United States General Accounting Office

GAO

Report to the Honorable
J. James Exon, U.S. Senate

July 1991

NUCLEAR WASTE

Extensive Process to Site Low-Level Waste Disposal Facility in Nebraska

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GAO

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General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

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July 5, 1991

The Honorable J. James Exon
United States Senate

Dear Senator Exon:

The Low-Level Radioactive Waste Policy Act of 1980, as amended in 1986, required states, either separately or in compacts of two or more, to dispose of commercial and certain federal low-level radioactive waste generated within their borders. Nebraska, as the host state for a compact of five states, underwent a site-selection process that led to the selection of a site in Boyd County.

In your letter of April 27, 1990, you stated that there was concern in Nebraska that the Boyd County site was selected without sufficient attention to the geology of the region and the county's proximity to water sources. This report examines

- the process used by the contractor for the five-state compact to choose a preferred site for a low-level radioactive waste disposal facility,
- the scientific merit of the geologic and hydrologic assessments made of the candidate sites,
- Nebraska's statutory policy that every effort be made to obtain community support for the proposed facility at the Boyd County site, and
- steps being taken to provide financial protection to the public against injury or property damages that might result from operation of the proposed facility.

Results in Brief

US Ecology conducted an extensive site selection process to identify three candidate sites and select a preferred site. The process was a combination of scientific assessments and judgments, subjective public involvement, and land availability. For example, community expressions of interest in the selection process and the identification of landowners willing to sell property for use as a disposal facility site were integral parts of this process.

The detailed geologic and hydrologic assessments at the three candidate sites appear to have been conducted in a technically correct manner. Furthermore, the independent geologists hired by the three local communities being assessed agreed that US Ecology's selection of the Boyd

County site over the Nemaha and Nuckolls sites was correct. Information obtained from the on-site assessments showed that the other two sites have geologic conditions that would make them technically challenging to license. However, while the Boyd County site is technically the strongest site and US Ecology is confident that the proposed disposal facility can be licensed on it, our work raised questions as to whether US Ecology had included sufficient information in its license application to fully characterize certain of the site's geologic and hydrologic aspects. The state license review team raised similar questions and has requested additional information on these and other aspects of the site for its use in evaluating the license application. Because of geologic characteristics of the other two sites, a technically strong substitute site is not readily available if the state's review does not support licensing a facility at the Boyd County site.

Nebraska's governor and several state legislators have questioned whether US Ecology satisfied a state policy to obtain community support for the proposed facility. While Boyd County had expressed interest in hosting the facility in 1988, it withdrew its support a few days before US Ecology announced its selection of the three candidate sites. In the contractor's view, it has complied with the state policy, but the issue remains open. Currently, the state legislature is considering the need for a county vote on the question.

Finally, US Ecology is seeking the state-required third-party liability insurance from a number of sources. In addition, the state of Nebraska recently enacted legislation requiring all states in the compact to share in the risk of third-party liability. Other states of the compact are committed to considering similar legislation.

Background

The Low-Level Radioactive Waste Policy Act of 1980, as amended in 1986, required states to have new disposal sites in operation by January 1, 1993. The act provided legislative direction to the states for developing disposal sites but also provided flexibility for states, compacts, and their designated contractors to accomplish this goal. The act also provided for federal regulatory and technical assistance to states and compacts. In turn, state legislation established state-specific regulations and requirements.

The Nuclear Regulatory Commission (NRC) has the primary responsibility for licensing and regulating low-level radioactive waste disposal facilities. However, NRC is authorized to enter into agreements with

states permitting them to assume authority for licensing and regulating these facilities and for possessing and using radioactive materials. Nebraska has been an "agreement state" since 1966. In this capacity, Nebraska is responsible for ensuring compliance with all applicable federal and state requirements and regulations for the development and operation of a low-level radioactive waste disposal facility in the state.

In 1982 Arkansas, Kansas, Louisiana, Oklahoma, and Nebraska formed the Central Interstate Low-Level Radioactive Waste Compact Commission to provide for low-level radioactive waste disposal within their borders. In June 1987 the compact selected US Ecology, a company experienced in low-level radioactive waste management and disposal, to develop, construct, and operate a low-level radioactive waste disposal facility. As its first task, the contractor assessed the member states to determine the most suitable state to host the facility. In December 1987 the compact selected Nebraska.

In July 1990, after screening the state, identifying potential sites, characterizing candidate sites, and selecting the Boyd County site, US Ecology applied to the state of Nebraska for a license to construct and operate an above-ground, vault-type disposal facility in Boyd County.[1] The state's review of the application will provide the basis for deciding whether to grant the license. The state estimates that its review will take about 15 months, concluding in October 1991, at a cost of about $6 millon.

State Screening and Site Selection Process

US Ecology used a methodical and detailed multistep process to develop screening criteria, to screen the state and interested counties, and to select three candidate disposal sites for detailed investigation. The process included technical records reviews; on-site assessments; and the consideration of nontechnical factors, such as public values and concerns, community support, and identification of available land.

This process included public involvement through a statewide citizens' advisory committee, public meetings, and workshops. Also, in accordance with a state policy that there be community support for the site selected for a disposal facility, site-screening activities were conducted

[1]The application did not address the management and disposal of mixed waste—waste containing both radioactive material regulated by NRC and hazardous wastes regulated by the Environmental Protection Agency. The compact and US Ecology decided to defer submission of this information until dual regulatory issues involving the two federal agencies have been resolved.

only where counties and communities had expressed interest in participation and consented to hosting a disposal facility. Finally, the contractor identified landowners willing to sell land for the facility.

After Nebraska was selected as the host state, US Ecology continued to assemble information on various areas of the state and developed a site-selection process, including criteria for screening and selecting a site. US Ecology presented this information to a citizens' advisory committee that it established as a formal mechanism to obtain public input and at public meetings and workshops. US Ecology used this public input to help refine its site-selection process and criteria.

The process involved a phased approach designed to identify broad geographic areas within the state that might be suitable for a disposal site. Then, in keeping with Nebraska's statutory policy that a disposal facility not be located in a community over its objections, US Ecology solicited input from counties and cities. By August 1988 20 counties had expressed interest in being part of the screening process and in hosting the disposal facility. The county-level phase of the site-selection process focused on the use of more specific criteria that had been developed to first identify broad potential areas within each interested county and then to designate smaller areas as potential siting areas. US Ecology then used land agents to locate landowners in the potential siting areas who were interested in selling their land. Areas without receptive landowners were excluded from further consideration as potential sites.

In November 1988 US Ecology asked the advisory committee to rank 27 unidentified potential siting areas, using selected siting criteria. US Ecology believed this helped confirm the relative importance of these criteria. Most of the 13 areas that the committee ranked highest were in Boyd and Nemaha Counties.

Following visits to promising tracts, as well as further interpretation of available data, US Ecology narrowed its choices to Boyd, Clay, Nemaha, and Nuckolls Counties. However, Clay County was eliminated from further consideration because, earlier in the public input process, US Ecology and the advisory committee had determined that each of the three candidate sites should be in different geologic regions of the state, and Nuckolls and Clay Counties were in the same geologic region. US Ecology chose Nuckolls County over Clay County because it regarded Nuckolls as having more favorable groundwater characteristics. Site-

screening efforts were then concentrated on the three remaining counties, leading to the identification of three candidate sites—in Boyd, Nemaha, and Nuckolls Counties.

After US Ecology announced the three candidate sites in January 1989, local monitoring committees made up of citizens from each of the counties were established, as required by state law, for the purpose of overseeing the site-specific characterization work. Appendix I provides additional information on the site-selection process.

Geologic and Hydrologic Assessments of the Three Candidate Sites

In January 1989 US Ecology started to characterize the three candidate sites to confirm geologic, hydrologic, and geographic information that it had assembled from reviews of records and input from experts familiar with Nebraska's geology. Among other things, the work included drilling more than 50 boreholes at each site, converting some of these into wells to assess the geology and groundwater, assessing surface water conditions, and mapping water drainage patterns. By mid-December 1989, US Ecology had completed the on-site work, and in January 1990 the contractor announced its selection of the Boyd County site.

Consulting geologists were hired by each of the local monitoring committees to observe the field work being conducted by US Ecology and its contractors at their respective candidate sites and to keep the committees apprised of the technical findings. These geologists concluded, notwithstanding some concerns that they raised, that US Ecology and its site contractors had performed their work in a technically correct and proficient manner and had reached appropriate conclusions about each site on the basis of the information collected. They also agreed that the work performed provided a sufficient basis on which to select the Boyd County site. Nevertheless, we had some questions about whether US Ecology had included sufficient information to fully characterize certain aspects of the hydrology and geology of the Boyd County site in its license application. State licensing officials also raised similar questions and have requested additional information on these and other issues for their use in evaluating the license application.

Nemaha and Nuckolls County Sites

Work at the Nemaha County site led US Ecology to conclude that modeling the groundwater under the site would be complex and would require more detailed study. This was due to the presence of multiple groundwater layers in the underlying rocks and sediments. The contractor also found that surface water and groundwater drainage could

direct any radionuclides that might be accidentally released from a disposal facility into a nearby creek that drains into the Missouri River System.

At the Nuckolls County site, the contractor concluded, on the basis of engineering tests of core samples, that unexpectedly large settlement 3 to 4 feet under the site would have a potential effect on the design of a disposal facility. Movement of water between geologic layers was also found. Therefore, the site would require careful evaluation to determine if it could meet the requirements for the long-term isolation of wastes and avoidance of continuing active maintenance after site closure.

Our review of geologic literature and data for Nemaha and Nuckolls Counties indicated that these complex geologic conditions were known to others in the years prior to the site selection process.

Appendix II provides additional details on the characterization of these two candidate sites, as well as the Boyd County site.

Boyd County Site

US Ecology's studies of the area around the Boyd County site found that a flood from the stream on the property could reach the facility. The contractor's computer modeling showed that wetlands on the property could receive groundwater as well as surface drainage in wet years. Accordingly, the proposed site design was modified to include drainage structures so that the disposal facility would not be affected by flooding. Because the disposal facility would be built above grade, however, the contractor concluded that there would always be sufficient depth to the water table to prevent water intrusion into the facility.

Geological studies performed for the Boyd County local monitoring committee also raised the issue of surface water drainage off the site and questioned whether the potential for groundwater movement carrying contamination from the site towards nearby Ponca Creek was sufficiently understood. According to two reports to the committee, because the geologic and hydrologic data were collected during a dry year, water-well data used for US Ecology's report on the safety of the site and proposed facility did not reflect the conditions during a heavy wet period. As a result, further examination of the groundwater would be needed, in US Ecology's opinion, to adequately determine if the site would generally remain well drained and free from flooding or frequent ponding, and if the depth of the water table is sufficient to prevent intrusion of groundwater into the facility.

On reviewing the characterization of the Boyd County site, we had concerns about whether US Ecology had included sufficient information in its license application on certain geologic and hydrologic conditions to satisfactorily demonstrate compliance with state technical requirements. Specifically, we were concerned about the information used to understand and model groundwater movement, to understand clay chemistry and surface water runoff, and to satisfactorily characterize the principal shale barrier under the site. For example, we believed that without further information on these areas US Ecology would have difficulty demonstrating site conformance with the state requirement that the disposal site be generally well drained and have a water table at sufficient depth to preclude groundwater intrusion into the facility. We brought our concerns to the attention of state license review team officials and were advised that the state had similar questions and was pursuing further information from US Ecology on these geologic and hydrologic features of the site.

US Ecology submitted its license application to construct and operate a low-level radioactive waste disposal facility at the Boyd County site to the state of Nebraska in July 1990. Nebraska's Department of Environmental Control and several other state agencies are several months into the license review. The team conducted a "completeness review" of the application and advised US Ecology that sections of the application were incomplete.

According to the program manager, US Ecology has provided some of the requested information and will submit more later. He also said that the state provided its first round of review questions to US Ecology in late February 1991 and that this process will continue until all of the state's questions have been answered. He specifically stated that an appropriate understanding of groundwater movement, clay chemistry, and surface water runoff will be achieved before any decision is made on the license application. These were the areas about which we had raised concerns over the amount of information contained in the site characterization.

The state hopes to complete its review of the application by October 1991. The US Ecology project manager stated that US Ecology does not expect any unresolvable problems with the license application review and that it will provide whatever additional information the state needs to complete its review.

Community Support Issue

In addition to the technical issues discussed above, there is some question about whether the state's community support policy has been satisfied for the Boyd County site. Nebraska's Low-Level Radioactive Waste Disposal Act states that

> "To the extent possible, consistent with the highest level of protection for the health and safety of the citizens of the state and the protection of the environment, the developer shall make every effort to locate the facility where community support is evident."

As previously noted, US Ecology solicited expressions of community interest and support in June 1988. Boyd County, and the Village of Butte near the site, responded favorably. The contractor completed the screening process through the stage of identifying the best potential siting areas. During this time, several counties, not including Boyd County, withdrew their interest in the project.

On December 6, 1988, about 1 month before US Ecology announced its selection of three candidate sites, the Butte Village Board of Trustees reaffirmed its support for the project. The board also noted, however, that it had the right to withdraw its participation in the project. Then, in a December 22, 1988, letter, the Boyd County Board of Supervisors requested that US Ecology agree to several conditions related to community support, public health and safety, and economic compensation and reimbursement. The county board also requested that (1) the facility be an above-ground structure, (2) a study of economic impacts be conducted, and (3) $1 million for public improvement projects be guaranteed to Boyd County. Many of these requests were already part of agreements and conditions for the candidate sites.

On December 30, 1988, US Ecology informed the county board that it did not have authority to agree to all of the requested conditions and further explained the conditions that were already part of the siting process. On January 18, 1989, US Ecology announced its selection of the three candidate sites. That same day, the contractor was informed of resolutions passed 8 days earlier by the county board of supervisors withdrawing support for the disposal facility and stating that US Ecology was unwilling or unable to meet the conditions imposed by the board.

US Ecology's position is that the county board's action cannot stop the facility licensing process because the compact and US Ecology have complied with the community support provision of Nebraska law.

Upon taking office in January 1991, the new governor of Nebraska began an inquiry into the community support issue. Since then, the governor's office has made no official statement on the issue, but the state legislature has been working on potential legislative solutions, including the possibility of a popular vote.

Strict Liability for Disposal Facility Operator

In the absence of federal requirements that operators of low-level radioactive waste disposal facilities obtain financial protection against losses by third parties, such as owners of land adjacent to a facility site, Nebraska passed a low-level waste act that made disposal facility operations subject to strict liability for all property damage, bodily injury, or death resulting from such disposal.

According to US Ecology's license application, the company will obtain nuclear facility liability insurance and other commercially available insurance as required by the state. It appears that a number of insurance carriers and service companies, including American Nuclear Insurers, will be providing this type of protection.

Because of concerns about major liability claims, the governor of Nebraska has begun to discuss a shared liability provision for the entire compact with the other states in the compact. Also, the Nebraska legislature recently enacted legislation that would establish shared liability arrangements with other compact members if they enact similar legislation. Other members of the compact are now considering supportive legislation. Enactment of supportive legislation by all members of the compact would constitute an amendment to the compact agreement. Under the federal low-level radioactive waste statute, the amendment to the compact will be submitted to the Congress for its approval.

Observations

On the basis of our review, it appears that (1) the site-screening and site-selection process was an extensive effort to comply with state law and policy in selecting a site for a low-level waste facility, (2) the geologic and hydrologic assessments performed at the three candidate sites appear to have been conducted in a technically correct manner, and (3) the selection of the Boyd County site, as the preferred site, was supported by the information assembled from existing records and gathered during the on-site characterization of the three candidate sites.

As previously noted, the site-selection process was, by design, not exclusively a scientific process. Rather, it was a combination of technical

records reviews, scientific assessments and judgments, subjective public input, community consent, and land availability. The combination of these factors resulted in the continued inclusion of potential siting areas in Nemaha and Nuckolls Counties, which have complex geologic characteristics that could complicate the contractor's ability to license a disposal facility in these potential siting areas. The site in Boyd County was preferable to the other two sites and the only candidate site with good potential to meet the state's licensing requirements. If licensing problems are encountered at the Boyd County site, however, there is no technically strong substitute site readily available. In such a case, some reevaluation of potential siting areas would be necessary to find new candidate sites.

We discussed the facts contained in this report with selected officials of the Central Interstate Compact, US Ecology, and the state of Nebraska's Department of Environmental Control. Their comments have been included where appropriate. As you requested, we did not obtain official comments on a draft of this report. We conducted our work between April 1990 and March 1991 in accordance with generally accepted government auditing standards.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will make copies available to the Chairman, Nuclear Regulatory Commission; the Secretary of Energy; appropriate state officials; and others upon request.

Please call me at (202) 275-1441, if you have any questions. Appendix III discusses our scope and methodology. Major contributors are listed in appendix IV.

Sincerely yours,

Victor S. Rezendes
Director, Energy Issues

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Abbreviations

GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
USGS	U.S. Geological Survey

Description of the Site Selection Process

From January 1988 until January 1989, US Ecology used a methodical and detailed multistep process to develop screening criteria, screen the regional areas within the state, identify and screen interested counties, and identify three candidate sites that it considered licensable. The process involved extensive public participation through a statewide citizen's advisory committee and numerous public hearings and workshops and included efforts to comply with state provisions, such as considering only areas in which community support was evident. In short, the contractor melded technical evaluations, public concerns, county and community interest and consent, and the identification of landowners willing to sell their property into a screening and site-selection process designed to narrow down areas of the state until three candidates sites for a disposal facility had been identified.

Developing Site Selection Objectives and Criteria

In 1987 US Ecology used information on environmental issues, waste volumes, and transportation factors to assess each of the five states in the Central Interstate Low-Level Radioactive Waste Compact Commission and recommended the selection of Nebraska as the compact's host state for a waste disposal facility.

As the first step in the site selection process, US Ecology developed a broad statement of objectives that would provide the primary direction for the process. These objectives were intended to lead to selection of three candidate sites for the subject disposal facility that could

- protect public health and safety,
- provide a geotechnically and environmentally suitable site,
- be licensed in a timely manner after site characterization,
- be located in an area that expressed interest in participating in the state screening process, and
- adhere to the requirements and deadlines of the federal Low-Level Radioactive Waste Policy Act, as amended.

In a manner consistent with these objectives, US Ecology continued to assemble information from existing records on the geography, geology, water resources, and other resource and environmental features of the state. It then developed a screening and selection methodology and criteria, based on pertinent state and federal law and regulations, that would identify progressively smaller and more technically suitable geographic areas.

By April 1988 the contractor had identified and developed preliminary criteria for the several phases of the site-selection process. It had also assembled sufficient information on the characteristics of the state to announce the structure and approach for a statewide selection process and presented this information to a citizen's advisory committee. US Ecology had established, through the League of Women Voters, the committee as a formal mechanism to achieve public participation and involvement in the site-screening and site-selection process. Through a series of meetings with the committee and other public hearings and workshops, US Ecology received and used public input on the selection process and criteria to focus on potentially licensable areas of the state.

Throughout the site-screening and site-selection process, members of the public raised numerous questions at meetings and workshops about the process and the technical work required for the license application. According to the independent moderator for the advisory committee meetings, the efforts of US Ecology and others were positive and productive in informing the public on relevant issues and questions.

US Ecology did meet with public opposition, including a lawsuit filed by Concerned Citizens of Nebraska against US Ecology and the compact, among others. The suit asserts a number of claims, including alleged violations of the U.S. Constitution and the federal Low-Level Radioactive Waste Policy Amendments Act. In October 1990 the court dismissed all claims against both US Ecology and the compact.

Both the executive director of the compact and the project manager for US Ecology said that appropriate efforts were made to obtain effective public involvement in the site-selection process. The project manager also stated that US Ecology never expected to pursue this project without public hesitation and even some strong public opposition. The compact is also confident that the provisions of its contract with US Ecology, the direction provided in Nebraska state law, and the applicable state and federal regulations and guidance for developing a low-level radioactive waste disposal facility have been appropriately followed.

Figure I.1 lists the basic screening criteria used to conduct the site-selection process and identifies the screening phase in which the criteria were applied. Our figure describes broad categories of criteria. Each category is further broken down into more detailed and specific criteria that were used as the screening process narrowed down areas. With the development of these criteria, US Ecology initiated a screening process

at the state, regional, and county levels to identify and narrow down areas to select three candidate sites.

Table I.1: Basic Screening Criteria Used by US Ecology

Consideration	Criteria	Applied to
Groundwater	Outside influence area of public water well	County
	Away from area with shallow fluctuating ground water	County
	Away from major ground water recharge zones	County
	Away from areas with complex hydrologic conditions	County
Geology	Stable tectonic processes	County Region
	Two miles or more from active faults	Region County
	Avoid areas with sand and gravel deposits on the surface with shallow depth to ground water	County
	Geologic hazards such as subsidence, mass wasting, slumping, liquifaction	County
	Geologic resources (e.g., mineable sand and gravel deposits, mineral concentrations and hydrocarbon deposits) that, if developed, could affect the safe operation of the proposed facility	County
Surface water	Outside 100-year flood plain	State
	Outside flood prone areas	County
	Away from water bodies (lakes, rivers, creeks, canals, and ponds) and wetlands	County
	Areas with drainage problems (e.g., local ponding)	County
Land Use	Outside boundries of legally dedicated lands	State Region County
Population & urban growth	Areas 15 or more miles from population centers over 100,000	State Region
	Areas 2 or more miles from population centers over 5,000	State Region
	Two kilometers (1.2 miles) or more away from population centers	County
Cultural resources	Outside national register sites	County
Biological resources	Outside designated critical habitat for federal or state listed threatened or endangered species	County
Community compatibility	Formal invitation by host entity to evaluate the site	Region

Source: US Ecology.

State and Regional Screening

The purpose of this initial screening process was to identify geographic areas within the state likely to include a suitable site for the proposed facility. This phase of the process had three basic steps, including (1) identifying suitable geographic areas, (2) obtaining formal expressions of interest in participating in the screening process from counties and local communities, and (3) identifying potential areas within the general areas expressing interest in the process.

In this phase, US Ecology used selected criteria for surface water, land use, population, and urban growth to begin the statewide screening process. Areas meeting all criteria were then screened to identify areas expected to have a high likelihood of containing a potentially licensable area.

To satisfy Nebraska's concerns about community support, US Ecology solicited input from counties and communities in June 1988 to determine their willingness to participate in the state and regional screening process. US Ecology excluded from further consideration any county not having this support. By August 1988 20 counties had formally expressed interest in the screening process. Attention was then directed toward these counties.

County Screening

Each interested county was screened against the county-specific criteria addressing groundwater and surface water, geology, land use, population, urban growth, and biological and cultural resources. The areas remaining after this screening were designated "potential areas" and were evaluated further to locate smaller areas within them. These smaller areas, ranging from one-half to 18 square miles in size, were designated as "potential siting areas."

Three counties withdrew their expressions of interest during the county-level screening process. Six other counties withdrew their expressions of interest after potential areas had been identified. In the remaining 11 counties there were 111 potential siting areas comprising 522 square miles. According to US Ecology, all of the siting areas had physical characteristics showing good potential for safely siting an above-ground disposal facility. Table I.1 shows the distribution of the potential siting areas and the estimated total land area by the counties involved.

Table I.2: Potential Siting Areas in the 11 Interested Counties

County	Number of potential siting areas	Approximate total area (square miles)
Boyd	21	116
Clay	3	33
Dawson	5	18
Gosper	12	24
Greeley	3	23
Keith	6	43
Kimball	13	76
Nemaha	13	14
Nuckolls	7	14
Perkins	22	132
Webster	6	29
Total	**111**	**522**

Source: US Ecology.

Evaluation of Potential Siting Areas and Selection of Candidate Sites

The evaluation of the potential siting areas involved closer application of more detailed criteria to all information that had been assembled on these areas as well as the professional judgments by US Ecology's site-selection team on geotechnical matters and land availability. This phase of the process led the selection team to identify candidate sites in Boyd, Nemaha, and Nuckolls Counties.

By October 1988, US Ecology had reached the point of screening the siting areas to begin the search for available land at least 320 acres in size, measuring one-half by one mile, and held by an owner agreeing to three basic conditions:

- granting an option to purchase the land at a future date,
- renewing that option periodically, and
- granting access to US Ecology to undertake site characterization work.

Land agents were then used to locate tracts of land within the siting areas and sign purchase option contracts with receptive landowners.

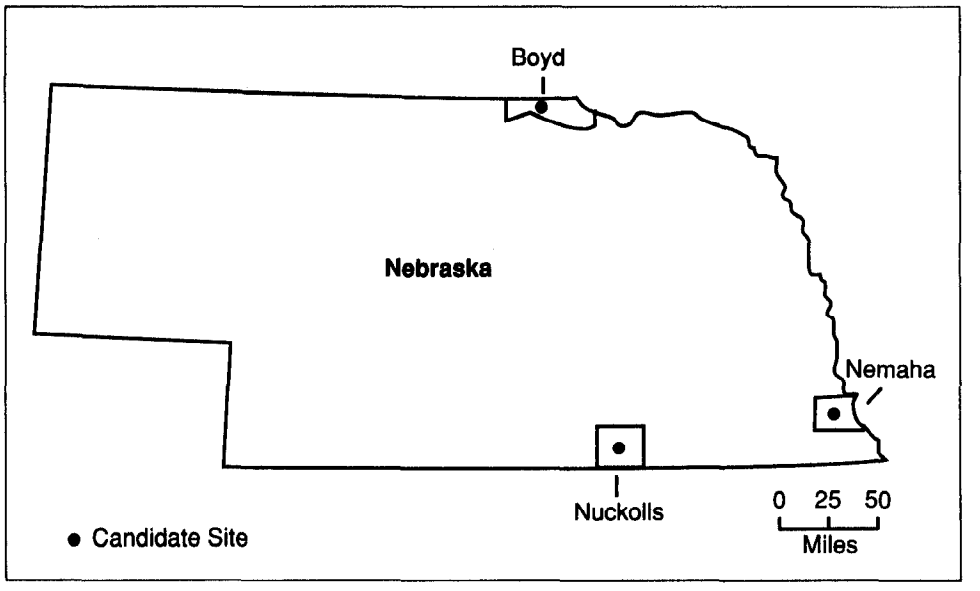
At a November 1988 public meeting, US Ecology had the citizen advisory committee participate in a two-part exercise using selected criteria to help test the relative importance of individual criteria. Each member of the committee applied the criteria to 27 unidentified representative potential siting areas selected by US Ecology. The committee members

generally favored 13 potential siting areas, most of which were in Boyd and Nemaha Counties. Others were in Clay, Gosper, and Webster Counties. According to US Ecology's report on the screening process, this exercise confirmed, in US Ecology's view, the importance of groundwater and other geologic factors in selecting potential sites and confirmed its siting team's professional judgment in developing the criteria and the relative significance of particular criteria.

The technical screening and siting team then continued to add or delete siting areas. By early December the most promising areas were visited, and the topographical, site drainage, and transportation access conditions were noted. Through this process, US Ecology identified what it considered as the most promising counties from a "hydro-geologic" perspective. Following the site visits and further examination of data, potential siting areas in Boyd, Clay, Nemaha, and Nuckolls Counties were viewed as having the greatest likelihood of being licensable. A condition established by US Ecology and the citizen advisory committee that each of the candidate sites be selected from a different groundwater geology region was then applied. Since Clay and Nuckolls counties were in the same region, US Ecology selected Nuckolls over Clay because of more favorable groundwater characteristics.

In January 1989 US Ecology publicly announced the identification of three candidate sites in Boyd, Nemaha, and Nuckolls Counties, meeting the state's legislated target date to select three candidate sites. It then started on-site characterization. US Ecology stated in its report on the selection process that its records review efforts on the geology, groundwater, surface water, topography, and environmental resources indicated that each site met or exceeded requirements to protect the environment and public health and safety. Figure I.1 shows the approximate locations of the three counties and the candidate sites.

Figure I.1: Location of Host Counties and Candidate Sites



Characterization of the Three Candidate Sites

In January 1989 US Ecology and its field contractor, Bechtel International Inc., started a year-long effort to characterize each candidate site, including drilling bore holes and well holes to assess the geology and groundwater, assessing surface water, and mapping water drainage patterns, among other activities. The local monitoring committees hired technical experts, including geologists, to observe this work. By mid-December 1989 the characterization had been completed. On the basis of the information collected, US Ecology concluded that the Boyd County site was technically superior to the other two sites.

Work at the Nemaha and Nuckolls sites confirmed the presence of geologic conditions that had been identified years earlier in geological studies of the respective areas in which the sites are located. After the on-site characterization, the geology of both sites was considered too complicated to be selected as the preferred site.

The Boyd County site appears to be preferable to the other two sites. Nevertheless, additional information and analysis will be needed to satisfy all state licensing requirements. Also during our examination of core samples from the three sites stored by US Ecology at a warehouse in Lincoln, we observed several unsatisfactory storage practices. According to a state official with whom we discussed this matter, US Ecology subsequently improved core storage conditions.

Geologic and Hydrologic Conditions of the Three Candidate Sites

US Ecology regarded all three candidate sites as having high licensing potential on the basis of records research and other data gathering up to the point at which the sites were selected for characterization. However, as a result of site drilling and technical evaluations of the cores obtained during site characterization, geologic conditions were found that would complicate selecting either the Nemaha or the Nuckolls site as the preferred site. This resulted in the selection of the Boyd site as the preferred site. Our review of certain geologic literature and data for those counties indicated that these geologic conditions were known to others for many years before the site-selection process.

On the basis of our comparison of geologic and geographic data for the three sites to technical siting criteria established by NRC and Nebraska's Department of Environmental Control, we agreed that the Boyd site is technically preferable to the other sites. However, we had several questions about local geologic and groundwater and surface water conditions that were not addressed in the US Ecology data and reports we reviewed or in license application material submitted to the state during the time

of our review. State officials also noted that the information on these areas included in US Ecology's license application was insufficient, and they have requested additional information.

Disposal Site Technical Suitability Requirements

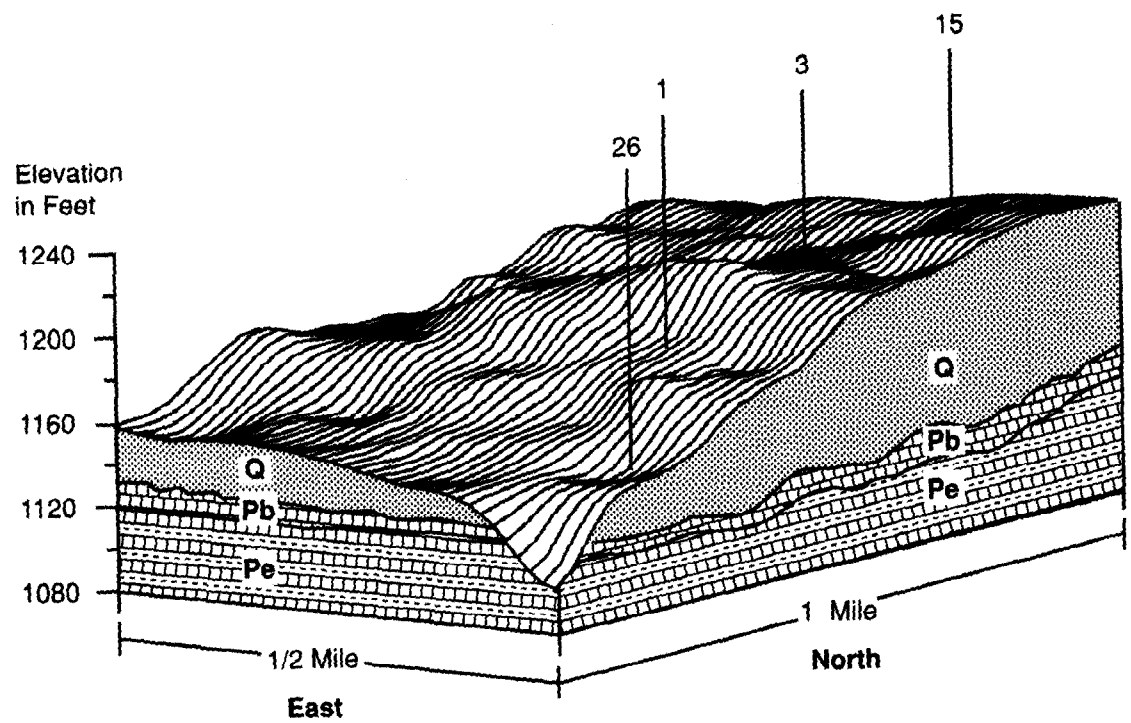
Nebraska's suitability requirements for licensing a low-level radioactive waste disposal facility are based on NRC guidelines and regulations. The requirements, among other things, address population centers, biological and other natural resources, as well as geologic and hydrologic criteria. The state asks that a site not be located where it is likely to be affected by population growth or development, nearby facilities and activities, or areas with exploitable natural resources.

With respect to geology and hydrology, areas with faulting, seismic activity, or volcanism are to be avoided, as are areas with surface geologic processes, such as erosion and landsliding, because these conditions could significantly affect the ability of the disposal site to meet performance objectives or may preclude defensible modeling to predict long-term effects. The state also requires that a site be well drained and free of flooding or ponding. Minimal upstream drainage areas are required to decrease the potential for runoff water to erode or inundate a disposal facility. Also required is sufficient depth to the water table so that groundwater will not intrude into the waste facility. Both NRC's and Nebraska's regulations for licensing low-level waste disposal facilities require that the site be capable of being characterized, monitored, modeled, and analyzed.

Nemaha County Site

The Nemaha County site consists of a gently sloping to moderately hilly terrain in rural farmland about 5 miles west of the city of Auburn and 3 miles southeast of the town of Johnson. Bechtel drilled 53 boreholes at the site and converted 16 into observation water wells. The bedrock of the site, as tested by the drilling program, consists primarily of shales and limestones overlain by as much as 75 feet of glacial sediments. Two limestone layers found in drill holes at the site are found elsewhere in the county and, in fact, have been quarried at locations adjacent to the candidate site. Bechtel also found groundwater movement among the sediments and the two limestone layers. Figure II.1 shows a generalized topographic and stratigraphic display of the Nemaha County site. This figure has been constructed on the basis of several boreholes, including the four shown.

Figure II.1: Three Dimensional Topographic and Stratigraphic Display of the Nemaha County Candidate Site



Lithology Symbol (not to scale)	Geologic Period	Unit Description	Thickness Range (Feet)
Q	Quaternary	Glacial Sediments	8.5–100.8
Pb	Permian	Beattie Formation (Includes Cottonw.Ls.)	0–13.6
Pe		Eskridge FM. (Shale/Ls)	43.9–48.8

Source: Prepared by GAO from information generated by Bechtel International.

Bechtel's supervisory geologist recognized that with multiple groundwater levels in Nemaha's limestones and sediments a more detailed study of that site would be required and modeling the groundwater would be complex. The presence of limestone at and near the surface would present special monitoring and modeling problems that would make demonstrating groundwater movement and predicting site performance difficult.

Surface water at the Nemaha site drains into two creeks. The northwest and eastern portions of the site drain northeast into Longs Creek which is one-half mile from the site and is a tributary of the Little Nemaha River. The western part of the site drains into a stream that eventually joins the Nemaha River. Bechtel found that most surface water at the site drains into Longs Creek, which ultimately drains into the Missouri River system. They also found that groundwater could discharge from the site and that there was the potential for long-term erosion along the gully in the northeast corner of the site. On these bases, the Nemaha site was considered by Bechtel and US Ecology as less attractive than the Boyd site.

A study dating back to 1932 had identified glacial sediments and limestones as groundwater sources for Nemaha County. Furthermore, on the basis of available geological data, both of the two limestone layers can be geologically projected to pass under the site. Bechtel, however, did not survey groundwater users in the area prior to the site selection, which limited its knowledge of which limestone beds were being used as water sources. Bechtel stated that it was informed that many water users were connected to the area water system and were not on wells. In our view further field assessment of the site prior to its selection as a candidate site, in particular assessments of the exposed limestones in adjacent quarries and groundwater sources, would have improved US Ecology's information and may have precluded the site from further consideration at that point. US Ecology's project manager stated that any on-site assessment, prior to candidate site selection, was not pursued because of a requirement in state law establishing the need for them to notify the governor and the state legislature of any on-site work.

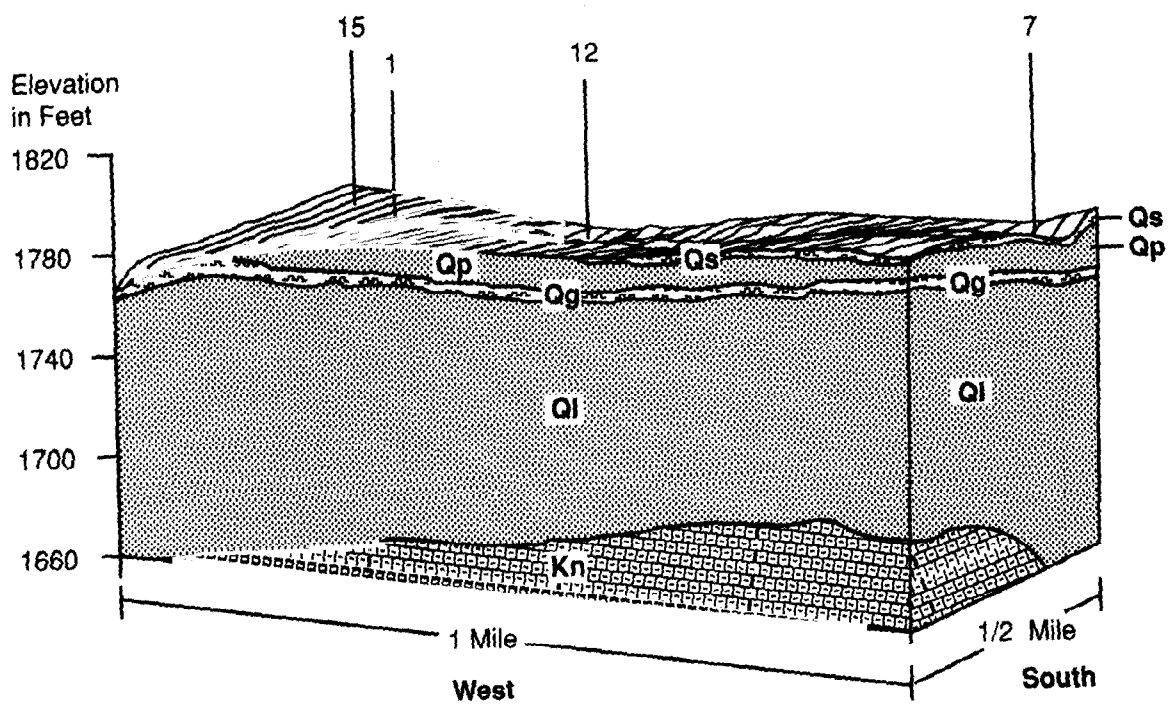
Nuckolls County Site

The Nuckolls County site lies in a part of the county consisting of plains variously eroded by local streams and rivers. The site is dissected by two small streams. One stream drains the northwest corner of the site, and the other runs from southwest to northeast starting near the center of the site. Bedrock of the site consists of chalk and shales overlain by unconsolidated sediments from 70 to 135 feet thick.

Bechtel drilled 64 boreholes at the site and converted 16 into observation water wells. Water was found at a depth of 28 to 60 feet. Studies by Bechtel of these water levels showed that water moves vertically between two underground formations. Figure II.2 provides a generalized topographic and stratigraphic display of the Nuckolls County site. The

figure has been constructed on the basis of several boreholes, including the four shown.

Figure II.2: Three Dimensional Topographic and Stratigraphic Display of the Nuckolls County Candidate Site



Lithology Symbol (not to scale)	Geologic Period	Unit Description	Thickness Range (Feet)
Qs	Quaternary/ Late Tertiary	Surficial Silts/Clays	1.5–6.4
Qp		Peorian Loess (Glacial Silty Clay)	7–18
Qg		Gilman Canyon Fm. (Organic Silt/Clay)	0–6
Ql		Loveland Loess (Glacial Silts/Clays)	58–120
Kn	Late Cretaceous	Niobrara Formation (Calc. Claystone/Chalk)	21.6–84.1

Source: Prepared by GAO from information gathered by Bechtel International.

Bechtel's drilling program and engineering tests of the glacial soils at the Nuckolls site found that settlement under building weights at the site would be substantial—3 to 4 feet—and higher than expected at either the Nemaha or Boyd County sites. The settlement was expected to occur during and after construction and would require special efforts to mitigate the effects. In this case, Bechtel noted that settlement would have a potential impact on the design of the facility and would require careful evaluation to determine if it could meet the requirement for long-term isolation and avoidance of continuing active maintenance after site closure.

In a previous study in 1948 by the U.S. Geological Survey (USGS), in conjunction with the state, a borehole had been drilled 1-1/2 miles from the site with a drawn geological cross section through the site. The cross section showed the projected thickness of the various glacial deposits. A second study by USGS in the mid-1960s had evaluated the building response of glacial sediments and stated that, although building conditions are generally good (in Franklin, Nuckolls, and Webster Counties), there were potential hazards to heavy structures because of settling under heavy loads when saturated with water. Because the amount of settling may not be the same at all places, the study concluded, unusual stress in the structure may occur.

Bechtel was aware of these previous studies prior to the selection of the Nuckolls site. Bechtel's supervisory engineering geologist told us that he was aware of these studies, but that a U.S. Bureau of Reclamation study done in 1960 convinced him that selecting a site in that location would not be a problem for a disposal facility. He also advised us that site excavation activities could have addressed the compaction concerns if the Nuckolls site had been selected as the preferred site; however, the settlement problem remained a major disadvantage of the Nuckolls site in comparison with the other two candidate sites.

Boyd County Site

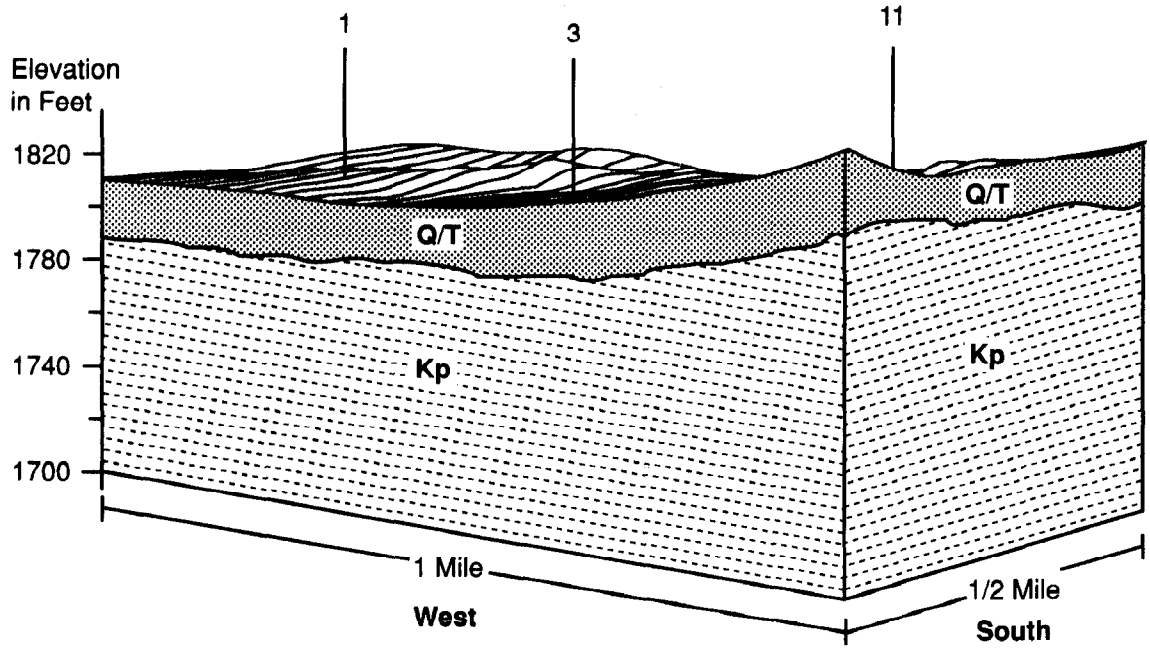
According to US Ecology and Bechtel's review of existing records and reports and the raw data they assembled, the overall geology of the area and the Boyd County site is relatively simple. The site is part of an intermediate plain lying between two stream valleys and the high plains. The site is dissected by a small stream that drains the southwestern corner of the property. Bedrock formations of the site are shales overlain by sediments from 10 to 40 feet thick. The extensive shale formation under the sediments is, in the judgment of Bechtel's supervisory

geologist, a substantial natural barrier between the site and an underlying aquifer.[1]

Bechtel drilled 107 boreholes at the Boyd site and converted 43 into observation and monitoring water wells. Water was found present in unconsolidated sediments overlying the shale at depths of from 5 to 15 feet below the surface. Groundwater monitoring showed a general flow trend towards the north. The aquifer is believed to underlie the site at depths of at least 1,000 feet and is believed to be effectively isolated from the site by the shale. The thickness and significant lack of permeability (capacity of a rock to transmit fluids) of the shale is an advantage to the site in preventing any possible spilled or leaked radionuclides from draining into the aquifer below. The deepest drill hole at the site found this shale to be 500 feet thick, and many drill holes at the site confirmed its presence under the entire site. The Ogallala Group rocks, also an important groundwater source, were found to be absent at and immediately surrounding the site. Figure II.3 provides a topographic and stratigraphic display of the Boyd County site. This figure has been constructed on the basis of several boreholes, including the three shown.

[1] An aquifer is water-bearing porous rock or sediment.

Figure II.3: Three Dimensional Topographic and Stratigraphic Display of the Boyd County Candidate Site



Lithology Symbol (not to scale)	Geologic Period	Unit Description	Thickness Range (Feet)
Q/T	Quaternary/ Late Tertiary	Surficial Sediments	0.6–37.4
Kp	Late Cretaceous	Pierre Shale	500+?

Source: Prepared by GAO from information gathered by Bechtel International.

Surface waters at the Boyd site drain into one poorly defined stream and several small wetlands. The stream drains the western portion of the site, flows northward through the site and intercepts Ponca Creek—a tributary of the Missouri River 40 miles away. The wetlands on the site are enclosed basins comprising about 43 acres. Bechtel conducted research to estimate flood activity over 100 years and found that a flood from the stream would reach the facility; accordingly, the site design was modified with drainage structures so that the disposal facility

would not be affected by flooding. Bechtel did not identify any groundwater movement to the wetlands in the application information; however, its computer modeling showed that the wetlands could receive groundwater in wet years. Bechtel concluded that, because the disposal facility was above grade, there would always be sufficient depth to the water table to prevent intrusion into the facility.

Also according to the Bechtel supervisory geologist, the relatively simple geology of the site, their understanding of the groundwater hydrology, and the surface water drainage patterns permit a conclusion that there would be no adverse effects on groundwater or consequences from wetlands on the site.

As of March 1991, Bechtel had not finished modeling the movement of groundwater at the site. Nor had it completed its analyses of the site's clay chemistry, which is important in determining the fate and effects of accidental radionuclide release on the environment. We also found that the Bechtel supervisory geologist had not obtained and reviewed historical aerial photos of the site taken during wet years to determine the effect of local flooding.

The consulting geologists for the Boyd County local monitoring committee were most concerned with the potential of surface and water runoff carrying any spilled radionuclides from the site. In one geologist's report, it was noted that in the event of a heavy rainfall period there was the potential for surface water discharge off the site and movement toward Ponca Creek. With regard to surface water movement, US Ecology is proposing engineered drainage and other man-made structures to address potential flooding and surface water runoff in wet periods. In a 1989 report, however, USGS stated that

> "There are neither experimental nor experiential real-time bases for long-term projections regarding the effectiveness of engineered barriers for long-term containment of radionuclides . . . . Engineering barriers including those designed to isolate the waste, drain the repository, stabilize the waste or the repository, or prevent the waste from coming in contact with moisture cannot be relied upon to provide long-term (300 to 500 years) isolation for the radioactive life of the waste."[2]

In this regard, we believe that without additional information, US Ecology may have difficulty in demonstrating the ability of the site to meet the technical requirements that (1) the site be generally well

[2]Geohydrologic Aspects for Siting and Design of Low-Level Radioactive-Waste Disposal, U.S. Geological Survey Circular 1034 (1989).

drained and free of areas of flooding or frequent ponding and (2) that sufficient depth to the water table exist so that ground water intrusion into the waste will not occur.

Furthermore in our view, information on the confining shale was not sufficiently developed in US Ecology data and reports. Specifically, there was no geological or geophysical effort to map its thickness under or across the Boyd site, and the difference between previously published estimates and actual measured values for the single penetrating drill hole at the site are over 200 feet. Such a centrally important feature, in our view, requires appropriate stratigraphic characterization to understand the thickness variation and its other geologic qualities.

Nevertheless, the site still appears to be technically preferable to the other two candidate sites on the basis of the geologic conditions found at those sites. As previously noted, the state license application review team has already raised questions on the specific areas of site geology, hydrology, and geochemistry. We believe this review will require that all the necessary data be assembled and analyzed to determine if the Boyd site can meet licensing requirements.

Geologic Core Storage

In November 1990, at the warehouse in Lincoln where geologic cores from all three candidate sites were stored (soil samples drawn from drilling to predetermined depths), we compared several cores with the core descriptions provided to the state in the environmental report and safety analysis report. In general, the core descriptions matched the cores we examined.

However, we also noted several conditions that did not appear to represent good storage practice. Specifically, we found that

- there was no readily available inventory document for the cores shipped from Omaha to determine if all geologic materials were accounted for;
- core containers were stacked on the floor and on shelves almost entirely in random order, with apparently no concern for assembling containers (boxes) associated with the same core together;
- core boxes were also poorly marked as to the depth interval of the core contained within, making identification of needed cores difficult to find;
- depth interval markings within core boxes were minimal, making core review more difficult; and
- some of the cores examined were desegregated or broken (some possibly from poor handling), which might affect subsequent sample reviews.

In addition, the overall conditions in the warehouse were not conducive to any detailed examination of the cores. The small locked cages in which the cores were placed were dimly lit, with no work tables on which to place and examine cores. In this regard, locating preselected cores, which were to be readily available upon our visit, for examination required searching, stacking, and restacking cores boxes. This had the potential for further disturbance to the contained geologic material.

Both NRC's and Nebraska's review plans for a license application for low-level radioactive waste facilities state that the technical review must compare collected geologic data with location plans to determine if they have been completely and conservatively interpreted to develop design parameters or assess geologic site conditions. In this regard, cores represent an historical record of site geology that must be preserved as undamaged as possible for application review to avoid the necessity of redrilling a site. While core storage and marking procedures are not uniform throughout government and industry, we note that agencies such as the USGS in Denver and the Oklahoma Geological Survey in Norman take great care to pallet and protect cores against damage while storing them in controlled and organized storage facilities. Core boxes and cores from federal project sites have included foot-by-foot depth indicators for restudy or sampling purposes.

We discussed these concerns with Nebraska officials in December 1990. Subsequently, the state's review manager for site characteristics advised us that some actions were taken in February by US Ecology and Bechtel to improve the core storage conditions, including the organization and improved labeling of core boxes, along with improved lighting and work space to review the cores. We did learn, however, that since our visit parts of a core were dropped and irreparably jumbled, in the state's efforts to improve storage conditions and practices.

Scope and Methodology

To address the issues discussed in this report, we interviewed officials of the compact, US Ecology, Bechtel International, and the state of Nebraska who are directly involved in site and facility development activities. We also interviewed representatives from the citizen's advisory committee and the three local monitoring committees that were established for the three candidate sites.

In addition, we reviewed materials, records, and reports generated by the above-named parties, as well as other sources of information on the site selection process, the technical geologic and hydrologic assessments of the three candidate sites, and related activities. We visited the Boyd County site in November 1990 to obtain a perspective on the site and the surrounding area, and we observed and selectively reviewed geologic core materials from the candidate site characterization work stored in Lincoln, Nebraska. In addition, we discussed selected aspects of compact and state responsibilities for implementing the Low-Level Radioactive Waste Policy Act with officials of NRC and the Department of Energy. We also reviewed reports and records and discussed selected technical work with representatives of the U.S. Geological Survey.

We discussed the facts contained in this report with selected officials of the Central Interstate Compact, US Ecology, and the state of Nebraska's Department of Environmental Control. Their comments have been included where appropriate. As you requested, we did not obtain official comments on a draft of this report. We conducted our work between April 1990 and March 1991 in accordance with generally accepted government auditing standards.

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Related GAO Products

Nuclear Regulation: The Military Would Benefit From a Comprehensive Waste Disposal Program (GAO/RCED-90-96, March 23,1990).

Energy: Bibliography of GAO Documents January 1986 - 1990 (GAO/RCED-90-179, July 1990).

Energy Reports and Testimony: 1990 (GAO/RCED-91-84, January 1991).

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