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# Risks Posed by Bevill Wastes

**Environmental Protection Agency**

**1997**

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## Introduction

Based upon information on potential and actual environmental threats and the availability of new risk assessment techniques, the Agency is seeking comment on whether reexamination of some Bevill waste is warranted. In this report, the Agency is providing the most current information available on the environmental risks associated with mining and mineral processing operations. The Agency is presenting new information on risks posed by Bevill wastes and is posing the question of whether some waste streams require additional study or regulatory controls given the availability of new risk assessment techniques. Conversely, the Agency is also soliciting comment on whether more protective environmental practices have been put in place and, if so, whether future regulatory actions are necessary.

## Background

When Congress excluded mining wastes from RCRA Subtitle C regulations (the Bevill Amendment of 1980), it gave the Agency directions to study these wastes and determine which ones should remain exempt from RCRA Subtitle C regulations. On December 31, 1985, EPA published the required Report to Congress on Solid Wastes from Mineral Extraction and Beneficiation[1], and on July 3, 1986 (51 FR 24496) published a determination that regulation of certain mining wastes under Subtitle C of RCRA was not warranted, primarily because traditional hazardous waste controls applied to large volume mining wastes may be technically infeasible or economically impractical. In making this determination, Congress required the Agency to consider several factors, including mining waste disposal practices, potential danger to human health and the environment, and the costs imposed by potential regulation of mining waste. See Regulatory Determination, July 3, 1986, 51 FR 2449; RCRA §§ 3001(b)(3)(A)(ii), 8002(f), and 8002(p).

While the Agency determined that Subtitle C regulations were not warranted for extraction and beneficiation wastes, it found that a significant quantity of mining wastes exhibited hazardous characteristics and expressed concerns about environmental damage from mining.[2] Further, the Agency expressed concerns about other hazardous properties of mining wastes such as, radioactivity, asbestos, cyanide, or acid generation potential, that is not identified by the current RCRA characteristics. 51 FR 2449.

The Agency similarly studied mineral processing wastes, exempted 20 large volume special wastes, and likewise expressed concern about actual and threatened environmental

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[1] EPA No. 530-SW-85-033

[2] 51 FR 24496, July, 1986 1.3 to 2 billion metric tons of nonfuel mining waste were generated annually. 755 million metric tons of mining waste had RCRA hazardous characteristics or were potentially subject to RCRA. Mineral processing facilities generated approximately 500 million metric tons annually. By comparison, in 1993 large quantity generators (industries subject to Subtitle C regulations) produced 258 million tons of hazardous wastes.



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damages caused by some of these wastes[3]. For at least two of the 20 special wastes, the Agency went so far as to recommend potentially pursuing a regulatory program under the Toxic Substances Control Program and the option of revisiting Subtitle C controls. 56 FR at 27214-16. The Agency found that current phosphogypsum process wastewater management practices are often not adequate to limit releases and associated risks.[4] The Agency pursued further studies and regulatory options and found areas where the toxicity of phosphogypsum wastes could be reduced. However, the costs involved were believed to be prohibitive and the Agency pursued no further regulatory action. (See Phosphoric Acid Waste Dialogue Draft Report on Activities and Recommendations, April 1995).

After studying beneficiation wastes, the Agency expressed concerns about the environmental threats from mining and stated that the Administration will work with Congress to develop expanded Subtitle D authority (i.e., Federal oversight and enforcement) to support an effective State-implemented program for mining waste and use RCRA section 7003 and CERCLA sections 104 and 106 to protect against substantial threats and imminent hazards in the interim. 51 FR 24496. At that time, the Agency believed if it were unable to develop an effective mining waste program under Subtitle D, the Agency may find it necessary to use Subtitle C authority in the future. 51 FR 24496.

As a result of this decision, EPA began to develop a series of alternative mine waste management approaches--so called Strawman I and II released in 1988 and 1990, respectively ( Strawman I , USEPA, Office of Solid Waste, May, 1988, and Strawman II, USEPA, Office of Solid Waste, May, 1990). These documents were staff-level products. Strawman II was based primarily on approaches developed by the Western Governors' Association Mine Waste Taskforce. These approaches embraced the idea of a mine waste program tailored to the unique aspects of each state's situation, considering the distinct climatic, geological, and ecological characteristics of each mine. While the Agency received valuable comments on these drafts, it became clear that the level of disagreement was considerable and that face-to-face interaction among the interested parties would be helpful.

In 1991, the states, industry, and the environmental community approached EPA and requested that EPA create a forum to further discuss mine waste issues. In 1991, EPA chartered the Policy Dialogue Committee (PDC) on Mining under the Federal Advisory Committee Act (FACA). The PDC had representatives from the states, the mining industry, the environmental community as well as from the major federal agencies (i.e., Department of the Interior (DOI) and the Department of Agriculture (DOA) and EPA). The purpose of the PDC was to inform the various parties of each others positions and further the debate on development of a national mine waste program. The PDC met seven times and ended in

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[3] Special Wastes from Mineral Processing Final Regulatory Determination and Final Rule, 56 FR 27300, June 13, 1991.

[4] The Agency studied 16 of these phosphoric acid facilities and found that 13 appear to have caused groundwater contamination and 12 have contaminants above primary drinking water standards that have migrated or are likely to migrate beyond the facilities boundaries. 56 FR at 27315.



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1992. While the level of disagreement among the parties has narrowed, it has not been mitigated. (A summary of the PDC activities can be found in the PDC White Paper this rule's docket).

Since the 1986 Determination to exclude certain mining wastes, the Agency has been developing various technical documents on improving the management of mining wastes and has given grants to several states to improve existing state mining programs. Despite these activities, the Agency has not established a Subtitle D or any federally enforceable regulatory program for mining or mineral processing wastes excluded by the 1980 Bevill Amendment.

**Environmental Damages and Releases from Bevill Exempt Wastes**

The Agency continues to believe that mining waste poses a broad range of environmental risk. Some types of mines and waste management practices pose very little risks while others pose significant environmental problems and threats to human health. In contrast to EPA's assertions, mining industry commentors indicate that: most environmental damage cases are representative of past mining practice no longer used; mining and mineral processing poses little, if any, environmental threat, and that state programs adequately regulate modern mines.

The Agency has found that some mining practices are no longer used. However, the Agency's studies also indicate that some currently operating Bevill mining and mineral processing wastes continue to contaminate groundwater and surface water, often through leaking surface impoundments, runoff from piles, wind blown dust, contaminated soil, and failure of dams. Further, the environmental consequences of mining and mineral processing may not be realized until long after cessation of operations, as indicated by the growing list of mine and mineral sites being addressed under the CERCLA Superfund program. When EPA studied mining wastes in 1985, there were 18 mine sites on the National Priorities List (NPL). Currently, there are over 60 NPL sites where the source of contamination is primarily caused by practices that continue today. (See Mine and Mineral Processing Sites on the NPL, EPA, 1997). For example, some tailing ponds and waste rock piles from both historic and currently operating mines are causing environmental damage from acid mine drainage. Further, of the 60 sites on the NPL, more than one-half have been active at some point since 1985, indicating that at least some of the problems are attributable to modern practices. The approximate cost of remediating mining sites currently on the NPL is $20 billion. Based on studies conducted by the Western Governors Association, EPA believes that there are approximately 200,000 abandoned mines in the U.S. It is probable that ten percent of those sites (20,000 abandoned mines) are causing some degree of environmental harm, according to studies performed by the National Park Service. There are no accurate cost estimates for remediating abandoned mines which are currently causing serious environmental harm. However, the Agency and the U.S. Forest Service have determined that mining practices caused contamination of over 10,000 miles of streams throughout the US.

The Agency has also had to take action at an additional 72 mines and mineral processing sites where contamination posed an imminent threat to human health and the



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environment.  Section 106 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) provides for abatement action by a State, local government, or the President, when there exists an "imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance."  In addition, Section 106 contains penalties for noncompliance, forcing potentially responsible parties to clean up a site, or pay as much as $25,000 a day. These orders are one of EPA's enforcement tools, which achieve cleanup at sites posing significant threat to human health and the environment where negotiations over Superfund cleanups have failed.

Review of these imminent threats cases indicate that mining and mineral processing activities continue to pose significant threats not only while operating but long after the cessation of operations.  This may occur to failure of dams or impoundments, accumulation of wind blown dust, movement of contaminated soil, generation of acid through weathering, and periodic releases of toxic chemicals.  At many of the sites, the greatest area of concern is direct human exposure, ingestion, or inhalation of contaminants. (EPA studied hazardous substances present in dust at mines sites in a report titled "Summary of NIOSH Bulk Dust Metals Data, 1991.")  Many of the site actions are time critical, meaning that action had to be taken before site conditions became worse.  Also, many practices that gave rise to the actions, such as storage of toxic chemicals and wastes, are similar to practices that occur at operating mines.  This information is presented in the technical background document "CERCLA Imminent Hazard - Mining and Mineral Processing Facilities, EPA, 1997."

In addition, there are many more documented cases from operating mines and mineral processing sites that have either actual or threatened groundwater, surface water, or soil contamination.  A number of environmental damages from mining were identified in the Agency's 1985 Report to Congress.  EPA continued to study environmental damages from mining and in 1994 published a report "Mining Waste Releases and Environmental Effects Summaries for Idaho, South Dakota, New Mexico, South Carolina, Nevada, Montana, Colorado, Arizona, and California, EPA, March 1994".  This 1994 report collected environmental release information on operating mines found in publicly available files maintained by state agencies. The report was based on data collected from 1986 to 1991.  The Agency found that operating mines were releasing cyanide, acids, tailings, dusts, and other materials containing hazardous substances into the environment.

EPA continued to collect additional environmental release information on operating mines for the period 1990 to present (See Damage Cases and Environmental Releases, EPA, 1997).  The mining industry, in comments on the January 25, 1996 proposal, contend that earlier environmental release information did not accurately reflect activities at modern operating mines.  However, in addition to EPA's earlier studies, the 1997 report has also found that operating mines are releasing into the environment the same types of contaminants (cyanide, acids, dusts, radioactivity, and tailings) that the Agency first identified as environmental concerns in its 1985 Report to Congress.  The 1997 report also confirmed that environmental releases noted in the Agency's 1994 environmental release state reports are continuing at operating mines.  Based on these reports, the Agency concludes that modern mining practices continue to release contaminants and other hazardous substances into the

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environment.

In the prior Bevill rulemakings, EPA expressed concern about wastes that may not necessarily exhibit a toxicity characteristic under RCRA yet may pose other types of risks. These include cyanide used in gold mining, acid generating wastes from copper and gold mining, and naturally occurring radioactivity. Since that time the Agency has documented numerous incidents of damage involving these wastes, including modern and operating mines being placed on the National Priorities List and requiring other response and remedial actions. One recent damage case involves the Summitville mine where cyanide and acid rock drainage caused severe environmental damage to nearby streams and rivers (see USGS Report on Summitville). The Summitville mine was built in the 1980's and operated into the early 1990's using waste management practices that are typical of modern gold mining. Additionally, the Agency is concerned about the rising cleanup costs from mines and mineral processing sites. As previously mentioned, EPA estimates the cost of remediation for mines and mineral processing sites proposed and on the NPL to exceed $20 billion. In the above example, the Summitville site cost the Federal government over $140 million in remedial and emergency actions and additional costs are mounting.

In the 1986 Regulatory Determination, EPA expressed concern about the hazards posed by naturally occurring radioactivity materials (NORM) in mining wastes. The Agency conducted a study of waste management practices in the copper industry in 1994 (See Technical Resource Document-Copper, Office of Solid Waste, USEPA, 1994) which noted that several copper mines located in Arizona produced uranium yellowcake by processing copper ore in the 1950's. Agency review of the chemical composition of copper ore indicates that uranium is often found in and around copper deposits. Recent studies indicate that some copper leaching operations may mobilize and concentrate NORM in various wastes streams and process solutions, potentially causing groundwater and surface water contamination. (See Technical Report on Naturally Occurring Radioactive Materials in the Southwestern Copper Belt of Arizona, EPA, 1996).

The 1985 Report to Congress also found that phosphate mining activities (mainly located in Florida) generated wastes which contained radon at levels exceeding 10 picocuries. EPA's Office of Radiation and Indoor Air also recognized the radiation risks associated with the disposal of phosphogypsum. In 1989, EPA issued a National Emission Standard for Hazardous Air Pollutants (NESHAP) applicable to radon emissions from phosphogypsum stacks (See 54 FR 51654, December 15, 1989). This rule required that all phosphogysum be disposed in stacks thereby permitting control and measurement of gaseous radon-222 which is emitted when radium present in phosphogysum decays.

The Agency again studied wastes generated from the production of phosphoric acid in the 1990 Report to Congress on Wastes from Mineral Processing and found that phosphogypsum wastes were causing groundwater contamination and that these wastes contained high levels of radon. In June, 1991 EPA issued its Regulatory Determination (see 56 FR 27300) which indicated that the Agency would review possible regulatory actions under the Toxic Substances Control Act to determine if TSCA could more effectively regulate phosphogypsum and process waste waters. The Agency chartered the Phosphoric Acid Waste Dialogue Committee under the Federal Advisory Committee Act in 1992 to determine if



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TSCA could effectively regulate phosphate wastes. This group met six times from 1992 to 1994 (See Phosphoric Acid Waste Dialogue Draft Report on Activities and Recommendations, April 1995). The Committee did not identify any affordable, technologically feasible in-plant process changes that would significantly reduce the volume and/or toxicity of phosphogypsum or phosphoric acid process wastewater. The Agency found therefore that since TSCA regulation would not be possible, the Agency would revisit the 1991 Regulatory Determination and determine whether RCRA Subtitle C regulation of phosphoric acid special wastes remains inappropriate.

As a follow-up to the conclusion of the Phosphoric Acid Waste Dialogue Committee, in 1992 the Agency evaluated the environmental risks posed by the disposal of phosphogypsum at 13 phosphoric acid production facilities in Florida by applying the RCRA National Corrective Action Prioritization System to each site. The results show that all 13 facilities would qualify as "high priority" under the National guidelines by either the composite score or a high individual groundwater or surface water pathway score. This evaluation also noted that there was groundwater contamination at all of the 13 sites.

Phosphate mining also presents other environmental risks associated with failures of clay ponds. When mining phosphate, the overburden is removed, and the phosphate ore is dug up and placed in small pits were it is broken up with water cannons and slurried to the mill. At the mill the phosphate slurry is crushed sized and washed. This process is used to separate the sand and clay from the phosphate ore. The sands are slurried to sand settling basins or it is pumped back into mine cuts. The clays are slurried to clay settling ponds, which often cover hundreds of acres. These ponds are unlined and often use earthen dams to retain water.

In 1971 there was a major failure of a clay pond at the city Services (now the Cargill Fertilizer) mine. That spill dumped more than 1 billion gallons of clay slimes and wastewater into the Peace River. In 1972 the state mandated that all new dams must be built to tougher engineering standards. The state however failed to require existing dams be closed by a fixed date. Therefore the mining companies continue to use their older ponds. IMC-Agrico alone has 17 of the old dams in operation.

Since 1990, there have been five major failures of clay pond dams: 1990 at Gardinier spilled 250,000 gallons into a tributary of the Peace River, 1991 US Agri-Chemicals spilled 175 million gallons into a tributary of the Peace River, 1993 Mobil Mining spilled 2 million gallons into the North prong of the Ajafia River, June, 1994 Imc-Agrico 1.7 billion gallons spill, October 2, 1994 IMC-Agrico spilled 127 million gallons into a tributary of the Peace River, and on October 31, 1994 Cargill Fertilizer spilled 20 million gallons into a tributary of the Peace River. The most recent spill occurred when a clay pond dam burst at the IMC Agrico Hopewell phosphate mine and dumped up to 500 million gallons of clay slime and water.

As noted earlier, the Agency first indicated its concern about environmental contamination from cyanide in the 1985 Report to Congress. In 1994, the Agency found that gold mining using cyanide solutions were causing releases into the environment (See Technical Resource Document-Gold, USEPA, 1994). Superfund cleanup activities at the



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Summitville gold mine indicated that cyanide solution leaked into the environment and contaminated the Alamosa River and as much as 10 feet of soil per year. The cost of clean-up at Summitville is estimated at $150 million. The Brewer gold mine in South Carolina experienced a major cyanide spill in 1987 when 10-12 million gallons of cyanide solution flowed into a nearby river. The Agency's most recent review of mining waste releases into the environment (See Damage Cases and Environmental Releases, EPA, 1997) again show that gold mines are releasing cyanide into the environment. For example, the Bald Mountain mine released 8,000 gallons of cyanide solution in 1993 and 1994. The Battle Mountain mine released 5,000 gallons if cyanide solution in 1995, while the Barrick Goldstrike mine released 2,200 gallons of cyanide solutions in 1996.

The 1985 Report to Congress also noted concern over the environmental effects of acid rock drainage from mining wastes on streams and rivers. The Agency is aware that acid rock drainage problems do exist throughout the United States and do exist in the western part of the US. In 1994 the Agency decided to reevaluate data regarding acid rock drainage (See Acid Rock Drainage Prediction, US EPA, 1994). This report concluded that acid rock drainage was an environmental concern at currently operating mines. The report identified three mines where acid rock drainage had occurred, the Newmont Rain gold mine in Nevada, the Cyprus Thompson Creek mine in Montana, and the LTV iron ore mine in Minnesota. The Newmont Rain mine identified acid rock drainage in a waste rock pile. This drainage was remediated and the company redesigned its waste rock pile to isolate sulfur bearing waste rock. Acid rock drainage was forming in the tailings pond at the Cyprus Thompson Creek mine in Montana. The LTV iron ore mine had acid rock drainage forming in the Dunka pit due to exposure of a sulfur bearing formation not found in any other portion of the mine. That drainage was being collected and treated.

The Agency remains concerned that mines are not routinely required to test waste rock and tailings for acid rock drainage potential throughout the life of a mine. Once acid rock drainage begins, the chemical phenomena continues for extremely long periods of time. Some of the most problematic mine sites on Superfund's National Priorities List (NPL) are sites where acid rock drainage has taken place (Summitville, California Gulch, Clear Creek, Iron Mountain, and Silver Bow/Butte). (See Mine and Mineral Processing Sites on the NPL, EPA, 1997). Acid rock drainage problems have also been identified at non-NPL sites, for example at the Blackbird and Stibnite mines in Idaho (see CERCLA Imminent Hazard - Mining and Mineral Processing Facilities, EPA, 1997).

As previously noted, the Agency has taken emergency action at 72 mine sites. (See CERCLA Imminent Hazard - Mining and Mineral Processing Facilities, EPA, 1997). The Agency cost estimate for removals at 22 of the 72 sites is $208 million, with the unweighted average cost of removal of $9.5 million per site. Agency evaluation of 9 additional non-NPL removal actions shows that the average cost of removal exceeded $800,000 per site. Removal costs at the Blackbird mine were not included in the calculation of average non-NPL removal costs since this action is one of the most expensive (estimated at $24 million) and the data would skew the average. One significant source of contamination at the non-NPL sites was water becoming contaminated through contact with tailings and waste rock.

The Agency has also studied the cost of remediation at mine sites. These costs are



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related to cleaning up a wide range of contamination, but these costs are not related to CERCLA actions. The Agency collected clean-up costs at 24 modern (post 1980) operating mines to determine the nature and cost of remediation (See Costs of Remediation at Mine Sites, USEPA, January, 1997). The total cost of remediation at the 24 mines was estimated at $85 million, with the unweighted average per site cost of remediation estimated at $3.5 million. Mines were required to clean up a wide range of environmental problems including the collection and treatment of acid rock drainage, the management of unauthorized discharges to streams, leakage of cyanide solutions, and nitrate contamination of groundwater.

These mounting costs have given rise to a study by EPA's Inspector General, who found critical gaps in some federal and state statutory and regulatory authorities to require adequate financial assurances at hardrock mines. According to the Inspector General, this lack of adequate financial assurances could result in EPA having to assume responsibility for remediation of some hardrock mine sites in the future. The report further finds that EPA had not effectively implemented its existing statutory authorities or used non-regulatory tools, such as partnerships, to minimize the environmental impacts of hardrock mining and help federal and state agencies eliminate financial assurance gaps. (See EPA Inspector General Report: EPA Can Do More to Help Minimize Hardrock Mining Liabilities, 1997).

**Natural Resource Damages**

Under Section 107(a)(4)(C) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA), persons are liable for damages for injury to, destruction of, or loss of publicly owned or managed natural resources, and the reasonable costs of assessing such injury. The term "natural resources" is defined by CERCLA Section 101(16) to include: land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States (including the resources of the fishery conservation zone established by the Fishery Conservation and Management Act of 1976), any State or local government, any foreign government, any Indian tribe, or if such resources are subject to a trust restriction on alienation, any member of an Indian tribe.

Section 301 of CERCLA requires the President to promulgate two types of regulations for the assessment of natural resource damages, Type A regulations, which are the standard procedure for simplified assessments in coastal and marine environments, using the Natural Resource Model for Coastal and Marine Environments (NRDAM/CME), and Type B regulations, which are the general procedures for conducting natural resource damage assessments, and the alternative methodologies for conducting assessments in individual cases. The President delegated the responsibility for issuing these regulations to the Department of Interior (DOI).[5] The DOI has codified its natural resource damage regulations in 43 CFR part 11.

There have been a number of natural resource claims at mine sites. (See Availability of Natural Resource Damage Assessment Modeling, US EPA, December, 1996 and Preliminary

[5] Executive order No. 12316, 46 Fed Reg 42237 (Aug. 14, 1981)



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Identification of Approaches Used in Valuating Natural Resources, EPA, 1990). It should be noted that these claims are among the largest in dollar amounts and have long litigation histories. Among the first natural resource claims at mining and mineral processing sites was the claim filed by the State of Idaho against Bunker Hill (see Idaho v. Bunker Hill, 635 F. Supp. 665, 675-676 (D. Idaho 1986). This claim involves natural resource damages to surface water, ground water, and biota at the Bunker Hill Superfund site. The estimated costs of natural resource damage at this site were estimated to exceed $10 million. Natural resource damage claims were recently settled at the Blackbird Mine in Idaho for approximately $60 million. Natural resource claims were filed at the Iron Mountain Superfund site. The estimated costs of natural resource damage at this site are not available, however this site may require perpetual care to treat acid rock drainage.

One of the most extensive natural resource claims at a mine was filed by Montana against the Atlantic Richfield Company at the Clarks Fork Superfund site (see Civil Action No. CV 83-317-HLN-CCL). Based on assessment studies conducted by Montana (see Appendix -Preassessment Screen:Clark Fork River Basin, Montana , October, 1991), the costs of natural resource damages at the Clark Fork have been estimated to exceed $600 million.

In 1992, United States District Court ruled that Utah had failed to adequately assess natural resource damages at the Kennecott Corporation's operations in the Bingham Mining District, near Salt Lake City, Utah. The Court's ruling is important since it directly summarizes the nature and extent of damages at the site. This record indicates that natural resource damages at the site may exceed $200 million dollars.

Currently, the Coeur d'Alene Tribe and the Departments of the Interior and Agriculture are undertaking a Natural Resource Damage Assessment in the Coeur d'Alene Basin of northern Idaho. The study area covers approximately 1500 acres and the main cause of damage is from historic mining and mineral processing. The assessment process began in 1991 and is ongoing. As of 1995, Idaho has settled its portion of the claim for $4 million. A description of the nature and extent of environmental damages in the Coeur d'Alene Basin can be found in the Coeur d'Alene Natural Resource Damage Assessment Public Information Updates dated September 1995, and March 1996. The estimated total costs of natural resource damage at this site were estimated at $600 million to $1.3 billion.

The Government Accounting Office (GAO) issued a report entitled, Superfund-Outlook for and Experience with Natural Resource Damage Settlements, April 1996 (GAO/RCED-96-71), which noted that there are approximately 60 sites on federal lands which may have natural resource damage claims exceeding $5 million. Not all of these sites are mine sites. Of the 98 natural resource damage cases settled as of April, 1995, six of those sites were mine or mineral processing sites with damage costs of $35 million.[6] The GAO testimony indicates that when natural resource damage claims are finalized at mine sites, they are quite costly, involve years of evaluation, and require complicated restoration

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[6] Testimony of Peter Guerro, director, Environmental Protection Issues, GAO, for Subcommittee on Water Resources and Environment, House Committee on transportation and Infrastructure Hearing (July 11, 1995).



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and recovery approaches.

**Population Studies**

EPA has collected new population information on both mines and mineral processing sites. EPA expressed beliefs in 1985 Report to Congress and 1986 Regulatory Determination that mining occurred in sparsely populated areas. EPA's new information indicates that there are significant populations within close proximity to hardrock mines and mineral processing sites. (See Population Studies of Mines and Mineral Processing Sites, EPA, 1997) This study analyzed the demographic characteristics of people living near operating mines and mineral processing sites. The Agency utilized data from the 1990 Census of Population. As a preliminary indicator of population, EPA determined the population found within one mile and five miles of 306 operating hardrock mines. EPA believes that there are approximately 1,000 operating hardrock mines in the US. Therefore, the population estimates should be viewed as conservative and the actual total population located near mines is larger than this report indicates.

Agency study of the 306 mines represent mining in the gold, silver, copper, lead/zinc, iron, and phosphate sectors. EPA demographic information indicates that 228,145 persons, 58,996 families, and 89,335 households live within 1 mile of 306 hardrock mines. The study of the distribution of more environmentally sensitive populations around these mines indicates that there are 106,367 children under the age of 19 within one mile, of which 55,374 people are under the age of 4. There are 28,003 people over the age of 65 located within one mile of the mines. The ethnic characteristics of the populations living near mines also warrants attention. There are a total of 51,468 non-white people living within one mile of the mines, of which 9,938 are classified Black, 5,452 are classified Native American, and 33,159 people are classified as Hispanic.

There are 3,465,876 persons, 873,441 families and 1,309,036 households located within 5 miles of those mines. Environmentally sensitive populations located within 5 miles include 1,050,572 children under the age of 19, of which 269,842 are under the age of 4. There are 396,197 people over the age of 65 within 5 miles of the mines. There are a total of 859,738 non-white people living within five miles of the mines, of which 235,274 are classified as Black, 50,714 are classified as Native American, and 500,479 are classified as Hispanic.

EPA is especially concerned about the relatively high percentage of children living within mines and mineral processing sites. Some of these facilities discharge significant quantities of lead, and other pollutants for which children may be especially susceptible. For example there are 63,014 children under the age of 19 located within 5 miles of lead mines, of which 17,172 are under the age of 4.

Agency studied the demographic characteristics of the population located around 112 mineral processing sites. These sites represent those facilities most likely to be affected by the rulemaking. (See Population Studies of Mines and Mineral Processing Sites, EPA, 1997) EPA demographic information indicates that 204,309 persons, 78,373 families, and 107,216 households live within 1 mile of 112 mineral processing sites. The study of the distribution of



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more environmentally sensitive populations around these mineral processing sites indicates that there are 135,587 children under the age of 19 within five miles, of which 72,621 people are under the age of 4. There are 28,003 people over the age of 65 located within one mile of the mineral processing sites. There are a total of 51,468 non-white people living within one mile of the mines, of which 51,499 are classified Black, 1,889 are classified Native American, and 45,340 people are classified as Hispanic.

There are 5,623,769 persons, 1,417,579 families and 2,136,729 households located within 5 miles of those mineral processing sites. Environmentally sensitive populations located within 5 miles include 1,585,086 children under the age of 19, of which 419,055 are under the age of 4. There are 727,244 people over the age of 65 within 5 miles of the mineral processing sites. There are a total of 1,342,613 non-white people living within five miles of mineral processing, of which 949,789 are classified as Black, 33,230 are classified as Native American, and 542,471 are classified as Hispanic.

Agency evaluation of the demographic characteristics of population located within one and five miles of mines and mineral processing facilities indicates that large numbers of people are living close to these facilities, and that environmentally sensitive groups within the population (children and the elderly) are also found in large numbers around these sites. This evaluation of population correctly found that mining and mineral processing sites do in fact have the potential to affect large numbers of people living nearby.

**Changes in Mining Technology**

The technologies used to mine ore have changed significantly since the 1985-1990 Bevill studies. The Agency recognizes that the vast majority of gold mining in the US now relies on the use of cyanide heap and vat/tank leaching. This significant expansion of this form of chemical extraction presents a range of environmental risks was not well understood in 1985. The gold mining sector is now one of the largest industrial consumers of cyanide. The environmental contamination found at the Summitville NPL site clearly shows how a relatively small gold cyanide mine can cause long term environmental damage. The introduction of cyanide heap leach designs which originated in Nevada into dissimilar climates and geologies, also presents different type of risks. For example, the contamination from cyanide process and waste waters from the South Carolina Brewer gold mine was the result of hurricane rainfall. Gold mines are being proposed in settings where cyanide mining has never occurred, and there may not be adequate experience with siting factors to adequately control such issues as snow melt, freeze thaw cycles, and avalanche and seismic threats.

Gold mining using cyanide has been conducted in Nevada for at least twenty years. Over the last five years, a number of gold mines have expanded open pits and will become some of the largest open pit operations in the U.S. This type of mining will require large scale dewatering of the regional aquifer. The Agency does not have adequate information to determine if any long term impacts of dewatering will occur. There is also concern that exposure of minerals in the pit walls may generate acids and mobilize metals which in turn would contaminate water in filling the pits at the conclusion of mining. The Agency also does



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not have adequate information to assess if a risk exists.

Phosphate mining and mineral processing in Florida is one of the largest consumers of sulfuric acid. The resultant phosphogypsum wastes not only contains residual phosphoric and sulfuric acids, but it also contains radioactive constituents. These piles and the management of waste acids presents a unique environmental concern given the karst geology of the state. The recent sink holes where millions of gallons of acid and contaminated wastes were discharged to groundwater is of particular concern to EPA.

In-situ mining of copper has been in existence for many years. The pumping of acids into mineral formations si a complex process and a certain amount of fluid is usually lost. The Agency is concerned that it's introduction at sites with complex hydrogeology may threaten surface and groundwater. For example, in-situ mining of copper has been proposed in Michigan at White Pine, located adjacent to Lake Superior.

The Agency is also see mining proposed in environments which are not in remote or arid sites. Gold mining has been proposed in Maine, Oregon, and Washington, there are several copper mines proposed in Michigan and Wisconsin, and large scale cyanide mining is operating or proposed in Alaska. Mining can be conducted in sensitive environments where there is a positive water balance, but care must be taken to address the specific risks these sites pose.

The Agency has also seen a resurgence of new mines in mineral sectors like uranium. There are over a dozen uranium mines currently proposed. Most will utilize in-situ recovery, and many are located on or near tribal lands.

Changes in technologies and mining methods such as in-situ mining, roasting of refractory ores, pressure oxidation, bacteriological leaching, and massive water diversion projects are not well understood by the Agency. The environmental risks associated with these technologies are similarly not well understood and regulatory changes may be warranted.

**Changes in Mining Waste Management**

The Agency has seen a trend for more mining wastes to be managed in protective impoundments utilizing synthetic liners and in tanks. EPA has conducted a series of studies to determine the feasibility of lining hard rock tailings ponds. In addition, EPA also performed studies comparing the requirements for uranium mill tailings against the management practices of gold cyanide mines and phosphoric acid facilities. Some new uranium mines are complying with the containment standards equivalent to Subtitle C regulations, according to the Nuclear Regulatory Commission (See NRC File). EPA believes that many metal mines and phosphate gypstacks and cooling ponds are comparable in size to uranium mill tailings, yet do not meet Subtitle C standards.

The Agency conducted a series of studies evaluating the design and operation of tailings ponds (See Technical Feasibility of Lining Tailings Ponds, US EPA, January, 1997) This report summarizes Agency study on the design and operation of tailings ponds. Agency evaluation of environmental releases indicate that tailings ponds are a source of surface and ground water contamination. Since the mid-1980's many mining companies have addressed



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this risk by designing tailings ponds with liners composed of clay, compacted soils, and synthetic liners. The Agency's 1997 report concludes that there does not appear to be significant engineering reasons why tailings ponds can not be effectively lined with synthetic liners.

The Agency has found that synthetic liners have been routinely installed at hard rock mines since the late 1980's. In 1991, The Western Governors Association prepared a report on gold mining permitting which showed that some gold mines were installing 20-80 mil synthetic liners at tailings ponds (See Abstracts of Selected Precious Metal Mine Permits, Western Governors Association, December, 1991). EPA conducted a series of site visits to operating mines in 1991 and 1992. The purpose of these visits was to gain a better understanding of waste management practices at operating hard rock mines. These visits confirmed that many hard rock mines were installing synthetic liners in 100-400 acre tailings ponds. These reports also noted that in tailings ponds which did not use synthetic liners, most of those units either used compacted soil, clay, or slimed liners. (See Technical Resource Document, Gold and Copper, US EPA, 1994). EPA visited the Stillwater mine in Montana in 1992 since this mine is often referred to regarding the design of its tailings ponds. The Stillwater platinum mine is located in an alpine environment in Montana. The first tailings pond was installed in 1986 and utilized a 100 mil synthetic liner. The company indicated at the time of the visit, that the liner performed well at the site. The Stillwater Mine is currently seeking approval to develop a second tailings ponds which also will be installed with a 100 mil synthetic liner. In 1994, EPA conducted a review of the literature on the design and operation of tailings ponds to determine if there were any engineering constraints to the installation of liners in large waste management units like tailings ponds (See Design and Evaluation of Tailings Dams, US EPA, 1994). This report also concluded that there were no engineering reasons why tailings ponds could not be routinely lined.

The Agency conducted a study to compare the design and operating standards for uranium mill tailings with those established by Florida for phosphogypsum stacks. (See Feasibility Analysis : A Comparison of Phosphogypsum and Uranium Mill Tailing Waste Unit Design, USEPA 1997) . The design standards established under the Uranium Mill Tailings Reclamation Act (40 CFR 192) were designed to protect groundwater from disposal units holding uranium mill tailings. These tailings are similar in size and density to tailings generated in hardrock mining. These standards have also been in place since 1983. During this study the Agency determined that four phosphogypsum stacks (New Wales, Ft. Meade, Plant City, and Nichols) were either built or in the design phase which represented new approaches to managing this type of wastes.

The 1993 Florida Phosphogypsum Management regulations are less stringent than the uranium mill tailings standards defined in 40 CFR 192 Subpart D in several important respects. First, the uranium tailings standards require a double composite liner with two geomembranes and an underlying layer of 3 feet of compacted soil with minimum hydraulic conductivity of $1x10^{-7}$ cm/sec. The gypsum standards require only one geomembrane and 2 feet of compacted gypsum with minimum hydraulic conductivity of $1x10^{-4}$ cm/sec (or an underlying 18-inch layer of compacted soil with maximum hydraulic conductivity of $1x10^{-7}$ cm/sec, which has not been used in any of the four cases analyzed in Section 4). Second, the



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uranium tailings standards require a leachate collection system that is also used as detection system. If the measured volume of liquids recovered exceeds a pre-determined action leakage rate, a response action plan is set in motion to mitigate or stop any leaks. In the gypsum case, leakage through the liner is expected and it is actually calculated in the technical reports presented in the permitting process.

All three gypsum stacks constructed or proposed since the enactment of the 1993 Florida Phosphogypsum Management regulations have followed or exceeded the Florida standards but none of the designs approach the protectiveness of the uranium mill tailings standards.

This report shows that phosphogysum stacks can be lined in units with average sizes exceeding 150 acres. Liner design usually involves the use of a 24 inch layer of compacted gypsum followed by a 60 mil geomembrane and the use of concentric underdrains. All of the four lined stacks will have extensive groundwater monitoring systems.

The Agency conducted a study to evaluate current State of Nevada gold cyanide mill tailings facility design, operation, and closure regulations, and compare them to the uranium mill tailings design and operating regulations promulgated at 40 Code of Federal Regulations (CFR) 192. (See Nevada Gold Cyanide Mill Tailings Regulation, US EPA, February, 1997). This report also evaluated the tailings pond designs used at three gold cyanide mill facilities in the State of Nevada. Nevada was selected for the comparison because it is the nation's largest producer of gold, has the largest number of gold cyanide mill facilities, and has promulgated the most advanced cyanide mill tailings facility regulatory framework.

The State of Nevada minimum design criteria for tailings impoundments include a 12 inch thick soil liner with a coefficient of permeability of $10^{-6}$ cm/sec, or equivalent. The design criteria for tailings impoundments under 192 requires three layers of solution containment - two of flexible geomembrane and a bottom liner of 3 feet of compacted soil with a coefficient of permeability no greater than $10^{-7}$ cm/sec, with geotextile leak detection collection system between the liners. Nevada regulations require review of dam design, construction and maintenance requirements prior to issuing a dam permit. 40 CFR 192 does not specify requirements for the dam associated with a tailings impoundment. Nevada State regulations are written and enforced to prevent degradation to the waters of the state, where the regulations are written to prevent any release to the groundwater. Because of this difference the Nevada regulations require identification of all drinking water sources, groundwater and surface water sources and quality. Nevada closure requirements are focus on preventing degradation of the waters of the state, and converting the land to a post-mining use. Also due to the low precipitation and high evaporation rates, typically state wide, final covers are designed to hold precipitation for subsequent evaporation. Nevada regulations for post closure monitoring are established on a facility basis, but is no longer than 30 years. The 192 regulations require monitoring of no less than 30 years.

Review of the liner designs at the Newmont Rain, Barrick Bullfrog, and Echo Bay McCoy mines indicate that all were successfully constructed using either 12 inches of amended soil liners or synthetic liners in conjunction with compacted clay liners. It is important to note that while there are differences in regulatory approach between UMTRCA and Nevada, EPA's information indicates that tailings ponds in Nevada are being lined and



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that there does not appear to be technological barriers to such installation.

**Risk Analysis**

The Agency believes that modern risk modeling techniques may provide a more accurate characterization of human health and environmental risks from Bevill-exempt wastes. In the 1985 Report to Congress on Extraction and Beneficiation wastes, the Agency generally characterized environmental damages but did not provide a quantitative estimate releases, exposures, or risks associated with mining waste disposal practices. In the 1990 Report to Congress on Mineral Processing, the Agency similarly characterized environmental damages from mineral processing wastes and went further in providing limited risk modeling by examining contamination through the groundwater pathway.

The Agency's qualitative review of damage cases indicate that the risks posed by disposal of Bevill waste is similar to risks from other industrial hazardous wastes. However, the Agency has not performed any type of quantitative risk modeling using information and data gathered since the initial Bevill studies. Further, the Agency has not modeled or analyzed risks associated other environmental pathways, such as air, soils, surface water, or food chain ingestion. In the case of mining and mineral processing, the air and soils pathways were significant factors in placing several sites on the National Priorities List[7]. However, the release of contaminants through these pathways was not evaluated by the Agency in its decision not to apply more stringent RCRA regulatory controls.

The Agency first identified concern over the health and environmental effects of metallic dusts in the 1985 Report to Congress. In 1991, EPA determined that National Institute for Occupational Safety and Health (NIOSH) had collected dust samples inside mining and mineral processing facilities. This information is summarized in an April, 1991 report form the Agency's consultant (See Summary of NIOSH Bulk Dust Metals Data, from SAIC to S. Hoffman, EPA, April, 1991). NIOSH data provided the Agency with information on the metallic content of dusts found within mining operations, which indicate dusts routinely contain lead, arsenic, chrome, and nickel. This data can not be used to forecast risk since NIOSH did not sample at the site boundary. This data is useful as long as it is used as a surrogate for the types of dusts likely to be found at mining and mineral processing sites.

Agency study of mine sites on the NPL has indicated that metallic dusts have the potential for adversely affecting human health. Recent study of lead bearing dusts at the Tri-State NPL lead site indicated that lead dusts from abandoned lead slag piles were potentially affecting nearby residents. Metal bearing dusts have been identified as a source of contamination at the Bunker Hill NPL site. The Agency for Toxic Substances and Disease Registry (ATSDR) recently completed a Preliminary Public Assessment for Big River Mine Tailings Desloge, 1996. This report concluded that the site located in Missouri is considered a public health hazard due to exposure to windblown lead bearing dusts. (See Memorandum from S. Hoffman to RCRA Docket, Review of Preliminary Public assessment for Big River

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[7] Examples include Atlas Asbestos, Johns-Mansville Asbestos, Anaconda Smelter, Denver Radium, East Helena, Bunker Hill,



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Mine Tailings). Of particular interest to the Agency is that while the lead tailings found at the Big River site had been abandoned for many years, they were still threatening public health twenty five years after disposal.

Since the 1985 and 1990 Bevill studies, the Agency has developed much more sophisticated release, fate, and transport modeling methodology. This methodology was recently used to quantify risk for cement kiln dust (CKD), a mineral processing operation similar to many of the operations studied in the 1985 and 1990 Reports to Congress, especially the calcining, elemental phosphorous, and lightweight aggregate mineral sectors. The CKD risk modeling analysis used the MMSOILS model, a screening-level multimedia contaminant release, fate, and transport model, to estimate ambient concentrations of constituents of concern in ground water, air, surface water, soils, and the food chain. MMSOILS was developed by EPA's Office of Research and Development to simulate the release of hazardous constituents from a wide variety of waste management scenarios and their subsequent multimedia transport through key environmental pathways.[8] MMSOILS also simulates numerous cross-media transfers of contaminants (e.g., atmospheric deposition to soil and ground water discharge to streams). As a screening-level model, MMSOILS was designed to provide rough order-of-magnitude exposure estimates in relatively simple environmental settings.

With respect to the groundwater pathway, new advanced risk modeling is similarly available. The risk methodology called the Composite Model for Leachate Migration with Transformation Products (CMTP) is being used by the Agency to predict groundwater exposure in domestic drinking water receptors. The risks posed by some mining and mineral processing wastes, especially those with high levels of lead and arsenic found at many NPL sites, may be more accurately characterized by application of these or other more modern modeling techniques. The Agency solicits comments on the efficacy of applying these types of modeling methodologies to mining and mineral processing wastes.

It should be noted that the Agency conducted a variation of multi-pathway risk analysis of mining to determine if the mining sector should be added to the Toxic Release Inventory (TRI) (See 61 FR 33588, June 27, 1996). The docket for this proposed rule includes evaluations where the Agency conducted risk screening using the Permit Compliance System, the Biennial Report System, the Aerometric Information Retrieval System, and the Facility Index system to assess the likely pollutant loadings caused by mining. Based on this analysis, the Agency proposed to add the mining sector to the TRI.

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[8] U.S. Environmental Protection Agency, Office of Research and Development, MMSOILS: Multimedia Contaminant Fate, Transport, and Exposure Model, Documentation and User's Manual, September 1992 (updated in April 1993).



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