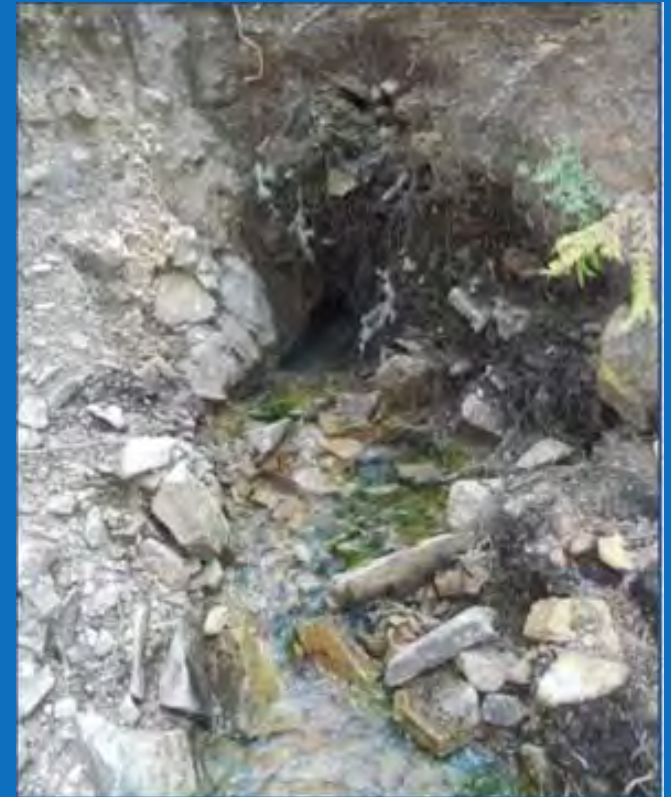
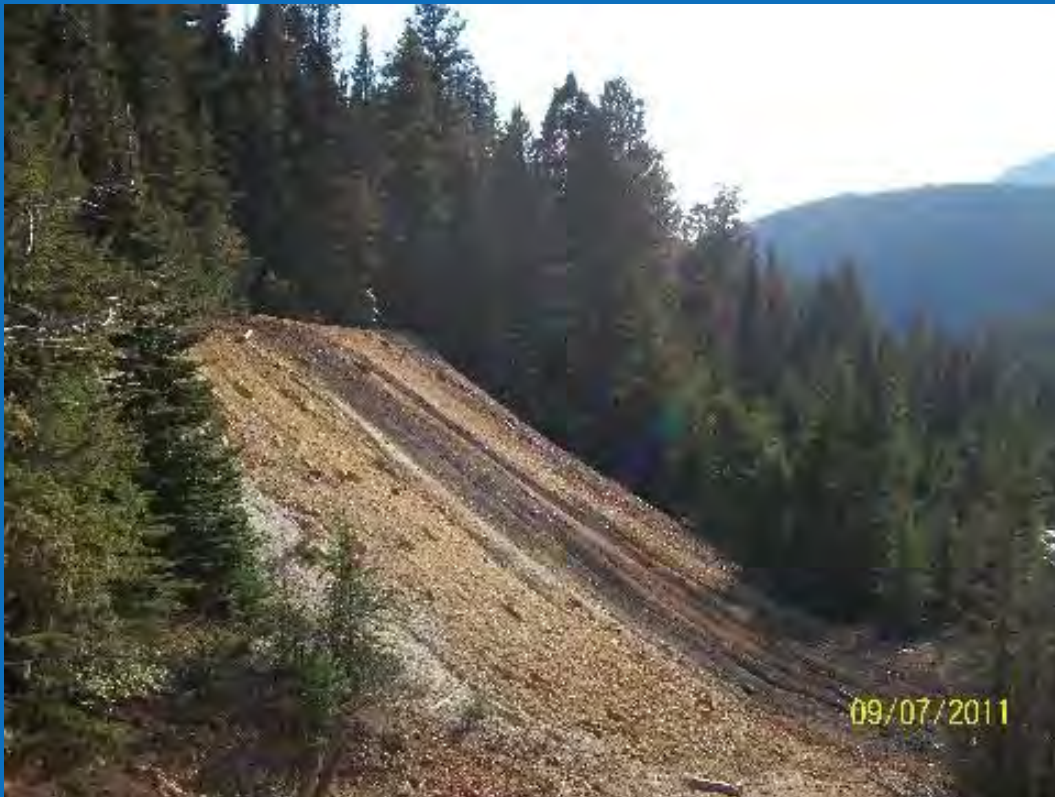


Benefit of accurate mapping



Moulton Mine

- Discovered 1886
- Large waste rock pile
- Discharging adit
- No workings map



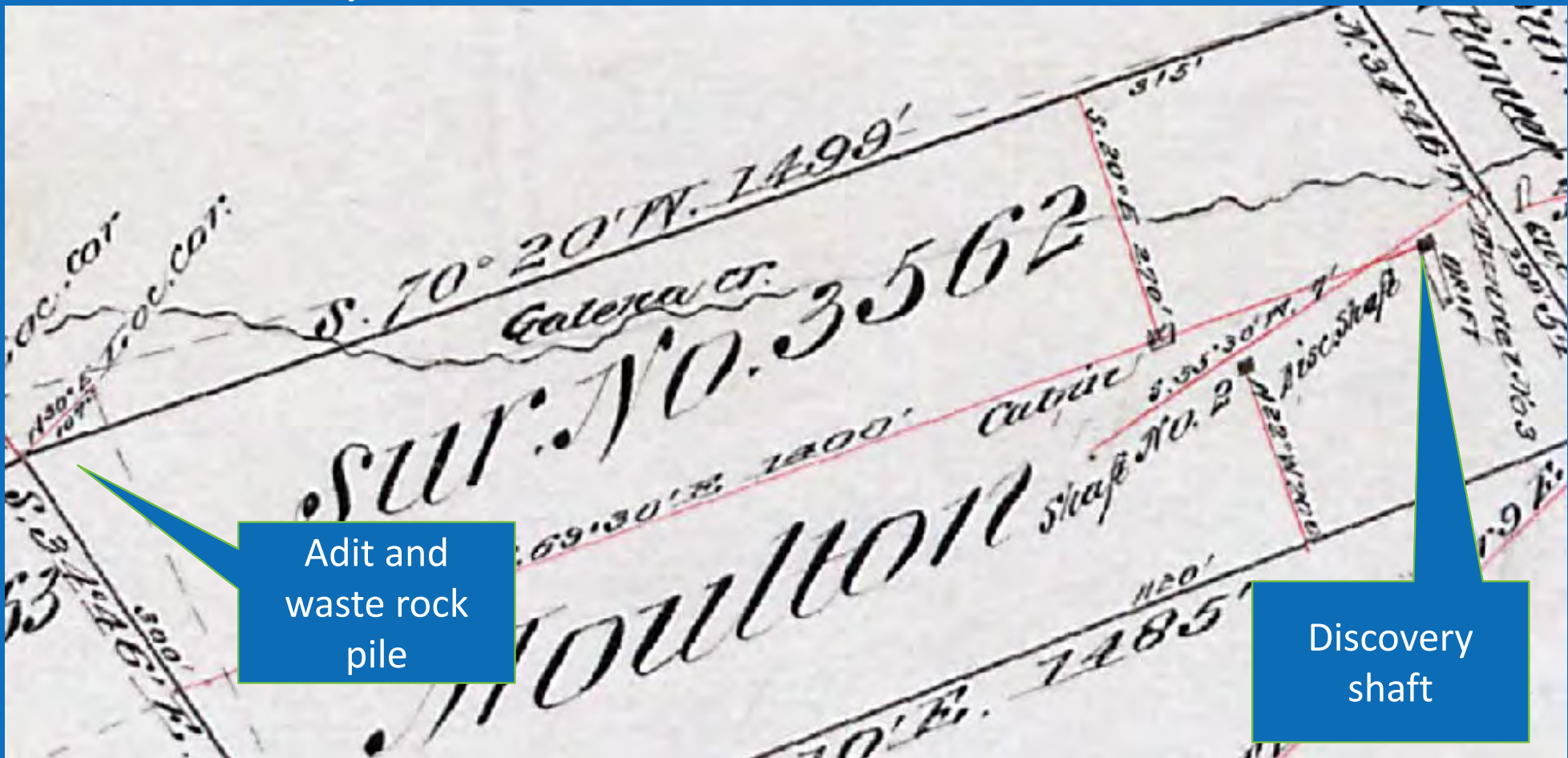
Moulton Mine

- Very little information available



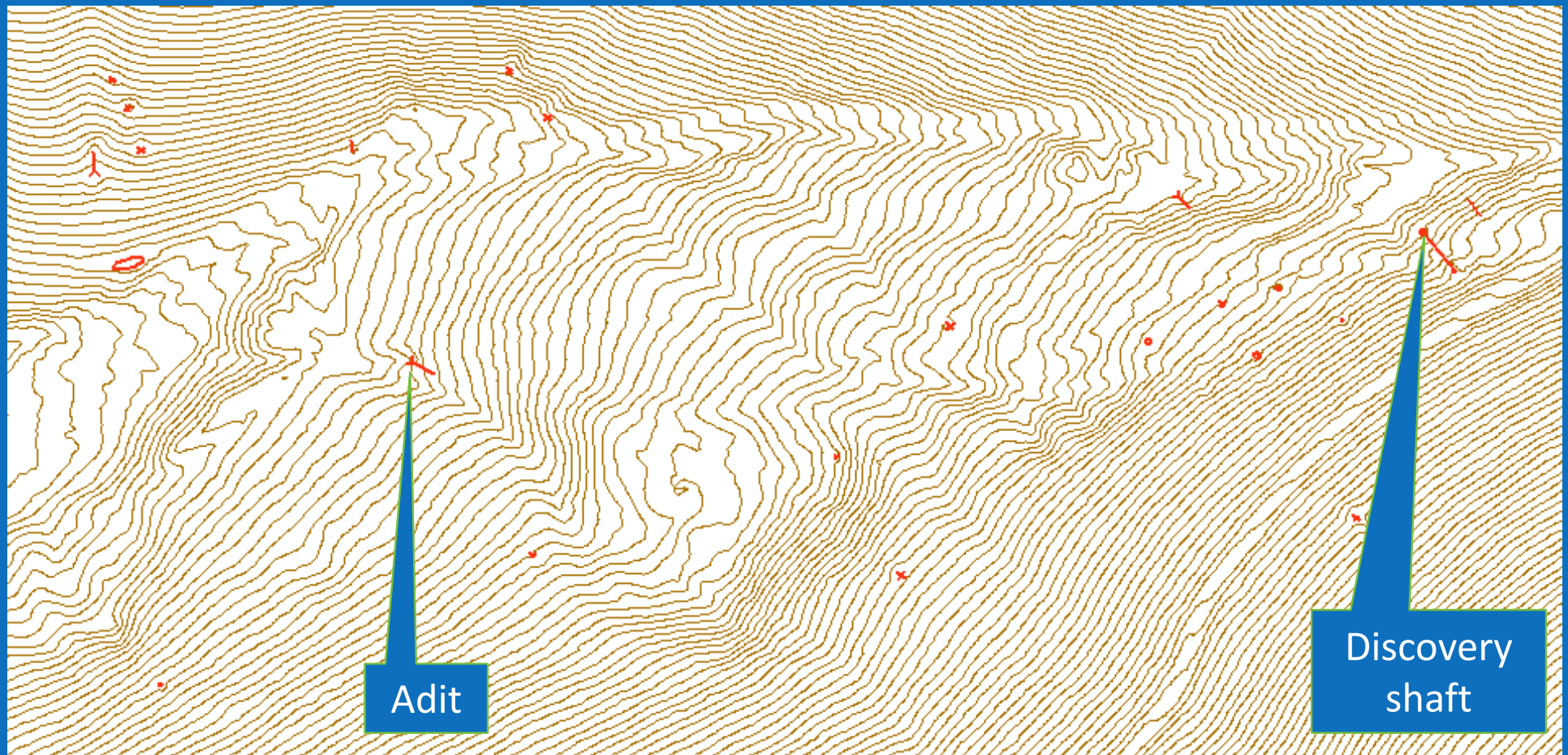
Moulton Mine

- 1890s Mine Survey
- Discharging adit and waste rock to east
- Discovery shaft to east
- Discharging adit and waste rock to west



Moulton Mine

- Lidar revealed discovery shaft
- Change in slope is geologic contact and vein

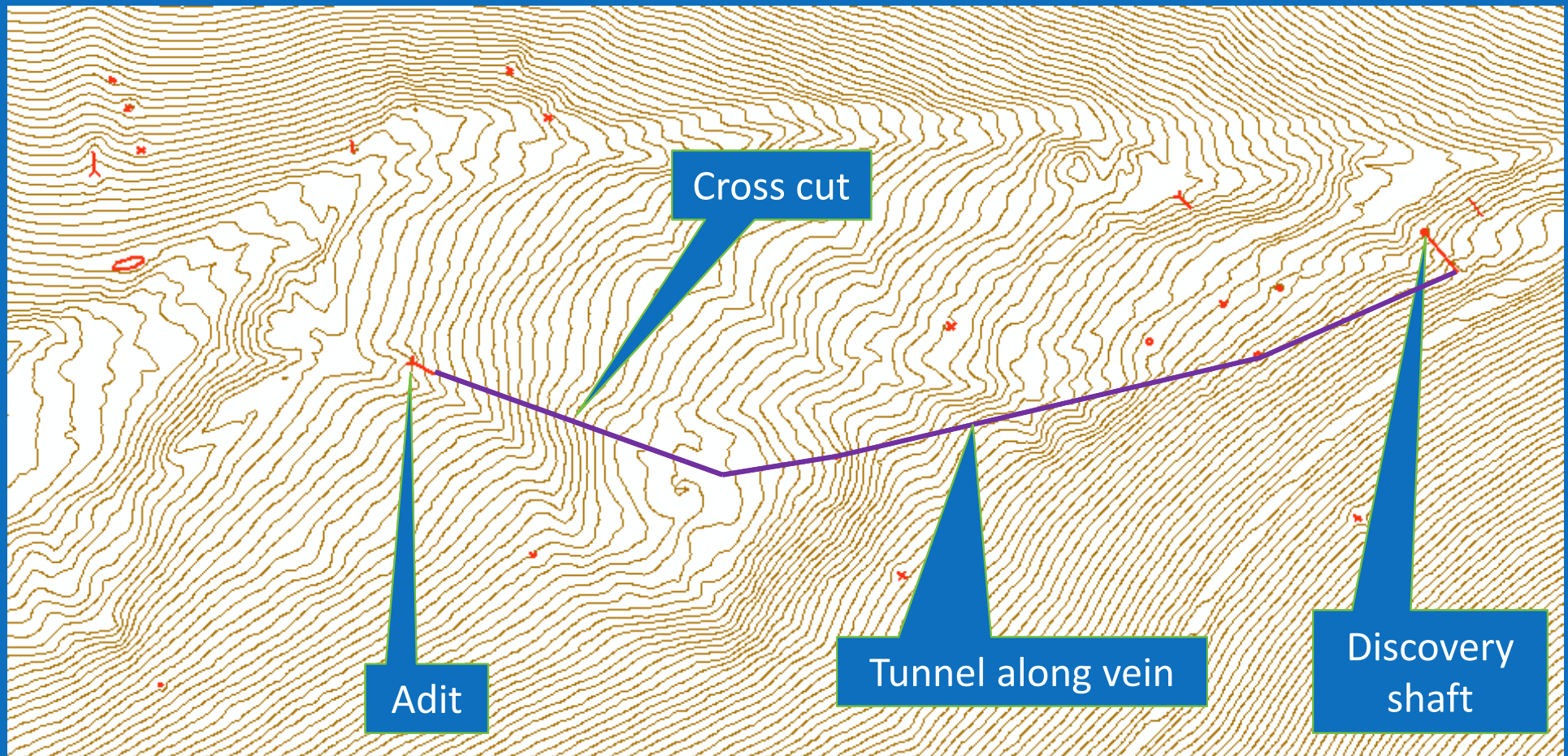


Moulton Mine

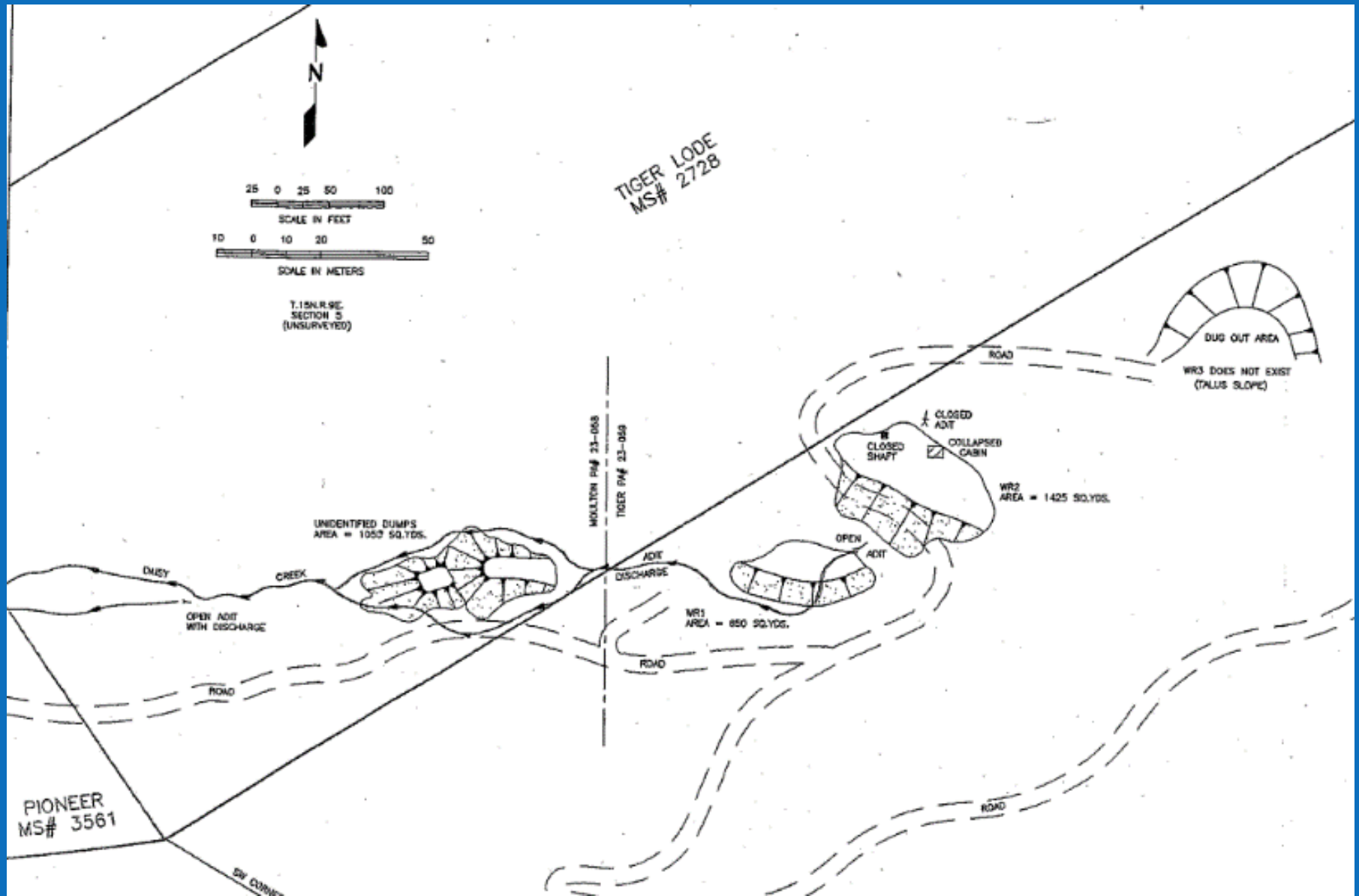
- 1894 mine inspector report described a shaft 100 feet deep
- 1897 mineral survey shows two shafts and a drift
- 1899 mine inspector report described a shaft 110 feet deep and a tunnel was to be dug 1200 feet long and 350 feet deep
- 1900 USGS report indicated that the target depth was 356 feet with a tunnel 1232 feet long
- 1951 mine inspector report indicated that the tunnel included a 356 foot crosscut to the vein

Moulton Mine Assumed Workings

- Cross cut assumed 356 feet
- Shaft estimated depth 274 feet
- Tunnel length approximately 1165 feet to shaft
- 1235 feet to claim boundary



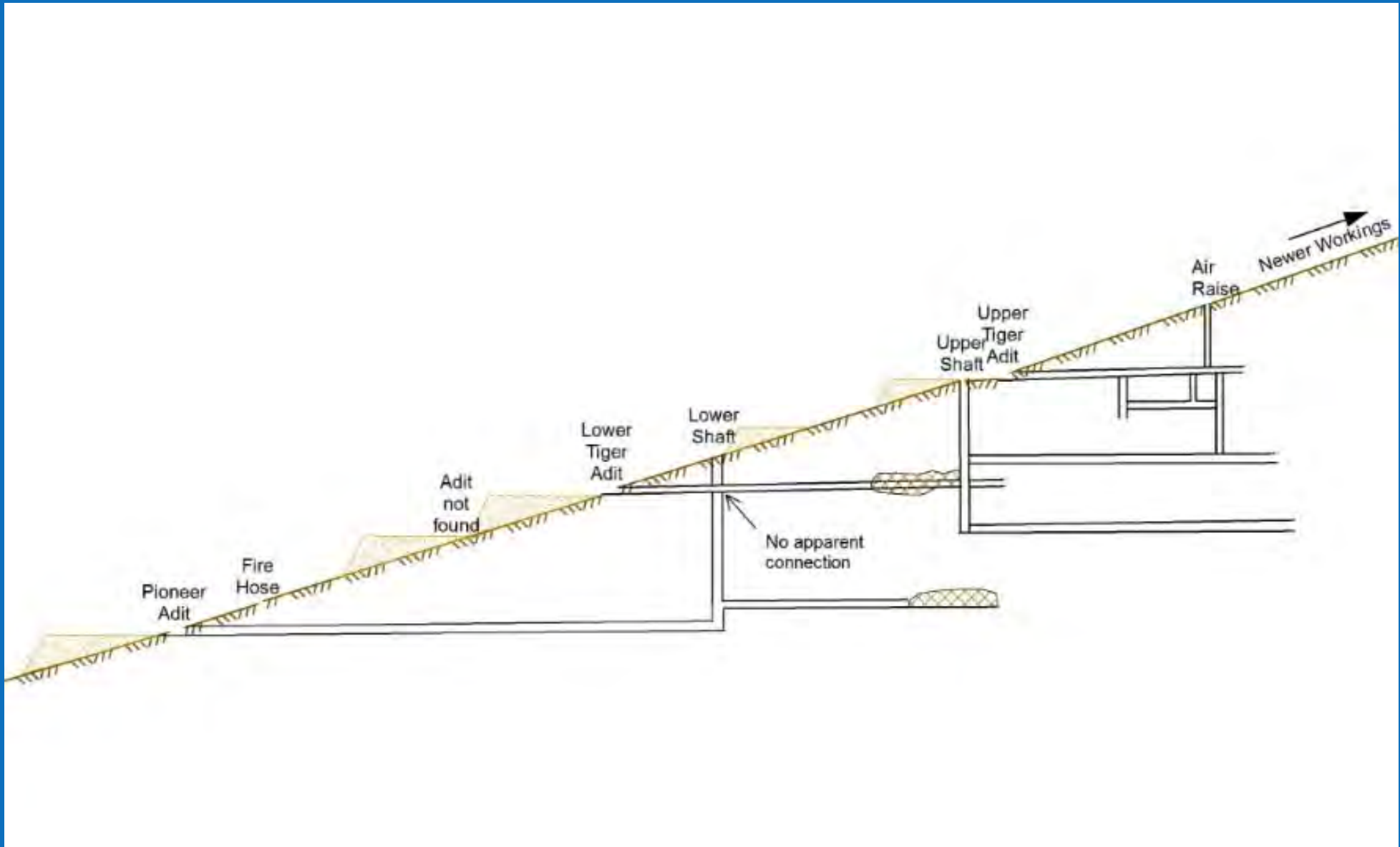
Tiger Mine – 1990s information



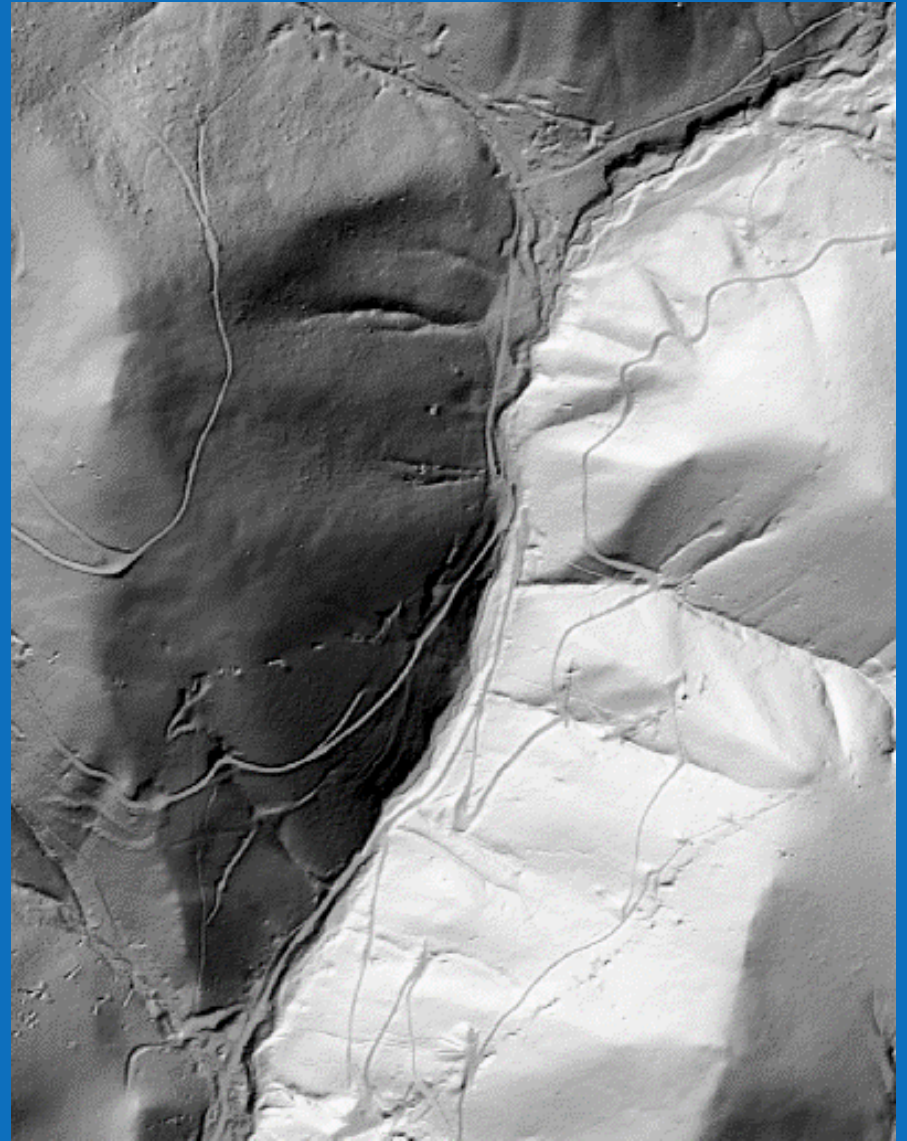
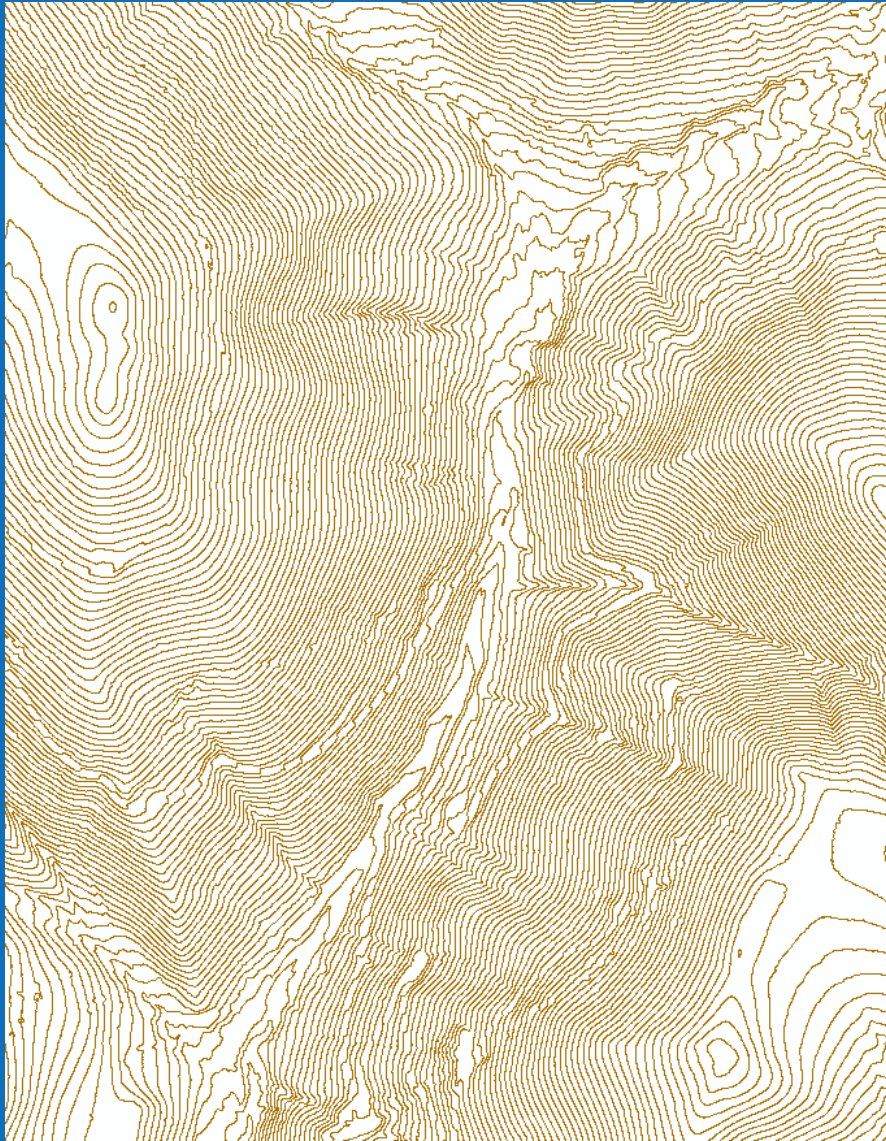
Tiger Mine – Combined historic and current info



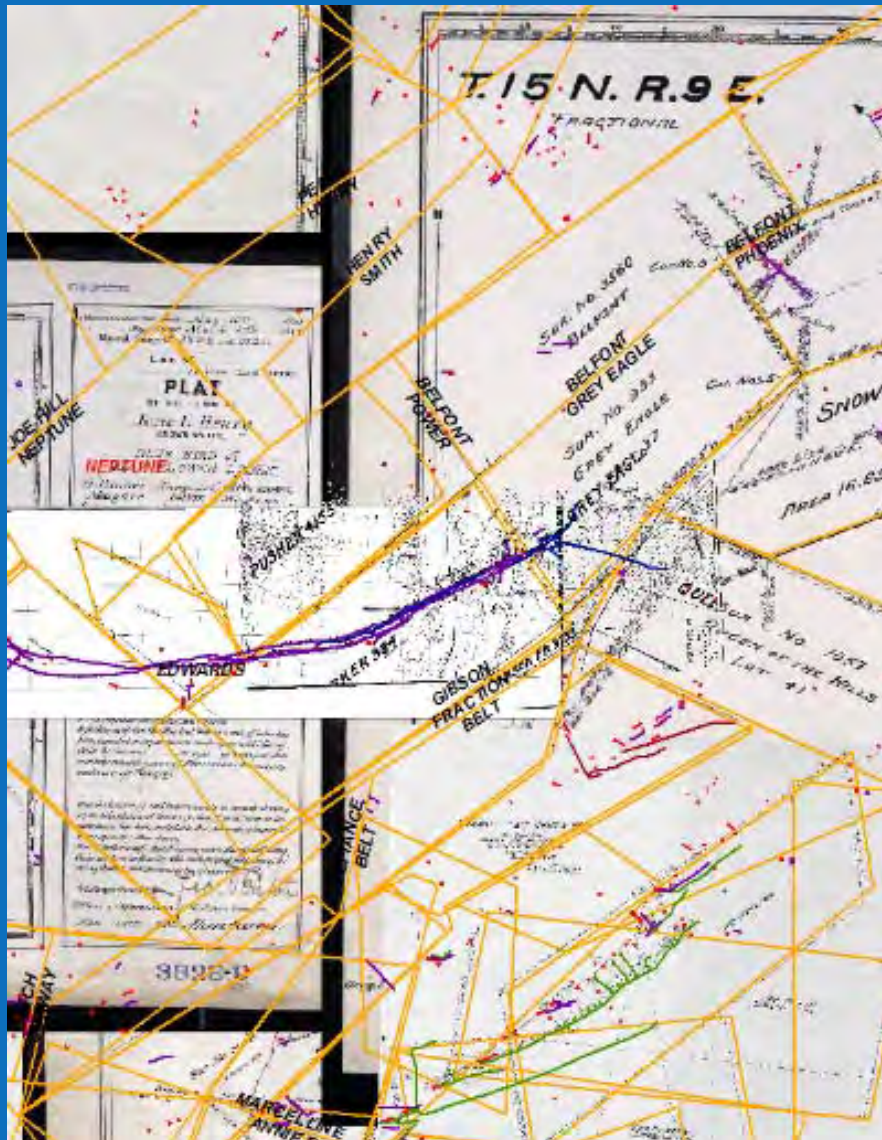
Interpretation of workings



Hillshade can Help with Visualization



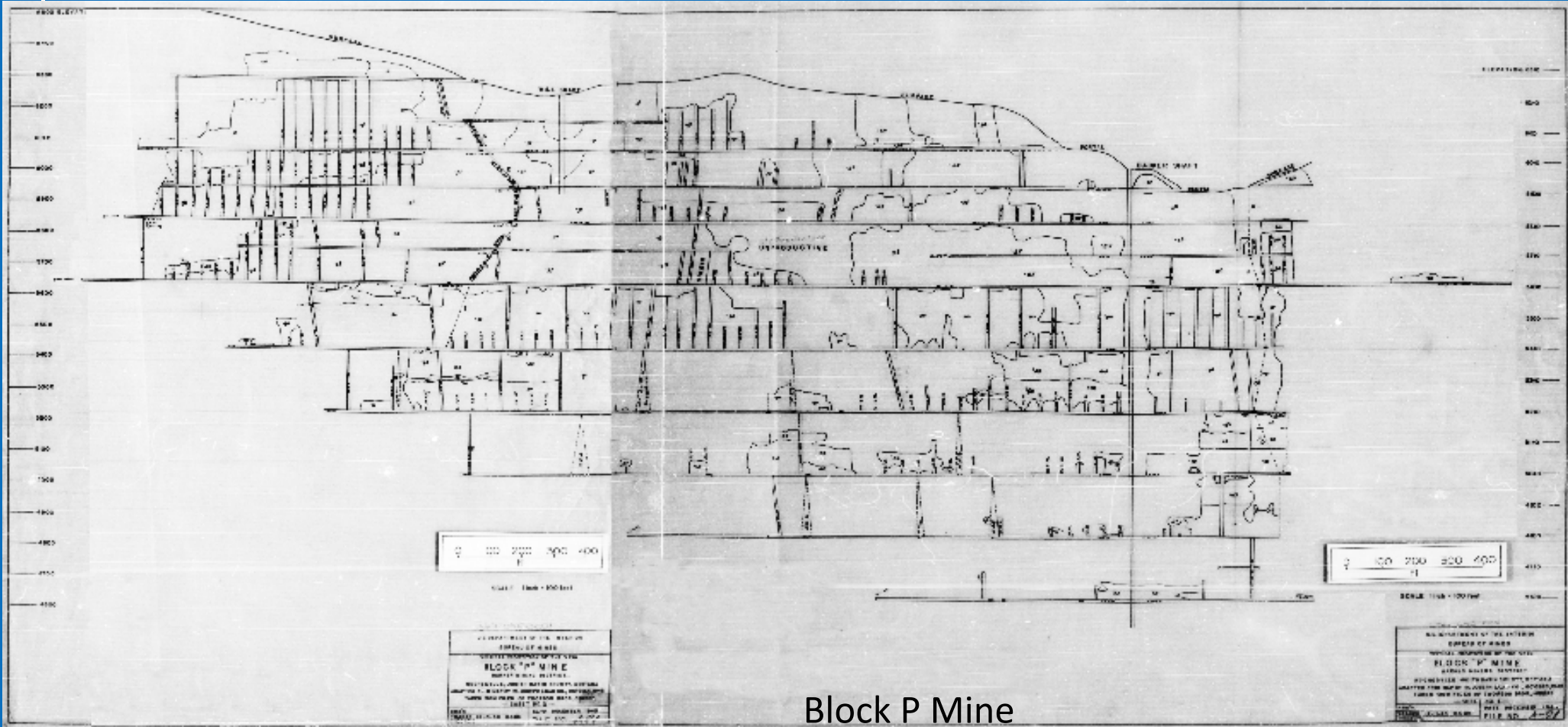
Blend all available data and simplify



Barker Hughesville Summary

- Pre-listing information identified 46 mine sites of which 16 were potential sources
- Research of historic information and Lidar mapping identified 64 mine sites and many, many small shafts and pits
- We believe all significant sites have been visited and sampled including discharging adits
- Knowledge of workings will help during RD/RA for source control

Questions?



Block P Mine



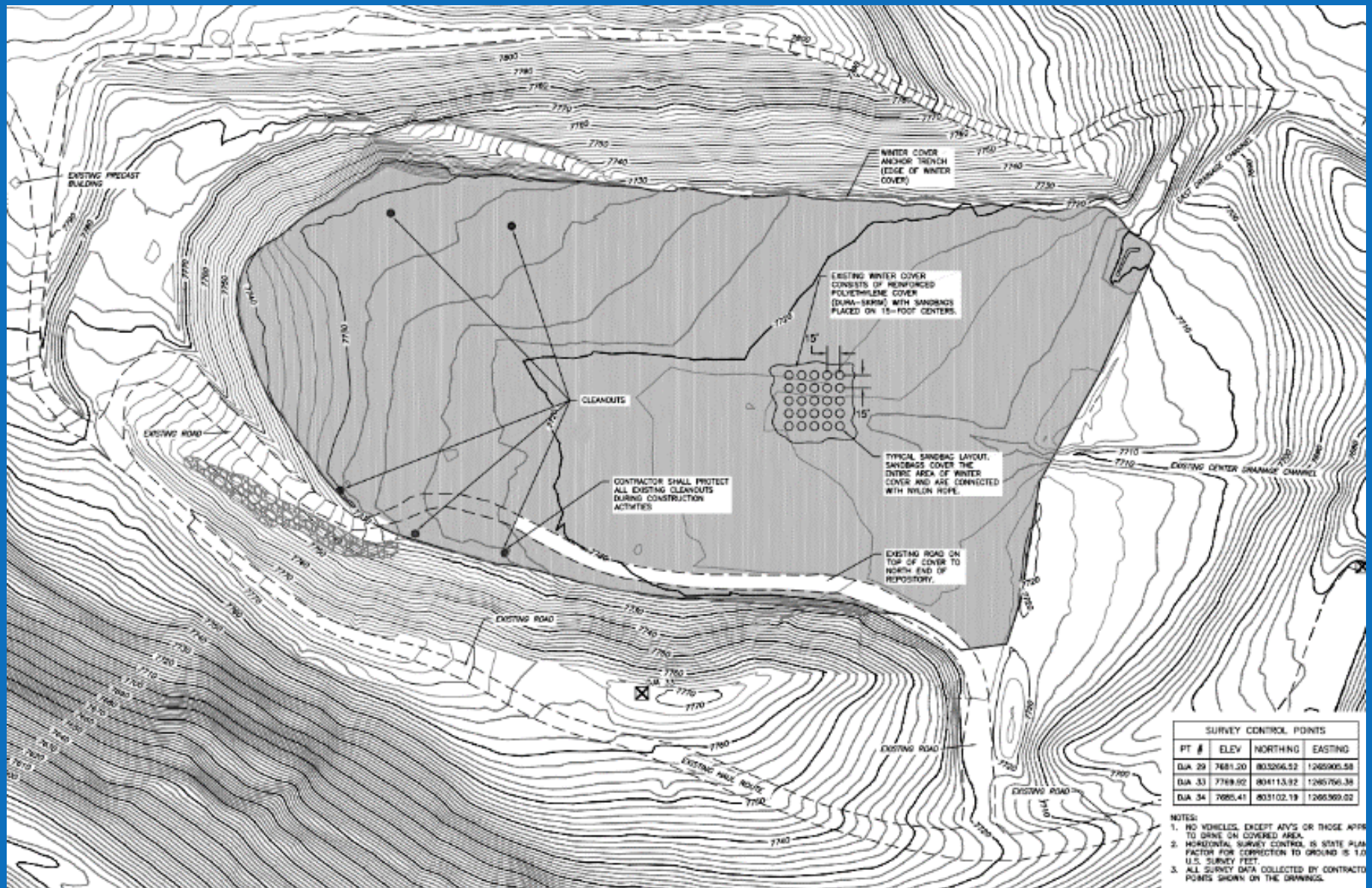
Upper Tenmile Site

Upper Tenmile Creek Mining Area Site

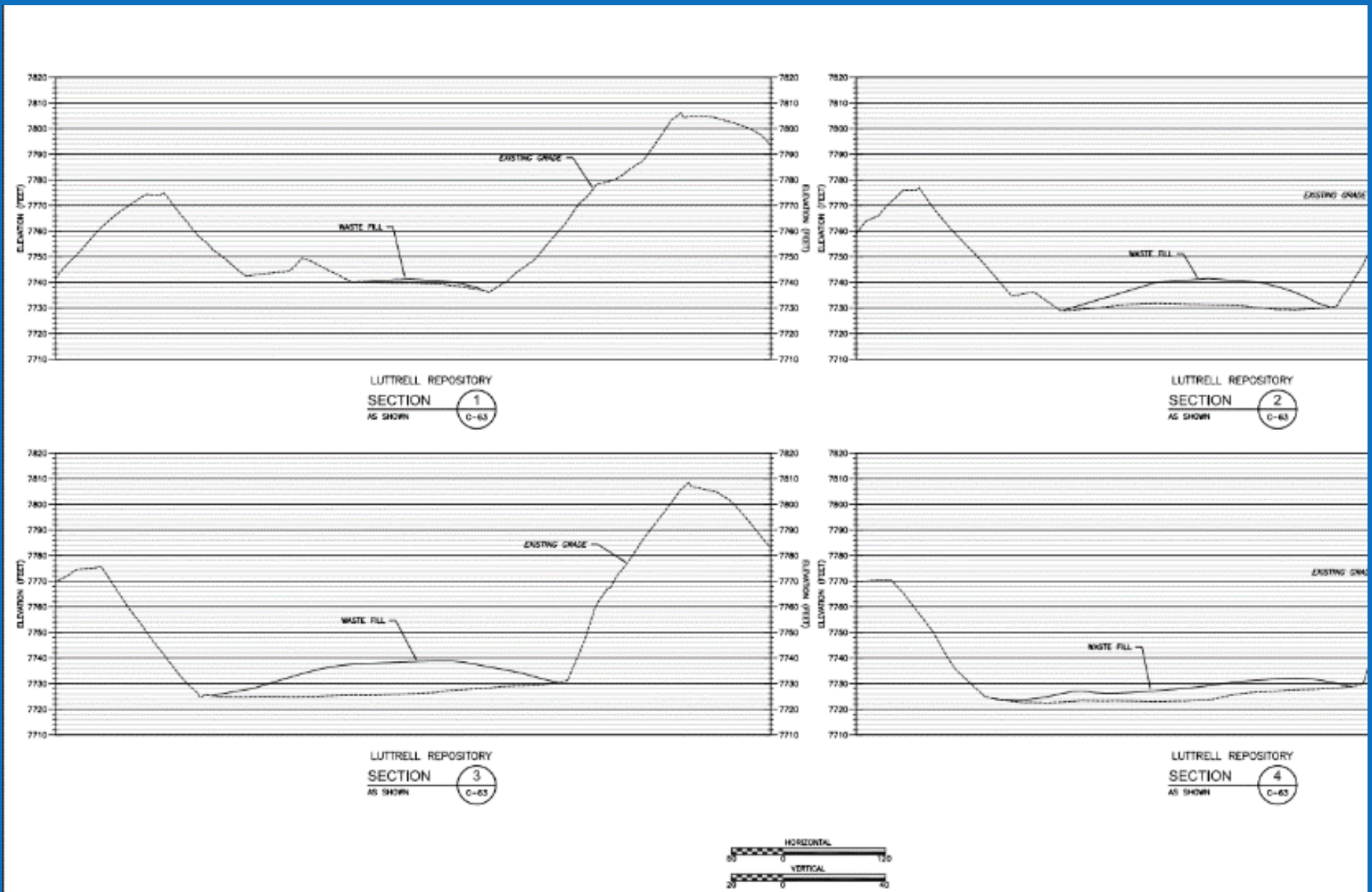
- NPL listing in 1999
- RI/FS 2000-2002
- ROD 2002
- Initial focus on residential yards with photogrammetric topography
- Shift to mine sites in 2011
- Lidar collected for entire site for mine site designs



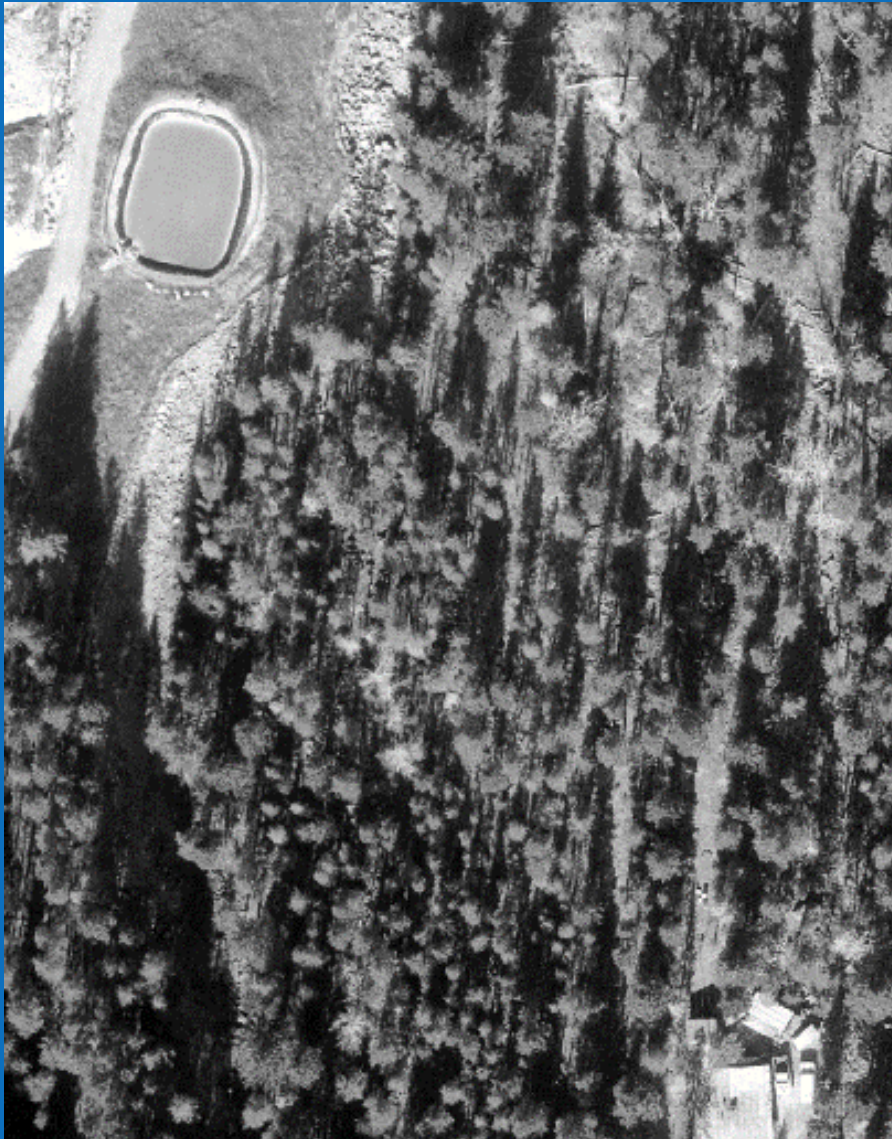
Upper Tenmile Creek Remedial Design



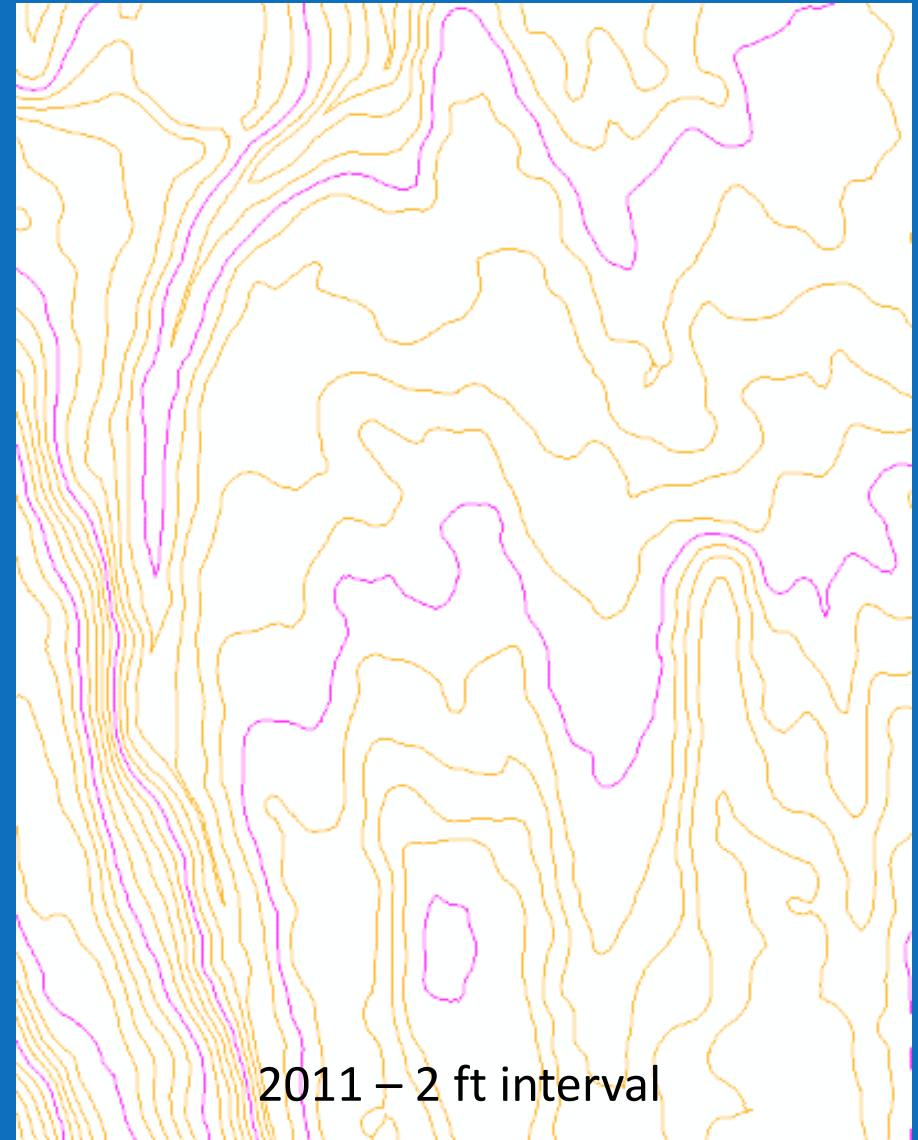
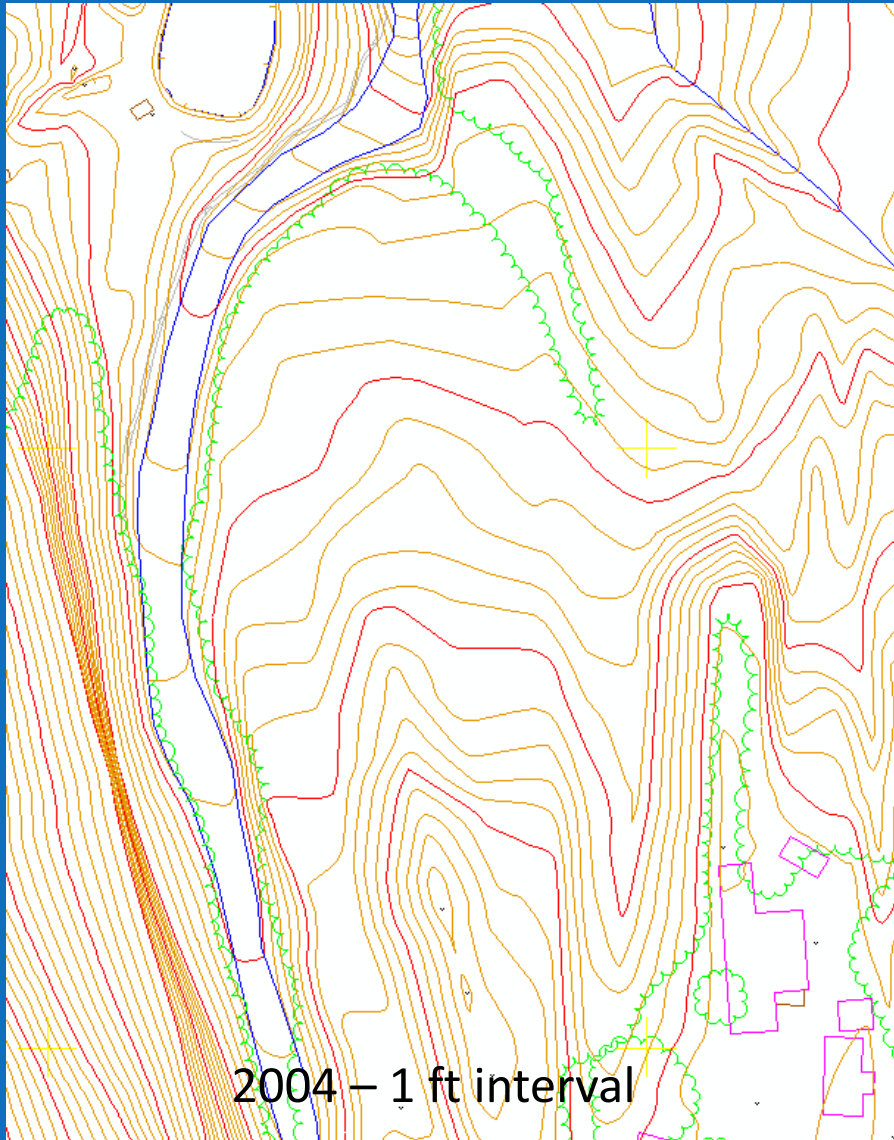
Upper Tenmile Creek Remedial Design



Rimini Comparison to Photogrammetry



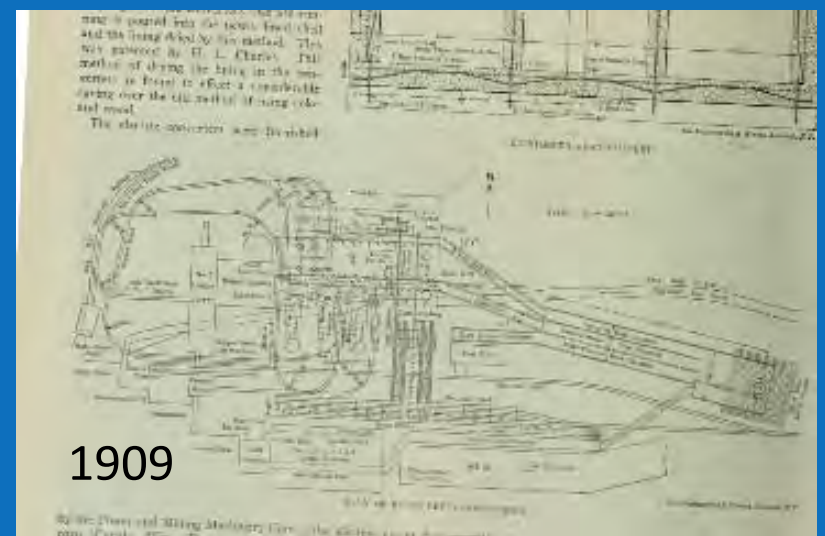
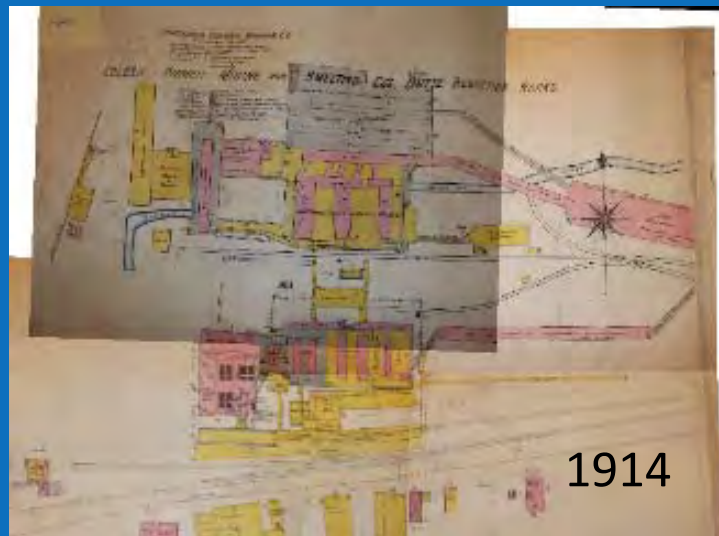
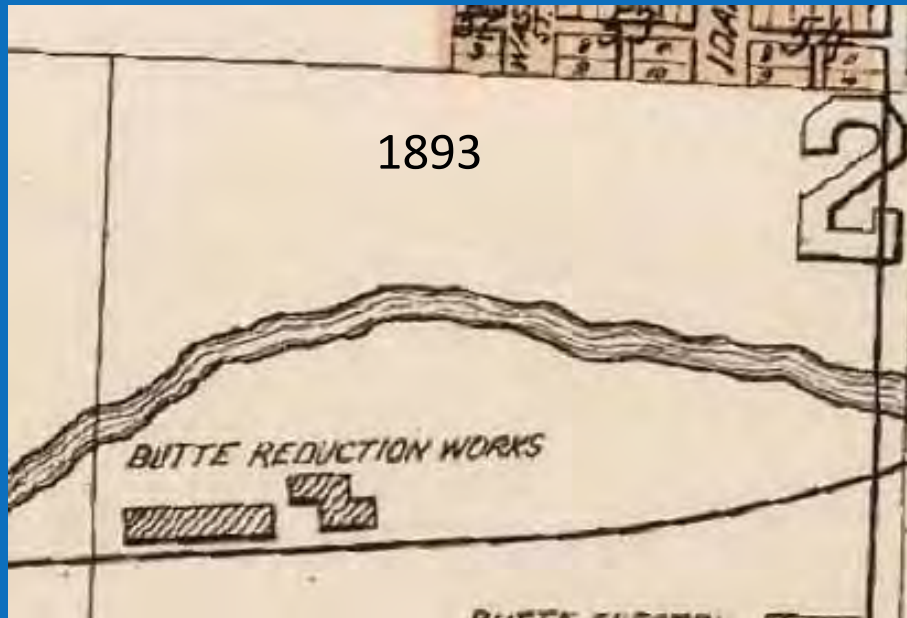
2004 Photogrammetry and 2011 Lidar



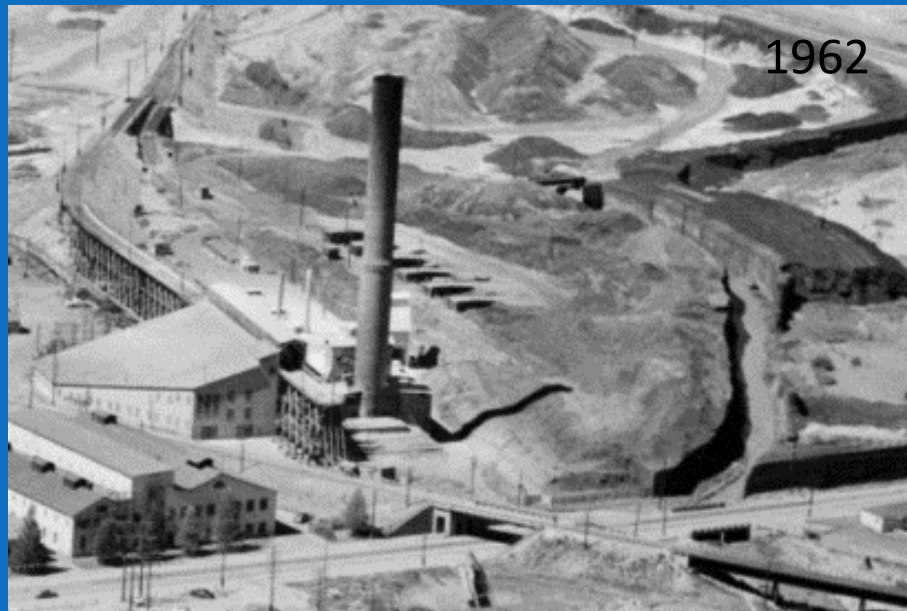


Butte Reduction Works

Butte Reduction Works, Montana



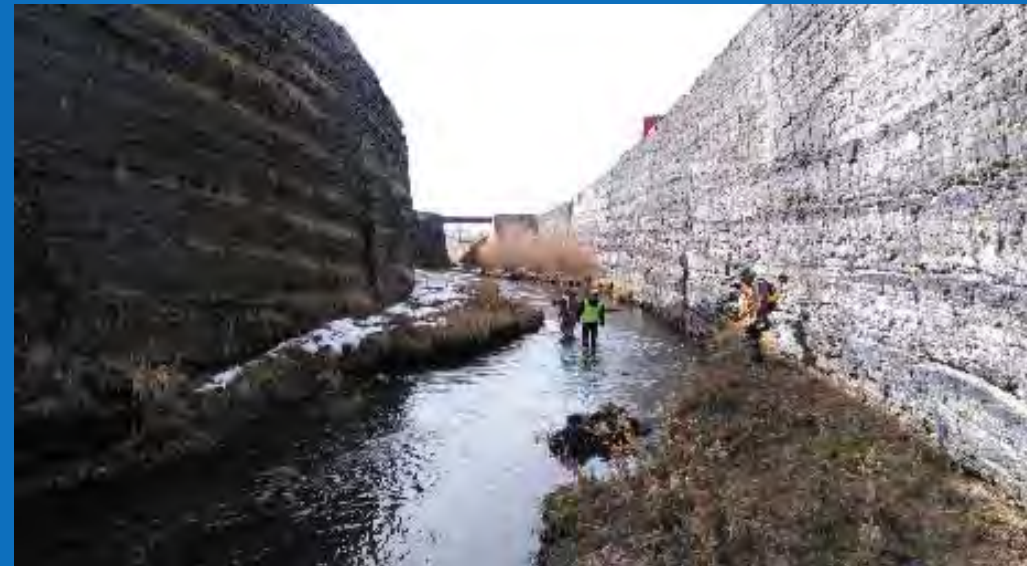
Butte Reduction Works, Montana



Butte Reductions Works Smelter



- Tunnel accurately located and mapped
- 305 foot smelter stack foundation located
- Poured slag walls more accurately mapped
- Will be used for design





Lidar Cost

Costs

Tenmile Creek Deliverables

- Orthophotography
- 2-foot contours
- Point files

- Approximately 34 square miles

- \$110,000 (\$3200/sq mi)

- Combined with other sites to reduce costs

Barker Deliverables

- Point Files (.las and MKP)
- No photography

- Approximately 7 square miles

- \$36,500 (\$5200/sq mi)

- Combined with other sites to reduce costs

Tenmile Photogrammetry

- Point Files
- Contours
- B&W photography

- Approximately 0.28 square miles

- \$17,000 (\$61,000/sq mi)

- Combined with ground survey to reduce costs