FROM WASTE TO WILDERNESS

MAINTAINING BIODIVERSITY ON NUCLEAR-BOMB-BUILDING SITES

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EXECUTIVE SUMMARY

The federal government spends around $6 billion each year on a program to clean up and contain the remaining hazards at Department of Energy (DOE) sites that were used for developing and building nuclear weapons during World War II and its Cold War aftermath. Most analysts agree that much of the money spent for this purpose in the 1990s was wasted; the program made minimal progress in cleaning up the sites. Nonetheless, members of Congress competed to spend as much of the money as possible to create jobs and boost their local economies. The DOE nuclear-waste-management program is arguably the biggest boondoggle in all of current pork-barrel spending.

The management of former nuclear-weapons-production sites is hindered by a complex and confusing set of federal and state laws. The laws seem to mandate restoring much of the area of nuclear-production complexes to allow residential and other ordinary forms of land use in the future. In some cases, this goal is infeasible or exorbitantly costly given current technology. In other cases, it is undesirable as a matter of sound public policy.

Because of public safety and national-security concerns, the federal government has tightly restricted access to nuclear-weapons sites for 50 years. As a result, these sites—some of which are quite large—are unique in the United States in their isolation from ordinary impacts of human activity. Some of the flora and fauna found at them is rarely found elsewhere, including many species listed as endangered or threatened under federal and state laws. The current government attempts to clean up these areas overlook the environmental value of their rare ecologies. Indeed, under current policy, the federal government could spend many billions of dollars in an effort to rehabilitate some parts of the sites in order to allow for uses that would destroy valuable species habitat.

The federal government should abandon the current nuclear-cleanup program as economically wasteful and environmentally counterproductive. It is time for a new form of stewardship strategy, emphasizing those steps necessary to protect public health from any actual threats posed by radioactive waste, while at the same time setting as a policy priority the isolation and conservation of DOE sites for their rich ecological diversity. Such a "waste-to-wilderness" strategy would give DOE a new flexibility to contain risks at existing sites at lower costs. It could save federal taxpayers many billions of dollars—perhaps as much as $1 billion to $3 billion per year. It would conserve some of America's most wild lands without requiring new federal measures to "lock up" additional multiple-use land elsewhere.

Taxpayer advocates and environmental organizations can find common ground in the use of old nuclear-weapons sites to protect wild and rare ecologies. The only losers would be government officials who administer the present cleanup program, short-sighted politicians, and local communities that desire pork-barrel "nuclear welfare."

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INTRODUCTION

The federal government spends around $6 billion each year on a program to clean up Department of Energy (DOE) sites used for nuclear-weapons development and production during World War II and the Cold War. More than $50 billion has already been spent for this purpose over the past decade. Yet spending billions of dollars on environmental cleanup is not necessarily good for the environment. It can actually prove both economically wasteful and environmentally harmful.

This has happened before; consider the *Exxon Valdez* case. In 1989, the *Exxon Valdez* oil tanker spilled more than 10 million gallons of crude oil into the waters of Alaska's Prince William Sound. Pressed by the federal government, the state of Alaska, and environmental activists, Exxon launched a massive cleanup operation in an attempt to salvage its public image. Exxon spent about $2 billion, much of it literally for scrubbing oil from fouled rocks and beaches. Within a few years, most analysts agreed that the *Exxon Valdez* cleanup had wasted much of this money and probably had done more environmental harm than good. The spraying of intense jets of hot water, widespread use of oil detergents, the physical impact of thousands of cleanup workers, and other aspects of the cleanup operation did significant damage to the shoreline ecology. It would have been better to leave nature to do the job alone.

The federal government spends $6 billion each year on a program to clean up sites used for nuclear-weapons development and production.

Today, the US government is engaged in its own environmental restoration and cleanup operation that may again be economically wasteful and environmentally harmful. Nuclear-bomb-building activities from World War II to the end of the Cold War left a legacy of widespread radioactive and other hazardous wastes deposited at numerous weapons-production sites across the United States. The imperatives of winning the Cold War led the government to neglect environmental considerations in the nuclear-bomb-building effort. At one point in the 1950s, for example, radioactive "transuranic waste" was poured in liquid form directly into the ground at Hanford, Oak Ridge, and Los Alamos, leaving future members of the American public potentially exposed to dangerous substances by government carelessness in nuclear-waste disposal.[1]

In the first half of the 1990s, as the bomb-building needs of the Cold War receded, federal spending for risk containment and maintenance at existing

facilities and for cleanup of old nuclear-weapons-production sites escalated. In recent years, it has been maintained at about $6 billion annually. This is the largest single area of direct federal spending for environmental protection, more than 30 times the direct spending by the government on the endangered species program. Yet many experts believe that the spending of vast sums of money at nuclear-waste sites has succeeded mainly in maintaining the status quo.[2] It has averted any dangerous releases of radioactivity and potential exposure of human populations to significant risks, but little progress in cleanup has been made, and future prospects appear little better. Over the next 75 years, total costs to US taxpayers for maintenance and cleanup operations at former nuclear-weapons-production sites will likely exceed $150 billion, and perhaps will be much more.[3]

Paradoxically, the nuclear-bomb-building sites—owing to the requirements of secrecy and protecting the public from radioactivity—represent some of the finest existing wild sites in America. Human impacts have been very minimal in many cases, since the sites were set aside for nuclear purposes. Under these special circumstances, endangered species and other plant and animal populations have thrived in many of these areas. If the current "cleanup" strategy continues, some of these existing wild areas are likely to face significant environmental damage. Federal taxpayers could end up spending billions of dollars in order to make lands available for other, less valuable uses. In the process, valuable wildlife habitat could be eliminated.

Spending billions on cleanup is not necessarily good for the environment. It can actually prove both economically wasteful and environmentally harmful.

As happened in the *Exxon Valdez* cleanup, policymakers and others are failing to consider adequately the potential environmental damages of their own cleanup and management efforts at the nuclear sites. This is partly because politicians and various interests view cleanup campaigns as pork-barrel spending projects. A 1998 report from Resources for the Future stresses that there are "enormous political pressures from interest groups and local communities," expressed forcefully through their representatives in Congress, to use the nuclear-waste program as a local "jobs factory."[4] Indeed, at the height of nuclear-weapons production in the 1960s, there were about 6,000 employees at the Hanford production facilities in Washington state. At the height of the cleanup effort in the 1990s, there were more than 15,000 employees trying to restore the Hanford site.

The overall cleanup program has demonstrated a robust ability to deliver jobs. A full five years after the 1989 close of the Cold War and the cessation of nuclear-weapons production at major sites in the complex, contractor employment for environmental-management activities had increased 7 percent nationwide to 136,000 workers.[5] A local newspaper in the Hanford area was moved to write of a vast "river of money" that Washington, DC, was sending to enrich the citizenry of eastern Washington state.[6]

Too many taxpayer dollars have already been wasted on such cleanup projects. The federal government should abandon the existing DOE cleanup and containment program as currently constituted. New program goals should be set. The federal government should pursue a policy to manage these sites to protect both public

health and the ecological value of the sites. This policy will best be served by maintaining large areas of the sites for conservation purposes. Keeping these areas isolated will allow a new flexibility in the management of the parts of the nuclear complex that still contain the most dangerous residues of the old bomb-building program. Under any likely strategy, the most contaminated areas at present will remain unfit for human occupancy for the foreseeable future.

Indeed, a policy of "waste to wilderness" would do more to conserve threatened ecological assets than most current environmental proposals. It would not involve large costs to achieve environmental goals, but might instead save the government billions of dollars. And unlike many such proposals, it would not require federal regulations to "lock up" multiple-use lands or to infringe upon private property rights.

The bomb-building sites—owing to the requirements of secrecy and protecting the public from radioactivity—represent some of the finest existing wild sites in America.

While it is difficult to know exactly how much the federal government could save by adopting the waste-to-wilderness proposal, there is no doubt that those savings would be substantial. As one indication of potential savings, DOE's *1996 Environmental Management Baseline Report* sought to estimate the cost reductions from adopting a new and less ambitious cleanup strategy that addressed "only existing risks to off-site populations and workers." Significant federal actions at the sites would still be required, but DOE estimated that this new strategy could reduce costs by 50 percent from their current levels.[7] Based partly on experiences with altered cleanup strategies at non-federal Superfund sites, economist Milton Russell has estimated that a new DOE strategy of less intensive cleanup could achieve cost savings of at least 33 percent below current spending levels.[8]

The proposal made in this paper could well achieve savings of this magnitude, perhaps a reduction of as much as $1 billion to $3 billion from the current $6 billion annual spending. A waste-to-wilderness strategy could, over the long run, save US taxpayers more than $50 billion.

A LEGACY OF ENVIRONMENTAL ABUSE

The scientists and managers of the Manhattan Project—the US program to develop the atomic bomb during World War II—and their successors were preoccupied with the challenges presented by designing and constructing new reactors and weapons. The singular focus on supplying the Pentagon with nuclear weapons fostered a prevailing culture whereby production trumped safety and environmental concerns. Accordingly, the managers of the nuclear program paid less attention to the problems posed by accumulating radioactive wastes.[9] These attitudes persisted throughout the Cold War years. As former Idaho governor and longtime DOE critic Cecil Andrus recently put it, "All the pizzazz and sex appeal were up front—building bigger bombs, more bang, bigger reactors.... No one paid any attention to the garbage coming out the back end."[10]

At the Hanford, Washington, and Savannah River, South Carolina, sites, where the greatest amount of high-level radioactive waste was generated, federal

As in the Exxon Valdez *cleanup, policy-makers are failing to consider the potential environmental damages of their own cleanup and management efforts.*

officials piped the hazardous liquid mostly into "temporary" underground storage tanks—many the size of an Olympic swimming pool. "Appropriate action" was to be taken at a later date.[11] Across the nuclear complex, the government initially disposed of transuranic wastes and low-level radioactive wastes in shallow burial grounds. Public officials also released millions of gallons of low-level radioactive liquids into seepage basins and sometimes directly into nearby streams.

DOE's predecessor, the Atomic Energy Commission (AEC), began in the late 1950s to take some preliminary steps to prepare high-level radioactive waste for some kind of long-term disposition. Beginning in 1957 at the Idaho National Engineering Laboratory (INEL), engineers constructed a calcination facility. In 1958, personnel at the Savannah River installation explored the feasibility of disposing of waste within tunnels drilled into the crystalline bedrock. Beginning in 1960, engineers at Hanford solidified high-level wastes and separated the most hazardous radionuclide constituents for ultimate disposal in a geologic repository. Hanford engineers also planned to permanently dispose of the solidified waste on-site.[12]

Due to the production complex's national-security exemption from external regulation, public officials conducted these waste-management practices "behind closed doors."[13] AEC periodically solicited recommendations from the academic or policy community, yet it discounted inconvenient advice. In 1961, the National Academy of Sciences (NAS) raised questions about AEC's approach and suggested that it consolidate disposal facilities at sites with favorable geologic characteristics. This suggestion, former DOE Chief Historian Richard G. Hewlett would write in 1978, was "reject[ed] out-of-hand," adding that "the overriding priority of the production program made that opinion unchallengeable."[14] When, in 1965, NAS characterized the waste-management program as "ad hoc," more concerned with saving money than environmental integrity, AEC Chairman Glenn Seaborg referred to the report as "unfavorable in an uninformed way," and soon thereafter dissolved the NAS committee.[15]

Despite AEC's best efforts to quash opposition to its waste-management practices, by the early 1970s its plans for on-site disposal paths had proven politically untenable. Georgia Governor Jimmy Carter joined South Carolina Senator Ernest F. Hollings in denouncing the bedrock disposal plan at Savannah River. Giving weight to this political resistance was a "very cautious evaluation" of the option by the Environmental Protection Agency (EPA). By 1974, Congress removed the Savannah River on-site disposal project from the federal budget.

At Hanford, 15 tanks holding high-level radioactive materials were leaking by the early 1970s. The leaks were of little concern to Hanford engineers, reflecting a generally lax attitude toward radioactive releases. Moreover, the engineers were confident they could seal the tanks if necessary.[16] For the public and for state officials, however, the leaks suggested the federal government could not be trusted with the permanent disposal of high-level waste at the site. Plans for an on-site repository were subsequently shelved as well.

In the 1970s, Congress made several changes in the organizational framework for the nuclear-weapons-production program, partly reflecting changing priorities for the cleanup efforts. In 1974, the old AEC became the new Energy Research and Development Administration (ERDA), which was placed in 1977 in the newly formed DOE. Influences outside the nuclear establishment were beginning to penetrate the traditional secrecy of the nuclear program. A DOE internal history notes that by 1978, "radioactive waste was now a major national issue, and the White House and Congress had become lead players in determining policy."[17]

The second-largest single component of the cleanup program, estimated to cost anywhere from $10 billion to $25 billion, is transuranic-waste disposal.[18] Beginning in 1970, AEC began to separate transuranic and low-level wastes. The transuranic waste would be packaged in retrievable storage containers awaiting a final disposition off-site. In 1969, a fire at Rocky Flats had released plutonium into the environment. The prospect of large amounts of transuranic elements entering the environment galvanized public opposition to the storage of this type of waste at a site only 17 miles west of Denver.

Public concern spread to INEL, to which the federal government had shipped portions of the Rocky Flats transuranic waste since 1954. The presence of Colorado's transuranic waste within Idaho borders emerged as a "cause celebre" among the Gem State's elected officials.[19] Public fears were fueled by several studies indicating that the transuranic waste stored at INEL posed a threat to the Snake River Aquifer—supplier of 20 percent of Idaho's drinking water and the source of water to irrigate many farms.

Senator Frank Church (D-Idaho) successfully exacted a promise from AEC that "within a decade" the Commission would begin the process of removing all transuranic waste from Idaho.[20] It would be transported to a proposed repository in the salt mines of Lyons, Kansas. Yet by June of 1974, a combination of intense opposition from Congressman Joe Skubitz (R-KS), and a series of unresolved technical questions, forced AEC to terminate its plans for the Kansas salt mines. In 1976, ERDA began construction of a transuranic-waste repository east of Carlsbad, New Mexico. This site, the Waste Isolation Pilot Plant, would also be plagued over the next two decades by a mix of political obstacles and lingering technical uncertainties that long delayed its opening.

A waste-to-wilderness strategy could, over the long run, save US taxpayers more than $50 billion.

REINING IN THE NUCLEAR-WEAPONS-PRODUCTION COMPLEX

During the 1970s and 1980s, environmentalists increasingly challenged the nuclear-production complex's lack of external oversight. In a 1984 legal challenge, the Legal Environmental Assistance Foundation, aided by the Natural Resources Defense Council, forced DOE to comply with the Resource Conservation and Recovery Act of 1976 at Tennessee's Oak Ridge Reservation's Y-12 plant. DOE's long-standing national-security exemption from the nation's environmental laws was becoming untenable.

During the latter half of the 1980s, DOE gradually accepted an increased public role in its nuclear decision-making. The process sometimes involved unusual twists and turns. In 1988, the FBI began flying over the Rocky Flats weapons facility, often at night, using infrared observation equipment to identify and document violations of the nation's environmental laws. In 1989, 70 FBI agents raided Rocky Flats. The Bureau instructed DOE and contractor personnel to log on to their computers, open their file cabinets, and walk away from their desks as the FBI began a major investigation into violations of myriad federal and state environmental laws.[21]

In the negotiations over future environmental compliance of the bomb-building program, some Rocky Flats officials reported that they were virtually "willing to give the [EPA] anything it wanted," out of fear of being jailed.[22] It was under these circumstances that DOE entered into its first "tri-party" agreement, a legal document signed by DOE, EPA, and state regulators that detailed how Rocky Flats would come into compliance with environmental law.

The singular focus on supplying the Pentagon with nuclear weapons fostered a culture whereby production trumped safety and environmental concerns.

In full retreat now, DOE rushed into similar agreements with federal and state regulators at major sites throughout the nuclear complex. The natural inclination of regulators to apply the full extent of the existing law, reinforced by the states' incentive to tap the deep pockets of the federal government, produced long wish lists of cleanup actions. DOE's commitment to these legal agreements may sometimes have been less than fully sincere. The administration of George Bush, the elder, sought to portray its pick for Secretary of Energy, Admiral James D. Watkins, as "Mr. Cleanup" during his confirmation hearings. As John Tuck, then DOE undersecretary, comments, the agency was "dragged and prodded to consider the environment" because to do otherwise might threaten the ability to supply the Pentagon with nuclear weapons. Tuck recalls that "we got into compliance agreements, in my view, because we had to stay in production to produce the requirements for the military. . . . I never thought we would have adequate dollars to manage all of these compliance agreements."[23]

As the Cold War unexpectedly wound down following the 1989 fall of communism in Eastern Europe, DOE's new large-scale cleanup role proved to have some important side benefits. The nuclear-weapons-production complex employed many tens of thousands of people, yet faced the loss of its traditional bomb-building functions. Institutional survival meant the Department and its constituencies would need a new mission. Now turning almost 180 degrees, DOE embraced compliance with environmental regulations and promised to "close the circle on the splitting of the atom."[24] In 1990, the multi-billion dollar Environmental Management (EM) program was born. Its official mission was "to reduce health and safety risks from radioactive waste and contamination resulting from the production, development, and testing of nuclear weapons."

Accompanying the Department's new commitment to the environment were extraordinarily high costs. In 1993, DOE Assistant Secretary Thomas Grumbly warned Congress that the long-term cleanup bill could be as high as $1 trillion. Even

after several large downward revisions, total costs in 1996 were estimated at $227 billion over a 75-year life cycle. More recently, responding to further pressures to reduce costs, DOE issued *The Accelerated Cleanup Plan*, which pledged to complete the task for $147 billion.[25] However, this latest plan faces an uncertain future, because it has failed to gain support from some of the key parties while many site managers question its workability.

Critics argue that these budget estimates should be viewed with a large degree of skepticism. One DOE manager, Hunter Weiler, explained shortly before leaving the Department that he had long since stopped reading DOE's budget projections because the numbers were simply arbitrary.[26] During the period of FY1992 to FY1996, for instance, DOE's EM program budget rose by 57 percent—even while the long-run projected-mean-life-cycle budget decreased by 65 percent.

Because compliance agreements at each site collectively provide an agenda for the cleanup program, the EM program's basic structure continues to closely reflect the institutional and political considerations that characterized the initial "tri-party" negotiations.[27] In Tuck's estimate, the development of the cleanup program was "politics fraught with pitfalls that are not to be believed. The process pits state vs. state for cleanup money."[28] Some of the incentives are perverse. By heightening the complexity of the regulatory framework at sites, regulators increase DOE's expenditures and forestall any major reductions in, or closure of, the cleanup program. The less accomplished today, the more money available tomorrow. In the words of DOE personnel at the Oak Ridge Reservation in Tennessee, by fostering a "backbreaking" regulatory and bureaucratic structure, regulators "force the federal government to spend money" on and near the site.[29] It is a new form of never-ending "nuclear welfare" for the surrounding communities.

Economist Milton Russell of the Joint Institute for Energy and Environment, a policy group near the Oak Ridge Reservation, explains the dual motivations behind the robust regulatory agenda at the sites:

> The DOE Environmental Management (EM) program by default inherited the Federal Government's obligation to communities and persons impacted by the decline in the DOE production mission. The EM program now had two tasks, not one. The only connection between the tasks was that money spent on remediation (mostly) flowed through host communities. Host communities and their political allies understandably seek to maximize this flow [of federal funds].[30]

Oak Ridge and its host community, according to Susan Gawarecki, Executive Director of the Oak Ridge Reservation Oversight Committee, were among the few sites willing to consider risk in any kind of realistic way. However, as she notes, "because we have not been irrational, Oak Ridge has not attracted the national attention (and budget money) bestowed on sites where anti-nuclear activists make exaggerated claims of environmental and health effects." Indeed,

as Gawarecki notes, since 1995 Oak Ridge's EM budget has declined by 23 percent, while the overall EM program has shown a modest increase nationally. At the Savannah River site, DOE's financial contribution to the host community in FY1996-97 exceeded that of FY1987-88, despite the end of the Cold War.[31]

Such political and bureaucratic considerations have created a program lacking clear goals or focus. In a 1995 report on the Hanford site commissioned by Congress, former DOE employees Steve Blush and Tom Heitman told the nation's lawmakers that "the mission of cleaning up the site has gotten lost in the legal and regulatory framework that governs it. . . . The existing framework . . . demands compliance with every regulation regardless of whether compliance would conflict with some important public health priority."[32]

With federal and state agencies toiling in regulatory labyrinths designed to attract money to the sites, the implementing private contractors—as one high-level official at DOE headquarters recently put it—are "laughing all the way to the bank."[33] Poorly planned projects, prolonged debates over regulations and disposal paths, and DOE employees adrift in a bewildering sea of leadership and management changes, all successfully keep the money flowing to private firms.[34] A web of political contributions in Washington and a revolving-door culture ensures that a select group of firms receives immensely lucrative contracts regardless of repeated technical and managerial failures.

Gridlock means that much of the budget at DOE sites is absorbed for what has come to be called "baby-sitting" or "hotel management." A former DOE overseer of the EM program, Alvin Alm, explained this phenomenon to Congress in 1996, stating that the "majority of EM funds are spent just to open the doors of the facilities every day and keep them in a safe and stable condition." Alm, as well as others within DOE, estimated that nearly 60 percent, or $3.6 billion, of the $6 billion annual budget is devoted to maintaining the sites. Alm considered in 1996 that "these mortgage costs are eating us alive."[35]

Because of the large public expenditures required to maintain the facilities, considerable focus has been given to expediting the pace with which DOE moves toward its final cleanup. This concern helped stimulate the Department's 1998 report, *Accelerating Cleanup: Paths to Closure*.

The DOE plan was coolly received by many of the groups most directly affected or actively involved in the public debate. A coalition of community organizations located near sites throughout the complex has urged DOE to discontinue it. Distressed by, among other things, "unrealistic assumptions," the organizations criticized the "artificial and impractical budget and schedule."[36] Energy Secretary appointee Bill Richardson spoke of a new "National Cleanup Initiative" at his confirmation hearings, but failed to mention the accelerated cleanup.[37]

In a series of interviews, managers at major sites across the complex expressed skepticism that the plan's reliance on efficiency gains would allow them to address

so-called "compliance gaps"—the difference between what is legally required by agreements with the states and the magnitude of federal budgetary assumptions. One manager, for instance, said the gap will "put us in court" with state regulators,[38] while another commented that "we have squeezed all we can from this orange."[39] Without a basic change in cleanup strategy, the widespread management failures of the past are likely to continue unresolved.

FROM NUCLEAR WASTELAND TO WILDERNESS

The *Financial Times* recently described what has become one of the wildest areas in Europe:

> Eastern Europe has a splendid new nature reserve, rich in wildlife and luxuriant with vegetation. It has an astonishing 270 species of birds, 180 of which nest there; wolves, wild boar and elk are just a few of the mammals roaming the forests; and the lakes and rivers teem with fish. There are more than 40 rare plants and animals recognized internationally as endangered species.
>
> Unfortunately, you have no chance of visiting this natural wonderland as a tourist. It is the Chernobyl Exclusion Zone, set up after the world's worst nuclear accident in 1986 to keep people out of the most radioactive area within 30km of the stricken reactor.[40]

One DOE manager explained shortly before leaving the Department that he had long since stopped reading DOE's budget projections because the numbers were simply arbitrary.

Low levels of radioactivity do not necessarily have a negative impact on biodiversity. For example, Ronald Chesser, a radiobiologist at the Savannah River Ecology Laboratory, has conducted research near the Chernobyl site in the Ukraine. Recently asked by DOE officials to assess the impact of the Chernobyl accident on the wildlife populations in the area, and similar to the report above, Dr. Chesser declared that it was surprisingly positive.[41]

Given all the federal mismanagement of the cleanup activities at the old US nuclear complex, and the presence of so much old radioactive material, one might think the lands would be unsuitable for most forms of life. However, like the area around Chernobyl, many of these sites ironically have become sanctuaries for wildlife. The United States nuclear-bomb builders went to great lengths to ensure that unauthorized citizens did not enter most parts of these areas. It would be a potential breach of national security if an unknown person somehow gained entry to the wrong place. Partly as a result, much of the nuclear-weapon complex's 2.1 million acres—an area in size larger than the states of Delaware and Rhode Island combined—offered protection to wildlife in a manner found at few other places in the United States. Ward Whicker, a radioecologist at Colorado State University, reports that the flora and fauna on nuclear-complex lands, are "absolutely thriving" as a result.[42] Radiation levels have declined in many areas, and even where low levels remain, "in almost all cases, all indicators (diversity, productivity, life-span) are higher" for the plant and animal populations within the old nuclear complex:[43]

u Local hunters marvel today at abundant turkey populations foraging along the boundaries of the Oak Ridge Reservation. The turkeys coexist with more than 40 state-classified endangered, threatened, rare, or special-concern species. The Oak Ridge Reservation has become the most important wildlife preservation area in Tennessee, and is home to peregrine falcons, cerulean warblers, and other rare animal species.[44]

u The Hanford Reach of the Columbia River, which flows east across the site before turning more directly south to form the reservation's eastern boundary, extends 51 miles. It is the last major spawning ground for salmon on the main stem of the Columbia. Identified by the US Fish and Wildlife Service as one of the two most important wildlife habitats in the state of Washington, the upland shrub-steppe wilderness of Hanford is being studied by The Nature Conservancy (TNC). To date, TNC has discovered numerous ecologically valuable plant and insect species. In all, more than 200 bird species are found within Hanford's boundaries. The site provides habitat for the Aleutian Canadian goose, the bald eagle, and the peregrine falcon, which are listed federally as threatened species. Some 36 mammals, including otter, muskrat, mink, beaver, and bobcats, coexist with over 250 native plant species. "We're sort of [an] island," ecologist Larry Cadwell of Battelle-Northwest observes of the Hanford nuclear complex, "sort of a last bastion of sagebrush-dependent species."[45]

u In 1949, AEC took possession of 890 square miles of the Snake River Plain in Idaho to construct experimental reactors, including the Navy's first prototype nuclear-propulsion plant. Today, the INEL site contains a bounty of antelope which, during the winter months, constitutes more than 30 percent of Idaho's pronghorn population. INEL is home to some 40 different species of mammals. Nearly 200 bird species live within the site's boundaries, including sage grouse, mourning doves, ferruginous hawks, burrowing owls, and prairie falcons. Four species found at INEL are listed federally as endangered or threatened.

By heightening the complexity of the regulatory frame-work, regulators increase DOE's expenditures and forestall any major reductions in, or closure of, the clean-up program.

u The Savannah River site is one of the largest contiguous tracts of wild area east of the Mississippi. Local personnel speak of a modern-day Davey Crockett who, until recently, made a living trapping animals for fur just outside the boundary. Five rivers flow among the Savannah River site's loblolly pine, longleaf pine, oak, ash, maple, and gum trees, and eventually come together in a 30,000-acre wetland. Here there are cypress-tupelo, Spanish moss, and other wetland vegetation. In all, the Savannah River site is home to more than 50 different mammal species, 100 varieties of freshwater fish, and over 200 species of birds. Federally listed species under the Endangered Species Act include the wood stork, red cockaded woodpecker, and shortnose sturgeon.

u In 1951, AEC began setting aside nearly 10 square miles of grasslands and shallow canyons just outside Denver to manufacture triggers for the nuclear arsenal. Kent Brakken, a biologist who earned his doctorate at the University of Colorado in nearby Boulder, calls the buffer zone of the Rocky Flats installation an "island of refuge and sanity."[46]

Because the Rocky Flats installation lies along the boundary of two distinct ecosystems, the Great Plains from the east and the Montane biome from the west, there is "extremely high diversity."[47] Where the flat irons buckled under pressure as they collided with the Montane biome many years ago, shallow canyons nurture wetlands and hillside wildflowers in unusual profusion. In these canyons the endangered preble mouse—officially designated unique by the Colorado Department of Natural Heritage—resides. Unusually large mule deer, including bucks with 30-inch racks, are protected at the site, along with coyotes, mountain lions, and other species.

Low levels of radioactivity do not necessarily have a negative impact on biodiversity.

The coexistence of nuclear materials, dispersed low-level radioactivity, and abundant wildlife populations raises a surprising conflict among environmental objectives. Environmentalists have frequently held that the nuclear-cleanup program should restore the old production sites to an original condition with no more than a "natural" background level of radiation. However, this approach may undermine the current conservation and biodiversity values of the land. The regulatory regime at the nuclear sites, Rebecca Sharitz of the Savannah River Ecology Laboratory notes, is focused on "contamination removal" rather than acting to support "self-sustaining ecosystems."[48] In a 1993 study, Whicker and two colleagues observed that the stringent application of current environmental regulations

> would likely be welcomed locally because of the jobs and economic stimulation it would provide. In general, the public and their elected officials tend to favor local "cleanup" projects because of the economic benefits and the sometimes superficial appearance that such activity is for a "noble cause." We believe the US is largely unaware of the costs to the taxpayer and the ecological devastation and loss that could result from unnecessary cleanup of a valuable ecological resource.[49]

(A similar paradox where military actions have created a valuable environmental asset exists on the Korean peninsula. The demilitarized zone between North and South Korea is the only real "wilderness" in the entire area of the two countries. As North and South Korea seek diplomatic accommodations, efforts are being made to ensure that the demilitarized zone will be maintained in its current ecological condition.)

Although there are more than 130 sites in the US nuclear-weapons complex, five are expected to account for more than 70 percent of total cleanup and containment costs: Oak Ridge in Tennessee, Hanford in Washington state, Savannah River on the border of South Carolina and Georgia, Rocky Flats in Colorado, and the Idaho National Engineering Laboratory. Paradoxically, the presence of radiation danger and national security concerns have meant that these very same places offer some of the finest and least disturbed plant and animal habitats in the United States. It is time for Congress to adopt a cleanup strategy that takes clear and full account of this reality.

FOUR PRINCIPLES

The laws that govern the management of nuclear wastes at the former weapons complex were written for other places and purposes, such as cleanup of chemical and other ordinary industrial hazards. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, better known as Superfund), and the Resources Conservation and Recovery Act of 1976 (RCRA), were only belatedly applied to the old nuclear-bomb-building sites.[50] The objectives driving these laws reflected the simple idea that "responsible parties" (in the case of the nuclear sites, the federal government) should restore the land to a near-pristine condition that preceded contamination. The laws do not envision the possibility that the more recent nuclear management of the lands may have changed their condition in an environmentally beneficial way. It is not recognized that the existence of moderate levels of radioactive danger and the long-standing exclusion of people may have created a situation of large (if unplanned) existing benefits for wildlife diversity. It probably never occurred to most legislators that current restoration of nuclear sites in some cases might actually end up doing more damage to the environment.

The coexistence of nuclear materials, dispersed low-level radioactivity, and abundant wildlife populations raises a surprising conflict among environmental objectives.

At the Rocky Flats installation near Denver, the nearby town of Superior supports a cleanup of the land to meet a hyper-stringent soil standard for radionuclides. The town has proposed the construction of a new strip mall there, complete with a "Loaf 'n' Jug," a western competitor to 7-11. Other development proposals abound, including one for a golf course. The various development proposals would displace the existing habitat, which is more favorable to many plant and animal species.

If Superior had to pay for the cleanup, the costs would greatly exceed the financial benefits of any new stores, housing, or other standard development projects. If Superior residents, or a prospective developer, had to pay for the cleanup, that would be meeting a market test. Indeed, were the federal government to transfer DOE sites, and any attendant liability, to willing private parties (a reverse Dutch auction has been suggested), taxpayers would be off the hook for these wasteful projects. Private incentives would be able to function normally. As things stand, however, there is no reason for federal taxpayers to spend billions to clean waste sites to meet unreasonable Superfund and RCRA cleanup standards, and then needlessly disrupt valuable species habitat.

This paper proposes an alternative goal for the future management of the nuclear-weapons complex. The waste-to-wilderness proposal would achieve a win-win outcome: both reducing costs to federal taxpayers and acting to achieve greater conservation of the existing ecological values of DOE sites. The proposal rests on the following four principles:

1) Explicitly recognize the high ecological value of old DOE bomb-building sites in their current condition in the conduct of future program planning.

Regulators and other involved parties currently are directed to consider future land use across the complex within the Superfund and RCRA framework. The various parties typically evaluate future risks to human health based on the assumption that the sites will accommodate industrial, recreational, or commercial uses. As a result, the "best" environmental outcome often becomes a costly, and in many cases ecologically harmful, full cleanup. The law does not provide for the consideration of using the land for conservation and biodiversity purposes. In the context of the secluded, ecologically rich weapons sites, this omission may arbitrarily preclude what may well be the current highest-value use of the land. Although efforts are now finally being made to give greater consideration to "stewardship" strategies, they lack a clear statutory basis and an explicit recognition of the full ecological potential of these sites.[51]

2) Minimize actual risk to off-site human populations.

At present, the public does not come in contact with many parts of DOE waste sites. For these sites to be "hazardous" to human health, humans must become exposed to contamination. Should existing restrictions on access continue, the current "hazardous" wastes in the nuclear complex likely pose no significant public-health risk. As DOE stated in 1997, "aside from a few urgent risks, most hazards at these sites present little imminent risk because physical and institutional controls greatly limit public access to the sites."[52] As we now do with orphan Superfund sites, it may make more sense to maintain the facilities without attempting further extensive cleanup and then simply fence off large portions from future public access. Recognizing the pressures that recreational use can place on the land, such sites will be "more wilderness than wilderness."

Laws that govern the management of nuclear wastes at the former weapons complex were written for other places and purposes, such as cleanup of chemical and other ordinary industrial hazards.

3) Recognize that long-term cleanup requires technological advance.

It will still be necessary to take some preventative and maintenance actions to stabilize waste and contamination on-site in the short run. In the long run, the waste-to-wilderness proposal offers the flexibility to allow for technological innovation to provide improved solutions. As the General Accounting Office noted in 1994, "developing less costly and more effective cleanup technologies may be the only way the nation can afford to clean up the vast amounts of waste generated by the nation's nuclear weapons complex."[53] The federal watchdog agency considered present actions as "often ineffective, extremely expensive, and offer[ing] only short term solutions."[54] Similarly, a 2000 report by the National Academy of Sciences declared that "at most of DOE's waste sites complete elimination of unacceptable risks to humans and the environment will not be achieved, now or in the foreseeable future." This is partly because the present "tools available for these purposes are of doubtful technical effectiveness."[55] The Academy called for a major rethinking of strategies for future management of nuclear-waste sites, following a more incremental and adaptive approach.

Rather than maintain the illusion that current technologies will provide a "final" solution, it is more appropriate to think of nuclear or other cleanup efforts as a series

of short-term remedies. The government may decide in the short term to leave the land as it is, then perhaps make other decisions about future uses when technological or other conditions may provide new and more favorable options. On a few occasions, DOE and its regulators have explicitly embarked on "interim" cleanup actions, designed to stabilize the hazard in the short term, when no viable technological remedy presented itself. These initiatives are worthwhile, but they have had a small overall impact so far; they represent tinkering at the margins—a patch of land here, a pond there—while the greater program failings continue. The waste-to-wilderness proposal builds in a much more comprehensive fashion upon this insight that future technology may afford cheaper, better remedies.

4) Enable stewardship at DOE sites to conserve ecological value and protect public health.

In an internal draft document of September 1997, DOE officials acknowledged "hazards will remain after cleanup at most sites," while adding that, "without long-term stewardship, these hazards could result in unacceptable risks to human health and the environment."[56] Indeed, under current technological constraints, the presence of radioactivity and other hazards over significant parts of the sites will require a continued restriction of public access. This reality conflicts with the Department's long-standing official communications with the public. For example, former DOE Secretary Frederico Pena, in presenting the FY1999 annual budget request before the Senate, spoke of the Department's commitment to "clean up our sites and return them" for, among other uses, "economic development."[57] The federal government needs to acknowledge more widely and explicitly to the American public that, given current standards, "cleaning up" and "returning" the sites is not always a cost-effective option, and a continuing federal stewardship of sites with radioactive hazards may be necessary for many years to come.

The Department has begun to take some steps in these directions, more fully acknowledging recently the need for long-term stewardship of the sprawling complex. In *From Cleanup to Stewardship*, released in October of 1999, DOE officials recognize that "Depending on the nature of the contaminant and the medium in which it is found, there are several limitations and challenges that preclude remediating many DOE sites to levels that would permit residential or other unrestricted land uses."[58] Indeed, fully 76 percent of the sites will require institutional controls to restrict public access in the foreseeable future.[59] This fundamental realization fully supports a biodiversity and ecological-protection set of goals for the land—an agenda that should rightfully displace the economically wasteful and currently dominant regime of pork-barrel economic development. DOE needs to take steps now to reduce sharply the extravagant spending levels of the past that have been justified to the American public by the stated goals—however impossible to realize—of total site cleanups.

A FUNDAMENTAL DEPARTURE

These four principles provide the foundation for a radical departure from the current DOE cleanup regime. The Environmental Management program, though only a decade old, was forged as a set of politically expedient compromises that would allow DOE and its predecessor agencies to continue in their primary lifetime mission: nuclear-weapons work. Today, despite the glaring inadequacy of the EM program, politicians, private contractors, and nearby communities perpetuate the problem because they desire the political and economic benefits. The program continues in its current form mainly because it provides jobs and salaries for more than 100,000 workers, many of whom would have to move to other areas of the United States if the current array of cleanup employment were not available.

A new stewardship strategy, with the explicit goal of maintaining attractive ecological conditions, would create a greater flexibility in managing the most contaminated areas.

There are precedents for the wilderness-stewardship strategy proposed here. From 1942 until the end of World War II, the Army produced a plethora of chemical weapons, including mustard gas, white phosphorus, and napalm, at the Rocky Mountain Arsenal 10 miles on the other side of Denver from Rocky Flats. The end of World War II allowed the Army to lease the land to private industry. From then until 1982, a private party used the site to produce agricultural pesticides, despite considerable residual chemical contamination.[60]

An example at the Savannah River site also illuminates the desirable outcomes that can occur when thinking shifts from "redressing a liability" to "preserving an asset." During Savannah River's bomb-production years, the Par Pond served as a reservoir for water being discharged from reactors, allowing the boiling water to dissipate heat before being released to the Savannah River. In this capacity, sediment in the Par Pond became contaminated with low levels of Cesium-137 and Strontium-90, as well as some transuranic elements.

In 1991, the federal government partially drained Par Pond. Thirteen hundred acres of sediment were exposed as a result, and EPA designated the area as a Superfund Operable Unit. Using Superfund's residential-land-use assumption, federal regulators determined that a full cleanup under the Superfund risk standard was necessary. The risk to the local biota, however, was minimal from the remaining radioactivity.

To reach the human-health standards mandated under Superfund, it was estimated the remediation effort would cost in excess of $1 billion. Additionally, the cleanup would cause "ecological devastation."[61] As a result, the Savannah River Ecology Laboratory strongly opposed the remediation project, favoring maintenance of a weakened dam and refilling Par Pond. The total cost associated with this approach to remediation was estimated to be $10 million to $14 million, a tiny fraction of the cleanup costs required under standard Superfund procedures.

Under the waste-to-wilderness proposal, such approaches would no longer be exceptions reached after years of controversy. Instead, the approach of ecological maintenance of old nuclear sites would be the initially preferred stewardship

approach. Managers would have two well-defined goals: preserve the ecological asset on-site while protecting the American public from any adverse health or other negative impacts off-site (or in any unavoidable on-site visits). Managers would take remedial action when on-site conditions have the potential for doing harm to people living off-site or who are not able to avoid exposure to radioactivity.

Little actual cleanup at the nuclear sites has occurred, despite the expenditure of many billions of dollars for this stated purpose.

The approach recommended here does not eliminate all burdens. For the foreseeable future, the federal government will have to bear the significant costs of managing these sites to contain the existing nuclear residues and other hazards. These sites are the product of a uniquely federal activity, constructing the nuclear weapons of the Cold War era. However, the federal government might well subcontract or otherwise delegate day-to-day operating responsibility for the sites to states, local governments, or private organizations (such as local land trusts or, perhaps, a profit-making firm). If the federal government retains management control, existing agencies (such as the Fish and Wildlife Service or the Bureau of Land Management in the Interior Department) might perform the actual management. The long-run goal, once the radioactive-waste issues have been resolved (perhaps with technologies unknown today), should be to transfer these sites to private ownership. If they are still most valuable in ecological uses at that time, non-profit organizations could be expected to be among the high bidders.

CONCLUSION

Since 1945, the United States has spent more than $5 trillion to build and operate a nuclear arsenal of more than 70,000 weapons. The need to build further nuclear weapons largely ended with the end of the Cold War. An important task now is to decide how to use and manage the former bomb-building sites of the nuclear-weapons complex.

This task has been greatly complicated by the application of an inappropriate set of federal and state laws, never intended for this purpose. The laws direct DOE to achieve goals that are technically impossible to realize in many cases. Even if they were technically feasible, they would often be economically wasteful and undesirable. Rather than make the old weapons-production sites available for various forms of new residential, commercial, or other ordinary development, as current law seems to require, the federal government should incorporate conservation and biodiversity options as well. A new stewardship strategy, with the explicit goal of maintaining attractive ecological conditions throughout old bomb-building sites, would create a greater flexibility in managing the most contaminated areas. This would often allow for much lower costs than current stricter cleanup plans.

Lacking any sound direction from Congress, the courts, or the executive branch, the various players in the system today are simply seeking to maximize their own advantage. The states have enjoyed massive inflows of pork-barrel spending; DOE bureaucrats have had high-paying and secure jobs; and private contractors have obtained large revenues. All the while, little broader public

benefit has resulted. Maintenance has been sufficient to protect the public health from the hazards now present at most existing facilities. But little actual cleanup at the nuclear sites has occurred, despite the expenditure of many billions of dollars for this stated purpose.

Like the beaches fouled by the oil from the *Exxon Valdez*, sometimes the environmentally and economically preferable course of action is to do little or nothing. In the case of the former nuclear-weapons-production complex, some heroic actions may still be necessary under any strategy to stabilize waste and contamination. However, spending many billions of dollars in some areas will have the main impact of opening up low-value land uses in areas of the nuclear complex where it would destroy the most environmentally valuable functions of these sites. Adopting the waste-to-wilderness proposal would save taxpayers tens of billions of dollars over the long run while providing greater protection of wilderness values than any pending proposal to lock up multiple-use land. As such, it represents the sort of "win-win" solution that should be more widely sought but is rarely achieved in environmental policymaking.

NOTES

[1] Mark Holt, *Nuclear Weapons Production Complex: Environmental Compliance and Waste Management*, Congressional Research Service, January 17, 1997, p. 4.
[2] Katherine N. Probst and Michael H. McGovern, *Long-Term Stewardship and the Nuclear Weapons Complex: The Challenge Ahead* (Washington, DC: Resources for the Future, 1998).
[3] Katherine N. Probst and Adam I. Lowe, *Cleaning Up the Nuclear Weapons Complex: Does Anybody Care?* (Washington, DC: Resources for the Future, 2000), p. 2. See also US Department of Energy, Office of Environmental Management, *Accelerating Cleanup: Paths to Closure* (June 1998).
[4] Probst and McGovern, *Long-Term Stewardship and the Nuclear Weapons Complex*, p. 22.
[5] Probst and Lowe, *Cleaning Up the Nuclear Weapons Complex*, p. 15.
[6] Karen Dorn Steele, "Hanford," *The Spokane Spokesman*, four-part series, November 13, 1994.
[7] DOE, "The Baseline Environmental Program at a Glance," www.em.doe.gov/bemr96/atglance.html, posted August 13, 1996.
[8] Milton Russell, *Toward a Productive Divorce: Separating DOE Cleanup from Transition Assistance* (Knoxville, Tennessee: Joint Institute for Energy and Environment, 1997), p. 10.
[9] Alvin M. Weinberg, *The First Nuclear Era: The Life and Times of a Technological Fixer* (New York: American Institute of Physics Press, 1994), p. 183.
[10] Quoted in "Idaho says U.S. 'failed miserably' on nuclear waste," *Denver Post*, February 22.
[11] National Academy of Sciences report, released in the early 1950s; quoted in Arjun Makhijani, *High Level Dollars, Low Level Sense* (New York: Apex Press, 1992), p. 137.
[12] In a 1978 paper, "Federal Policy for the Disposal of Highly Radioactive Wastes from Commercial Nuclear Power Plants," DOE Chief Historian Richard G. Hewlett writes, "A policy for the defense wastes at Hanford was all but an accomplished fact. . . The Commission had also assumed that the Savannah River would also be disposed of on-site;" report made available through DOE History Division, Office of the Executive Secretariat, Washington, DC, p. 14.
[13] Steele, "Hanford."
[14] Hewlett, "Federal Policy for the Disposal of Highly Radioactive Wastes," p. 9.
[15] F.G. Gosling and T.R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management 1942-1994 History Division* (draft) (Washington, DC: Executive Secretariat, DOE, March 1994), p. 15.
[16] Hewlett, "Federal Policy for the Disposal of Highly Radioactive Wastes," p. 25.
[17] Gosling and Fehner, *Closing the Circle*, p. 26.
[18] The generation of "transuranic waste" dates as far back as the operation of plutonium-production reactors and chemical-processing plants during World War II under the Manhattan Project. These wastes were included in the "low-level" category until 1970. They were then given a separate classification as transuranic wastes, owing to the presence in such wastes of particularly long-lived radioactivity (the rate of decay was very low for some of the components). Because of the very long lifetime and expected persistence during this period of some degree of nuclear-waste hazard, there was a new recognition of a need to separate the disposal and treatment of transuranic wastes from ordinary low-level wastes. See US DOE, *Buried Transuranic-Contaminated Waste Information for US Department of Energy Facilities* (June 2000).
[19] Gosling and Fehner, *Closing the Circle*, p. 15.
[20] Ibid.
[21] The grand jury that reviewed the case found "a culture of criminal misconduct" within the Rocky Flats installation. However, the Justice Department blocked the jury from issuing indictments. The controversy continued throughout the 1990s, with the jury seeking the representation of George Washington Professor of Law Jonathon Turley.
[22] See General Accounting Office's *Department of Energy: National Priorities Needed for Meeting Environmental Agreements* (RCED-95-1), 1995.
[23] Ibid. Bill White, deputy secretary during Clinton's first term, supports Tuck's version of events. White has characterized the former administration as taking "a very cynical view of these environmental agreements," considering them "a necessary evil to keep production going." Indeed, Admiral Watkins observed as he was entering into the agreements that they would "have the effect of committing the Department's resources beyond funds that are currently available."
[24] Thomas Grumbly, a former assistant secretary for environmental management, considered in 1993, "Our mission at the Department of Energy is no less significant than trying to close the circle on the splitting of the atom begun a half-century ago by [the Manhattan Project]."
[25] DOE, Office of Environmental Management, *Accelerating Cleanup: Paths to Closure* (1998), p. 5. In a *March Status Report on Paths to Closure*, DOE revised this life-cycle estimate to between $151 billion to $195 billion. This document is available at www.em.doe.gov/doclistb.html.
[26] Interview with Hunter Weiler, November 1996. This interview, as well as others done for this study and quoted below, was conducted by Ethan Brown, a former graduate student in the School of Public Affairs at the University of Maryland.

[27] Many agreements have been re-negotiated. However, precedents set in the first agreements remained important factors during these negotiations.
[28] As quoted in *The Denver Post*, March 1, 1994.
[29] Interview with DOE-Oak Ridge personnel, May 1998.
[30] Milton Russell, *Toward a Productive Divorce*, p. 2.
[31] DOE remains the single largest manufacturing employer in the state of South Carolina.
[32] Steve Blush and Tom Heitman, *Trainwreck Along a River of Money*, available through DOE Environmental Management Office, Public Affairs, Washington, DC, 1995, p. 4.
[33] Interview with DOE employee, Headquarters, October 1997.
[34] For more on the organizational structure and decision-making within the EM program, see the National Academy of Science's *Barriers to Science: Technical Management of the Department of Energy Environmental Rededication Program* (1995). See also the National Research Council, *Improving the Environment: An Evaluation of DOE's Environmental Management Program* (1995).
[35] As quoted in "Alm's Goal Jibes With Managers Plans," *Inside Energy with Federal Lands*, June 10, 1996.
[36] Letter from the Military Production Network dated October 8, 1997. As quoted in "Groups Say 2006 Plan is not 'Salvageable,'" *Inside Energy with Federal Lands*, October 3, 1997.
[37] Such changes in leadership and direction have led at least one DOE employee to quip, "Plans are Us."
[38] Interview with INEL EM manager, July 22, 1998.
[39] Interview with Hanford EM manager, August 12, 1998.
[40] Clive Cookson, "Back to the wild on Chernobyl's wastelands," *Financial Times*, October 21/22, 2000.
[41] Interview with Dr. Ron Chesser at the Savannah River Ecology Laboratory, February 4, 1998.
[42] Telephone interview with Dr. Ward Whicker, June 3, 1998.
[43] Whicker elaborates in specific reference to radionuclides in the natural environment throughout the nuclear complex: "If we restrict ourselves to radioactivity rather than other contaminates, it is rather clear that it takes very high levels of radioactivity to cause ecological impacts that we can see. I don't know of anywhere in the DOE complex where radioactive contamination is making it difficult for plants and animals to maintain themselves."
[44] Kathryn S. Brown, "The Great DOE Land Rush?" *Science*, October 23, 1998, p. 616.
[45] As quoted in "Hanford Habitat Key to Survival," *The Tri City Herald*, three-part series, February 25-28, 1996.
[46] Interview with Dr. Ken Brakken, June 22, 1998.
[47] Ibid.
[48] Interview with Rebecca Sharitz, January 1998.
[49] F.W. Whicker, T.G. Hinton, and D.J. Niquette, "To Remediate Or Not: A Case Study," *Environmental Health Physics*, Research Enterprises Publishing Segment, p. 483. Proceedings of the 26th Midyear Topical Meeting of the Health Physics Society, Coeur d'Alene, Idaho, January 24-28, 1993. Sponsored by the Columbia Chapter, Health Physics Society, Richland, Washington.
[50] For a critique of the federal Superfund program, see James V. Delong, *Superfund XVII: The Pathology of Environmental Policy* (Washington, DC: Competitive Enterprise Institute, August 1997).
[51] See US DOE, Office of Environmental Management, *From Cleanup to Stewardship* (October 1999); and US DOE, Office of Environmental Management, *Long-Term Stewardship Study*, draft for public comment (October 2000).
[52] The Department's conclusions are based on a study conducted by the Consortium for Environmental Risk Evaluation (CERE). In 1995, CERE told Congress "the greatest potential for significant risks to workers, to the public and nearby tribes, and to ecological receptors lies largely with the inventories at the installations of plutonium, spent nuclear fuel, and nuclear wastes." CERE's remarks stem from a review of over 1,600 separate risk-related documents at major sites within the complex. The study is considered the most comprehensive analysis of DOE-related risks to date. For further information, see CERE's *Health and Ecological Risks at the U.S. Department of Energy's Nuclear Weapons Complex: A Qualitative Evaluation CERE Interim Risk Report*, March 1995, available through the Environmental Management Office Information Center, Washington, DC.
[53] US General Accounting Office, *Management Changes Needed to Expand Use of Innovation and Cleanup Technologies*, RCED-94-205, 1994.
[54] Ibid.
[55] National Research Council, *National Academy of Sciences, Long-Term Institutional Management of U.S. Department of Energy Legacy Waste Sites* (Washington, DC, August 2000), pp. ix, 4.
[56] DOE, *Moving from Cleanup to Stewardship* (draft), prepared by the DOE's EM Program Office of Strategic Analysis, Washington, DC, September 17, 1997, p. 1.
[57] Frederico Pena as quoted in a statement of James M. Owendoff, acting assistant secretary for environmental management, before the Strategic Forces Subcommittee, Armed Services Committee, United States Senate, March 12, 1998.
[58] DOE, *From Cleanup to Stewardship* (DOE, Office of Environmental Management, Washington, DC, 1999), p. 12.
[59] Ibid., p. 36.

[60] Karen B. Wiley and Steven L. Rhodes, "From Weapons to Wildlife: The Transformation of the Rocky Mountain Arsenal," 40 *Environment* (June 1998).

[61] Whicker, et al., p. 483.

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