2004

Danger Lurks Below: The Threat to Major Water Supplies from U.S. Department of Energy Nuclear Weapons Plants - Executive Summary

Alliance for Nuclear Accountability

Radioactive Waste Management Associates

Executive Summary

The United States is facing a grave, long-term threat: the legacy of its nuclear weapons program.

The US nuclear weapons production complex is vast: 13 major nuclear weapons facilities located in 10 states and scores of smaller sites. The sites include hundreds of factories and hundreds of square miles. The large, highly contaminated sites occupy an area the size of Delaware and Rhode Island combined.

Here were produced uranium, plutonium and tritium for use in atomic bombs. Poisonous radionuclides and toxic chemicals were their dangerous byproducts. These toxins have contaminated surface and subsurface water throughout the nuclear weapons complex. The contamination is relentlessly leaching, migrating, and moving off site. The poisons threaten important municipal and agricultural water supplies, have placed major rivers at risk and are potentially hazardous to the water supply of several large cities.

Cleanup is underway at the major nuclear weapons factories run by the Department of Energy (DOE). This cleanup has, thus far, cost US taxpayers billions of dollars, yet DOE sites are still plagued by serious problems.

In *Danger Lurks Below: The Threat to Major Water Supplies from US Department of Energy Nuclear Weapons Plants*, the Alliance for Nuclear Accountability (ANA) details the alarming short falls of DOE's cleanup program. Danger Lurks Below shows how hazardous materials are migrating away from the factory sites and demonstrates the inadequacy of current remediation techniques being used by DOE.

Founded in 1987, ANA is a national network of organizations that represents the concerns of communities near US nuclear weapons factories. It develops educational materials, presents testimony and seeks safe solutions for the cleanup of the factories.

This report was researched and prepared for ANA by Dr. Marvin Resnikoff and the research staff of Radioactive Waste Management Associates, a consultant firm located in New York City. Dr. Resnikoff is a high-energy nuclear physicist who has been researching and studying nuclear waste management issues for over 28 years.

The product of over two years of research, *Danger Lurks Below* involved a scrupulous analysis of thousands of studies prepared by the National Research Council and US agencies, including the Department of Energy, the Environmental Protection Agency, the General Accounting Office and the US Congress's Office Of Technology Assessment.

In addition, studies prepared by contractors managing the US weapons complex, research reports and books written by independent engineers, scientists, and epidemiologists, and research information developed by public interest groups were also consulted. Finally, the full text and individual chapters were reviewed by an extensive list of public interest groups located in the vicinity of each of the nuclear weapons facilities.

The Challenge of Cleanup

In its 1999 report, *Groundwater and Soil Cleanup*, the prestigious National Academy of Sciences warns, "The Department of Energy faces monumental challenges in restoring the environment at installations that were part of the U.S. nuclear weapons production complex." The National Academy adds, "Despite the large amount invested in DOE environmental management, progress on groundwater and soil remediation has been slow."[1]

Eight years earlier, in 1991 the respected US Office of Technology Assessment also sounded an alarm about contamination levels in the nation's nuclear weapons production complex. In its detailed report, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production,* the agency says: "Contamination of soil, sediments, surface water, and groundwater throughout the weapons complex is widespread." The report goes on to say: "Almost every facility has confirmed groundwater contamination with radionuclides or hazardous chemicals."[2]

Since the publication of these reports *some* of the problems highlighted in the reports have begun to be addressed, but the task remains, in the National Academy of Science's words, "monumental."

How have we arrived at this challenging moment in US history? What factors contributed to this widespread, seemingly intractable, contamination? Why has DOE not made more progress in addressing this problem?

History of the Nuclear Weapons Complex

In the early 1940s, the Atomic Energy Commission (AEC), later known as the Department of Energy, opened factories across the nation to design, construct and test nuclear bombs for use in World War II. The Manhattan Project, as this project was initially called, was run as a top-secret operation. The factories were typically sited near a river or lake or directly above ground water. At the time, a water-rich location was seen as advantageous because the nuclear reactors and other processes required large amounts of water. This advantage has now become a terrible detriment as pollutants have contaminated these bodies of water, making cleanup exceptionally difficult.

On August 6, 1945 the US dropped an atomic bomb on Hiroshima, Japan, followed by another bomb dropped on Nagasaki three days later. Nuclear weapons production continued even after the war to build a stockpile of weapons as a part of the United States' military policies. By 1967 this arsenal totaled 32,000 nuclear weapons. Since then the arsenal has been reduced to approximately 10,000 long-range nuclear weapons.

In the 1980's the US stopped producing plutonium and tritium and started to shut down some of the nuclear weapons factories. This change was a result of the Cold War's end, new disarmament treaties, a shift towards recycling plutonium out of dismantled weapons, environmental litigation and aggressive grassroots organizing.

In 2003 with new aggressive policies of the Bush administration, there are signs that parts of the weapons complex may be re-activated. There are strong forces pushing for a new plutonium pit facility, resumption of nuclear testing at the Nevada Test Site, the development of new nuclear weapons, including earth penetrating weapons, and operations of a $4.5 billion laser fusion project at Lawrence Livermore (the National Ignition Facility.) All of these new plans would greatly complicate cleanup plans by generating additional contamination.

Spreading Contamination

Both surface and subsurface water systems are at risk from DOE nuclear weapons factories. Some of the major rivers at risk include the Columbia River in Washington, the Clinch River in Tennessee, the Savannah River in South Carolina and Ohio's Great Miami River. Other smaller rivers are also impacted. Pollutants from nuclear weapons operations have been detected in several important aquifers, including the Snake River Aquifer in Idaho, the Tuscaloosa Aquifer in South Carolina, Ogallala Aquifer in Texas and the Great Miami Aquifer in Ohio. (An aquifer is a permeable, water-bearing unit of rock or sediment that yields water in a usable quantity to a well or spring.) The contamination in these vital water systems includes dangerous long-lived radioactive pollutants and toxic chemicals. Among the affected cities which are dependent on at-risk rivers and aquifers for all or portions of their municipal water supplies are Richland, Washington, Cincinnati, Ohio and Kingston, Tennessee.

These water contamination problems are particularly acute at a time when widespread droughts, in conjunction with population growth, are severely taxing important water resources. Throughout much of the Southwest and West, multiple years of drought have already drawn down water tables, aquifers and water reservoirs. At the same time as these factors are making water scarcer, the nuclear weapons complex is exacerbating this situation by compromising available water supplies with dangerous contaminants.

Groundwater accounts for approximately 42% of the public and domestic water supplies in the United States (crop irrigation is the largest use of this groundwater). Clearly this is an immensely important resource that nuclear weapons production has placed at risk.

Contamination has traveled from DOE sites to the groundwater via many different routes. As precipitation encounters surface contamination it can percolate through the soil, carrying the pollutants down towards the aquifers. And as surface water flows, it carries contaminants further from their source and may spread the contamination into nearby streams and rivers, municipal reservoirs, as well as further offsite. Injection techniques, unlined landfills, trenches and pits, degrading waste containers, breaks in pipelines, or deliberate dumping also cause the spread of contaminants into the subsurface.

Health Hazards

The health impact of radiation was poorly understood at the time of the construction of the weapons complex. The use of radiation detectors and the idea of health physics were in their infancy when the weapons complex was built. The International Commission on Radiological

Protection was officially formed in 1950, several years after Los Alamos and Oak Ridge were built; this commission is the international body that recommends radiation standards. As more information from Japanese bomb survivor data and other sources became available, it was apparent that no radiation dose was too small to cause cancer, that is, no threshold existed. Also, increasing the dose increased the likelihood of developing cancer.

But it was not just ignorance that caused Atomic Energy Commission and Department of Energy to downplay the hazards associated with radiation. It was part of a deliberate policy to keep the public ignorant of the threat posed by nuclear weapons factories. DOE suppressed studies that showed the risk to workers at nuclear weapons factories, cut off funding for important health studies, such as those by Dr. Thomas Mancuso, and frequently failed to release documents showing migration of radionuclides off of the sites. These policies continue to this day.

Similarly, little was known at first about the health hazard of toxic chemicals. Later, critical data was often not released on a timely basis. Many hazardous chemicals, such as mercury, toluene, benzene, arsenic, chromium and trichloralethylene (TCE), were used regularly within the DOE complex. The hazard of these materials was only later appreciated by the Environmental Protection Agency. Almost all DOE facilities used TCE for degreasing machinery. Because of the large number of motors involved in their operations, the practice was particularly prevalent at the three gaseous diffusion plants in Tennessee, Kentucky and Ohio. Massive amounts of mercury – over 350 tons - were irresponsibly dumped by the Y-12 Plant in Oak Ridge into nearby streams that drained to the Clinch River. Many of these chemicals have since been shown to be carcinogenic, and mercury is known to damage the neurological system.

Reckless Waste Management Policies

At the nuclear weapons factories, immense quantities of radioactive and toxic chemicals were poured *directly* into the ground. Unbelievable as it seems today, millions of curies of radioactive materials and tons of toxic chemicals were poured into drainage ditches, seepage and evaporation ponds, and unlined burial grounds. This practice continues to the present day at Hanford. From these unstable disposal sites, contaminants have quickly migrated to surface and subsurface water systems. Sometimes these contaminants were even directly poured or injected into underground bodies of water. This was not an accident. It was deliberate government policy that was consistent with the DOE "solution" to radioactive waste management: dilution.

Dilution has always been DOE's preferred method for solving many waste problems. Often concentrations of contaminants in groundwater at the site perimeter are reduced due to dilution. Thus it appears as if the area is not heavily contaminated and makes it easier for a nuclear factory to meet regulatory guidelines regarding off-site emissions. From a public relations standpoint, out-of-sight-out-of-mind is certainly attractive. However, as contamination spreads, more people are affected. According to prevailing scientific opinion, the total dose to the population is the important parameter. The linear no-threshold hypothesis holds that a dose of 100 rems to 100 people (1 rem per person to 100 people) or to 1000 people (0.1 rem per person to 1000 people) produces the same number of fatal cancers. Thus, dilution does not necessarily lead to fewer occurrences of cancer.

Furthermore, dilution does not take into account the fact that diluted radionuclides will travel long distances downstream from the point of release and reconcentrate in mollusks, fish, bird and other creatures that could be subsequently eaten by unsuspecting humans. For example, radioactively contaminated mussels have been found in Oregon, near where the Columbia River empties into the Pacific Ocean, more than 200 miles downstream from the Hanford complex. Neither does dilution address the problem of radionuclides adhering to sediments along waterways such as riverbanks and streams. Subsequently, when water levels drop (for example during a drought) dangerous contaminants can be resuspended and travel in the direction of the prevailing wind.

Contamination of Groundwater

Perhaps nowhere is DOE's dilution policy more alarming than in the contamination of underground water. This is contamination that is almost impossible to map accurately and for which current technology does not allow for complete cleanup. Yet it is these aquifers that are such a vital part of the nation's water supply.

A brief summary of ground and surface water contamination problems at the 13 major DOE sites follows (for a more detailed discussion see individual site profiles):

Fernald Site

This site is located in southern Ohio. It produced uranium compounds and metals. Uranium is the principal contaminant found in Ohio's Great Miami Aquifer. This aquifer is located directly underneath the Fernald plant and provides water to the city of Cincinnati. Uranium is one of the radionuclides that can be removed by pump-and-treat, but the fact that the contaminated groundwater is moving off-site is of serious concern. The aquifer is also contaminated with radium and thorium. A local stream, Paddy's Creek, served as a recharge area for the Great Miami Aquifer and carried uranium below ground to the aquifer. The present uranium concentrations in groundwater range from 500 to 800 parts per billion (ppb); the concentration must be brought down to 30 ppb to meet EPA regulations. Major municipal water intakes from the Great Miami Aquifer are located just three-quarters of a mile from the site's east boundary.

Hanford Reservation

At this site in south-central Washington, nearly two-thirds of the nation's inventory of high-level waste is stored in massive tanks, 68 of which are known or suspected to have leaked over a million gallons. Hanford reprocessed nuclear fuel and produced plutonium. Carbon tetrachloride, chromium (vi), nitrates, tritium, iodine-129, uranium, strontium-90 and plutonium-239 and 240 are some of the identified pollutants in groundwater at Hanford. Cesium-137 and technetium-99 have been found deep underground beneath the high-level waste tanks and are moving towards the Columbia River. At Hanford, DOE estimates that over 444 billion gallons of wastes were poured directly into onsite ponds and trenches as recently as the 1990s. An underground mound of contaminated groundwater formed and is now spreading and migrating into the environment. Over 200 square miles of groundwater beneath Hanford are contaminated. The 200-Area, where reprocessing and waste disposal took place, will be restricted forever.

Idaho National Engineering and Environmental Laboratory (INEEL)

This site is in southeastern Idaho. It is the primary nuclear reactor development laboratory in the US. The Snake River aquifer in Idaho has been contaminated with TCE, tetrachloroethene and other hazardous materials. For the first time in 2000, plutonium was also detected in two separate places in the aquifer. Starting in 1952 and continuing to mid-1980, six deep wells were drilled into seepage basins, and wastes were dumped directly into the Snake River Aquifer. This unsafe practice continued for thirty years. Now three of these wells are known sources of contaminant plumes. There are no plans to remove plutonium from the aquifer. Several shallow injection wells were also used to dispose of an average of 360 million gallons per year of contaminated wastewater deep underground. INEEL also operated 8 unlined percolation ponds in which toxic and radioactive wastes were disposed.

Lawrence Livermore National Laboratory

Located in northern California, this facility conducts research on new weapons and oversees the fabrication and testing of new weapons at the Nevada Test Site. Underneath the site are two regional aquifers and several perched aquifers. Twelve groundwater plumes contaminated with volatile organic compounds stretch beneath 85% of the site. The major contaminants found in the groundwater include trichloroethylene, dichloroethene, dichloroethane, carbon tetrachloride, chromium, and tritium. Unsafe waste disposal policies resulted in widespread contamination. For example, the practice of disposing cardboard boxes containing hazardous wastes into unlined landfills continued until 1985. Contamination also results from leaking tanks and disposal in unlined pits, as well as evaporation trays. A tritium groundwater plume extends one mile under the site.

Los Alamos National Laboratory

Los Alamos is situated on top of a volcanic plateau in New Mexico. This site has been responsible for the design, development, and testing of nuclear weapons. The first atomic bomb, Trinity, was designed and built here. Groundwater beneath the site discharges into the nearby Rio Grande River. Plutonium, thorium, tritium, and uranium contaminate the groundwater. The full extent of groundwater contamination is currently unknown. A large source of contamination is waste buried onsite on small mesas that drain into onsite arroyos and canyons, such as Acid, Los Alamos, Mortandad and Pueblo Canyons. Liquid wastes were poured directly into the canyons; Pueblo and Los Alamos Canyons received the majority of liquid radioactive discharges. Flash floods periodically flushed these dangerous toxins to the Rio Grande River.

Mound Facility

Also known as the Miamisburg Environmental Management Project, Mound is located in southwestern Ohio. Here, detonators for activating explosives in nuclear warheads and plutonium-238 heat generators for satellites were produced. The recovery and enrichment of tritium from weapons components also occurred onsite. The Great Miami Buried Valley Aquifer is located beneath the site as a sole-source aquifer. Major contaminants of concern in the soil and groundwater are plutonium, tetrachloroethane, tricholorethene, and 1,2, -trans-dichloroethane. Tritiated wastewater was diluted and discharged into the Great Miami River. An open ditch leading into the Miami-Erie Canal and a pipeline carried contaminants into the Great Miami River.

Nevada Test Site

This site in southern Nevada was the location for underground and aboveground testing of nuclear bombs. Two main aquifer systems lie beneath the site: Underground nuclear testing has left residual amounts of strontium, cesium, and plutonium as well as other contamination in the subsurface, including the groundwater. DOE maintains that contamination in the subsurface will remain in place surrounding the areas of testing. However, with an increasing draw of water by the rapidly growing, greater Las Vegas area, this must be considered a race against time. Adding to the potential contamination burden, Yucca Mountain, a part of the Nevada Test Site, has been selected by DOE, Congress and the President for burial of irradiated fuel from commercial nuclear power plants.

Oak Ridge Reservation

Located in eastern Tennessee, this site is comprised of three major industrial complexes: Oak Ridge National Laboratory, Oak Ridge East Tennessee Technology Park, and the Nuclear Weapons Components Plant (Y-12). This site enriched uranium at the gaseous diffusion plant and produced the machined components for nuclear weapons assembly. The Knox Aquifer is the main aquifer located beneath the site. It is contaminated with mercury, strontium, and thorium. There is an abundance of surface water onsite and contamination has traveled into the aquifer via surface water. Cesium-137 and mercury were released from the White Oak Dam and are present in sediments in the downstream Watts Bar reservoir. The causes of the pollution have also included deep injection, unlined pits, deliberate releases into onsite streams, leaky burial grounds, waste storage tanks, spill sites, seepage ponds, contaminated inactive facilities, and hydrofracturing. (In this waste disposal technique, fractures are made by pumping fluids under great pressure into boreholes. Then, wastes encased in cement are placed in the enlarged fractures.) At Oak Ridge, some landfills were placed directly in aquifer discharge areas. The US Southern Regional Burial Ground, sometimes called Burial Ground 4, placed waste, including significant amounts of strontium-90, in continuous contact with groundwater.

Paducah Gaseous Diffusion Plant

This site, located in western Kentucky, produced low-enriched uranium that was sent to Portsmouth for further enrichment while Portsmouth was operating. The main contaminants of concern for groundwater are technetium, trichloroethylene, and uranium. According to DOE, 180,000 gallons of TCE may be present in the aquifer, at concentrations vastly exceeding regulatory limits. Thousands of gallons of contaminated materials have leaked from large pits onsite. At one time over 65,000 tons of scrap metal were stored on site at Drum Mountain. Other means of contamination include improper disposal practices, leakage from lagoons and pits, spills, and leachate from scrap metal. Plumes of TCE and technetium-99 are moving towards the Ohio River.

Pantex Plant

Located n the Panhandle region of northern Texas, Pantex handles the assembly and disassembly of nuclear weapons as well as the fabrication and testing of explosives. The Ogallala Aquifer is found beneath the site and is the largest single water-bearing unit in North America. TCE from a so-called "perched" aquifer has now been found in the Ogallala Aquifer. Wastewater discharged to unlined ditches, on-site treatment/disposal of high explosives contaminated solvents, and spills and leaks of hazardous materials have all contributed to groundwater contamination. The main contaminants of concern found in the groundwater are plutonium, trichloroethylene, tritium, and uranium.

Portsmouth Gaseous Diffusion Plant

At this southern Ohio location, uranium was enriched for use in nuclear weapons production reactors. The Berea and Gallia aquifers lie directly beneath the site. Several drainage ditches funneled contaminated liquid wastes offsite to nearby streams and creeks, such as the Little Beaver Creek. Wastewater provided the majority of the flow for this creek. Pollutants were also discharged from several onsite-holding ponds to nearby streams. Wastewater was discharged to the Scioto River, via the Sewage Plant Effluent pipeline. Poorly designed landfills have also contributed to the contamination, with Big Run Creek at potential risk from the now closed Peter Kewitt Landfill. Technetium, uranium, trichloroethylene, chlorinated solvents and chromium are the main contaminants of concern found in the groundwater.

Rocky Flats Site

Situated northwest of Denver, Colorado, this is the only factory in the United States to have mass-produced the plutonium "pit" or triggers for nuclear weapons. This site is located above the Denver Basin aquifer. Ruptured pipes beneath buildings have leaked, many fires and explosions have released plutonium to the environment, and illegal dumping, burning, or burial have contributed to the contamination. Plutonium has spread to the groundwater, as well as tritium and uranium. Some groundwater plumes have migrated offsite. Two bodies of water that run through the site, Walnut Creek and Woman Creek, carry contaminants into nearby water supply reservoirs. The nearby Great Western Reservoir, a source of water for the city of Broomfield, was closed because of these contaminants. Standley Lake has also been affected. Unlined retention ponds along these creeks are potential sources of contamination to groundwater.

Savannah River Site

This site, located in southeast South Carolina, produced plutonium and tritium for nuclear warheads. The Savannah River Site is situated above the greatest water recharge area on the southeastern seaboard. Groundwater, soil, engineered units and facilities are all contaminated. Contaminants of concern in groundwater include chlorinated volatile compounds, metals, and radionuclides such as tritium, cesium, uranium, and strontium. Contaminants spread rapidly throughout the site due to a high water table existing beneath the site, a permeable surface, and a high annual rainfall. Five tributaries of the Savannah River drain all of the site's surface water, funneling surface contamination to this river, which is found along the site's southwest border. Other causes of the contamination include discharges from seepage basins (the site has 68 such impoundments), a 195-acre burial ground, sanitary landfills, discharges from the 5 reactors located on site, reactor disassembly basins, deep boreholes and onsite ponds that were used for waste dumping. A now-closed radioactive landfill, the Old Radioactive Waste Burial Ground, occupies 23 square kilometers (or 5683 acres) in the central portion of the SRS. Par Pond has been regularly used for disposal of contaminated effluent.

At all of the sites listed above, DOE operated landfills. Most of these landfills were unlined and almost all have leaked into the surrounding environment. Water moving through landfills and liquid waste directly dumped into unlined pits, ditches, seepage and evaporation ponds allow radioactive and toxic chemicals to move rapidly through the environment. Once radioactive and toxic chemicals are released and dispersed within aquifers, the containment and recovery difficulties are greatly magnified.

To compound the problem, incomplete records have been kept of much of this dumping. In some cases, records have been sloppily maintained with valuable data either "lost" or burnt up in fires. Obviously, if the location and boundaries of contamination is unknown, and if the exact composition of the contamination is also a mystery, remediation is greatly complicated.

Inadequate Technology

The technology to clean up DOE nuclear weapons sites has not been adequately researched and is not fully developed. State of the art technologies are not used for budget-cutting reasons. Clay liners in use at many DOE site will degrade, though how quickly is not known. Vitrification, a method of solidifying high-level waste from leaking high-level waste tanks, has been used at Hanford but it is still not known how long the glass logs produced by this process will maintain their integrity. Though storing solid high-level waste is better than storing liquid high-level waste, three major vitrification attempts at Hanford have failed in the last 15 years.

Pump-and-treat technology, in use at INEEL, Hanford and Portsmouth, is not removing all the pollutants. Almost without exception, radionuclides are *not* removed and, instead, are disposed of directly into surface waters. The exceptions are uranium removal at Fernald, small-scale cesium and strontium removal at Hanford for some of the waste streams, and technetium removal at Paducah. In some cases, pumps remove contaminants from the plume front and return it at the rear of the same underground plum, in a never-ending cycle. Additionally, it is not clear whether rigorous enough standards are being applied for the removal of uranium-contaminated water.

Often where the technological problems seem to be too daunting, DOE has decided to simply leave a major pollutant in situ, for example contaminants that have built up behind dams at Oak Ridge. DOE hopes the earth and its waters will stand still. Yet during heavy rains these contaminants wash over the dams, contaminating the nearby Clinch River.

In order to protect the public, each site will require extensive remediation followed by maintenance, including pump and treat technology, repackaging waste, capping landfills and maintaining burial grounds or landfills. This process will go on for the indefinite future. For example, DOE estimates that at the present pump-and-treat rate, the Snake River Aquifer at INEEL will not be cleaned till the year 2095.

Pumps must draw water back onto DOE sites; contaminated aquifers must be treated to the extent that is possible. The radioactive and hazardous chemicals must be removed, packaged and stabilized. It is obvious that the genie unleashed by the nuclear weapons complex can never be entirely put back in the bottle. But, to the extent that is possible, these cancer-causing materials must be sequestered for their hazardous lives.

Long-term stewardship at the nuclear weapon factories is vital. It entails many activities, such as monitoring of remediated areas, maintaining facilities and vegetated areas, in addition to ensuring the containment of all remaining materials and contaminated areas.

Recommendations

Given the long-term health threat to humans, future generations and the environment, the federal government must act to stop the continued poisoning of vital resources by radioactive and chemical contaminants. To this end, we offer the following policy recommendations:

1. ***There must be full transparency regarding waste management and clean up***. All documents, research studies, monitoring reports, public hearing records, minutes of task force meetings, and memoranda pertaining to government decisions regarding contamination and proposed cleanup activities at DOE nuclear weapons sites must be must available for public scrutiny at convenient locations. Previously suppressed reports must be released now. Citizens in a functioning democracy have a right to full and complete disclosure of what materials were handled at each of the sites, what contamination levels still exist, what health risks are present and what will be done.

2. ***Adequate monitoring of both operating and recently closed sites must continue for the indefinite future***. Location and depth of monitoring wells, types of contaminants being monitored, frequency of sampling, and full disclosure of monitoring results must be available at public document rooms near each weapons factory, on the web, and at the Environmental Protection Agency in Washington, DC. This information should be updated on at least a quarterly or semi-annual basis.

3. ***The public must be actively involved in the clean up of DOE sites***. Public hearings on proposed remediation plans must be held at convenient locations and times. The public has a right to share in the responsibility for protecting their communities by setting cleanup standards, choosing remediation plans, establishing zoning restrictions, and evaluating monitoring technologies. Technical assistance grants to help citizens review highly technical and complex programs and hire outside independent experts must be increased. Unfortunately, DOE appears to be moving in the opposite direction, limiting public input, community hearings and site-wide remediation planning.

4. ***Sufficient funding for DOE clean up activities must be provided***. Particularly during times of economic downturn and/or periods of war, there will be a strong temptation to cut back on the funding for the environmental remediation program. Funding for cleanup cannot be subject to political whims. However, monies should not simply be thrown at the same set of contractors that have historically worked for DOE, a policy that has resulted in scandalously wasteful policies. Congress should begin to exercise its rightful authority over DOE programs.

5. ***Adequate research monies must be allocated to develop fail-safe technologies for clean up.*** In particular effective, safe, long-term stabilization methods must be developed for high-level waste stored in aging and leaking underground tanks and pump-and-treat technologies must be developed to handle the full spectrum of radionuclides and toxic chemicals that are now polluting aquifers at nuclear weapons factories.

6. ***Unsafe disposal practices must be halted at once***. Dilution of pollution can no longer be seen as the solution. Dumping into aquifers, creeks, streams and rivers can no longer be tolerated. Dumping into cribs and seepage ponds is not acceptable. Burial in unsafe landfills must be abandoned. In the case where leaking burial grounds cannot be stabilized they should be exhumed with full and careful protection afforded to workers involved in this process.

7. ***All federal and state environmental laws, regulations and legally binding clean-up agreements must be adhered to throughout the nuclear weapons complex***. Any attempts by DOE to avoid compliance with these requirements must be halted. Efforts by DOE to exempt certain wastes from current laws must be resisted. Attempts to redefine radioactive wastes so they appear to present less of a hazard to people and the environment in order to allow less stringent guidelines for management and disposal must also be stopped.

8. ***The goal must be to remove all contamination sources from intimate contact with aquifers and groundwater systems***. All wastes must be sequestered on DOE sites. While high-level waste presents the greatest potential risk, the most immediate danger often comes from waste materials that are in contact with groundwater systems and migrating both on and off-site. In any instance where high-level waste is in contact with groundwater then the highest priority must be assigned to clean up.

9. ***The intention of DOE to return any part of nuclear weapons sites to industrial and/or recreational uses must be carefully investigated on a case-by-case basis***. The temptation for DOE to use site transformation as a public relations stunt will be grave. When Rocky Flats is converted to a functioning "wildlife refuge," a term which evokes ideas of clean, natural habitats, who will feel that the site is still seriously contaminated and in need of remediation? Given widespread contamination elsewhere on a site, the probability of contaminants traveling by air or wind to those released areas, thereby putting workers at a new factory or recreationists at risk, will be high.

- Both soil and groundwater must be remediated to the extent that available and developing technology allow in order to meet the same cleanup requirements that apply to other hazardous waste sites in the affected states. The goal must be to meet the health risk (and ecological-risk) standard allowing for future public use to be unrestricted due to contamination for as much of the site and groundwater as is possible.
- The groundwater strategy goal for each site must be to clean up (remediate) the groundwater to restore the highest potential beneficial uses, presumed to be drinking water and irrigation, in keeping with Environmental Protection Agency and state legal requirements.
- US DOE must be held to the same legally applicable standard for groundwater to be cleaned up to allow future beneficial use and to prevent surface water contamination as all other hazardous waste sites. Where technology does not allow this, long-term stewardship must be applied as well as focused research and technology development efforts.

10. ***DOE, policy makers and the public need to accept that significant portions of the nuclear weapons complex are so contaminated that they will have to remain off limits for hundreds of years***. Access to thousands of acres of land will need to be restricted for the indefinite future.

11. ***Long-term stewardship at these sites is vital***. The underlying idea behind long-term stewardship is to restrict access to contaminated areas while monitoring the residual contamination in order to protect human health and the environment. In addition to continual maintenance, there must be ongoing research and review to ensure that proper practices are in place and being implemented.

12. ***Long-term stewardship must not become long-term neglect.*** Given DOE's track record of rosy pronouncements regarding the success of clean up strategies, even when there is substantial residual contamination, there is always the danger that "remediated" sites will, in fact, not be fully cleaned. Long ignored nuclear weapons sites may eventually disappear from the public's radar screen. As a result, future generations may feel less impetus to fund ongoing decontamination and monitoring at these facilities. Personal and institutional memory is short, much shorter than the extraordinarily long lives of these radioactive and toxic materials. Only the continued vigilance of an informed citizenry will assure that long-term stewardship remains a vital, realistic policy.

[1] National Research Council, Groundwater and Soil Cleanup: Improving Management of Persistent Contaminants, National Academy Press, Washington, D.C. 1999.

[2] US Congress, Office of Technology Assessment, Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production, 1991, p.23.