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RCRA/CERCLA BACKGROUND SOIL SAMPLING PLAN AT THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT FERNALD, OHIO REMEDIAL INVESTIGATION/FEASIBILITY STUDY FEBRUARY 1992

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RCRA/CERCLA Background Soil Sampling Plan

at the

Fernald Environmental Management Project

Fernald, Ohio

Remedial Investigation/Feasibility Study

February 1992

U.S. Department of Energy
Fernald Office

DRAFT FINAL

1.0 INTRODUCTION

Remedial activities at the Fernald Environmental Management Project (FEMP) will include soil removal under both Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) programs. In order to determine the effectiveness of any soil removal program the background character of the soils must be established. This sampling plan is designed to provide a statistically valid characterization of the concentration of metals and radionuclides in background soil. This plan is the culmination of efforts under the FEMP RCRA and CERCLA programs and incorporates all Department of Energy (DOE), Westinghouse Environmental Management Company of Ohio (WEMCO), United States Environmental Protection Agency (U.S. EPA) and Ohio Environmental Protection Agency (OEPA) comments. Agreement on the concept of this sampling plan was reached with all parties concerned at a meeting in Chicago on January 16, 1992.

The data gathered under this RI/FS Work Plan Addendum will be used for the RI/FS Site-Wide Risk Assessment to support selection of preliminary remediation goals (PRGs). It is also urgently needed to comply with the approved closure plan requirements of the Plant 6 pad and bulk storage tanks T5 and T6. Data collected under this plan will support certification of all RCRA closures at the FEMP. Further, closure certification requires that soil sampling data from closure activities be compared to background concentrations of naturally-occurring constituents.

2.0 DEFINING A BACKGROUND AREA

The development of a background sampling plan first requires a definition of a background area. A review of EPA comments on an earlier draft of a background sampling plan, the geologic data, and the various guidance documents for determining background has resulted in a definition of a background area and a sampling logic for the area. In brief, the approach is to treat the glacial overburden as a bulk material; sample the glacial overburden over a wide area, where it can be demonstrated with earlier sampling that the impact of the FEMP has been minimal or is not present; collect samples at three depths at each location to determine the impact of possible local sources of contamination; collect what is believed to be an excessive amount of samples in one sampling program, to assure that a sufficient number of samples are available in case the variability within the initial analytical results is greater than estimated from the historic sampling.

2.1 DEFINING GEOLOGIC BACKGROUND

The geologic units at the FEMP consist of three principle units. The first geologic unit is the Ordovician bedrock which consists of calcarious shales with thin interbedded limestone layers generally less than six inches thick. The Ordovician bedrock material underlies the buried valley, where the Great Miami Aquifer is located, and the adjacent uplands. The Great Miami Aquifer is the second geologic unit and is characteristically composed of a 150- to 200-foot-thick sequence of very clean, fine to coarse sands with occasional discontinuous clay lenses. Overlying the aquifer is the third geologic unit, unconsolidated glacial overburden, which is the surface material over most of the FEMP and generally the area north of the Great Miami River.

The geomorphology of the area around the FEMP clearly indicates that the ice lobe that deposited the glacial overburden moved down the present Paddys Run valley. Although there are differences in texture and grain size, the bulk chemistry of all of this material is similar since it was derived from bedrock and glacial deposits to the north. The advancing ice mixed these materials and smeared them over the bedrock and aquifer as it advanced to the south-southeast across the FEMP. A detailed description of the glacial deposits in the area is included in Brockman (1988).

It is quite possible that the glacial overburden was deposited by multiple advances of the small lobe of the continental ice sheet. There has been no identification of any time-stratigraphic feature within the glacial overburden such as a fossil soil or lake bed with distinctive fossils. These features, if they existed, would generate a concern that there might be chemical differences in the soil material above and below these time lines. The absence of distinct time lines also precludes the possibility of correlating materials at a given depth with any other material at a similar depth.

The glacial overburden varies from 20 to 50 feet in thickness within the boundaries of the FEMP. The surface deposits within the glacial overburden include clay-rich till, angular fine-grained loess, lacustrian deposits of beach sand, and settled lake clays as well as outwash lenses of sand and gravel. These surface deposits are all reworked material derived from the till that was smeared over the area by the advancing glacier. While their grain size distribution is different, these surface materials are not likely to have a wide range of chemical compositions because of their common origin.

Even the flood plain of Paddys Run consists of glacial overburden that has been reworked by the lateral meanders of the stream and the deposition of material washed down the valley from the north.

Thus, even though this material has a different soil classification, it probably has a bulk composition that is similar to the more clay-rich material forming the banks of the stream valley.

The FMPC RI/FS Groundwater Report (DOE 1990) presented generalized cross sections and fence diagrams from borings in the Production Area that were produced by grouping thin, silty, sandy lenses and predominantly clay-rich zones. These sections show that there is a relatively local sandy layer greater than 10-feet thick under the southwestern quadrant of the Production Area where the glacial overburden is 35 to 40 feet thick. This sand layer is not laterally extensive and there is no similar sand under the southeast quadrant of the Production Area where the glacial overburden is only 20 feet thick. This lateral variation in composition and thickness makes it impossible to correlate a sand strata in one area with a sand strata in another area with any degree of confidence.

This lack of vertical stratigraphy and the common origin of the components of the glacial overburden suggest that a bulk characterization of the glacial overburden should be used for a background determination. Clearly, a detailed chemical characterization of the vertical sequence of individual sand, silt, and clay-rich materials under the southwest quadrant would not give a representative or comparable set of data for the vertical sequence under the southeast quadrant of the Production area. How then could a detailed vertical sequence of samples from a location outside the site be adequately compared to any sequence within the site? Such an approach simply cannot be implemented.

Under the Soil Conservation Service classification system, the surface soils in and around the FEMP have many different names. The distinctions that result in the different names are largely due to textural differences, not bulk chemical differences. The textural differences are due to mechanical erosion, chemical weathering, and local variations in grain size. Most of the soils described in the Hamilton and Butler county soil surveys have a vertical extent of 36 inches or less. Descriptions of the underlying material are quite similar regardless of the surface soil type. This further suggests that a bulk characterization of the soil could be used for a background determination.

A final argument for bulk characterization is suggested by the extensive rework of materials by man's activities at the FEMP site. Construction activities have required multiple cut and fill operations during the forty year history of DOE's activities. These operations tend to further homogenize the various soil types.

2.2 PREVIOUS SAMPLING

The litigation study conducted by IT Corporation in 1986 for National Lead of Ohio included soil sampling within a five-mile radius from the center of the FEMP. Soil samples were analyzed for isotopic uranium to help interpret the extent to which airborne emissions from the FEMP have impacted the surrounding area. The data were evaluated on a quadrant by quadrant basis to determine the mean concentration of each uranium isotope. Data from the litigation study on radionuclides in the area northwest of the FEMP show relatively low variability with a coefficient of variation of 37 percent.

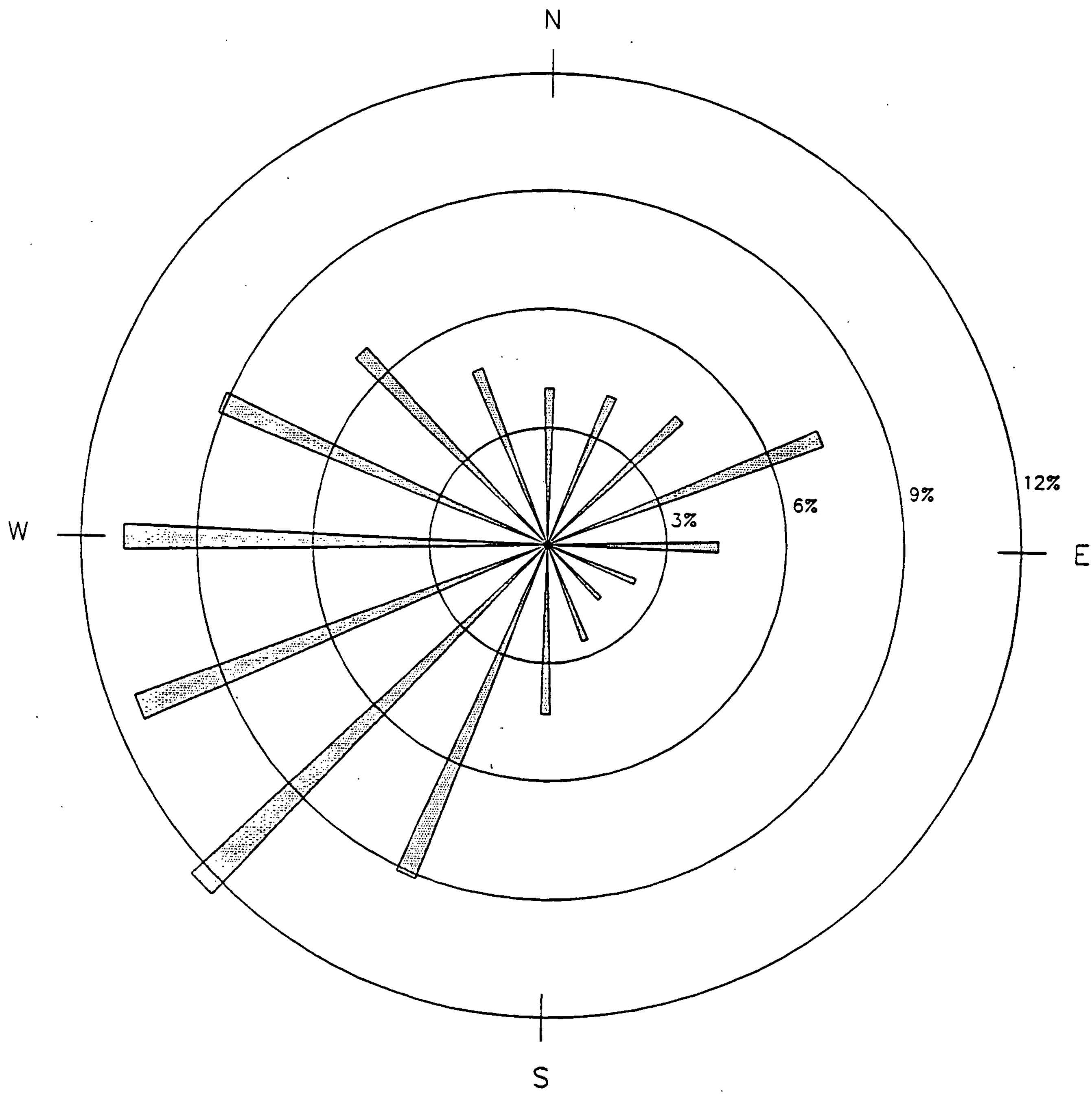
2.3 WIND DIRECTION

The litigation study finding is consistent with the records for the prevailing wind direction at the FEMP. Figure 1 is the wind rose for all data from 1987 through 1990 for the FEMP at a 10-meter height. The figure clearly shows that the prevailing winds are from the west southwest. More importantly, Figure 1 shows that the least frequent wind direction is from the southeast. Therefore, the area to the northwest of the FEMP would have experienced the least impact from airborne contamination.

2.4 BACKGROUND AREA DEFINED

Three converging lines of evidence indicate that the area to the northwest of the FEMP is an appropriate background area. Geologically, the upper portion of the Paddys Run drainage area is the source area for the glacial overburden deposited on the FEMP. Isotope-specific data for uranium have shown that the area to the northwest has the least variation between sample results. The prevailing winds indicate that the area northwest of the FEMP is the least likely area to be significantly impacted by air emissions from the FEMP.

Background sampling will be conducted within six square miles located north of the village of Shandon. The background area shown in Figure 2 is the northern end of the northern portion of the Paddys Run drainage basin.



NOTES:

DIAGRAM OF THE FREQUENCY OF OCCURENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING. EXAMPLE – WIND IS BLOWING FROM THE NORTH 4.0 PERCENT OF THE TIME.

1987 – 1990
10–METER LEVEL
FEMP

602.A_WROSEBOB_CIN

FIGURE 1. WIND ROSE FOR 10–METER LEVEL

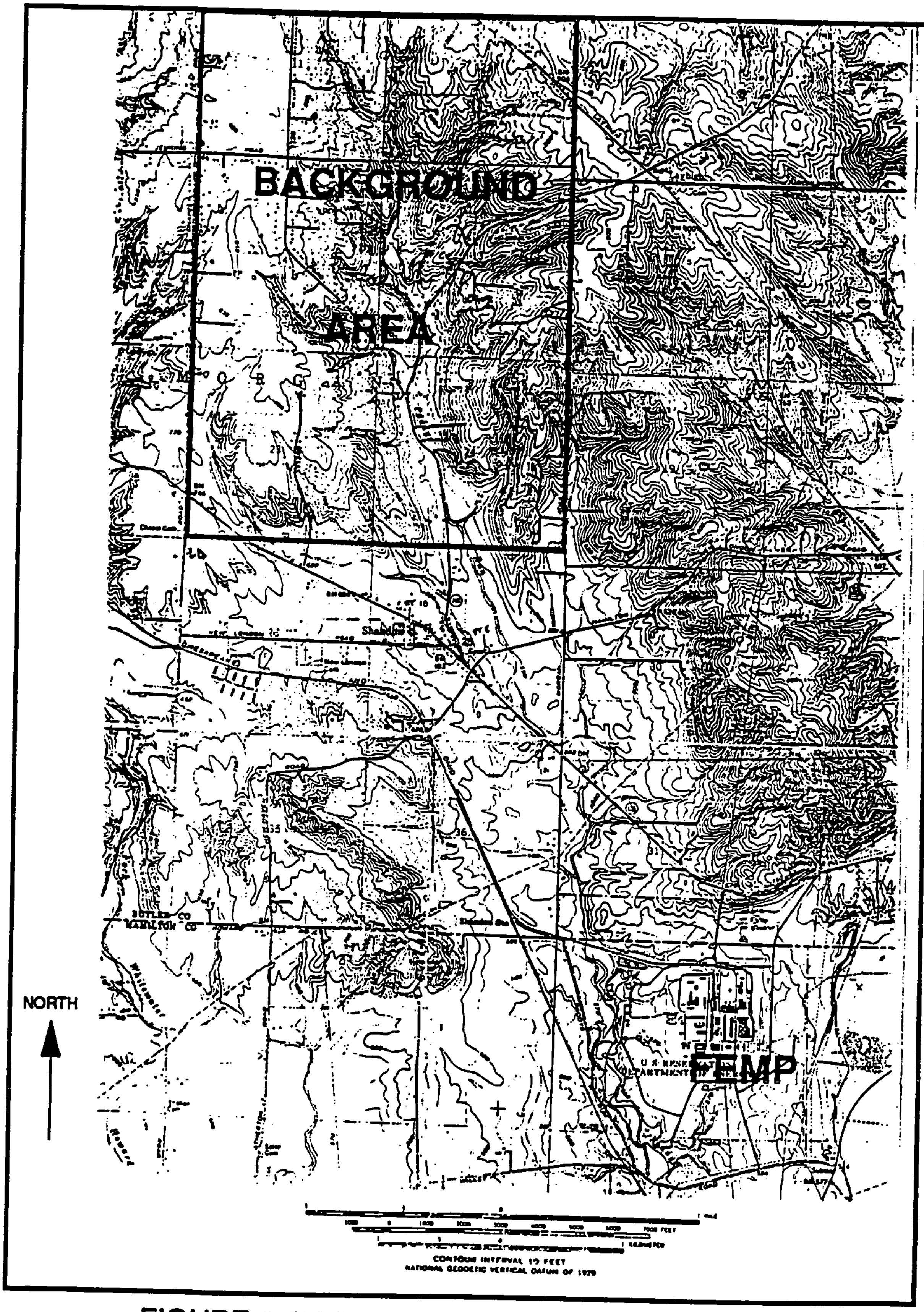


FIGURE 2 BACKGROUND AREA LOCATION

3.0 SAMPLING APPROACH

The sampling approach is designed to characterize a material that is relatively homogeneous chemically, but has a weathered surface. This weathered surface may also contain contamination from local activities such as lead from automobile exhaust or arsenic from agricultural pesticides. Therefore, it is proposed that samples be collected over a wide area to sample the variability of the glacial overburden. Samples will also be collected at three depths at each location to determine the impact of weathering and potential local contamination.

3.1 SAMPLING AREA

Figure 3 shows the background sampling locations for the six-square-mile area. Five sampling sites were selected at random in each of the six 1-square-mile sections. The locations were adjusted using the following criteria:

- Areas where solid or hazardous waste may have been stored or areas affected by their runoff
- Roads, parking lots or other paved areas
- Railroad tracks or areas affected by railway access
- Storm drains or ditches presently or historically receiving industrial, urban or agricultural runoff
- Fill areas
- Spill areas
- Areas subject to residential influence such as fertilized yards and gardens

Because the FEMP is essentially flat and it is important to get a full soil profile, locations were also moved to relatively flat areas. Some locations are in the bottom of the Paddys Run valley in order to sample floodplain deposits.

Since it may not be possible to get permission or find access to all these locations, Figure 4 was prepared with an alternate set of 30 random sampling locations. The objectives of the sampling

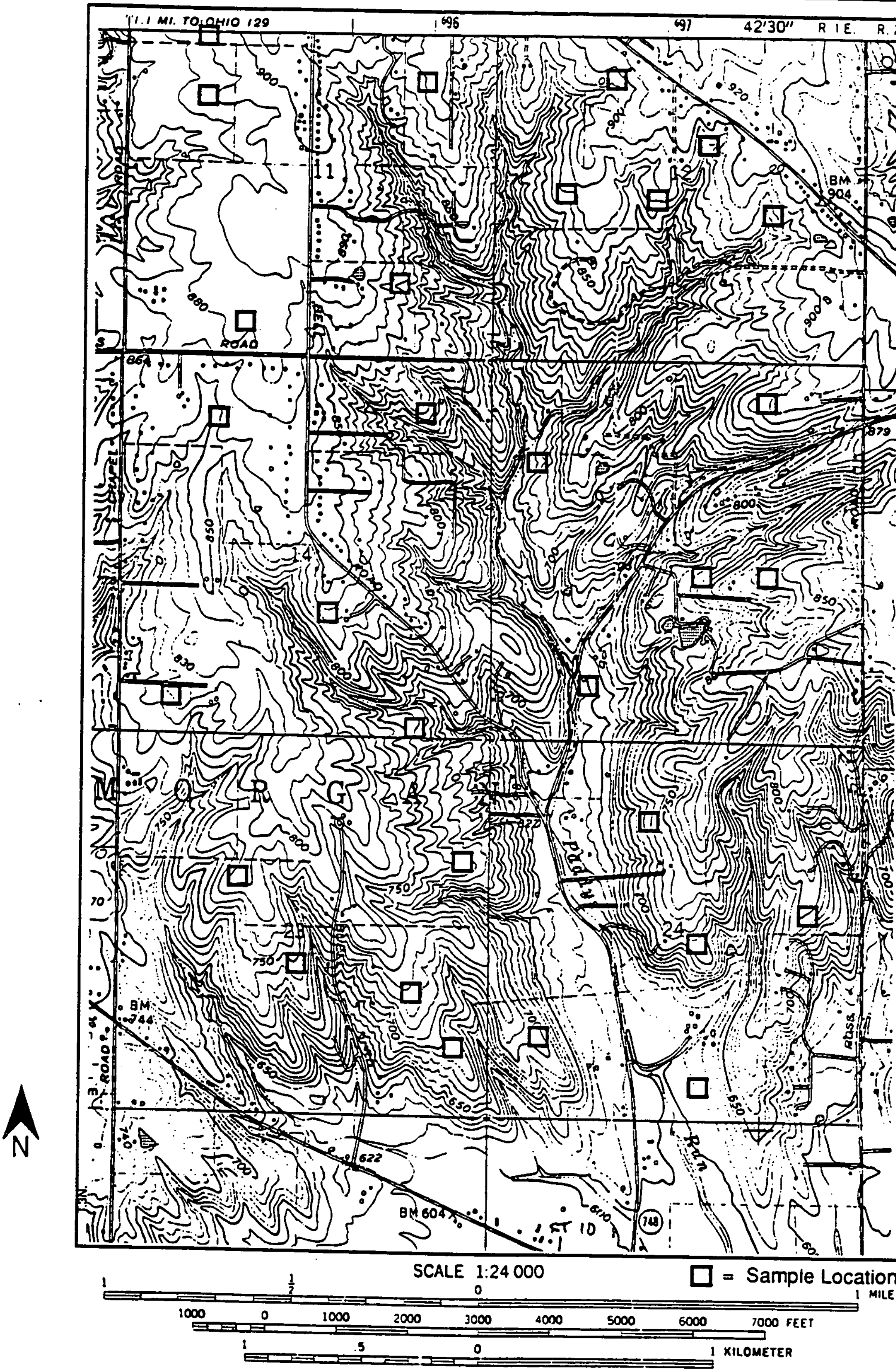


Figure 3. BACKGROUND SOIL SAMPLE LOCATIONS

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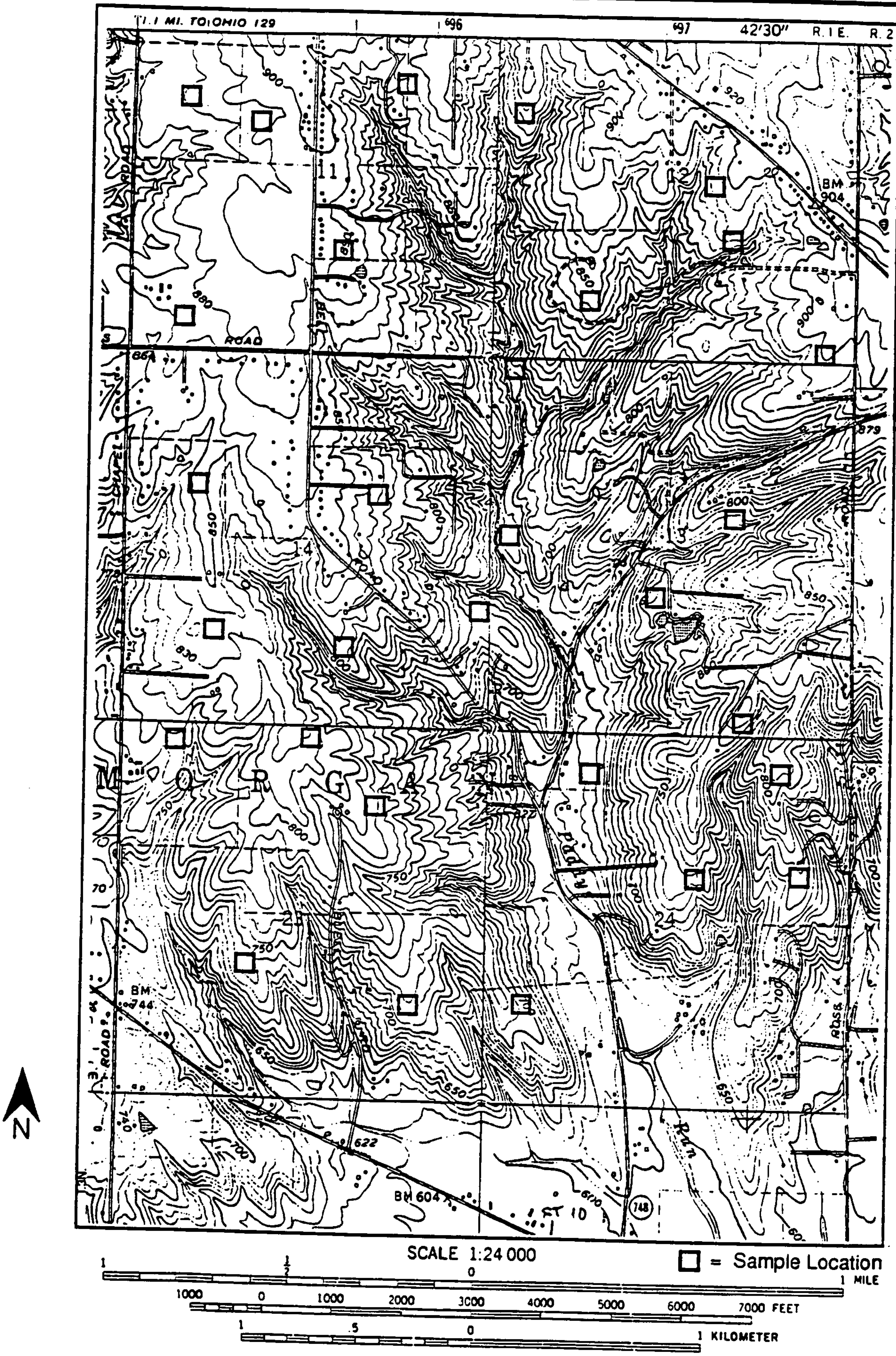

CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 4. ALTERNATE BACKGROUND SOIL SAMPLE LOCATIONS

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program can be achieved by substituting locations from Figure 4 if locations in Figure 3 are not available.

These locations have been selected using the U.S. Geological Survey, Shandon, Ohio, 7.5 minute, topographic quadrangle which was photorevised in 1981. Since the areas have not been field checked, some locations may have to be adjusted in the field in accordance with the criteria listed above if conditions have changed since the map was revised.

3.2 VERTICAL PROFILE SAMPLING

A sample from the surface to a depth of six inches will be collected to determine the nature of soil that is influenced by local activities of man and weathering. This will include the impact of lead from gasoline, metals from fertilizers, and any leaching due to weathering or plant nutrient uptake. A second sample will be collected from a depth of 36 to 42 inches, by definition the lower extent of significant weathering. A third sample will be collected from 48 to 54 inches, which is below the depth of soil development but above the perched water table.

The samples from each layer will be statistically tested to determine the variability of the values for the metals within each layer. Then, the variability will be compared between the layers. It is anticipated that the surface layer will probably contain more distinct differences from the other two layers because it is most directly impacted by man and weathering. The background composition of the glacial overburden will be established by statistical analyses of the chemical data in the deepest and perhaps the middle sampling zones, if the two do not have a significant difference.

This approach will allow sampling to be conducted with hand augers, minimizing the impact on the area where samples are collected. This should make it easier to obtain permission to enter private land for sampling. The relatively lower cost of hand auguring over machine auguring also means more sample locations can be used than are statistically required during the sampling program.

3.3 SAMPLING PROCEDURES

Surface samples will be collected with a stainless steel hand trowel. The samples at 36 to 42 inches and 48 to 54 inches will be collected with stainless steel hand samplers. Regardless of the sampling equipment all sampling will follow procedures specified in Section 6.4 of the RI/FS Quality Assurance Project Plan (QAPP) unless specifically altered in this plan. No radiation survey will be conducted owing to the expected low concentrations of radionuclides in these areas. Such survey could potentially lead to the avoidance of areas having higher naturally-occurring radionuclide concentrations.

As outlined in the RI/FS QAPP (1988), Section 5, page 25, Visual Classification of Soils forms will be completed for each boring to provide a description of soils encountered and Field Activity Daily Logs will be completed to document sampling activities. After sampling, boreholes will be filled with excess sample material and locally available topsoil. A stake will be placed next to each boring which will have the 1000-series boring number clearly written, using an indelible marker. Each sample location will then be surveyed by a licensed surveyor so a permanent record of the location can be entered into the RI/FS database.

Quality control samples will be used to check the analytical validity of field procedures, field equipment, and laboratory analyses. The RI/FS contract lab regularly performs its own quality control procedures as outlined in the QAPP. The field program and data validation collect the following quality control samples:

- One rinsate per day or one per ten samples (whichever is most frequent)
- One blind duplicate for every three borings (9 samples)
- One container deionized/water blank for each lot of sample containers or lot of deionized water used.
- Decon blanks for each lot of nitric acid and methanol used for decontamination of field equipment

All appropriate field equipment will be decontaminated prior to use following the sequence below:

1. Alconox and deionized water wash
2. Deionized water rinse
3. Nitric acid (10%) rinse
4. Deionized water rinse
5. Methanol rinse
6. Deionized water rinse

Decontamination will be conducted at a location sufficient distanced from the site to avoid cross-contamination. Sample preparation and packaging for shipping will be performed at an off-site location.

3.4 ANALYTICAL PARAMETERS

All soil samples will be analyzed for the parameters listed in Table 1. This list was compiled after a review of the potential contaminants of concern for all operable units. Potassium-40 has been added to the list as a quality check for gamma spectroscopy analysis although it is not a contaminant of concern. Organic compounds and pesticides will not be analyzed as their presence in the environment is most frequently due to anthropogenic sources. Further, data collected to date under the RI/FS would not suggest any significant natural level of organics. Table 1 also lists the risk-based concentrations of concern for each of the analytes and the required detection limits. The risk-based concentrations of concern which will be used to determine preliminary remediation goals in turn dictate the analytical detection required in the analyses. In some cases, these detection limits are lower than those prescribed in the QAPP or QAPjP. Several radionuclides will require more sensitive analytical procedures than are required under the standard analytical protocols of the RI/FS QAPP, but are being utilized to ensure adequate knowledge of the environment.

Table 2 is a summary of the data quality objectives of this program.

3.5 SAMPLE SIZE

Representative samples will be collected at three sampling depths at 30 locations within a six-square-mile area northwest of the FEMP site. Because the determination of background is critical to the completion of two closures under RCRA and the Baseline Risk Assessment under CERCLA, all 90 soil samples will be analyzed as soon as they are collected. This will ensure that even if some samples do not pass validation there will be a sufficient number of samples, possibly 30 for each depth interval, available for the statistical analysis. Analysis of this number of samples exceeds the minimum requirements of pertinent guidance addressing RCRA closure actions.

TABLE 1

LIST OF PROPOSED ANALYTES

Radionuclides	Risk-Based (10^{-6}) Cleanup Goal[a] (pCi/g)	Analytical Detection Limit (pCi/g)	Inorganics	Potential Level of Concern[b] (mg/kg)	Detection Limit (mg/kg)
Actinium-227	1.0	0.6	Aluminum	--	20
Cesium-137	0.01	0.2	Arsenic	270	1.0
Protactinium-231	0.06	0.1	Antimony	110	6.0
Lead-210	0.3	0.3	Barium	13,500	20
Radium-224	0.2	0.5	Beryllium	1400	0.5
Radium-226	0.3	0.3	Cadmium	270	0.5
Radium-228	3.8	1.0	Chromium	1300	2.0
Strontium-90	10	1.0	Cobalt	--	5.0
Technetium-99	270	1.0	Copper	--	2.5
Thorium-228	0.8	0.6	Lead	190	0.5
Thorium-230	1.9	0.6	Manganese	27,000	500
Thorium-232	2.3	0.6	Mercury	80	.04
Uranium-234	1.2	0.6	Molybdenum	1100	2.0
Uranium-235	0.01	0.02	Nickel	5400	4.0
Uranium-238	1.4	0.6	Selenium	--	0.5
Potassium-40	--	10	Silver	800	2.0
Ruthenium-106	39	1.0	Thallium	20	1.0
			Vanadium	1900	5.0
			Zinc	54,000	2.0

[a] Assuming a lifetime risk of cancer incidence of 1×10^{-6}, and utilizing the method and parameters recommended in Part B of the Risk Assessment Guidance for Superfund (12/91), except that a 70-year exposure period was deemed appropriate for the FEMP.

[b] Calculation was based on Eq. 5 of the Risk Assessment Guidance for Superfund, Part B .

TABLE 2
DATA QUALITY OBJECTIVES FOR THE BACKGROUND CHARACTERISTICS OF SOILS

Activity	Conduct hand soil sampling with trowels and hand augers at 30 background locations. Samples will be collected at 0-6, 36-42 and 48-54 inch depth intervals. All samples will be analyzed for the constituents listed in Table 1.
Objectives	Define the background concentration of radionuclides and metals in soils.
Prioritized Data Use(s)	The priority data use is background soil characterization. Background soil characterization data is used for risk assessment, selection of remedial alternatives, and during determination of final remediation levels.
Appropriate Analytical Level	Radionuclides: Level V Inorganic Chemicals: Level IV
Constituents of Concern	See Table 1.
Level of Concern	See Table 1.
Required Detection Limits	See Table 1.
Critical Samples	No individual sample is considered critical; however, an aggregate of samples is considered critical to characterization of background. The study requires that a sufficient number of the samples pass the specified data validation to meet the criteria of Section 4.0 for each of the three sampling intervals.

4.0 STATISTICAL ANALYSIS

4.1 DESCRIPTIVE STATISTICS

The statistical analysis of the sample data will begin with the calculation of descriptive statistics. These descriptive statistics will provide summary information and allow for a preliminary and subjective evaluation of the data. The descriptive statistics will include the arithmetic and geometric mean and standard deviation, sample median, minimum and maximum exposures, and sample size. Descriptive statistics will be calculated separately for each contaminant at each of the three sampling depths.

The mean concentration will be further characterized by a 95 percent confidence interval. A 95 percent confidence interval is an interval for which there is 95 percent certainty that the interval estimate contains the true mean concentration. An interval estimate of the mean exposure is preferable to a point estimate, such as the mean, because interval estimation provides information on the precision of the estimation.

Sampling results will also be evaluated using an upper one-sided tolerance limit. The upper tolerance limit (UTL) will provide a maximum concentration below which a specified portion of all concentrations will fall, with a high degree of confidence. In essence, a UTL is an upper confidence limit for a percentile of a distribution of concentrations. For these sampling results, the UTL will be calculated such that it will provide a maximum concentration below which 95 percent of all concentrations will fall, with 95 percent confidence.

It is expected that some number of samples will yield nondetectable results for certain contaminants of interest. Here, a nondetectable result is defined as any sample which is reported to be less than the sample quantification limit (SQL) as defined by the analytical method. A method for handling nondetectable values is essential in producing accurate descriptive statistics. The method to be used involves setting all nondetectable values to one-half of the SQL.

The data will also be evaluated to identify potential outlier observations. An outlier is defined as a measurement that is extremely large or small relative to the rest of the data and is suspected of misrepresenting the true background concentration. If a particular observation is suspected as being an outlier, additional data validation, field investigations, and confirmation sampling and analysis will be conducted as necessary to determine the reason for the anomalous value. A suspected outlier will not be eliminated from the data set unless there is definitive evidence that the measurement is in error.

4.2 COMPARISON OF SAMPLING DEPTHS

The mean contaminant concentrations at the three sampling depths will be tested statistically by using analysis of variance (ANOVA) techniques. If there is no statistically significant evidence of differences in mean concentrations among the three sampling depths, the data may be pooled to obtain an overall estimate of background contamination.

ANOVA procedures are parametric methods based on the assumptions that exposure measurements are independently and normally distributed with constant variance. These assumptions will be tested to determine the validity of the ANOVA results. If the assumptions do not appear reasonable, alternative procedures based on the random reclassification of the sample results may be used. These procedures, commonly referred to as randomization or permutation tests, are useful when the validity of the assumptions associated with common parametric statistical procedures are questionable.

The assumption of normality will be tested by using the Shapiro-Wilk procedure (Shapiro and Wilk 1965) and an omnibus test developed by D'Agostino and Pearson (1973) which is able to detect deviations from normality due to either skewness or kurtosis. If the data are not adequately described by a normal distribution, the natural logs of the data will be evaluated. This is equivalent to assuming that the data follow a lognormal distribution; that is, the natural logarithms of the data are normally distributed.

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D'Agostino, R. B. and Pearson, E. S., 1973, "Testing for the Departures from Normality. I. Fuller Empirical Results for the Distribution of b_2 and $\sqrt{b_1}$," Biometrika, 60, 613-622.