of depth, though research on this question is inconclusive (Bittner, King, and Holston, 1988). As a marine sediment, the Selma Chalk is laced with numerous sand lenses. If chemical contaminants were to exploit a fracture connected to such a sand lens, they would move horizontally, increasing the possibility of coming in contact with additional fractures.

The reality that all landfills leak is generally accepted. Chemical Waste Management, Inc., owners of the landfill, claims that it would take 10,000 years for one drop of water to percolate through the Selma Chalk. However, chemical wastes, not water, are being disposed of at Emelle. Although it is no longer legal to landfill liquid wastes, between 1977 and 1985 a variety of liquid wastes (including industrial solvents) were buried in steel barrels. How these wastes will react with the calcium carbonate materials of the Selma Chalk formation and how this will affect the fate and transport of chemical contaminants from the disposal cells was not considered in the original 1974 EPA report, nor have there been published studies on this issue. There is, however, research which suggests that organic chemicals of the type commonly disposed of at Emelle will have the effect of expanding fractures in the Selma Chalk through shrinkage of the clays (Brown and Thomas, 1987). The safety of the Selma Chalk became a matter of public concern and legislative debate during early 1990 (Lewis, 1990).

6. The other counties (Blount, Cleburn, Hale and Perry) also had black majorities.

Chapter 11
Uranium Production and its Effects on Navajo Communities Along the Rio Puerco in Western New Mexico

*By Wm. Paul Robinson**

Background

Uranium mining and milling technology typically involves the generation of large volumes of waste, called mine and mill tailings, which contain significant concentrations of hazardous and radioactive chemicals and are produced when the uranium values are separated from the rest of the ore. Uranium mining, the removal of naturally occurring uranium ore from the ground, is restricted to areas where uranium is found in significant concentrations. Ore containing uranium in the 0.10% — 1.0% (occasionally as high as 5.0%) range is frequently exploited, resulting in 100 to 1000 times as much waste tailings as the produced product.

Uranium milling, where chemical separation of the natural uranium is conducted, is found next to or in the general region of the ore deposits. Mill tailings are usually disposed of at or near the mill site, using a wide range of technologies with varying degrees of success. The mill tailings produced by this processing operation typically contain 85% of the original radioactivity of the ore, and essentially all of the heavy metals, frequently found in hazardous concentrations in the uranium ore, as well as toxic mill reagents disposed of along with waste rock.

**Paul Robinson is the Educational Director of the Southwest Research and Information Center located in Albuquerque, New Mexico. Southwest is a nonprofit educational organization working on various natural resources, environmental and consumer interests. Activities include educating people and agencies about toxic and nuclear waste, air pollution, agricultural development, land use, economic development and health.*

SOURCE: The Proceedings of the Michigan Conference on Race and the Incidence of Environmental Hazards. Eds.: Bunyan Bryant and Paul Mohai. University of Michigan School of Natural Resources (Ann Arbor), 1990.

The radioactivity found in uranium mill tailings results from uranium decay series radionuclides found with the uranium, such as thorium-230, radium-226, radon-222 and associated radon decay products. The heavy metals found in association with uranium vary in different locations and include arsenic, lead, molybdenum, selenium and copper in New Mexico ore bodies. Toxic mill reagents also vary for different operations but include sulfuric acid, ammonium chloride, and other hazardous organic chemicals such as tertiary amines and diesel fuel, for conventional uranium mills.

Uranium has been mined to provide energy for two dominant applications, nuclear power reactors and nuclear weapons. As a result, essentially all the uranium mining on the planet has occurred since 1945. Though this uranium mining activity has occurred since the Second World War, a significant portion of the world's uranium resources has been exploited on land still retained by aboriginal or other land-based communities. Those native or traditional community lands are the lands left for aboriginal communities after the major land acquisitions by government and private interests in the 19th and early 20th centuries.

A list of locations where significant uranium reserves have been found and mined on aboriginal lands includes:

1) Australia—particularly the Arnhem Land Area of the Northern Territory, home to a large existing aboriginal community;

2) Canada—particularly in northern Saskatchewan area inhabited by Cree-Dene Native Americans;

3) Southwest Africa—Namibia—under South African mining concessions in the "last colony in Africa"; and

4) United States—on Navajo, Laguna Pueblo, Havasupai, and Colville Confederated Tribal Lands, along with pre-1848 Hispanic Land Grants at Cebolleta and San Mateo Springs.

This list identifies important uranium producing regions on land retained by native communities within the four largest uranium producing countries (the Namibian production is included as part of South Africa's uranium within this context).

At uranium operations near native communities, uranium has been extracted for commercial nuclear power operations or weapons applications far removed from any direct economic or social needs of the residents of the mining regions. For the mine and mill operators, the political, environmental, economic and health impacts of uranium extraction on native and traditional communities have been of far lesser importance than the short-term economic value of the production of a strategic raw material like uranium. As with many other extractive operations on native lands, resource extraction for raw materials export — a "raw materials colony" relationship — has a devastating effect on the health, economic conditions, and cultural viability of the native community.

The case of Navajo people living near the Rio Puerco of western New Mexico (See Map 1) illustrates the diverse long-term impacts of resource extraction, particularly uranium mining, on native people. The actions of the people of the area to counter the cultural and health impacts of the mining operations illustrates the responses available to native people to protect themselves and their children from the long-term effects of uranium production and other resource extraction wastes.

Uranium Production in Navajo Country, Focused on the Church Rock Area

The Navajo Nation is the largest Native American tribe, as measured by either reservation size or population, in the United States. The reservation covers 17,000 square miles, the size of West Virginia, in New Mexico, Arizona and Utah; but many of the approximately 200,000 Navajo live in the "Indian country" surrounding the reservation. Some of this surrounding area includes lands allotted to individual Navajo or their families, not the tribal government. Several areas of the reservation, as well as "allotments" off the reservation in the Eastern Navajo Agency of New Mexico, have produced large quantities of uranium, as well as oil and gas and coal.

Uranium has been mined and milled at several locations in Navajo Country — Cameron, Mexican Hat, and Kayenta Chapters (a Chapter is a local government unit, about the size of a county, in the Navajo governmental system), in Arizona; Shiprock, Red Rock and Cove Chapters, near the Four Corners; and Churchrock, Crownpoint and Becenti Chapters, in New Mexico. Mining at Cameron, Mexican Hat, Kayenta, Red Rock and Cove occurred in the 1950s and 1960s to supply uranium for nuclear weapons. Mining at Becenti and Crownpoint occurred in the late 1970s and 1980s for nuclear power applications. The longest sequence of mining in Navajo country took place in Churchrock Chapter and took place during the period 1954-1986.

Each of these communities, as with other mining communities worldwide, has its own individual history of mineral rights ownership and development, economic impacts, waste generation and management and local concern over chronic health effects. However, among these cases, the effects of uranium mining at Churchrock are uniquely severe and very revealing. Churchrock Chapter is located east of Gallup, New Mexico and includes part of the watershed of the Rio Puerco, a tributary of the Colorado River. Geologically, part of the Southern San Juan Basin, the Churchrock area comprises a mining district in the Western part of the Grants Mineral Belt, the source of 45% of the uranium ever mined and milled in the U.S.

The Churchrock area, and the Puerco Valley, have been home for Navajo sheepherders and farmers since well before the U.S. acquisition of the region after the Treaty of Guadalupe-Hidalgo in 1848. As a result of military campaigns in the 1860s and 1870s and the completion of the railroads in the 1880s and 1890s, Navajo people, along with other tribes in the United States, had their lands defined by U.S. government treaties and laws. These legal formulas have been modified frequently and identify the legal status of tribal reservation lands and individual allotments within a highly complex mix of surface and subsurface ownership — much more complex than the "checkerboard" nickname often applied to the region.

Navajo people had no central government prior to 1923. At that time, oil and gas interests sought approval from Navajos for leasing of tribal lands for exploration. The current government of the Navajo Nation derives from the Navajo Tribal Council created for these lease approvals in the 1923 period and still serves as a vehicle for resource development leasing. The uranium mined near Churchrock has come off of leases issued for tribal land, not individual allotments. As a result, lease income has gone to the tribal government for use and distribution, not to Navajo individuals in the Churchrock area directly impacted by the mines.

Further distancing the Churchrock residents from tribal government is the location of the community outside the formal boundaries of the Navajo reservation. Since off-reservation Navajo such as the Churchrock residents have individual allotments, and off-reservation Navajo are a minority among their own people, tribal government provides significantly fewer services to off-reservation, rather than on-reservation, chapters. A significant result of this political relationship is that the tribal government leased land to the uranium mining companies without the consent or active involvement of the local residents and collected mineral

revenues without directing them to the communities directly affected by the mines.

Uranium was first identified at Churchrock in the early 1950s along the north side of the Rio Puerco Valley, where uranium bearing rock is exposed at the surface. Exploration for commercial quantities of ore lead to leasing and subsequent drilling for core samples in a northerly direction from the uranium-bearing outcrops towards deeper and deeper ore zones. Significant commercial reserves were discovered in the Churchrock Chapter along the Pipeline Arroyo, a tributary of the North Fork of the Rio Puerco.

Sporadic uranium production in the area occurred in the 1950s and 1960s, prior to the most recent U. S. uranium boom of the 1970s. Fueled by anticipated development of new nuclear reactors, the Navajo tribal government held a series of uranium exploration and development lease sales for tribal government lands in the area. Two companies acquired leases and developed mining plans for specific ore bodies, United Nuclear Corporation and Kerr-McGee Nuclear Corporation. After mine plan approval in the late 1960s and early 1970s, these companies sank mine shafts into the ground to provide access to ore found in the mineral rich rock 1000-1800 feet below the surface. Kerr-McGee extracted uranium ore from its leases and transported it by truck to its mill at Ambrosia Lake, 50 miles east of Churchrock. United Nuclear successfully worked a land exchange with the State of New Mexico which provided the company with a mill and tailings site bordering its mining lease, and also spanning both sides of the alluvial Pipeline Arroyo streambed.

Uranium Mining and Mill Impacts at Church Rock

With only seven inches of rain per year, the Churchrock area is arid, desert-like terrain. The Rio Puerco is an ephemeral stream, naturally flowing only in response to rainfall and runoff conditions. In contrast, the ore body is found within a very productive groundwater-producing zone, or aquifer, called the Morrison Formation of Jurassic Age. The water found in this aquifer would prevent underground mining without the application of mine dewatering technology. Mine dewatering results in the removal and discharge of water from within the mine. Huge volumes of mine water were removed; dewatering rates reached 5,000 gallons per minute (gpm) — equivalent to 8,000 acre-feet per year — a discharge rate sustained until mine dewatering ceased at the Kerr-McGee and United

Table 1
Permit Violations by Discharges from Uranium Mines at Churchrock, New Mexico

Mine/Mine Operator	Period of Record	Months out of Compliance	# of Violations
Church Rock/ Kerr-McGee	5/80-3/83	7 of 35	7
Parameters Violated: total uranium; dissolved radium-226; pH			
Northeast Church Rock/UNC	1/80-2/83	13 of 38	19
Parameters Violated: total uranium; total and dissolved radium-226; chemical oxygen demand.			
Old Church Rock/ UNC	1/80-2/83	25 of 37	37
Parameters Violated: total and dissolved radium-226; chemical oxygen demand; total suspended solids.			

Nuclear mines in 1986. Neither the Navajo Nation nor the local Churchrock residents were compensated in any way for the removal of this tremendous volume of water from beneath their lands.

At 328,000 gallons per acre-foot, 8,000 acre-feet converts to approximately 2.8 billion gallons per year. This flow was the only perennial flow in the Rio Puerco. This mine water was untreated until 1980, some twenty years after the first uranium was produced in the Churchrock area. Treatment of the water is of concern since it contained radioactive and heavy metal pollutants mixed with the water as it flowed through the mine

to in-shaft pumping stations. Few records of the chemical quality of the mine water were retained by the mine operators due to poor operational procedures at the mines and the mine operators' challenges to the jurisdiction of the Federal Water Pollution Control Act over discharges to the Rio Puerco, preventing enforcement of such legislation until jurisdiction was confirmed in 1980. These challenges argue that the Rio Puerco was not "waters of the United States" under the law, and therefore not subject to the water quality protections provided under that Act. During the period between the passage of the Water Pollution Control Act in 1972 and the decision to assert jurisdiction over the stream in 1980, the mines were lawfully permitted to discharge untreated mine water.

To determine the water quality of uranium mine discharges into the Rio Puerco after the Clean Water Act jurisdiction was confirmed, records for the first three years of permitted discharges were reviewed in 1983 by Southwest Research staff to identify permit compliance history. This review showed a consistent pattern of permit violations for hazardous materials such as uranium and radium for all three mines in the area. These frequent permit violations were not the only defilement of the water used by Churchrock area Navajos. On July 16, 1979, the United Nuclear uranium mill tailings dam broke, releasing more than 94,000,000 gallons of tailings liquids, with a pH of 1 — similar to battery acid -- and 1,100 tons of tailings solids into the Rio Puerco. This flow reached more than 40 miles beyond the tailings facility into Arizona and stained the streambed with yellow and green chemical salts. Identified as the largest spill of radioactivity in the history of the U.S. nuclear industry, the Churchrock spill has resulted in impacts on water quality in the Rio Puerco and important changes in the lives of the Navajo communities which have historically used surface and ground water along the Rio Puerco.

The spill precipitated a cleanup effort by United Nuclear Corporation, the owner of the tailings site. To assess potential health effects, human and livestock health studies were conducted by the Center for Disease Control (CDC). During the period after the spill, and continuing to the present, Churchrock Navajos have had severe difficulty trying to sell their livestock to local butchers and meat markets as a result of perceived impacts of the spill contaminants on the animals using the Rio Puerco. The Churchrock tailings site is also listed on the Federal Superfund National Priority List as a result of seepage under the tailings into ground water off site onto allotments, and potentially onto tribal land. The Churchrock site is one of three uranium mill tailings sites on that list of the most hazardous

waste disposal sites in the United States.

Uranium Wastewater and Health Risks

Though the spill is among the largest releases of radioactivity in the history of the nuclear industry, it does not appear to have had as devastating an effect on the Rio Puerco as the decades of mine dewatering which preceded the spill. Studies of human and livestock health effects after the spill indicated that the same pollutants found in high concentrations in mine and tailings water had showed up in abnormally high levels in the muscles and organs of cattle, sheep and goats which grazed along the Rio Puerco downstream of the mines and mills. A cow grazing downstream of the mine dewatering flows, but upstream of the tailings spill showed higher levels of radioactive thorium-230, radium-226, lead-210 and polonium-210 than animals grazing elsewhere in the Puerco watershed. CDC studies related these increased levels to the propensity of uranium, thorium and radium to attach to suspended solids in river water, which would distribute contaminants downstream along the Rio Puerco into Arizona.

The CDC report stated that "years of chronic exposure to dewatering effluent may lead to radionuclide levels in the animals that would exceed those expected from the pulse of tailings liquid released in the spill" (CDC, 1980: 22). CDC researchers also determined that federal exposure standards for the general public would be exceeded when livers and kidneys of exposed cattle were eaten over a fifty year period. Liver and kidney meats are regularly eaten by Navajo, particularly the elderly for whom such "choice" meats are provided.

The human health risk assessments which identified this excess cancer risk for resident populations assumed that livestock were the only individuals drinking Rio Puerco water. However, there is a strong record from Navajo residents of the Puerco Valley of direct human ingestion of water from the stream.

Individual interviews with Navajo in the area identified respondents who personally reported drinking from the Rio Puerco prior to and since the spill. "During the summer, when flow would stop," reports one local resident, "we would dig with the shovel and uncover some water, then we drink it ...." After the spill, some local Navajos tried to avoid using the stream in response to signs installed by New Mexico environmental staff "discouraging use of water in the Rio Puerco." However, as no alternative water supplies adequate to meet livestock needs were, or are available, the Rio Puerco continues to be a primary water source for Navajo livestock.

Navajo people along the Rio Puerco filed a lawsuit against United Nuclear for damages, but when the case was settled in 1985 for $550,000 total among 240 plaintiffs (slightly more than $2,000 per plaintiff), many local people thought that the problem had gone away. One resident reported that people "never really knew about the water contamination before the spill" or simply forgot about it after the settlement.

The residents along the stream currently rely on shallow alluvial wells or water from the stream for their livestock and domestic water supplies. This alluvial water supply is directly connected to the surface water so heavily impacted by mine dewater and spill releases. Several of these alluvial wells also show significant contamination from radionuclides and trace elements associated with uranium ore.

Few community water systems exist in the Navajo parts of the Puerco Valley and more than half of the 10,000 Navajo in the Puerco Valley rely on shallow wells for domestic water supplies. This situation continues into the 1990s where water which was contaminated by more than twenty years of uranium mine and mill discharges is still the primary water supply for Navajos and their livestock.

The Navajo Nation has selected land along the Rio Puerco to relocate tribal members being moved off their traditional lands as a result of the Navajo-Hopi Land Partition. Approximately 250,000 acres along the Puerco have been selected and those land have essentially no surface water available other than the Rio Puerco. The U.S. Geological Survey has begun a multi-million dollar study to fully document, for the first time, the water quality in the Puerco and its stream bed alluvium. This study is designed to identify water supplies for the "new lands" relocatees and may also benefit the longer term residents of the Puerco who continue to suffer from a lack of reliable, high-quality water supplies.

Recent Community Action for Clean Water

Since 1985, Navajo people in the Puerco Valley, assisted by the Puerco River Education Project of Southwest Research and Information Center, have been actively pursuing the provision of clean water to communities along the Puerco. This program has involved extensive community education to upgrade Navajo tribal recognition, and recognition within New Mexico state government, of the pollution problem in the Puerco. The Project has developed informational material for distribution

to Navajo leaders at the Chapter and tribal levels, along with state and federal officials, to inform them and to identify an appropriate solution — local water systems. The Project has also conducted surface and ground water sampling to fill in information gaps and better document the extent of surface water, ground water and soil contamination along the Rio Puerco.

The Puerco River Education Project has also served to link the various Navajo communities along the river to build the cooperation necessary to bring limited funds to bear on the water supply shortage in the valley. This cooperation has lead to the formation of a Puerco Valley Navajo Clean Water Association and a community-planned celebration commemorating the tenth anniversary of the July 16, 1979, spill. This celebration on July 16, 1989 focused on the need for water in the communities, not the horror of the spill itself.

Rather than concentrate on the negative impacts of the accident such as physical and psychological scars and continuing depressed markets for livestock, local residents chose to remember the spill in more positive ways. People came together to run, eat, dance and sing as a community to show the strength of their culture and communities, in spite of the serious problems that have occurred. Involving chapters along the 100 mile reach of the Rio Puerco in both New Mexico and Arizona, the "Celebration for Clean Water" broke new ground by establishing cooperative and non-competitive community relationships. This use of traditional song and dance, Navajo foods, and an uncommon degree of inter-chapter unity and resulted in increased community involvement and respect for those individuals organizing to address the need for new water supplies, particularly among elders and elected leaders.

The sponsorship of the "Celebration for Clean Water" by a Navajo-directed organization focused media and government agency attention directly on the people affected by the problems of the Puerco River, and allowed Navajo people themselves to advocate for better water supplies. Beyond the need for new water supplies, the Association has recognized that the community has suffered as a result of the history of irresponsible uranium development in the Puerco Valley (as demonstrated by the history of permit violations and the listing of the Churchrock tailings on the Superfund Priority List) and its continuing legacy for the community. Therefore, the Association has expanded its goals to include the support of community-scale economic development to avoid the kind of long-term environmental consequences associated with uranium production in the

region. The Puerco Valley Navajo Clean Water Association (PVNCWA) combines the community leaders' personal recollections of the spill with the understanding that, despite the evidence of contamination from mine dewatering and the spill, little has been done in the past ten years to rectify the Third World water resource and economic conditions which persist in the Rio Puerco Valley section of Navajo land.

Summarizing this point during Inter-Faith Hearings on Toxics in Minority Communities in Albuquerque, New Mexico in September 1989, Kee Joe Benally, PVNCWA leader from Lupton Chapter asserted:

> There's about 14,000 Navajos living in New Mexico and Arizona along the [Puerco]. Many don't have running water in their homes. They don't have enough water for their animals. They don't grow crops because of the water shortage. If we had water, we would have jobs because we could raise more livestock and grow our own food. This is all we ask. Our Association will be learning about how we can help ourselves in our own communities in this way (Benally, 1989).

The Association recognizes that, while $50 to 60 million will be spent on cleanup at the UNC mill (since the spill the site has been included on the Superfund National Priority List), no funds have been allocated to address water needs of the families downstream of the mine and mill. To combat this inequity, the Association has held community meetings, contacted elected leaders and non-profit philanthropic organizations, and hosted national and international delegations to the area concerned about uranium effects on the Native American community. These events have dramatically increased public awareness of the Association's efforts and the poor condition of community water resources, and helped build working relationships among the seven chapters along the Puerco: Mariano Lake, Pinedale, Church Rock, and Manuelito in New Mexico; and Lupton, Houck, and Sanders in Arizona.

In the future, the Association will focus on raising funds and support for community water systems to distribute water to existing Navajo homes. Water is the lifeblood of the people as well as being key to their economic livelihood. In an effort to generate local income opportunities, the Association is investigating small scale economic development programs based on improved water supplies such as community farming, along with its continuing effort to educate local residents and local, tribal, state and federal officials.

While not the first grassroots Navajo group to advocate for social and racial justice around environmental problems, the Association is the first to cover such a wide area and cross state lines. The key to the organization's future is its ability to participate in and control decisions which allocate resources to the chapters and which impact the use—and abuse—of Navajo natural resources.

Chapter 12
Pesticide Exposure of Farm Workers and the International Connection
*By Ivette Perfecto**

Introduction

The interaction of the environment and race raises a variety of interesting conceptual questions, to say nothing of important practical and moral ones. As James O'Connor (1989) recently pointed out, there is little in the way of formal social theory which relates questions of the environment to the productive process in any way shape or form. The sorts of epistemological questions so common in the class/race/gender debate have not even been raised regarding questions of the environment.

While it is not my intent to elaborate a theoretical formulation concerning the interaction between race and environment, some comments are in order if only to put the observations of this paper in some sort of context. Further elaboration of these theoretical strings are presented elsewhere (Vandermeer and Perfecto, 1990).

In the modern capitalist world system, firms, regions, and eventually nation-states compete with one another. Competition requires individual capitalists to maintain wages at the lowest possible level. Empirically, we know that their ability to do so is influenced by the race or gender of the workers, allowing greater levels of exploitation through the ideology of

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**Ivette Perfecto has a Ph.D. in Ecology and is an Assistant Professor in the School of Natural Resources of the University of Michigan. Her general research interest is in agroecology, particularly integrated pest management in Central America. She has done extensive research in Nicaragua on alternatives to pesticides in the corn agroecosystem. She now teaches Agroforestry and Tropical Natural Resources Conservation in the School of Natural Resources at the University of Michigan.*