2016 International Petroleum Environmental Conference

MINE TAILINGS DRAINAGE – A BOTTOMS UP APPROACH USING HDD DRILLING AND INSTALLATION METHODS

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Tailings Dams

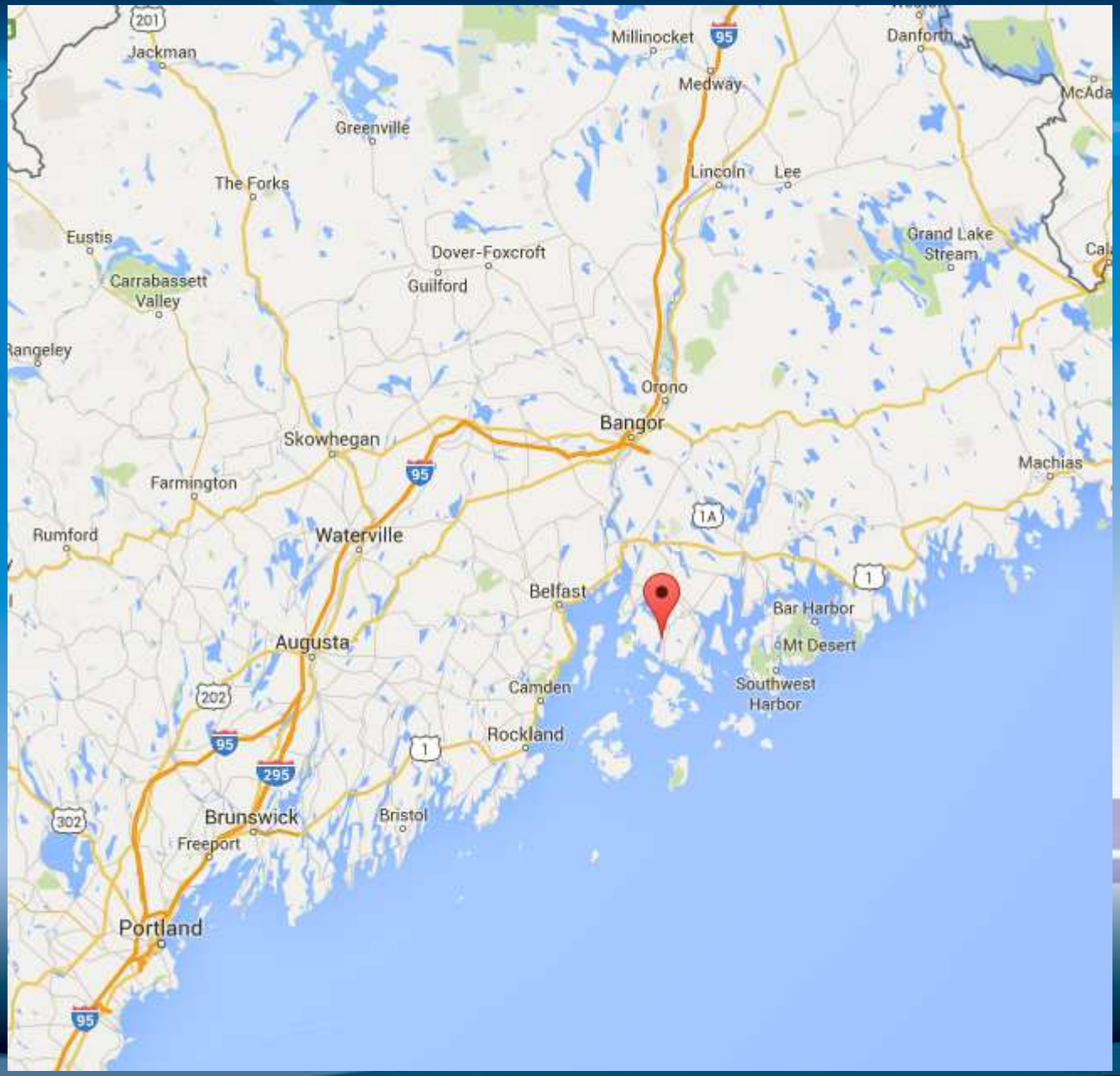
- Impoundments used to retain tailings
  - Effluents, ground rock, dry stacked or pumped as slurry
- Many times constructed from local materials or tailings themselves
- Guidelines exist for design, construction and closure
- Some dams raised over time
  - Conditions may change
  - Supervision may change
- Estimated 3,500 worldwide

Why Do They Fail?

- **Poor construction**
- **Overtopping**
- **Foundation failure**
- **Piping – erosion**
- **Poor maintenance**

Callahan Mine - Maine

- **Open pit zinc/copper mine**
  - **Deposit discovered at low tide in 1880**
  - **Commercial mining started in 1887**
  - **Mining/milling ended in 1972**
- **Added to National Priorities List – Superfund in 2002**
- **State of Maine entered into Administrative Order to Complete RI/FS in 2005**
- **Tailings impoundment designated as OU3**


Jackman
Millinocket
Danforth
Medway
McAda
Greenville
The Forks
Lincoln
Lee
Eustis
Grand Lake Stream
Dover-Foxcroft
Guilford
Carrabassett Valley
Rangeley
Orono
Bangor
Skowhegan
Machias
Farmington
Rumford
Waterville
Belfast
Bar Harbor
Mt Desert
Augusta
Southwest Harbor
Camden
Rockland
Brunswick
Bristol
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OU 3 Tailing Impoundment

- 17 acres
- Over 700,000 cubic yards of material
  - Fine sand, silt and clay
  - Saturated material
- Three sided dam
  - 60’ height
  - 1.3H to 1V
  - Constructed of cobble and boulder sized waste rock material

OU 3 Tailing Impoundment

- **Impoundment "marginally unstable" under long term static conditions**
- **May fail under long term design magnitude earthquake**
- **Tailing material and seepage result in sediment and surface water contamination**
  - **Pb, Zn, Cd, As, Mg**

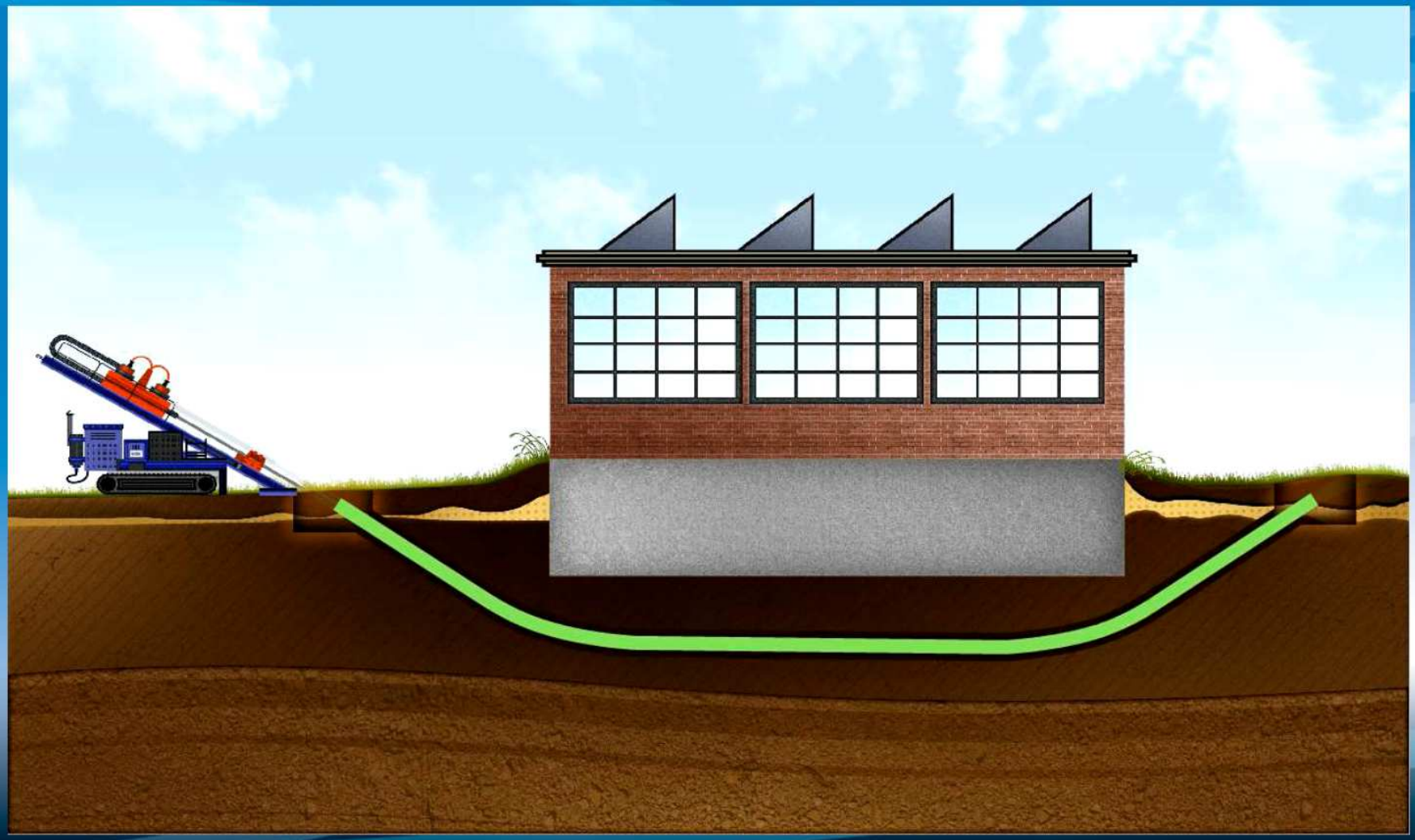
OU 3 Remediation Goals

- **Reduce contaminant load to surface and ground water**
  - **Dewatering of tailings impoundment**
    - **Water sent to anaerobic wetland bioreactor**
  - **Excavation, regrading and capping**
    - **Reduce surface water recharge infiltration and seepage**

Dewatering Options

- **Vertical wells**
  - **Based on modeling 20 required**
    - **Would preclude excavation, regrading and capping**
    - **No power on site**
  - **Deep trench**
    - **Either excavated or installed "one pass"**
    - **Cost estimate over $1,000,000**
  - **Directionally drilled horizontal well**
    - **No surface access needed during construction or dewatering**
    - **Bit/well could be steered and placed precisely**
    - **Gravity flow – no power needed**

Continuous Well Installation

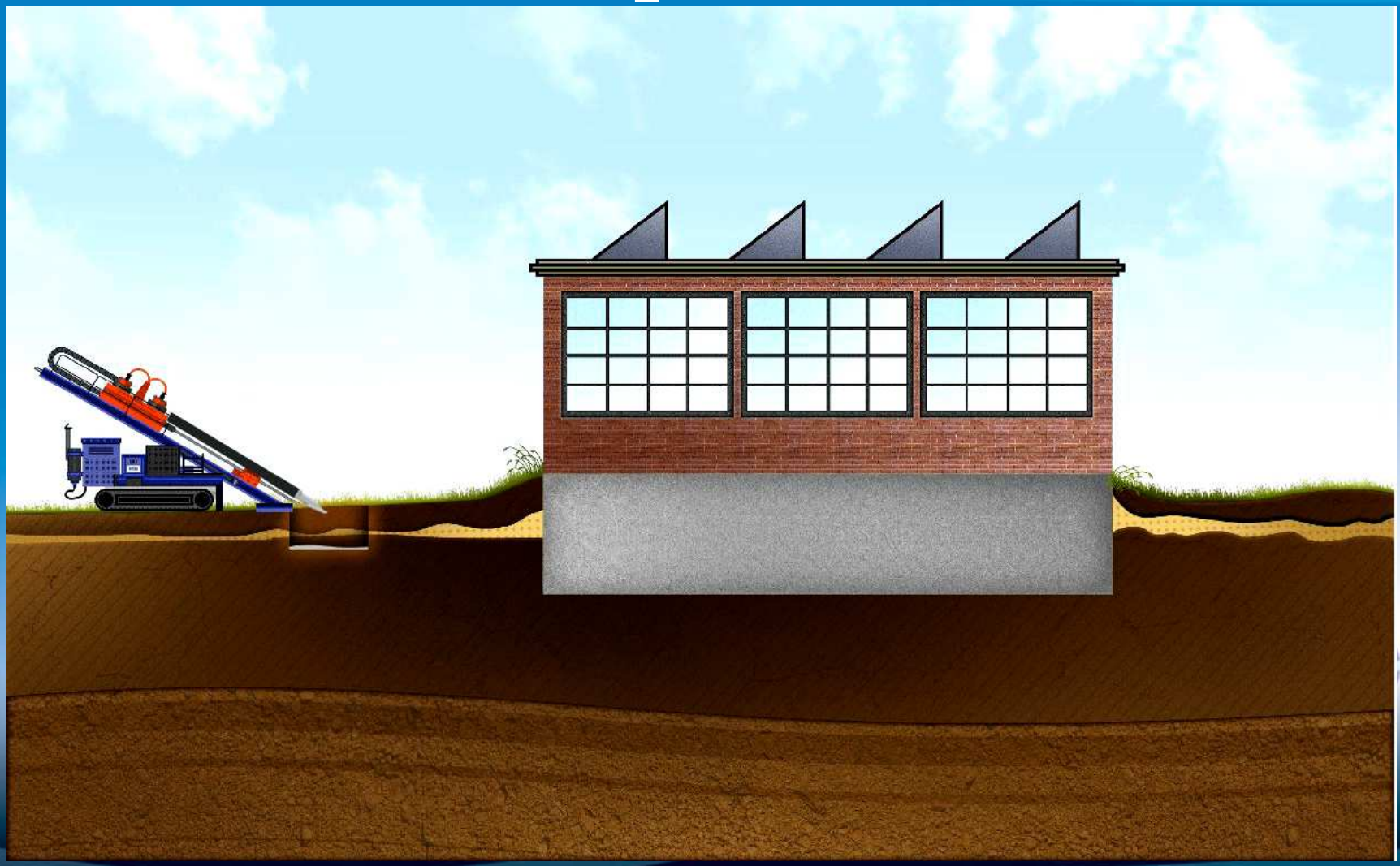


Site Constraints - Continuous

- **Well screen needed to be at the base of the tailings**
- **No rig up area to drill from East to West**
- **Limited rig up area to the North**
- **No room to work or lay out well materials on the South side of the pond**


Rig Up
Area
Old Mine Rd

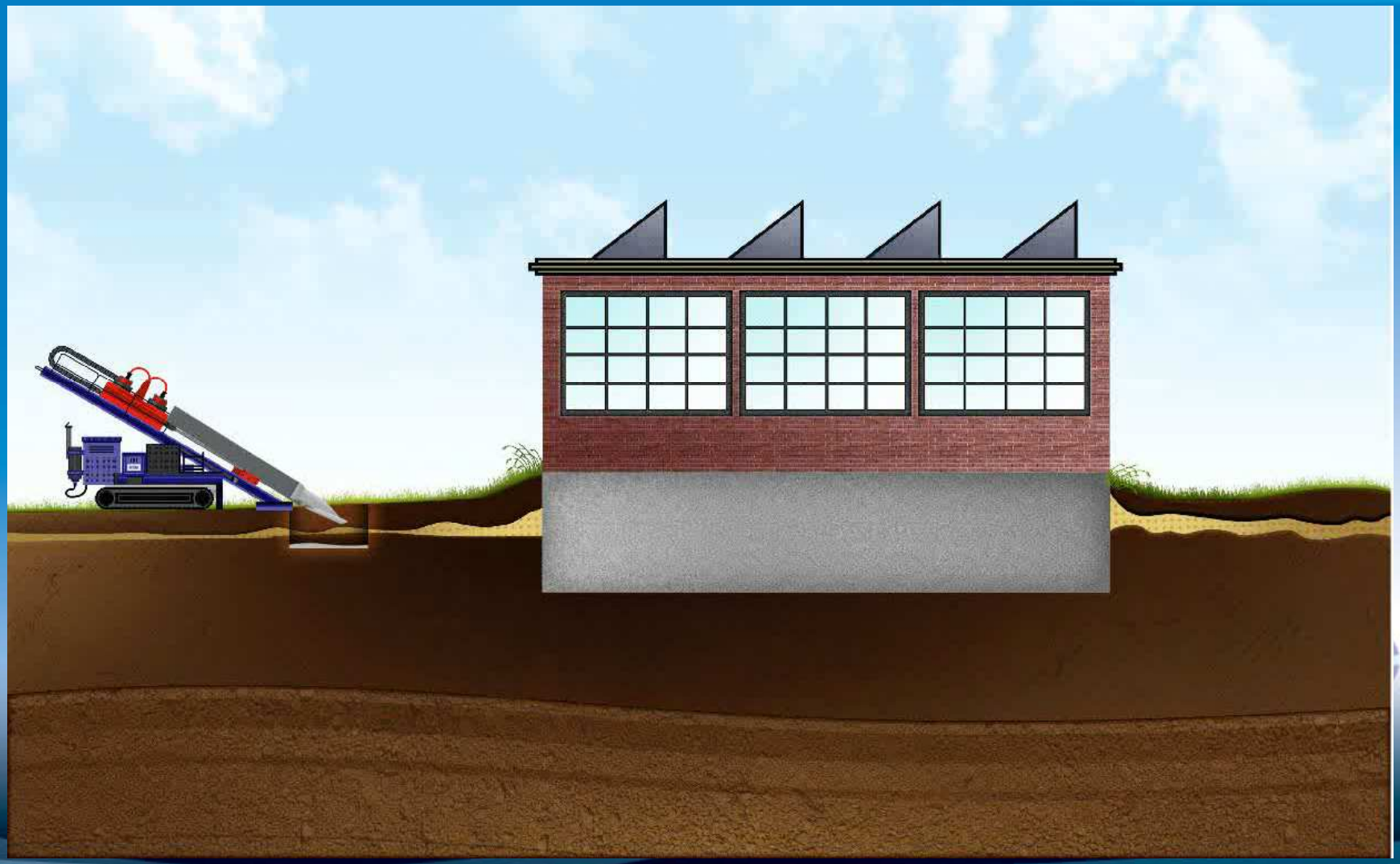
Blind Well Open Hole



Site Constraints – Open Hole Blind Completion

- **Would borehole stay open in tailings consisting of silts, sands and clays?**
  - **50' of saturated thickness above the borehole**
- **Could PVC be pushed 900' into an open borehole?**
- **Would the material flow uncontrollably back to the rig?**

Blind Well Knock Off



Knock Off Blind Well Method

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Knock Off Installation

- **The method would solve the problems of borehole stability and compressive forces on the PVC screen and casing**
- **EVERYONE still concerned about uncontrolled flow of tailings back to the rig**

Solution

- Drill pad construction prior to equipment mobilization
- Install and cement 40’ of 16” steel casing at the exit point
  - Crude horizontal “blow out” preventer
- Installed using auger boring methods
- Surface casing installation proved challenging
- Screen installed as a slope of 6° above horizontal

Drill Pad Construction

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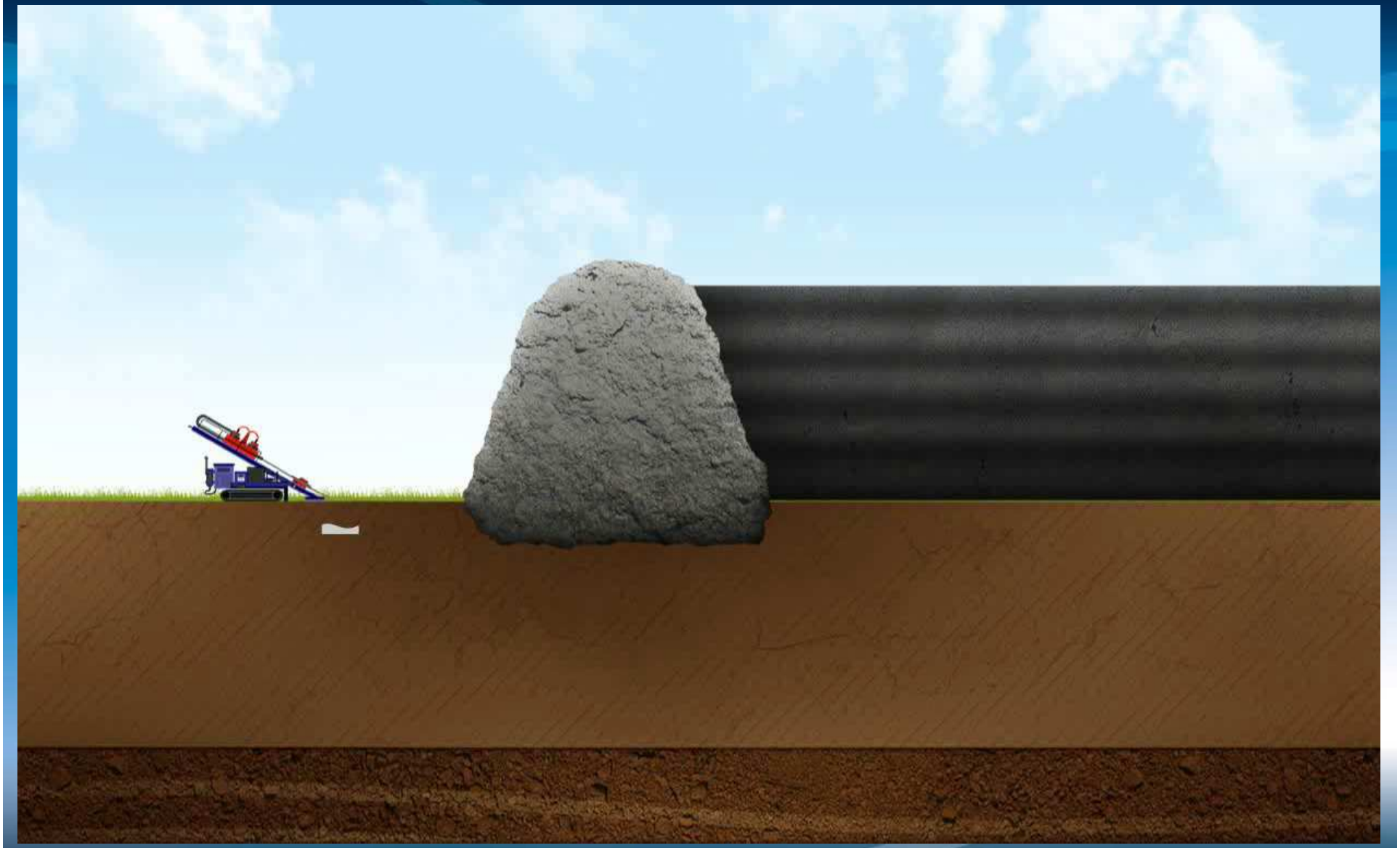
VOLVO

Drilling and Installation

- **Entered surface casing with 12 ¼ tricone bit to drill through grout plug and under dam into tailings**
- **Pulled tricone and re-entered borehole with knock off bit**
- **Drilled to 995' MD**
- **End of well**
  - **24' above entry point**
  - **40' below top of tailings**

Drilling and Installation

- **Installed 4” dia., sch. 80 PVC screen and casing inside of drill pipe**
  - **740’ screen**
  - **251’ casing**
  - **991’ total length**
- **Engaged knock off bit and removed drill pipe**
- **Cement-bentonite grout to 140’ MD**



Well Development

- **Flush with fresh water**
- **Flush with enzyme additive to break biopolymer drilling fluid**
- **Jet screen with fresh water**

Finally

- **Flow rate after development – 5 gpm**
- **Monitor drain flow rates**
  - **Siltation**
  - **Screen plugging**
  - **Periodic maintenance**

In Summary

- HDD blind well drilling is a viable solution to tailings dewatering
- Worst case scenario must be included in project planning
- Communication between regulators, stakeholders and contractors is paramount
- Review and preplanning required
  - Project scope
  - Site visit
  - Preconstruction meeting

Contact Information

- **Office locations**
  - **Bellefonte, PA**
  - **Mineral Wells, TX**
  - **Bremerton, WA**
  - **www.horizontaldrill.com**
  - **800.239.5950**
  - **Follow DTD on Linkedin/Twitter**
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Timeline

- May 2014 – Discussed HDD as a remedial option with Maine DEP
- June 2015 – Site walk and Bid Submittal and award
- July 2015 – Propose casing to stabilize bore incase of uncontrolled release (not part of original SOW)
- August 5 – Animas River mine failure
- August 13 – Complete setting casing (3 pm), EPA shuts down work on US mine sites pending review
- August 25 – Begin HDD
- September 1 – Demobilize

References

- Tailings Dams Risk of Dangerous Occurrences – Bulletin 121 – ICOLD Committee on Tailings Dams and Waste Lagoons (1995-2001)
- www.tailings.info
- www.fema.gov
- www.klohn.com
- US EPA
- OU3 Draft Final Remedial Design Report – 5 December 2014 – prepared by AMEC Environmental & Infrastructure