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STUDY OF RADIOACTIVE WASTE STORAGE AREAS AT THE FED MATERIALS PRODUCTION CENTER APRIL 25, 1977

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STUDY OF RADIOACTIVE WASTE STORAGE AREAS AT THE FEED MATERIALS PRODUCTION CENTER

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NATIONAL LEAD COMPANY OF OHIO
P. O. Box 39158
Cincinnati, Ohio 45239

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UNITED STATES ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
OAK RIDGE OPERATIONS OFFICE

2675

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I. SITE

A. Description

The Feed Materials Production Center (FMPC) is an industrial facility owned by the United States Energy Research & Development Administration and operated by the National Lead Company of Ohio. It is located near Fernald, Ohio, on a 1050-acre site about ten miles northwest of Cincinnati and eight miles southwest of Hamilton. Most of the site, including all of the production and waste storage areas, is in Hamilton County, Crosby Township. Approximately 200 acres, mostly grass covered with some shrub- and tree-covered sections, are in Butler County, Ross Township. See Figure 1 for the general location of the FMPC. Figure 2 shows some detail of the FMPC and the surrounding area.

The primary work at the FMPC is the production of purified uranium metal and compounds for use at other ERDA sites. In regard to ^{235}U content, the uranium may be depleted, normal, or slightly enriched. The average content is close to normal. Through 1976, the plant's major starting material was semi-pure uranium concentrate and most of the waste stored at the FMPC resulted from the conversion of this material to pure UO_3 or reactor-grade uranium metal. A small amount of thorium work has also been done. The processing of recycle uranium and

thorium has introduced minimal amounts of transuranics and fission products into the waste storage areas.

1. Physiography

(a) Topography. The FMPC is situated on a terrace ranging in altitude from 575 to 600 feet, about 50 feet above the Miami River floodplain. Nearby hills, which rise to 900 feet, mark the limits of an ancient river valley which was filled in with glacial till. In the FMPC area, this valley is about three miles wide.

(b) Land available. Production and waste storage areas at the FMPC are relatively flat, with the elevation changes occurring chiefly at the project boundaries.

Since the time that production began in 1952, approximately 18 acres have been committed for waste storage and disposal. About the same amount of space is available between the storage and production areas for additional storage and disposal facilities. A considerably greater amount of land is available north of the pit area.

The waste area is located on the west side of the project, about 900 feet from the project boundary. Paddy's Run, a small stream which has intermittent flow, runs along the west side of the project and is located between the waste area and the property line. See Figure 3. The storage-disposal area is

flat, with some sloping due to the final dirt covering over buried wastes. Final grading over retired burial pits is designed to avoid low spots and provide for good surface drainage with run-off directed into an active clearwell.

2. Cultural Factors

(a) Demography and land use. The land surrounding the FMPC is primarily used for agriculture. There are 27 residences on the north side of the project and most of these are in a subdivision to the northeast. Otherwise, there are approximately ten scattered residences and one small business located in the adjacent areas. In recent years, a trailer park was established about 1-1/2 miles southeast of the waste storage area. The population and location of nearby towns and cities are given in Table 1.

Hamilton and Butler Counties have a considerable amount of industrial activity but the major economic activities in this rural area are farming, dairying, and the raising of beef cattle. Several small industries are located within a few miles of the site.

Farm crops include sweet corn, grain corn, soybeans, and wheat. Truck crops are widely grown and sold at local produce stands and in nearby urban markets. In the Miami River flood plain, east of the FMPC, the soil is fertile and is reported to

contain some of the best farm land in the state. In the gently rolling uplands west of the flood plain, the soil contains more clay and is less fertile. The growing season is 180 days.

Although the area around the FMPC is rural, Hamilton and Butler Counties are not among the state's leading agricultural counties. For 1974, in cash receipts from nine major agricultural commodities, Hamilton County was among the top ten of Ohio's 88 counties in only one commodity, greenhouse and nursery products.(1) The county ranked seventh with receipts of 3.7 million dollars from this farm activity. Butler County was not ranked among the top ten counties in any of the nine major commodities. Grain corn is the major crop in both counties in regard to total acreage.(2) In 1975, the acreage used was 6,700 acres in Hamilton County and 49,700 acres in Butler County with an average yield of 79.4 bushel per acre. Total grain corn acreage in Ohio in 1975 was 3.5 million acres and the average yield was 92.0 bushels per acre.

The nearest Hamilton County park is the Miami Whitewater Forest located approximately five miles southwest of the plant site in northwest Hamilton County. The park contains 2,031 acres in a natural state for wildlife sanctuaries. The park is well known for its white-tail deer, predatory birds, and rare plantlife. Recreation facilities consist of summer concerts and movies at the harbor area, hiking, Braille Trail for the blind,

85-acre lake for fishing and boating, wildlife cruise boat, golf course, four youth camps, family camp, ballfields, playfields, outdoor education, winter sports - sledding, ice skating, skiing, and museum and visitor center.

Fort Scott Camps, owned by the Archdiocese of Cincinnati, is two miles southeast of the FMPC and is located on River Road, New Baltimore. This camp contains five hundred wooded acres on a hill overlooking the Great Miami River. Fort Scott Camps were originally started in 1922 to provide camping facilities for intercity children. Present capacity is 472 campers and the camp is used during ten weeks in the summer. The present facilities include cabins, swimming pool, riding stables, tennis courts, and hiking trails.

Camp Ross Trails, owned and operated by the Girl Scouts of America, is approximately two miles northeast of the plant, on Layhigh Road, Ross. The camp contains approximately 300 acres of woods and meadows. Camp Ross Trails was established in 1960 and now has facilities to serve between 5,000 and 6,000 girls per year. Areas are provided and equipped for resident camping in the summer and troop camping the year around. The camp grounds also have historical importance because of Indian earth works preserved there.

There are two large consolidated public school systems in the near vicinity of the plant site. The Ross Local School District has three schools, about four miles to the northeast. Total enrollment is 2,070. The Southwest Local School District has four schools to the south and west of the plant, within a radius of six miles. The total enrollment of these four schools is 1,884.

(b) Archeology and historical features. Four prehistoric indian sites listed in the National Register of Historic Places are located within a three-mile radius of the FMPC. The "Adena Circle" and "Demoret Mound" are located on the grounds of Camp Ross Trails and are being preserved by the camp owners. The "Colerain work" is a fortification or sacred enclosure surrounding about 95 acres in a large horseshoe of the Great Miami River, about one mile east of the plant. The parapet of these ancient remains is fairly well preserved and in places is 8-10 feet high. Nearby, overlooking the Colerain site, is the "Dunlap work," a site with prehistoric origins which is believed to have had later use as well.

The Miami Purchase Association is an independent local historical society which acts as the Southwestern Ohio Regional Preservation Office for the Ohio Historical Society. Records

maintained by this local group do not indicate that the area occupied by the FMPC contains any known sites of archaeological importance.(3) A complete archaeological survey of the Paddy's Run area is planned for 1979.

The old village of Whitewater, more commonly known as "Shakers' Town" is situated on the Dry Fork of the Whitewater, in Crosby Township approximately five miles west of the plant site. It had its origin about the year 1820, with the United Society of Believers, commonly called "Shakers'." Originally, this society engaged in some manufacturing and in the raising of garden seeds, but later turned exclusively to farming and expanded their holdings from forty acres to twelve hundred acres in only a few years. They replaced their first log cabins with dormatory-type brick structures which are presently privately-owned and well kept landmarks.

The town of New Baltimore, located two and a half miles from the plant site, played a role in Civil War History. General John Hunt Morgan and a party of approximately 225 men raided the farm area adjacent to New Baltimore in July, 1863. They stopped at a blacksmith shop operated by William Raisch, Sr., the only smith in the area, and forced him to shoe some of Morgan's horses. The old Raisch farmstead on Flick Road, one

mile south of New Baltimore, remains intact. Following his raid, Morgan burned the New Baltimore bridge to delay his pursuers.

Old Fort Dunlap or Colerain village is located about two miles to the east of this site and on the opposite bank of the Great Miami River. This village and small fort was founded in 1790 by John Dunlap, an immigrant from Colerain in the north of Ireland.

Fort Dunlap is principally memorable as the scene of the fiercest and longest sustained Indian attack recorded in the annals of Hamilton County. The little garrison suffered severe losses and the fort was damaged by fire. The women of the settlement played an important role in the defense of the fort during this attack. They exhibited the caps of soldiers above the pickets to draw the Indians' fire and when the garrison was in danger of falling short of bullets, the women melted down all the pewter plates and spoons to keep up the supply. The continuous siege had lasted more than twenty-four hours when the Indians, despairing of success and perhaps apprehensive of the arrival of reinforcements from Cincinnati, retreated. Stone monuments have been erected in that area to mark the location of the old Fort.

(c) Future land use. The Great Miami River basin area has been the subject of several water resource studies. According to these studies, the basin's population is expected to grow by about 50% from 1960 to 1980, and 100 percent from 1960 to 2000. It is anticipated that manufacturing productivity will increase at twice the rate of population growth, thus generating a significant increase in the waste water that must be treated and eventually discharged to the river.[4]

These studies that forecast population growth were centered around the industrial area between Dayton and Hamilton. Because of the lack of industry, growth in the FMPC area will be much less than that expected for the upstream urban areas. Up to the year 2000, growth in the area from New Baltimore to the Ohio River is expected to be low and will produce very little additional pollution load in the Great Miami. In this lower stretch, the lack of a large pollution load is expected to enable the water quality to recover from the upstream burdens. Based on these studies and expectations, it appears reasonable to conclude that land availability in the FMPC area will not become critical during the next several decades.

3. Climatology

Climatological data for this area are available from two Environmental Data Service Stations: (1) the Abbe Observatory

located in Cincinnati, Ohio, and (2) the Greater Cincinnati Airport, located about 12 miles southwest of downtown Cincinnati and about two miles south of the Ohio River in the State of Kentucky.

Colder nocturnal temperatures are experienced at the airport location than at the Abbe Observatory, due primarily to the suburban location with its attendant stronger radiational cooling. The FMPC is also located in a suburban (or rural) area, and for this reason the information presented here has been taken from the data recorded at the airport station, plus available data from FMPC observations.[5,6]

The climate is continental with a rather wide range of temperatures from winter to summer. A precipitation maximum occurs during winter and spring with a late summer and fall minimum. On the average, the maximum snowfall occurs during January, although the heaviest 24-hour amounts have been recorded during late November and February.

The freeze-free period lasts on the average 187 days from mid-April to the latter part of October.

The heaviest precipitation, as well as the precipitation of the longest duration, is normally associated with low pressure

disturbances moving in a general southwest to northeast direction through the Ohio valley and south of the Cincinnati area.

Summers are warm and rather humid. The temperature will reach 100°F or more one year out of three. However, the temperature will reach 90°F or higher about 26 days each year. Winters are moderately cold with frequent periods of extensive cloudiness.

(a) Precipitation. The normal annual precipitation, in water equivalent inches, is 39.04. Annual record mean precipitation is 40.40 inches. For both precipitation and temperatures, all normal values are based on the record for the 1941-1970 period; all record mean values are means for the period 1948-1975.

Maximum precipitation for a single month during the 28-year period (1948-1975) was 12.18 inches during March 1964 and the minimum was 0.18 inches in September 1963. A 24-hour period maximum of 5.21 inches occurred in March 1964. The record mean and normal precipitation by month for the 1948-1975 period are shown in Table 2.

A summary of precipitation data for the FMPC from 1960 through 1976 is given in Table 3. The maximum monthly

precipitation was 11.15 inches in March 1964. Minimum monthly precipitation was 0.04 inches measured in October 1963.

Snow and ice pellet data for the 1947-48 through 1975-76 period show that the maximum monthly accumulation was 15.3 inches in January 1964 and the maximum in a 24-hour period was 9.8 inches in March 1968. Snowfall record means, by month, for the same 28-year period are listed in Table 4.

(b) Temperature. The normal average temperature is 54.0°F and the record mean is 53.9°F. The record high was 102°F in August, 1962 and through 1976, the record low was -19°F in January, 1936. However, on January 18, 1977, a record low of -25°F was recorded.

Record mean and normal temperatures by month for the 1948-1975 period are shown in Table 5.

(c) Wind. Mean speed data have been collected over a 28-year period; prevailing wind direction data over a 16-year period; fastest mile and direction over a 12-year period.

The prevailing wind direction is SSW at a mean speed of 9.1 mph. The fastest mile recorded was 40 mph from the SSW occurring in February, 1967; April, 1970; January and June, 1971; and December, 1973. The only wind rose available at this time

(Figure 4) was plotted using data from the U. S. Weather Service for the area of the Greater Cincinnati Airport.[7] The only conclusion one can draw from this data is that there is a slightly higher probability that the wind will be from a southwestern direction. Winds of similar velocity, however, may be from any other direction at a given time.

A survey of the NLO records indicates that wind speed (gusts) exceeded 50 mph on eleven occasions during the period 1960-1976; wind speed exceeded 60 mph (slightly) on two occasions during this period.[6]

4. Geology

Glacial actions during the time of the Illinoian and Wisconsinan ice sheets gave the area its basic geological features. In the FMPC area, outwash from retreating glaciers filled in the wide valley of a large ancient river. Through this fill, the Miami River has cut its present course and the river bed is now located about 60 feet below the original level of the glacial deposits.

The relatively broad valley "low" between two topographic "highs" which trends northwest from the FMPC and then bends toward the west at Shandon is believed to have been cut by the Dry Fork Creek when it was, prior to glaciation, a major

tributary to the ancestral Great Miami River, Paddy's Run Creek presently flows through this abandoned waterway. After blockage by glaciation, the Dry Fork cut its present course and now flows into the Whitewater River about nine miles southeast of the FMPC. High areas to the north and southwest are believed to be in most part expressions of Ordovician bedrock which survived stream and glacial erosion. The highest elevation is about 920 feet above sea level at a location approximately several miles northwest of the site.

The FMPC is located on a relatively flat terrace at an elevation of about 50 feet above that of the present Great Miami River. The Great Miami is located east and south of the site area and flows from northeast to southwest. The terrace effect, sharply defined by the 550-foot contour just east of the plant reflects the down-cutting into unconsolidated glacial drift by the present-day Great Miami River. See Figure 5. Indian Creek, Paddy's Run, and the Whitewater River are nearby tributaries to the Great Miami River.

(a) Soil types. Soils at the FMPC site are categorized as Fincastle-Xenia silt loams.[8] These soils are light colored, medium acid and moderately high in productivity when properly managed. Moisture-supplying capacity is moderate, as is

fertility and organic content. They have formed in 18-40 inches of loess over limy loam till of Wisconsin age. Fincastle soils have poor drainage and in areas where this soil is predominant, artificial drainage is required for moderate crop productivity. If artificial drainage is not used, the water table remains high for extended periods in winter and spring.[9] Fincastle-Xenia soils cover large areas west of the FMPC.

Soils in the Great Miami River flood plain are classified as Genessee silt loam and Genessee loam.[8] These soils are characterized by moderate permeability, deep root zone and high available water capacity with slow runoff. They form valuable cropland and, because of good drainage, are easily worked in early spring while the upland Fincastle soils are still wet and muddy.

In other nearby areas of Hamilton and Butler counties, the predominant farm soils are the Russell, Xenia and Wynn types. A comparison of the agricultural value of these soils is given in Table 6.[9]

(b) Stratographic units. Bedrock for much of southwestern Ohio and for the FMPC site area in particular consists of very old, indurated shales and limestones of Upper Ordovician Age, probably deposited about 400 million years ago. The Ordovician

bedrock consists primarily of fossiliferous marine limestone and shales laid down in a shallow epicontinental sea which inundated much of the central part of the United States. Land area during this period in geologic history lay a considerable distance to the east.

Uncomformably overlying these ancient Ordovician rocks are glacial deposits of Pleistocene Age. These glacial deposits are identified with the two youngest of four massive continental ice sheets known to have encroached upon much of North America during the past one million years.

With one minor exception, a short lobe which protruded as far as New Baltimore, the last glacial intrusion into the area extended no further south than the bluffs along the south side of the Miami Valley. When the ice melted back from the valley the accumulated drift deposits from the glaciers filled it to a height of more than 200 feet above its bedrock floor of limestone and shale. Probably most of the drift now lying at the surface was deposited by the last glacier, the Wisconsin Glacier. Subsequent erosion by the Miami River and its tributaries have since trimmed away substantial portions of this glacial fill, leaving terrace remnants standing higher than the adjacent bottom lands.

(c) Sub-surface characteristics.[10,11] The top 25 feet of soil within the FMPC site contains sufficient clay to render it relatively impervious to the infiltration of water although in some places beds of sand and gravel extend to the surface. This varied character of the sub-surface formations has resulted in a wide range of water surface elevations. Permeable formations are layered with clay layers which are less permeable and serve to trap water in small local systems near the surface. In this general location, water in shallow dug wells was probably derived from these systems.

Tests have shown the coefficient of permeability in the lower sand and gravel layer to be 2000 gallons per square foot per day. By comparison, the confining clay layer has a coefficient of about three gallons per square foot per day. Ground water velocity in the vicinity of the plant is estimated at about 1.5 feet per day.

The immediate underlying sediments are unconsolidated glacial drift, deposits of clastics laid down during the advance and withdrawal of the Pleistocene glaciers. Underlying the FMPC is about 50 feet of a clay-rich till which may be a remnant of a large glacial moraine. Beneath the till is about 150 feet of sand and gravel which fills the buried valley of the pre-glacier

river. In the FMPC area, these deposits are separated into two layers by a layer of clay 10 to 20 feet thick. The top of the clay layer is about 125 feet below the surface.

The clay layer does not extend entirely across the buried valley. Data from well drilling shows the layer pinches out between the FMPC and the Miami River. Since well drilling has not been extensive in this general area, it is possible that there are local discontinuities in the clay bed, where it thins out or is totally absent.

During interglacial periods, there likely occurred much reworking, sorting, and rearranging of deposited glacial material, the principal geological processes being stream erosion and redeposition. In a relatively small area may be found both stratified drift and unstratified till having particle size variations from fine clay and sand through coarse gravel and large boulders. Recently, three rather large angular "chunks" of pink, white, dark gray igneous rock of granitic composition, each weighing an estimated 500-600 pounds were uncovered near the plant waste storage pits. The source area of these large granitic boulders (erratics) undoubtedly lay a great distance to the north or northeast since exposures of this type of rock are not known anywhere within the State of Ohio. Thus, there is

a multitude of possibilities for the intermixing of rock types; likewise, there is almost unlimited possibilities as to the shape, size, distribution, and interfingering of individual beds.

5. Hydrology

The valley of the lower Great Miami River, extending from Dayton to the Ohio River about 15 miles west of Cincinnati, is one of the most productive sources of ground water in the mid-western United States. A major buried valley averaging two miles in width and 150-200 feet in depth, formed during inter-glacial intervals of the Pleistocene Epoch and subsequently filled with highly permeable sand and gravel outwash, follows essentially the course of the present Great Miami River. The Fernald project is located in this former buried valley, the so-called New Haven Trough. See Figure 6.

Test borings through the earth formations underlying the FMPC site reveal that the sand, gravel, and clay are deposited in a very irregular manner, sometimes appearing as small lenses of a single material and at other places as mixtures of two or more of the constituents. Figure 7 depicts a somewhat idealized vertical section along a north-south line through the plant site. Figure 8 depicts a geologic cross-section along an east-west line across the ancient buried valley through the U. S. Government Reservation.

The Great Miami River valley has an abundant supply of water owing to both the high storage capacity of the valley-train aquifers and the high average annual rainfall of about 40 inches. Because of such plentiful recharge and storage, the sustained dry-weather flow of the Great Miami River is one of the highest in Ohio. The Great Miami River's high dry-weather flow, or base flow, is due largely to the high permeability and storage capacity of the sand and gravel deposits which underlie much of the streambed. Ground water in these deposits is hydraulically connected with the river. Under natural conditions the gradient is from the aquifer to the river; therefore, ground water discharges into the river. In periods of little or no precipitation, streamflow results almost entirely from ground-water discharge.

The physical characteristics of the sand and gravel deposits in the Miami Valley have given rise to ground water resources which are of tremendous potential economic value. At the present time, only limited use is being made of the ground water in the vicinity of the FMPC but increased industrial use will undoubtedly be experienced in the next decade.

Test borings for foundation design, well drilling, and waste pit excavations within the confines of the FMPC have demonstrated

the existence of many ground water systems. Some of these ground waters are quite localized and result mainly from infiltrated precipitation being trapped by an underlying impervious layer of clay. There are two major water-bearing formations (aquifers) in the FMPC site; one is a sand and gravel layer approximately 50 feet in thickness, the top of which is about 80 to 90 feet below the ground surface; the second, and most important, is a sand and gravel formation more than 70 feet in thickness which is found about 140 feet below the ground surface. See Figure 7.

These two formations are separated by a layer of impervious blue clay of considerable areal extent. The blue clay formation is sufficiently impervious in the immediate plant area to cause the water contained in the deep formation to be under a considerable hydrostatic head (artesian system). The water contained in the shallow aquifer apparently represents the normal water table (water at atmospheric pressure) for the area and as such is dependent on local rainfall for replenishment. The formations near the ground surface are composed of sand and gravel mixed with varying amounts of clay. For the most part, these surface materials (10 to 20 feet in thickness) contain enough clay to prevent the rapid infiltration of precipitation. The shallow aquifer, therefore, probably would not support a sustained high rate of pumping or withdrawal of water.

In the FMPC plant site, the water in the shallow formation appears to be flowing in a southeasterly direction toward the Miami River. The static water levels in Test Wells Nos. 2, 3, 4, and 5 located on the west side of the waste disposal area are higher than the water level in Test Well No. 1 on the east side of the waste disposal area. This difference in elevation indicates that the shallow ground water in the vicinity of the waste disposal pits is moving from Paddy's Run toward the main production wells. See Figure 9. The locations of the test and production wells are shown in Figure 10.

The deep aquifer (artesian in the FMPC site) undoubtedly is supplied with water from a much larger recharge area than is the shallow aquifer. It may also contain water which has been accumulating for a long period of time. The precipitation pattern and the surface formation characteristics in the plant site, therefore, will not affect the water-producing ability of the deep aquifer to any great extent. On average, one-half million gallons of water is withdrawn daily through the FMPC production wells from the deep aquifer for on-site usage.

The static water level in the production wells and in the well at the location of the "Old Administration Building" are approximately the same, thereby indicating that the deep and

shallow aquifers are interconnected. Chemical analyses of water samples from both deep and shallow wells indicate that the deep and shallow ground water are of the same general composition, a further indication of direct interchange between the two systems. It is quite possible that the layer of blue clay separating the two water-bearing formations is in places discontinuous, thereby permitting water to flow from one aquifer to the other.

Surface runoff from rain falling on the production area can be intercepted near the south end of the project and pumped into the Miami River through the same effluent line bearing normal process wastes. The initial portion of all rainfall, which is potentially contaminated from the process operations, is diverted in this manner. Excessive runoff from rainstorms of relatively high intensity exceeds the pumping capacity of the diversionary system only after most of the contamination has been washed away and pumped into the Miami River. This excess runoff is permitted to discharge through a large storm sewer on the south of the project into a natural gully which drains into Paddy's Run, an intermittent stream flowing roughly from north to south just west of the waste pits and residue storage tanks west of the project. See Figure 10. Surface runoff in the immediate area of the chemical waste pits is

captured and directed to the "Wet Chemical Waste Pit," Pit 5, or collected in the clearwell to permit settling prior to final discharge to the Miami River.

6. Ecology

(a) Flora. Plant species growing on the FMPC site are, with a few notable exceptions, representative of those species found in unmanaged woodlots in southeastern Ohio. The exceptions are the decorative plants used for landscaping. Following the construction activity phase, flat grassy areas were established between the plant buildings and around most of the inner security fence. These areas are mowed regularly. About 325 acres between the outer boundary and occupied area are maintained as pasture and are not mowed.

In undisturbed areas along drainage ditches and Paddy's Run, shrub and tree growth is vigorous and shelters a variety of wildlife. Walnut trees planted by former residents are still growing in some areas and produce what appears to be a normal nut crop. Wild blackberries thrive in some sections bordering on the pasture area. Low shrubs in the wooded Paddy's Run area show evidence of light deer browsing.

Considering the small size of the trees in the wooded areas and the diverse species composition, it is evident that the

plant community is far from equilibrium. The growth appears typical of the mixed hardwoods, shrubs and grasses that would be expected in this area for abandoned or reverting farmland.

In mid-1972, a planting program was initiated which consisted of the planting of 131,000 tree seedlings and the transplanting of trees and shrubs from the site woodlots to the lawn areas around the Administration and support buildings. The tree seedlings were planted along the main plant entrance road and in open grassy areas outside the production area. Varieties used were Austrian Pine, Norway Spruce, and White Pine.

(b) Fauna. No documentation has been made of the mammal or bird species or populations on the site. Animals common in this area have been sighted on numerous occasions: White-tail deer, cottontail rabbit, grey squirrel, woodchuck, oppossum, raccoon, red fox, skunk, muskrat, mink. Hunting is prohibited on the site and the undisturbed wooded areas and fencerows serve as a wildlife sanctuary. No mammal on the endangered species list is known to inhabit the site or the surrounding area.

Birds are numerous in this farm area and, in cold weather, roosting sparrows, starlings and pigeons have been a nuisance. Other species seen daily in warm weather are killdeer, mourning dove, red-winged blackbird, robin, and common crow. There have

been frequent sightings of other species: red-tailed hawk, red-headed woodpecker, quail, snipe (probably woodcock), cardinal, mockingbird, buzzard, crane, mallard and other ducks. There is no reason to suspect that a full-scale survey would not produce a list of bird species considered common in this general area.

(c) Aquatic. Fish surveys and benthic studies have been conducted on the Great Miami River and its tributaries by the Miami Conservancy District.[12] Most of the work has been done in the upper reaches where the pollution load is greatest. Results show that the fish population and game-fish species decrease sharply in the Dayton area and then remain stable, at the reduced level, from that point to the backwater pool at the junction with the Ohio River. Gamefish commonly found upstream of Dayton were catfish, several bass species, crappie, sunfish, and bluegill. Sauger and white bass were found in the backwater at the Ohio River.

After extended wet periods, small fish are visible in pools in Paddy's Run. These minnows probably move upstream from the Miami River. During long dry spells, there is no flow and only a few stagnant pools persist. These natural conditions prevent the establishment of a permanent aquatic community in this stream.

A shallow one-acre, man-made pond onsite has had a high game-fish population for many years. The pond was built over 25 years ago as a settling basin for Water Treatment Plant effluent but has never been used for that purpose.

7. Natural Phenomena

(a) Tornado. During the period 1953-1975, Ohio averaged slightly more than 13 tornadoes annually. About 498 have been reported since 1900. More significantly, there were 8 in Hamilton County and 7 in Butler County during the 1953-1975 period. There were 13 in Hamilton County and 11 in Butler County during the period 1900-1975.[13]

Only one tornado is known to have touched the FMPC; this occurred May 10, 1969.[6] There was no damage to the FMPC property. A tornado passed near the northeast boundary on May 13, 1973 but caused no damage to the FMPC.

The probability, Ps, that a tornado will strike a particular location during one year is equal to the tornado frequency (average number of tornadoes per year), $\bar{n}$, times the ratio of the average individual tornado area, a, to the total area, A, in which the tornado frequency has been determined. The expression is given as

$$Ps = \bar{n}\ (^{a}/A).$$

For the probability of a tornado striking the waste storage area:

a = Area of waste storage pits, 12.6 acres; A = Area of Hamilton County, 264,960 acres; $\bar{n}$ = 0.17, since there were 13 tornadoes in Hamilton County in the 76-year period from 1900 to 1975. Therefore,

$$Ps = (0.17)(12.6/264,960)$$
$$= (0.17)(0.87 \times 10^{-5})$$
$$= 0.81 \times 10^{-5}$$

The probability of a tornado striking the waste storage area is 0.81×10^{-5} per year or about one tornado every 100,000 years.

(b) Lightning. The topography of the pit area is flat to gently rolling. There are no tall objects which would attract lightning. There has been no known damage due to lightning in this area.

(c) Flood. The approximate elevation of the site is 580 feet. The Miami River has never been reported over 555 feet at maximum flood stage in this area.[14]

There are no records for the flow in Paddy's Run, the small stream along the west edge of the plant site. This stream originates near the plant and does not have a large drainage

area. Although the stream has left its banks on numerous occasions, it is far enough below the general site level so that flooding does not bring serious consequences. Some minor rechanneling of the stream has been done onsite.

(d) Earthquakes. A report from the Seismological Observatory, Xavier University, Cincinnati, Ohio, lists 78 earthquakes which occurred in Ohio between 1776 and 1964.[15] Six were reported in the Cincinnati area. All of these were in the period 1925-1937 and all were of low intensity (III-Modified Mercalli Scale, 1956 revision). None of these would have damaged the storage pits. There has been no seismic activity in the local area since 1964.[16]

(e) Other Phenomena. There are no volcanoes in this region of the United States. The land in this area is relatively stable and there are no mining or oil drilling activities; subsidence is not a problem.

B. Assessment

Low-level radioactive waste stored at the FMPC may be separated into two general classes for the purpose of considering possible hydrogeological consequences. In general, wastes are either wet or dry, depending on the manner in which they are generated and the subsequent treatment process. The term

"wet" means that there is an aqueous layer present in the storage location. "Dry" means an absence of such a layer although the wastes may be damp and contain trapped liquid.

Obviously, the thick layer of glacial deposits in this area permit relatively easy passage of water. This feature is one of the main reasons why high pumping rates are possible in wells which tap the aquifer located beneath the clay layer. This feature would also permit easy travel of soluble contaminants, if they are leached out of the storage pits or if standing water produces a pressure which forces liquid out of the confining clay or rubber liners into the permeable deposits.

The storage area is slightly higher than the land to the east, south, or west. Drainage from the north is intercepted by a ditch which discharges into Paddy's Run. Surface drainage, therefore, is away from the stored wastes, thus reducing the amount of surface water available for infiltration into the waste. In addition, retired pits are graded in a manner to enhance drainage of precipitation.

No storage problems are anticipated because of ground movement caused by seismic activity.

Since retired pits are covered with clean soil, the external radiation at the site boundary is expected to remain within current standards. The covering also eliminates the chance of material becoming airborne. Even while the pits are in active use, with some wastes exposed to drying conditions, airborne radioactivity at the boundary has been less than 1% of the present ERDA guides for uncontrolled areas.

At the present level of waste generation, land is available in the waste storage area for an additional 100 years of operation.

II. FACILITIES

A. Description

In regard to volume, most of the solid waste generated at the FMPC results from the neutralization of acidic waste solutions. Filter cake and sludges collected from the neutralized wastes are deposited in chemical waste pits. Other contaminated solids such as ceramics, graphite, debris, and dry residues are also placed in a storage pit if the contained uranium or thorium values are too low to warrant recovery.

1. Storage.

There are three facilities used at the FMPC for the long-term storage of wastes: K-65 Tanks; Metal Oxide Tanks; Chemical Waste Pits. The five waste pits are identified by number based on a chronological sequence of their construction. They are further identified as "dry" or "wet" pits. This distinction is made on the basis of the physical state of the material as it is placed in the pit. If the material is placed as a slurry, the pit is known as a wet pit. If the material is placed as a dry solid, the pit is known as a dry pit. The present status of each pit is given in Table 7.[17]

In this "Storage" subpart, pits 1, 2, and 4 are described in one section because of their similar construction and features. Pits 3 and 5 are described separately.

(a) K-65 and Metal Oxide Tanks.[17] There are two K-65 tanks and two metal oxide tanks. These tanks are of cylindrical concrete construction, 80 feet in diameter and approximately 27 feet high. The capacity of the individual tanks is 125,000 cubic feet. The tank walls are of concrete, 8 inches thick. The walls were post-stressed with high tensile steel wire and the wires protected by a 3/4 inch grout coating. In 1964, the two K-65 tanks were protected by enclosing them with an earth embankment.

The K-65 tanks were used for the storage of Refinery residues that resulted from the processing of pitchblende ores. These residues or tailings contain ^{226}Ra. Pitchblende ore processing at the FMPC was discontinued in 1959; however, the residues resulting from this work remain in storage. Other similar residues were sent to the FMPC from other sites and are stored in the K-65 tanks. The K-65 wastes are the property of the African Metals Corporation and are stored at the FMPC under a lease contract which expires June 30, 1983, and which prohibits abandonment by the lessee.

One of the metal oxide tanks contains similar tailings or residues from Refinery operations at FMPC. However, these residues are not from pitchblende but are the result of processing of ore concentrates and contain only the trace of radium not

removed in the concentrate process. These metal oxides are owned by ERDA. The other metal oxide tank is empty.

(b) Pits 1, 2, and 4. These pits are essentially "in-ground" facilities which were constructed by digging a large basin and then lining the walls with 1.5 to 2.0 feet of impervious clay. High dikes were not required since it was intended that the wastes would not extend above the surface contour.

Maximum depths for Pits 1 and 2 were 17 feet and 13 feet, respectively. Both pits have been filled; covered with clean, uncontaminated fill; and graded to provide surface drainage away from the pits.

Pit 4 is partially filled and is used principally for the disposal of dry solids. Maximum depth of the pit is 24 feet. A concrete pad, located on the northeast edge, provides space for the temporary holding of drummed material destined for eventual disposal. A hydrant at the pad provides water for vehicle rinsing.

(c) Pit 3. Pit 3 was constructed at the west end of the storage area plateau. Dirt removed during the excavation was used to form the pit west wall. The dirt was placed in 6- to 8-inch layers and compacted with sheepsfoot rollers. A natural layer of impervious clay formed the pit bottom. After the

excavation, the pit walls were covered with a thick clay layer. Maximum depth of the pit was 24 feet from the pit bottom to the top of the embankment.

Capacity of pit 3 was 225,600 cubic yards, which is equivalent to 46 million gallons. The surface area is 296,000 square feet.

This pit was constructed to receive neutralized waste slurries. The slurry inlet pipe was at the north end of the pit. The solids settled and the clear supernate flowed into an adjacent clearwell from where it was sampled and pumped for off-site discharge.

Pit 3 has been filled with respect to its capacity to function as a settling basin and has been partially covered with clean fill. The remaining capacity is being used for the disposal of filter cake. When all space has been utilized, the covering will be completed and the surface graded and seeded to control run-off and erosion.

(d) Pit 5. Pit 5 is a rubber-lined settling basin with a capacity of 115,000 cubic yards and a surface area of about 3.6 acres. It was constructed to replace Pit 3. The pit is 25 feet deep and the top of the pit embankment is about 10 feet above the surrounding ground surface. Neutralized waste enters the east

end and the clear supernate is discharged through an overflow tower at the west end. From the tower, the liquid flows by gravity to the Pit 3 clearwell where it is sampled and pumped for offsite discharge.

2. Equipment.

Residues are transported from various producing plants on site to the chemical waste storage pits with NLO personnel and equipment. The process plant and type of residues generated will govern the type of container and mode of transportation to be utilized. The following are presently used: (a) drummed material transported on semi-flatbed trailers; (b) metal dumpsters via a dumpster vehicle; (c) bulk residues by dump trucks and dump trailers; and (d) pyrophoric metal in drums conveyed on four-wheeled flatbed trailers pulled by a tow tractor.

The manner in which residues are placed in the pits depends upon the type of containers and the mode of transportation utilized. Dump trucks, dump trailers, and dumpster units are emptied directly onto the pit's edge. Drummed residues are emptied onto the pit's edge with an industrial fork truck equipped with a drum rotator. The materials are then pushed into the pits by either a bulldozer or a drag line scraper.

Loose contamination is washed from bulldozers, drag line scraper, vehicles, dumpster, and fork trucks with water at the pit. Empty drums are washed in the Plant 8 drum washing facility. The Decontamination facility is utilized to remove fixed contamination from containers and equipment when the need arises.

There is no fixed radioactive waste processing or handling equipment installed at the chemical waste storage area.

3. Utilities.

(a) Electrical service. The electrical power service to the waste disposal area is a 480-volt, 3-phase, 60-cycle, 175-amp circuit via a pole line from the production area to the K-65 area. This line continues to the clearwell pump house with a branch feeder going to power the No. 1 test well and the east side of the pit area. Step-down transformers have been installed to provide lighting for night operation and single phase service.

The feeder to the clearwell pump house is used to power two 40-hp clearwell pumps, a 1/4-hp vent fan and 7.5 kw of electrical heat. A branch feeder supplies two additional 15-hp test well pumps and provides for lighting on the west side of the pit area.

(b) Telephone, Alarms, & Signals. One telephone is located in the chemical waste pit area at the pad for No. 4 Pit. The

service for this phone is via the same pole line that provides the area with electric power and lights.

There is one emergency (disaster) telephone and one code call bell in the K-65 area, in the box on Pole #10, located 20 feet north of K-65 drum handling building.

There is one ADT fire pull box on the east side of the K-65 drum handling building.

There are two ADT alarm horns--one at the clearwell pump house and one on Pole #10, 20 feet north of drum handling building of K-65.

The wires for the above alarm and telephone system are strung on messenger cables on the same poles as the electrical service.

(c) Water. There are 3 freezeproof hydrants located in the pit area. These hydrants provide treated (process) water for washing out of trucks and for cleaning concrete pads. The first hydrant is located near the center of the concrete pad for Pit No. 1 (now filled and covered). The second is at the location of the former Plant 8 UAP Flocculating tanks to provide process water for this process. The third is installed at the southeast corner of the Pit 4 (Dry Chemical Pit) concrete pad. Treated water is also available at the clearwell pump house.

(d) Roads. There are three roads that provide access to the pit area. Only one of these roads is in common use. This blacktop road starts at the west end of 2nd Street and passes through a gate in the inner security fence and proceeds west to the K-65 drum handling building (E 2045 & S 2081). The blacktop road then extends north to the pit area. From here the roads are crushed stone or gravel. The blacktop road is approximately 12 feet wide and crowned for drainage.

The other two roads are gravel and provide access to the pit area by circuitous routes through gates in the security fences that are normally kept locked by the Security Department.

4. Security.

The entire storage area is enclosed by an 8-foot cyclone type fence topped by three strands of barbed wire. Classified matter is not stored in the low level waste storage area. Therefore, fence patrol roads, protective lighting, and alarms are not provided.

During the day shift the storage area is open and is part of a much larger limited area in which guards and other internal controls permit access to site employees or those authorized by them.

On the off shifts and all shifts Saturday, Sunday, or holidays, the storage area is locked and is not part of the limited area. Access is controlled by Security personnel. Once every four hours a security patrol checks the area for any abnormal or unusual condition.

5. Nuclear Safety.

As of February, 1977, the following total quantities of uranium in waste materials had been placed in pits 1-5 according to records of the Nuclear Materials Control Department:

Uranium	Total U kg	U-235, kg
Enriched	73,568	691.5
Normal	294,918	2099
Depleted	2,587,726	4177

Enriched, normal, and depleted uranium wastes have been combined throughout the plant history. Nuclear Materials Control estimates the average ^{235}U isotopic content of the several pits as follows:

Pit No.	Period Used	Approximate % ^{235}U
1	1952 - mid-1959	0.712
2	1952 - mid-1964	0.209
3	mid-1959 - Nov. 1968	---
	Jan.1975 -	0.785
4	1964 -	0.207
5	Nov.1968 -	0.682

6. Support.

There are no offices or change rooms in the storage area. All office activities are conducted at the regular Transportation Department office. Requests for material transport from a plant to the waste storage area are made to the Department Supervisor who schedules a work crew as needed. Direct supervision of storage area activities is easily provided since all Transportation Foremen are assigned vehicles for daily use.

There is no need for a change room in the storage area since the plant work force changes into Company-supplied work clothing at the start of each shift. At the end of each shift, the used clothing is collected for washing in the plant laundry. If an employee's clothing is severely soiled with radioactive material or any potentially hazardous material, he is instructed to return to the locker area and make an immediate clothing change.

Vehicles or equipment which must be decontaminated are washed at the Pit 4 concrete pad. Wash water drains into Pit 4 and periodically, standing water in this pit is pumped into Pit 5 for settling and discharge. Lime is added to Pit 4 occasionally to maintain a pH suitable for uranium precipitation.

B. Assessment

Facilities presently available for waste management are considered adequate for properly handling the type of low-level waste produced by FMPC operations.

Utilities, equipment, roads, and support activities currently used will be suitable for future anticipated waste handling. Any potential problems due to changes in waste characteristics would receive prompt attention.

III. OPERATING PRACTICES

A. Description

1. Land burial.

The five chemical waste pits used for in-ground storage are described in Section II,A,1. As noted, an impermeable clay liner or a rubber membrane liner has been used to minimize the leakage of materials out of the waste storage pits. Water surface elevation varies in this area but is generally considered to be at 540-525 feet. There is no generalized aquifer in the plant area above this level since other area wells which extend below the 525 foot contour are dry. The bottom of the clay-lined storage pits extend to 548.0 feet. The bottom of the rubber-lined pit is at 560.0 feet.

Paddy's Run is located just west of the waste storage area but does not come into contact with the pit walls. The relatively small area drained by the creek upstream of the pits and the unobstructed stream bed downstream are two major factors controlling the creek level in the pit area on the occasions when the creek reaches a flood-like condition. Since the FMPC has been in operation, there have not been any weather or run-off conditions which have led to stream flow erosion near the base of the west slope of the storage area plateau. The area is inspected frequently and any adverse chronic effects of stream flow would be corrected and controlled.

2. Special storage.

With the exception of pitchblende residues in the K-65 tanks, there have been no wastes generated at the FMPC for which special storage was required. Some recycle materials containing transuranium nuclides have been processed but the concentrations of transuranics in waste residues have been below the level at which special storage becomes necessary.

3. Waste.[17]

(a) Solid wastes. No facilities exist at FMPC for treatment of solid radioactive wastes as such. Solid wastes generated at FMPC are discarded without treatment to Pit 4. The uranium or thorium content or contamination of these wastes is regarded as minimally soluble, and below economic recovery levels. Direct pit storage is feasible without fire hazard, water pollution, or other incidental problems.

Contaminated combustible residues, sewage sludge, graphite, and oils are treated as process residues and incinerated in various facilities. The uranium values are recovered from the generated ash in the Recovery Plant or the Refinery.

(b) Liquid wastes. In general, liquid wastes from uranium and thorium processing are first neutralized and then may follow one of two routes. In one treatment route, the neutralized wastes are sent to Pit 5 where the solids settle out and the clear

supernate overflows to the clearwell for discharge. In the other route, the neutralized wastes are filtered and the resulting filter cake is deposited in the remaining space in Pit 3. A small amount of filter cake has also been deposited in Pit 4.

Liquid wastes are generated to some degree in every operation at FMPC. All of the major process areas have individual treatment facilities capable of pretreating the liquid wastes that are peculiar to that particular process step. Virtually all of the radioactive materials in the wastes are removed in these facilities.

Generally, these plant treatment facilities are simple installations which provide equipment and tankage to collect waste liquors, adjust the pH for precipitation of uranium values, and to filter the resultant slurry. Where oils are present, preliminary steps are taken to break out the oils by acidification and decant before neutralization and precipitation. The filter cake containing the radioactive materials is sent to the Refinery or the Recovery Plant as a process residue. After sampling and analysis is performed to ascertain that uranium content is within pré-set allowable discard limits, the filtrate is pumped to the General Sump.

When thorium is processed in the Pilot Plant, after neutralization the waste liquors are treated with barium carbonate and aluminum sulfate before filtration in order to reduce ^{228}Ra activity in the filtrate. Because of its higher ^{228}Ra content, raffinate from the thorium extraction process is segregated from other thorium liquid wastes and subjected to a double $BaCO_3$-$Al_2(SO_4)_3$ treatment and filtration before the resultant filtrate is pumped to the General Sump.

Physically, the General Sump is a collection of vertical tanks of various sizes, pumps, piping, and valves established on a controlled pad. It is designed to facilitate the storage and transfer of liquid wastes within the tankage complex and the discharge therefrom, and the addition of various reagents and coagulation aids. Provisions have been made for ease of sampling, both grab and continuous. Controls are simple but adequate. The pad is equipped with its own sump and drainage trenches to handle any leaks or accidental spills.

The process wastes from the various production plants and service facilities are received at the General Sump, checked for SS content, and segregated or selectively combined as required. If a certain waste exceeds discard specifications it is sent to the Refinery for recovery of SS values.

Thorium wastes, if present, are segregated, again co-precipitated with barium carbonate and aluminum sulfate to further reduce ^{228}Ra activity, and then pumped to the Wet Chemical Waste Pit (Pit 5).

All acidic uranium-bearing wastes are adjusted for pH with calcium oxide to obtain a maximum precipitation of radioactive material. Thereafter, these wastes are pumped to Pit 5.

Other wastes are settled and decanted in successive steps prior to discharge of the supernatant liquor to the river. The settled sludges are also transferred to Pit 5.

All liquid wastes, before discharge from the General Sump to the Wet Chemical Waste Pit or to the Miami River, are sampled. The samples are analyzed to ascertain concentrations and total content of radioactive materials.

All liquid wastes discharged to Pit 5 enter at the eastern or smaller end of the basin. The huge volume of the pit, in addition to providing settling time for solids in the effluent as received, also allows time for slow interreaction of effluents and resultant additional precipitation of radioactive solids. The solids, which contain almost all of the uranium, thorium, and radioactivity remaining in the waste, settle out and remain in the pit

for long-term storage. The supernatant liquor, practically solids free, overflows through an effluent control tower near the western end of the pit into a clearwell from which it is pumped to the Miami River.

The major portion of FMPC's liquid process wastes is routed through the General Sump to Pit 5. However, there are three process waste streams which are routed directly to the pit. They are: Zirnlo Slurry, Heat-Treat Quench Water, and Slag Leach Slurry. These streams are produced in minor quantities and radioactivity in all three streams is effectively controlled by settling in Pit 5 without processing at the General Sump.

Although Pit 3 can no longer be used as a settling basin and is partially covered, the existing space is being used for the disposal of filter cake. When all space has been used, the covering will be completed and the surface graded and seeded to control run-off and erosion.

4. Monitoring.

Test wells have been drilled around the Waste pits to permit monitoring of ground water in the area. The location of these wells is shown in Figure 10. Sampling of these wells, performed on a quarterly basis, furnishes an indication of the condition of the pit liners.

Nitrates and chlorides found in well samples in amounts slightly higher than background in past years indicated that the natural clay liners used in Pits No. 1 through No. 4 were not completely impervious; however, recent analyses show concentrations of these ions essentially at background levels. From this it is concluded that (1) permeation from Pits 1, 2, 3, and 4 through the clay linings has essentially ceased, and (2) if there are any losses of liquids with accompanying pollutants through the rubber lining of Pit 5, such losses are not significant enough to affect the quality of the water in the subsurface aquifers. No increase in uranium or radioactivity has ever been detected in the test wells.

In addition to test well samples, surface water in Paddy's Run is sampled and analyzed weekly. It is likely that any leak or seepage from the pits would migrate to Paddy's Run. In addition, grab samples of surface water in the pit area are obtained on a random basis and analyzed for radioactivity, NO_3, and Chloride. Any unusual concentrations would be investigated.

In addition to water sampling, an environmental air sampling program is employed to determine the amount of radioactive material in the air surrounding the project. Six permanent air sampling stations are operated around the perimeter of the FMPC

as shown in Figure 3. These units are in continuous operation. Filter samples are collected and analyzed each week. Results show that the average concentration of radioactive material in the air surrounding the FMPC is less than 1% of the ERDA Concentration Guides for uncontrolled areas.

The six air sampling stations shown in Figure 3 also serve as radiation monitoring stations. Thermoluminescent dosimeters are used to determine the radiation at these locations. Air sampling station 6 is located on the project boundary about 1000 feet west of the K-65 tanks. As might be expected, this is the location of the highest radiation level along the boundary. During 1976, the average radiation dose at this location was 0.012 millirads per hour (mrad/hr). The average of all six stations was 0.010 mrad/hr. These averages include natural and cosmic background radiation.

5. Maintenance.

The storage pits are covered with top soil when filled to capacity; grass seed is sown and grass is mowed to maintain good site appearance.

Surrounding areas to the storage pits are graded and ditched for proper run-off of surface water. Areas of possible contaminated water are graded and ditched for drainage to a controlled pit.

(a) Fire prevention. Fire protection problems encountered at the burial site are minimal, confined to pyrophoric materials, usually uranium chips, turnings, sludge, and other residues which are slated for burial, and those problems that might be associated with vehicles used in transporting material to the site. Since the amount of this type of material at the radioactive waste storage area at any one time is minimal, fires which occur present little problem. In addition to the pyrophoric materials, there is a possibility of grass fires in the area surrounding the pits; however, vegetation is satisfactorily controlled by normal groundskeeping activities.

No permanent fire suppression facilities are provided at the burial site other than two 30 lb Dry Chemical fire extinguishers. A 1-1/2 inch hose line is available on the Pit 4 pad for washing the pad and the vehicles used in transporting burial materials to the pits. Another source of water, a well approximately 1000 feet southeast of the pits, provides water at the rate of 150 gpm, which should be adequate source of water to control any fire that occurs.

Fire prevention inspections of this site are made by the Fire & Safety Inspectors on a monthly basis.

The nearest manual fire alarm box, No. 4412, is located approximately 1500 feet from the pits. The normal first alarm response to this location is one 1000 gpm pumper, one 3500 gallon water tanker, one rescue vehicle, and a minimum of five fire brigade members. If a fork lift is called to handle drums, a shield and protective clothing is available for protection of the driver. Turnout gear, respirators, and other protective equipment is available for fire brigade personnel.

With the operations presently being conducted at the burial/storage site, no additional fire protection is deemed necessary.

6. Permanent records.

Permanent records for all material types and quantities of uranium and thorium materials discarded to the FMPC chemical storage pits are jointly maintained by the Nuclear Materials Control and the Budget, Cost and Nuclear Materials Accounting Departments. All such discards are documented via the standard form, ERDA-741, Nuclear Material Transaction Report. Routine reports for quantities forecasted and discarded to the chemical storage pits, the river and atmosphere are issued by Management to the ERDA. Periodic reports that summarize the quantity, volume and weight of materials discarded are prepared and submitted under the Solid Waste Information Management Systems (SWIMS).

7. Personnel.

Properly trained and qualified operators are used to operate the various vehicles and equipment for movement of residues to final storage. Safety items, such as goggles, respirators, gloves and normal outer protective clothing are utilized by all personnel involved in the residue storage operation.

8. Off-Site Transportation.

A few shipments of waste residues have been shipped to off-site burial facilities and have been packaged and shipped in accordance with Title 49 CFR. It is unknown whether or not these facilities will ever be utilized again, but if they are, applicable packaging and shipping regulations will be followed.

In the event of an accident involving an off-site shipment from NLO, instructions are provided to the carrier on the bill of lading and guidance is provided NLO personnel in the "Procedure For Handling Incidents Involving Shipments of Radioactive Material Originating at the FMPC."

9. Criticality.

Solutions discharged from the process plants to the General Sump are limited by the concentration limits specified in procedure SOP 43-C-108:

General Sump Influent Specifications

Plant or Area	Maximum Level (lb U/gal.)
Plant 1	0.00008
Plant 2 Raffinate	0.004
Plant 2 Filtrate	0.0004
Plant 2 Condensate	0.0004
Plant 4	0.0004
Plant 5	0.0004
Plant 6	0.00016
Plant 8	0.0004
Plant 9	0.00008
Pilot Plant	0.0004
Technical Laboratory	0.0004
Decontamination	0.0004
Pilot Plant Thorium	0.0004 lb Th/gal.

Plants may obtain approval of the General Superintendent to pump streams with higher uranium levels. In emergencies, plants may obtain approval of Water Treatment Supervisor to pump such streams.

Uranium discharged to the chemical pits is limited to 35 lb/day. As noted in Section II, A, 5, "Nuclear Safety," the average U-235 content of the enriched uranium in the pits is less than 0.9%. This material cannot be made critical.

10. Emergency response.

Specific plans have been prepared to cope with credible accidents and emergencies at the FMPC.[18] There are no specific plans for coping with emergencies arising in the waste storage area. The probability of accidental loss of material from the "dry" or covered pits is extremely remote. Also, escape of radium-bearing residues from the concrete K-65 tanks is remote and could probably occur only because of a catastrophic natural disaster. Discharge of liquid from the pit area is via a clearwell which has enough surge capacity to permit the settling of solids inadvertently released from pit 5.

B. Assessment

Disposal of waste at the FMPC is a continuous process and an integral part of site operations. As such, waste management receives attention during process reviews, assessment of monitoring data and during the consideration of long-range waste management plans. Problems or potential problems which might hinder burial or storage operations are not permitted to go without attention.

Operating practices are evolved which consider applicable ERDA Manual Chapter requirements and objectives.[17] When necessary, budget submissions are made for major additions or changes in the waste management systems.

IV CONCLUSIONS

Radionuclide confinement at the FMPC has been good during the 26 years of operation. Since there are no serious potential problems evident, there would be no adverse effect if major actions are not taken for the next three years.

At this time, there is no evidence that radioactive materials from the waste storage area are resulting in significant concentrations in air, surface water, or ground water. Therefore, there is no justification for changes in the waste storage site, facilities, or operating practices. The lack of pressing problems does not mean that the long-term storage of wastes should continue without periodic reviews.

A list of recommendations is given in the next section. Successful completion would put into use knowledge gained from past operations and would provide additional information to aid in assessing the movement of wastes by ground water.

V RECOMMENDATIONS

1. Study the need for additional test wells in the area north and northeast of the waste storage area. Four additional wells would cost about $20,000.

2. Initiate laboratory studies to determine the ion-exchange capacity of FMPC soils and estimate the rate-of-travel for important radionuclides. Cost of these studies might reach $50,000 and require 1-2 years to complete.

3. Initiate laboratory and pilot plant studies to determine if reprocessing of wastes would improve long-term storage of the wastes. These studies would require about 16 months for completion and cost $200,000.

4. Install a rubber or plastic membrane in all future storage pits. Such a liner should be installed regardless of the "Wet" or "Dry" classification assigned to the wastes.

5. Insure that operating procedures for the use of membrane-lined pits eliminate the chance for organic materials to enter the pits and damage the lining.

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Table 1. Population

Town or City	Approximate Distance from FMPC to Nearest Edge (mile)	Estimated Population
Fernald	1-3/4	30
Shandon	2	200
Ross	2-1/2	3000
New Baltimore	2-3/4	200
New Haven	3	200
Dunlap	4	100
Harrison	5	4408*
Miamitown	6	700*
Groesbeck	7	6000*
Forest Park	7	15139*
Fairfield	8	14680*
Hamilton	8	67865*
Mt. Healthy	8-1/2	7446*
Cincinnati	9	452524*
Cheviot	10	11135*

*1970 census.

Table 2. Record Mean and Normal Precipitation

1948 - 1975

(Water Equivalent Inches)

Greater Cincinnati Airport

Month	Record Mean	Normal	Month	Record Mean	Normal
January	3.55	3.34	July	4.26	4.12
February	3.06	3.04	August	2.64	2.62
March	4.09	4.09	September	2.99	2.55
April	3.67	3.64	October	2.32	2.15
May	3.75	3.74	November	3.24	3.08
June	3.81	3.81	December	3.02	2.86
			Annual	40.40	39.04

Table 3. Precipitation Measured At The FMPC, 1960 - 1976

(Water Equivalent Inches)

Year	Total Precipitation	Monthly Records Maximum		Monthly Records Minimum	
1960	30.76	6.04	June	0.55	March
1961	45.69	8.75	July	1.32	January
1962	33.45	6.63	July	0.57	April
1963	29.22	9.78	March	0.04	October
1964	41.52	11.15	March	0.67	October
1965	38.63	6.56	September	0.82	May
1966	35.89	4.83	April	0.78	October
1967	33.07	5.86	May	0.44	January
1968	39.81	10.36	May	0.30	February
1969	34.17	5.26	September	0.91	March
1970	34.31	5.20	April	0.98	January
1971	32.86	4.35	September	1.11	April
1972	38.68	5.49	April	1.08	February
1973	47.72	7.61	July	1.07	February
1974	43.63	7.09	August	1.03	October
1975	40.89	5.65	March	1.50	July
1976	29.56	5.59	August	0.41	December

Table 4. Snowfall

1947/48 Through 1975/76

(Inches)

Greater Cincinnati Airport

Month	Record Mean	Month	Record Mean
July	0.0	January	5.9
August	0.0	February	5.2
September	0.0	March	4.9
October	0.1	April	0.4
November	2.8	May	Trace
December	3.9	June	0.0
		Total	23.2

Table 5. Record Mean And Normal Temperatures (^{o}F)

1948 - 1975

Greater Cincinnati Airport

Month	Record Mean	Normal	Month	Record Mean	Normal
January	30.8	31.1	July	75.5	75.6
February	33.6	33.3	August	74.2	74.4
March	41.7	41.7	September	67.3	67.8
April	53.5	53.9	October	56.3	56.8
May	63.3	63.2	November	43.6	43.8
June	71.9	72.1	December	34.4	33.7
			Annual	53.9	54.0

Table 6. Agricultural Evaluation of Soils

Yield Potential Per Acre

Soil	Corn Bu.	Soybeans Bu.	Wheat Bu.	Hay Tons	Truck Crops Suitability
Russell	105	36	40	4.5	Good
Xenia	105	36	40	4.5	Good
Wynn	95	30	35	3.5	Very poor
Fincastle	105	40	40	4.0	Fair
Fox	120	35	45	5.0	Good
Genessee	130	50	55	6.0	Good

Table 7. Status Of Waste Storage Pits

Pit No.	Pit Type	Pit Volume Cubic Yards	Status
1	Dry	40,000	Filled & covered
2*	Dry	13,000	Filled & covered
3**	Wet	226,500	Filled - being covered
4	Dry	53,000	87% Filled
5	Wet	115,000	95% Filled

*Pit No. 2 was built for a dry pit and primarily used as such; however, some wet materials were introduced into this pit just prior to the completion of Pit No. 3.

**Pit No. 3 is filled to capacity when considered as a wet pit, since it is no longer a useful settling basin. This pit is being used for storage of additional solid (dry) wastes while the covering process is being carried out.

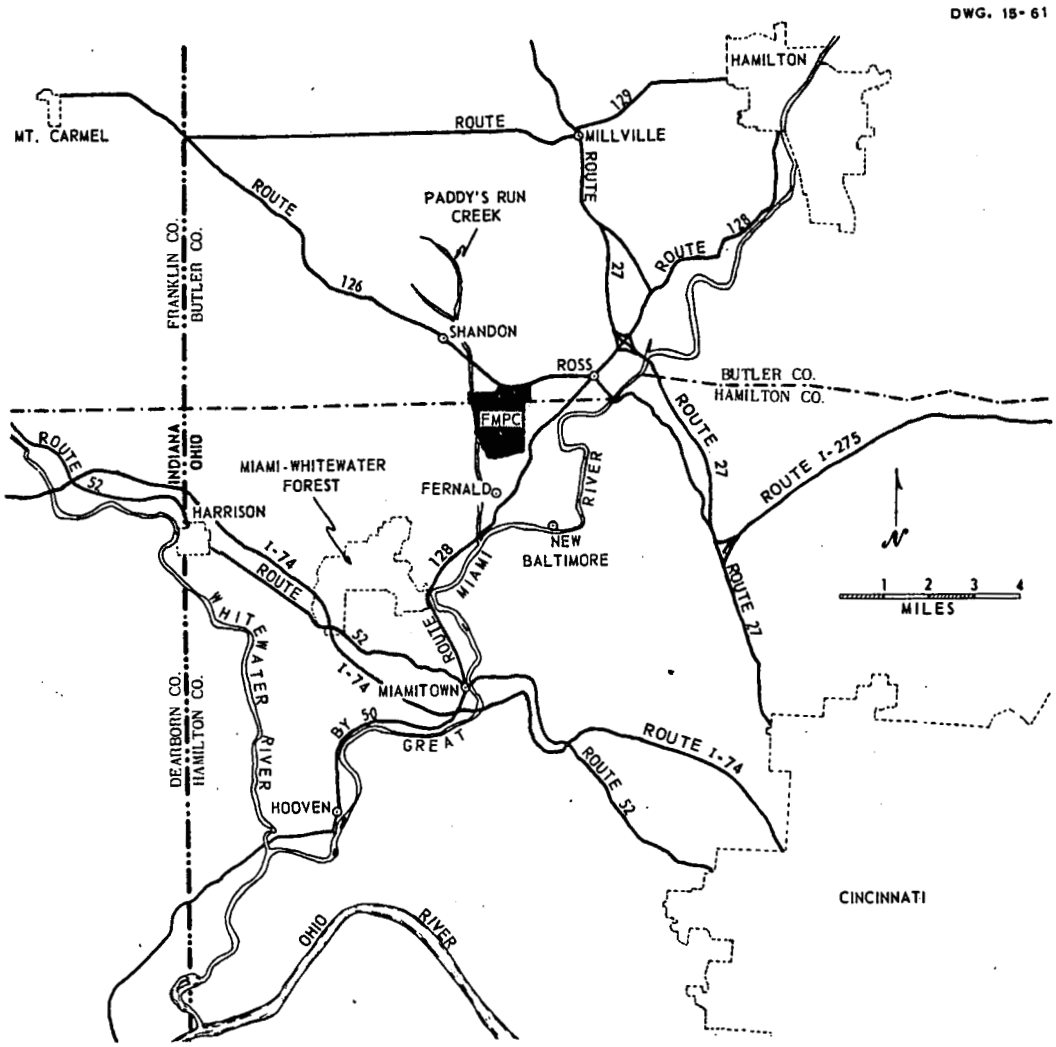
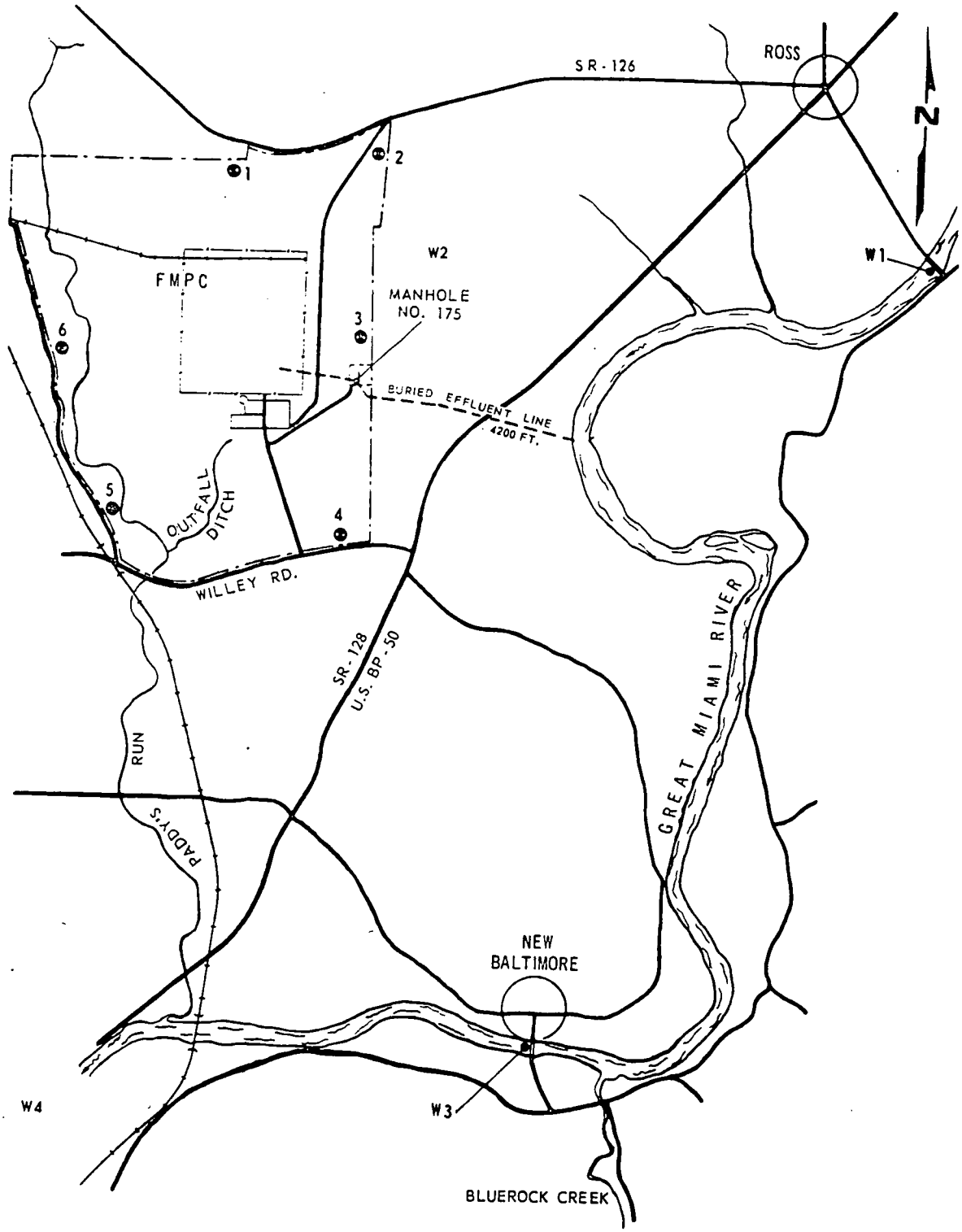


FIGURE 1 Area Map



W4 is located at Miamitown,
4.7 miles from Paddy's Run.

FIGURE 2 FMPC and Surrounding Area

⊕ BOUNDARY AIR SAMPLING STATIONS.

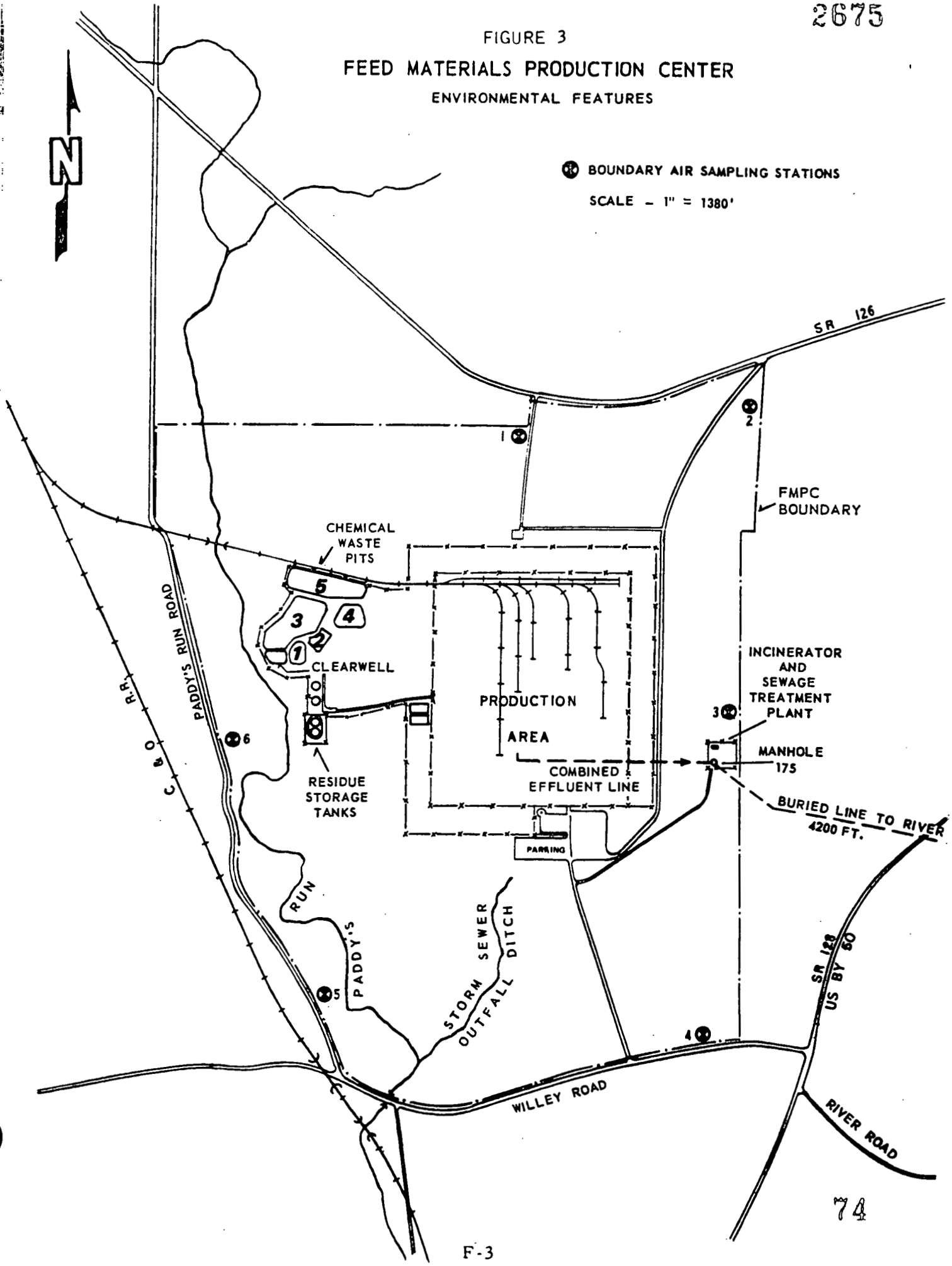
W1, W2, W3 & W4 - WATER SAMPLING LOCATIONS

SCALE: 1" = 3055'

FIGURE 3

FEED MATERIALS PRODUCTION CENTER

ENVIRONMENTAL FEATURES



WIND DIRECTION & SPEED OCCURRENCES

BASED ON HOURLY SURFACE WIND OBSERVATIONS TAKEN AT GREATER CINCINNATI AIRPORT.

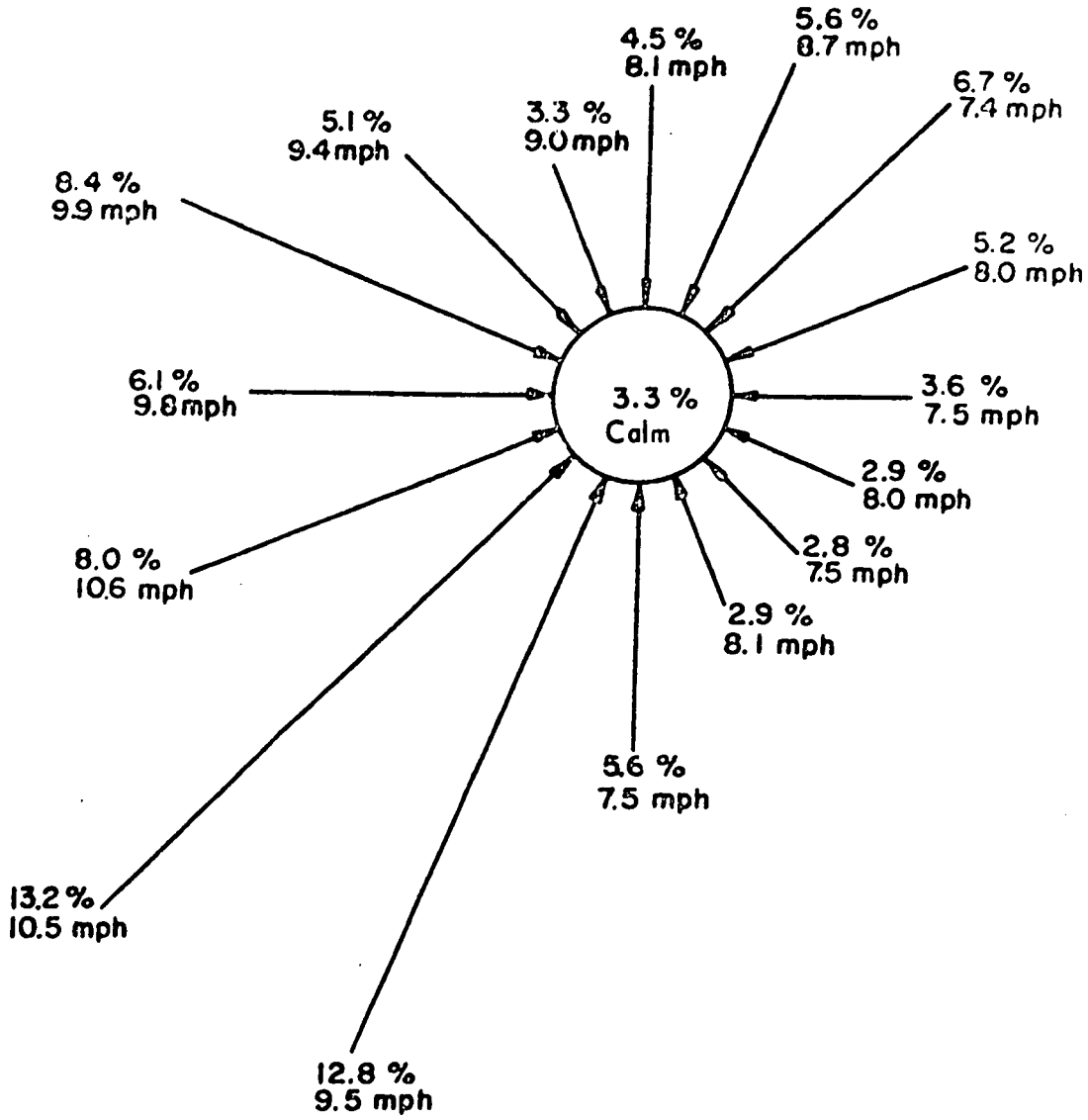


FIGURE 4

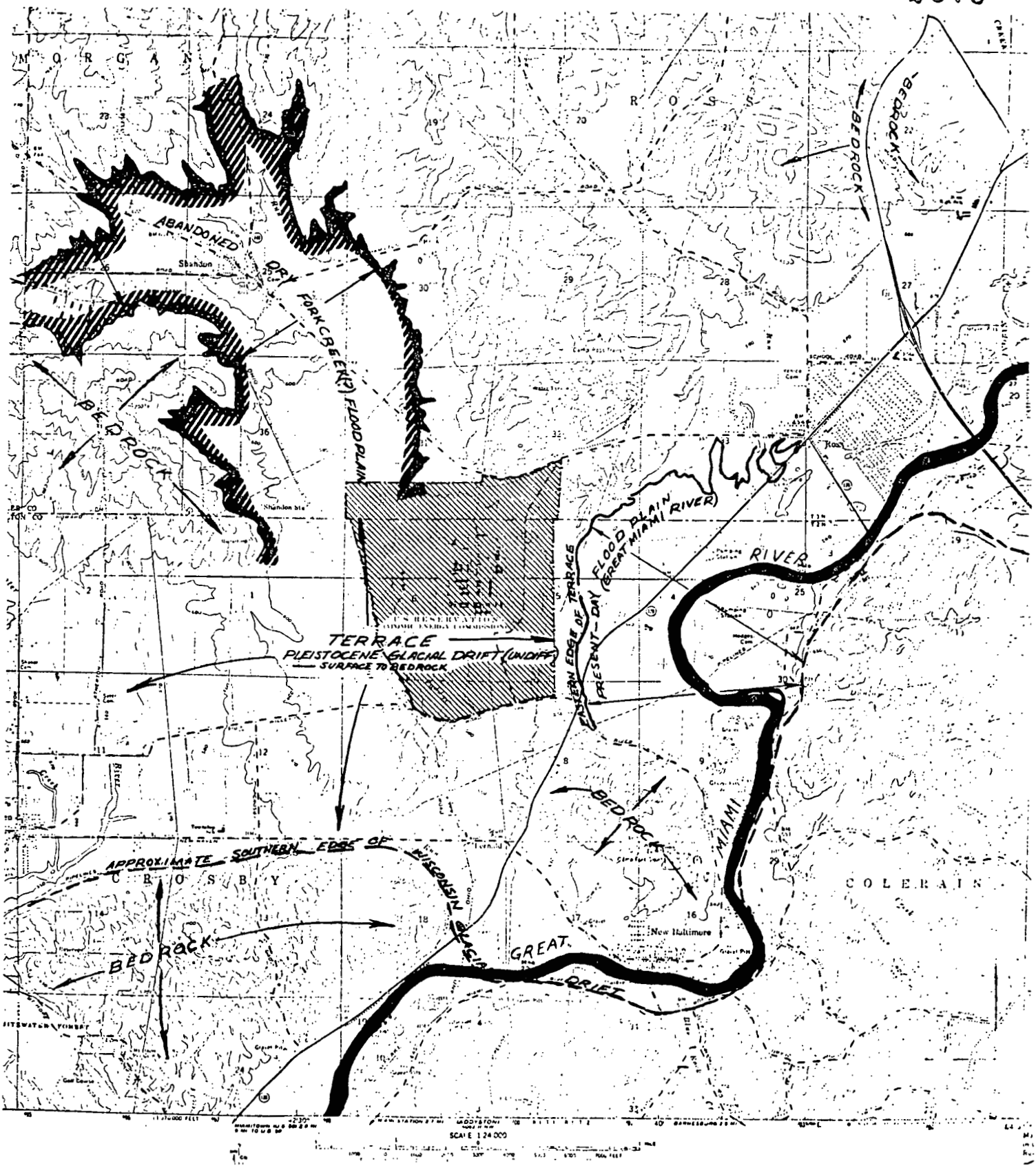
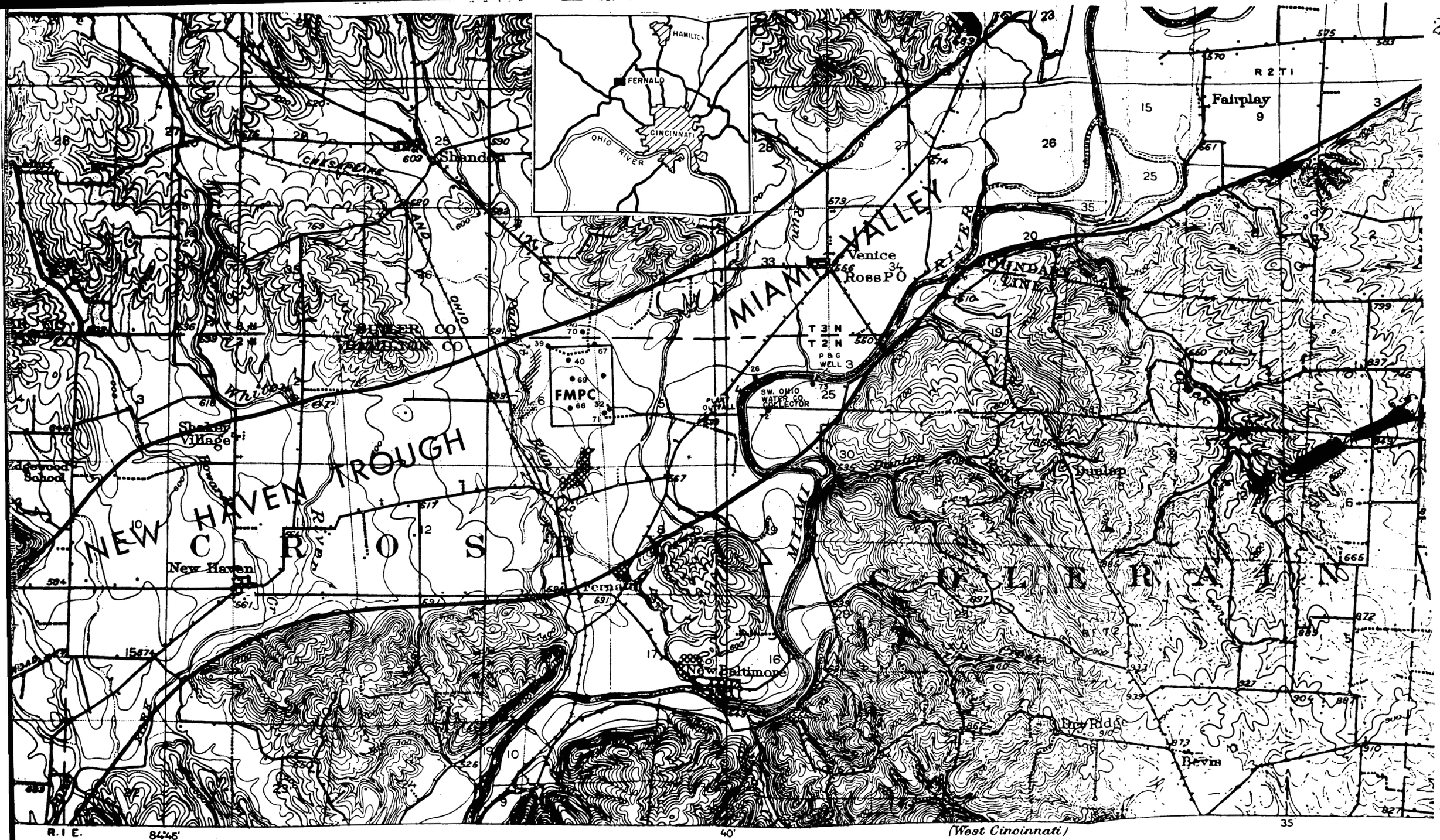


FIGURE 5 Geological Features of the FMPC Area

— — — *Defines Terrace Edge*



CLAY
SAND OR SANDSTONE
GRAVEL OR CONGLOMERATE
BOUNDARY OF PRE-GLACIAL VALLEY

FIGURE 6 Topography of Fernald Area and Miami Valley

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour interval 20 feet.

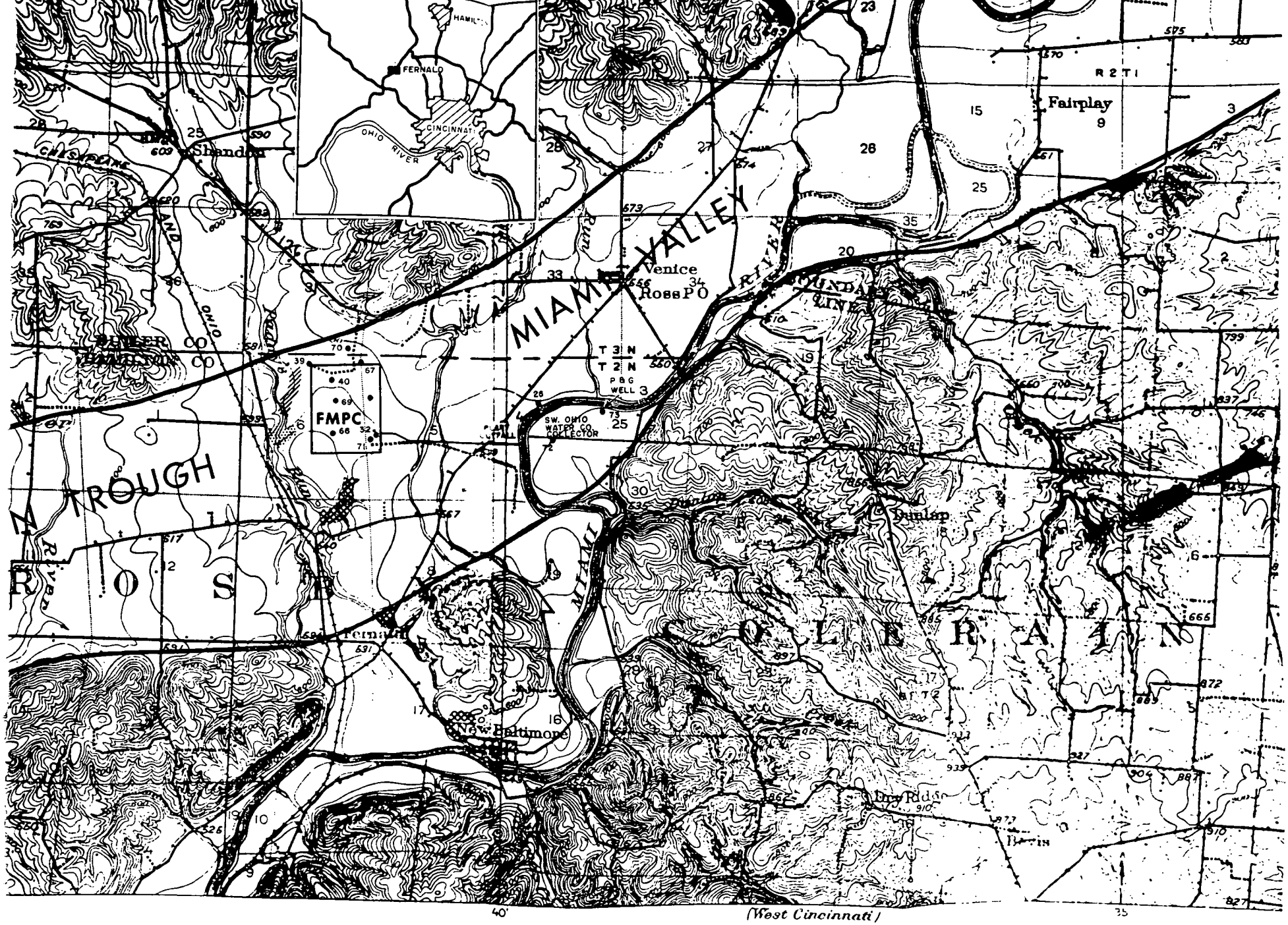


FIGURE 6 Topography of Fernald Area and Miami Valley

D OR SANDSTONE

VEL OR CONGLOMERATE

NDARY OF PRE-GLACIAL VALLEY

F-6

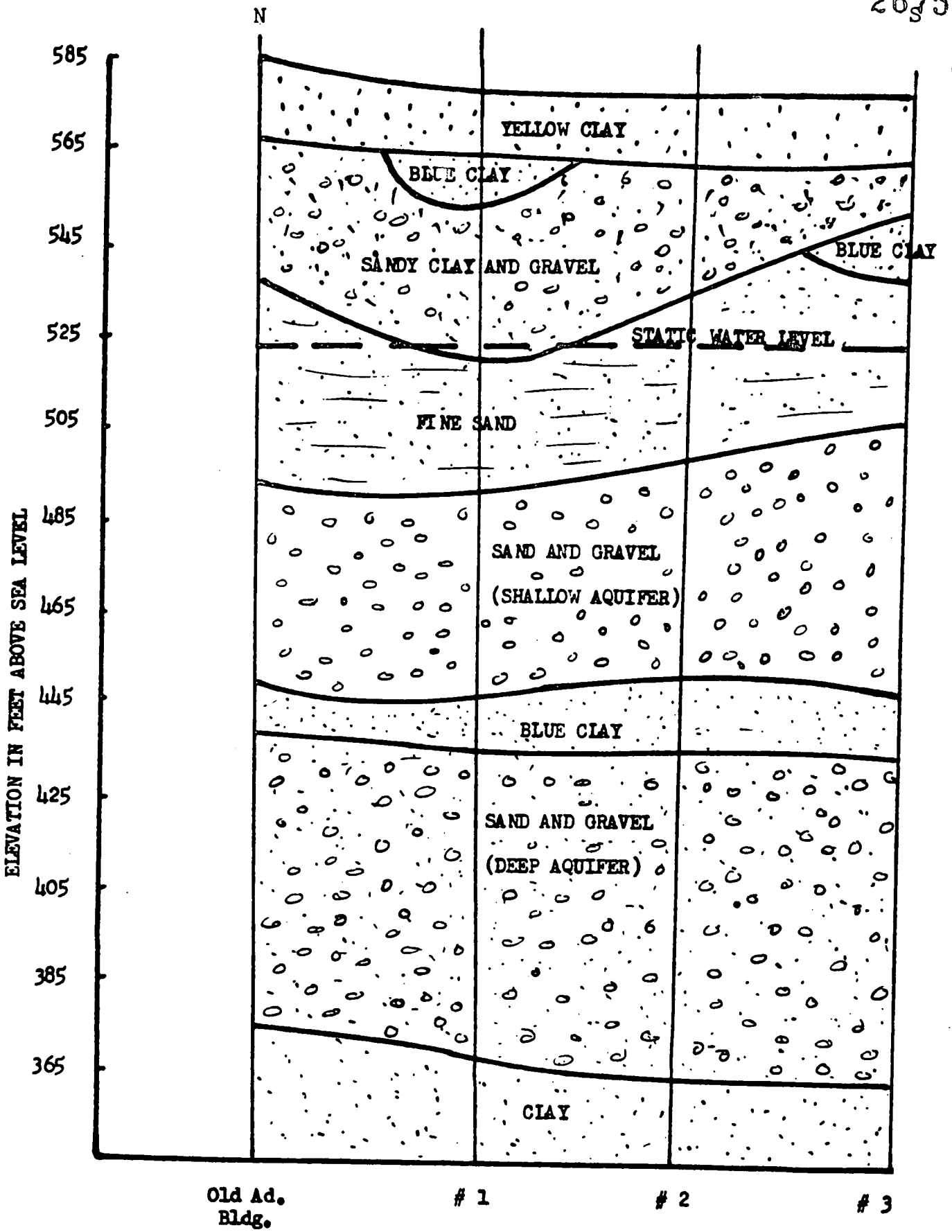


FIGURE 7 Vertical Section Through Deep Wells on Plant Site

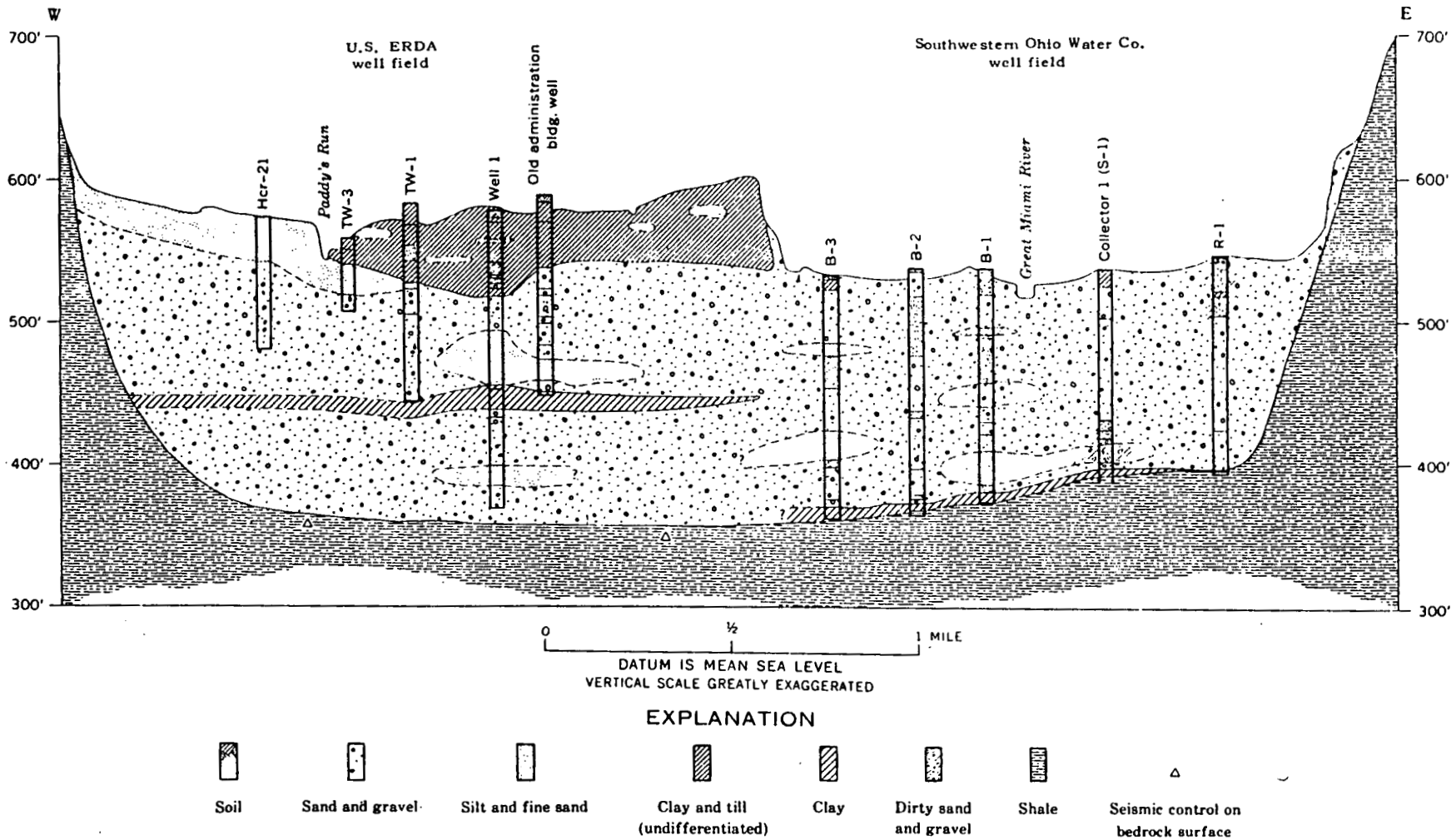


FIGURE 8 Geologic Section of the U.S. Energy Research & Development Administration and the Southwestern Ohio Water Company Well Fields

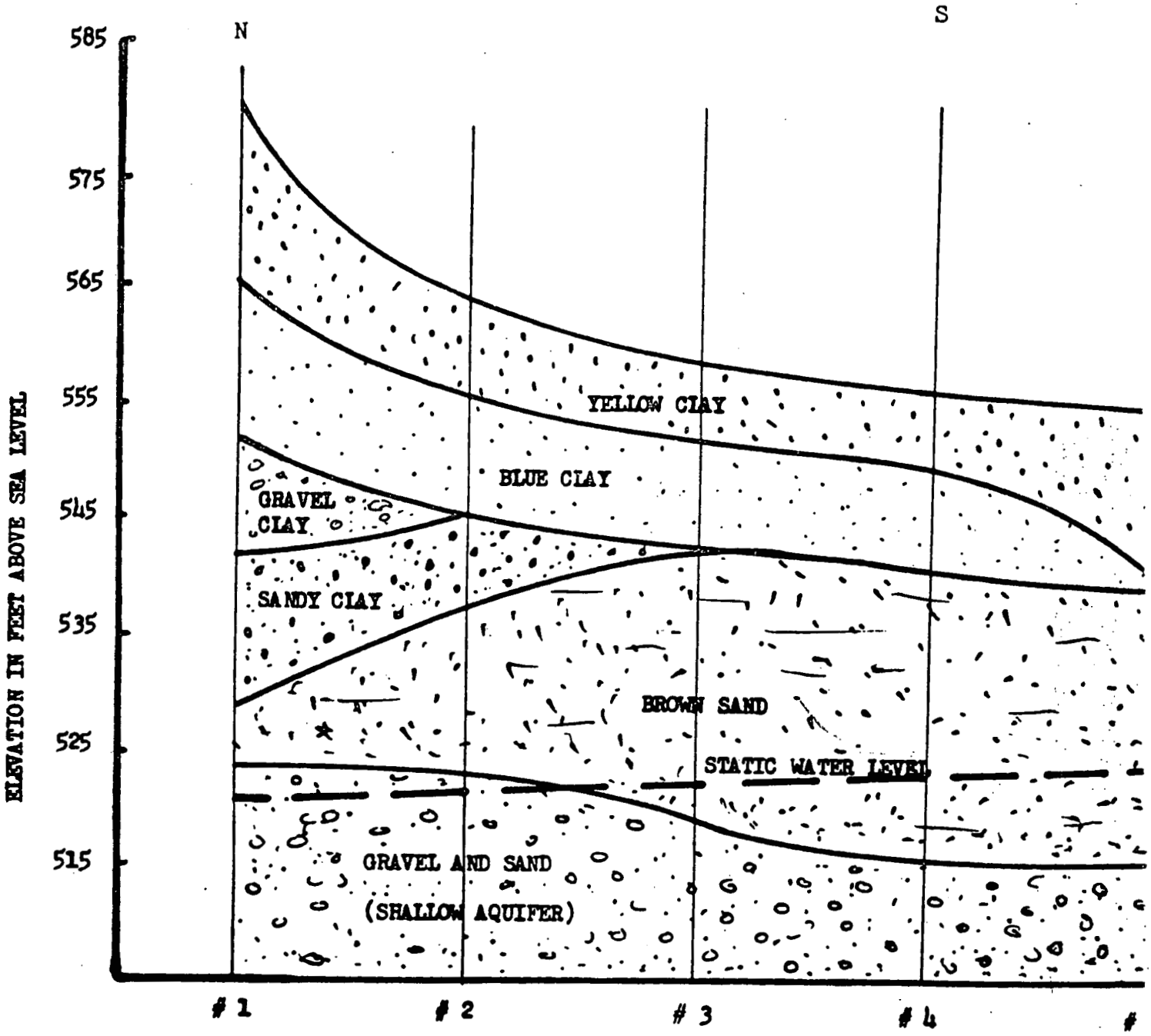


FIGURE 9 Vertical Section Through Shallow Test Wells Near Waste Disposal Area

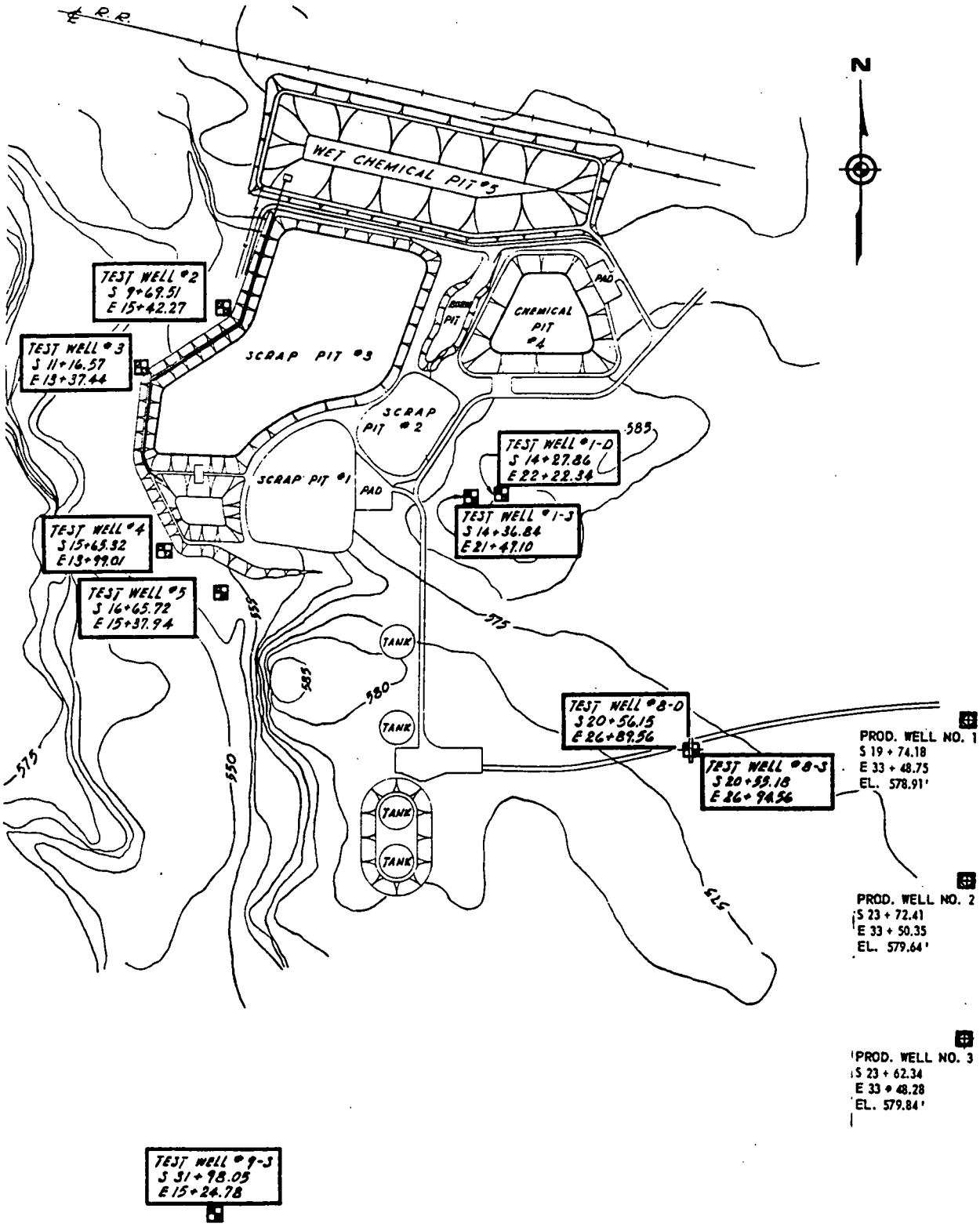


FIGURE 10 Location of the Three Water Production Wells and Five of the Eleven Test Wells