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SITE SELECTION EXPERIENCE FOR A NEW LOW-LEVEL RADIOACTIVE WASTE STORAGE/DISPOSAL FACILITY AT THE SAVANNAH RIVER PLANT

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SITE SELECTION EXPERIENCE FOR A NEW LOW-LEVEL RADIOACTIVE WASTE STORAGE/DISPOSAL FACILITY AT THE SAVANNAH RIVER PLANT*

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ABSTRACT

Preliminary performance criteria and site selection guides specific to the Savannah River Plant, were developed for a new low-level radioactive waste storage/disposal facility. These site selection guides were applied to seventeen potential sites identified at SRP. The potential sites were ranked based on how well they met a set of characteristics considered important in site selection for a low-level radioactive waste disposal facility. The characteristics were given a weighting factor representing its relative importance in meeting site performance criteria. A candidate site was selected and will be the subject of a site characterization program.

BACKGROUND

The Savannah River Plant is located in a humid region in South Carolina and will be required to site a new low-level radioactive waste storage and disposal facility in 1988. DOE Order 5820.2, Chapter III, Management of Low-Level Radioactive Waste, provides general regulatory guidelines for use in developing site specific selection criteria for new low-level waste disposal facilities. For selecting a waste disposal site, the criteria should address the following:

- Size, including disposal and administrative areas, and buffer zones
- Hydrogeologic characteristics which permit disposal completely above or completely below the transition zone (the zone between the unsaturated and saturated zones) and reliable prediction and control of radionuclide migration
- Potential impacts of natural hazards such as floods, erosion, tornadoes, earthquakes, and volcanoes on site performance

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- Impacts on current and projected population distributions and local families or businesses; land use, resource development plans and nearby public facilities (i.e., parks, schools, and streets); accessibility to transportation routes, and utilities; and the location of waste generators.

The first step in selecting a site for a new facility is to assume that low-level radioactive waste will continue to be disposed of at the Savannah River Plant. Thus the 300 square miles of the Savannah River Plant are considered the region for consideration.

INITIAL SCREENING

The subsurface geology and hydrology of the Savannah River Plant site was evaluated for areas especially favorable for disposal and storage of low-level radioactive waste. Seventeen potential sites were identified for consideration and the more favorable ones were subjected to more site specific geologic and hydrologic investigations including test borings to define the geohydrology.

More extensive hydrologic studies to evaluate groundwater flow directions and velocities will be conducted to further characterize the three sites identified as being best suited to host the new facility. The top rated site will be proposed as the location for a new facility for storage/disposal of low-level radioactive waste at the Savannah River Plant.

The criteria established and applied in the identification of potential sites considers both economic and geotechnical constraints. However, since one evident mode of migration of radioactive nuclides from a disposal/storage site to the biosphere is through soil moisture and groundwater movement, the geohydrology of the site becomes an important consideration in site selection. Maximizing the retention capabilities of a geologically chosen site can be accomplished through engineering design and construction techniques.

Criteria considered in the identification of potential sites include:

- Remoteness from Plant boundaries
- Convenience to waste generators, transportation, and utility lines
- Relatively flat topography to minimize erosion potential
- Maximum reasonable horizontal and vertical distance to surface streams to increase the flow path and time of travel of subsurface water. This also reduces the potential for flooding.
- Low hydraulic conductivities and hydraulic gradients to increase the time radionuclides spend in the disposal site area and therefore maximize radionuclide decay

- Maximum distance between the bottom of the waste and the water table because horizontal travel in the ground does not begin until the radionuclides reach the zone of saturation
- Minimum depth to water table should be on the order of 50 to 60 feet to allow placement of the waste above the zone of water table fluctuation while allowing for a minimum soil cover of 15 feet (5 m) over the waste after placement.
- Sufficient area to accommodate existing and projected waste inventories.

POTENTIAL STORAGE/DISPOSAL SITES

Seventeen potential sites were identified using the criteria and principles discussed above. Existing data from topographic maps, monitoring wells, and water table maps were used.

APPLICATION OF SITE SELECTION CRITERIA

The use of topographic maps, monitoring wells, water table maps, and application of geohydrologic principles are the main methods used in the selection of potential sites. No detailed geophysical or geological investigations were made for the purpose of identifying these sites. Depth-to-water data exists at some of the proposed sites; however this type of data is not available over most of the SRP site, especially in areas that do not have facilities or have not been developed. Since, hydrologically, the most critical step in the evaluation of a potential site is an accurate approximation of the depth to the water table based on field observations (water table and soil characteristics), these data were determined for the selected sites for which no such data existed. Based on the known parameters of the 17 prospective sites, weighting factors were applied and initial selections were made.

These weighting factors were:

- Distance to plant streams
- Distance to public land or roads
- Distance to the waste generators
- Topography
- Available area

SITE PERFORMANCE CRITERIA

Performance criteria have been identified to ensure that the objectives of the storage/disposal site will be incorporated into the site selection and design. These criteria all relate directly or indirectly to occupational radiation dose or dose to the public and apply to all methods of radioactive waste management. Radiation dose limits less than or equal to those in DOE Order 5480.1 and the Nuclear Regulatory Commission Rule 10 CFR 61 are set forth in the performance criteria. These limits are presently used for all operations at the Savannah River Plant and are, therefore, considered achievable. The conceptual design of the facility is one of "near-zero release". The actual operating and design parameters will be such that members of the work force and the general public will receive actual doses orders of magnitude less than the current limits.

The performance criteria are as follows:

1. RADIOACTIVITY IN GROUNDWATER - The concentration of radionuclides in groundwater at the storage/disposal site boundary must not exceed those established in the EPA National Primary Drinking Water Standards Regulations, 40 CFR 141 (1977).

2. RADIATION DOSE TO PERSONS - The radiation dose to any member of the public due to releases of radioactivity in the groundwater, surface water, air, soil, plants, etc., must not exceed

   - 10 mrem/yr to whole body, gonads, or bone marrow

   - 30 mrem/yr to other organs, gastrointestinal tract, bone or thyroid

3. MINIMUM DEPTH BETWEEN WASTE AND WATER TABLE - The minimum distance between the waste and the groundwater table at SRP shall be at least 10 feet (3 meters).

4. DISTANCE BETWEEN ROOT ZONE AND WASTE - The waste should be emplaced below the root zones of plants which are indigenous to the area to prevent vegetation uptake of the waste material. At SRP this criterion can be met by placement of waste at a minimum depth of 16 feet (5 meters).

5. SURFACE WATER AND EROSION CONTROL - Surface topography should be such as to minimize erosion (i.e., minimum slope) and surface water should be routed to avoid erosion and infiltration. Precipitation should be directed away from the site.

6. SUBSIDENCE - Subsidence of wastes and backfilled soil should be minimized to avoid undue maintenance of surfasce topography and to avoid enhanced water infiltration and potential unacceptable migration of radionuclides. To achieve this, wastes (or waste packages) must be physically stable and spaces between packages must be minimized or filled with compacted soil or other fill material.

7. POST-CLOSURE CONTROL - It is assumed for the purpose of projecting radionuclide movement that institutional control shall be maintained for 100 years following site closure. During this period it is assumed that the site will be well maintained to prevent surface erosion, intruder entry, etc.

   This post-closure criterion also requires that the site be designed such that the above performance criteria will be met for an additional 200 years. The total of 300 years is approximately 10 half-lives of fission product elements of concern, Sr-90 and Cs-137. At the end of this period the radioactivity will have decreased sufficiently so that no significant hazard remains. The means of meeting this criterion will be 1) limitation on the inventory of radionuclides emplaced in the site, and 2) deeper burial and design of a burial unit that will prevent the waste from reaching the environment before radioactivity has decayed to innocuous levels.

SITE RANKING METHODOLOGY

The site selection guides considered in this study are specific to the Savannah River Plant site. In general they could be applied to other prospective waste storage/disposal sites in humid climates. Several facts are implicit in the criteria given. The SRP site is located in the Atlantic Coastal Plain of the southeastern United States. This means that the upper 600-1000 feet (180-300 meters) of material consists of deeply weathered, loosely consolidated or unconsolidated sediments. The material itself is primarily sandy-clay to clayey-sand, and in general is quite homogeneous over the plantsite. Therefore, the emphasis given to geologic materials at prospective sites is not a factor considered here.

The following are the characteristics (site selection guides) considered important in site selection for a low-level radioactive waste storage/disposal facility at the Savannah River Plant. Each characteristic is given a weighting factor, ranging from 1-6, representing its relative importance in meeting the performance criteria set forth above. Values for each prospective site are assigned ratings for each characteristic which increase relative to their effect on meeting the performance criteria. The prospective sites are then evaluated by multiplying their ratings times the weighting factor for each characteristic and summing the results. The total scores indicate the relative merit of each potential site. The characteristics are quantifiable for each site, but the break points for the ratings and the magnitude of the weighting factors are basically subjective.

As an example of the procedure, consider the depth to the water table. If a prospective site has a depth to the water table of 75 feet it then has a rating of 4. The weighting factor for this important characteristic is 6, giving a score of 24. The scores for all other characteristics are then added, giving the total points for the site.

SITE SELECTION GUIDES

Depth to Water Table (Weighting Factor = 6)

The present reference process for radioactive waste disposal calls for emplacing the waste in trenches and boreholes so that the bottom of the disposal unit is at least 10 feet (3 meters) above the water table, and the top of the waste is at least 16 feet below the final site grade. Therefore, for a twenty-foot waste zone, depth from the surface to the water must be at least 46 feet (14 meters). Since transport is much slower in the unsaturated zone, depths greater than 60 feet are rated more highly.

Depth (ft)	Rating
>80	5
71-80	4
61-70	3
46-60	2
<45	0

Distance to the Public (Weighting Factor = 6)

Placement of the storage/disposal facility a greater distance from the public has two beneficial effects. The farther the facility is from public water supplies the longer the time is available for radionuclides to decay before they have the possibility of interacting with the water supplies. If the site is remote from public access then the probability of accidental exposure to a member of the public during operations is minimized.

Distance (miles)	Rating
>4	4
3-4	3
2-3	2
1-2	1
0-1	0

Distance to Waste Generators (Weighting Factor = 6)

The volume of waste and the distance that it must be transported from each generator has an impact on the dose to waste transport personnel, the probability of a transportation accident, and the economics of waste management. It is also desirable to avoid widespread dispersal of waste within the plantsite. At SRP there are multiple waste generators which are widely dispersed, so a volume-of-waste weighted method was used to rate the potential sites. The

distance from each potential site to each operating area was rated, then weighted by the percentage of waste produced by each operating area, and finally multiplied by the criterion weight (6). The score for each potential area is then the total of the individual ratings.

Distance (miles)	Rating
<2	4
2.0-3.9	3
4.0-5.9	2
6.0-8.0	1
>8	0

Distance to Nearest Stream (Weighting Factor = 5)

Since surface water in the humid eastern United States generally represents areas of groundwater discharge and since transport by surface water is much more rapid than by groundwater, it is desirable to maximize the distance from the groundwater to surface water.

Depth (ft)	Rating
>2000	5
1500-2000	4
1000-1500	3
500-1000	2
<500	0

Available Surface Area (Weighting Factor = 4)

The available surface area of a prospective storage/disposal site is important from an economic standpoint because the effort involved in characterizing sites and the desire to limit the number of sites containing waste. The useful life of a site is determined by the area of ground available for waste management activities.

Acres	Rating
>200	4
100-200	3
50-100	2
25-50	1
<25	0

Surface Topography (Weighting Factor = 2)

The energy available for erosion by surface runoff is directly proportional to the slope of the land surface. Therefore, the lower the slope, the more slowly the land surface will erode. This factor has a low weighting because it can be altered during site engineering.

Maximum Slope (%)	Rating
0-1.2	4
1.2-2.5	3
2.5-3.7	2
3.7-5.0	1
>5	0

SITE RANKINGS

The site selection guides were applied to the seventeen potential sites identified at SRP. Figure 1 is a map showing the locations of these sites. Table 1 is a summary of the rating process, listing the sites in order of their apparent suitability. This table shows that sites B, G, and K are the highest rated sites.

Table 1. Sites Ranked by Ratings Score

Site	Score
G	98
B	97
K	94
L	88
I	87
P	84
E	80
Q	78
D	75
C	72
F	71
J	66
A	60
H	55
M	55
N	45
O	37

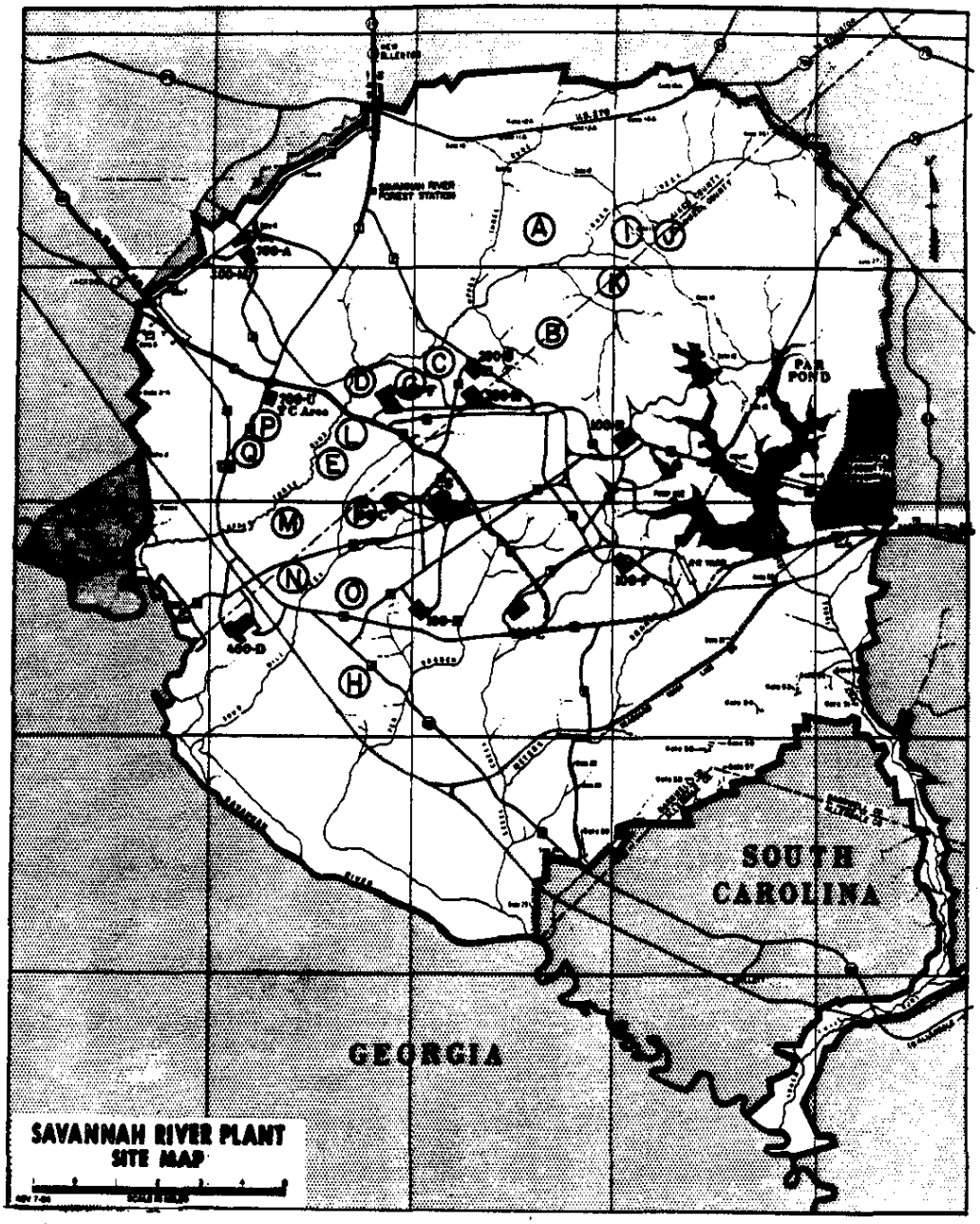

FIGURE 1. Site Selection Map

SELECTION OF CANDIDATE SITES

Of the five top ranked sites, only G, B, and L are currently available. Therefore, these three sites were chosen as the candidate sites. Site G, which is adjacent to the existing Burial Ground was chosen to be the preferred site because all the required support facilities (roads, railroad line, electric power, etc.) were already in place nearby. This candidate will then be the subject of a detailed characterization program.