Elements of a Modern Mine
(Fort Knox and Pogo as Examples)
“Mining is a water project with a gold by-product”

-- Pete McGee (DEC)
HISTORIC WORK IN FISH CREEK

Looking West
Photographed In 1992
FORT KNOX MINE
June 12, 2001
Each Hole Is Sampled, Bar-coded, And Assayed.

6.75-Inch Blast Holes
Drilled On 17-Foot Centers
33-Feet Deep
PREPARING FOR A BLAST

0.4 Pounds Of Explosives Per Ton Of Rock
DELAY CONTROLLED BLAST
40,000 Pounds Of Explosives Per Day
Blast near Berekely Pitt Butte Montana
MINING 80,000 TO 100,000 Tons/Day

150-Ton Haul Truck

23-Cubic Yard Hydraulic Shovel

150-Ton Haul Truck
150-Ton Haul Truck  994 Loader
SAFETY
Left Hand Traffic
High Berms
100-Foot Haul Roads
Max. 8% Grade
Dumping Ore Into The Crusher
GYRATORY CRUSHER

Rock Crushed To 8-Inch Size
1/2 MILE CONVEYOR
From Crusher To Mill Stockpile (300,000 tons)
GRINDING CIRCUIT

42,912 Tons Per Day
96.34% Availability
LEACH CIRCUIT

7-Leach Tanks
Gold Is Dissolved
With Cyanide

Detox
Residual Cyanide
Is Destroyed

6-CIP Tanks
Gold Is Loaded
Onto Carbon
Cyanide
Cyanide (CN) - Toxicity

Cyanide Kills in low concentrations
• 200 ppb = drinking water standard
• 22 ppb = acute standard for fish (WAD)
• 5.2 ppb = chronic standard for fish

Pathway: inhalation, ingestion, or absorption

Mechanism of toxicity: prevent uptake of oxygen by cells; hypoxia
Cyanide – Natural Detoxifying

Human body natural detoxifies and excretes cyanide

CN does not: accumulate or biomagnify
No evidence it’s a carcinogen, mutagen, or teratogen
Cyanide – Industrial Use

1.1 Million Metric Tons Produced Worldwide

Mining
6%

Other: 94%

Plastics, adhesives, fire retardants, cosmetics, pharmaceuticals, food processing, table/road salts
Cyanide – Natural Sources
Cyanide – Fate and Persistence

- CN chemically very active; breaks down with oxidant; $\text{H}_2\text{O}_2$; sunlight
- Broken down by enzyme and bacteria in soil; adsorption; precipitation; volitization
- Complexes with metals
- Some degradation products are toxic; generally specific conditions
GOLD BAR

95% Dore

90% Gold & 5% Silver
Gold!
Gold & Smiles!
TAILING POND
(Deposition Of Ground Rock And Water Recycle)
Pumpback Wells
(taken from the tailings dam)
Looking West
Photographed In 1992

Looking West
Photographed In 1999
Water Quality Limits
Drinking water = 0.2 mg/l
Fish (acute) = 0.022 mg/l
Fish (chronic) = 0.0052 mg/l
Interceptor well = 1 mg/l
Monitoring well = any statistical change
Copper Concentration; Fort Knox

limit for fish = 0.00364 (acute); 0.00274 (chronic)

Note: Seepage values below detection limit
Upper Talarik Creek
## Use + Criteria = Standard

Table in parts per billion

<table>
<thead>
<tr>
<th>Use</th>
<th>Copper</th>
<th>Cadmium</th>
<th>Arsenic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drinking Water</strong></td>
<td>1300*</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td><strong>Stock Water</strong></td>
<td></td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td><strong>Irrigation</strong></td>
<td>200</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td><strong>Aquatic Life</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chronic</td>
<td>3.64</td>
<td>0.52</td>
<td>340</td>
</tr>
<tr>
<td>Acute</td>
<td>2.74</td>
<td>0.09</td>
<td>150</td>
</tr>
</tbody>
</table>

* Simplified from elsewhere in DEC Regulations
One Seasons Growth
After Recontouring and Seeding
Burbot with Grayling
Property Rights & Permitting
Warm-up Exercise
Desire or Proposal

Final Decision:
Does proposal comply with the law?

Already own Property Rights

Environmental Rules

Public Oversight

Private Land Example
Warm-up Exercise
Desire or Proposal

Need Property Rights or Public Landowner’s Approval

Public Values (including Environmental Values)

Property Rights Decision

Public Oversight

Environmental Rules

Final Decision
The Mine That Must Not Be Named
Two Views of Permitting?

duck tape...
Large Mine Permitting Team: State Agencies

- Department of Natural Resources (Lead State agency for mining projects)
- Department of Environmental Conservation
  - Div of Water, Div of Air Quality, Div of Env. Health
- Department of Fish and Game
- Department of Law
- *Department of Transportation & Public Facilities
- *Department of Commerce, Community and Economic Development
Federal agencies typically participate in the Large Mine Permitting Team approach:

- US Environmental Protection Agency
- US Army Corps of Engineers
- US Fish and Wildlife Service
- National Marine Fisheries Service
- Bureau of Land Management (if project on BLM land)
- U. S. Forest Service (if project on USFS land)
No Single Permit to Mine
50-70 permits;
Each agency has own authority

• Plan of Operations (DNR)
• Reclamation and Bonding (DNR)
• Waste Management Permits and Bonding (ADEC)
• Certification of NPDES and ACOE Permits (ADEC)
• Sewage Treatment System Approval (ADEC)
• Air Quality Permits (ADEC)
• Fish Habitat and Fishway Permits (DNR)
• Water Rights (DNR)
• Right of Way/Access (DNR/DOT)
• Tidelands Leases (DNR)
• Dam Safety Certification (DNR)
• Cultural Resource Protection (DNR)
• Monitoring Plan (Surface/Groundwater/Wildlife) (DNR/DEC)
• Coastal Zone Consistency Determination (DNR)

• US EPA Section 402 NPDES Water Discharge Permit
• US EPA Air Quality Permit review
• US EPA Safe Drinking Water Act (UIC Permit)
• US ACOE Section 404 Dredge and Fill Permit
• US ACOE Section 10 Rivers and Harbors Act
• US ACOE Section 106 Historical and Cultural Resources Protection
• NMFS Threatened and Endangered Species Act Consultation
• NMFS Marine Mammal Protection Act
• NMFS Essential Fish Habitat
• NMFS Fish and Wildlife Coordination Act
• USFWS Threatened and Endangered Species Act Consultation
• USFWS Bald Eagle Protection Act Clearance
• USFWS Migratory Bird Protection
• USFWS Fish and Wildlife Coordination Act

(These are only some of the authorizations required)

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“Major” Permits

- Plan of Operations (DNR)
- Reclamation Plan (DNR)
- Solid Waste Permits (DEC)
- Financial Assurance [Bond] (DNR & DEC)
- Water Discharge Permit (DEC/EPA Oversight)
- Wetlands Permit (US Army Corps of Eng/ EPA)
- State Certification of EPA and US Army Corps Permits.
Other Important Permits: State Permits

- Air Quality Permits (ADEC)
- Fish Habitat and Fishway Permits (DF&G)
- Water Rights (DNR)
- Right of Way/Access (DNR/DOT)
- Dam Safety Certification (DNR)
- Cultural Resource Protection (DNR)
- Monitoring Plan (Surface/Groundwater/Wildlife) (DNR/DEC/DF&G)
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What’s *not* on these lists?

EIS done under NEPA

Environmental Impact Statement completed to comply with the National Environmental Policy act
What is NEPA?

• State of Alaska has no equivalent of NEPA (though for a large project, the state process duplicates many of NEPA’s procedural steps).

• It is very difficult for a major Alaska project to avoid NEPA)
NEPA is also a process

• How long is the EIS process?

About 1-3+ years to comment

Agencies Define

Draft EIS

Final EIS

Proposed Project Defined by Developer

Begin Process Here

Formal Public Comment Opportunity

Important: Agencies encourage comment at any time – the earlier the better
Legacy Issues and Desired Outcomes

Historic Issues (Spain & Pennsylvania)

Desired Outcome (Alaska)
Illinois Creek Mine Dumps

Initial Recontour & Seeding

Success

Illinois Creek
Reclamation
Reclamation Bond is based on a detailed engineering analysis.
## Bond Amounts for Alaska Mines

<table>
<thead>
<tr>
<th>Operation</th>
<th>Total Bond ($ Millions)</th>
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<tbody>
<tr>
<td>Greens Creek Mine</td>
<td>$29.2</td>
</tr>
<tr>
<td>Red Dog Mine</td>
<td>$154.9</td>
</tr>
<tr>
<td>Fort Knox (&amp; True North) Mine</td>
<td>$37.6</td>
</tr>
<tr>
<td>Usibelli Coal Mine &amp; Exploration</td>
<td>$11.3</td>
</tr>
<tr>
<td>Kensington Project</td>
<td>$7.4</td>
</tr>
<tr>
<td>Rock Creek Mine</td>
<td>$6.8</td>
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<tr>
<td>Pogo Mine</td>
<td>$26.7</td>
</tr>
<tr>
<td>Nixon Fork Mine</td>
<td>$3.5</td>
</tr>
</tbody>
</table>
Environmental Audits

- Environmental Audits on 5 year schedule tied to reissuance of permits
- All environmental systems audited (company and agencies)
- Audits by 3rd party experts
- Financial Assurances revisited and recalculated based on Audit results
Pogo Layout

- **Mining**
  - Portal and ramp access
  - Method is drift and fill
  - Highly mechanized

- **Mill**
  - Complex metallurgical process – environment focused
  - Separation of cyanide and non-cyanide contacted materials
  - Four recovery processes
  - Non-cyanide contacted material is separated and dry-stacked
  - Cyanide contacted material detoxified and used as paste backfill

- **Remote Camp**
  - Combination of various schedules to accommodate employees from Alaska and Lower 48
Pogo Mill – Floatation Cells & Ball Mill
Pogo Dry Stack Tailings
The End