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Potential Health and Environmental Hazards of Uranium Mine Wastes

Executive Summary

Report To The Congress Of The United States

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POTENTIAL HEALTH AND ENVIRONMENTAL HAZARDS OF URANIUM MINE WASTES

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A Report to the Congress of the United States
in Response to Public Law 95-604

June 10, 1983

U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

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SECTION I

INTRODUCTION

PURPOSE OF THE REPORT

Uranium mining operations release some radioactive materials into both air and water and generate large quantities of solid wastes containing low levels of radioactive materials. Solid wastes produced by past mining operations remain on the surface at many inactive mining sites, and represent a potential health and environmental hazard similar in concept to uranium mill tailings. Contamination of surface and subsurface water supplies also represents a potential problem. To evaluate these potential problems, the Congress, in Section 114(c) of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), instructed the Administrator of the Environmental Protection Agency (EPA) to prepare a report "which identifies the location and potential health, safety, and environmental hazards of uranium mine wastes together with recommendations, if any, for a program to eliminate these hazards."

This report analyzes the potential health and environmental impacts of both active and inactive uranium mines, lists the locations of these mines, identifies additional information needs, and recommends needed actions.

CONTENTS OF THE REPORT

This Executive Summary contains a brief description of the material presented in the main text, including the principal findings, conclusions, and recommendations. The full report consists of this Executive Summary, a main text, and appendices. The full report has been reviewed by the uranium mining industry, States and the Nuclear Regulatory Commission. Comments have been incorporated where possible.

The Agency could not assess the environmental impacts of uranium mining on a site specific basis because of a lack of adequate time and data. Instead, we have done a generic assessment to develop an overview of the regional impacts of the industry. We believe this assessment to be fully responsive to the concerns which initiated this request to the Agency, and to adequately evaluate the regional environmental impacts of the uranium mining industry in the United States.

This assessment is based on mathematical models of representative (average) facilities, classed by type and size of operation. Such models do not necessarily correspond with the operation of any specific individual mine, and the assessments of environmental impacts should not be associated with releases from any particular mine. Such an analysis can present a composite picture, and can be useful in determining if there is a need for actions on a national scale.

In making this assessment, we have generally used realistic but conservative parameters which tend to overestimate the potential environmental impacts. This was done deliberately, with the intent of putting an upper bound on the possible impacts. As a result some mining operations may cause substantially lower impacts than is indicated in this report. Therefore, this study should not be used to assess the potential environmental impacts of any specific mine, and it should be recognized that there is a wide diversity within the industry. Use of the results of this study should be limited to the purpose for which they were developed.

Main text

The main text consists of seven chapters covering the following subject matter:

- --a general description of uranium mining
- --an inventory of both active and inactive uranium mines
- --sources and amounts of pollutants released to the environment
- --amounts of solid waste generated
- --pathways of human exposure to pollutants
- --health risks and environmental impacts
- --recommendations and conclusions

Appendices

The appendices cover the following subjects:

- --a detailed listing of the active and inactive uranium mines in the United States and their locations
- --observations of existing conditions at selected inactive mines
- --a description of the methodology used in the health risk and environmental impact assessments

SCOPE OF THE REPORT

This report addresses potential health impacts caused by air and water emissions and solid wastes at active and inactive underground and surface mines. We emphasize radiological impacts because we believe these to represent the most significant health hazards although nonradiological aspects of ground water and air contamination were also studied. Impacts from other mining activities, such as exploration, site preparation, and in situ leaching, were evaluated in proportion to their potential significance and the amount of available information about them.

Pathways of Exposure

Underground and surface mining release radioactivity and chemicals into air and water and generate solid wastes that may spread through wind and water erosion and release radon-222 into air. We have examined the extent to which people may be exposed to these released materials or residual solid wastes and thereby incur an increased chance of cancer or other health effects from:

--breathing air containing radon daughters,
--drinking water containing uranium and its daughters,
--eating food contaminated by either air or water, and
--living in homes on land covered by mine wastes.

Estimates of the health risks from each of these pathways are presented in this report.

Method of Analysis

Our preliminary evaluations indicated little actual environmental data is available to evaluate the impacts of releases from uranium mines. Therefore, we developed models of active and inactive mines using the available data and evaluated these impacts on a broad generic basis. To the extent possible, operating parameters and pollutant release rates characteristic of the various classes of mines were used in our models. Finally we extrapolated the health risks from the model mines to obtain an estimate of the total health effects from all active and inactive mines on regional populations within 50 miles from each mine. We estimate the risk to the total U.S. population is no greater than a factor of 3 or 4 higher than our estimates for regional populations.

The availability of information to assess the health and environmental impact from uranium mines varied greatly depending upon the type of release and pathway of exposure. In some cases, we had to assume the most appropriate values to use in the analyses. For some release-pathway combinations, we were able to make a quantitative risk assessment. For other release-pathway combinations, the information was so limited that we could identify only the potential for impact.

We have expressed the health and environmental impacts in this report in a number of different ways:

--Estimates of the risk of cancer to individuals and to population groups

--Estimates of the risk of genetic effects to the descendants of exposed individuals and population groups

--Estimates of radioactiviy and chemical concentrations in the environment and a comparison of these concentrations with air or water standards or with existing background levels

--Estimates of land areas disturbed, amounts of solid wastes generated, quantities of water discharged, and quantities of contaminants released to air and water

--Qualitative observations of a potential health impact

It must be recognized that the primary effect of radiation exposure is cancer although genetic effects are also evaluated.

Uncertainty of Health Risk Estimate

To assess the increased chance of cancer and of genetic effects occurring after exposure to radiation, Federal agencies base risk estimates on studies of persons exposed at high doses and assume that the effects at lower doses will be proportionately less. Such assessments are based on a statistical risk to all persons in a large population exposed to a known radiation dose. Because of uncertainties in the health risk analyses presented in this report, these estimates should be used carefully.

BRIEF DESCRIPTION OF URANIUM MINING OPERATIONS

The two major mining methods used in the United States are underground and surface (open pit) mining. During 1978, underground mines produced 5.5 million metric tons of ore containing 8300 metric tons of uranium oxide (U_3O_8) while surface mines produced 7.5 million metric tons of ore containing 8700 metric tons of U_3O_8. In situ leaching, heap leaching, and mine water extraction methods accounted for the remaining 1300 metric tons of U_3O_8 production.

Underground Mining

Underground mining uses shafts and tunnels to gain access to the ore. A mine may extend underground for a mile or more at several depths. The ore is moved to the surface and stored for transport to a uranium mill. Waste rock and sub-ore* generated during mining are also stored at the surface as a waste pile. At most underground mines, these wastes remain on the surface when mining ceases.

Large capacity ventilation systems are used at underground mines to keep the radon-222 decay product concentrations in the working areas below occupational exposure limits. Air is usually forced down through the main shaft along the tunnels to the working areas and then exhausted through ventilation shafts. Large underground mines may have as many as a dozen ventilation shafts. However, while ventilation removes radon-222 decay products from the working areas, it discharges radon-222 to the atmosphere.

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*Sub-ore contains uranium at a concentration uneconomical to mill. This concentration varies with the "cutoff level" of the mill receiving the ore. The cutoff level is usually determined by the cost of milling vs. the value of the recovered uranium.

Surface Mining

Surface mining is done by excavating one or more pits. The top soil and overburden above the ore are removed and stockpiled. The uranium ore is then removed and stockpiled for shipment to a uranium mill. Sub-ore is also removed from the pit during these operations and stockpiled for possible future use.

The present practice at most surface uranium mines is to backfill the mined out pits with overburden as part of a reclamation program. However, even though backfilling is performed, some waste remains on the surface after mining is completed, and the final pit may not be backfilled. Most older inactive mines were not backfilled and little or no reclamation was done.

Mine Dewatering

Since most uranium ore deposits are below the water table, groundwater must be controlled to prevent mines from flooding. Underground mines and most surface mines are dewatered to allow for excavation or shaft sinking and ore removal. Both underground and surface mines discharge this water to natural surface drainage systems. The discharged water, if necessary, is treated with barium chloride and allowed to settle to reduce radium and suspended solids before it is released. In addition to local effects, the long-term impacts on regional water availability and quality are also important considerations.

Exploratory and Development Drilling

The uranium industry has drilled approximately 1,300,000 exploratory and development drill holes through 1977. It appears from mine site surveys and aerial photography that very few drill sites have been reclaimed. Some States do require backfilling of drill holes.

The average drilling depth has increased with time and will probably continue to do so in the future. Deeper drilling will tend to increase the possibility that aquifers with good quality water may be degraded by being connected, via the drill holes, with aquifers of poorer quality water.

SECTION II

ACTIVE MINES

NUMBER OF MINES

In 1978 there were about 340 active uranium mines in the United States. A list of these mines is presented in Appendix E and includes the type of mine, location, and owner. Table 1 summarizes the locations, numbers, and types of active mines:

Table 1

Location of Active Mines in United States in 1978

State	Surface	Underground	In situ	Other
Colorado	5	106	0	4
New Mexico	4	35	0	3
Texas	16	0	8	1
Utah	13	108	0	3
Wyoming	19	6	3	2
Other	3	1	0	0
Total	60	256	11	13

HEALTH IMPACT OF AIR EMISSIONS-ACTIVE MINES

Radiological Impacts

Exposure to radionuclide emissions into air from active uranium mines increases the chance of cancer. These risks of cancer are the primary public health impact from air emissions due to active uranium mines. Individuals who might be living near uranium mines are exposed to higher radiation risks than those farther away. Our estimates of potential impacts are based on model mines in the absence of adequate field data. For our model of a large underground mine we estimate that individuals living for a lifetime 1 mile from the mine would have an increased chance of fatal lung cancer of 2 in a thousand resulting primarily from breathing radon-222 decay products. The increased risk caused by the mine to an individual living 25 miles away is several hundred times lower. Risks from other types of uranium mines are somewhat lower.

We estimated the health impact from all active uranium mines operating in 1978 by multiplying the risks from the model mines by the number of active mines of each type. This procedure provides only a very rough estimate of the total population risks from all mines and is accurate only to the extent the model mine represents an average for all operations. Based on this rough extrapolation of the total risks from all mines, we estimate that the radionuclide emissions into air from all active uranium mines operating in 1978 would cause less than one fatal cancer in the regional population living around these sites.

The risk of genetic defects in future generations due to airborne radiation exposure from uranium mines is very small compared to the natural occurrence of hereditary disease. The largest potential increase in genetic defects would occur near large surface mines. Exposure of the population near a large surface mine for one year is estimated to result in a very small chance of additional genetic effects to their descendants (less than 0.0001 such effects in the population).

Nonradiological Impacts

We estimated the air concentrations of nonradioactive pollutants produced by our model mines at an assumed location of the nearest individual--1 mile from center of mine site--and determined the following emissions presented minimal potential risk to the population:

--airborne stable trace metals

--airborne combustion products from heavy equipment operation

--nonradioactive gas emissions at in situ leach mines

However, the estimated concentrations of particulates in the form of dust in ambient air near large surface mines exceeded the national ambient air quality standard. Most dust near active surface mines is caused by vehicle traffic.

HEALTH IMPACT OF WATER EMISSIONS-ACTIVE MINES

Radiological Impacts

The health risks due to radionuclide emissions to water from active uranium mines are lower than those caused by radionuclide emissions to air. Although we were able to estimate cancer risks caused by radionuclides in discharged water from our model underground and surface mines, we could not do so for in situ leach mines because of insufficient data. However, radionuclide releases in water appear to be low from in situ mines. As with our estimates of air emission impacts, models utilizing some actual data were used to develop this information.

For our model of an average underground mine, we estimated that individuals living for a lifetime 1 mile from an underground mine would have an increased chance of cancer of about one in a hundred thousand due to releases to surface water. We estimated that about one additional cancer in several hundred years might occur from the normal controlled releases from these mines.

However, mine water discharged to nearby streams can recharge shallow aquifers, many of which are presently used for drinking water or may be in the future. We do not have enough information at this time to evaluate the potential health risks from using these aquifers, but using these aquifers for drinking water could result in increased radiation exposure.

Where such a problem may exist, the state radiological program should investigate existing records to determine the contaminant levels in these aquifers due to mining, and evaluate the significance of the health risks from using these shallow aquifers. If a state determines that sufficient data do not exist to perform an evaluation, additional sampling and analyses should be performed by the state to acquire the necessary data.

Nonradiological Impacts

We estimated the concentrations of nonradioactive pollutants in the streams used by the general population of the region from our mine models. These concentrations were from dewatering the model mines and were calculated after the discharge was diluted by the receiving stream. Under these conditions, none of the pollutant concentrations alone or in combination exceeded the EPA Water Quality Criteria concentrations for use in irrigation and livestock water. However, the recharge of shallow aquifers and the use of these aquifers for drinking water present a potential problem similar to that discussed for radionuclide emissions. Thus States may want to evaluate pollution concentrations to ensure drinking water standards are met.

HEALTH IMPACT OF SOLID WASTES-ACTIVE MINES

Radiological Impacts

Uranium mining operations generate large quantities of solid wastes containing low levels of radioactive materials. An average surface mine generates about 6 million metric tons of solid waste per year, while an underground mine generates considerably less--about 20 thousand metric tons per year. These wastes consist of sub-ore, waste rock, and overburden. At surface mines the sub-ore comprises only a few percent of the waste while at underground mines, because much less waste is produced, the sub-ore may comprise up to 90 percent of the waste.

Through wind, water erosion, and release of radon-222, these wastes can potentially contribute to air and water pollution. These wastes pose this hazard because they contain elevated concentrations of radium-226. Sub-ore (depending upon the cutoff grade for milling) may contain up to 50 picocuries per gram (pCi/g) of radium-226, and, even though the overburden and waste rock contain lower concentrations of radium-226 than the sub-ore, large quantities of these wastes can contain concentrations of radium-226 in excess of 5 pCi/g.* EPA has proposed that uranium mine wastes containing radium-226 in quantities greater than 5 pCi/g be listed as "hazardous wastes" under the Resource Conservation and Recovery Act (RCRA) and has also proposed regulations for the treatment, storage, and disposal of these wastes (43 FR 58946, December 18, 1978). The EPA is currently conducting an extensive study of solid wastes from mines, including uranium mines at the request of Congress. If warranted, further regulations on mining would be promugated.

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*The radium-226 concentration of most soil and rock is about 1 pCi/g.

Use of Wastes in Building Construction

Using wastes containing elevated levels of radium-226 as land fill for residential construction or building homes on land contaminated by these wastes can greatly increase the chance of lung cancer to individuals living in these structures. Radon-222 formed from the decay of radium-226 is an inert gas that readily seeps through foundations, floors, and walls and accumulates in the inside air of a house. The radon-222 then decays to daughter products which, when breathed, will lodge in the lungs and cause radiation exposure to the lung tissues. For example, the use of uranium mill tailings in the construction of homes in Grand Junction, Colorado, resulted in radon-222 decay product concentrations inside the homes that required a Federal-State remedial action program for the affected structures (Public Law 92-314). These mill wastes, however, contain much higher concentrations of radium-226 than mine wastes. A survey of homes in Florida on reclaimed land containing wastes from phosphate mining showed about 20 percent of these homes have radon-222 decay product concentrations in excess of 0.03 working level (WL).* Lifetime residency in a home with this level could increase the chance of lung cancer by as much as 4 in 100--thus doubling the normal risk of lung cancer.

The mechanisms by which uranium mine wastes may cause health risks are similar to those which have occurred from uranium mill tailings and phosphate wastes. Although uranium mine wastes usually have a lower radionuclide content and are less suitable as a construction material than the sand-like tailings, these wastes are still a potential health hazard to individuals if effective waste disposal methods are not used. EPA has provided to the States survey reports of radiation anomalies that may be due to use of mine wastes in construction and will continue to support State use of this data.

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*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha rays with a total energy of 130,000 MeV. The working level expresses a concentration of radioactivity in the air, not how much radiation a person receives. EPA estimates that the average working level in U.S. homes is about 0.004 WL.

SECTION III

INACTIVE MINES

NUMBER OF MINES

There are about 3400 inactive uranium mines in the United States. A list of these mines developed from computer listings maintained by the U. S. Department of Energy is presented in Appendix F including the type of mine, location, and owner. The following table summarizes the numbers and types of inactive mines by State:

Table 2

Location of Inactive Mines in United States

State	Surface	Underground	Other
Arizona	135	189	2
Colorado	263	902	52
New Mexico	34	142	12
South Dakota	111	30	0
Utah	378	698	17
Wyoming	223	32	10
Other	108	43	8
Total	1252	2036	101

HEALTH IMPACT OF AIR EMISSIONS- INACTIVE MINES

Radiological Impact

Radionuclide emissions into air at inactive mine sites are small compared to the emissions from active mines according to our estimates of model mines. The principal radionuclide emitted, radon-222, emanates from unsealed mine vents, portals and residual waste piles. This causes only small increases in the risk of lung cancer to individuals living near these mine sites. Utilizing the same models as for the active mines, we estimated risks of cancer from radon-222 emissions to air from our model inactive mines.

By multiplying the risks from our model mines by the number of inactive mines of each type, we extrapolated the total number of potential cancers from all inactive mines. This procedure provides only a very rough approximation of the total risk from all inactive mines.

By these estimates, radon-222 emissions from inactive uranium mines would produce the following cancer risks:

-- Individuals living for a lifetime 1 mile from an inactive mine would have an increased chance of lung cancer of about 2-3 in 100,000.

-- The amount of radon-222 released each year from all inactive uranium mine sites would cause about 0.1 lung cancers in the regional population around these sites.

Nonradiological Impacts

We did not identify any significant health impact associated with nonradiological air emissions at inactive uranium mines. Our estimates of dust emissions from wind erosion of waste piles showed that insignificant concentrations of nonradiological pollutants would exist in air at these inactive sites.

HEALTH IMPACT OF WATER EMISSIONS-INACTIVE MINES

The extent to which inactive surface and underground mines harm water quality is poorly understood. Ground water in contact with ore bodies and consequently in mines typically contains radionuclides and trace elements, and the flow of the water away from the site carries dissolved and suspended radionuclides and trace elements.

Site specific studies are needed to determine the present and potential impacts of inactive uranium mines on both surface and groundwater quality. As with active mines, the potential exists for contamination of drinking water supplies. States may desire to conduct sampling of drinking water at a few sites in the vicinity of inactive mining districts to provide data to evaluate whether such a potential is valid.

HEALTH IMPACT OF SOLID WASTES-INACTIVE MINES

Surface Mines

We estimate that over 1 billion tons of solid wastes were generated at surface uranium mines through 1978. These wastes consist of sub-ore and overburden. The sub-ore, which may comprise about 3 percent of the total wastes, contains significantly elevated concentrations of radium-226 (up to 100 pCi/g).* Although the overburden contains much lower concentrations of radium-226 than the sub-ore, large quantities of these wastes can contain radium-226 in concentrations in excess of 5 pCi/g--the level EPA has proposed be used to judge whether wastes should be considered as a candidate for designation as hazardous waste under RCRA. Such a determination would require that specified disposal methods be developed for these mine wastes.

*The radium-226 concentration of normal soil and rock is about 1 pCi/g.

In many surface mines opened since 1970, the general practice is to backfill the mined-out pits with wastes as part of a reclamation program. However, at most older inactive surface mines, little or no reclamation was done.

Underground Mines

We estimate that about 30 million tons of solid waste consisting mostly of sub-ore were generated at underground uranium mines through 1978. As in surface mining, the sub-ore contains significantly elevated concentrations of radium-226 (up to 100 pCi/g). There has been very little reclamation at inactive underground mine sites, so most of these wastes remain on the surface at these sites.

Use of Wastes in Building Construction

As discussed in the section on active mines, uranium mine wastes would present a significant hazard to individuals if homes are built on land contaminated by these wastes or if these wastes are used in construction materials for homes. Individuals living in these homes could have an increased chance of lung cancer from breathing radon-222 decay products. The extent to which uranium mine wastes have previously been used for these purposes is not well known.

However, some information is available which shows that uranium mine wastes may have been widely used as landfill in the construction of various types of buildings. In 1972 EPA and the former Atomic Energy Commission (AEC) tried to identify locations of higher-than-normal levels of gamma radiation in an attempt to locate uranium mill tailings. During this study, over 500 locations were identified where uranium ore was believed to be the source of elevated gamma radiation. Since it is unlikely that ore-grade material would be used as landfill, we suspect that uranium mine wastes (perhaps sub-ore) may be the source of the abnormal gamma radiation at these sites.

In order to better define the off-site use of uranium mine wastes, EPA is studying the extent to which these wastes have been used away from the mine sites for landfill or in construction materials for use in homes. If mine wastes were involved in construction of homes, a health risk from radon-222 emissions would exist. A preliminary survey has already been completed and the information has been shared with the interested agencies in appropriate States.

SECTION IV

CONCLUSIONS AND RECOMMENDATIONS

The evaluation of the potential impacts of uranium mining was performed largely by means of analytical studies of model facilities. We believe that the results give an adequate representation of the industry. In order to determine the extent of possible problems, our studies were specifically designed to give conservative results. It should be recognized that actual mines may operate under conditions producing substantially smaller impacts than the results presented.

Compared to uranium milling, health and environmental effects of uranium mining are not as well understood, despite the existence of over 3000 active and inactive mines. We have noted throughout this report instances of the absence or inadequacy of pertinent information.

CONCLUSIONS

Solid Wastes

Solid uranium mining wastes are potentially hazardous to health when used as building materials or when buildings are constructed on land containing such wastes. The hazard arises principally from increased risk of lung cancer due to radon-222. In a 1972 survey of communities in uranium milling and mining regions, EPA and the former Atomic Energy Commission found more than 500 locations where such wastes had been used.

Airborne Effluents

a) Individuals living very near active underground mine exhaust vents would have an increased risk of lung cancer caused by exposure to radon-222 emissions. Surface mines and in situ mines are less hazardous, and inactive mines do not have significant radon-222 emissions. Other airborne radioactive emissions from all types of mines are judged to be smaller.

b) The number of additional cancers committed per year in regional populations due to radionuclide air emissions from the approximately 340 active mines and 3300 inactive mines was estimated to be about 0.6 cancers in 1978. This number of estimated additional cancers is small, about one-third of the estimated additional cancers in regional populations due to radon emissions from the 24 inactive uranium mill tailings piles addressed by Title I of the Uranium Mill Tailings Radiation Control Act. (These mill tailings piles represent about 13 percent of all tailings currently existing due to U.S. uranium milling and mining). These potential effects are not of sufficient magnitude to warrant corrective measures, especially considering the large number of sites involved.

c) The following emissions were judged to cause an insignificant health risk at all types of mines:

1. airborne nonradioactive trace metals
2. airborne combustion products from heavy-duty equipment operations
3. nonradioactive emissions from in situ leach sites

d) Airborne dust near large surface mines (primarily caused by vehicular traffic) may exceed the National Ambient Air Quality Standard for particulate matter.

Waterborne Effluents

a) We estimate that an insignificant health risk accrues currently to populations from waterborne radioactivity from an average existing mine.

b) Uranium mine dewatering and water discharges, which are increasing as more and deeper mines are created, may in the future have significant effects on water quality. Current treatment practices are controlling the release of radioactivity into surface waters.

c) Water in inactive surface and underground mines usually contains radionuclides and trace elements in concentrations comparable to ground water in contact with ore bodies. Some abandoned underground mines in certain areas of Colorado and Utah probably discharge such waters to nearby streams and shallow aquifers. Available data is not sufficient to conclude whether or not there is a problem.

d) We could not determine, using models, that there is no health hazard to individuals who drink water drawn from surface or underground sources. Water discharges from active mines to nearby streams and stream channels may extensively recharge shallow aquifers, many of which are either now used or could be used for drinking water. Such determinations must be made on a site-specific basis, and take account of the additive effects of multiple mines. These studies can be made easily a part of State or utility surveillance programs.

Exploratory and Development Drilling

Harm from effluents due to exploratory and developmental drilling is probably small compared to effects of operating mines. Under current regulations and practices, however, aquifers penetrated at different levels can mix, creating the potential for degrading good quality groundwater.

RECOMMENDATIONS TO CONGRESS

1) Based on this study, we do not believe at this time that Congress needs to enact a remedial action program like that for uranium mill tailings. This is principally because uranium mine wastes are lower in radioactivity and not as desirable for construction purposes as uranium mill tailings. Nonetheless, some mining waste materials appear to have been moved from the mining sites, but not to the extent that mill tailings were.

2) Some potential problems were found that might require regulatory action, but none of these appear to require new Congressional action at this time.

SECTION V

OTHER FINDINGS

1) Regulations may be needed to control wastes at active uranium mines to preclude off-site use and to minimize the health risks from these materials. These regulations would need to address the use of the materials for construction purposes as well as ultimate disposal of the materials.

EPA proposed such regulations in 1978 under the Resource Conservation and Recovery Act (RCRA). In 1980, Congress amended RCRA to require further EPA studies before promulgating general regulations for mining wastes. An EPA study by the Office of Solid Wastes on all types of mines, including uranium mines, is currently being conducted. The amendment does not affect EPA's authority to regulate use of uranium mine wastes in construction or reclamation of lands containing such wastes.

2) Standards are needed to control human exposure from radioactive air emissions from uranium mines. This is principally because of potential exposure to individuals living near large underground uranium mines rather than concerns regarding the exposure of regional populations. We have proposed such standards under Section 112 of the Clean Air Act.

3) EPA has conducted two field studies in 1972 and 1978 which define possible sites at which mine wastes may have been used in construction or placed around buildings. The information developed in these studies has been sent to State health departments. The States should conduct follow-up studies, as appropriate, to determine whether there are problems at these sites.

4) The adequacy with which NPDES permits protect individuals who may obtain drinking water near the discharge points for uranium mine dewatering should be evaluated by States. Under the Public Water Systems provision of the Safe Drinking Water Act, radionuclide standards now exist for drinking water.

5) Some site specific studies should be considered by States to determine the extent to which inactive uranium mines may be significant water pollution sources.

6) States with uranium mines should determine the feasibility of controlling fugitive dust from large surface mines and incorporate the recommendations in State Implementation Plans.

7) States should require borehole plugs in drilling operations that will prevent interaquifer mixing (exchange) and also seal drilling holes at the surface.