Mining & Mercury in Nevada

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Mining & Mercury in Nevada

Voluntary Mercury Reduction Program (VMRP)
- Voluntary Program: 2002-2006

Nevada Mercury Control Emissions Program (NMCP)
- State Regulation: 2006 - Present

Federal Gold Mine NESHAP (40 CFR Part63 Subpart E7)
- Federal Regulation: 2010 - Present

Mercury Research
- Ambient mercury deposition network
- Ambient mercury passive sampler
- Fugitive mercury emissions
Mercury not from historical mining operations.

Mercury is naturally occurring and geologically concentrated.

Mercury co-located with gold deposits in ~1:1 ratio.
Mining & Mercury in Nevada

Gold recovery utilizes thermal processes that volatize Hg.

Nevada has ~50 permitted mines; ~25 with various thermal processes.

Mercury is *not* used or added for gold recovery.
Mining & Mercury in Nevada

Thermal Units
(a source of direct or indirect heat)

- Roaster
- Autoclave
- Electro Winning
- Melt furnace
- Retort
- Oven
- Lab equipment
- Pregnant & Barren tanks
- Other
Voluntary Mercury Reduction Program

1998: 1st time metal mining industry required to estimate & report mercury emissions for TRI.

2000: TRI reports that Nv mining emitted 10.5 tons of mercury in 1998. Four mining companies (5 facilities) accounted for more than 90% of emissions.

2002: NDEP & EPA develop Voluntary Mercury Reduction Program (VMRP) with four mining companies with largest emissions.
Nevada Mercury Control Program

- State Program, effective March 8, 2006.

- Applies to *all* precious metal facilities with thermal process units.

- The NMCP requires best available mercury emission controls technology to reduce emissions.

- The NMCP is a control-based program—not a health risk-based program.
NMCP Overview

- Program requires NvMACT mercury controls on existing and new thermal units.

- To address existing sources a transitional or “phased” approach was implemented.

- Phase-1: Industry inventory, data collection & permit for existing processes w/ work practice standards.

- Phase-2: Determine NvMACT technology and emission limit and issue final Hg permit.

- 24 months to install & operate control technology.
Control Technology Review

Determine best technology on a performance basis.

Determine what of the best is applicable (engineering-wise)

- Include cost & mine life factors
- Include collateral pollutant increase & available resources (eg: water, power)
- Select a technology
- Determine a case-by-case Hg emission limit
- Public Notice
Testing started in 2006 for VMRP facilities. Testing in 2007 and each consecutive year after for all facilities, for all thermal units, not designated de-minimis.

Develop modified M29 test method specific to industry.
- High mercury concentration
- High moisture
- Particulate-bound mercury
Facilities required to report annually based on actual production and annual source test.

Annual Emissions Report demonstrates effectiveness of the Program.

Online at: ndep.nv.gov/baqp/hg/aer.html
Reported Mercury Emissions from Nevada Mines (lbs/yr)

22,136 (high) to 1,393 (current) is a 94% reduction industry-wide.
NMCP Progress

Prior to 2002 mercury emission estimates from mining in excess of 22,000 lbs/yr.

Through implementation of VMRP and NMCP mercury emissions reported below 2,000 lbs/yr (2009).

Once all NvMACT controls implemented project <1,000 lbs/yr.
Federal Gold Mining NESHAP


- Hg is defined as a HAP under the CAA.

USEPA implements Subpart EEEEEEEE (E⁷) April 2013, applicable to gold mines in US and sets Hg emission limits for 3 source categories.

- “Source categories” are a group of units; NMCP has unit level emission limits.

Control technology-based program like NMCP and was developed from 5 years of NMCP data.

- E⁷ limits established 1x; NMCP re-evaluated each time.
Federal Gold Mining NESHAP

Effective April 24, 2013.

E7 applies to gold mines only; not silver or other non-ferrous metal mines.

E7 requires a Title V permit for applicable sources.

During promulgation of E7, EPA did not include fugitive emissions in definition of source category:

- Data limited for site characterization & time.
- Little info on how fugitives may be controlled.
Federal Gold Mining NESHAP

**Ore pre-treatment group**

- ORE MINING
- GOLD LEACHING
- CARBON ADSORPTION & DESORPTION
- KILN

**Non-carbon group**

- CARBON
- MERRILL-CROWE
- RETORTING & SMELTING
- ELECTROWINNING

**Carbon group**

- CARBON REGENERATION
- EW CELL
- BARREN TANK
- FURNACE

**MACT Existing = 0.25 lb/ton of concentrate**
**MACT New = 0.20 lb/ton of concentrate**

**MACT Existing = 2.6 lb/ton of concentrate**
**MACT New = 0.14 lb/ton of concentrate**

MACT limit for existing & new sources = 149 lbs/million tons of ore
Other Mercury-Related Projects

- Mercury Deposition Network
- Ambient Air Monitoring: Passive Samplers
- Characterization of Fugitive Emissions at Mine Sites
Other Mercury-Related Projects

Mercury Deposition Network

NDEP funds and participates in operation of National MDN sites in Nevada.
  - Sites would have otherwise closed due to lack of funding.

MDN is the only network providing a long term record of total Hg concentration and deposition in precipitation.
  - 88 MDN sites across the US, but only two in the Great Basin area (NV).
Other Mercury-Related Projects

Development of a Passive Hg Sampler

- Current samplers are expensive, difficult to operate & require electricity.
- UNR passive sampler will be relatively cheap, simple and require no electricity.
- Passive methods under development are tested against established active sampling methods along with air quality and meteorology measurements.
- Field testing at UNR Agricultural Experiment Station.
- NDEP was awarded a $364,000 research grant from EPA to fund UNR’s development.
Fugitive Mercury Emissions

UNR funded to study factors that affect fugitive Hg emissions

Two mines chosen for study:

Twin Creeks

Cortez Pipeline
Fugitive Mercury Emissions

Laboratory & Field Components

Factors that effect Hg emissions:

- Material type
- Environmental conditions
Fugitive Mercury Emissions

- Fugitive Hg emissions are ~20% of point source emissions.

- Large differences in emissions between mines (no “universal” emission factors).

- Emission estimate reflects one stage in the life of a mine
  - emissions will vary depending on activity, age, and reclamation

- Factors important to consider:
  - mercury concentration/host rock characteristics
  - surface area of mining disturbed materials
  - characteristics of tailings impoundments
  - climatic conditions
  - ore-processing techniques
  - age of materials and reclamation
  - natural background & global pool
Fugitive Mercury Emissions

Remediation study
- Techniques or methods that may reduce Hg emissions from mine surfaces.

Hg Emission Model validation
- Testing model regression equations developed in Eckley et al.

Emission estimates for additional mines
- Estimated annual Hg release for Goldstrike and Gold Quarry mines for 2010.
Fugitive Mercury Emissions

Remediation Study

Materials collected from four mine sites:
- Waste Rock/Cap
- Leach ore
- Tailings
- Dust control solution
- Wetting of materials

Returned to UNR greenhouse for remediation treatments and tests.
Fugitive Mercury Emissions

Remediation Study Results

Results showed that capping mining waste materials with a low-Hg substrate can reduce Hg emissions from between 50 to nearly 100%.

The spraying of typical dust control solutions often results in higher Hg emissions, especially as materials dry after application.

The concentrated application of a dithiocarbamate Hg control reagent appears to reduce Hg emissions, but further testing is needed to make a definitive assessment.
Fugitive Mercury Emissions

Modeling of Annual Site Emissions

- Site-specific model inputs:
  - Total Hg concentration of substrate
  - Substrate area
  - Environmental conditions: # of days in each solar level and # of days wet/dry.

- Hg flux calculated for waste rock, dry leach, dry tailings, and reclaimed areas using appropriate regression equation for each solar level.

- Most significant emission surfaces were the heap leach pads and the tailings ponds.
  - Capped for remediation and bonded.
Fugitive Mercury Emissions

Modeled emissions:

- **Gold Quarry**: 39–42 kg yr\(^{-1}\)
  Mean Hg = 5.2 ug g\(^{-1}\)
  Area = 15.2 km\(^2\)

- **Goldstrike**: 14–17 kg yr\(^{-1}\)
  Mean Hg = 2.7 ug g\(^{-1}\)
  Area = 19.7 km\(^2\)
Fugitive Mercury Emissions

Modeled emissions: limitations and questions

- Relatively few data points.
- Assumption of a 10% disturbed area for heap leach and waste rock.
- Very limited pit data.
- Age factor needs to be better understood and could influence timing of remediation.
- Cyanide solution as a source of Hg to the air versus actual material wetness unclear and this could influence emissions.
- Limited tailings and heap leach data - model results very sensitive to changes in how these materials are handled.
- Assumption that carbonaceous ore measurements can be translated to all stock piles.
Fugitive Mercury Emissions

Research needs to improve model of fugitive Hg emissions:

- Wetting and material age affect the magnitude of Hg released from specific materials.

- More field data points for model testing
  - Only have one season
  - Tailings and heap leach data very limited and emission estimates complex.

- Application of model to other mines
  - Could be helpful for TRI estimates.
  - Application to other mines not trivial.

- Speciation of Hg emissions from nonpoint sources needs to be determined - lab and field study.
Fugitive Mercury Emissions

Research needs to improve model of fugitive Hg emissions:

- Lab studies to better understand if Hg released from tailings and active heap leaching is from solution or solid materials

- More soil concentration measurements with depth would be useful for understanding potential impacts.

- All measurements made in this study were conducted in an enclosed greenhouse on a relatively limited selection of mine materials at a smaller scale; may not be directly representative of conditions and results that would occur with capping on actual mine surfaces.
Questions?

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