Tailings Dam Break Models in Nevada - A Practitioner's Perspective

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Presentation Outline

- Tailings Impoundments vs. Water Reservoirs
- The State of The State of Nevada
- Who and What?
- Level of Effort
- Guiding Assumptions
- Golder's Nevada Assumptions
- Where to Go From Here?
- Questions & Answers

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Tailings Impoundments vs. Water Reservoirs

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Variability!!!

Differentiator	Tailings Impoundment	Water Reservoir
Geometry	Gradually Increasing Height and Volume	Fixed Height and Design Volume
Consistency	Variably Fluid to Solid; Variable in Plan and Depth; Often Small Water Volume	Always Fluid
Ponding Against Dam	Variably Against or Away from the Dam	Always Against Dam
Facility Life	Variable Operational and Closure Life	Long Operational Life
Downstream Risk	Low to High	Typically High

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The Big Questions*!!!*

Differentiator	Tailings Impoundment	Water Reservoir
How Much Leaves?	Variable	All
Where Does it Go?	Runout or Flow	Models Predict Well

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15 Tailings Dam Break Models in Nevada

- Address 2004 Regulation Changes
- Mostly 2005 through 2007
- A few since 2007
- Mostly “Significant” Hazard Dams
- 14 Gold Tailings/1 Copper Tailings
- 10 Active; 5 Inactive

Typically Large Dams

- Dam Heights 100 ft to 350 ft

- Impounding Volumes 1,474 acre-feet to 99,000 acre-feet (2 mt to 170 mt)

Who Did the Dam Breaks?

Engineering Consultants – 13; Mining Staff – 2

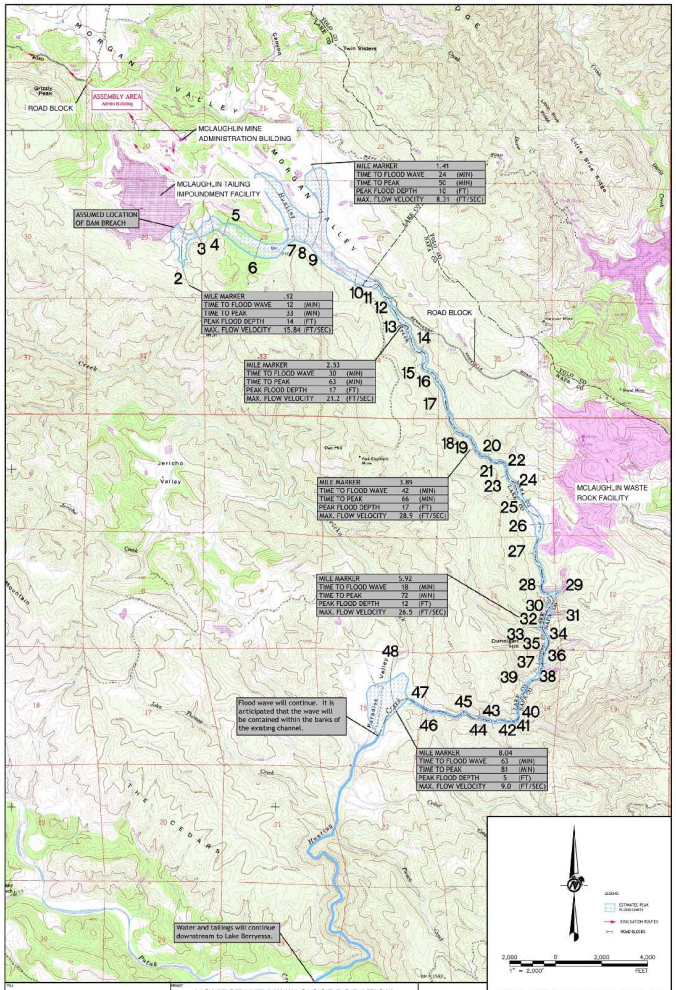
Engineering Consultants

- Brand A – 6 DBMs
- Brand B – 4 DBMs
- Brands C, D, and E – 1 each

2 Consultants – 70% of all EAPs in Nevada

What Models were Used?

- HEC (HEC-HMS for break; HEC-RAS for flood) – 4
- SMPDBK – 4
- DAMBRK – 7



How Rigorous Were Models?

- Depended on Downstream Impact!!!
- Life, Health, Property, Environment, Social
- The Nevada TSFs Didn't Warrant Sophistication Due to Low Impact – Most Cases

What Leaves the Impoundment?
2 Philosophies Used in Nevada

Assumption Set 1 – 9 DBMs

Gold TSF in Closure - USA

- Partial Depth Dam Break
- Supernatant/Storm water Only
- Released <1% to 26% of total tailings/water volume
- Used for Both Active and Non-Active Facilities
- No Differentiation Between Active and Inactive TSFs

What Leaves the Impoundment?
2 Philosophies Used in Nevada

Assumption Set 2 – 6 DBMs

- Full Depth Dam Break
- Some Tailings and all Supernatant/Storm water leave Impoundment
- Results in release of 13% to 66% of total tailings/water volume
- Differentiation Between Active and Inactive TSFs

4October 2010 Ajka Tailings - Hungary

What Leaves the Impoundment? Golder Models

- Tailings full to design capacity; freeboard full of water
- Full embankment height for active impoundments
- Partial embankment height for recently-closed impoundments
- Location based on engineering judgment of highest risk – location at deapest water pool, or location at deepest dam in beach area
- 5% cone based on observations of case history – 2005 Los Frailes in Spain; lead-zinc mine

Golder Assumption on What Leaves TSF

Golder Photos
2005 Failure
Los Frailes TSF
Spain

Downstream Flood Model
Golder Assumptions

In valleys – modeled as water; increased roughness {0.04 to 0.1} to model

(a) turbulent flow
(b) higher viscosity
(c) narrow valleys and outcrops

On alluvial fans or basins –

- Tailings drop out on ground slopes <1% for active TSFs, 2% to 5% for recently closed TSFs,

- Balanced outflow and depositional geometry

Discussion for Resolution

Do We Differentiate Between Operational and Closure Conditions?

- Many dams will stay listed as regulatory dams after closure
- Depends on whether water ponds for closure
- How much leaves in closure?
- Mapping inundation in closure conditions very different than in flood conditions
- Time frame of model – immediately after mining or some years after mining?

Discussion for Resolution (cont)

Where and how deep does breach occur?

- The location which would cause the greatest release
- The deepest section of dam to full depth of the dam
- The supernatant pool area at the location of the deepest pool
- Other based on engineering judgment

Discussion for Resolution (cont)

- Low and High Inundation Maps? Low for water, high for tailings

- At what depth do you stop the flood model?

- Manning's n constant appropriate for a large wave. Even significantly rough flow surfaces would seem smooth to a flood that's many feet deep.

Questions