Mine Water Truck Tracking
Rio Tinto Kennecott Copper
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Dust suppression is a key component for safety and air quality compliance within Kennecott’s Bingham Canyon Mine. Light-duty vehicles and haul trucks driving on haul roads create fugitive dust within the pit of the mine and spreading to the surrounding residential neighborhoods. Increased dust may result in health, safety and environmental hazards and a reduction in productivity. The Mine uses 6 water trucks to distribute a mixture of water and surfactant to hold moisture in the dirt roads and decrease dust. These trucks are equipped with GPS units, Wi-Fi, and Linux boxes to collect data. The data is imported to a PI server in semi-real time as the trucks pass designated stations. Kennecott has created a web mapping application using ArcGIS tools to analyze the water truck data and visualize the water distribution.
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**GEOGRAPHIC OVERVIEW**

- **Salt Lake Valley is surrounded by 2 mountain ranges, Oquirrh Mountains to the West and Wasatch Mountains to the East.**

- **Kennecott owns 100,000+ acres of land in Salt Lake and Tooele Counties and stretches the entire length of Salt Lake Valley with mining operations adjacent to a population of 1.2 million.**

- **Kennecott’s Bingham Canyon Mine sits next to the fastest growing communities in Utah.**

- **Kennecott is a self-sufficient mine with copper production plants from the pit to the concentrator, smelter, refinery, and tailings impoundment.**
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**BINGHAM CANYON MINE**

- **Kennecott's mine has been operational for 100+ years and has produced more copper than any mine in history – more than 19 billion tons. In addition to copper, it also produces gold, silver, molybdenum, and sulfuric acid.**

- **The mine is 3 miles across and approximately 3/4 mile deep and is the largest man-made excavation on earth.**

- **The elevation of Bingham Canyon Mine drops from 8,340 ft at the top to 4,390 ft in the pit.**
Dust Suppression and Air Quality

- The Utah Department of Environmental Quality (UDEQ), Division of Air Quality (UDAQ) implements and enforces the federal Clean Air Act in the State of Utah.

- The Kennecott Utah Copper Bingham Canyon Mine operates under an Air Approval Order from UDAQ that dictates acceptable levels of airborne particulate matter that result from mining activities on site.

**Cause of Dust at Mine**
- Driving light-duty and haul trucks on dirt roads
- Wind erosion of overburden
- Ore from Crusher
- Blasting
- Overburden dumping
- Expansion projects

**Benefits of Dust Suppression**
Less fugitive dust results in:
- Less maintenance on haul trucks and prolonged tire life
- Greater safety through improved road conditions and visibility
- Increased productivity
- Cleaner air, better health and respiratory conditions
- Compliance with Clean Air Act
Kennecott’s Contribution to Utah’s Air Quality

Point Source Emissions:
Stationary, Mobile, and Fugitive

- Kennecott’s annual average contribution: 5.8%
- Other primary sources: 94.2%

Our efforts to minimize impacts:
1. Idle reduction program to reduce emissions
2. CNG vehicles and haul trucks
3. Reduce driving speed
4. Shut down Power Plant during winter months
5. Park at Lark and TRAX to Daybreak
6. LEED-Certified buildings
7. Dust Suppression at Mine
Fugitive Dust Control Plan

- Bingham Canyon Mine has developed a Fugitive Dust Control Plan where dust is suppressed through a combination of road watering and environmentally safe chemical dust control measures on active ore and waste haul roads. The roads are ranked based on status, usage, and risk to high fugitive dust.

- The Mine currently utilizes six water trucks with 50,000 gallon tanks for wetting road surfaces to reduce fugitive dust. These trucks are equipped with GPS units, Wi-Fi, and Linux boxes to collect data. Software developed by Open Loop Energy, reads ground speed and automatically varies water output based on speed. The data is recorded and used to calculate the number of water loads per month. This system reduces maintenance costs and improves watering efficiency.

- The water is sourced from mine dewatering efforts and is mixed with a surfactant (10 gal surfactant / 50,000 gal water) to hold moisture and lower the surface tension. The water tanks are refilled at designated stations 30-60 minutes, depending on outside temperature and haul road traffic.

- In addition to routine watering, magnesium chloride is applied to access roads as a means of dust suppression during the dry months, typically between May and July. The Mine uses approximately 2.5 million pounds of magnesium chloride per year. The application of MgCl results in less watering as it absorbs moisture from the atmosphere and resists evaporation.

*Photo source Open Loop Energy*
Using ArcGIS for Mine Water Truck Tracking

**INPUT**

- Data upload through wireless mesh
- PI Database
- Data import through custom script
- SQL Database

**PROCESSING**

- SQL Server
  - Convert Water Truck data to spatial data
- ArcGIS for Desktop
  - Create data layers
  - Create mosaic dataset
  - Create domains and range
  - Time enable data
- Data Layers
  - Water Truck Tracks
  - Water Truck Zones
  - Haul Road Status
  - Mine grid and features
  - Mine imagery basemap

**OUTPUT**

- Windows Server
  - Publish REST Services
- ArcGIS for Server
  - Upload Layers
- ArcGIS Online
  - Create Web Maps
- Operations Dashboard and ArcGIS Pro
Mine Water Truck Data Sources

Mine Water Truck Data

- Kennecott’s Bingham Canyon Mine has 6 water trucks each with a 50,000 gallon tank. These trucks spray water onto the haul roads to reduce dust.
- Each truck is equipped with a GPS unit, Wi-Fi, and a Linux box to store the data.
- Over 80 operational and maintenance parameters are collected every 5 seconds including the truck’s location data latitude, longitude, and timestamp.

  - **Operational Parameters:**
    - Truck Speed (mph)
    - Flow Rate (gal/sec)
    - Daily Water Use (kgal)
    - Water Pattern and Spray Density
    - Spray Heads on/off

  - **Maintenance Parameters:**
    - Water Tank Level (%)
    - Hydraulic Pressure (psi)
    - Hydraulic Filter Alarm
    - Hydraulic Fluid Temperature (C°)

PI Database

- The data is uploaded through wireless mesh to a file server in semi-real time as the trucks pass designated stations.
- A script imports the raw data into the PI database where it is formatted.
- The large volume of data is stored in the PI database and only exported to SQL as needed.

SQL Database

- The data is imported into a SQL database then exported into a separate spatial database to be used in GIS.
- Create a scripted procedure to import the data into the spatial database at a set time interval.
Mine Water Truck Data Processing

**ArcGIS for Desktop**
- **ArcCatalog**
  - Create a line feature class to store the water truck track imported from PI with all of the appropriate field names for each parameter
  - Create coded-value domains and range domains
  - Create mosaic datasets for custom Mine imagery and elevation data
- **ArcMap**
  - A map document is created including the following feature class layers
    - Water Truck Track – time enabled based on timestamp field
    - Dust Management on Haul Roads
      - Symbolized by road status
        - Dust Management on Roads
          - MgCl - As Needed
          - Water Truck / Surfactant Maintained
          - Closed - Unless accompanied by Water Truck
          - Closed - All Traffic
          - Open - No Dust Speed
  - The haul road status is used to determine which roads the water trucks should spray. There is not a need to water the road if the status is “MgCl”, “Closed”, or “Open”.
- **Water Truck Zones**
  - The operational area of the Mine was divided into 11 Zones stored as a polygon feature class
  - Each zone is ranked with the lowest value being highest priority. The priority rank determines which zones will be sprayed with water
- **Mine Grid and Features**
  - Reference layers for the Mine
Mine Water Truck Data Processing

ArcGIS for Desktop
- ArcMap
  - Publish mosaic dataset for custom Mine imagery
  - Publish water truck track, haul roads, and zone feature classes
  - Publish Mine grid and features

Map Document with Mine Water Truck Layers

Published Map Service
Mine Water Truck End User Applications

ArcGIS for Server
- ArcGIS Server Manager
  - Online portal used to manage the ArcGIS Server site and Web Adaptor, manage and organize services, administer security, and view server log messages
- ArcGIS Online Organizational Site
  - Import services as layers, create maps and applications to be used within Kennecott
  - Create Mine group to assign roles and privileges to Water Truck application users
  - Create web maps and applications shared with the group
Mine Water Truck End User Applications

ArcGIS Online Applications for Different User Roles

- Publisher: ArcGIS Online Web Map and Applications to share with AGO Mine Group
Mine Water Truck End User Applications

ArcGIS Online Applications for Different User Roles

- Created using ArcGIS Online and JavaScript API
- User: JavaScript Application – Query by Date, Water Truck, Zone, or Parameters
Mine Water Truck End User Applications

ArcGIS Online Applications for Different User Roles

- Manager: Operations Dashboard with widgets for truck speed, flow rate, and tank level
- Ability to query by water truck, date range, road type, or zone
Mine Water Truck End User Applications

Next Steps

- GeoEvent Extension – Real-time data visualization, requires PI connection
- ArcGIS Pro – For more advanced users to share the Water Truck project and analyze data
Thank You
Rio Tinto Kennecott Copper

References

- Rio Tinto Kennecott: http://www.kennecott.com/
- Open Loop Energy: http://openloop.net/

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