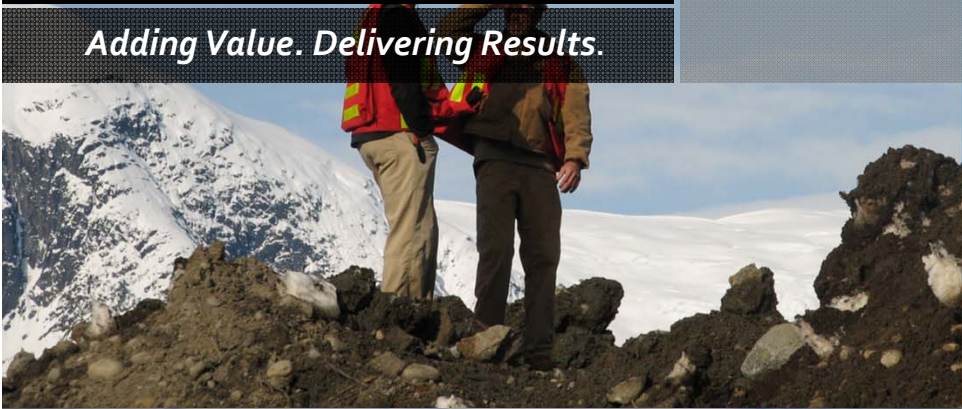


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Adding Value. Delivering Results.

Some Unique Approaches to Tailings Management and Heap Leaching



GOLD

TAILING STORAGE FACILITY DESIGN AND CONSTRUCTION

Project Spotlight: *Fort Knox Mine, Alaska*

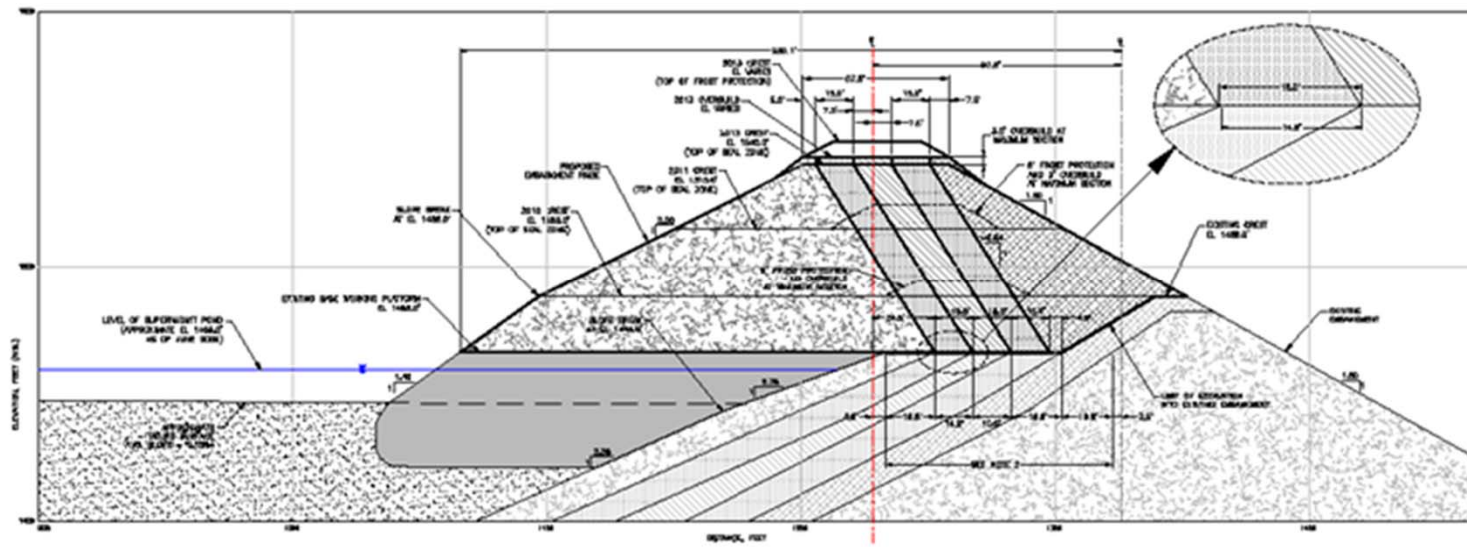
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TAILING STORAGE FACILITY DESIGN AND CONSTRUCTION

Project Spotlight: *Fort Knox Mine, Alaska*

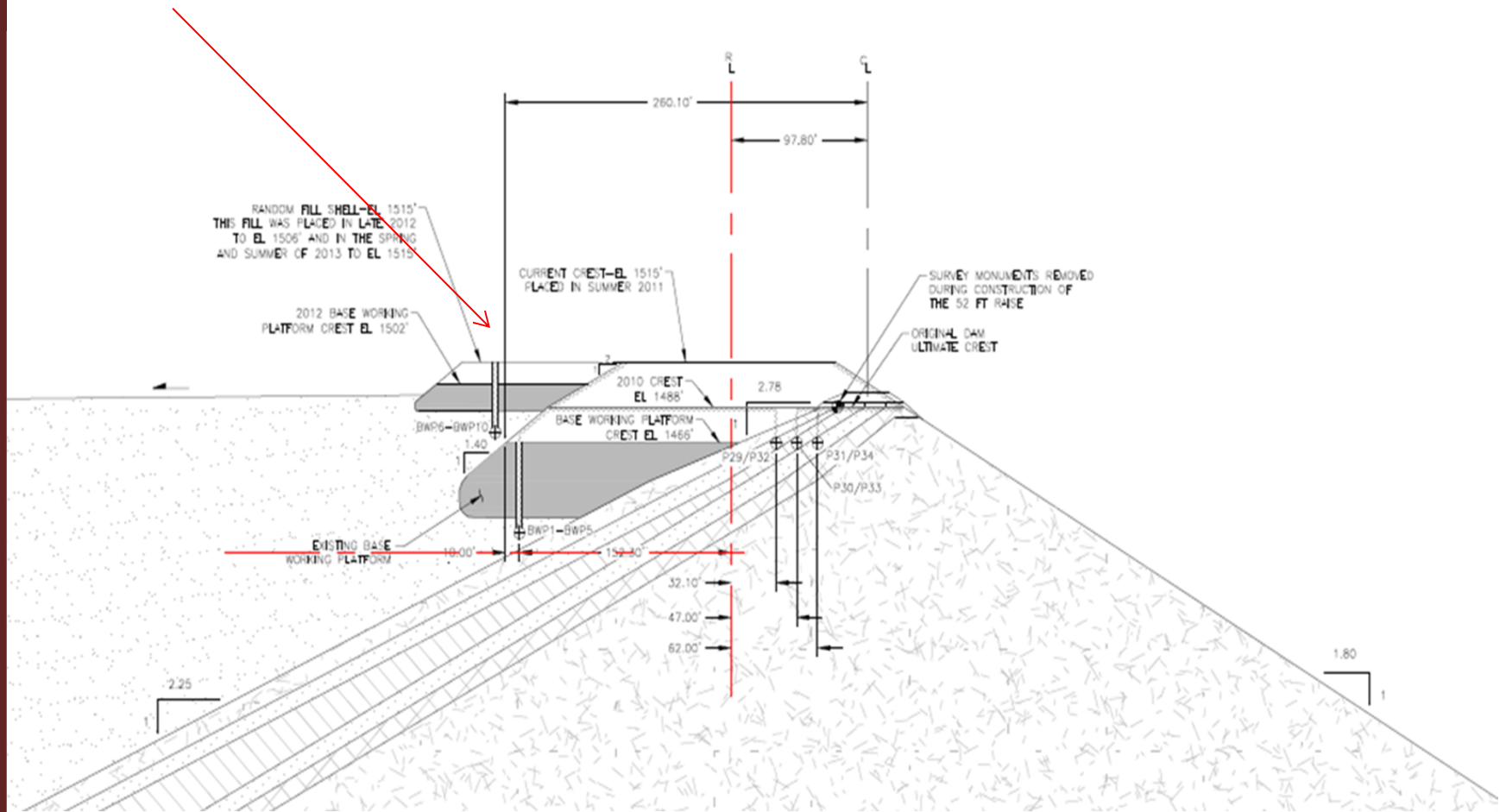
- Large Embankment Dam converted to centerline raises
- Construction of first platform in deep water
- Rock fill separator dyke constructed also in deep water
- Excavated first into dam to re-orientate the “engineered” zones and then re-used Seal Zone material
- High seismic and cold climate area



TAILING STORAGE FACILITY DESIGN AND CONSTRUCTION

Project Spotlight: *Fort Knox Mine, Alaska*

Recent second platform and step out on tailings beach



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TAILING STORAGE FACILITY DESIGN AND CONSTRUCTION

Project Spotlight: *Fort Knox Mine, Alaska*



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TAILING STORAGE FACILITY DESIGN AND CONSTRUCTION

Project Spotlight: *Fort Knox Mine, Alaska*



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TAILING STORAGE FACILITY DESIGN AND CONSTRUCTION

Project Spotlight: *Fort Knox Mine, Alaska*



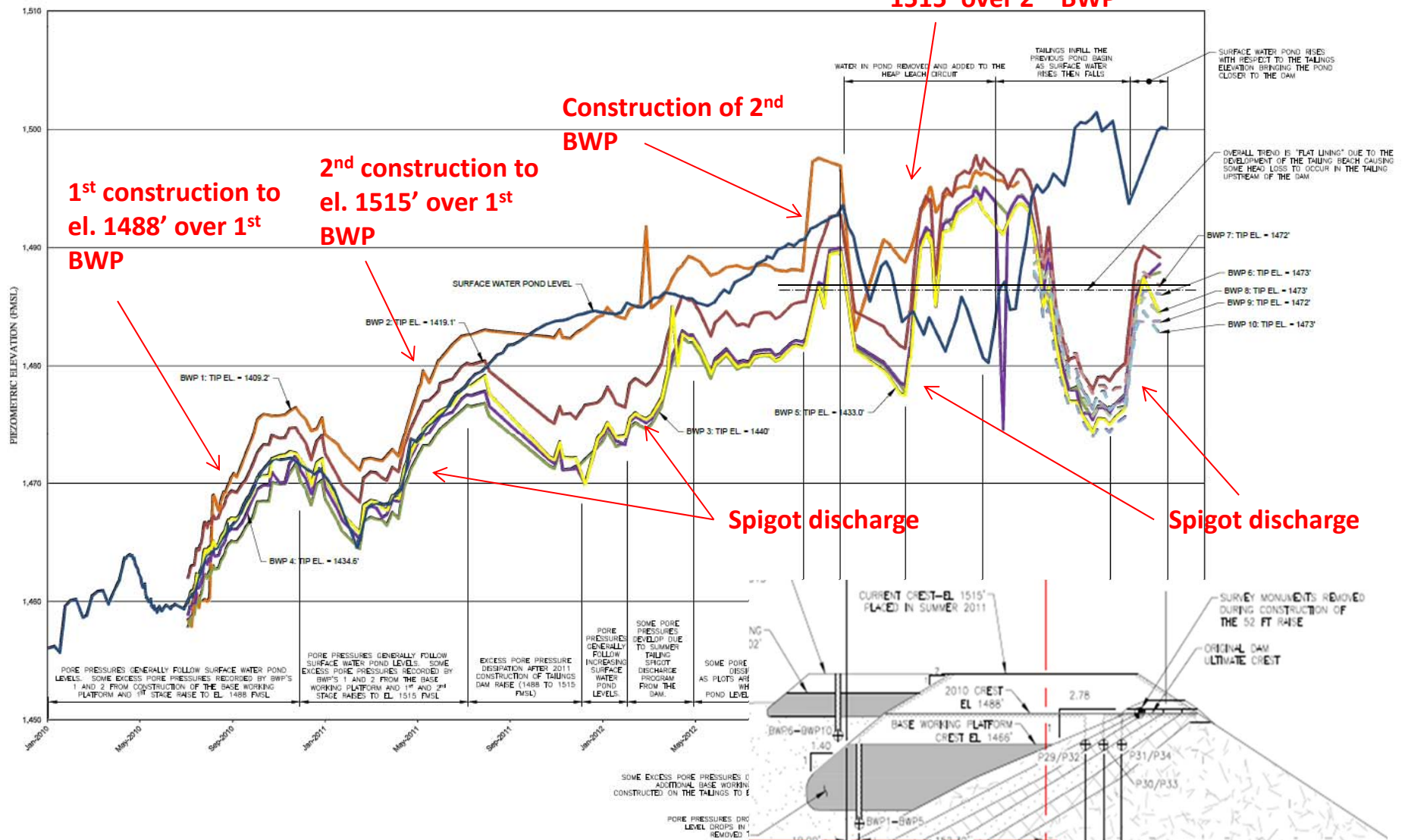
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TAILING STORAGE FACILITY DESIGN AND CONSTRUCTION

Project Spotlight: *Fort Knox Mine, Alaska*

1st construction to el. 1515' over 2nd BWP

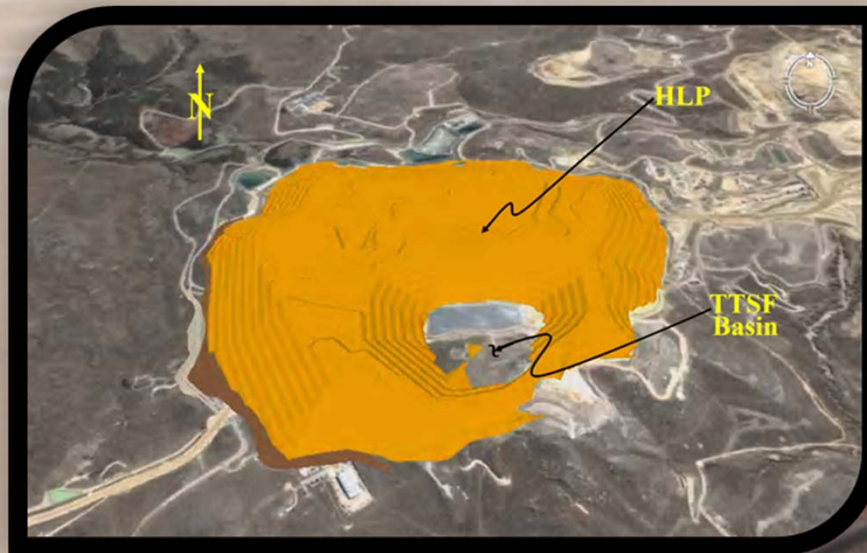


Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinoa Mine*, Peru

- Wrap around leach ore embankments provide tailings containment
- Design for high seismic loading
- Rotational deposition of thickened tailings to produce drained beaches
- Separate fluids removal systems
- 2011/2012 extensive geotechnical investigation to prove up earlier adopted design parameters



Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinoa Mine*, Peru



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Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinua Mine*, Peru

Key Issues

Leach ore embankments needed to provide the high level of security required of other major tailings dams

However, the leach ore is placed in thick 16 m uncompacted lifts to maintain adequate permeability for leaching and is irrigated with a high solution rate (10 L/hr/m²)

Loose structure made static and dynamic liquefaction a key issue



Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinua Mine*, Peru

Design Solution

Provide the embankments with wide cross sections to support loading and leaching and thus wide shells

Keep side slope leaching rates low (max. 3 L/hr/m²)

Thicken the tailings to reduce the amount of water entering the combined facility

Use a rotational tailings deposition method from the inside crests of the embankments to build drained and stable beaches against the embankments

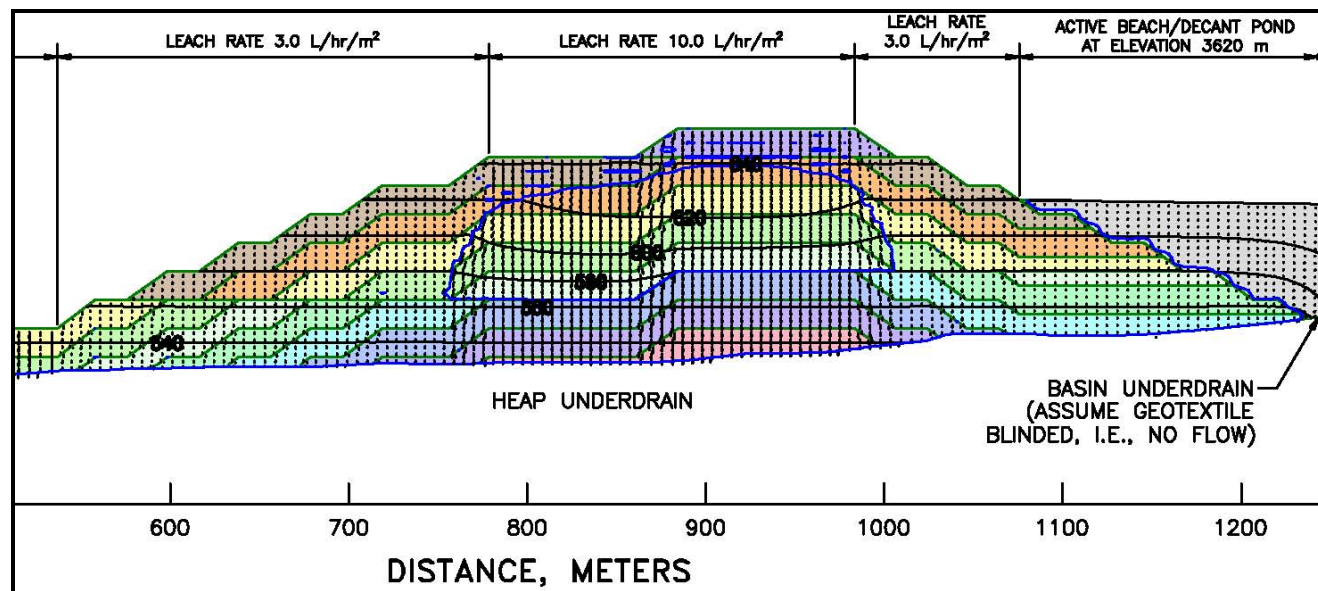


Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinua Mine*, Peru

Design Approach

Keep the ore that becomes saturated or near saturated when under leach well-removed from the outer faces of the embankments and contained behind large unsaturated structural shells



Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinoa Mine*, Peru

2011/2012 Geotechnical investigation consisted of:

Sonic drilling to obtain leach ore samples

SCPT testing to evaluate liquefaction potential, residual (post-liquefaction) undrained shear strengths, and peak undrained shear strengths of the mill sands and leach ore

SCPT testing and piezometers installations to fill in gaps from previous installations to evaluate pore pressure profiles within the mill sands and the leach ore embankments

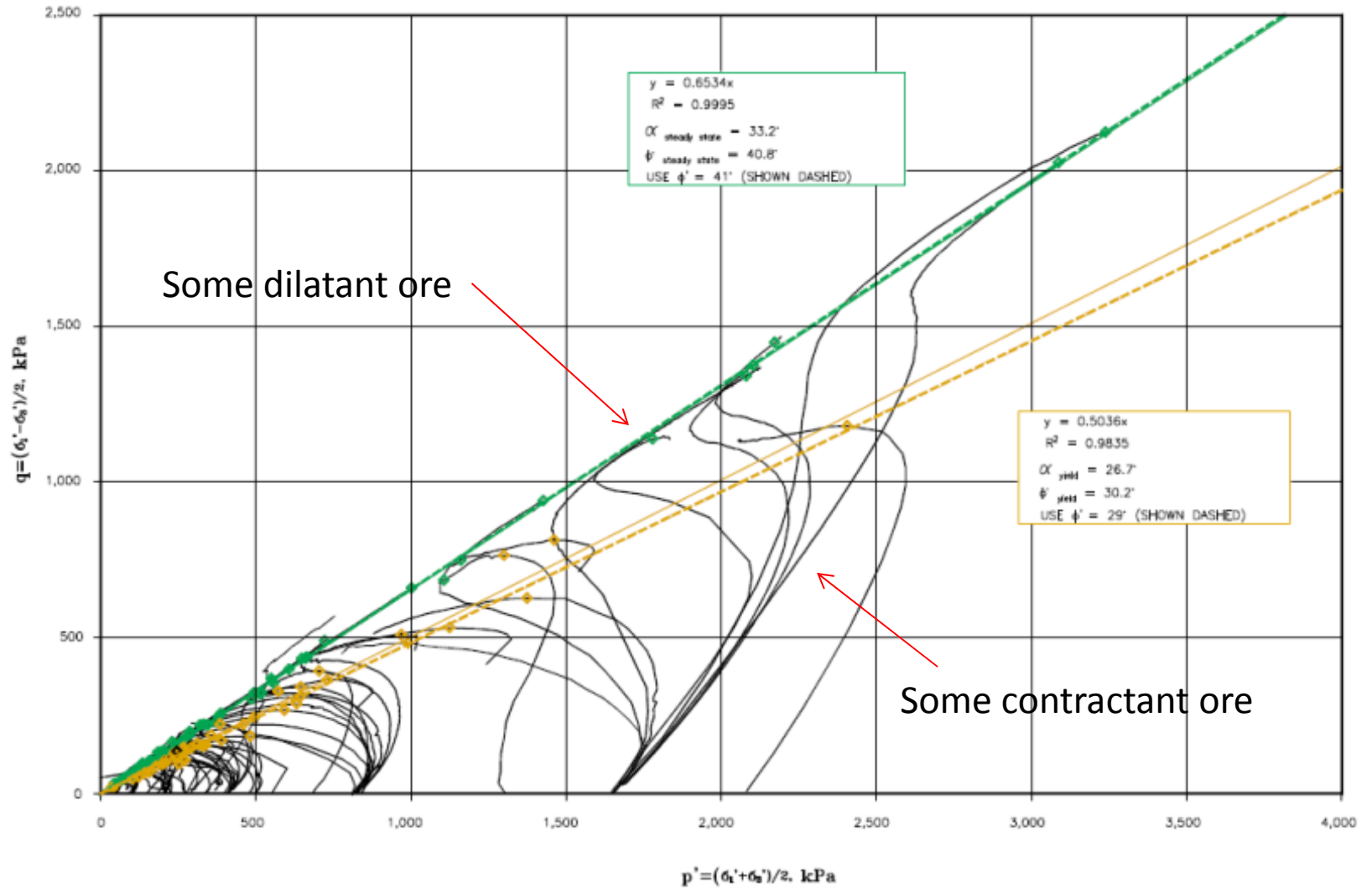
Assess potential borrow material for suitability for use in raise berm construction associated with expanding mill sands storage capacity



Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinua Mine*, Peru

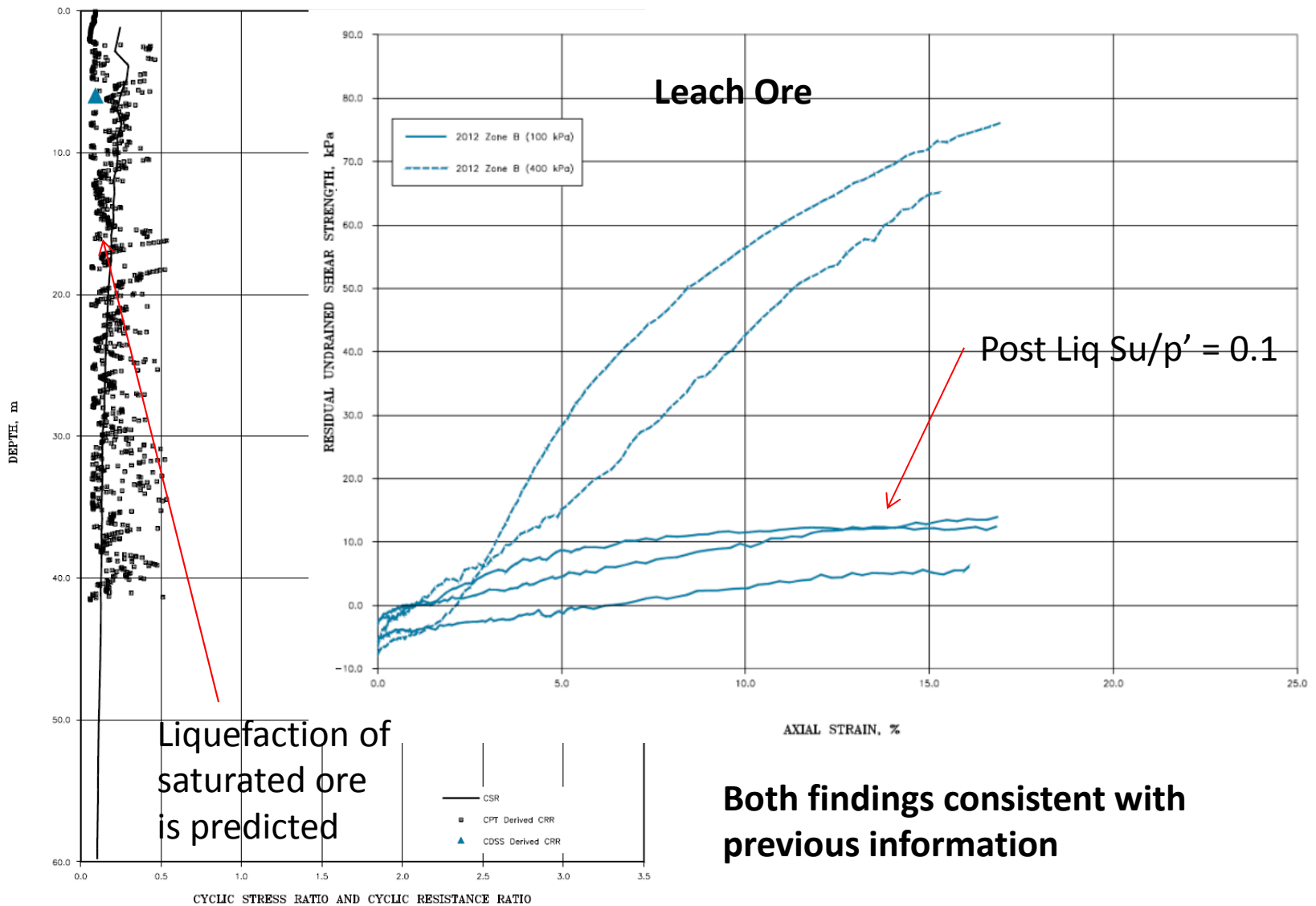


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Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinua Mine*, Peru

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Liquefaction of saturated ore is predicted

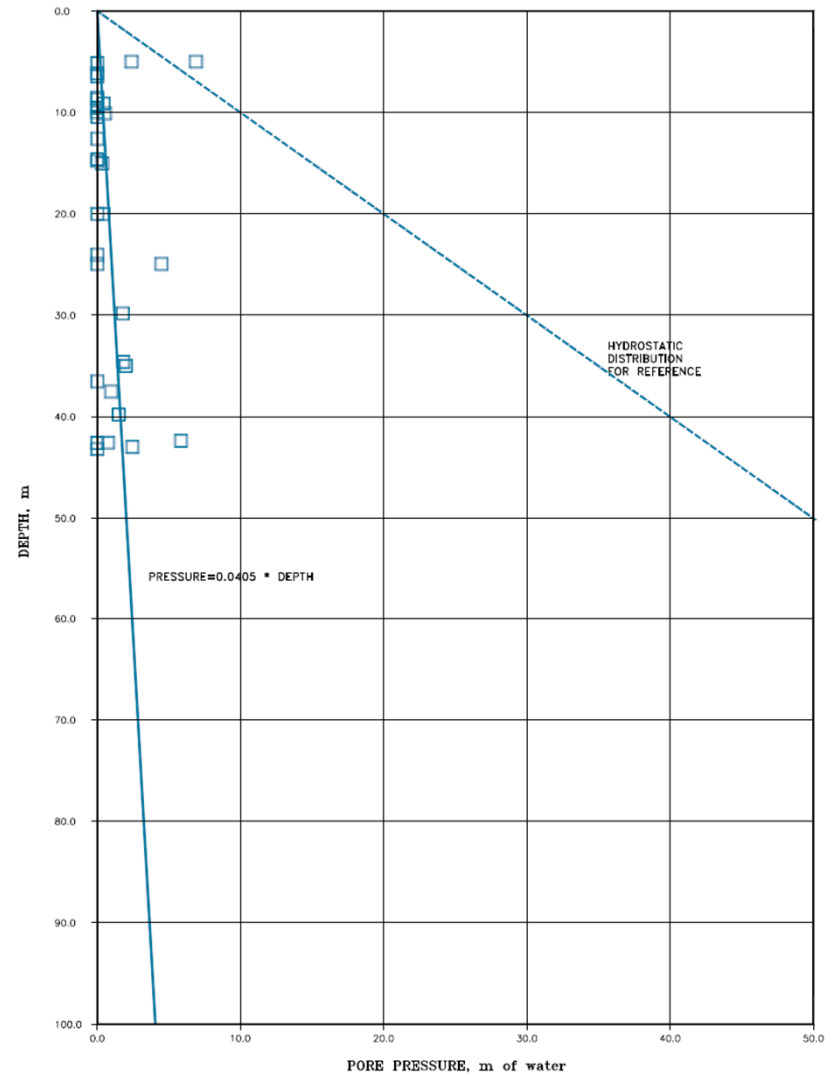
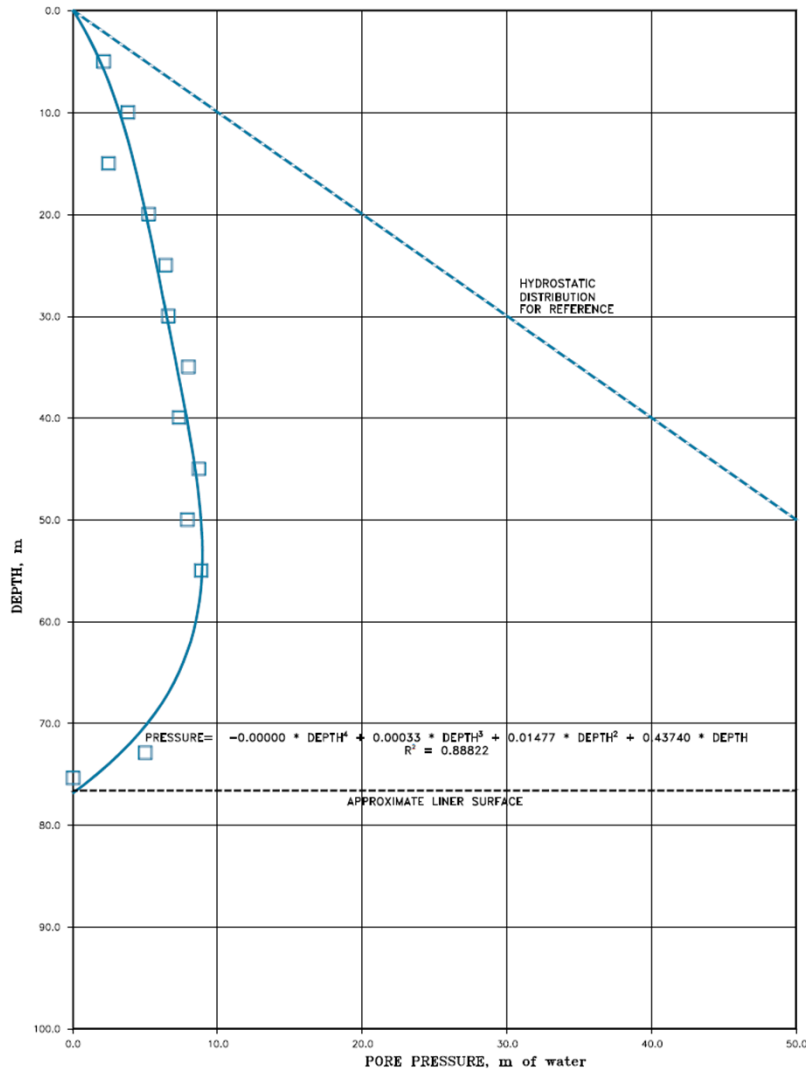
Both findings consistent with previous information

Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinoa Mine*, Peru

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Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinoa Mine*, Peru

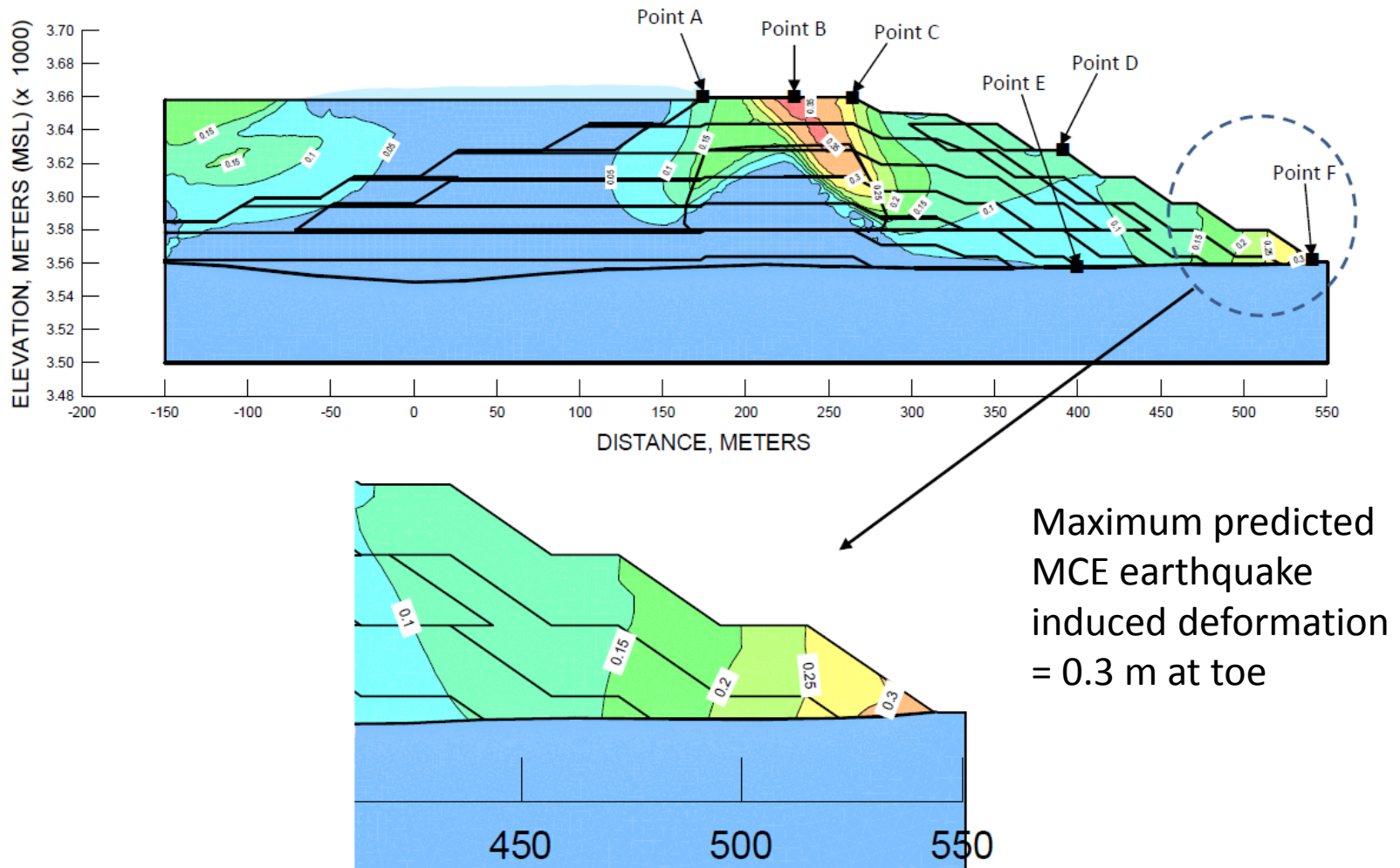


Figure I-3: Section H (Crest Elevation at 3660 meters) – Deformation Analysis Results (Total Deformation Contour)

Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinua Mine*, Peru

North Expansion Design Underway

Consists of two new storage impoundments:

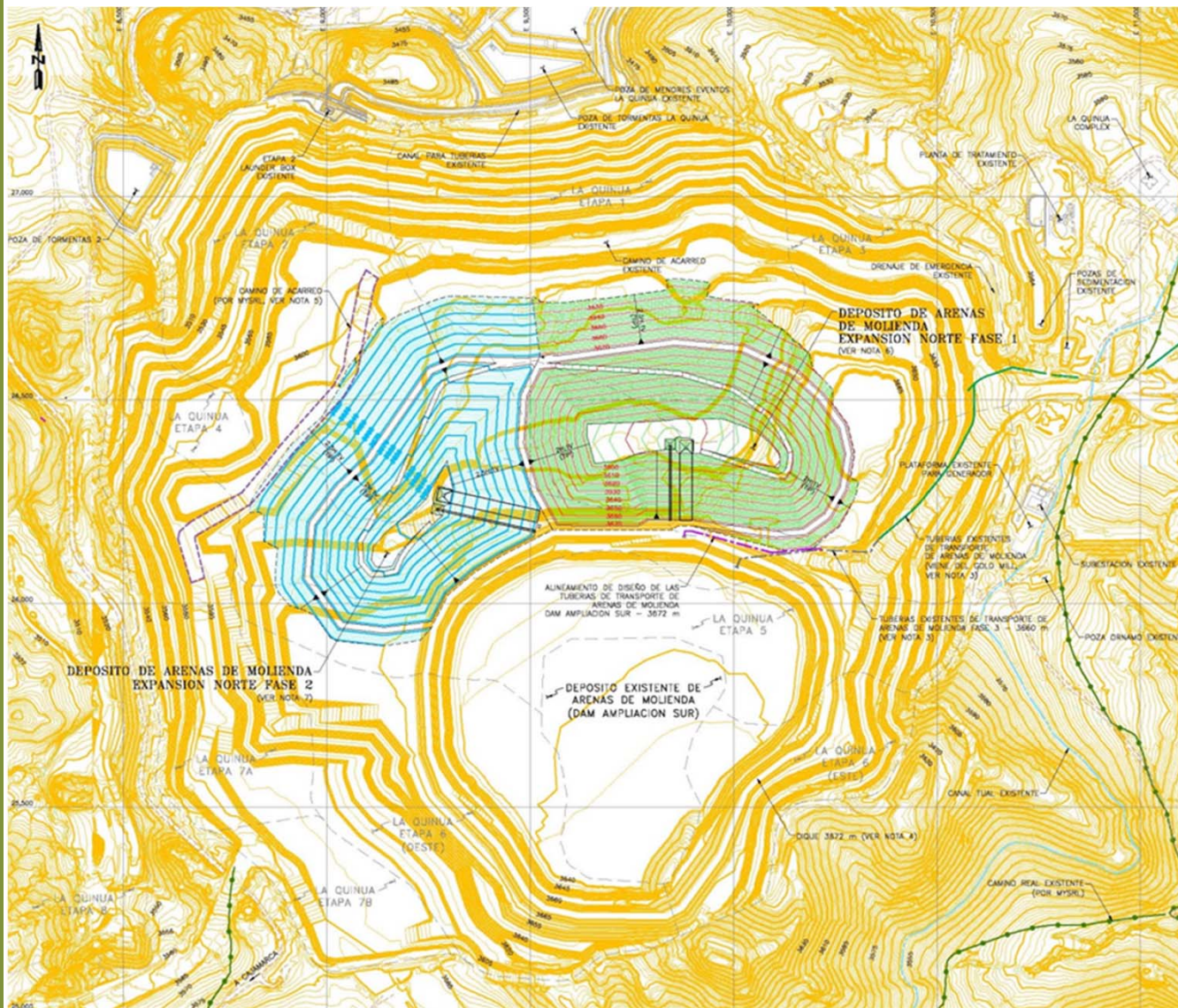
- Stage 1 with a capacity of 18 Mt, and
- Stage 2 with a capacity of 11 Mt.



Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinua Mine*, Peru



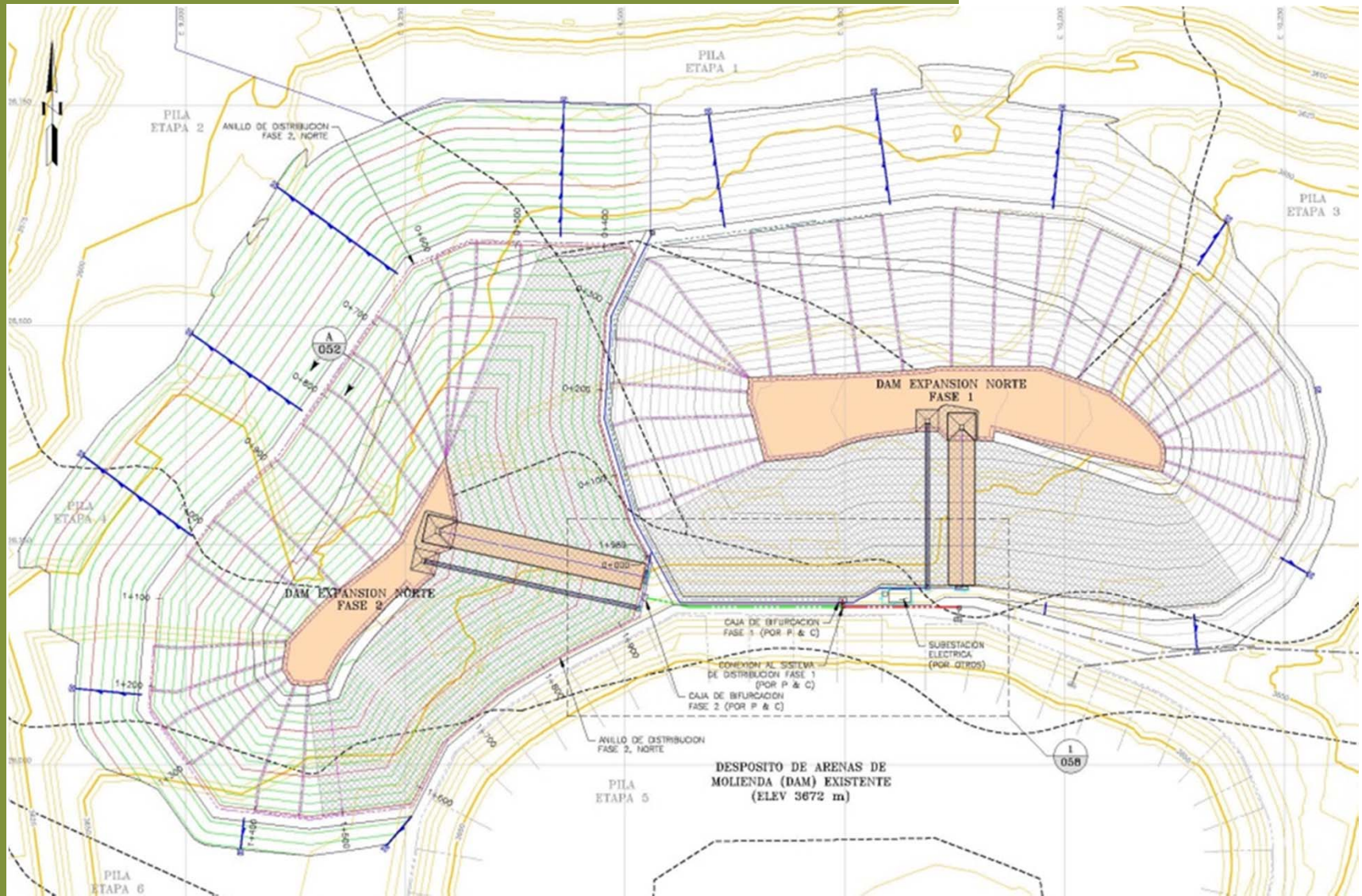
Leaching operations will end prior to the construction of the North Expansion.

Gold

Tailings Storage Facility Within a Heap Leach Pad

Project Spotlight: *La Quinoa Mine*, Peru

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Copper

A Possible New Reclaim Water Barge Access

Project Spotlight: *Sierrita Mine*, Arizona



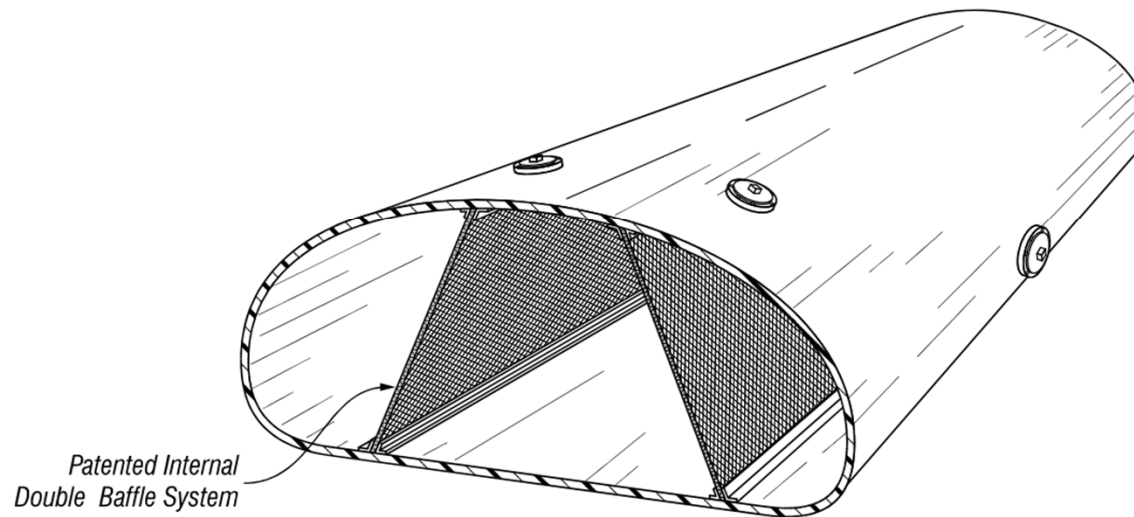
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A Proposed New Reclaim Water Barge Access

Project Spotlight: *Sierrita Mine*, Arizona

Using Aqua Barriers Filled with Water or Geotubes Filled with Tailings

Inflated double baffle  illustrating the patented inner restraint double baffle system.



All external and internal components are welded together. This one-piece construction principle eliminates the problems associated with detached internal or external components which may become misplaced.

Copper

A New Reclaim Water Barge Access

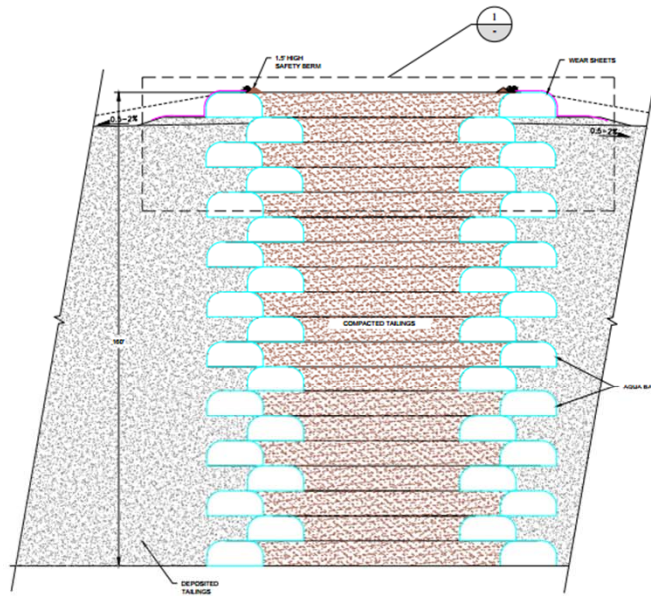
Project Spotlight: *Sierrita Mine*, Arizona



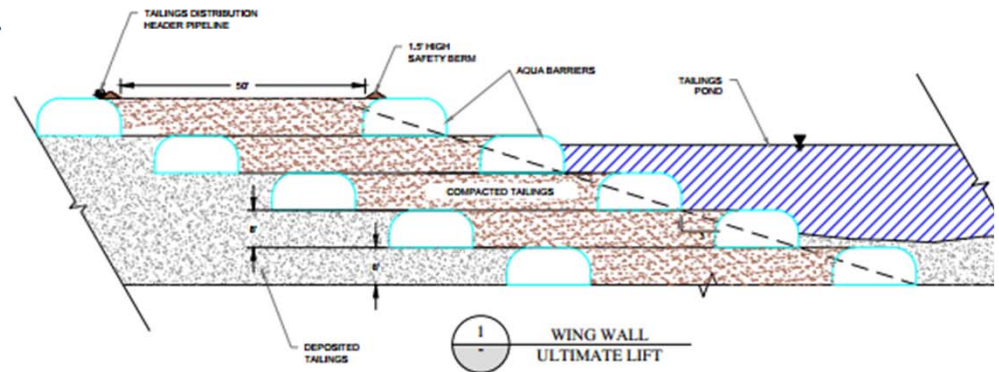
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A New Reclaim Water Barge Access

Project Spotlight: *Sierrita Mine*, Arizona



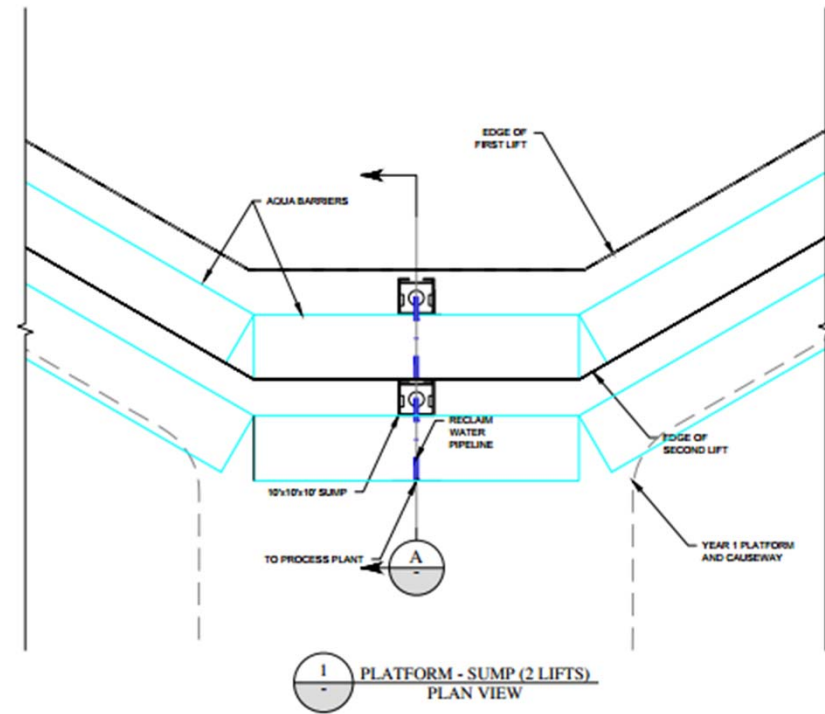
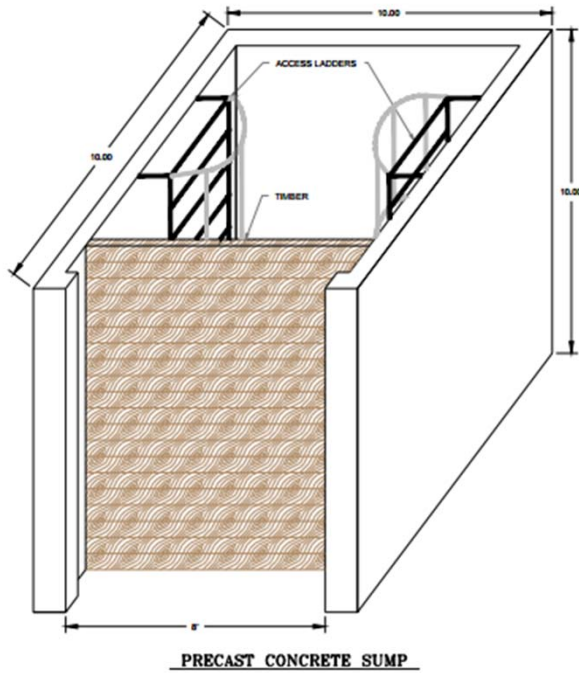
B
1 ACCESS CAUSEWAY
CROSS SECTION (TYP)



1 WING WALL
ULTIMATE LIFT

A New Reclaim Water Barge Access

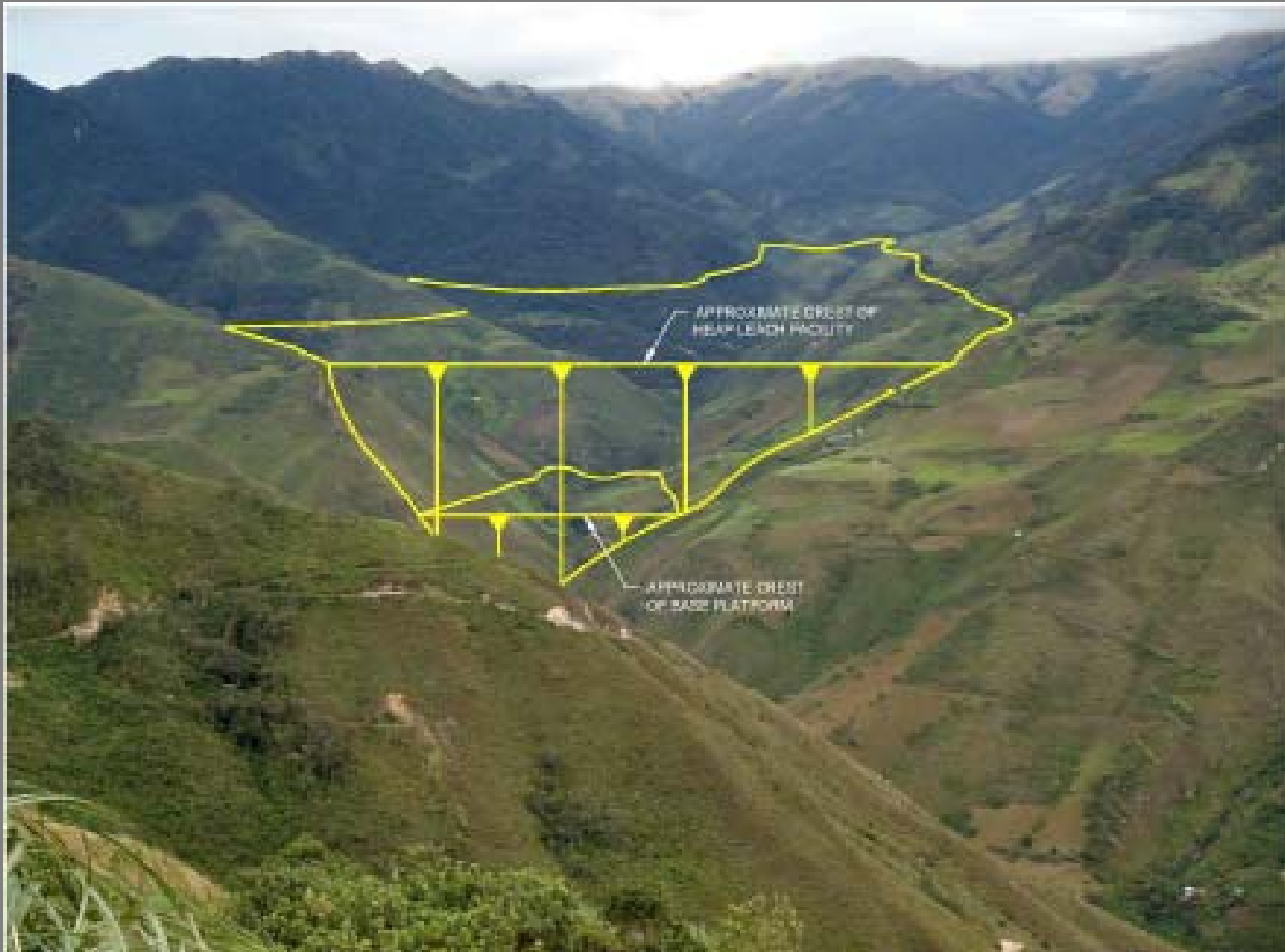
Project Spotlight: *Sierrita Mine*, Arizona



Copper

Steep and In Places Unstable Slopes to Line

Project Spotlight: *La Granja Mine*, Peru

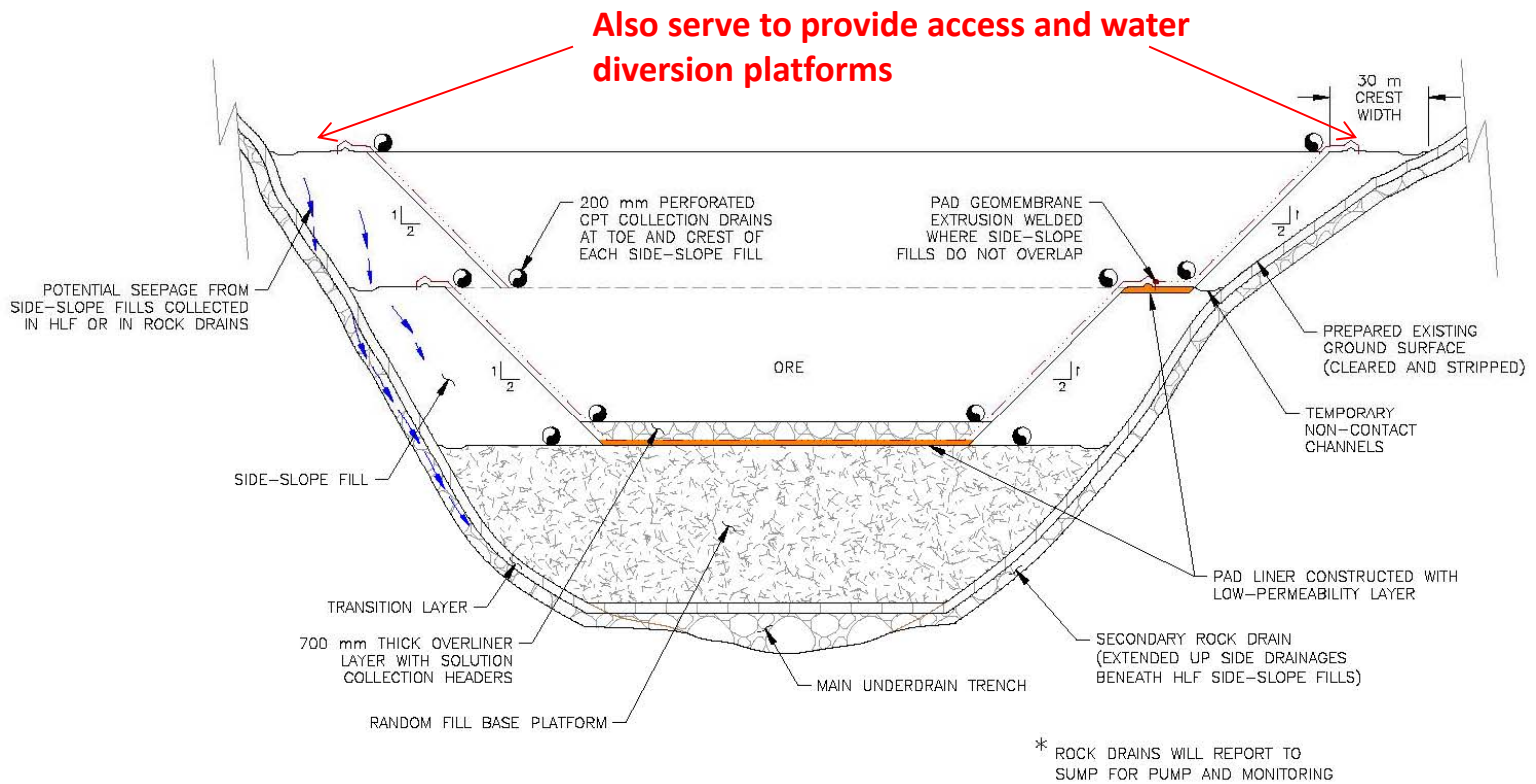


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Steep Slopes to Line

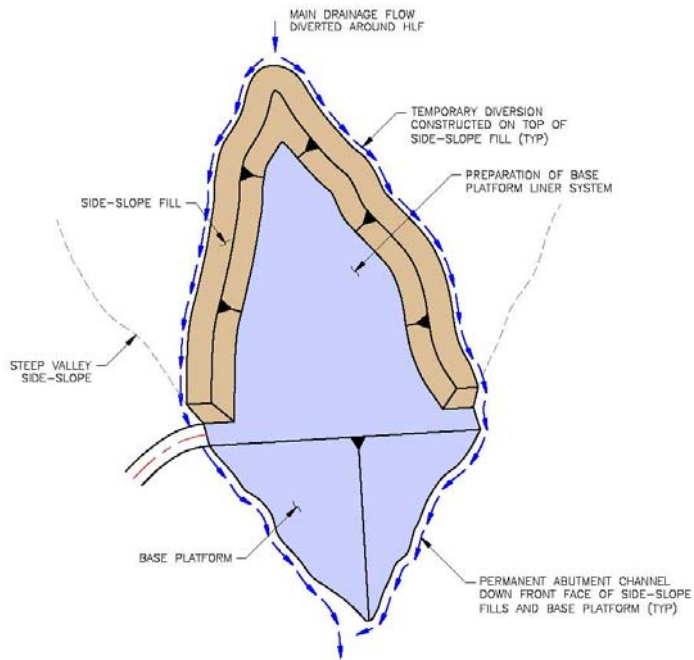
Project Spotlight: *La Granja Mine*, Peru

Side Slope Fills

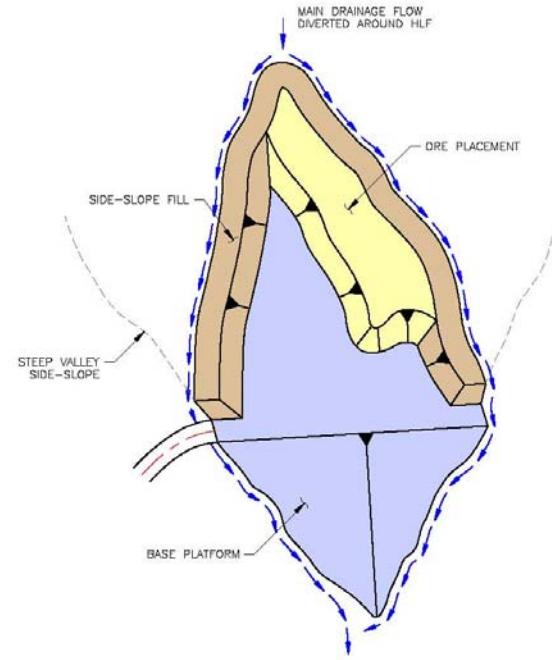


Steep Slopes to Line

Project Spotlight: *La Granja Mine*, Peru



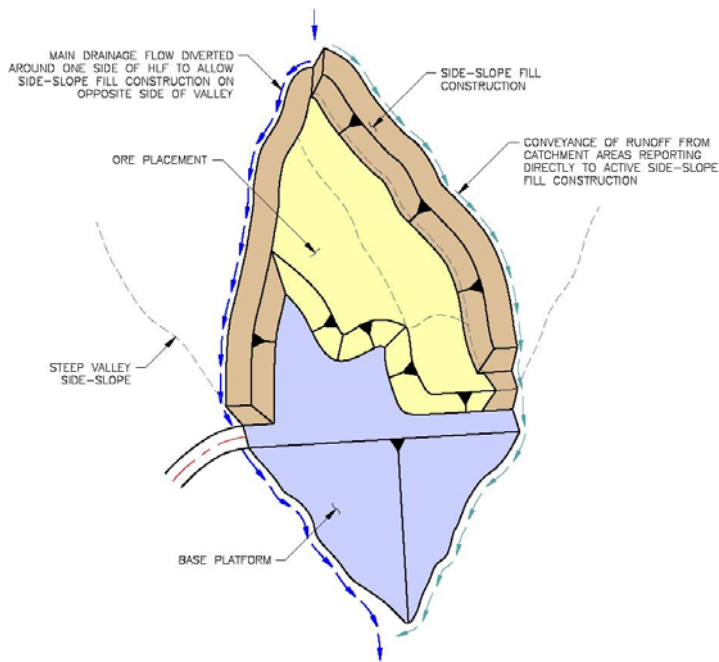
Step 1



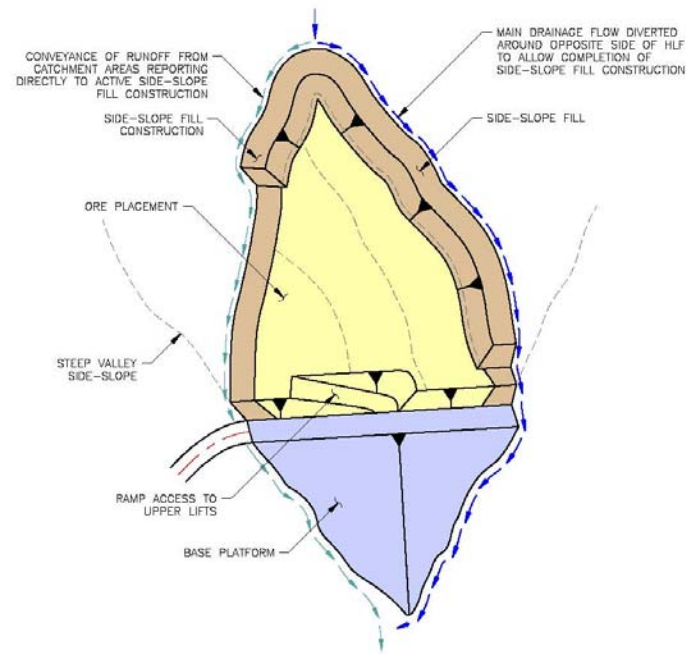
Step 2

Steep Slopes to Line

Project Spotlight: *La Granja Mine*, Peru



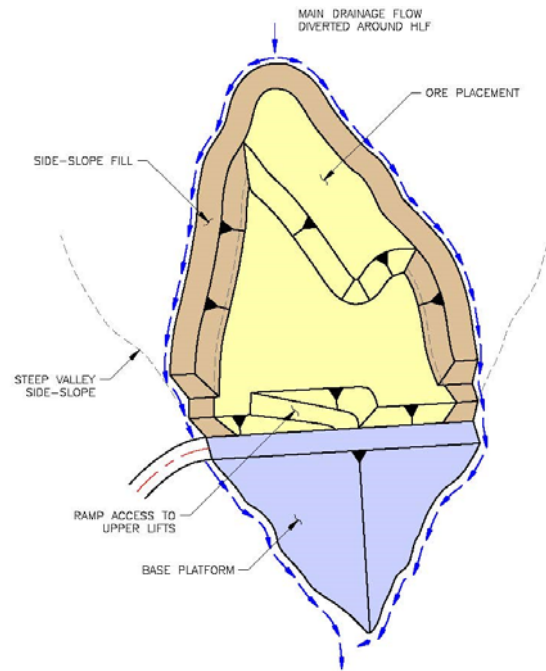
Step 3



Step 4

Steep Slopes to Line

Project Spotlight: *La Granja Mine*, Peru

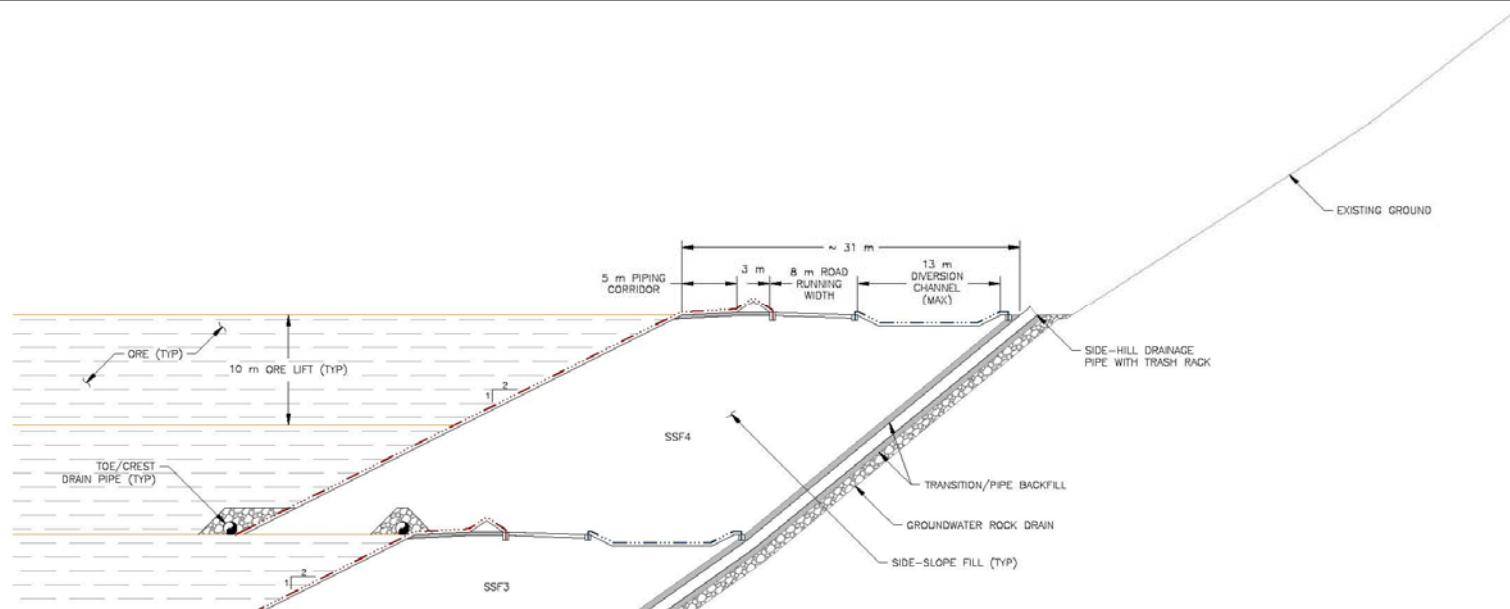


Step 5

Copper

Steep Slopes to Line

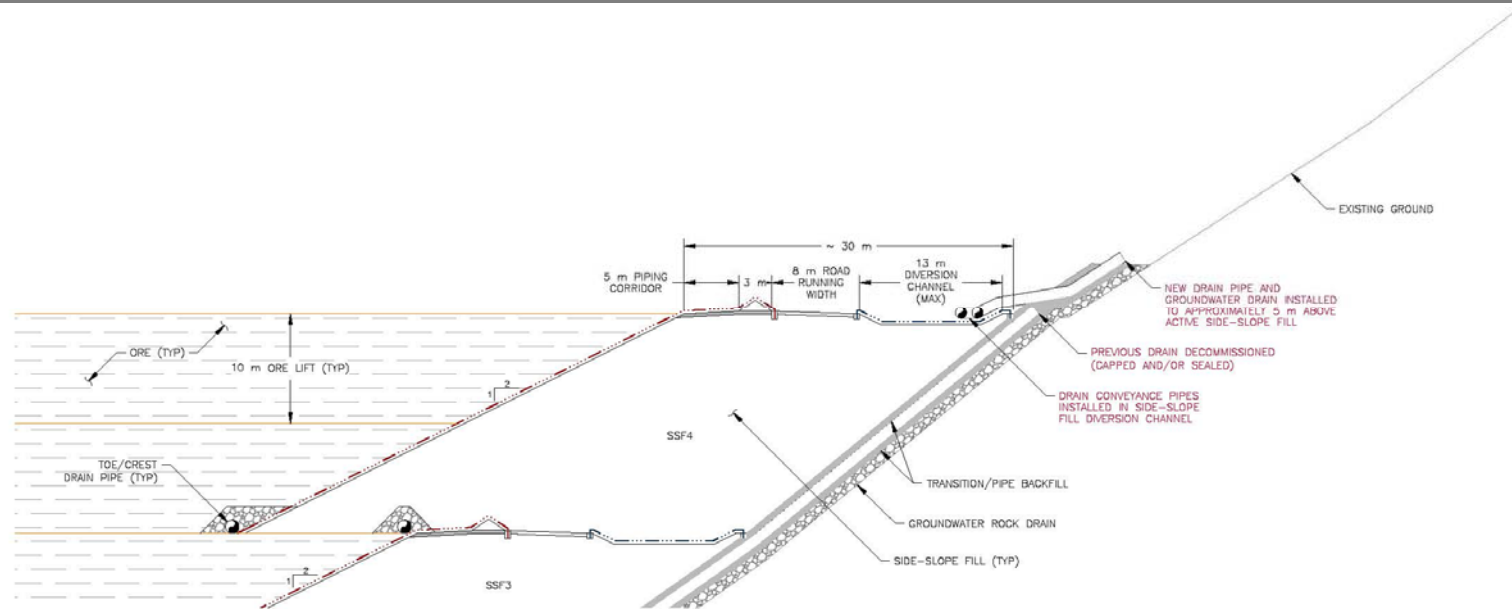
Project Spotlight: *La Granja Mine*, Peru



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Steep Slopes to Line

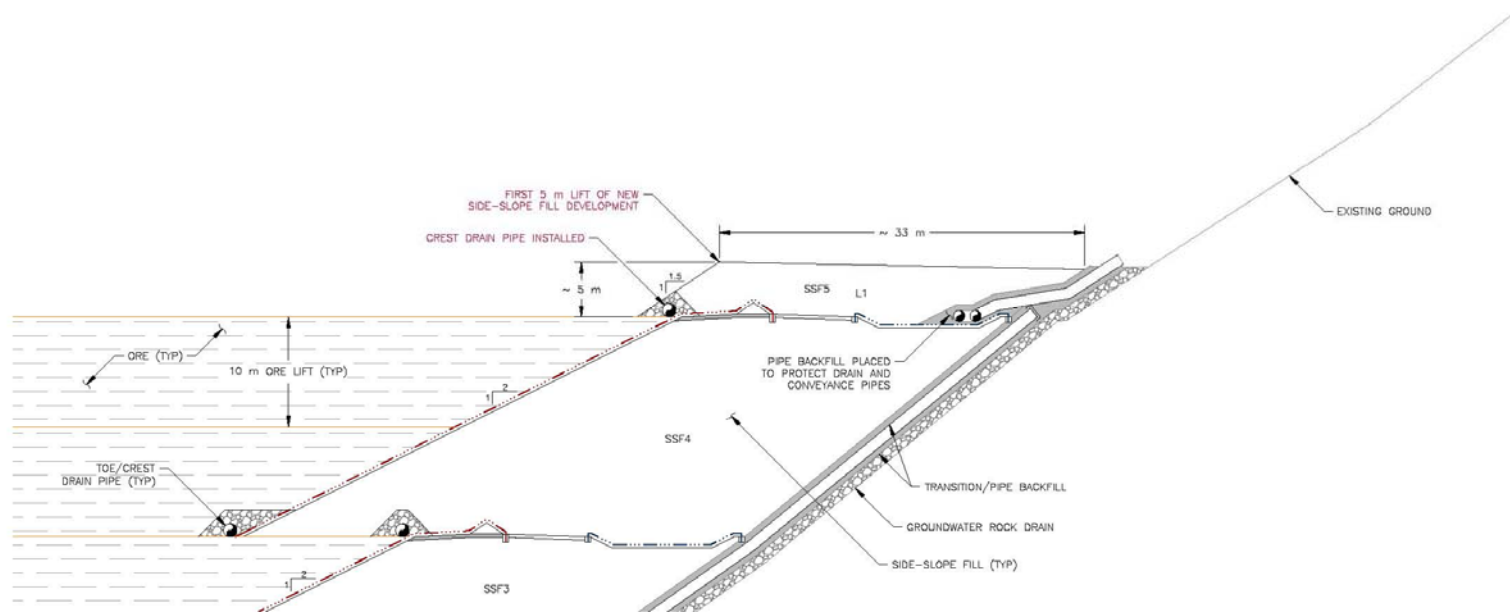
Project Spotlight: *La Granja Mine*, Peru



Copper

Steep Slopes to Line

Project Spotlight: *La Granja Mine*, Peru

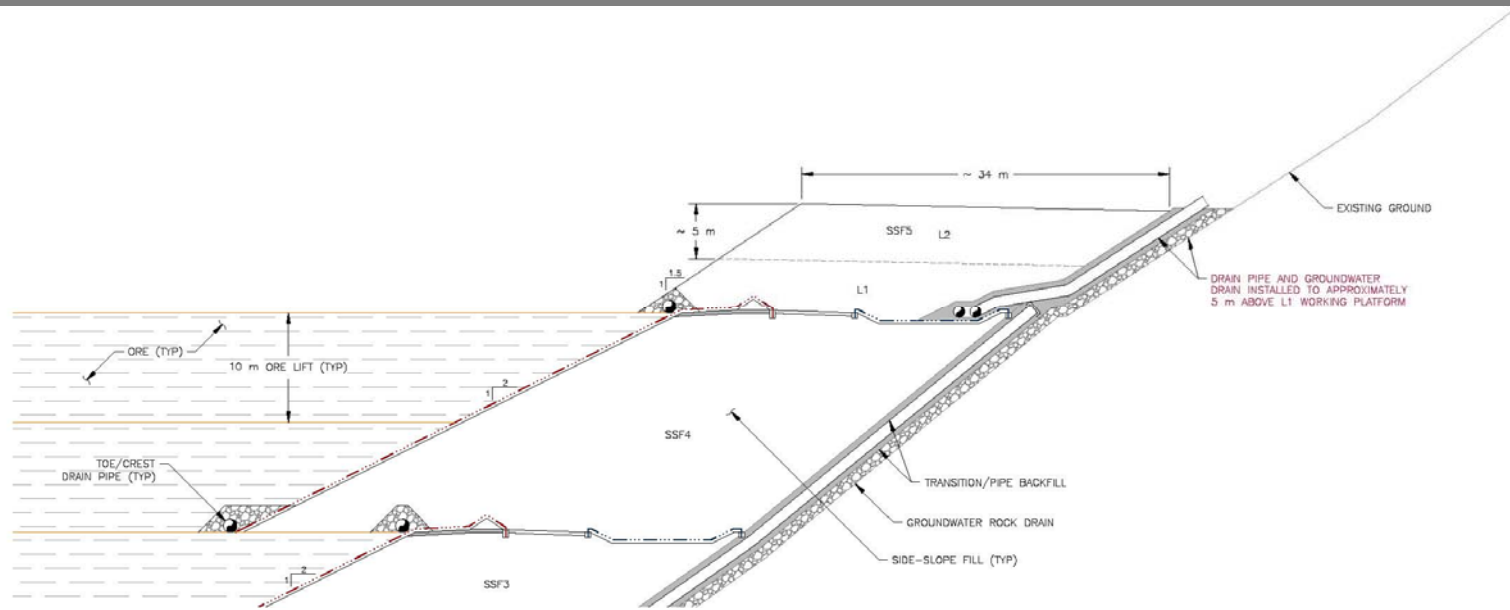


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Copper

Steep Slopes to Line

Project Spotlight: *La Granja Mine*, Peru



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Gold

Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska



Knight Piésold

Gold

Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

Largest height heap from toe to crest - current design 800' but planned to be expanded to 1100'

Maximum of 500' above liner at any point

In-heap solution collection pond for winter operations

Ore is competent granite - free draining and high strength

Leaching occurs all year including through very cold winters



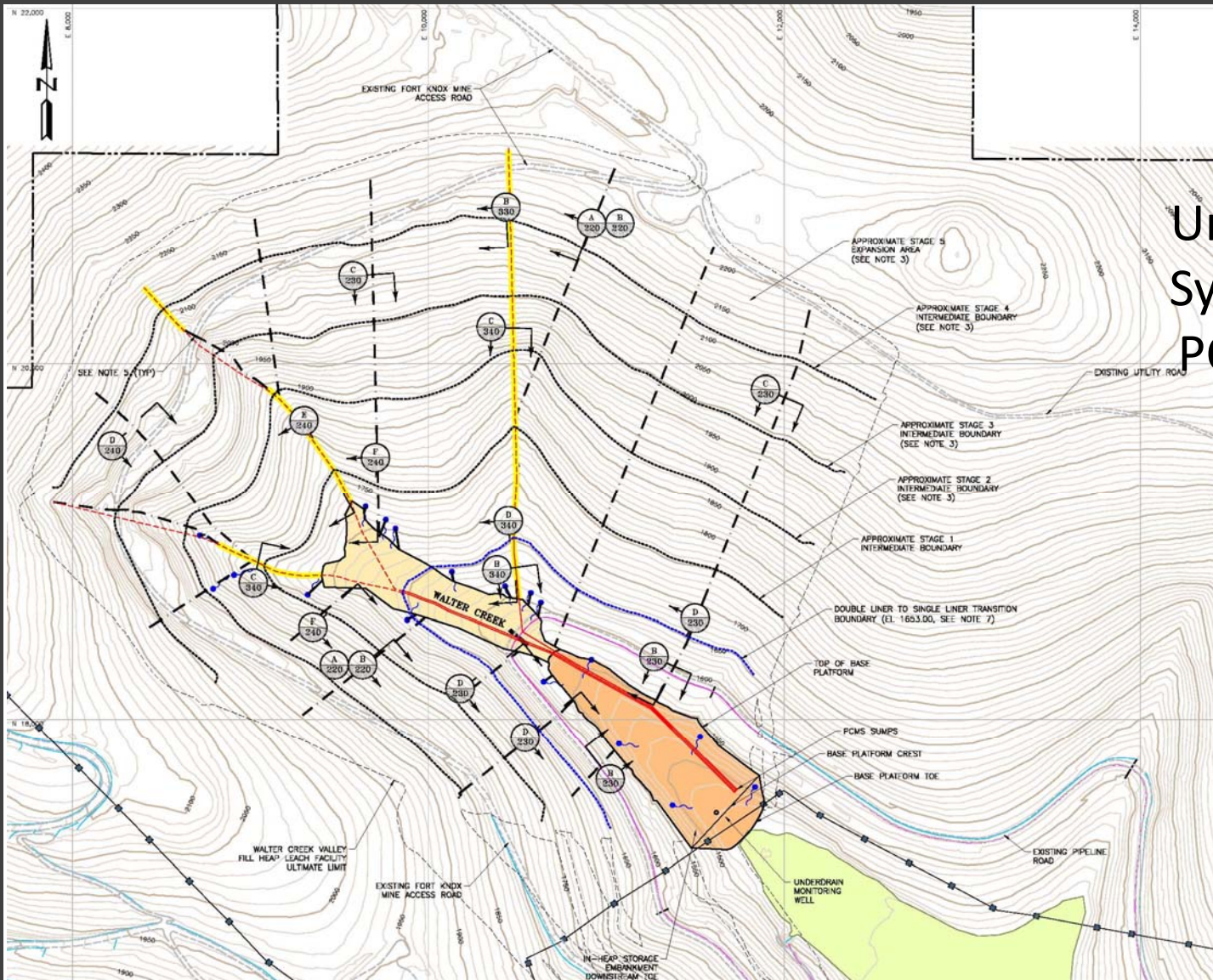
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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

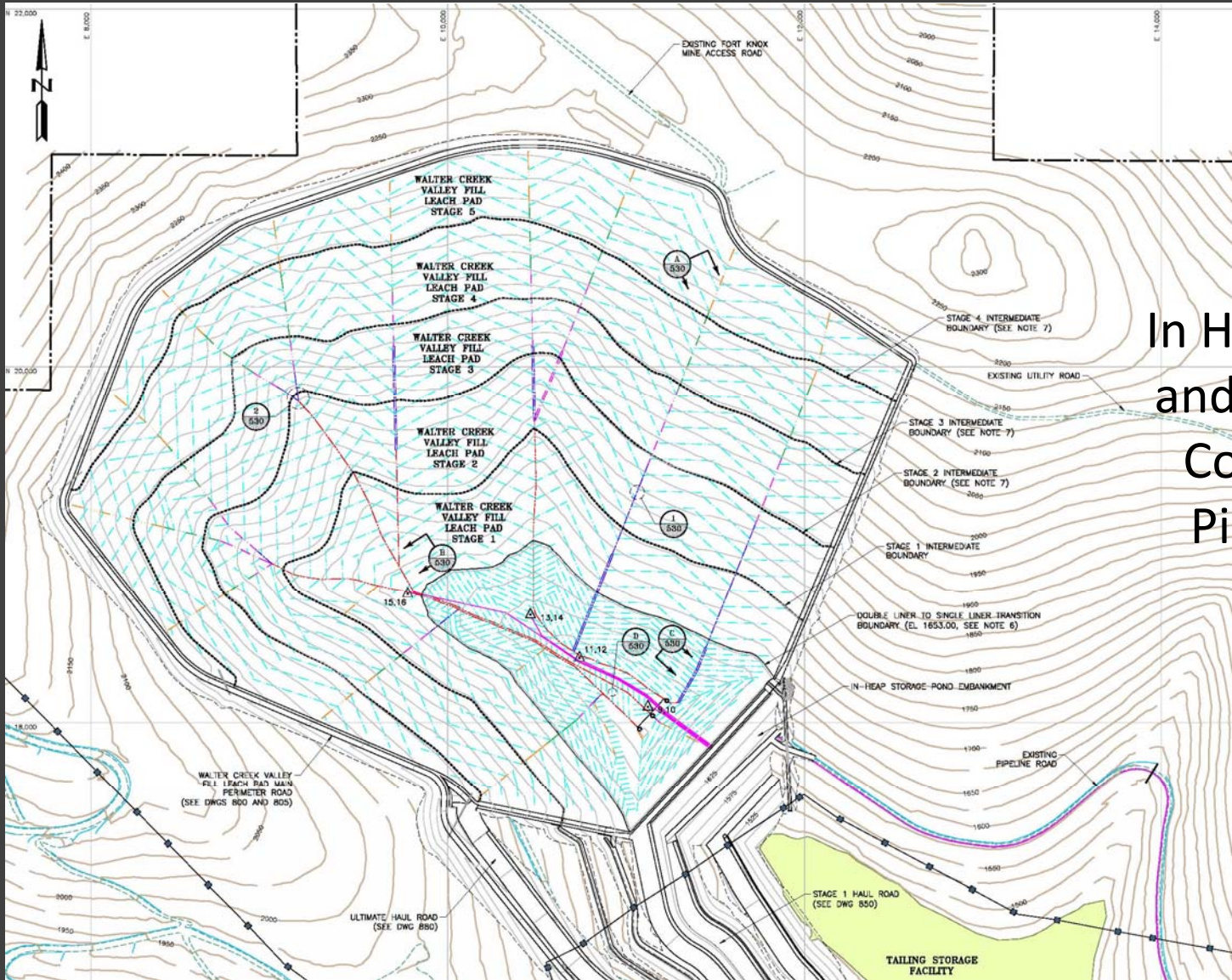
Underdrain System and PCMS Plan



Gold

Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

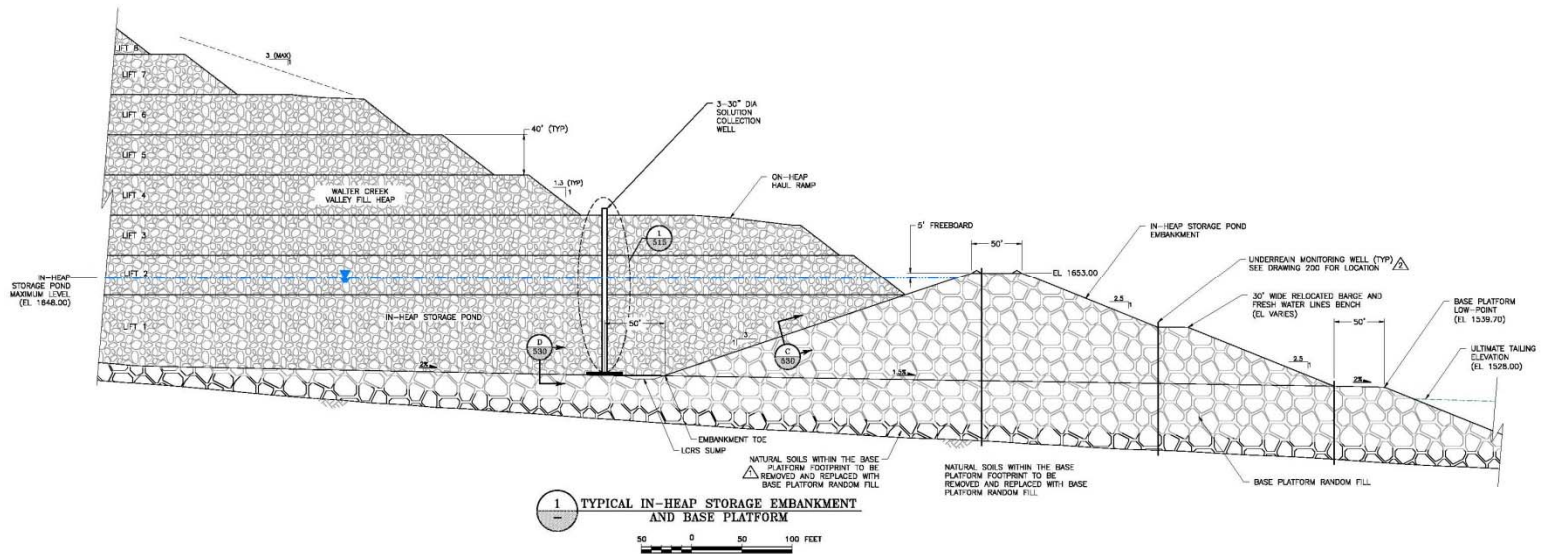
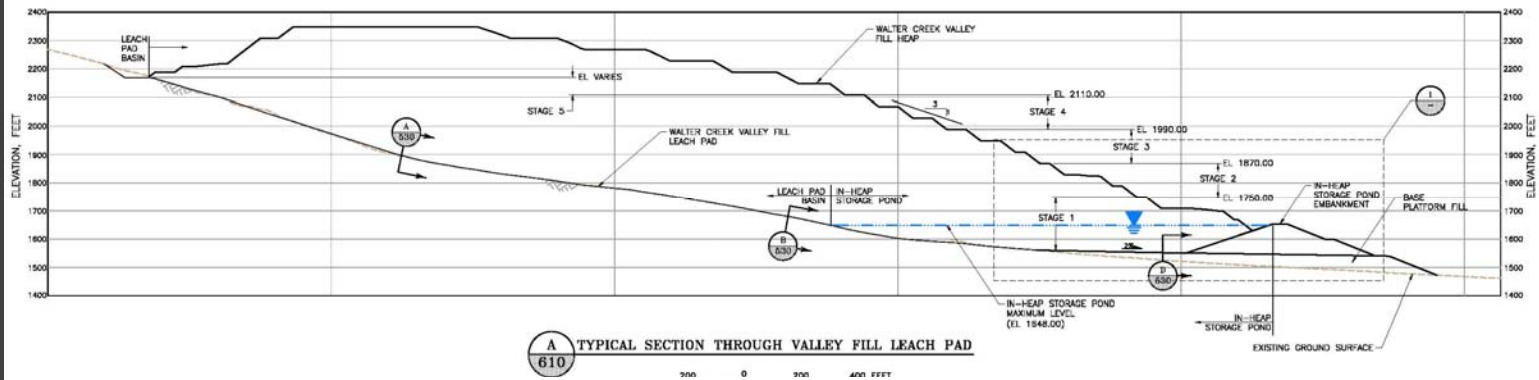


In Heap Pond
and Solution
Collection
Pipework

Gold

Large Height and Cold Regions Heap Leach Facility

Project Spotlight: Fort Knox, Alaska



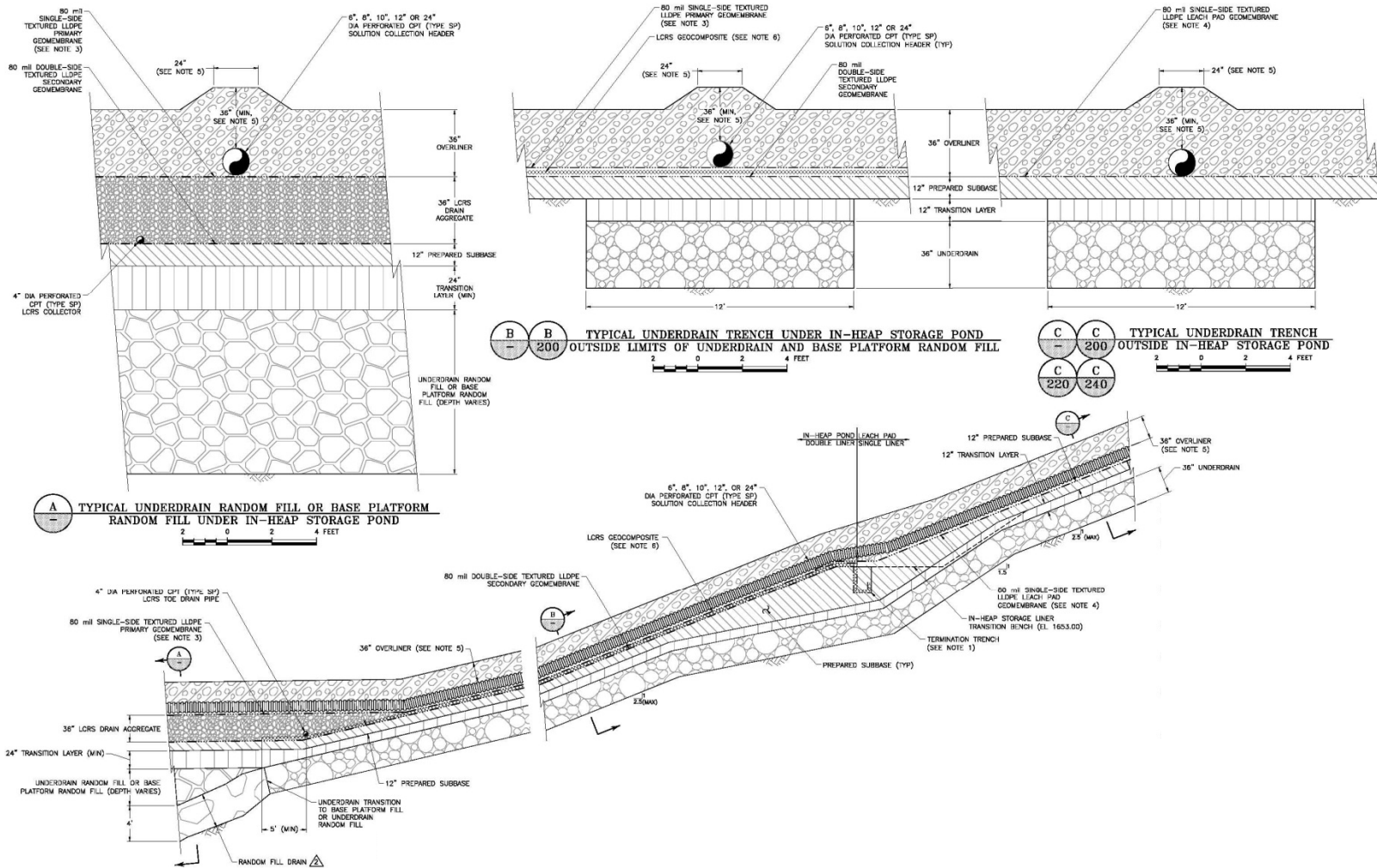
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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: Fort Knox, Alaska

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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

Performance to Date



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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

Liner system consistent with industry standard, and using best practice construction QA/QC

Double lined area under In Heap Pond – LCRS flows are 0.01 gpm or 2 orders of magnitude less than permit levels

PCMS system for the detection of leaks “located beneath the portions of the liner which have the greater potential for leakage” – nothing reported

Groundwater drain system under the HLF that will intercept any seepage from it – any seepage will report to it – no impacts of CN reported

Groundwater regime that is contained in the valley and drains to the TSF – seepage cannot exit anywhere else

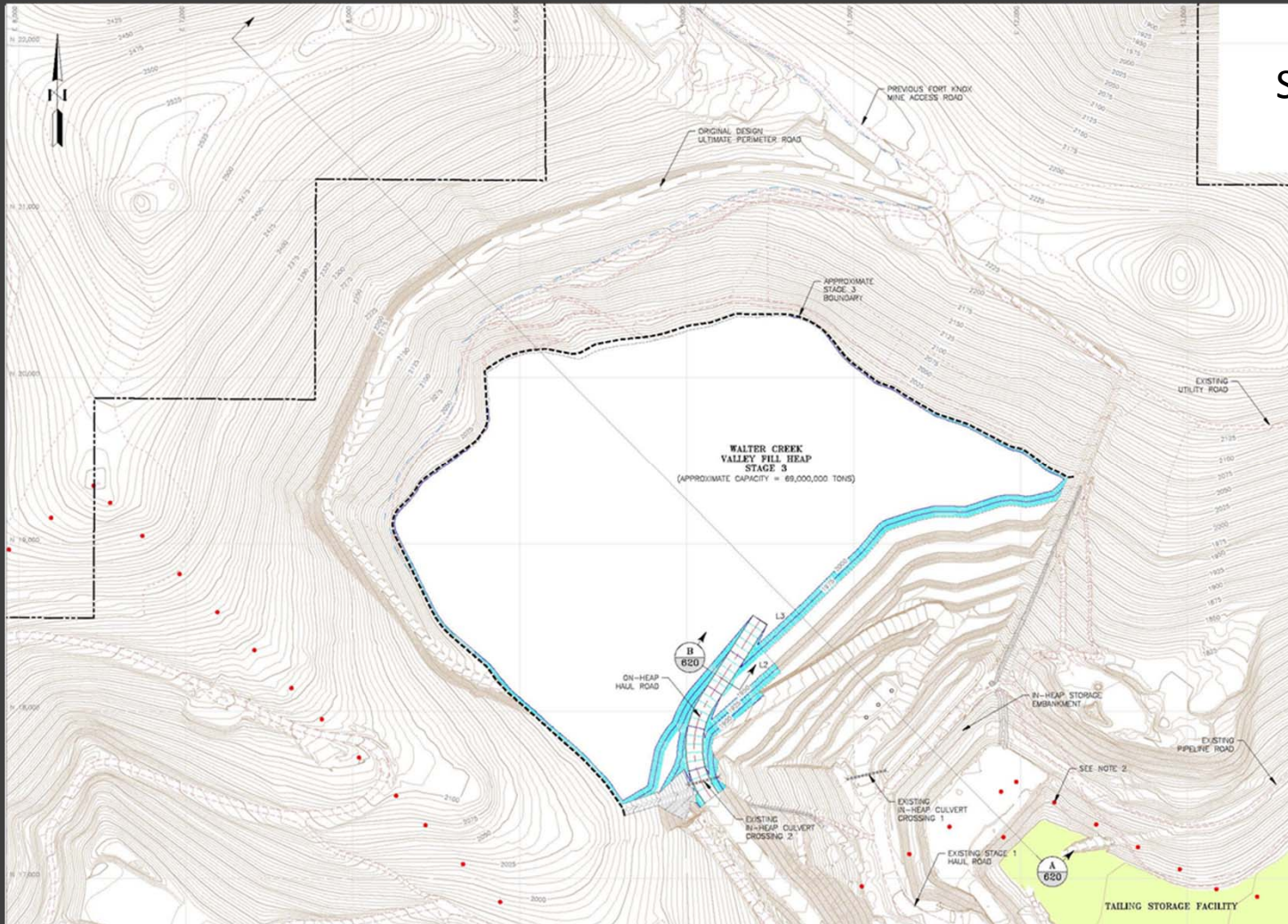
Extensive flow, head pressure and water quality monitoring give results to date that are equal to or better than design

Gold

Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

Stage 3



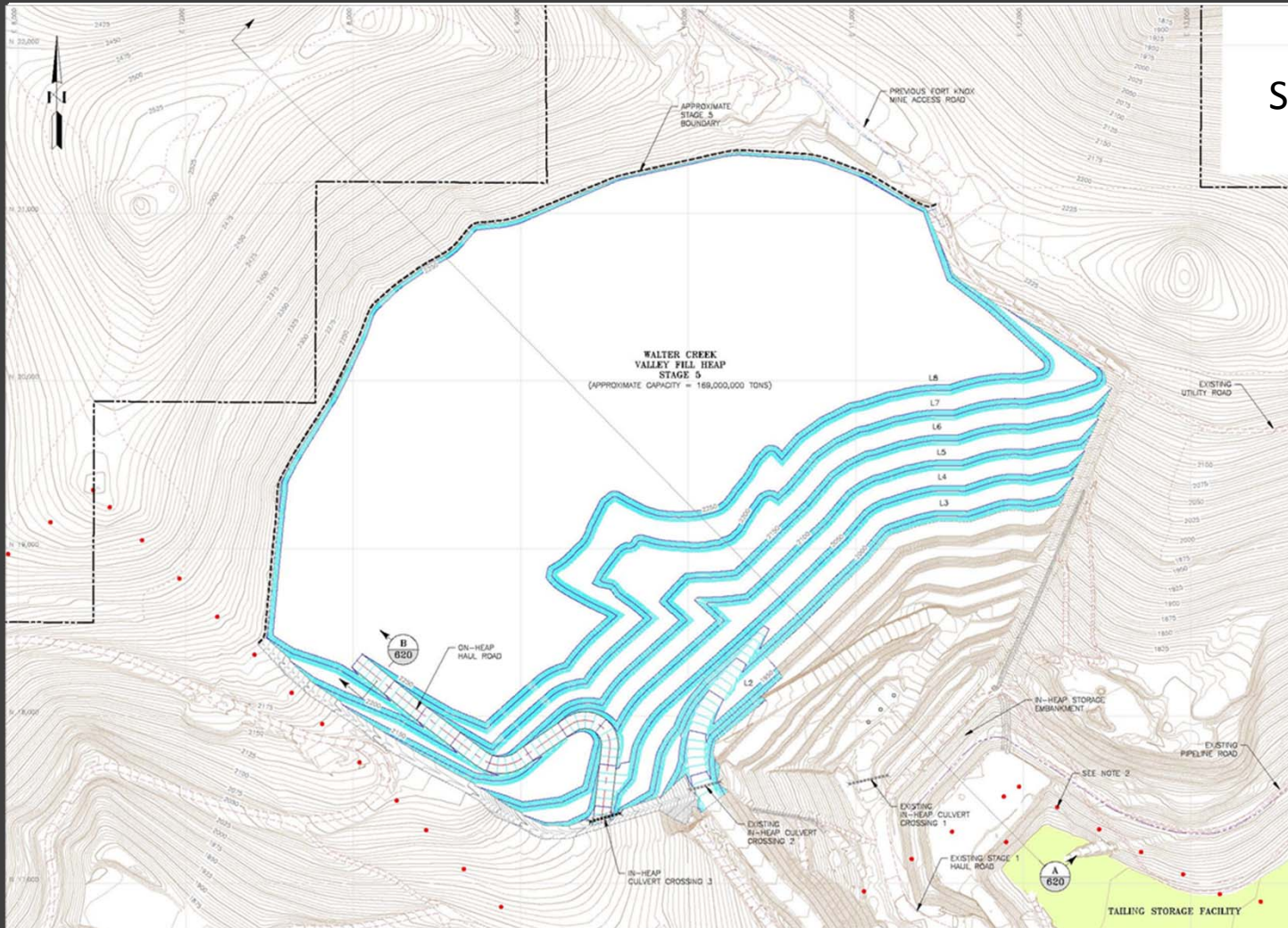
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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

Stage 5



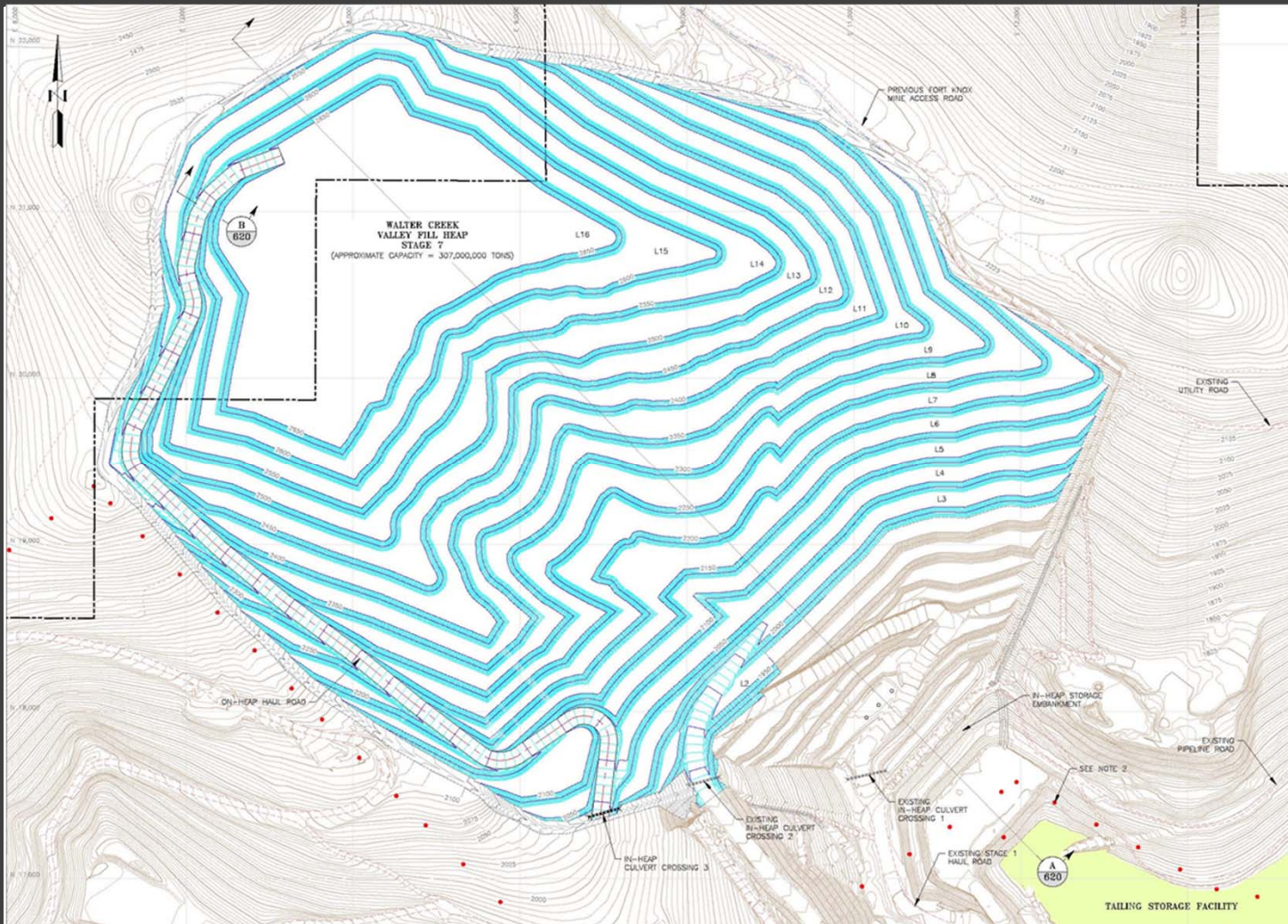
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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska

Stage 7

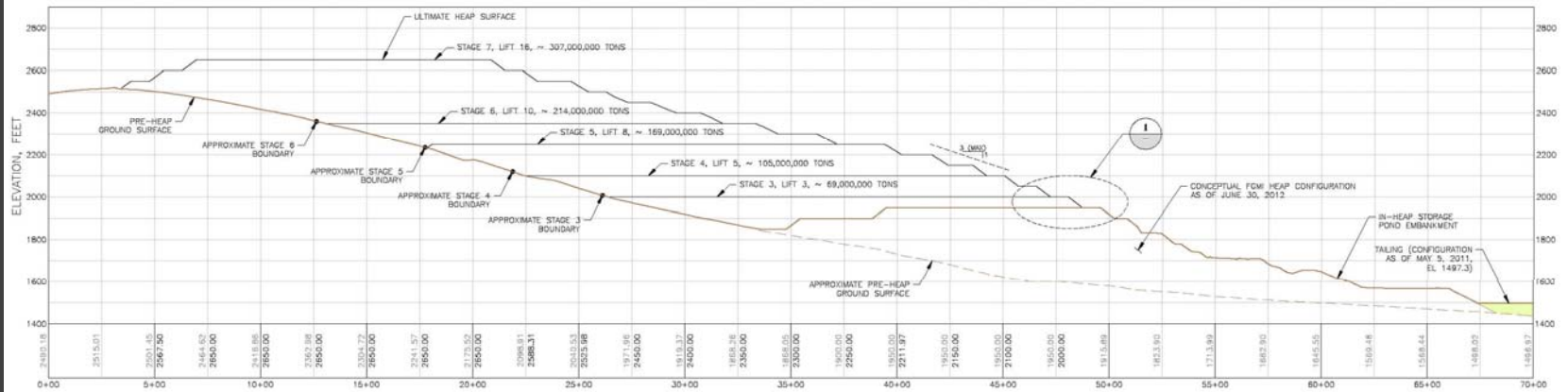


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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska



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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska



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Large Height and Cold Regions Heap Leach Facility

Project Spotlight: *Fort Knox*, Alaska



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A large excavator is silhouetted against a bright, golden sunset sky. The excavator is positioned in the lower right quadrant of the frame, with its arm and bucket raised. The ground is covered in snow, and the overall scene is bathed in the warm, orange and yellow light of the setting sun. The background shows a line of trees and a distant horizon.

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Thank you