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ENVIRONMENTAL ASSESSMENT OF THE PROPOSED SITE STABILIZATION AT AMAX INC.'s PARKERSBURG, WEST VIRGINIA SITE

FINAL REPORT

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Summary

Amax Inc. has made an application to the U. S. NRC for a license to stabilize its Parkersburg West Virginia site, thereby reducing the risk to the public from the contaminated soils and pyrophoric materials which exist on the formerly used site.

An environmental assessment of the proposed action has been prepared using some synthesized guidelines for evaluating the acceptability of the environmental impact. Synthesized guidelines were necessary because there is only a limited number of directly applicable NRC or EPA requirements. The guidelines were synthesized from proposed or actual NRC and EPA regulations applicable to similar problems such as low-level waste management, mill tailing stabilization, and hazardous waste management.

The proposed action involves the consolidation of contaminated soils into an area containing the pyrophoric material and placing this material in a mound which will be capped with clay and protective top soil. This action is intended to 1) reduce or eliminate leaching of the contaminated material, 2) reduce emission of radon from the ground surface, 3) prevent erosion and dispersion of surface activity, and 4) eliminate the potential for contact with the pyrophoric material.

An estimation of the radiological consequences associated with the proposed action was made as part of the assessment. This analysis showed three things.

1) The current emissions of radon from the site are producing low levels of radiation exposure to the nearest residents.

2) The planned site stabilization activities are expected to result in a temporarily increased level of radiation exposure as a result of dust generated during the stabilization activities.

3) After site stabilization, the radiation exposures from the stabilized site are expected to decrease to near natural background levels.

The pyrophoric material which is currently buried on the site and which will be covered with contaminated soil in the proposed action is expected to oxidize slowly to ZrO_2. This will result in a gradual reduction of amount of chemically hazardous material.

In the process of conducting the environmental assessment, analysis of possible off-normal situations was performed. The most significant accident of a radiological nature that was examined involved the postulated degradation of integrity of the clay cover with resultant increased leaching of containment materials.

Based on analysis conducted as part of this environmental assessment, the following conclusions are drawn.

1. The proposed action does reduce direct radiation exposure, the amount of radionuclide leaching, the rate of radon-226 emission and the potential for surface contamination erosion and dispersion. Furthermore, it reduces the potential for personnel coming in contact with the slowly-oxidizing zirconium waste.

2. During this activity several precautions should be exercised to reduce the dose consequences to personnel involved in the stabilization and to nearest residents. These precautions should include the use of water or similar agents to minimize dusting, the use of dust masks for site construction personnel and suspension of work when wind conditions are such that the nearest residents could receive significant dust exposures.

3. The stabilization action should seek to minimize the use of organic materials in the soil mound so as to minimize the generation of water soluble organic compounds which could function as complexing agents and reduce the radionuclide retardation potential of the natural soil.

4. Action should be taken to render the buried drainage tile system to a stable condition. This is necessary to assure that existing contamination is not washed from the system.

5. A maintenance and monitoring program should be implemented following stabilization to assure that the stabilized area retains its design features. This program should also check that deep-rooted plants are not established on the cap. Groundwater monitoring should be continued to verify the performance of the cap. Care should be taken to assure that no major water pumping is performed in the area without strict and frequent sampling of groundwater monitoring wells during such activity.

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1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

Amax Inc. presently owns a 375-acre site in Wood County, West Virginia, a portion of which was occupied by a zirconium ore processing facility. When test activities were ceased in 1977 and Amax decided to close the Parkersburg W.Va. site, an NRC site survey was conducted. This survey identified some soil activity levels which result in unrestricted area dose levels above the acceptable limits of the Code of Federal Regulations, Title 10, Part 20, Section 105 (10 CFR 20.105). There is a need for Amax to take action to reduce these unrestricted area dose levels. Amax has applied for a new possession only license for the purpose of effecting a site stabilization project which will provide for the safe storage of the contaminated soil on the site previously occupied by the zirconium processing operations.

The proposed stabilization project is to provide for protection of health, to minimize danger to life, and to restore a major portion of the land area to unrestricted or productive uses.

2.0 THE ASSESSMENT

2.1 SCOPE

This environmental assessment of the proposed Amax site stabilization project has been performed in accordance with the requirements of the Code of Federal Regulations, Title 10, Part 51 (10 CFR 51) "Licensing and Regulatory Policy and Procedures for Environmental Protection." Part 51.5 (b) 4 (iii) lists radioactive waste disposal as an activity which may require an environmental impact statement (EIS). This report is an environmental assessment which examines the proposed action and provides a basis for the decision regarding the necessity of an EIS. The requirements of 10 CFR 51.31 stipulate an environmental assessment is to be used by the Nuclear Regulatory Commission (NRC) staff as an aid and a basis for deciding whether to prepare an EIS or to issue a negative declaration.

This assessment addresses several issues, only some of which are directly covered by existing legislation or guidelines for repositories specifically designed, constructed and operated for the disposal of radioactive and other hazardous substances (in this case, contaminated earth and pyrophoric material). Therefore, guidelines for use in this assessment were developed through synthesis of the Federal regulations, proposed rules and reports which are listed and exerpted or paraphrased below.

- Federal Register 6/24/81 p 38081-38105 "Proposed Rulemaking on Land Disposal of Low-Level Radioactive Waste." This proposed rule states NRC's planned approach to evaluating shallow land burial sites and operation. These rules address many requirements and practices which are thought to be very similar to those involved in the proposed action.

- 40 CFR 190 "Environmental Radiation Protection Standards for Nuclear Power Operations." While this is not applicable to operations of site stabilization activities, this standard does define a generally applicable dose limit of 25 mrem/yr whole body, 75 mrem/yr thyroid and 25 mrem/yr to any other organ of the general public due to routine operations (i.e., chronic exposure). It appears reasonable to apply such operational standards to the proposed action.

- Federal Register 1/9/81 p 2556-2563 "Proposed Disposal Standards for Inactive Uranium Processing Sites." This specifies groundwater protection standards which are applied at 0.1 km from a tailings disposal pile and thereby establishes guidelines for an operation such as the Amax site stabilization project which involves similar waste and similar long-term safety concerns.

- 10 CFR 20 "Standards for Protection Against Radiation." This specifies concentration and dose limits for a wide variety of licensed activities and the "as low as reasonably achievable" philosophy. These guidelines and concepts are applicable throughout the fuel cycle and are expected to be applicable for site stabilization operations.

- Federal Register notifications relative to the implementation of the Resource Conservation and Recovery Act of 1976 and its amendments. The primary Federal Register notices of concern here have been December 18, 1978 p 58946-59028; May 19, 1980 p 33159-33258; January 12, 1981 p 2802-2897; and February 5, 1981 p 11126-11177. These identify issues of concern in the management of hazardous waste in landfill (shallow land) disposal sites. The concerns related to hazardous waste disposal are similar to those appropriate to low-level and reactive wastes found at the Amax site. These Federal Register notices serve to identify reasonable approaches to the waste disposal concerns.

- Final Generic Environmental Impact Statement on Uranium Milling, NUREG-0706. This report, by the U.S. Nuclear Regulatory Commission, identifies the hazards and analytical methods appropriate for a waste which is somewhat similar to the Amax wastes. The report is related to the Federal Register notice of 1/9/81 for the disposal of mill tailings.

- Improvements Needed in the Land Disposal of Radioactive Wastes - A Problem of Centuries. GAO report to Congress dated 12 January 1976. This report reviewed the historical performance of several shallow land burial operations and made recommendations for future activities by NRC. Some of these concerns are still relevant. Among the points it highlights is the need for sites which have simple geologic and hydrologic characteristics so that safety analysis can be performed with a reasonable level of confidence.

- U.S. NRC Branch Technical Position on the Disposal Onsite Storage of Residual Thorium or Uranium From Past Operations (SEC 81-576) October 5, 1981. This paper to the NRC commissioners identifies performance and to some degree design standards which the NRC Staff intends to use in

evaluating action plans for sites with residual uranium or thorium contamination.

The synthesis resulted in development of several specific criteria. These criteria are presented in the following paragraphs and are grouped into four general phases: Site Selection, Construction, Containment, and Site Release.

Site selection

The site should be selected such that it is:

- of relatively uncomplicated geological and hydrological features so that reasonable quantitative analysis is possible.
- easily and rapidly drained of rainwater and snow melt.

Construction

During construction of the burial mound certain activities should be pursued to assure that performance of the stabilized mound will be compatible with design objectives. The specific actions considered to be necessary are to:

- control of dust to minimize on- and off-site doses.
- verify extension of the clay cap down to the gravel-sand layer to assure that lateral movement of water into the contaminated soil is not possible.
- verify the operation of the drainway around the mound to assure that standing water does not exist.

Containment

Continuing and periodic monitoring of the burial site will be required to assure that the engineered and natural barriers which limit material transport remain in place and are working properly. These activities consist of:

- maintenance activities such as inspection for erosion and removal of undesirable plants such as deep-rooted vegetation or trees
- monitoring of the annual dose to the nearest actual resident. It should be less than 25 mrem whole body, 75 mrem to the thyroid and 25 mrem to other organs.
- monitoring the groundwater at the plant boundary to assure that it does not exceed the limits in the National Primary Drinking Water Standard or 10 CFR 20 Appendix B.

Site Release

The removal of contaminated material must proceed until activity levels low enough so that the site can be released for unrestricted use. The levels of activity which are acceptable for release are based on the levels specified in NRC branch technical position for disposal or onsite storage of residual thorium or uranium from past operations, i.e., 10 pCi/gm total activity level.

2.2 ACTIVITIES

During preparation of the assessment, applicable Federal and State legislation and Federal guidelines were reviewed. Appropriate Federal and State agencies were contacted in person, by phone or mail. Conferences were held with Amax personnel and consultants. A site inspection, including surrounding areas and communities, was conducted. Data from the site visit, personal contacts and independent investigation were collected, evaluated and analyzed for incorporation into the final assessment.

2.3 ORGANIZATION

This assessment is organized according to the guidelines established by the President's Council on Environmental Quality (40 CFR 1506) and the requirements of the U.S. Nuclear Regulatory Commission (10 CFR 51). Part 3.0 describes the Proposed Action, including alternatives. Part 4.0 identifies the environmental components affected by the proposed action and the alternatives, and evaluates, in qualitative terms, the proposed and alternative actions. Part 5.0 addresses the environmental consequences of the Proposed Action. These parts are followed by an Appendix A which supports Section 4.0 in that it contains an identification and justification of environmental "non-issues" in this assessment; Appendix B which presents details of the leaching and water transport analysis; and Appendix C which presents details of the radon emission calculations.

3.0 PROPOSED ACTION AND ALTERNATIVES

A description of the existing site, environmental characteristics, relevant site history, and details of the proposed action are presented in Section 3.1. Possible alternative actions are identified and briefly described in Section 3.2. This information serves as a data base for the identification of environmental components which would be affected by both the proposed action and the alternatives. The identification of those environmental components are presented in Section 4.

3.1 PROPOSED ACTION

The soil at a number of locations on the Amax site in Wood County, West Virginia has been found to be contaminated with low levels of natural uranium and thorium as a result of previous zirconium ore processing activities. Investigations of the site have also indicated the presence of pryophoric material. The proposed action is to stabilize the radioactively contaminated soil and the reactive (pyrophoric) waste material so that major portions of the site may be restored to productive, unrestricted use. The basic plan is to move contaminated soil to a limited area where additional contaminated soil exists and the pyrophoric material is buried. A clay cap with a protective earthen cover will then be constructed to cover the material and minimize rainwater infiltration and leaching of the radioactive contaminants.

A brief discussion of the site and the surrounding area is presented in Subsection 3.1.1 and review of the site history of the last 24 years is presented in Subsection 3.1.2. Details of the clearing and cap construction are discussed in Subsection 3.1.3.

3.1.1 Site Description

The Amax site is in Wood County, West Virginia (Figure 3.1) at 39°15'01"N and 81°41'W. Wood County consists of 235,520 acres[1] with a reported population of 93,648 (U.S. Bureau of Census 1980).[2] About 43% of the county population reside in the City of Parkersburg, the County Seat. Though a number of industries flourish in the Parkersburg area, the county is best characterized as rural. The Amax site is situated on the east bank of the Ohio River, in an area known as Washington Bottom.

Washington Bottom, as a geologic feature, becomes evident about five miles west of Parkersburg and trends westward, then southwestward and south for a distance of five miles. It is bounded on the north and west by the Ohio River and on the east by an escarpment which in the past constituted the eastern bank of the river. The area of the Bottom is about 21,000 acres about half of which is farmland. The remainder has become industrialized during the past 30 years. The Amax property which lies at the approximate center of the Bottom (Figure 3.2), is about eight miles southwest of Parkersburg and one mile south of the town of Washington, West Virginia.

About one-third of the Amax property, 126 acres, has been developed for commercial use. The primary access road, Foster Road, intersects Dupont Road to the east and marks the northern boundary of the property (Figure 3.3). Additional access is via a rail spur from the B&O Railroad which parallels DuPont Road to the east.

The most predominant feature on the commercialized (northeastern) portion of the site is a water storage tower. About 700 feet west of Dupont Road and 100 feet south of Foster Road is a one story building of 100 x 50 feet dimensions which is the L.B. Foster office. South of the office is an area, intersected by the railroad spur, about 800 x 800 feet which is principally occupied by remains (mostly foundations) of the former Amax plant and concrete floor slabs on which construction of the L.B. Foster pipe fabrication plant was initially commenced. The portion of this area between the rail spur and the

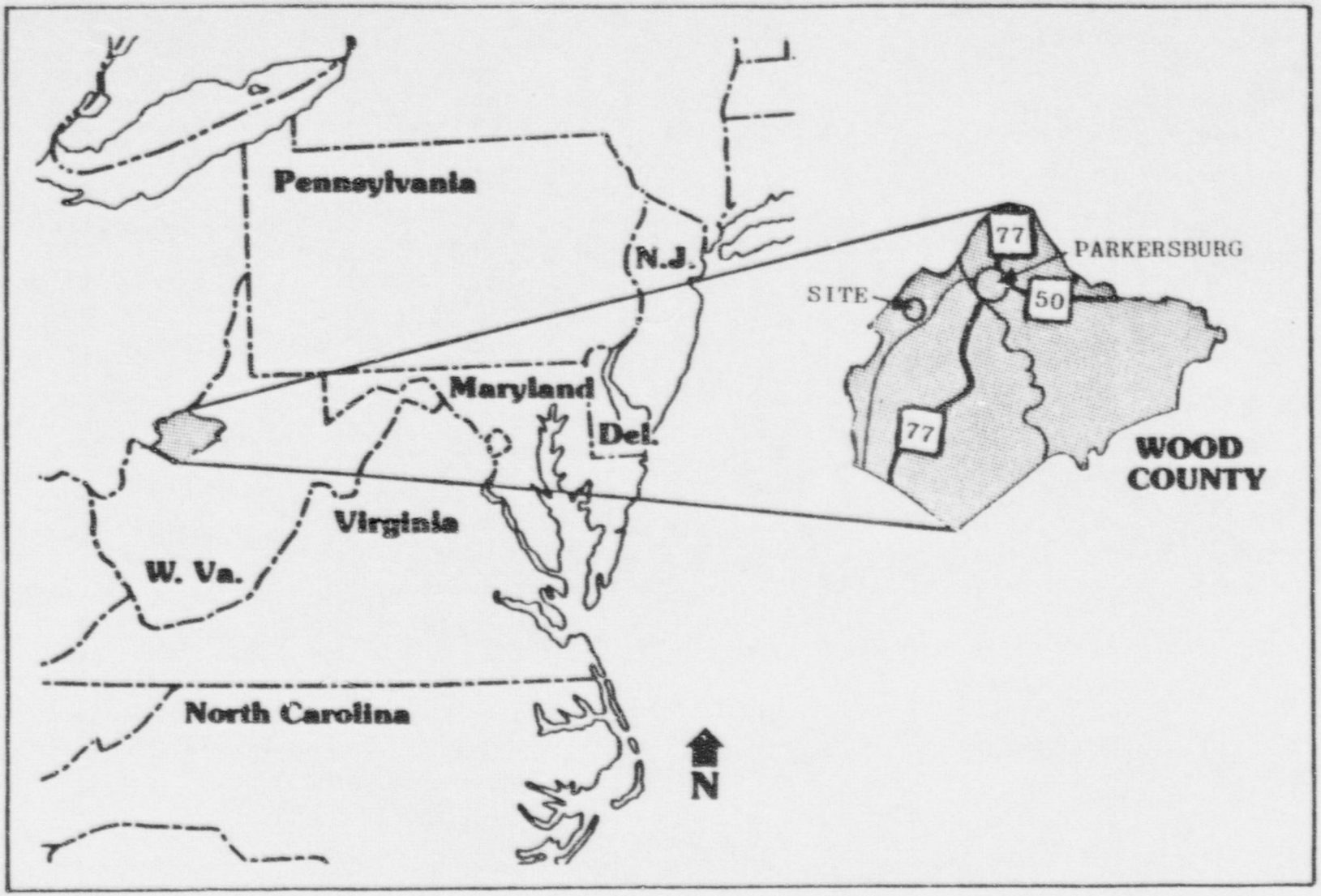


Figure 3.1. Wood County and Amax Site Locations.

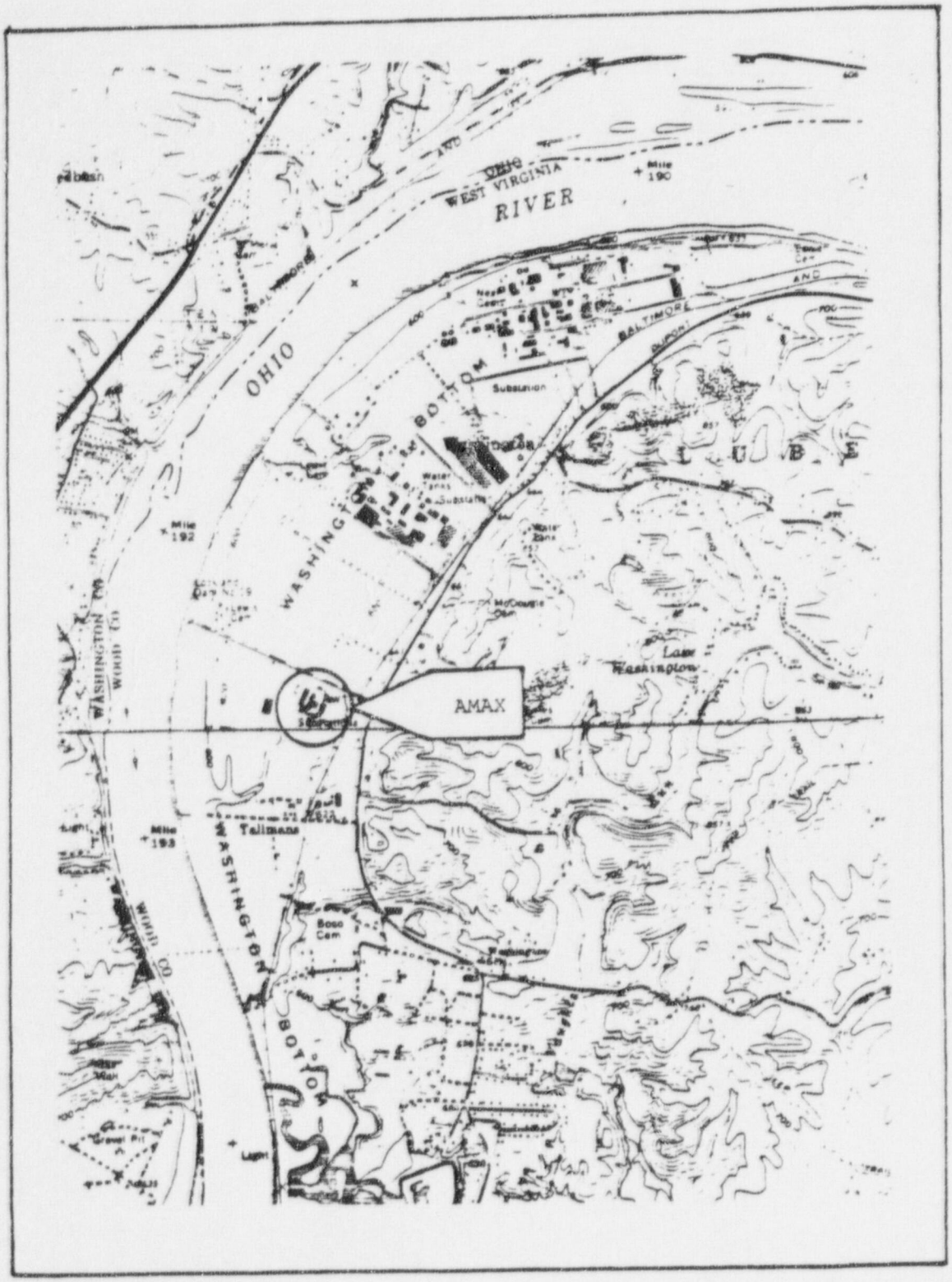


Figure 3.2. Amax Location in Washington Bottom.

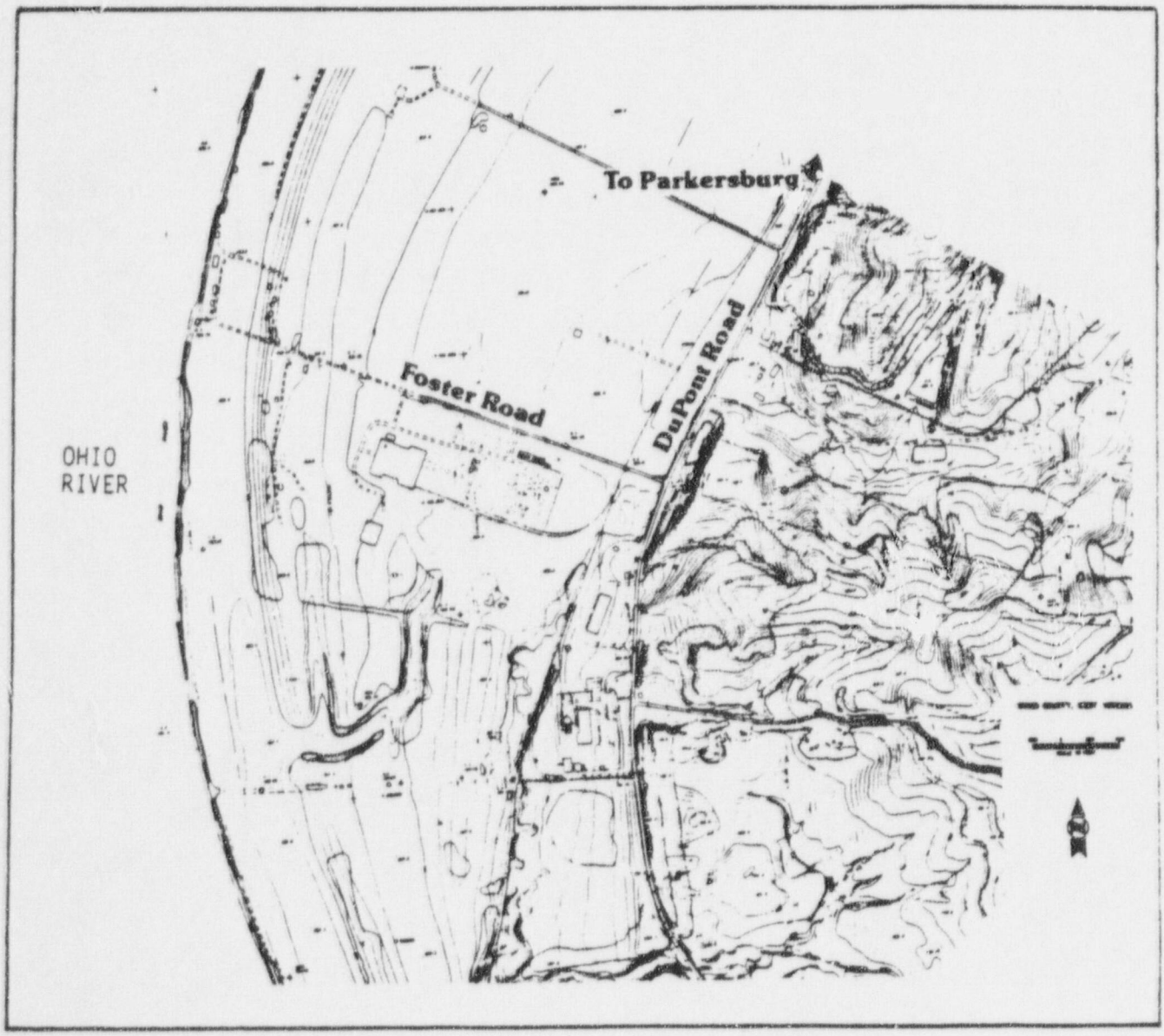


Figure 3.3. Amax Property.

office building is now used as a temporary finished pipe storage area. The larger (350 ft. x 300 ft. x 40 ft. high) of the two relocated pipe fabrication plant buildings is 650 feet west of the office. The second fabrication structure (125 ft. x 75 ft. x 40 ft. high) is 300 feet south of the larger pipe plant building (Figure 3.4).

Land Use

Immediately to the north of the Amax site (Reference Figure 3.2) is farmland which extends northward for some 3,000 feet to the Borg-Warner Chemicals plant property which, in turn, borders the property of the E. I. duPont de Nemours Co. property. Together, the property of these two companies, each of which employ more than 1,000 persons, extends northward for about one mile.[3] Northeast of the duPont plant are some scattered small industrial buildings. The remainder of the bottomland to the east is unoccupied.

The land immediately to the south of the Amax site is owned by the Monongahela Power Company, but is currently, leased as farmland. There are two industries south of the Amax property; AGA Burdox, Inc. (.3 miles, bordering DuPont Road) which produces oxygen and nitrogen and employs less than 100 persons and the Nitro Industrial Coverings Company, an even smaller concern.[3] The remainder of the bottomland to the south is farmland with scattered residences in the eastern portion starting about a mile south of the Amax property. There are four residences which are within less than a mile of the proposed stabilization site: one, 1,800 ft. to the south; two, 2,200 ft. to the northwest; and one, 4,000 ft. to the northeast.

Demography

As has been previously indicated, the Amax site is not near any large population centers. Population distribution out to 50 miles for each of the 16 cardinal compass directions is shown on Table 3.1.

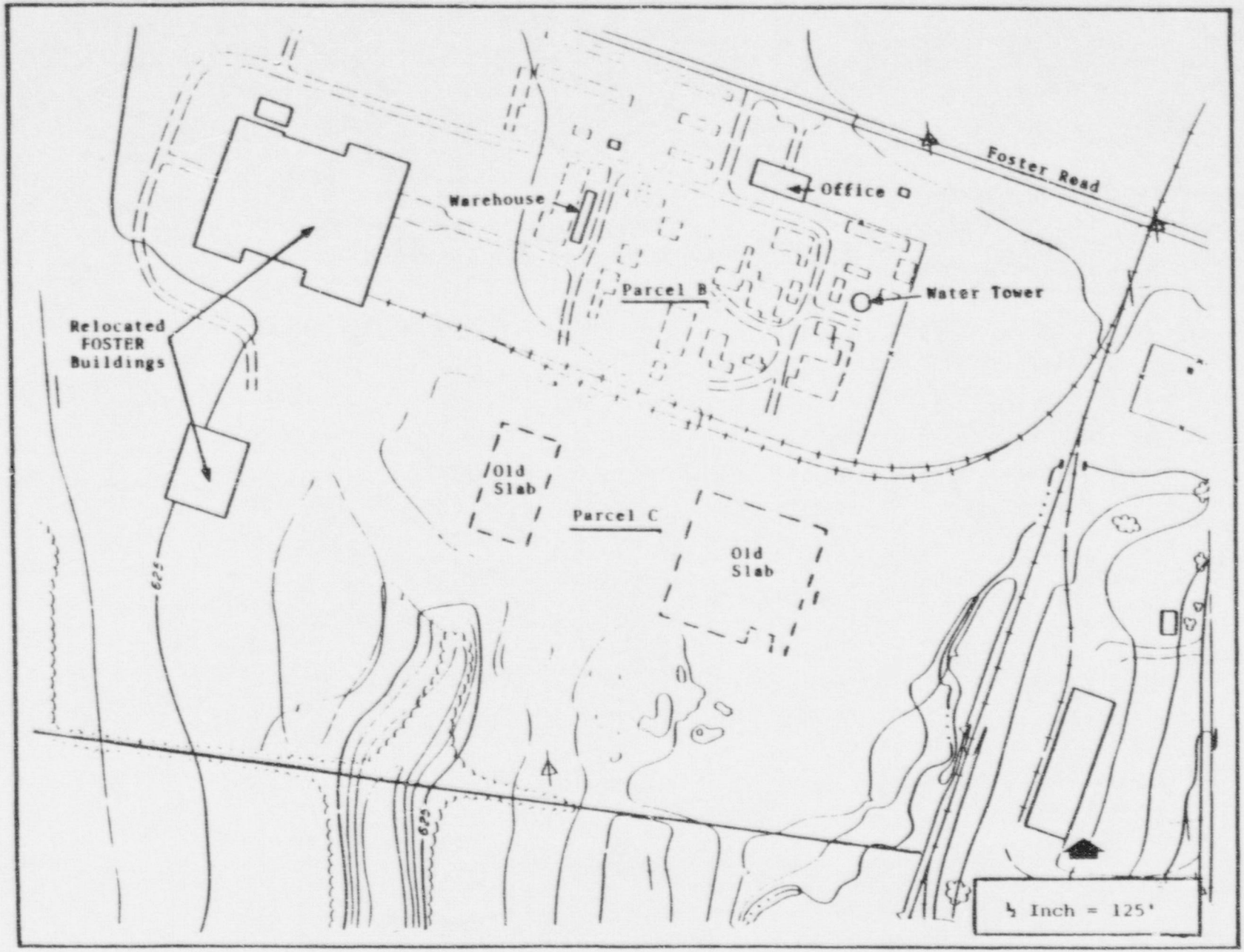


Figure 3.4. Commercialized Portion of Amax Property.

Table 3.1. Population Data

Direction	0-5 Miles	5-10 Miles	10-20 Miles	20-30 Miles	30-40 Miles	40-50 Miles
S	8.050E+02	1.911E+03	4.525E+03	5.393E+03	7.126E+03	6.113E+03
SSW	6.600E+02	1.592E+03	3.378E+03	5.189E+03	6.646E+03	6.698E+03
SW	4.540E+02	8.730E+02	5.852E+03	2.527E+03	1.260E+04	1.069E+04
WSW	4.490E+02	9.860E+02	3.435E+03	5.342E+03	6.719E+03	4.231E+03
W	4.450E+02	1.041E+03	4.458E+03	1.179E+04	4.494E+03	5.093E+03
WNW	4.130E+02	1.041E+03	4.458E+03	1.179E+04	4.494E+03	5.093E+03
NW	4.130E+02	1.121E+03	6.552E+03	1.432E+04	8.949E+03	1.122E+04
NNW	4.720E+02	1.121E+03	3.409E+03	1.071E+04	4.932E+03	1.229E+04
N	5.140E+02	1.121E+03	4.036E+03	3.952E+03	4.143E+03	1.326E+04
NNE	5.350E+02	1.121E+03	7.444E+03	5.388E+03	3.845E+03	2.802E+03
NE	5.550E+02	1.033E+03	2.080E+04	7.375E+03	5.379E+03	6.704E+03
ENE	6.890E+02	6.558E+03	6.740E+03	7.022E+03	8.371E+03	7.392E+03
E	8.050E+02	3.109E+04	7.444E+03	2.731E+03	5.213E+03	4.705E+03
ESE	8.050E+02	1.911E+03	4.127E+03	2.096E+03	3.814E+03	4.843E+03
SE	8.050E+02	6.911E+03	6.285E+03	2.288E+03	3.556E+03	4.525E+03
SSE	8.050E+02	1.911E+03	4.974E+03	3.510E+03	8.775E+03	4.304E+03

Geology

The geology of the river bottom land between river miles 190 to 194, the general area of interest in this assessment, has been defined as a result of a number of wells having been drilled and is very similar throughout. Topographically the area is characterized by a series of river bank terraces which rise in elevation from the river (590 ft. msl) eastward to about 635 ft. msl at the industrialized area of the Amax property. The terraces are drained by gullies with intermittantly flowing streams. The soils in the area are classified as the Huntington-Ashton-Wheeling Association and are characterized by a clayey silt that ranges from one to ten feet thick.[1] This is underlain by interbedded layers of sand and intermixed sand and gravel down to bedrock which lies about 100 feet below the surface. Figure 3.5 shows the typical geohydrologic profile of the area.

Toward the end of the Pleistocene Epoch (12,000-15,000 years ago) when glacial melt water flowed through the Ohio River Valley at a much higher rate, coarse sands and gravels were transported to the Washington Bottom area. These sands and gravels were deposited from the slower moving water on the inside of the meander bend. As flow rates in the river decreased the sand and gravel was overlain by fine sand, silt and clay.

The groundwater level at the Amax site is located approximately 50 feet below the surface which is nearly the elevation of the Ohio River.[4] The flow direction of this groundwater is variable but is generally perpendicular to the river flow.[5,6] The groundwater table is charged by the river as the surface layer of highly impermeable silty clay causes precipitation to run off on the surface to the Ohio River. The strata from the water table to the surface constitutes the unsaturated zone wherein there is only capillary water and little water movement except in the absence of the overlying silty clay layer which prevents infiltration of runoff. Water, if it does enter these unsaturated sand and gravel layers, moves rapidly and vertically down to the water table.

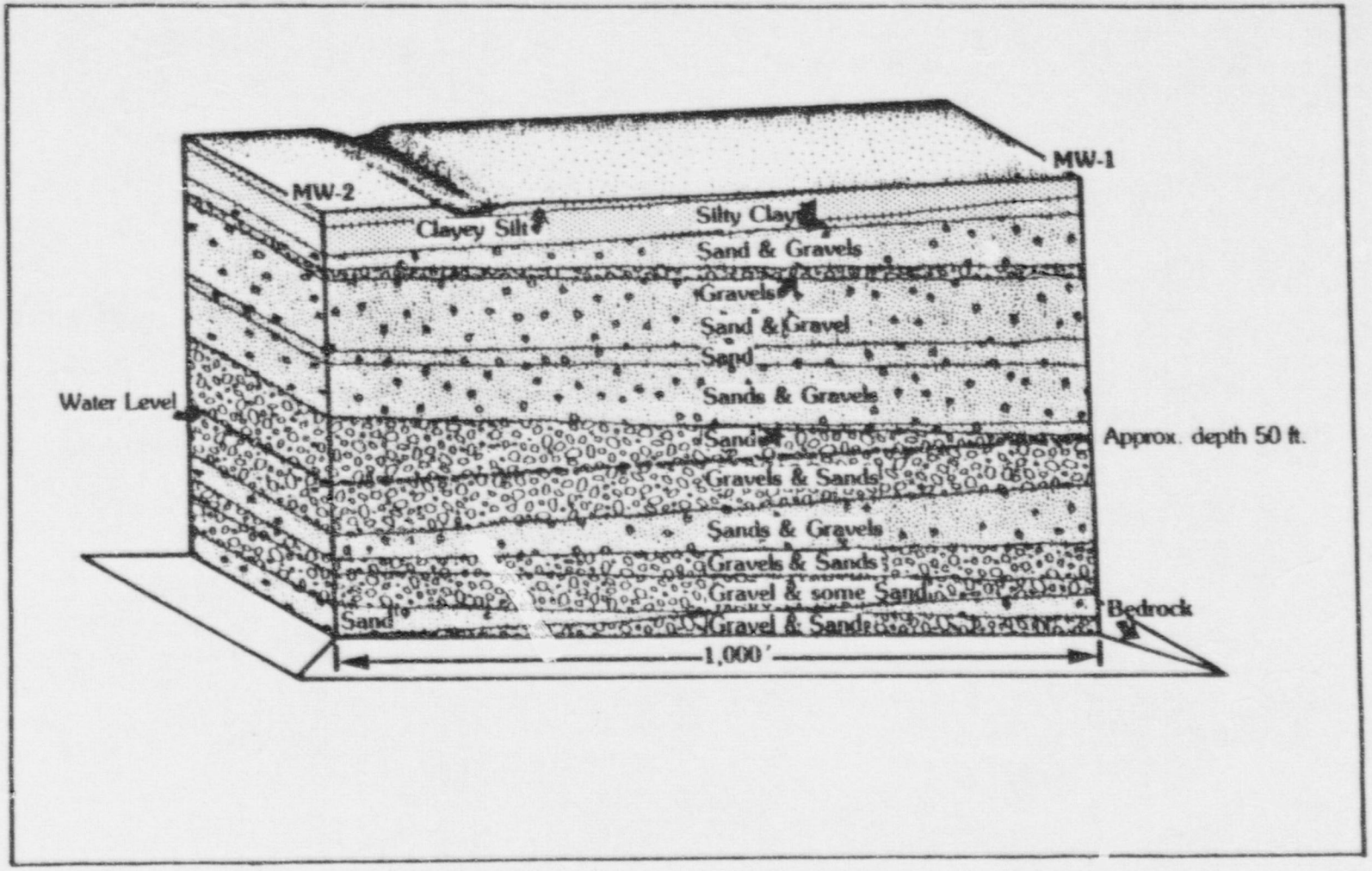


Figure 3.5. Geohydrologic Profile Typical of the Amax Site.

Hydrology-Subsurface

Six wells have been drilled at the Amax site, two of which were geophysically logged using four logs. These were the natural gamma log, the epithermal neutron log, the gamma gamma density log, and caliper log. These well logging techniques provide an accurate description of the geohydrologic strata penetrated. The natural gamma log is the measure of the natural radioactivity and is indicative of silt and clay lenses or radioactive contamination at a site. In the case of Monitor Well 1, the natural gamma tool recorded very low count rates within the subsurface materials with a small increase within the top 7 feet of materials. This increase is indicative of a finer grained matrix (clay and silt). Otherwise, the gamma ray log showed clean sands and gravels throughout the borehole. The neutron epithermal neutron tool and gamma gamma tools were used to assess variation in subsurface porosity and density. Both of these tools are affected by changes in borehole diameter and rugosity (nonuniformity) so a caliper log was run in conjunction with them. In no instance has there been any evidence of clay lenses or perched water within the unsaturated zone. The absence of clay or any other material that would hold or cause horizontal water movement in the unsaturated zone has been further verified by the facts that; 1) during examination of the site for radiological contamination below the surface, none of the 1,422 test holes that were water jetted to a depth of 12 feet held water[7] and 2) none of the 27 on-site test pits, dug down to initial contact with sands and gravels, will hold water even during heavy rains.[8]

Hydrology-Surface

e surface water features are dominated by the Ohio River as the only continually running water source. Surface runoff from rainfall at the site flows toward 1) the ditch parallelling the B&O railroad tracks or 2) the drainage channel running south and then west to the Ohio River or 3) directly into the Ohio River. The flow directions for runoff water are summarized in Figure 3.6.

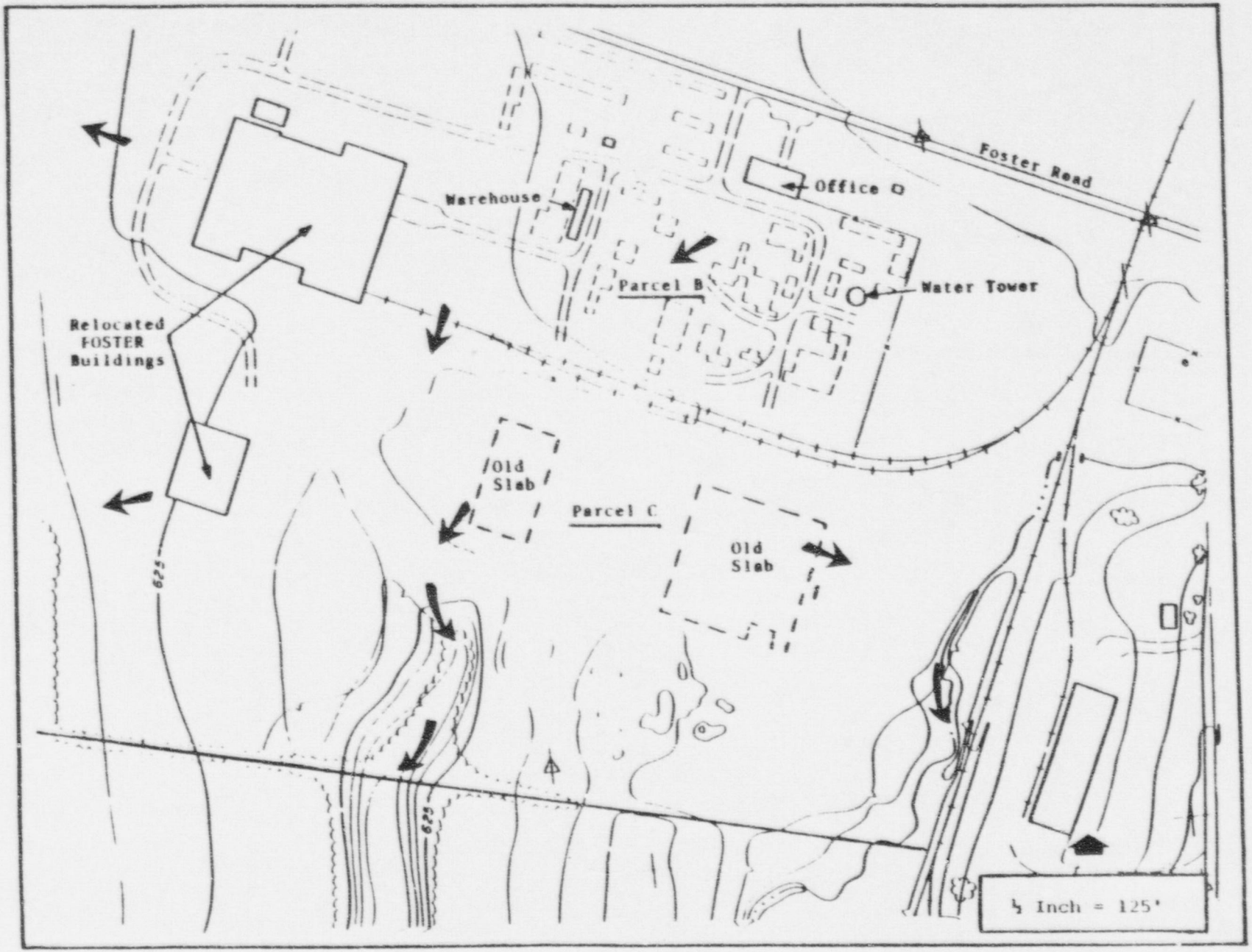


Figure 3.6. Present Site Surface Water Runoff Directions.

Although the land on which the L.B. Foster and former Amax facilities are located is classed as river bottom land, it is neither wetland nor floodplain. The highest recorded floodwater level reached only to a level of 616.5 ft. msl in 1913. The potential for flooding at the level where site stabilization is planned (625-630 msl) is not considered credible.

Climatology

The climate of Parkersburg can be described as moderate. Located on the bank of the Ohio River and in the extreme north of the "upper south," Parkersburg is in the farthest north area where tender vegetation, such as magnolias, are able to survive most of the winters. In summers, prolonged hot weather is infrequent. During the period of record (90 years), there have been only 24 days with a temperature of 100°F or more. Likewise, prolonged cold weather is infrequent; temperatures of -10°F or lower have occurred on only 13 days. The average temperature is lowest in January (33°F) and highest in July (75.2°F). Precipitation averages 38.9 inches per year. The heaviest rains are in June and July. The lightest amounts are in October. On the average of once every four or five years, a dry spell in July or August does some damage to crops in the vicinity. Days with measurable snowfall average about 25 for the year; the average annual snowfall is about 24 inches. However, total snowfall amounts vary greatly from winter to winter, ranging from over 55 inches to less than 4 inches.

Parkersburg is not a windy city, the winds being light most of the time. Occasionally a winter storm may be accompanied by winds up to gale force and, also infrequently, the winds associated with a summer thunderstorm may be nearly as intense.[9]

During the last 89 years the highest wind speed recorded was 66 mph from the northwest, during the month of November, 1966. High northwesterly winds, when they occur, are caused by the passage of a strong, rapidly moving cold front. There are no indications that tornado velocity winds have been

experienced during the period of record in the Parkersburg area. Due to the fact that the Parkersburg area is, for the major portion of the year, under the influence of the circulation of the Bermuda High pressure-patterns, the prevailing wind is southwesterly.

On-site meteorological data on wind speeds and direction is not available from the applicant. However, general climatological characteristics in the area can be referenced to the U.S. National Weather Service recording station at Parkersburg.[10]

For subsequent atmospheric dispersion calculations, joint frequency distributions of wind direction, speed and stability class from Parkersburg were used. The meteorological dispersion factors (chi/Q) were produced from the Gaussian Plume model and diffusion coefficients for Pasquill type turbulence as described in Regulatory Guide 1.111. The annual average chi/Qs as a function of distance up to 50 miles from the site in the sixteen 22-1/2 degree compass point sectors (i.e., centered on the north, northeast, southeast, etc.) were calculated and are shown in Tables 3.2 and 3.3. These point source chi/Q values will be used together with the concept of an "apparent" point source for the purpose of calculating downwind concentrations from the site areal sources.

Seismology

Parkersburg is located in a seismic risk Zone 1 (Figure 3.7), where only minor damage may be expected.[11,12] U.S. Geological Survey data show the epicenter of a mild (IV on the Modified Mercali Scale) earthquake occurred at Parkersburg on July 15, 1874. At the town of Rockport, about 13 miles south-southeast of Parkersburg, there was an earthquake epicenter of intensity V on October 20, 1974. The next closest recorded seismic activity (M.M.IV) was about 80 miles south-southeast of Parkersburg in 1970.

Table 3.2 Annual Average Chi/Q Values at Various Distances

NORMAL RELEASE
NO DECAY, UNDEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) SECTOR	DISTANCE IN MILES 0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.716E-05	4.972E-06	2.356E-06	1.456E-06	7.719E-07	5.027E-07	3.640E-07	2.811E-07	2.266E-07	1.885E-07	1.605E-07
SSW	1.537E-05	4.415E-06	2.115E-06	1.307E-06	6.916E-07	4.500E-07	3.255E-07	2.512E-07	2.024E-07	1.683E-07	1.432E-07
SW	2.605E-05	7.477E-06	3.576E-06	2.211E-06	1.173E-06	7.643E-07	5.538E-07	4.279E-07	3.452E-07	2.872E-07	2.447E-07
WSW	1.756E-05	5.041E-06	2.410E-06	1.491E-06	7.911E-07	5.160E-07	3.740E-07	2.892E-07	2.334E-07	1.943E-07	1.655E-07
W	4.213E-05	1.208E-05	5.768E-06	3.570E-06	1.897E-06	1.239E-06	8.994E-07	6.960E-07	5.622E-07	4.683E-07	3.993E-07
WNW	3.650E-05	1.049E-05	5.007E-06	3.102E-06	1.651E-06	1.080E-06	7.845E-07	6.076E-07	4.912E-07	4.094E-07	3.492E-07
NW	2.385E-05	6.852E-06	3.274E-06	2.027E-06	1.078E-06	7.041E-07	5.110E-07	3.955E-07	3.195E-07	2.661E-07	2.269E-07
NNW	1.430E-05	4.107E-06	1.968E-06	1.216E-06	6.439E-07	4.191E-07	3.033E-07	2.341E-07	1.887E-07	1.569E-07	1.335E-07
N	1.917E-05	5.514E-06	2.644E-06	1.634E-06	8.641E-07	5.619E-07	4.064E-07	3.135E-07	2.525E-07	2.099E-07	1.786E-07
NNE	2.928E-05	8.430E-06	4.046E-06	2.500E-06	1.322E-06	8.588E-07	6.206E-07	4.784E-07	3.851E-07	3.199E-07	2.720E-07
NE	3.503E-05	1.008E-05	4.840E-06	2.991E-06	1.582E-06	1.028E-06	7.434E-07	5.733E-07	4.617E-07	3.836E-07	3.262E-07
ENE	1.555E-05	4.486E-06	2.168E-06	1.336E-06	6.999E-07	4.510E-07	3.235E-07	2.477E-07	1.983E-07	1.639E-07	1.388E-07
E	9.697E-06	2.787E-06	1.342E-06	8.268E-07	4.342E-07	2.804E-07	2.016E-07	1.547E-07	1.241E-07	1.027E-07	8.710E-08
ESE	8.858E-06	2.546E-06	1.227E-06	7.554E-07	3.960E-07	2.553E-07	1.833E-07	1.405E-07	1.126E-07	9.309E-08	7.886E-08
SE	1.276E-05	3.658E-06	1.755E-06	1.082E-06	5.706E-07	3.699E-07	2.668E-07	2.053E-07	1.651E-07	1.370E-07	1.164E-07
SSE	1.080E-05	3.091E-06	1.482E-06	9.129E-07	4.799E-07	3.104E-07	2.235E-07	1.717E-07	1.379E-07	1.143E-07	9.702E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) BEARING	DISTANCE IN MILES 5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.391E-07	8.117E-08	5.581E-08	3.324E-08	2.316E-08	1.755E-08	1.401E-08	1.160E-08	9.853E-09	8.538E-09	7.514E-09
SSW	1.241E-07	7.235E-08	4.971E-08	2.958E-08	2.060E-08	1.560E-08	1.245E-08	1.031E-08	8.753E-09	7.583E-09	6.673E-09
SW	2.122E-07	1.241E-07	8.542E-08	5.096E-08	3.555E-08	2.697E-08	2.155E-08	1.785E-08	1.517E-08	1.315E-08	1.158E-08
WSW	1.436E-07	8.405E-08	5.791E-08	3.459E-08	2.414E-08	1.832E-08	1.465E-08	1.214E-08	1.032E-08	8.948E-09	7.881E-09
W	3.467E-07	2.033E-07	1.402E-07	8.391E-08	5.865E-08	4.454E-08	3.563E-08	2.954E-08	2.513E-08	2.180E-08	1.921E-08
WNW	3.034E-07	1.781E-07	1.230E-07	7.370E-08	5.154E-08	3.916E-08	3.134E-08	2.599E-08	2.211E-08	1.919E-08	1.691E-08
NW	1.970E-07	1.155E-07	7.965E-08	4.763E-08	3.329E-08	2.526E-08	2.020E-08	1.674E-08	1.424E-08	1.235E-08	1.088E-08
NNW	1.157E-07	6.746E-08	4.635E-08	2.758E-08	1.921E-08	1.455E-08	1.161E-08	9.609E-09	8.161E-09	7.070E-09	6.221E-09
N	1.548E-07	9.013E-08	6.189E-08	3.680E-08	2.561E-08	1.939E-08	1.547E-08	1.280E-08	1.086E-08	9.410E-09	8.279E-09
NNE	2.356E-07	1.369E-07	9.389E-08	5.570E-08	3.871E-08	2.928E-08	2.334E-08	1.929E-08	1.637E-08	1.417E-08	1.246E-08
NE	2.826E-07	1.643E-07	1.127E-07	6.690E-08	4.651E-08	3.518E-08	2.805E-08	2.319E-08	1.968E-08	1.704E-08	1.499E-08
ENE	1.197E-07	6.854E-08	4.649E-08	2.717E-08	1.870E-08	1.403E-08	1.112E-08	9.142E-09	7.724E-09	6.661E-09	5.838E-09
E	7.527E-08	4.335E-08	2.954E-08	1.738E-08	1.201E-08	9.045E-09	7.187E-09	5.925E-09	5.016E-09	4.333E-09	3.804E-09
ESE	6.809E-08	3.912E-08	2.660E-08	1.561E-08	1.077E-08	8.103E-09	6.432E-09	5.298E-09	4.483E-09	3.870E-09	3.396E-09
SE	1.007E-07	5.841E-08	3.999E-08	2.368E-08	1.644E-08	1.242E-08	9.899E-09	8.178E-09	6.937E-09	6.003E-09	5.277E-09
SSE	8.392E-08	4.854E-08	3.318E-08	1.961E-08	1.361E-08	1.028E-08	8.191E-09	6.766E-09	5.739E-09	4.966E-09	4.365E-09

Table 3.3 Annual Average Chi/Q Values at Various Segments

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES .5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.527E-06	8.044E-07	3.678E-07	2.276E-07	1.609E-07	8.278E-08	3.377E-08	1.763E-08	1.162E-08	8.549E-09
SSW	2.267E-06	7.210E-07	3.298E-07	2.033E-07	1.436E-07	7.380E-08	3.006E-08	1.568E-08	1.033E-08	7.592E-09
SW	3.836E-06	1.222E-06	5.595E-07	3.467E-07	2.453E-07	1.265E-07	5.177E-08	2.709E-08	1.788E-08	1.317E-08
WSW	2.586E-06	8.242E-07	3.779E-07	2.344E-07	1.659E-07	8.567E-08	3.513E-08	1.841E-08	1.216E-08	8.959E-09
W	6.198E-06	1.976E-06	9.086E-07	5.647E-07	4.003E-07	2.071E-07	8.520E-08	4.474E-08	2.960E-08	2.183E-08
WNW	5.378E-06	1.720E-06	7.925E-07	4.933E-07	3.501E-07	1.815E-07	7.481E-08	3.934E-08	2.604E-08	1.921E-08
NW	3.515E-06	1.123E-06	5.163E-07	3.209E-07	2.274E-07	1.177E-07	4.837E-08	2.538E-08	1.678E-08	1.237E-08
NNW	2.109E-06	6.711E-07	3.065E-07	1.895E-07	1.338E-07	6.881E-08	2.803E-08	1.462E-08	9.630E-09	7.079E-09
N	2.833E-06	9.008E-07	4.107E-07	2.547E-07	1.790E-07	9.194E-08	3.740E-08	1.948E-08	1.282E-08	9.422E-09
NNE	3.333E-06	1.078E-06	6.272E-07	3.969E-07	2.727E-07	1.397E-07	5.664E-08	2.942E-08	1.934E-08	1.419E-08
NE	5.183E-06	1.649E-06	7.514E-07	4.618E-07	3.271E-07	1.677E-07	6.802E-08	3.535E-08	2.324E-08	1.706E-08
ENE	2.313E-06	7.306E-07	3.272E-07	1.993E-07	1.392E-07	7.012E-08	2.770E-08	1.411E-08	9.166E-09	6.671E-09
E	1.434E-06	4.531E-07	2.039E-07	1.247E-07	8.735E-08	4.431E-08	1.769E-08	9.093E-09	5.939E-09	4.339E-09
ESE	1.310E-06	4.133E-07	1.854E-07	1.131E-07	7.909E-08	3.999E-08	1.590E-08	8.146E-09	5.312E-09	3.876E-09
SE	1.879E-06	5.951E-07	2.697E-07	1.659E-07	1.167E-07	5.963E-08	2.408E-08	1.248E-08	8.197E-09	6.011E-09
SSE	1.587E-06	5.008E-07	2.260E-07	1.386E-07	9.729E-08	4.957E-08	1.996E-08	1.033E-08	6.782E-09	4.972E-09

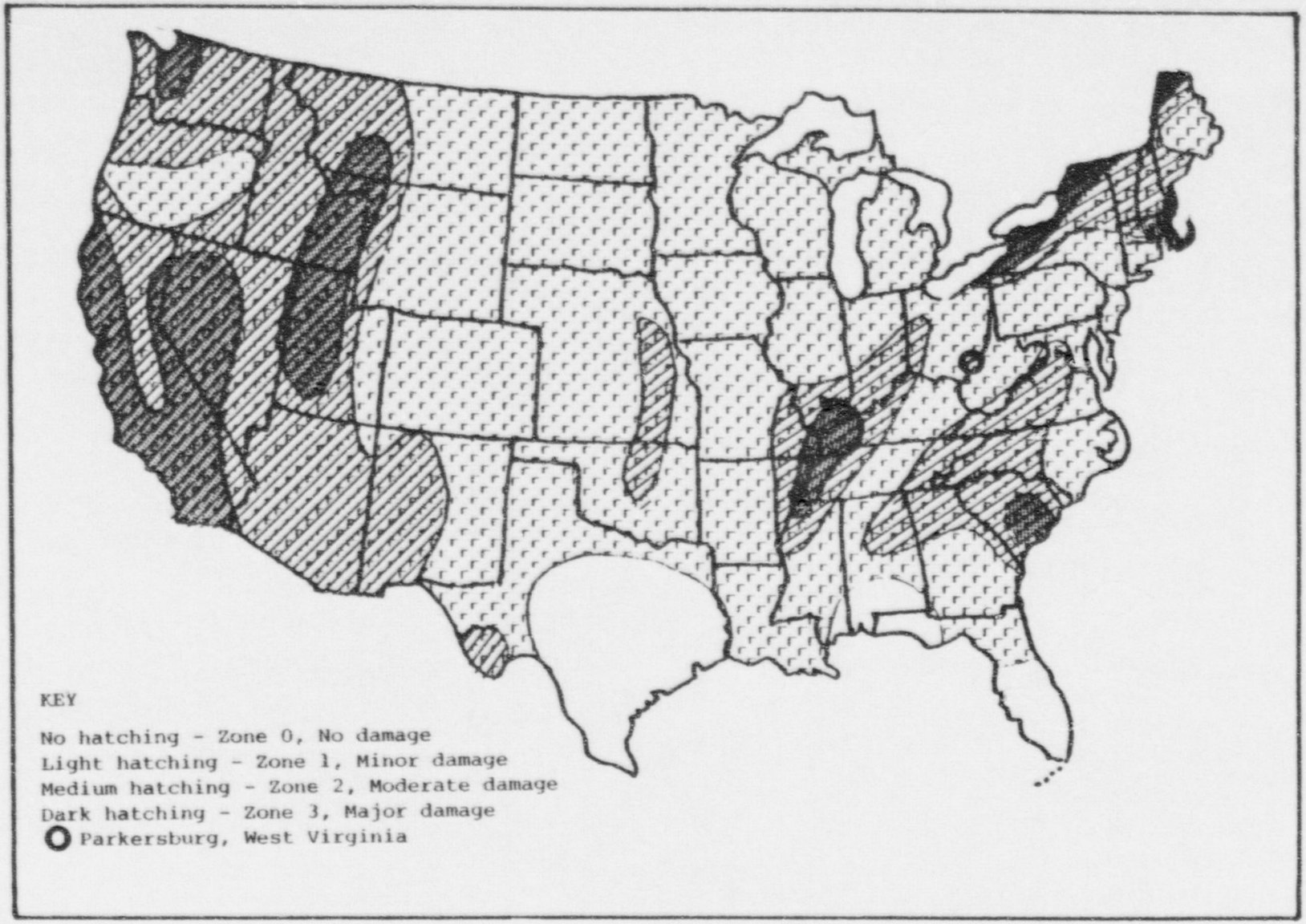


Figure 3.7. Seismic Risk Map of the United States.

Air Quality

The Ambient Air Quality Standards for the State of West Virginia parallel those of the Federal Ambient Air Quality Standards. Although the only ambient air monitoring station in the Parkersburg area (about 8 miles downwind from the Amax site) does not provide any measurement of air quality at the Amax site, it is the opinion of State Air Pollution Control Commission that the area of interest is an attainment area.[13]

Water Quality

There are no water quality sampling stations on the Ohio River in the vicinity of Parkersburg and the Amax site. Therefore, a year's (1979) records from the nearest sampling stations at Willow Island (about 30 miles upstream from Parkersburg) and Belleville (about 10 miles downstream), were examined. The objective of examining these data was to determine the quality of the Ohio River water.

Thirty-five water quality parameters were sampled, twenty of which are listed as state water quality criteria.[14] Six (dissolved oxygen, $CaCO_3$, ammonia, barium, manganese, and fecal coli) of the twenty criteria were exceeded in the samples from both stations. With the exception of fecal coli, which was 151 mg/l higher at Belleville, the criteria were exceeded in nearly equal amounts at both sampling stations. The criterion for phenols was slightly exceeded at the Willow Island sampling station but was not exceeded, and was significantly lower at the downstream Belleville station. No measurements of radioactivity have been made by the state but a recent groundwater sampling program by Amax show that radioactivity in the groundwater under the site conforms to EPA standards (40 CFR 141.15) and NRC standards (10 CFR 20, Appendix B).[15]

3.1.2 Site History

The Wood County plant site was originally developed by the Carborundum Company in 1957 for the production of high-grade zirconium metal for use in the construction of nuclear reactors for the U.S. Navy under an Atomic Energy Commission contract. This process started with the conversion of zircon ore ($ZrSiO_4$) to zirconium carbonitride followed by chlorination of the carbide to zirconium tetrachloride ($ZrCl_4$). The zirconium tetrachloride was purified and reduced to zirconium metal by the Kroll process which involves reacting the zirconium tetrachloride with magnesium metal to produce primarily zirconium metal and magnesium chloride.

During 1961 and 1962, the Carborundum Company processed Nigerian zirconium ore under an Atomic Energy Commission license. In addition to zirconium, this ore contained 6 percent hafnium, up to 8 percent thorium (ThO_2) and 0.2 percent uranium (UO_2). The processing of the radioactive Nigerian ore was under license by the Atomic Energy Commission, and both the ore and all residuals were stored in drums on the site. The use of Nigerian ore ended in 1962 when another source of zircon ore, which contained no radioactivity, was established. Operations with this uncontaminated ore continued until 1970.

Amax and Carborundum operated the facility as a joint venture, under the name of Carborundum Metals Climax, from 1965 to 1967. Amax then became the sole owner of the business. The Nigerian ore and radioactive residual, left over from processing during 1961 and 1962, were stored on the site until September 1968. During the seven years of storage, some drums deteriorated and spilled on the soils in the storage area. To reduce the residual radiation, soil located beneath the stored drums was disposed of by packaging for off-site burial. Nearly 3,000 drums of ore, residual material, and soil were transported from the property to an approved AEC burial site at Morehead, Kentucky in 1968.

The processing of zirconium ore was discontinued in late 1969, when purchased zirconium tetrachloride was substituted. Amax produced zirconium and

metal sponge until November 1974, at which time all production at the site was terminated.

In November 1974, Amax received a license from the Nuclear Regulatory Commission (NRC) to conduct laboratory-scale experiments on baddeleyite ore (ZrO_2) which contained less than 0.5 percent total thorium and uranium. The test material and all of the process residuals were contained within one building on the site. After the laboratory tests were concluded in late 1975, all remaining baddeleyite ore was sold and its process residuals were transported to an approved NRC disposal site. Based on a site inspection in 1977 concerning the closeout of Amax's baddeleyite license, NRC identified soil associated with the Nigerian ore at above acceptable radiation limits. This inspection included the area bounded on the east and north by the security fence, on the west by the westernmost on-site road and on the south by the railroad tracks (Figure 3.8). A number of locations, the hatched portions in Figure 3.8, within the survey area were found to be emitting at 50 to 80 times natural background. A cleanup program was initiated and subsequently seventy (70) drums of contaminated soil was collected and shipped to an approved NRC disposal site.

In 1977, the Wood County property and buildings were sold to L. B. Foster Company (Foster) for use as a pipe manufacturing facility. Building construction, which started in 1977, ceased in March 1978 when pyrophoric material was uncovered.

As a result of problems encountered in the construction of new buildings with regard to pyrophoric material found on the property in 1978, Amax repurchased the site from Foster. The history of the ownership and major activities at the Amax site which has been presented in the foregoing paragraphs is summarized diagrammatically in Figure 3.9.

During 1979, Foster leased from Amax a portion of the property west of the former zirconium plant which was found to be free of radioactivity, and their pipe manufacturing buildings were relocated as shown in Figure 3.10. The manufacture of pipe was begun again in late 1979 by Foster. Today the facilities

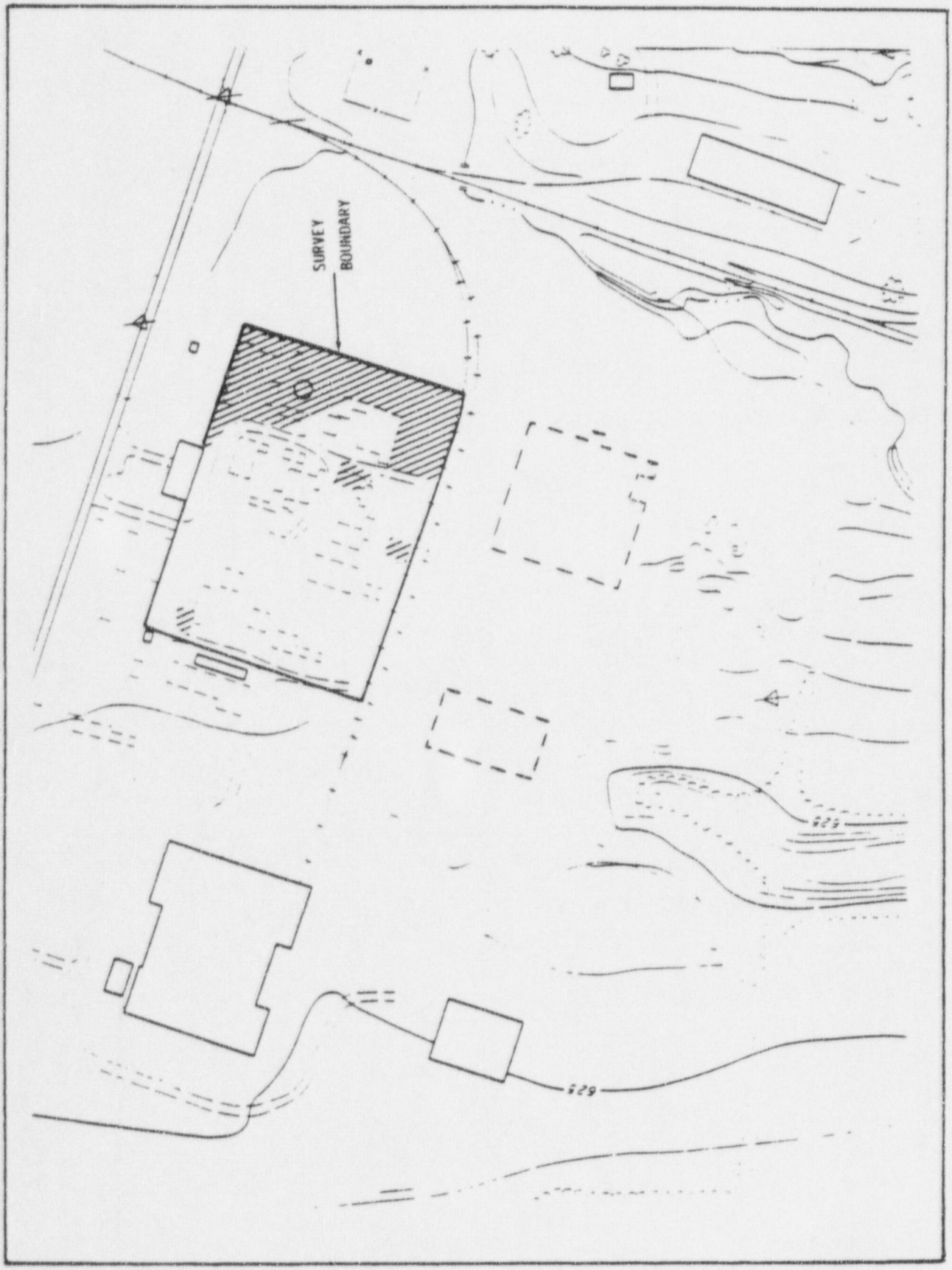


Figure 3.8. Contaminated Areas, 1977 Survey

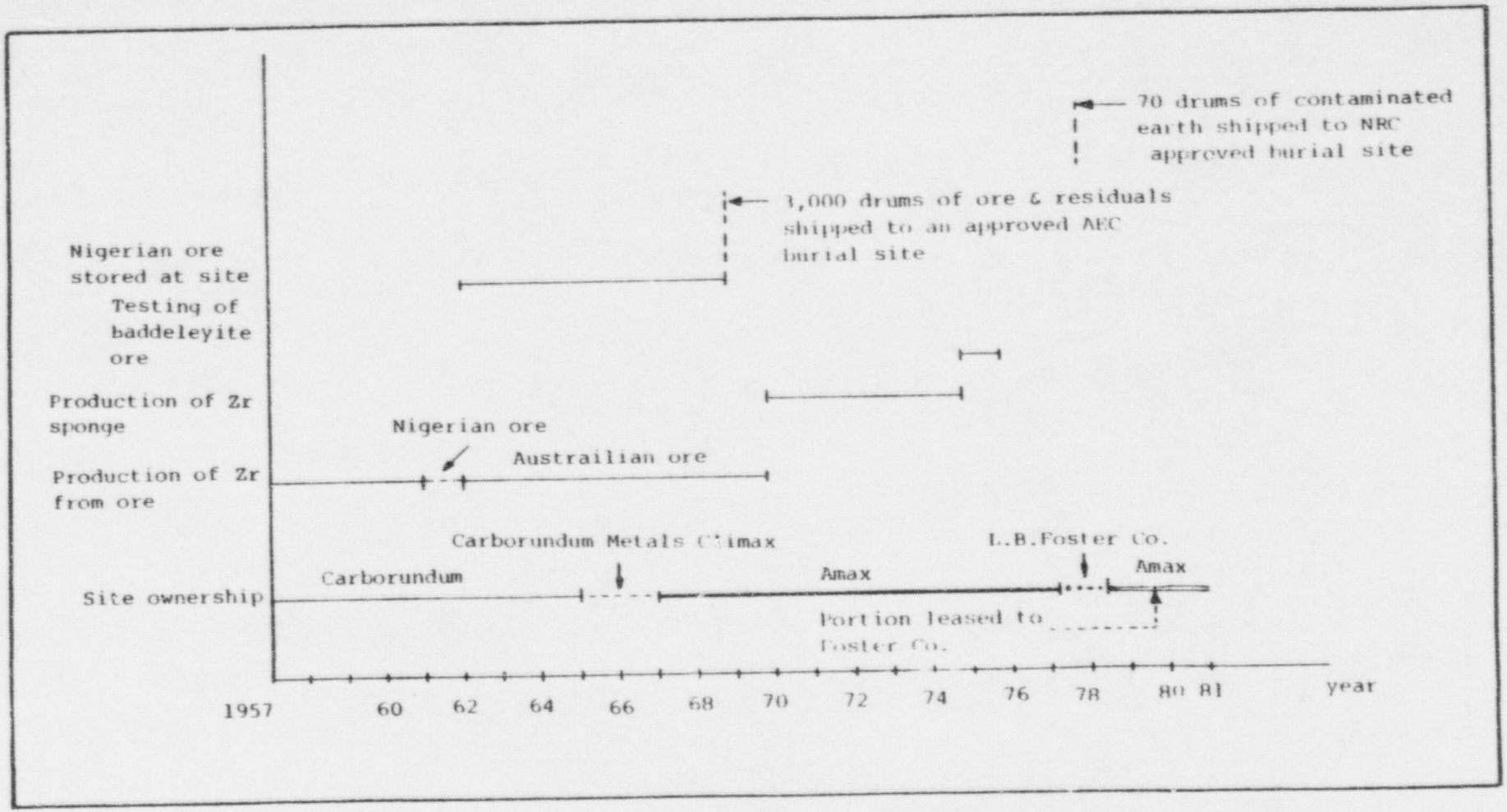


Figure 3.9. Amax Site History.

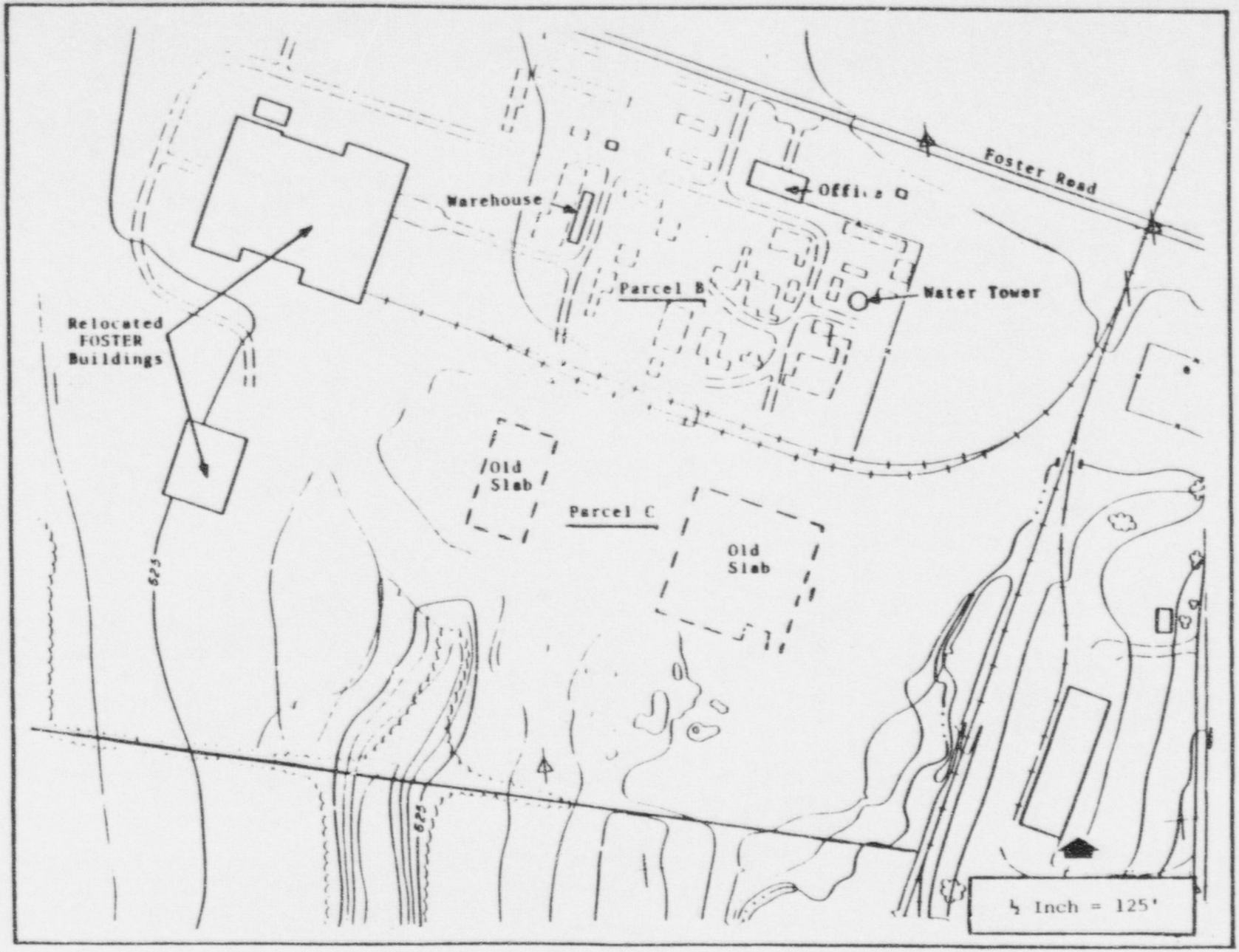


Figure 3.10 Present Location of L. B. Foster Buildings.

on the property consist of an office building, new plant buildings, roadways, old building foundations (slabs and floors), storage areas, water and gas mains, an elevated water storage tank and well field, storm drainage systems, and a railroad spur from the Baltimore and Ohio Railroad line leading to the plant (Figure 3.10).

In addition to the obvious physical features remaining from the previous use of the site there also remain areas where the soil is contaminated with radioactivity.

In 1980 a survey was conducted during which the area investigated was much larger than that surveyed in 1977.[7] The area of investigation north of the railroad tracks was basically the same as that of the 1977 survey except that it was expanded to 25 feet beyond the fence lines. The area to the south, including the railroad tracks, extended to the southern boundary of the Amax property, and approximately 200 feet and 75 feet further east and west of the northern portion, respectively. The entire area was divided into a grid pattern consisting of 1,422 twenty-five by twenty-five foot squares. Each square was measured for both surface and subsurface radioactivity. The surveyors also examined areas outside this grid pattern and, as a result, located two small areas of contamination. One was slightly to the west of the grid pattern and the other area was southwest into the property adjoining the Amax southern property line.

Approximately one quarter of the survey area (excluding that on other property), about five acres total, was found to be emitting gamma radiation at rates of from two to over ten times the natural background. Activity was found to range from two to five times background over 52% of the total contaminated area, over 26.5% of the area emissions were from five to ten times background, and greater than ten times background over 21.5% of the contaminated areas. The areas of ground contamination are shown in Figure 3.11. The most highly active portions of the contaminated areas shown in Figure 3.11 were in the:

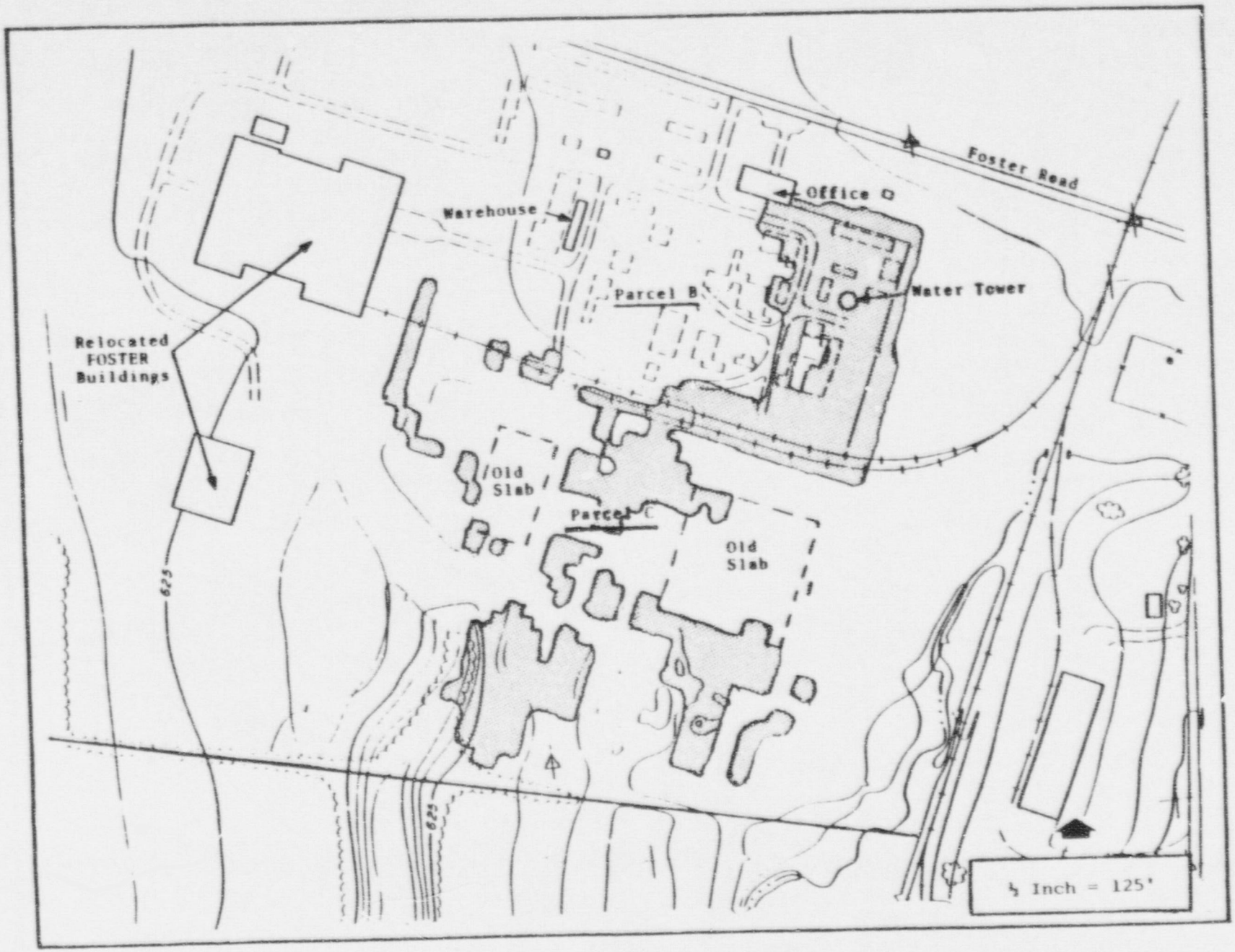


Figure 3.11. Areas of Ground Contamination.

- Area north of the railroad tracks
- Along the tracks
- Center of the area just south of the tracks between the two old slabs
- along the southern edge of the easternmost old slab
- central and southwestern portion of the most southwestern contaminated area.

The area of contamination which crosses the Amax property line and continues southwestward was all within the "two to five times background" range.

As was previously mentioned, subsurface radioactivity was also measured. Figure 3.12 shows radioactivity greater than twice background as a function of depth.

In the contaminated area north of, and including, the railroad tracks investigations have indicated that the radioactivity in the soil is highest, by a factor of two to four, two to four inches below the surface and has tapered off to background by 24 inches depth. The activity in the contaminated soil which extends well into the property to the south has been found to degrade to background at a maximum depth of 18 inches. An explanation of the presence of the radioactive soil, its areal extent, and depths at which detected south of the railroad tracks, has not been forthcoming. The area was used for refuse and waste disposal however was not designated for radioactive or reactive wastes.

In addition to the aforementioned contaminated areas there is a storm drain that runs from the Amax manufacturing area to the Ohio River (Figure 3.13). As shown on the figure, the drain has four man ways. The man ways were measured for radioactivity and attempts were made to decontaminate them. The decontamination efforts were not successful as the gamma activity was minimally

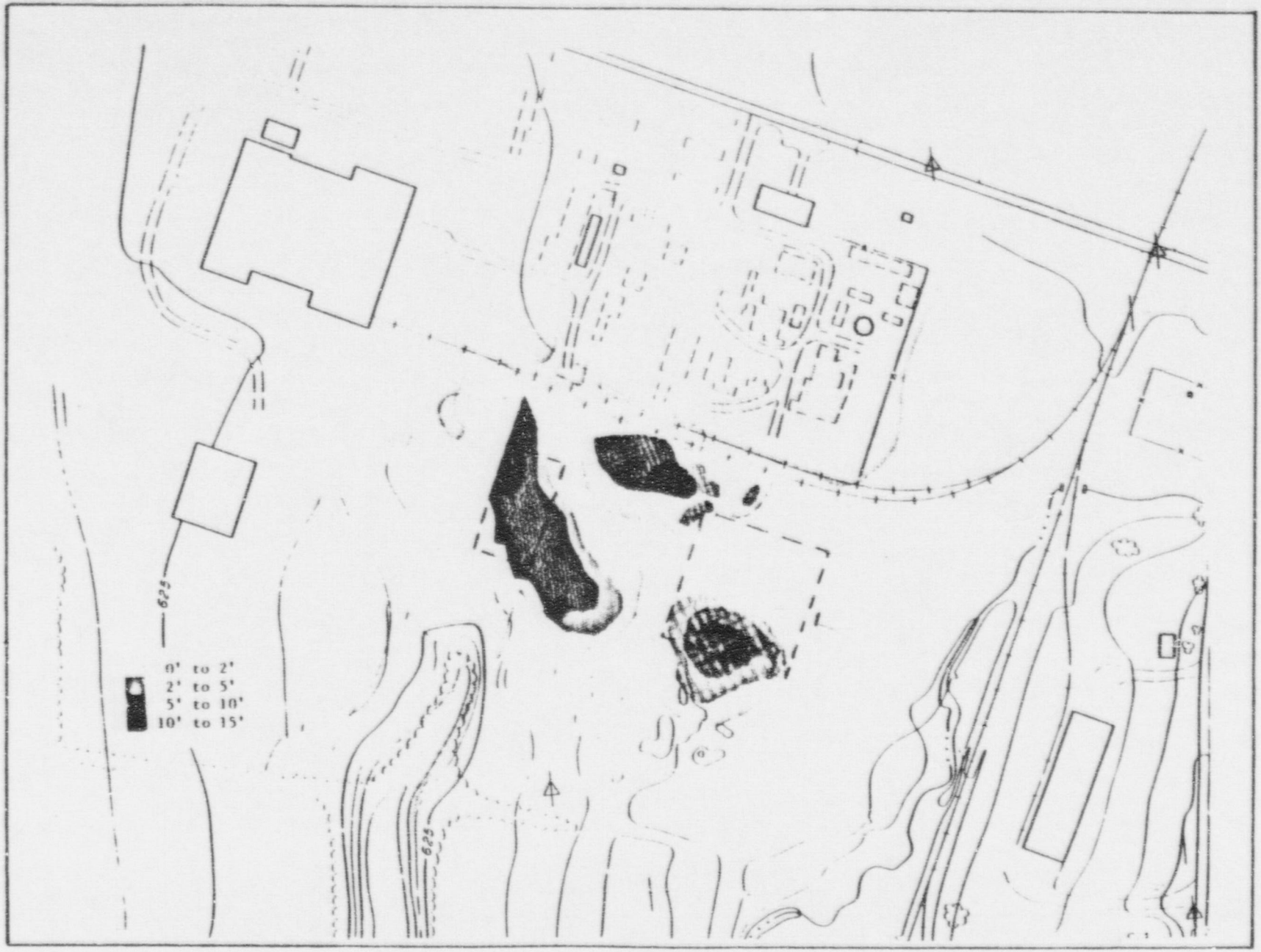


Figure 3.12. Radioactivity Greater than Twice Background as a Function of Depth

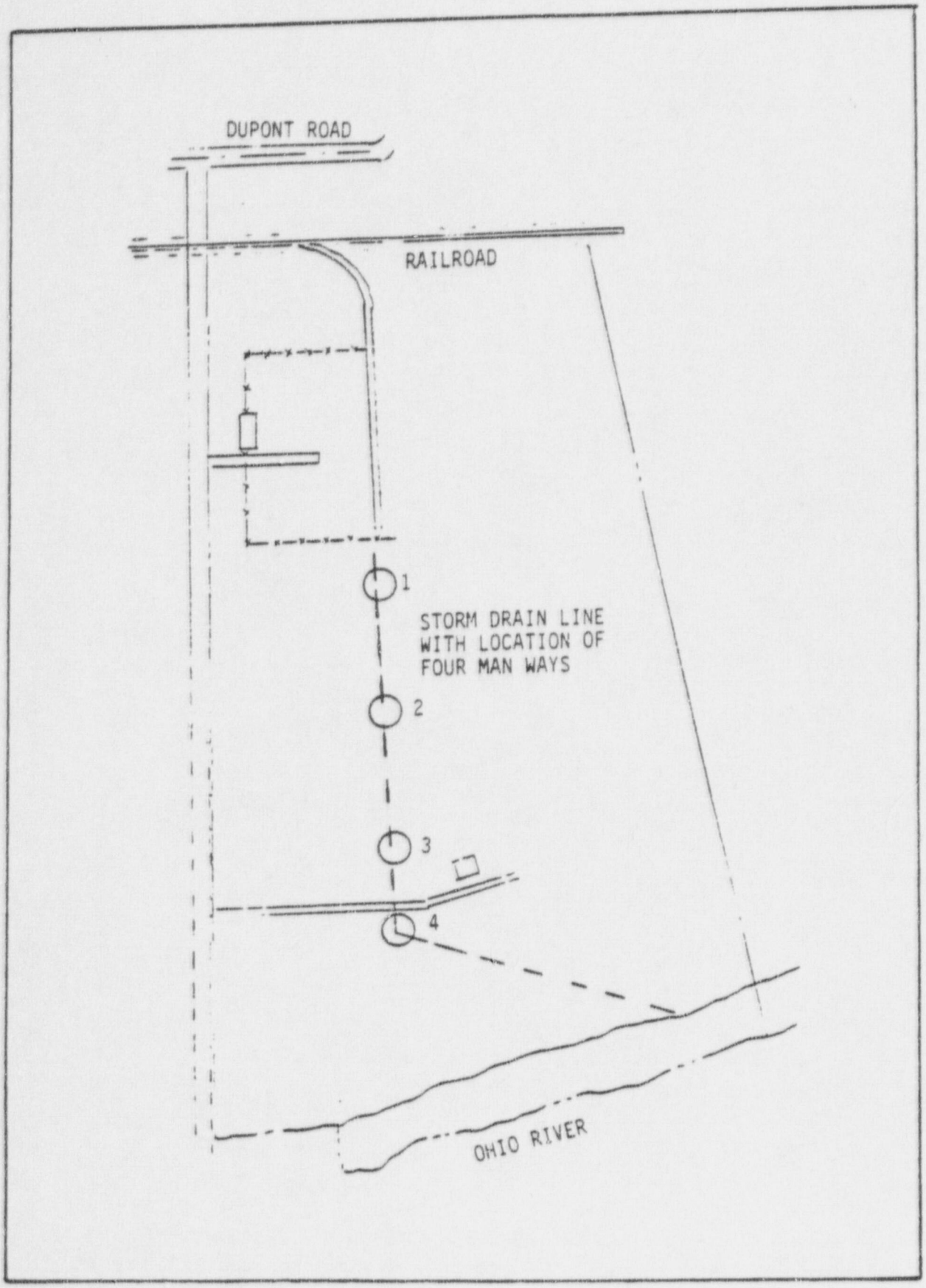


Figure 3.13. Storm Drain

affected. The levels of activity in the man ways far exceeds the levels the NRC* has specified as acceptable, and it must be presumed that the piping associated with the system also is contaminated to unacceptable levels. Plans for stabilization of this component of the Amax site have not been addressed. It would appear appropriate to eliminate the pipeline as a site drainage method, hydraulically isolate and possibly backfill it to provide structural stability.

During initial construction of buildings for the L.B. Foster pipe fabrication plant, it was discovered that some areas also contained nonradioactive pyrophoric waste material.

While doing surface grading in the area of the western "old slab," Figure 3.10, the bulldozer encountered material which ignited. The resultant fire destroyed the bulldozer. Soon thereafter, while using a backhoe in the dirt-floor area of a Butler Building that had been erected on the eastern "old slab," an explosion occurred. The force of this explosion hurled a large steel component from the backhoe through the roof of the building, 40 feet above. After two other minor instances of combustion, construction work was stopped.

During the previously discussed radiological survey while holes were being water jetted for subsurface radioactivity measurements an MSA Explosimeter was used for detection of explosive gasses in the air just above the hole. In total, four holes were determined to have detectable concentrations of flammable atmospheres and in three of these cases white smoke was noted indicating a minor pyrophoric or chemical reaction. In June of this year there was an absolutely spontaneous combustion of what had appeared to be nothing more than plain earth. The pyrophoric material is thought to be waste zirconium and production by-product material known as "sidewall material." "Sidewall material" results from the Kroll reduction process which converts zirconium tetrachloride ($ZrCl_4$)

*Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Material.

to zirconium metal. The composition of "sidewall material" is variable but it contains zirconium metal, magnesium metal and chloride salts of these two metals and is known to be pyrophoric.

The exact nature of pyrophoric reactions, their initiating and propagation conditions are not fully understood. Many mechanisms have been suggested to explain pyrophoricity of metals, but no single theory is completely adequate in explaining the nature of this phenomenon. The pyrophoric combustion reactions are not completely reproducible and therefore caution must be used in dealing with such materials.

Investigations of the site by Amax[7,15] suggests that the most likely location for the pyrophoric material is in the area where the Foster buildings were originally to be constructed, that is, south of the original zirconium processing area. There is some uncertainty with this assessment because of the lack of satisfactory zirconium survey techniques.

3.1.3 Stabilization Plan/Construction

The stabilization plan proposed by Amax is based on a series of technical studies involving site characterization and radiation surveys, safety evaluations and cost estimates.

The proposed plan is to move all of the contaminated soils into parcel C (Figures 3.10 and 3.11) south of the railroad spur and construct a mound designed to preclude material transport.

This stablization involves five major steps. These steps are:

1) Collection of all the contaminated soil (about 10,000 cubic yards) into the area which is designated 'Parcel C.' This soil will be compacted to form a mound which has surface runoff features compatible with the rest of the site area.

2) After the contaminated soil is compacted in the desired shape, the entire mound will be covered with a 6-inch layer

of clayey material. This clayey material is designed to provide a base for a final clay cover.

3) The final clay cover of, 12-inch thickness, is to be added to the mound in order to form a highly impermeable layer and to protect the waste material from leaching. The permeability of the final clay cap will be less than 1×10^{-7} cm/sec.

4) A 30-inch layer of soil will then be placed over the clay cap to protect it from weathering or erosion and to provide a soil base for growing an acceptable cover crop.

5) The final step in stabilization will be the seeding of the soil cover with a naturally growing grass to control erosion.

Figure 3.14 shows a cross section of the completed burial mound. The drawing is not to scale. It does show, however, several major features of the stabilization plan. These major features are: 1) a clay cover to prevent infiltration, 2) a slope to carry away precipitation, 3) a clay cap that extends down to the sand and gravel layers to prevent horizontal movement of water and 4) a drainage system to remove surface water. The shaded area in Figure 3.15 indicates the approximate areal extent of the burial mound.

The local area clays found on the river bottomland have been described by the West Virginia Geological Survey as river silt consisting principally of illite with some galenite and clarinite.[5] Woodward and Clyde, Consulting Engineers, as a result of extensive on site sampling and analysis programs, have established that sufficient clay, suitable for cap construction, exists on site and could be used.[8] The Amax plan, however, calls for obtaining the clay from a local commercial borrow pit.

3.1.4 Containment and Monitoring

The design and construction (detailed in 3.1.3) of the proposed cap to cover and prevent migration of contaminants from the gathered, compacted, and covered soil should obviate the possibility of leachate generation and migration to the adjacent surface or subsurface soils. Two interrelated natural phenomena,

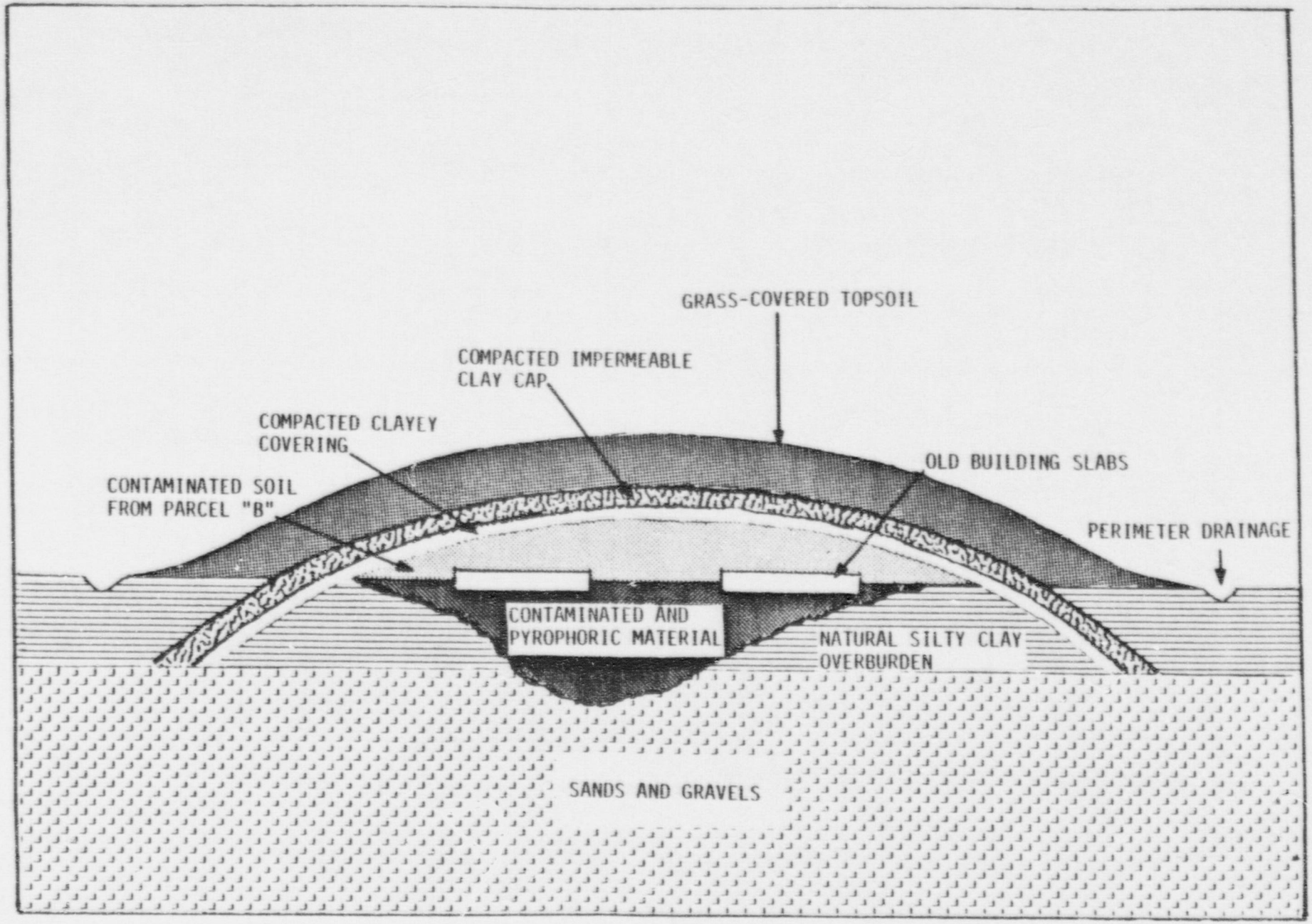


Figure 3.14. Conceptual Cross Section of the Burial Mound.

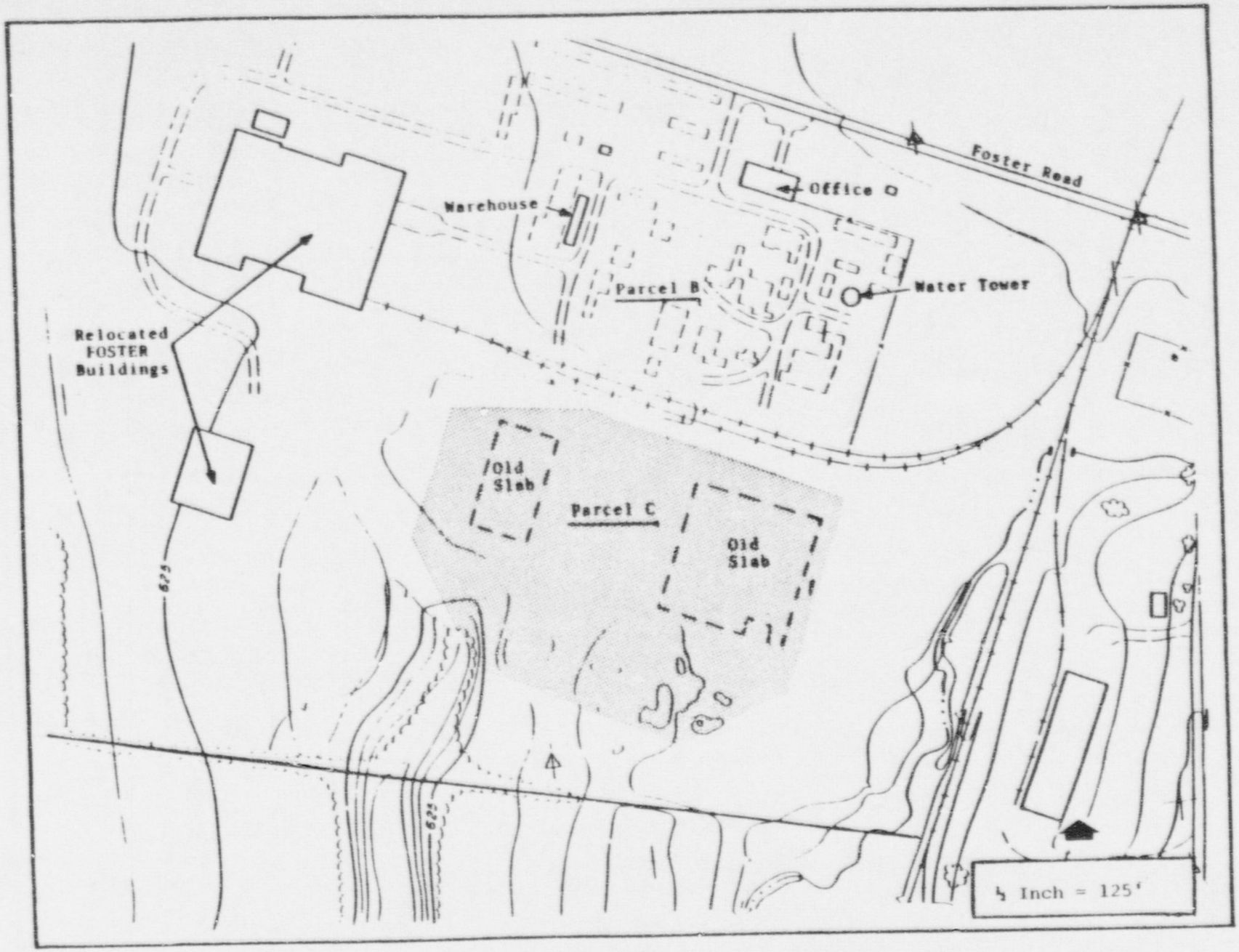


Figure 3.15. Plan View of the Proposed Burial Mound.

rain runoff and erosion, will continually be at work to degrade the integrity of the protective cap.

In order to sustain the integrity of the effluent control system (the cap) and its effective performance, a program of scheduled inspection and maintenance needs to be developed. Preservation of healthy vegetation cover over the entire area (Figure 3.15) will be required to prevent thinning of the topsoil layer and exposure of the underlying clay cap to weathering and possible infiltration of water into the buried, contaminated earth. This will also preclude loss of topsoil and subsequent clogging of drainage ways. Periodic clearance of the perimeter drainage ways must also be effected so there will be no standing rain runoff water around the perimeter of the capped area and no possibility of water seeping under the edges of the cap.

In addition to the implementation of a scheduled maintenance program, an evaluation of the containment program needs to be instituted. The evaluation program will consist of periodic sampling of groundwater monitoring wells which are to be located around the perimeter of the stabilization cap.

Last, but absolutely vital to the effluent control system integrity, the capped area must be barred from human use, i.e., no construction and no disturbance of the surface which would reduce the effectiveness of the cap as an infiltration barrier.

3.2 ALTERNATIVES TO THE PROPOSED ACTION

In addition to the proposed action, three alternatives have been defined and are addressed in this section. These alternatives are: stabilization of the pyrophoric material before stabilization of the site (3.2.1), disposal of the material at other authorized sites (3.2.2) and no action-defer stabilization (3.2.3). Each of these alternatives are discussed in the following paragraphs. Analysis of the alternatives, to the extent of identifying the environmental components that would be affected, is presented in Section 4.

3.2.1 Stabilization of the Pyrophoric Material Before Site Stabilization

Because the "sidewall material" is pyrophoric and represents some degree of hazard, it might be considered appropriate to stabilize the material prior to covering it as part of a site stabilization effort. Because of the uncertain nature of the causes and mechanism for metal pyrophoricity, there are no standard techniques by which this metal stabilization can be effected.

It is generally considered, however, that oxidation of the pyrophoric metal will render it stable. To accomplish such an oxidation reaction, it is possible to burn the pyrophoric material in an open pit or trench fire. This was practiced in stabilizing pyrophoric zirconium scrap at Oak Ridge National Laboratory.[17]

This treatment technique for the pyrophoric materials at the Amax site would involve several steps. First, the materials would have to be located and dug out by using equipment which minimized the potential for initiation of a pyrophoric reaction and maximized personnel protection. The unearthed materials would then be transported to a fire and burned. Thus, the reactive pyrophoric materials could be stabilized by oxidation. Following this, the site could be stabilized according to the proposed method.

3.2.2 Disposal of the Material at Other Authorized Sites

The radioactively contaminated soil could be consolidated at one point on the property and packaged in DOT approved containers, labeled and transported to an authorized disposal site. Likewise, the residue from the oxidation of the pyrophoric material (Section 3.2.1) could be collected and packaged for shipment to a licensed disposal site. This would preclude the work associated with on-site capping of the contaminated material and the necessity for possible long-term monitoring of the capped material.

3.3.3 No Action

No action would, in effect, be a denial of the application for the proposed action, i.e., the action proposed was not considered a satisfactory resolution of the problem and submittal of a different proposed action would be required.

4.0 AFFECTED ENVIRONMENT

The previous section (3.0 Proposed Action and Alternatives), identified the actions that could be taken to stabilize the Amax site. Each of these actions, if implemented, would have some impact on the environment. This section identifies those environmental components which are expected to be impacted by the proposed action as well as by the alternatives. Part 4.1 identifies those environmental components which would be impacted by the proposed action, part 4.2 identifies the environmental components which would be impacted by the alternatives and part 4.3 presents a qualitative evaluation of both the proposed action as well as the alternatives.

4.1 AFFECTED ENVIRONMENT OF THE PROPOSED ACTION

The proposed action, as described in Section 3.1, involves the movement of soils from some areas of the site to a specific area of the site where stabilization is to occur. The estimated total surface area of disturbed land is about 30 acres, including the on-site, and topsoil borrow areas. Such earth moving operations would generate some quantity of dust, and thus will impact the air quality in the immediate area of the site. Additionally, there will be a significant increase in truck traffic on Foster and DuPont roads as large quantities of cover materials will be imported from an off-site commercial borrow pit. During site stablization, the areas where soils are removed will be left unprotected against erosion and some would occur during periods of rainfall thereby affecting the surface water quality in the surrounding area. If proper management of surface run-off such as slope grading, surface water diversion, collection and treatment or release to the river are observed, the impact on the Ohio River will be negligible. After site stabilization some potential for water quality impacts may exist if the disturbed areas are not properly managed (i.e., proper slope grading, revegetation, and drainage). Besides air and water quality impacts, some impacts on natural resources due to the proposed action will occur.

Removal of the top soil from certain areas of the site, the soil borrow areas totaling approximately 11 acres, will not be readily usable for farming purposes. In summary, air quality, water quality and natural resources will be the environmental components impacted by the proposed action.

4.2 AFFECTED ENVIRONMENT OF THE ALTERNATIVES

Section 3.2 defined three alternatives, these being (1) site stabilization but only after stabilization of the pyrophoric material, (2) removal of the stabilized pyrophoric and radioactive material for shipment to licensed or approved waste burial sites and (3) no action--denial of stabilization authorization. This section identifies the environmental components which would be impacted by the alternatives. Each alternative is addressed on an individual basis.

4.2.1 Alternative 1 - Site Stabilization After Pyrophoric Material Stabilization

This alternative would involve the same environmental components as would be impacted by the proposed action. The extent of impact, however, would be greater. Stabilization by open incineration would impact air quality more than the proposed action because (1) additional earthmoving must be accomplished to retrieve the buried pyrophoric material and to construct an incineration pit or trench and (2) the products of incineration will generate a significant amount of particulates. There is also an inherent hazard in digging for and retrieving the pyrophoric material.

4.2.2 Alternative 2 - Disposal Off-Site

The alternative of disposing of the material at one or more existing off-site waste disposal sites was also considered. Such an alternative would involve the excavation of material from the present site. This earthmoving would impact both air quality (dust), water quality (siltation) and increase the potential for pyrophoric material handling accidents. Stabilization of the pyrophoric material would also be a part of this off-site disposal option. The onsite impacts would then be comparable to the impacts found in the previous alternative (Site Stabilization after Pyrophoric Material Stabilization).

The transportation of material away from the Amax site would involve the risk of enroute accidents wherein material might be spilled. The added expense of transportation does not enhance the cost-effectiveness of this disposal alternative.

4.2.3 Alternative 3 - No Action - Denial of Request for Stabilization Approval

A final alternative was defined as denial of Amax's request to initiate site stabilization. This would produce less air quality impact because no earth moving would be involved. It would, however, result in continued surface radiation, greater radon releases and surface water quality impact due to runoff from contaminated soil. As such, even the no action alternative has air and water quality impact.

4.3 SUMMARY QUALITATIVE EVALUATION

A matrix has been prepared in which the various available options (the proposed action and the alternatives thereto) are plotted against the environmental concerns associated with each option. The comparison matrix is presented in Table 4.1. The table shows that higher air and water quality

Table 4.1. Impact Comparison Matrix.

OPTIONS	CONCERNS AND SEVERITY OF IMPACT																				
	Air Quality			Water Quality			Surface Radiation			Natural Resource Disturbance			Pyrophoric Reaction Potential						Transportation Risk		
	Lo	Med	Hi	Lo	Med	Hi	Lo	Med	Hi	Lo	Med	Hi	Near Term			Long Term			Lo	Med	Hi
													Lo	Med	Hi	Lo	Med	Hi			
Proposed Action		▲			▲		▲					▲		▲		▲					
Pyrophoric Material Stabilization Before Site Stabilization			▲			▲	▲					▲			▲						
Pyrophoric Material Stabilization, Retrieval Of All Material, Off-site Disposition			▲			▲					▲				▲				▲		
No Action	▲					▲								▲			▲				

impacts are associated with waste retrieval or processing activities on the site. Over the longer term, higher air and water quality impacts would result from the no action option. The pyrophoric nature of some of the waste material means that some potential for pyrophoric reaction exists in either the long- or the short-term. The fact that oxidation is expected to occur in the ground should decrease the longer term potential for pyrophoric reaction.

The potential for transportation accidents associated with off-site disposal options means that these options have an element of risk to the environment and the public which the on-site disposal options do not.

In summary, it appears that while there are impacts associated with the proposed action, they are less severe than those associated with alternative actions. A quantification of these impacts and a comparison of these impacts against the guidelines identified in Section 2 is presented in the following section.

5.0 CONSEQUENCES OF THE PROPOSED ACTION

The previous section identified those environmental components which will be impacted by the proposed action and the alternatives. This section quantifies, to the extent possible, the impacts and also evaluates the proposed action relative to the guidelines synthesized in Section 2.2. This section is organized into three major parts. The first (5.1) addresses environmental impacts and consequences resulting from normal operation. The second (5.2) addresses environmental impacts and consequences resulting from off-normal conditions. The third section (5.3) presents a summary evaluation of the proposed action in light of the guidelines identified in Section 2.1.

5.1 CONSEQUENCES OF CONSTRUCTION AND NORMAL MAINTENANCE

The proposed stabilization operation will result in some environmental impact. As identified in Section 4.1, the impacts are in the area of air quality and water quality, and natural resources. The air quality impacts are (1) short-term (about one month) generation of airborne particulates associated with the construction activity and (2) long-term (continuous) radon generation associated with the decay of thorium in the buried soil. Water quality impacts are of short-term and are associated with siltation which would occur during the site stabilization. Impacts to natural resources will result from on-site removal of topsoil and, unless positive restoration action is taken, these borrow areas will remain unsuitable for other purposes for a number of years. The radiological and non-radiological impacts which can be quantitatively estimated are discussed in the following paragraphs.

Radiological

The radiological impact of proposed activities will involve two mechanisms. The first is generation of airborne particulates containing thorium and uranium associated with the stabilization activities. The second is radon emission from the stabilized site as the result of thorium decay.

The dusting which will occur with the site stabilization activities has been estimated using an U.S. EPA[18] source term factor. The factor is based on the use of a wetting agent, such as water, which is being planned by Amax Inc.

The estimated cloud density in the actual operation area is 4.2 mg/m^3. Assuming 1) a breathing rate of 9.6 m^3/day, 2) one-half the particles being in the respirable size range, 3) 0.8 weight percent thorium and 0.2 weight percent uranium and 4) one month of exposure, the maximum occupational doses of personnel involved in the stabilization activitv have been calculated. The results are presented in Table 5.1. This table shows that the major doses are to the lungs and the bone. The committed dose to the lungs is 9.8 rem which, if linearized over 50 years, amounts to an annual dose of 0.2 rem/year. This can be further reduced by about an order of magnitude through the use of half-mask respirators. Direct radiation exposure to construction people is estimated to be 10 to 20 millirem based on measured external dose rate at the site.

Dosages to the nearest resident from the stabilization activities was also estimated. The nearest resident is located about 1400 feet to the south of the stabilization area. Dust concentrations to the south have been estimated using meteorological data from Parkersburg, the guidelines of U.S. Nuclear Regulatory Guideline 1.111, and the concept of an "apparent" point source. The latter point allows for the calculation of downwind concentrations from an areal source. Figure 5.1 shows the calculated results. The figure shows that air quality standards(40 CFR 50) are expected to be met at distances of greater than about one-half mile. Using this calculated dust concentration profile, the doses to the nearest resident were calculated. In addition, general population doses were calculated. These are presented in Table 5.2. The table shows again that

Table 5.1 Maximum Doses to Personnel Involved in Site Stabilization Activities

Radionuclide	Committed Dose Equivalent (rem/50 years)				
	Total Body	Liver	Bone	Lungs	G.I. Tract
Th-232 + daughters	1.7E-1	1.6E-1	4.0E+0	8.6E+0	7.8E-4
U-238 + daughters	8.2E-2	7.6E-2	1.4E+0	1.2E+0	4.7E-4
Total	2.5E-1	2.4E-0	5.4+0	9.8E+0	1.2E-3

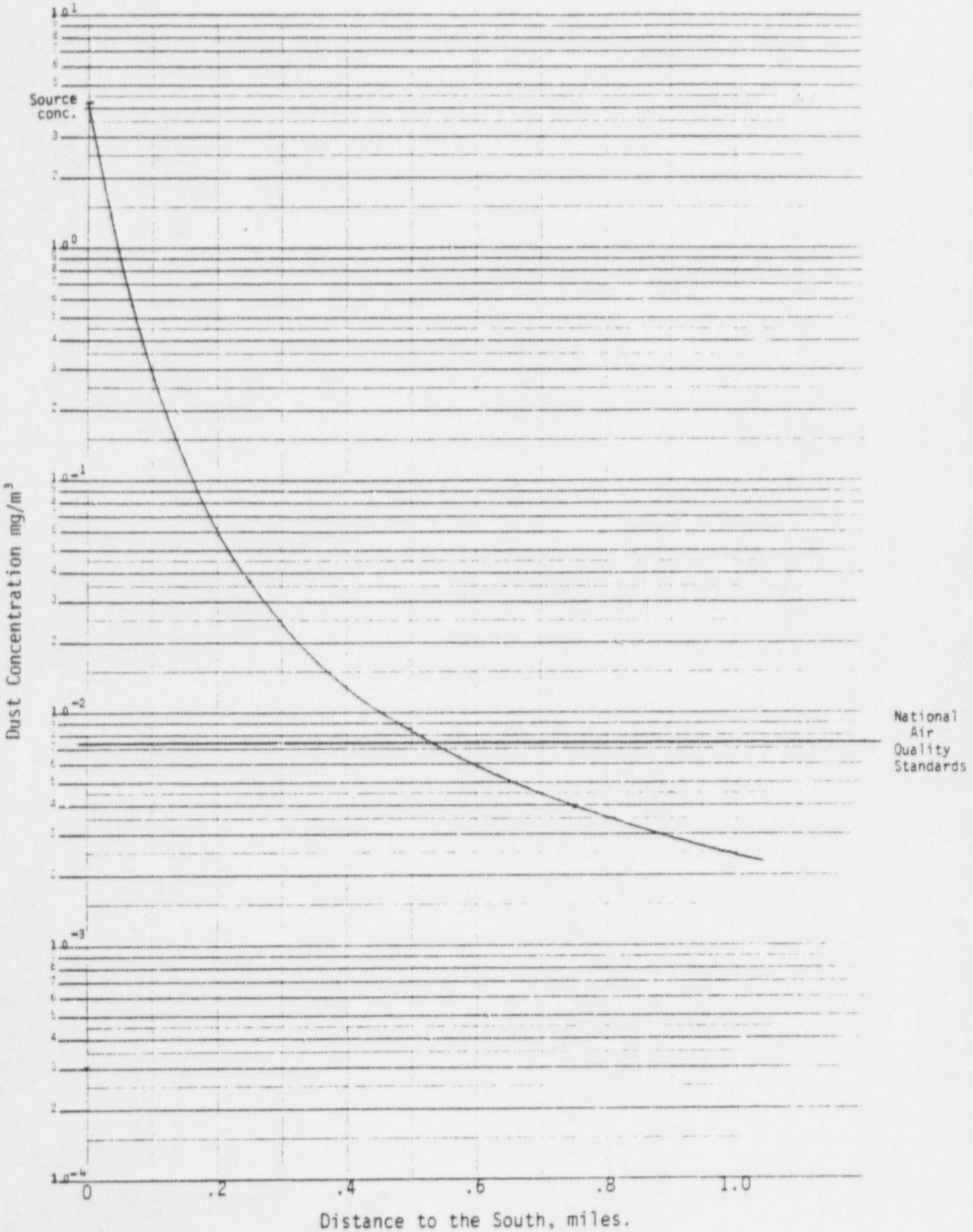


Figure 5.1. Dust Concentration to the South as a Result of Site Stabilization Activities.

Table 5.2 Doses to the Nearest Resident and the General Population As a Result of Site Stabilization Activities

	Activity Inhaled (μCi)	Committed Dose Equivalent (rem/50 years)				
		Total Body	Liver	Bone	Lungs	G.I. Tract
Nearest Resident						
from Th-232 + daughters	1.1×10^{-6}	2.8E-4	2.5E-4	6.2E-3	1.3E-2	1.2E-6
from U-238 + daughters	8.7×10^{-7}	1.3E-4	1.1E-4	7.9E-3	1.4E-2	1.5E-2
Total		4.1E-4	3.6E-4	1.4E-2	2.7E-2	1.5E-2

	Committed Dose Equivalent (rem/50 years)				
	Total Body	Liver	Bone	Lungs	G.I. Tract
General Population out to 50 miles					
from Th-232 + daughters	9.8E-1	9.2E-1	2.3E+1	4.9E+1	4.3E-2
from U-238 + daughters	5.2E-1	4.3E-1	8.4E+0	6.9E+0	2.7E-3
Total	1.5E+0	1.4E+0	3.2E+1	5.5E+1	6.9E-3

the organs receiving the major doses are bones and lungs. The major dose commitment level is 27 mrem to the lungs. For the general public, the lung is again the organ which receives the greatest dose, 55 man-rem.

In addition to the dust generated during site stabilization, there are some off-site doses resulting from the natural decay of the on-site uranium and thorium. Radon, an inert gas resulting from the decay of Th-232 and U-238, will migrate to the surface and be emitted from the waste pile. Radon emission rates were estimated using the procedures in the Final Generic Environmental Impact Statement on Uranium Milling.[19] A more detailed discussion of the calculational method and results is presented in Appendix C. The result of the calculation for the covered waste is that the radon-222 emission rate is 1.3×10^{-4} pCi/m^2-sec.

The dose consequences of the Rn-222 release rate to both the nearest resident and the general population have been calculated are presented in Table 5.3. These doses are based on the currently recommended dose conversion factor[19] of 0.625 mrem/yr per pCi/m^3. The table also shows the annual dose estimate which is estimated to occur if site stabilization were not to occur. In this latter case the emission rate would be about 6.8×10^{-4} pCi/m^2-sec.

Direct radiation exposure following stabilization should be at rates consistent with the surrounding area, i.e., about 10-15 uR/hr.

A potential off-site dose is that associated with leaching of the covered waste. An analysis of this covered waste leach situation is presented in Appendix B. The results of this analysis show that some leaching is expected but the expected dose consequences due to radionuclide transport to the Ohio River are extremely small. A more pessimistic calculation of the doses resulting to someone who consumed the leachate prior to mixing with the Ohio River was also performed. The results of this analysis are presented in Table 5.4. The table shows that for even this pessimistic case, the dose consequences are small (49 mrem to the bone).

Table 5.3 Doses to the Nearest Resident and the General Population As a Result of Radon Releases Before and After Site Stabilization

Status	Emission Rate	Dose to Bronchial Epithelium (rem/yr)	
		Nearest Resident	General Population
Prior to Stabilization	6.8×10^{-4} $\frac{pCi}{m^2\text{-sec}}$	2.2×10^{-5}	2.4×10^{-1}
After Stabilization	1.3×10^{-4} $\frac{pCi}{m^2\text{-sec}}$	8.1×10^{-6}	1.6×10^{-5}

Table 5.4. Estimated Dose to a Hypothetical Individual Consuming Leachate at a Point Just Prior to Mixing With the Ohio River.

Radioisotope	Concentration (μCi/ml)	Dose to Various Organs (rem)		
		Total Body	Liver	Bone	G.I. Tract
Ra-226	3.1×10^{-11}	1.1×10^{-2}	2.7×10^{-7}	1.5×10^{-2}	1.6×10^{-5}
Ra-228	0	0	0	0	0
Th-230	9.0×10^{-16}	$<10^{-15}$	$<10^{-15}$	$<10^{-15}$	$<10^{-15}$
Th-232	1.2×10^{-15}	2.8×10^{-10}	1.9×10^{-10}	4.3×10^{-9}	9.7×10^{-11}
U-234	1.3×10^{-8}	1.0×10^{-3}	1.0×10^{-3}	1.8×10^{-2}	1.2×10^{-3}
U-238	1.3×10^{-8}	9.5×10^{-4}	9.5×10^{-4}	1.6×10^{-2}	1.1×10^{-3}
Total		1.2×10^{-2}	1.9×10^{-3}	4.9×10^{-2}	2.3×10^{-3}

Non-Radiological

In addition to the radiological consequences of the proposed action, there will be some non-radiological impacts. The impacts of concern in this assessment are those associated with air and water quality. The air quality impact is the result of dust during stabilization and the water quality impact is the result of siltation, also during stabilization.

Dusting during construction has been estimated and presented in the previous paragraphs. The results were presented in Figure 5.1 and it shows that air quality standards are expected to be met a short distance off-site. These consequences from a non-radiological standpoint are similar to that which might be expected from the farming activities which occur in other areas of Washington Bottom.

A second non-radiological impact associated with the proposed action is siltation and its impact on water quality. It is estimated that during the construction of the soil stabilization facility a total of about 15 acres of ground will be bare of vegetation and/or otherwise disturbed. This disturbed area can readily be managed and the consequences of reasonable siltation management practices would be that no significant impact should be noticed in the context of the Washington Bottom area with its farming activities.

Another non-radiological impact associated with the proposed action will be the disturbance of about 10 to 15 acres of Amax property to secure topsoil for the final earthen cap at the burial site. Removal of about 18 inches of soil will first be required to get root-free dirt. It is estimated another 18 inches will then have to be excavated to meet the requirements for covering the clay cap. This activity will result in the surface depression of a fairly large area or a number of smaller areas. Such areas will probably become swampy as have other areas on the site where shallow excavations have been made.

5.2 CONSEQUENCES OF OFF-NORMAL CONDITIONS

Radiological

Off-normal situations are also potential reasons for environmental impacts. The most severe accident is considered to be the degradation of the clay cap which will result in leaching of the waste contents. In evaluating the accident it was assumed that the soil cover is intact but the clay cap is fractured so that rainwater can penetrate the contaminated material and leach contained radionuclides. Using the water balance method developed by Thornthwaite[20] and the Parkersburg meteorological data[9], leaching is expected to occur during the months of January through April. Details of the leach analysis are presented in Appendix B, Section B.3.

The dose consequence of this postulated accident were calculated assuming that a person received all of their water from a contaminated well near the Ohio River. The concentration and associated dose levels for this postulated accident are shown in Table 5.5. This shows that the critical organ is the bone of the well user and that the 50-year dose commitment is moderate, 690 mrem.

Non-radiological

A potential non-radiological release that could arise from a failure of the cap would be a leaching of non-radiological components from the buried waste. Principal contaminates which might be contained in the waste are zirconium tetrachloride ($ZrCl_4$), magnesium chloride ($MgCl_2$), as well as metallic zirconium and magnesium. The greatest source of chloride is thought to be $MgCl_2$. Because it is quite soluble in water (54g/100 ml H_2O) it will be leached relatively quickly producing a chloride concentration in the leachate of up to about 400 g/liter. This level would be diluted when it reached the groundwater but might be detectable. If it were detectable, the chloride ion would be a good indicator that some other waste material was also being leached.

Table 5.5. Calculated Consequence of Off-Normal Waste Leaching Conditions

Radionuclide	Concentration of Radionuclide at Well (μCi/ml)	Dose Resulting from Drinking Contaminated Water (Rem/50 years)			
		Total Body	Liver	Bone	G.I. Tract
Ra-226	3.1×10^{-11}	1.1×10^{-2}	2.7×10^{-7}	1.5×10^{-2}	1.6×10^{-5}
Th-230	1.8×10^{-14}	$<10^{-15}$	$<10^{-15}$	$<10^{-15}$	$<10^{-15}$
Th-232	2.4×10^{-14}	5.6×10^{-9}	3.8×10^{-9}	8.6×10^{-8}	1.9×10^{-9}
U-234	2.6×10^{-7}	2×10^{-2}	2×10^{-2}	3.6×10^{-1}	2.9×10^{-2}
U-238	2.6×10^{-7}	1.9×10^{-2}	1.9×10^{-2}	3.2×10^{-1}	2.2×10^{-2}
		4.1×10^{-2}	3.9×10^{-2}	6.9×10^{-1}	4.6×10^{-2}

The buried pyrophoric material is expected to oxidize slowly to a stable ZrO_2 form over a long time period. The soil cover acts as an oxygen diffusion barrier which prevents any oxidation from occurring rapidly.

5.3 SUMMARY EVALUATION

The previous parts of this section have presented quantitative analysis of the impacts associated with the proposed site stablization plan. This part is intended to summarize this evaluation considering the guidelines identified in Section 2.1. Table 5.6 presents a comparison of the status of the proposed action relative to the guidelines. The table shows that the projected performance is adequate, provided that measures are taken to assure continued design performance of the passive protection systems. The issue of uncertain groundwater flow direction is recognized. Current groundwater flow patterns (toward or away from the river) are acceptable. Concern would be appropriate if significant water pumping were to occur in the area which would change groundwater flow direction and rate.

Table 5.6 Summary Comparison of Status of the Proposed Action Relative to the Guidelines

Guideline	Status
• Uncomplicated geology/hydrology	Geology is not complicated but hydrology is complicated by the apparently fluctuating flow rate and direction.
• Easily and rapidly drained	If constructed and operated as discussed in Section 3.1.3, drainage should be adequate.
• Control of dust	No mention made in performance plan, but it should be done to reduce occupational and offsite dose consistent with ALARA philosophy.
• Verification of completeness of cap's seal	No mention is made in the stabilization plan of verification activities. This is probably more appropriate for NRC as the regulatory authority.
• Verification of drainway performance	No mention is made in the stabilization plan of verification activities. This is probably more appropriate for NRC as the regulatory authority.

Table 5.6 (Continued)

• Maintenance activities to assure passive performance	No stated plan but the items addressed in Section 3.1.4 should be covered.
• Monitoring annual dose to assure nearest resident receives less than 25 mrem/year whole body and organs other than the thyroid, less than 75 mrem/year thyroid	Projected doses are 2.4 mrem/year the bronchial ephithelium, less than the 25 mrem/year guidelines.
• Monitoring plant groudwater.	If current sampling plans continue they should verify the performance of the clay cap in preventing material leaching.

APPENDIX A

The purpose of including this appendix in the environmental assessment is to identify and explain why certain environmental components are not issues in connection with the proposed action. Further, its inclusion is to provide assurance that possible impacts of the proposed action on all environmental components have been investigated and assessed.

Environmental issues are classed as key, significant, and minor. Key environmental issues are those that could prevent the proposed action. Significant issues are those that would not necessarily prevent the proposed action but require thorough investigation and possible plan, program, or procedure modification in order to obviate or mitigate environmental impacts to an acceptable level. Minor issues are those which are very short-term in nature, can be obviated or mitigated by the use of alternative but standard engineering practices, or are of such small magnitude that their environmental effects are well within the legislated limitations, i.e., they are insignificant. Those environmental components which will not be subject to any adverse impacts as a result of the proposed action are classed as "non-issues." Identification and justification for such classification of the following listed environmental components is provided below:

Climatology/Meteorology - Climatological impacts or changes result from changes in the physics of the upper atmosphere, stratosphere and ionosphere. These kinds of changes would, in turn, alter meteorological characteristics of a local area. Very localized, short-term, small-scale changes in meteorological phenomena have been observable at certain large metropolitan areas under specific meteorological conditions. Such alterations have been due to city-generated heat or industrial and transportation-related pollution. These pollutants will not be generated at the Amax site as a result of implementation of the proposed action.

Geology - The proposed action does not involve any significant construction, but rather will result in some minor changes to the surface expression in a small area (approximately 11 acres). No significant excavation is planned so no subsurface strata will be disturbed or altered in any way.

Historical and Archaeological Resources - There is no evidence that the previously developed 126 acres on the Amax property trespassed on any historical or archaeological resources. The proposed action does not consist of any expansion of the presently developed area. Therefore, these resources will not be impacted.

Hydrology - The proposed action will result in the construction of a mound approximately 700 x 700 feet in area the highest point of which (the center) will be about 9 feet above the existing grade. This will result in no increase in total runoff from this area and while perimeter drainage ways will be provided, they will lead into existing natural drainage channels so there will be no net effect on the local surface hydrology. Likewise, due to the small area covered by the impermeable clay cap, there will be no significant effect to the vadose zone.

Land Use - The proposed action involves stabilization of portions of previously industrialized land lying within the Amax property limits. There will be no areal expansion beyond the present property boundries due to the proposed action. Therefore land use, for the purposes of this environmental assessment, is not an issue.

Natural Resources - Water - The use of natural resources in carrying out the proposed action will be insignificant. A number of thousands of gallons of water may be required for dust suppression during construction, but this is returned immediately to the environment.

Socioeconomics - The proposed project will be short-term (four to six months) and offer employment to no more than a dozen persons. It would, therefore, have no affect on the elements that comprise socioeconomics as an environmental component.

Species and Ecosystems - The area is not a habitat for any threatened or endangered species. The fact that the site has been industrialized for over 20 years renders it unattractive to all but small forms of wildlife. Soil conditions and dearth of vegetation in the area of the former Amax complex would make that particular portion of the property even less habitable.

APPENDIX B

DISCUSSION OF THE WASTE LEACHING PHENOMENA AND ASSOCIATED CONSEQUENCES

The leaching of waste constituents (U, Th, Ra, etc.) from the buried contaminated soil and the subsequent transport of these contaminants to a potable water supply is a general release scenario of concern in this environmental assessment. Quantitative estimates of the release amounts and the consequences of these releases are developed and presented in this appendix. Section B.1 presents estimates of the water balance for the soil cover overlaying the clay cap. These estimates show the timing and amount of water available at the upper layer of the clay cover. Section B.2 presents estimates of the amount of water that penetrates the clay cap under normal conditions and also estimates the transport of waste constituents away from the burial site. Section B.3 presents estimates of the leaching of waste constituents in off-normal conditions where the clay cap may be fractured. Section B.4 presents estimates of the leaching that occurs when no waste burial action is taken. Section B.5 presents a summary of the leaching analysis presented in previous sections and draws conclusions concerning the effectiveness of the proposed action.

B.1 WATER BALANCE FOR THE COVER SOIL

The soil cover which is proposed to be placed over the clay covered contaminated soil acts as both a deflector for incident rainwater as well as an absorber of water which moderates the amount of water available at the top of the clay cap. A method of quantitatively estimating the availability of water at the top of the clay cap is presented in an EPA document[1] which draws heavily on previous work by Thornthwaite.[2] This technique has been used, together with data on Parkersburg, West Virginia meteorology[3] and Wood County West Virginia soils,[4] to develop quantitative estimates of the water available at the upper surface of the clay cap. Table B.1 presents the results of this analysis and shows the expected amount of water at the surface of the clay cap. The table shows that water is expected at the cap only during the months of January through April. In other months the evapotranspiration potential and

Table B.1. Amount of Rainwater Expected to Reach the Top of the Clay Cap Each Month.

	Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean Monthly Temperature °C	0.5	1.2	6.3	12.0	17.5	22.1	24.0	23.2	19.9	13.4	7.0	2.0
Average Monthly Precipitation (cm)	8.3	7.1	9.0	8.2	8.8	10.4	10.8	9.4	7.1	6.1	6.4	7.3
Predicted Drainable Water (cm)	1.9	6.0	6.1	1.9	0	0	0	0	0	0	0	0

Note: The field capacity is estimated to be 0.4cm H_2O/cm soil.

the soil capacity are such that free water does not exist at the upper clay surface.

B.2 WATER PENETRATION OF THE CLAY CAP

Water that reaches the top of the clay cap can either run off the sides into the drainways or can penetrate the clay cap. Estimates of the amount of water which goes each way can be developed using the technique described by Wong[5] which is also discussed in an EPA report.[6] The model developed by Wong is based on analysis of a rectangular saturated volume which retains its rectangular shape while it either penetrates the clay liner or flows toward the drain. A graphical integration technique is used for the equation

$$\frac{V_1}{V_0} = \int \frac{h}{h_0} \, d\left(\frac{s}{s_0}\right)$$

The fundamental equations required to do this graphical integration are:

$$\frac{s}{s_0} = 1 - t/t_1$$

$$\frac{h}{h_0} = 1 + \frac{d}{h_0 \cos\theta} \, e^{-kt/t_1} - \frac{d}{h_0 \cos\theta}$$

with $t_1 = s_0/(k_1 \sin\theta)$ and

$$k = \frac{s_0}{d} \cdot \frac{k_2}{k_1} \tan\theta$$

where

V_1/V_0 = fraction of water volume which goes to the drain system
s = length of the saturated volume at time t (cm)
s_0 = length of the saturated volume at time = 0 (11,500 cm)
h = height of the saturated volume at time t (cm)
h_0 = height of the saturated volume at time = 0 (76.2 cm)
t = time (sec)
k_1 = saturated hydraulic conductivity of cover soil (4.23×10^{-4} cm/sec)
k_2 = saturated hydraulic conductivity of cap (1×10^{-7} cm/sec)
d = thickness of the clay liner (30.5 cm)
θ = angle of the mound slope (13.7^0)

The h/h_0 vs s/s_0 results are plotted in Figure B.1 so that the graphical integration can be made. Two curves were drawn, one for the pessimistic reference case with values listed above and one for a more optimistic case with a higher saturated conductivity for the cover soil (4.23×10^{-3} cm/sec). Integration of the curve shows that drain efficiency is expected to range from 78% to 97.5%. This means that an estimate of the annual leach generation rate can be made as follows:

$$V = \frac{Adn}{10^3}$$

$= 1.4 \times 10^6$ liters

where V = leach volume (ℓ)
A = area of the burial zone (4.05×10^8 cm^2)
d = annual depth of rainwater to reach the top of the clay cap (15.9 cm)
η = fraction of water seeping through the liner (.22)

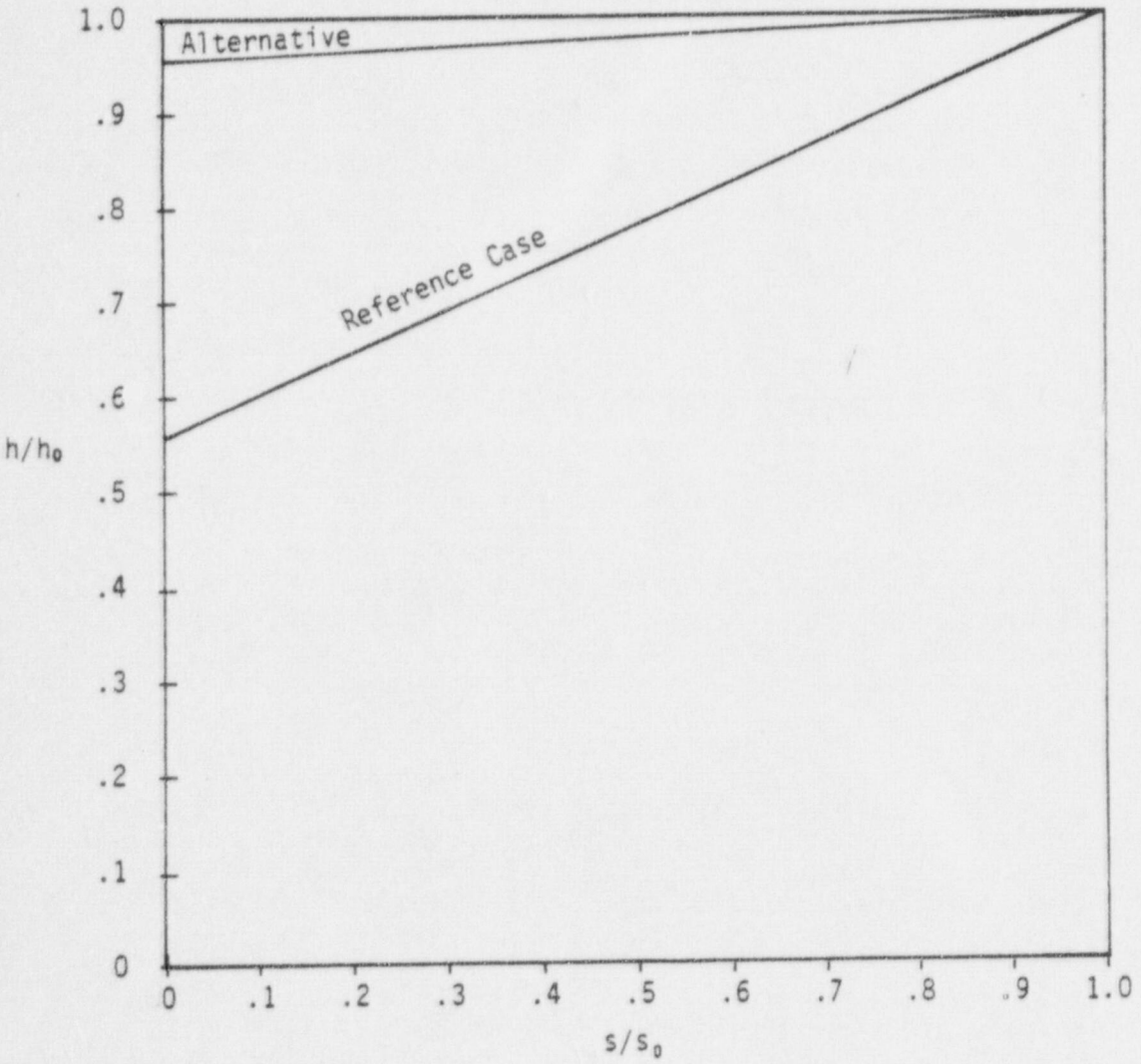
This is an estimate based on the lower drain efficiency factor. If the higher drain efficiency factor (.975) is used, a water volume of 1.6×10^5 liters is obtained.

This leaching will result in a solution containing waste components. The initial concentration of these waste components can be estimated by assuming that sparingly soluble but plentiful components (e.g., uranium, thorium) are at their solubility limit while more soluble but less plentiful components (e.g., radium) are totally solubilized.

After waste components have been solubilized and are transported by the flowing water the concentration of these materials will decrease due to three phenomena; dispersion, adsorption and decay. A simplified expression which is a useful estimator of waste component concentration after release from the burial site is the following equation[7]

$$C = \frac{C_0 V_0}{8 \times 10^3 (\pi\tau)^{3/2} \sqrt{D_x D_y D_z}} e^{-\lambda\tau}$$

where C = resulting concentration (μCi/ℓ)
C_0 = initial solute concentration (μCi/ℓ)
V_0 = leachate generation (m^3)



A plot of h/h_0 vs. s/s_0 for the proposed waste burial mound.

Figure B.1

D = diffusion coefficient (m^2/yr)

L = distance from leachate entry point (m)

λ = radionuclide decay constant (yr^{-1}) = ln 2/half life in years

τ = solute travel time for distance L (hrs) = $\frac{L}{v}(1 + \rho K_d/\theta)$

v = groundwater velocity (m/yr)

ρ = bulk density of the medium (g/cm^3)

K_d = distribution coefficient for the particular species in the particular medium (ml/g)

θ = effective porosity of the medium

A summary of the waste inventories, initial leachate concentration and leachate concentration at a point 670 meters west of the site (just prior to mixing with the Ohio River) is presented in Table B.2. Several major assumptions which were made in constructing this table are:

1. The puff dispersion model is a reasonable predictor of the concentration levels at different locations down the flow stream from the release point. This would appear to be the case because the release time (0.25 years) is much less than the travel time to the observation point (100-300 years).

2. The concentration of parent isotopes (U-238 and Th-232 are based on measurements reported by ATCOR, Inc.[8] and are set at 1.8 and 2.5 Ci respectively.

3. The concentration of daughter isotopes down to actinium and proactinium are assumed to be in equilibrium with the parent isotopes because of their limited solubility.

4. Radium and its daughters will exist at levels significantly below equilibrium levels because its moderate solubility (about 11 grams/liter) allows it to be washed away by each year's water seepage (1.6×10^5 liters). In fact, only one year's amount of production will be assumed available during the start of the leach cycle.

The consequences of these normal releases can be bounded by examining the dose consequences to anyone drinking the water prior to entering the Ohio River. Any doses resulting from water consumption after the dilution by the Ohio River would be orders of magnitude lower.

The 50-year dose commitment to an individual whose annual water intake consists entirely of contaminated water would be:

Table B.2. Calculation Table for the Leaching and Transport of Radionuclides from the Proposed Amax Inc. Burial Mound.

Radionuclide	Waste Inventory (Ci)	Initial Leachate Concentration, C_0 (μCi/ℓ)	C_0V_0 (μCi) [3]	λ(yr^{-1}) [4]	τ(yr) [5]	C_{outlet} (μCi/ℓ)
Ra-226	1.5×10^{-5} [1]	9.4×10^{-5}	1.5×10^{1}	4.4×10^{-4}	216 years	3.1×10^{-8}
Ra-228	0 [2]	0	0	1.0×10^{-1}	216 years	0
Th-230	1.8	4.6×10^{-9}	7.4×10^{-4}	8.4×10^{-6}	324 years	9.0×10^{-13}
Th-232	2.5	6.4×10^{-9}	1.0×10^{-3}	5.0×10^{-11}	324 years	1.2×10^{-12}
U-234	1.8	1.3×10^{-2}	2.1×10^{3}	2.6×10^{-6}	109 years	1.3×10^{-5}
U-238	1.8	1.3×10^{-2}	2.1×10^{3}	1.5×10^{-10}	109 years	1.3×10^{-5}

[1] $C_{Ra\text{-}226} \simeq C_{Th\text{-}230}(1-e^{-\lambda Th230(1)})$ - i.e., the amount of radium-226 produced in one year.

[2] $C_{Ra\text{-}228} \simeq C_{Th\text{-}232}(1-e^{-\lambda Th232(1)})$ - i.e., the amount of radium-228 produced in one year.

[3] Leach volume - 1.6×10^{5} liters over a four-month period.

[4] λ = ln 2/half-life in years

[5] τ = travel time = $\frac{L}{v}(1+\frac{\rho K_d}{\theta})$; L = 670 meters; v - 700 meters/year; ρ = 1.8 g/cm^3; θ = 0.4; K_d = 50 ml/g for thorium and 25 ml/gram for uranium.

$$D_i = C_i I_W DCF_i$$

where D_i = 50-year dose commitment from isotope i (rem)
C_i = concentration of isotope i (μCi/ℓ)
I_W = individual's annual water intake (800 ℓ/yr)
DCF_i = 50-year dose conversion factor (rem/μCi)

A summary of the calculated doses is presented in Table B.3. The table shows that doses are minimal with doses of tens of millirem being received by the total body and the bone. From this it can be extrapolated that the more probably doses which would result from radionuclide consumption following dilution into the Ohio River would be nondetectable.

B.3 OFF-NORMAL LEACHING CONDITIONS

In addition to the normal leach conditions discussed in Section B.2 it must be recognized that a degradation of the cap could cause additional leaching to occur. Accurate prediction of the degree of cap failure is impossible to predict but some reasonable assumptions can be made and the effects evaluated. For this particular analysis, it is assumed that the clay cover is effective in diverting only 50% of the water at its upper surface. This means that a leach volume of 3.2×10^6 liters are generated annually. The impact of this is presented in Table B.4 which is a simplified version of Table B.2. This table shows a factor of 20 increase in the concentrations of thorium and uranium. This would mean an increase in doses from uranium from those established in Table B.3.

B.4 LEACHATE CONCENTRATION IF NO ACTION IS TAKEN

It is also possible to estimate the leachate concentration resulting from the present situation where no waste cover exists. The estimate is generated by assuming that:

1. Each year's generation of radium (1.5×10^{-5} Ci) is washed away because of its significant solubility.

2. The annual amount of leachate produced is 50% of the annual precipitation times the contaminated area (10 acres) or a volume 2×10^7 liters.

With these assumptions, Table B.5 has been prepared. Analysis of the table shows that the predictive models for radium and thorium appear reasonable in

Table B.3. Estimated Dose to a Hypothetical Individual Consuming Leachate at a Point Just Prior to Mixing With the Ohio River.

Radioisotope	Concentration (μCi/ml)	Dose to Various Organs (rem)			
		Total Body	Liver	Bone	G.I. Tract
Ra-226	3.1×10^{-11}	1.1×10^{-2}	2.7×10^{-7}	1.5×10^{-2}	1.6×10^{-5}
Ra-228	0	0	0	0	0
Th-230	9.0×10^{-16}	$<10^{-15}$	$<10^{-15}$	$<10^{-15}$	$<10^{-15}$
Th-232	1.2×10^{-15}	2.8×10^{-10}	1.9×10^{-10}	4.3×10^{-9}	9.7×10^{-11}
U-234	1.3×10^{-8}	1.0×10^{-3}	1.0×10^{-3}	1.8×10^{-2}	1.2×10^{-3}
U-238	1.3×10^{-8}	9.5×10^{-4}	9.5×10^{-4}	1.6×10^{-2}	1.1×10^{-3}
Total		1.2×10^{-2}	1.9×10^{-3}	4.9×10^{-2}	2.3×10^{-3}

Table B.4. Calculation Table for the Leachate Concentrations Under Off-Normal Conditions.

Radionuclide	Waste Inventory (Ci) [1]	Initial Leachate Concentration (μCi/ℓ) [2]	C_{outlet} (μCi/ℓ) [3]
Ra-226	1.5×10^{-5}	4.7×10^{-6}	3.1×10^{-8}
Ra-228	0	0	0
Th-230	1.8	4.6×10^{-9}	1.8×10^{-11}
Th-232	2.5	6.4×10^{-9}	2.4×10^{-11}
U-234	1.8	1.3×10^{-2}	2.6×10^{-4}
U-238	1.8	1.3×10^{-2}	2.6×10^{-4}

[1] Initial inventories same as in Table B.1.

[2] Initial concentration of radium decreased by dilution effect; Th, U are unchanged because they are based on solubility limits.

[3] The same factors used for λ and for τ in Table B.1 are used here.

Table B.5. Predicted and Measured Leachate Concentrations Beneath the Amax Inc. Site

Radionuclide	Predicted (pCi/ℓ)	Measured (pCi/ℓ)
Ra-226	0.75	0.04
Th-230	0.0046	0.006 - 0.016
Th-232	0.0064	0.001 - 0.013
U (234 and 238)	26,000	0.5 - 2.0

that they compare with predicted numbers within an order of magnitude. The uranium leachate is overpredicted by a significant amount. Two possible reasons for this overprediction are 1) selective adsorption of leached uranium before or after it reaches the water table, or 2) a very slow reaction rate (kinetics) for the dissolution of uranium at lower temperatures (≤25°C). This second phenomena has been reported by Ogard et al.[9]

B.5 SUMMARY

This appendix has presented a quantitative analysis of the hydrologic performance of the proposed contaminated burial site. The analysis has shown that the concentration of radioisotopes in the leachate is minimal and that the doses resulting to a hypothetical person who might consume the leachate before it is mixed with the Ohio River are minimal (49 mrem/50 years to the bone). The more credible doses which would result to someone using or consuming Ohio River water would be many orders of magnitude lower because of natural dilution with the Ohio River waters. Under off-normal or no action conditions the amount of uranium and thorium leached would be increased with a resulting increase in downgradient uranium and thorium concentrations. The result is doses which increase by about an order of magnitude.

Based on the ability to predict existing groundwater concentrations, the quantitative predictions are considered to be accurate within an order of magnitude for radium 226 which is one of the major dose contributing isotopes and pessimistic for uranium 234 and 238 which are the other major dose contributing isotopes.

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APPENDIX C

CALCULATION OF RADON FLUX FROM THE PROPOSED BURIED MOUND

This appendix summarizes the method used for estimating the radon emission rate from the proposed burial mound and presents the calculations which establish the estimate.

Radon exhalation from radioactive waste can be attenuated by providing covers over the burial site. The degree of radon emission attenuation depends upon the cover material's ability to restrict the diffusion of radon, and the cover thickness. The method used in this assessment for estimating the radon attenuation through a cover is based on Appendix P of "Final Generic Environmental Impact Statement on Uranium Milling" report (NUREG-0706).

The proposed burial site will consist of radioactive soils covered by a composite soil cover. The materials and thickness of the cover are illustrated in Figure 3.14. As shown in this figure, the cover is comprised of a 6-inch layer of clayey soil, a 12-inch layer of impermeable clay and a 30-inch layer of vegetated top soil.

The calculation for the rate of radon diffusion through a composite soil cover can be obtained using the following equation:

$$J_n = J_o \left(\prod_{m=1}^{n} f_m\right) \exp\left(-\sum_{m=1}^{n} b_m x_m\right) \qquad (1)$$

where:

J_n = radon flux at the surface of the n^{th} layer of the cover $(\frac{pCi}{m^2 s})$

J_o = radon flux at the surface of the radioactive soil layer $(\frac{pCi}{m^2 sec})$

$b_m = (\frac{\lambda P_m}{D_m})^{\frac{1}{2}}$

λ = decay constant of radon isotopes (sec^{-1})

D_m = effective bulk diffusion coefficient of the m^{th} layer $(\frac{cm^2}{sec})$

P_m = porosity of the soil material of the m^{th} layer

x_m = the thickness of the m^{th} layer (cm)

The function f_m is given by the following expression:

$$f_m = \frac{2}{\left(1 + \frac{P_{m-1}}{P_m}\left[\frac{D_{m-1}/P_{m-1}}{D_m/P_m}\right]^{\frac{1}{2}}\right) + \left(1 - \frac{P_{m-1}}{P_m}\left[\frac{D_{m-1}/P_{m-1}}{D_m/P_m}\right]^{\frac{1}{2}}\right) e^{-2b_m x_m}} \qquad (2)$$

The term for the radon flux at the surface of the radioactive soil is given as follows:

$$J_o = [Ra]\rho E\left[\frac{\lambda D_o}{P_o}\right]^{\frac{1}{2}} \quad (10^4\ cm^2/m^2) \qquad (3)$$

where

[Ra] = concentration of radium in the contaminated soil ($\frac{pCi}{gm}$)

ρ = density of the contaminated soil (g/cc)

E = emanating power

The sources of radon generation considered in this study are Th-232 for Rn-220 and U-238 for Rn-222. The decay chain of Th-232 generates Ra-228 which then decays to Rn-220. Because of the long half-life of Th-232, the annual amount of leachate generated and the high solubility of Ra-228, the amount of Ra-228 estimated to be accumulated in the mound is negligible. Thus generation of Rn-220 will not be significant. On the other hand, the decay chain of U-238 produces during one year measurable amounts of Ra-226 which in turn decay to Rn-222. The estimated quantity of Ra-226 generated in the burial mound each year is calculated at 1.5×10^{-5} Ci (see Appendix B). This quantity of Ra-226 concentration is associated with about 10,000 cubic yards of soil and so the average concentration is 1.4×10^{-3} $\frac{pCi}{gm}$.

The average density of the contaminated soil is assumed to be similar to the average density of the natural soil at the site which is about 1.3 g/cc. The emanating power represents the percentage of the quantity of radon gas available for release from the contaminated soil in which it is generated. The emanating power can then be assumed at 20% as was done in NUREG-0706.

Values of the effective bulk diffusion coefficient (D) may be measured experimentally for any given material at ambient moisture level and expected degree of compaction. In cases where values of D are not readily available, they can be obtained through the use of an empirical equation obtained from experimental data:

$$\frac{D}{P} = 0.106 \exp(-0.261\ M) \qquad (4)$$

where M is the weight-percentage of soil moisture, D is the effective bulk diffusion coefficient and P is the porosity of the soil.

The moisture percentages of the different layers of the mound cover are not readily available, thus approximate values are estimated for these layers as follows:

- For the excavated radioactive soil or layer (0), the soil moisture percentage is estimated at 6 to 8% which is typical for non-clay soils.
- For layer (1), the soil can be termed as clayey material, thus the moisture percentage is assumed to be from 8% to 10%.
- The layer (2) consists of highly impermeable clay, thus its moisture percentage is assumed to be from 9% to 15%.
- The moisture percentage of the top soil layer or layer (3) is again assumed to be from 6 to 8% as in layer (0).

From the estimated moisture percentages, equation (4) can thus be used to calculate the ratio of the bulk effective diffusion coefficient and the porosity of the soil for each individual layer (D_m/P_m).

Layer (0): $M_{average} = 7\%$

$$\frac{D_0}{P_0} = 0.106 \exp(-0.261 \times 7) = 0.017\ cm^2/sec$$

Layer (1): $M_{average} = 9\%$

$$\frac{D_1}{P_1} = 0.106 \exp(-0.261 \times 9) = 0.010 \text{ cm}^2/\text{sec}$$

Layer (2): $M_{average} = 12\%$

$$\frac{D_2}{P_2} = 0.106 \exp(-0.261 \times 12) = 0.005 \text{ cm}^2/\text{sec}$$

Layer (3): $M_{average} = 7\%$

$$\frac{D_3}{P_3} = 0.017 \text{ cm}^2/\text{sec}$$

The porosity of each soil layer is calculated from the following equation:

$$\text{Porosity (P)} = 100\% - \left(\frac{\text{bulk density}}{\text{particle density}} \times 100\right)$$

The following data on bulk density and particle density for each layer are estimated from literature information.

	Bulk Density	Particle Density
Clay	1.65 g/cc	2.65 g/cc
Clayey soil	1.60 g/cc	2.65 g/cc
top soil	1.30 g/cc	2.65 g/cc

Thus the calculated porosity values of layer (0), (1), (2), and (3) are 51%, 40%, 38%, and 51% respectively.

Table C.1 summarizes the pertinent properties of each layer.

Table C.1. Estimated Properties of the Material of the Cover Layers

Layer	Type of Soil	D_m/P_m (cm^2/sec)	P_m (%)
(0)	Silty loam, clayey loam	0.017	51
(1)	Clayey soil	0.010	40
(2)	Clay	0.005	38
(3)	Silty loam, clayey loam	0.017	51

The thickness of layers (1), (2) and (3) are respectively 15 cm, 30 cm, and 75 cm.

Estimate for Rn-222 Generation

As discussed previously, the source of Rn-222 generation is Ra-226 which is a decay product of U-238. The concentration of Ra in the contaminated soil available for Rn-222 generation is estimated at 1.4×10^{-3} pCi/g.

The radon flux at the surface of the radioactive soil can then be calculated using equation (3). With

$\lambda = 2.1 \times 10^{-6}\ sec^{-1}$ (Rn-222 decay constant)

$\frac{D_0}{P_0} = 0.017\ cm^2/sec$

$E = 0.2$

$\rho = 1.3\ g/cc$

then J_0 is given as follows:

$$J_0 = (1.4 \times 10^{-3})(1.3)(0.2)(2.1 \times 10^{-6} \times 0.017)^{\frac{1}{2}}(10^4)$$

$$= 6.88 \times 10^{-4}\ pCi/m^2 sec$$

To calculate the radon flux at the surface of the top soil layer (J_3), equation (1) can be rewritten as follows:

$$J_3 = J_0 \left(\prod_{m=1}^{m=3} f_m\right) \exp\left(-\sum_{m=1}^{m=3} b_m x_m\right)$$

or

$$J_3 = J_0 (f_1 f_2 f_3) \exp(-[b_1x_1 + b_2x_2 + b_3x_3]) \quad (5)$$

$$b_m x_m = \left(\frac{\lambda P_m}{D_m}\right)^{\frac{1}{2}} x_m$$

$$b_1x_1 = \left(\frac{\lambda P_1}{D_1}\right)^{\frac{1}{2}} x_1 = \left(\frac{2.1\times10^{-6}}{0.010}\right)^{\frac{1}{2}} (15) = 2.175\times10^{-1}$$

$$b_2x_2 = \left(\frac{\lambda P_2}{D_2}\right)^{\frac{1}{2}} x_2 = \left(\frac{2.1\times10^{-6}}{0.005}\right)^{\frac{1}{2}} (30) = 6.15\times10^{-1}$$

$$b_3x_3 = \left(\frac{\lambda P_3}{D_3}\right)^{\frac{1}{2}} x_3 = \left(\frac{2.1\times10^{-6}}{0.017}\right)^{\frac{1}{2}} (75) = 8.325\times10^{-1}$$

and f_m is presented as in equation (2); thus:

$$f_1 = \frac{2}{\left(1 + \frac{P_0}{P_1}\left|\frac{D_0/P_0}{D_1/P_1}\right|^{\frac{1}{2}}\right) + \left(1 - \frac{P_0}{P_1}\left|\frac{D_0/P_0}{D_1/P_1}\right|^{\frac{1}{2}}\right) e^{-2b_1x_1}} = 0.895$$

where $P_0 = 0.51$; $P_1 = 0.40$; $D_0/P_0 = 0.017$ cm^2/sec; $D_1/P_1 = 0.01$ cm^2/sec and $b_1x_1 = 2.175\times10^{-1}$

$$f_2 = \frac{2}{\left(1 + \frac{P_1}{P_2}\left|\frac{D_1/P_1}{D_2/P_2}\right|^{\frac{1}{2}}\right) + \left(1 - \frac{P_1}{P_2}\left|\frac{D_1/P_1}{D_2/P_2}\right|^{\frac{1}{2}}\right) e^{-2b_2x_2}} = 0.853$$

where $D_2/P_2 = 0.005$ cm^2/sec, $P_2 = 0.38$, $b_2x_2 = 6.15\times10^{-1}$

$$f_3 = \frac{2}{\left(1 + \frac{P_2}{P_3}\left|\frac{D_2/P_2}{D_3/P_3}\right|^{\frac{1}{2}}\right) + \left(1 - \frac{P_2}{P_3}\left|\frac{D_2/P_2}{D_3/P_3}\right|^{\frac{1}{2}}\right) e^{-2b_3x_3}} = 1.319$$

where $D_3/P_3 = 0.017$ cm^2/sec; $P_3 = 0.51$; $b_3x_3 = 8.325\times10^{-1}$
thus:

$$J_3 = J_0 (f_1 f_2 f_3) \exp(-[b_1x_1 + b_2x_2 + b_3x_3])$$

$$= 6.88\times10^{-4} \frac{pCi}{m^2 sec} (0.895)(0.853)(1.319) e^{-(0.2175 + 0.615 + 0.8325)}$$

$$= 1.31\times10^{-4} \text{ pCi/m}^2\text{sec}$$

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

MAY 5 1982

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USNRC REGION 4
MAIL SECTION

AMAX Environmental Services, Inc.
ATTN: Mr. James E. Kerrigan
Senior Environmental Engineer
Denver West Office Park
1707 Cole Boulevard
Golden, Colorado 80401

Gentlemen:

Enclosed for your information are five copies of our environmental impact appraisal of the proposed site stabilization at AMAX Inc.'s Parkersburg, West Virginia site. We have also enclosed for your information five copies of the notice which will be published in the Federal Register.

Sincerely,

W.A. Nixon

W. A. Nixon
Uranium Process Licensing Section
Uranium Fuel Licensing Branch
Division of Fuel Cycle and
Material Safety, NMSS

Enclosures:
1. Environmental Impact Appraisal
2. Notices

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UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NO. 40-8355

AMAX INC.

NEGATIVE DECLARATION REGARDING STORAGE OF

CONTAMINATED SOIL UNDER LICENSE

The U.S. Nuclear Regulatory Commission (the Commission) is considering licensing AMAX Inc., to stabilize and store soil contaminated with source material at a site in Wood County, West Virginia. The low-level contamination resulted from past zirconium ore processing operations at the site. AMAX Inc. has proposed to collect and move all soil contaminated above acceptable limits to a central area on the site and to stabilize the wastes under a clay cap designed to reduce water infiltration, prohibit dispersal of solid radioactive particulates into air and to limit any radon or thoron emissions. The stabilized material would remain in storage under a license issued by the Commission to AMAX Inc.

The Commission's Division of Fuel Cycle and Material Safety has prepared an environmental impact appraisal for the proposed contaminated soil stabilization and storage actions. On the basis of this appraisal, the Commission has concluded that the environmental impact created by the proposed actions would not be significant and does not warrant the preparation of an environmental impact statement, and, accordingly, it has been determined that a negative declaration is appropriate. The environmental impact apppraisal is available for public inspection at the Commission's Public Document Room

at 1717 H Street, N.W., Washington, D.C. A copy may be obtained upon request addressed to the U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, ATTENTION: Director, Division of Fuel Cycle and Material Safety.

Dated at Silver Spring, Maryland, this 3rd day of May, 1982.

R. G. Page, Chief
Uranium Fuel Licensing Branch
Division of Fuel Cycle and
Material Safety, NMSS

ENVIRONMENTAL IMPACT APPRAISAL

AMAX INC.

PARKERSBURG, WEST VIRGINIA SITE

DOCKET NO. 40-8355

PROPOSED SITE STABILIZATION

PREPARED BY

DIVISION OF FUEL CYCLE

AND MATERIAL SAFETY

U. S. NUCLEAR REGULATORY COMMISSION

APRIL 1982

APPENDIX D