THE PRACTICAL USE OF COMPUTER GRAPHICS TECHNIQUES FOR SITE CHARACTERIZATION

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In this paper we will describe the approach utilized by Roy F. Weston, Inc. (WESTON) to analyze and characterize data relative to a specific site and the computerized graphical techniques developed to display site characterization data. These techniques reduce massive amounts of tabular data to a limited number of graphics easily understood by both the public and policy level decision makers. First, we will describe the general design of the system; then the application of this system to a low level rad site followed by a description of an application to an uncontrolled hazardous waste site.

This system was developed and applied to a real life problem in the "heat of battle" in the Formerly Utilized Sites Remedial Action Program (FUSRAP) being conducted by the U.S. Department of Energy. The system proved itself sufficiently useful to be expanded for the application to hazardous waste sites under WESTON's Superfund contract with the U.S. Environmental Protection Agency for clean up of abandoned hazardous waste sites. In addition, this system is now being integrated into the JACOBS/WESTON Technical Assistance Contract (TAC) for management of the clean-up of mill tailing sites under the U.S. Department of Energy's Uranium Mill Tailing Remedial Action Program.

Under this initial effort, WESTON, under sponsorship of the Government, was assigned the task of complete site characterization of a FUSRAP site, development of a generic data management system that could be applied to other sites, and evaluation of alternative remedial measures for the site.

The first step in identifying and resolving any site radiological problem is to fully characterize the site. Thus, existing site characterization data was collected in the following categories:

1. History of Site Operations.

2. Radionuclide Activity and Concentration of Buried Materials.

3. Geotechnical Concerns.

4. Groundwater Kinetics.

5. Surface Erosion.

6. Radon Gas Emanation.

7. Chemical Contamination.

Specifically, the data was evaluated for content, extensiveness, reliability, and sufficiency, i.e., would the existing data base support conceptual engineering evaluation of alternatives.

The approach taken in evaluating the data is shown in Fig. 1. Characterization of a site requires the management from numerous and diverse data collection activities. Associated with these activities are various independent and dependent data components such as radiological conditions, hydrogeologic descriptions, chemical analysis of soil and groundwater, site physical characteristics and relevant site operational history. To permit a multi-disciplinary team involved in the Remedial Action Program to effective utilize this data, a capability was required which centrally stores, analyzes and displays the data through a variety of standard techniques. The data management functions needed to meet the project objectives of site characterization and evaluation of alternative remedial actions are:

1. Data Entry.

2. Information Integration.

   - Data Storage.
   - Data Analysis.
   - Data Presentation.

3. Evaluation and Decision.

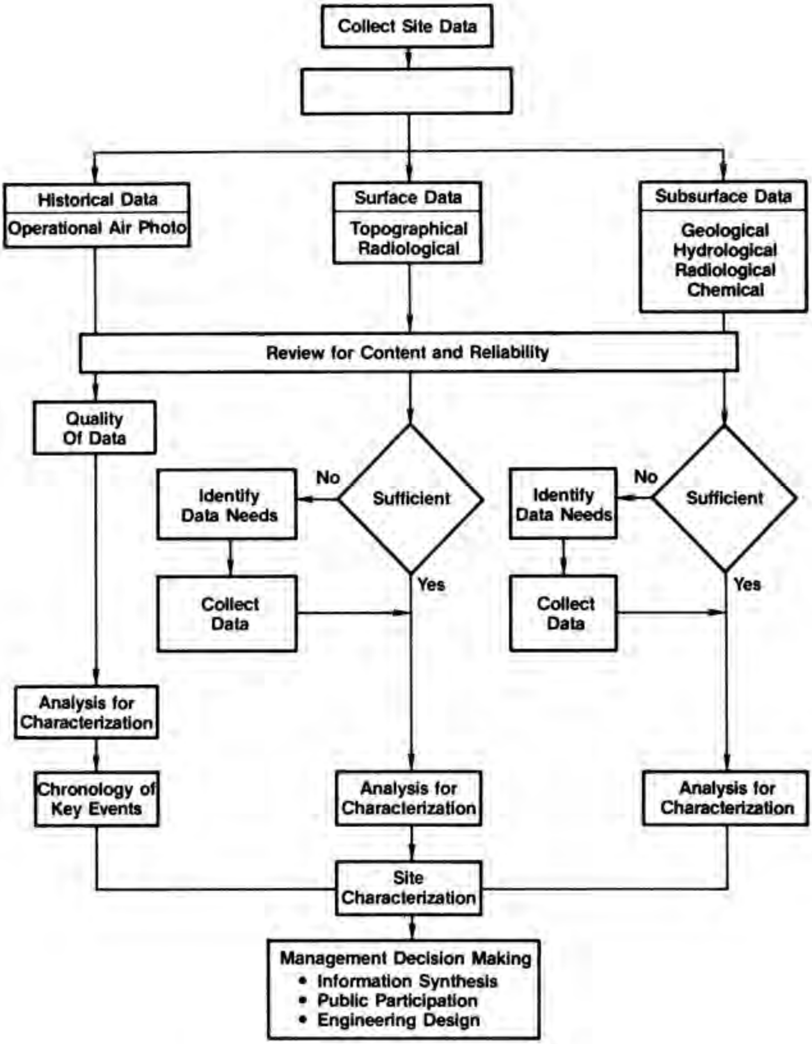


Fig. 1

Flow Chart For Analysis Of Site Characterization

The relationship of these functional data management requirements with the basic components of a computerized data management system is shown in Fig. 2.

As shown, the computerized data management system consists of four basic components:

1. Data.
2. Data Base Files.
3. Process Modules.
4. Output.

It is the efficient management of the interrelationship of these components through the various functional stages which provides the successful vehicle for achieving the program objective. Evaluation of this requirement identified the following attributes required for such a system.

1. Comprehensive, centralized file management structure with minimum data redundancy.

2. Multi-site capability with ability to support the overall program.

3. Modular approach to processing components.

4. Independence of data files from processing software.

5. Maximum use of available standard software.

6. Functional development of processing software and resultant output.

7. Graphical and tabular output capability.

8. Data editing and review capability.

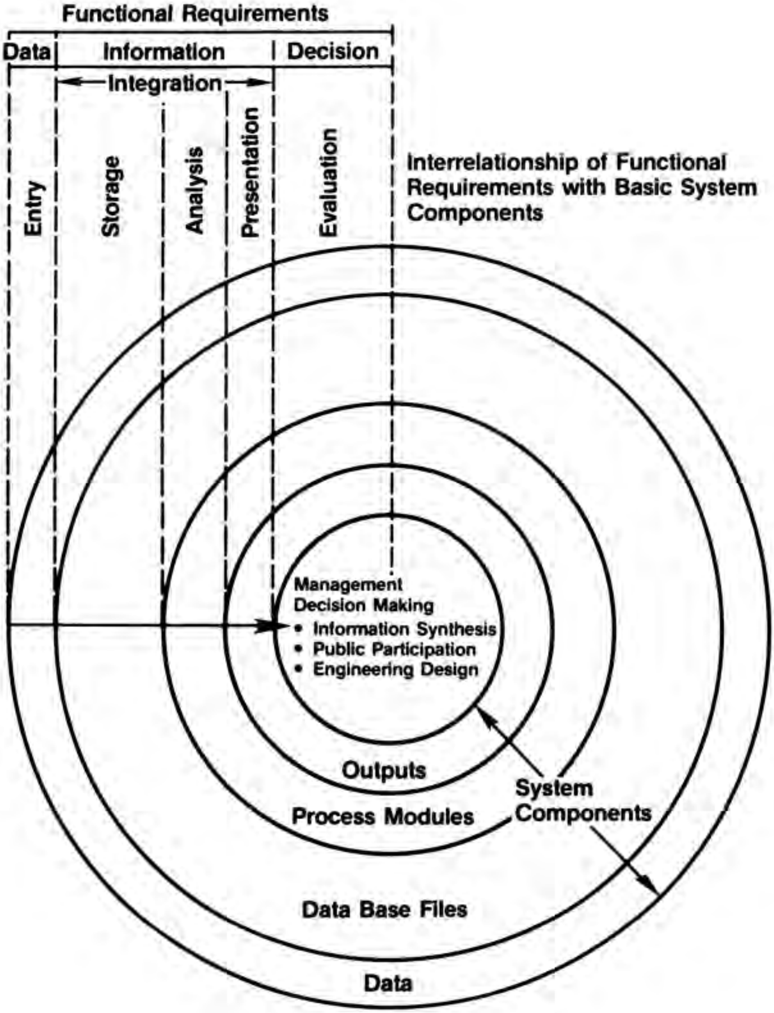


Fig. 2
Data Management Requirements

WESTON's approach to meeting this need was the design and development of a modularized data management system built around a central data base core. The construction of this system permitted a standardized approach to the site characterization methodology, yet provided the flexibility necessary to meet specific demands posed by unique site situations. This system's approach is conceptually shown in Fig. 3. Shown again are the four basic system components (data, data base files, process modules, and output). Also, added are the specific data element and components necessary to meet the system's objectives. Basically, the system accepts data from the various field surveys and incorporates site related information such as the exact location of known contaminants and concentrations, physical structures and features and topographical data. These data are then stored in various data base files organized to provide maximum flexibility. Processing modules then interact with the appropriate data base files to analyze and present these data in various output formats for further evaluation by the appropriate professional disciplines and decision makers, ultimately leading to a cost-effective concept engineering solution.

Our Data Management System embodies the data entry, storage, integration, presentation and analysis functions necessary to support the data requirements associated with a Remedial Action Program. An overview of the Data Management System, identifying the major system components and illustrating these relationships is shown in Fig. 4.

The data base functions are the core or center of the data management system. It is a collection of independent subfiles logically connected by a network of supporting software. Within each file are the various record types that logically define specific segments of the data area represented by the file. The approach taken in the design of this system was to categorize the processing into a number of self-contained modules. Each module contains programs specific to its function. Several important advantages result from this approach. Modular systems are inherently less complex than non-modular systems -- due to the fewer interconnections involved. Also, systems with fewer interconnections are easier to understand. Since each module is designed to be as self-contained as possible, the system can respond to changing processing needs. Output is a function of the processing module involved. Capabilities include tabular reporting, three-dimensional graphic representation and data plotting.

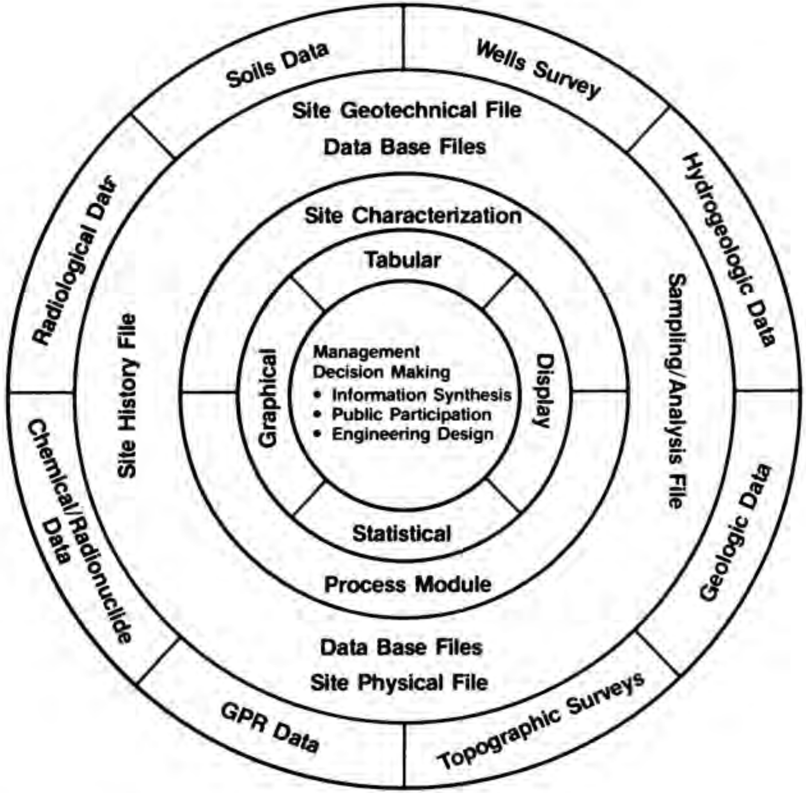


Fig. 3

Data Management Systems Concept

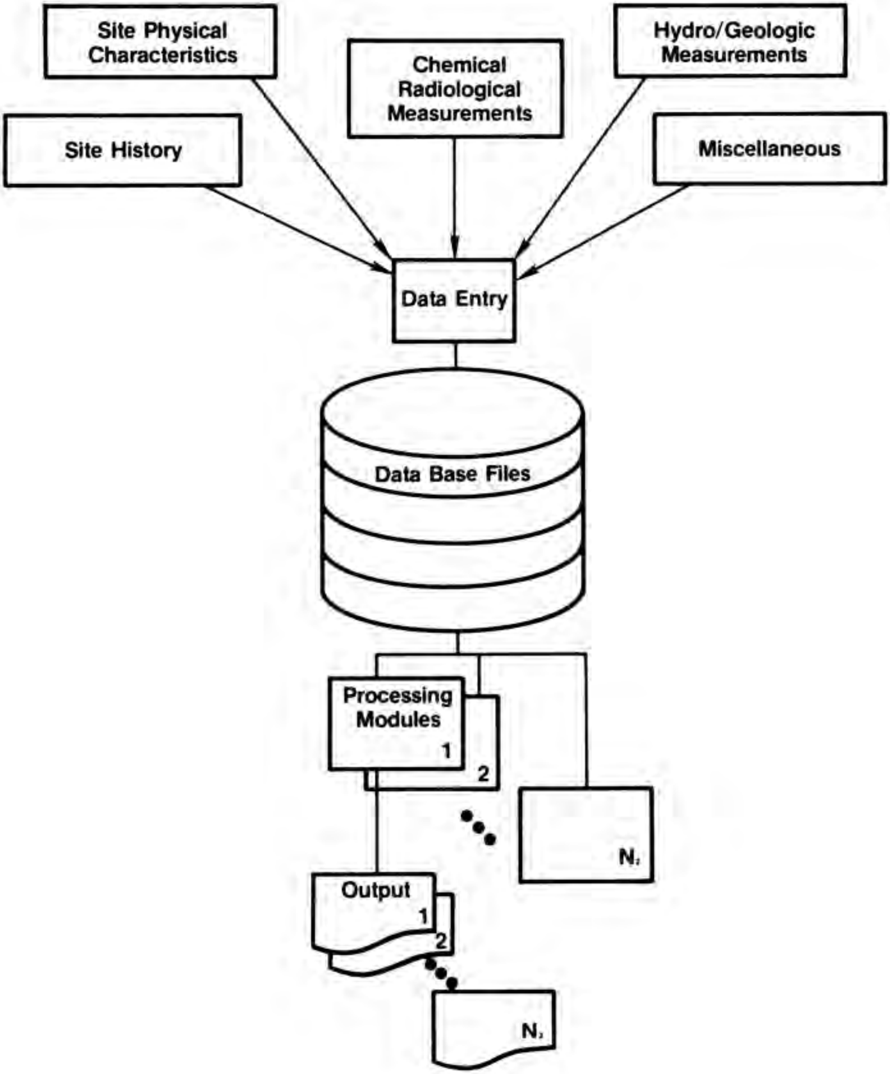


Fig. 4

Computer System Overview

Let's look at application of the system to a low level rad site. Due to time limitations, we will show two examples; a simple example and a complex one.

Consider a simple example of the use of a module -- GRAIN SIZE DISTRIBUTION. The site data base is shown in Fig. 5. From the site data base, we go into the sampling/ analysis file as shown in Fig. 6. Utilizing the data in soils element of file, the processing module (shown in Fig. 7) analytically manipulates the raw data, calculates and plots the GRAIN SIZE DISTRIBUTION-GRADIENT CURVE shown in Fig. 8, or tabulates the results (Fig. 9). This output is produced in a manner of minutes and saves valuable time of the geologist.

The following examples are more complex. From the site data base, we go into the site physical file as shown in Fig. 10. Utilizing the data in this file, and the sampling/analysis file, the processing module (shown in Fig. 11) will generate three-dimensional plots describing the levels of contamination throughout the site. The next slides (Figs. 12 and 13) show the output and is real data from the site depicting beta gamma radiation one centimeter above the surface. A key element of the system is the development of a standard reference grid (Fig. 14) (concept originally developed at ORNL) which is used to locate all field and sampling activities. Another feature of the system is the ability to produce topographical differentiation contour maps based upon historical surveys to determine erosion, settling, migration and/or dumping activities at the site (see Fig. 15).

The system is also capable of generating three-dimensional topography and superimposing the location of wells and their gamma log readings as shown in Figs. 16 and 17, to show the nature of subsurface contamination. Another feature of the system is the ability to display and calculate the volume of a surface pile of rubble from surveying the site as shown in Fig. 18, and the results are tabulated in Fig. 19. This module has been successfully used to determine the volume of material to be removed from a site.

We also reviewed historical aerial photos of the site and correlated them with past and current operations as shown in Figs. 20, 21 and 22.

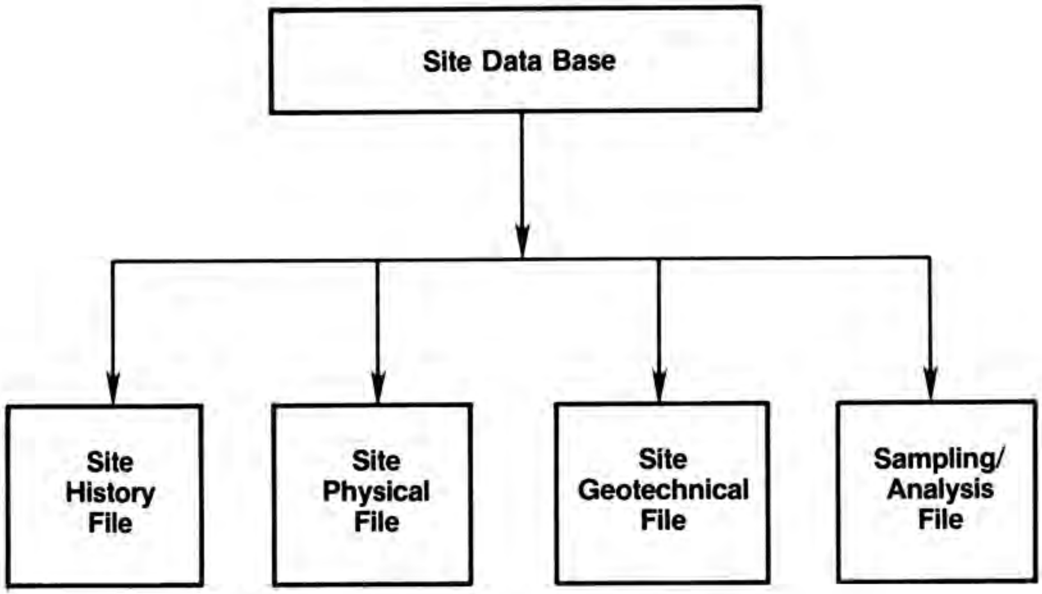


Fig. 5

Data Base Files

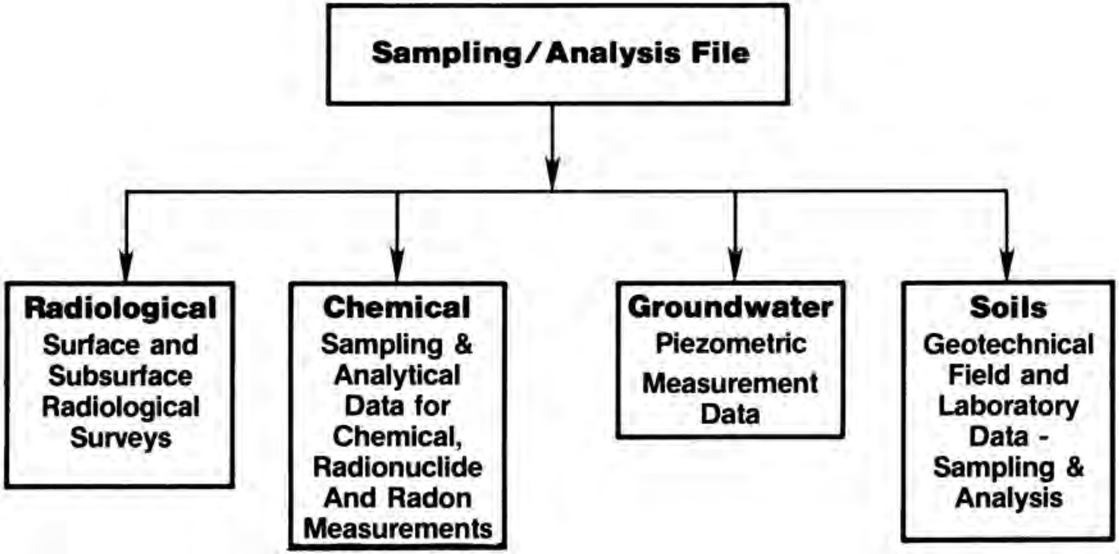


Fig. 6

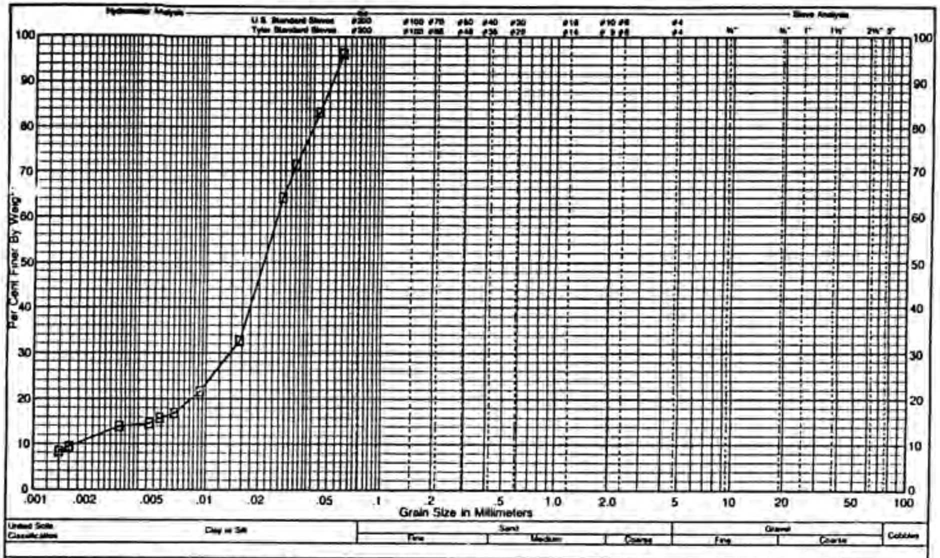
File Organization - Sampling/Analysis File (Example of Grain Size Distribution)

Processing Module Name: Hydanl Hydrometer Analysis Report
Description: Laboratory Hydrometer Analysis of soil samples to determine the grain size distribution. Produces values of temperature, different concentrations, and hydrometer readings versus time. These values are read by the module and stored. Results of calculations performed on this data results in tabular values or semi-log plots of grain size versus percent finer. The grain size of specific percentages (D90, D50, D40) are also calculated and used to determine the uniformity coefficient.
Data Input: Laboratory readings associated with hydrometer analysis.
Output: Semi-log plot of grain size distribution and work sheet of intermediate data values and percentage of specific grain sizes.

Fig. 7

Data Management System Processing Module Description

(Example of Grain Size Distribution)



Symbol	Sample	D60	Specific Gravity	Description of Sample
				SAMPLE NO. 1 WELL NO. B-1 SAMPLING DEPTH 4-6FT. UNIT NO. 2 D80 = .051 D40 = .18

Fig. 8

Example of Grain Size Distribution Gradient Curve

Hydrometer Analysis Data Sheet

Project Identification — St. Louis

Sample No.	56	Analyst	Stanley
Beaker & Sample Wt.	36.395	Hydrometer No.	2
Sample Wt. (Wet)	35.000	Temperature	22.800
Sample Wt. (Dry)	34.195	Dispersant	Calgon
Percent Water	2.300	Concentration	4.200
		Unit ID	3

Time	T^.5	R	Temp.	Theta	RL	C	CO	x	%	X-Mill
0.50	0.71	38.00	22.80	41.69	4.20	33.8	34.195	59.0	98.8	0.0590
1.00	1.00	35.10	22.80	42.66	4.20	30.9	34.195	42.7	90.4	0.0427
2.00	1.41	30.30	22.80	44.17	4.20	26.1	34.195	31.2	76.3	0.0312
3.00	1.73	26.00	22.80	45.58	4.20	21.8	34.195	26.3	63.8	0.0263
11.00	3.32	15.00	22.80	48.92	4.20	10.8	34.195	14.8	31.6	0.0148
30.00	5.48	11.20	22.80	50.11	4.20	7.0	34.195	9.1	20.5	0.0091
60.00	7.75	10.30	22.60	50.33	4.20	6.1	34.195	6.5	17.8	0.0065
90.00	9.49	9.70	22.20	51.01	4.20	5.5	34.195	5.4	16.1	0.0054
120.00	10.95	9.30	22.20	51.12	4.20	5.1	34.195	4.7	14.9	0.0047
270.00	16.43	9.10	21.90	51.23	4.20	4.9	34.195	3.1	14.3	0.0031
681.00	26.10	8.40	22.40	51.34	4.20	4.2	34.195	2.0	12.3	0.0020
1307.00	36.15	8.40	21.90	51.34	4.50	3.9	34.195	1.4	11.4	0.0014

D90 + 0.0424
D50 + 0.0214
D40 + 0.0178
Uniformity Coefficient 0.42
Unit 3

Fig. 9

Example of Hydrometer Analysis Work Sheet

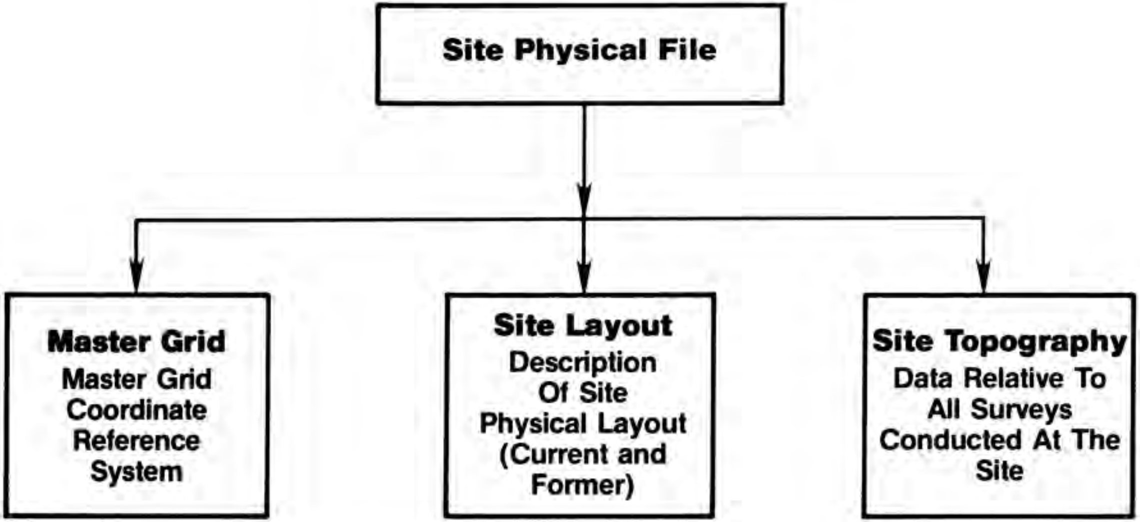


Fig. 10

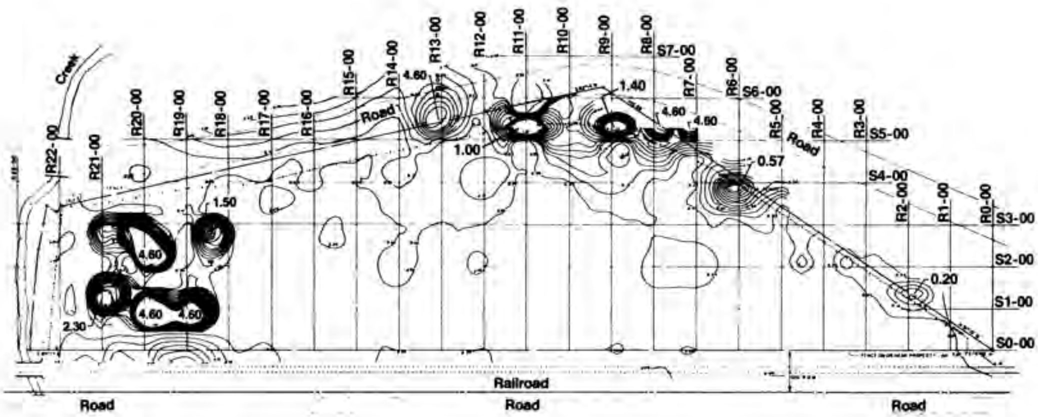
File Organization - Site Physical File

Processing Module Name: Threed Three-Dimensional Plot
Description: Equally spaced (gridded) data values are read and represented by a three-dimensional plot of the surface described by those values. The data values may be for any variable which can be represented in plan view over the site.
Data Input: Values of a particular variable occurring in equally spaced intervals (i.e., gridded data from the NUPRX module).
Output: Gridded three-dimensional plot of a continuous surface

Fig. 11

Data Management System Processing Module Description

(Example of Site Characterization



1.00 Peak Values (mRAD/Hr)

Isopleth of Beta—Gamma Radiation Levels
At 1 CM Above Surface (mRAD/Hr)
—Interval: 0.05 mRAD/Hr)

Fig. 12

Isopleths of Beta-Gamma Radiation Levels One CM Above the Surface

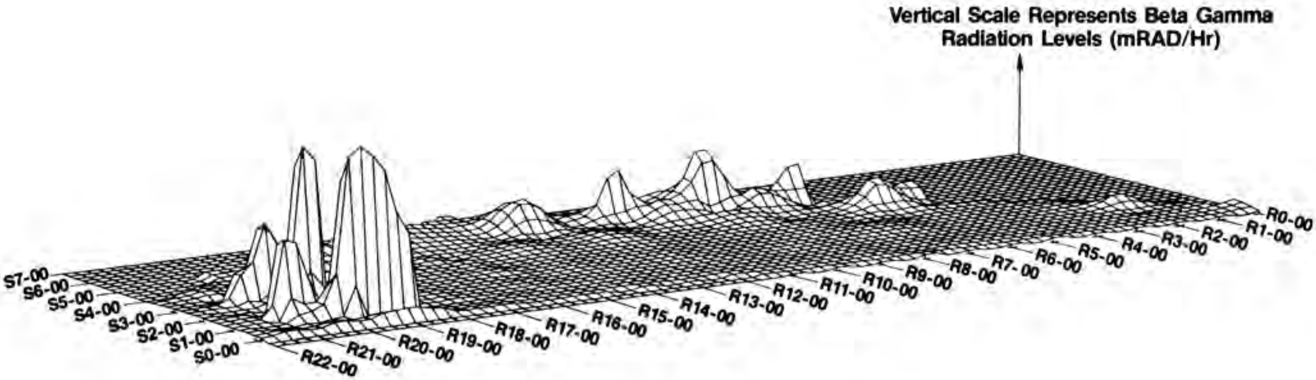


Fig. 13

Three Dimensional Interpretation of Beta Gamma Radiation One CM Above the Surface

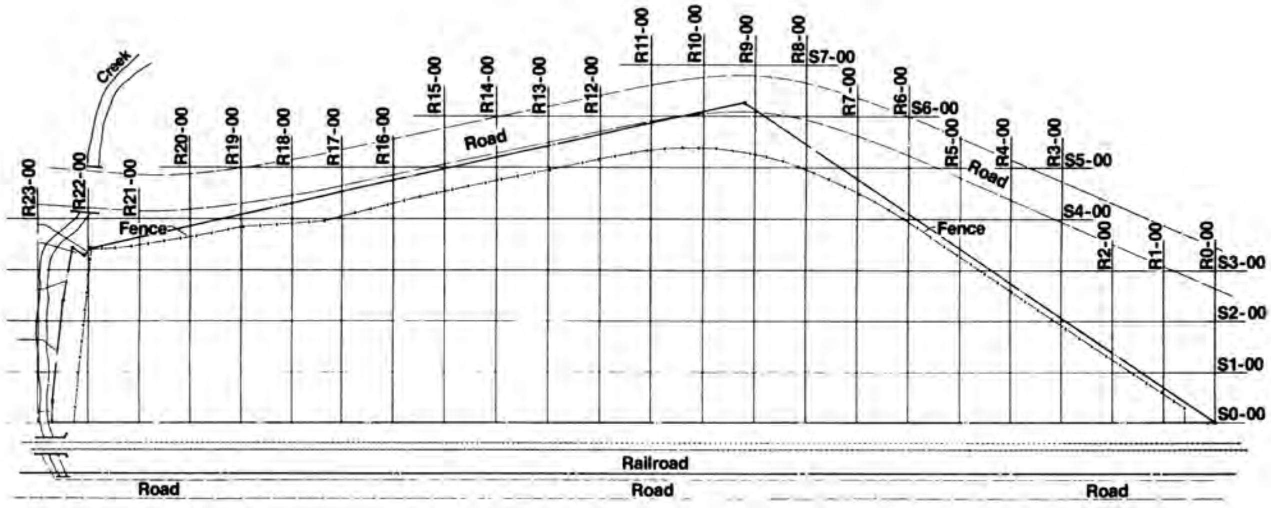
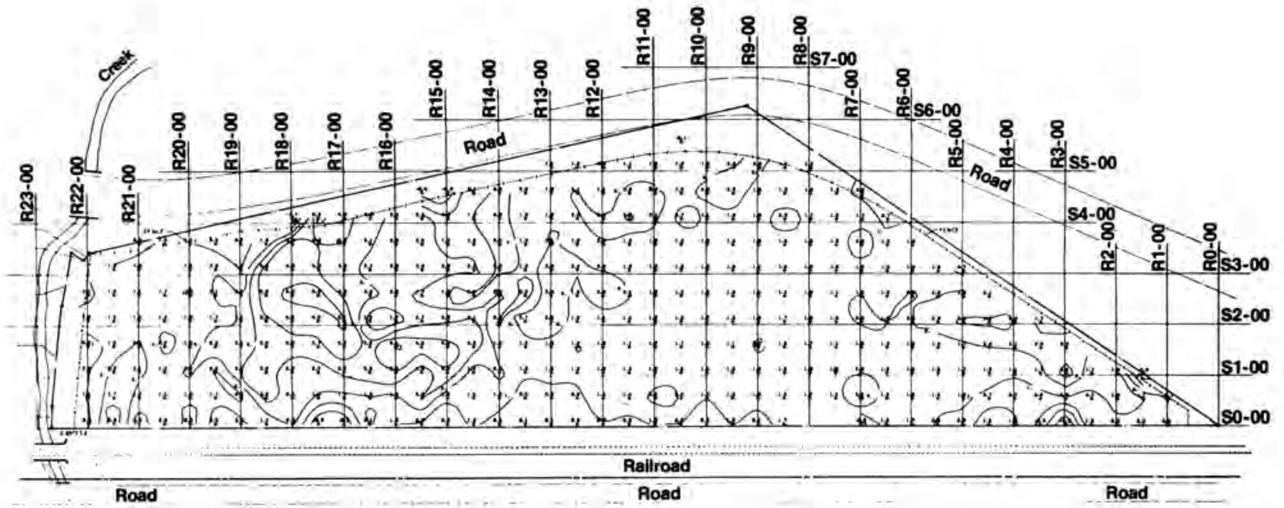


Fig. 14

Site Map With Grid System



Indicates Fill In Feet—(Removal Minus)
Difference Contour—Interval: 1 Foot

Fig. 15

Topographical Differentiation Contour Map

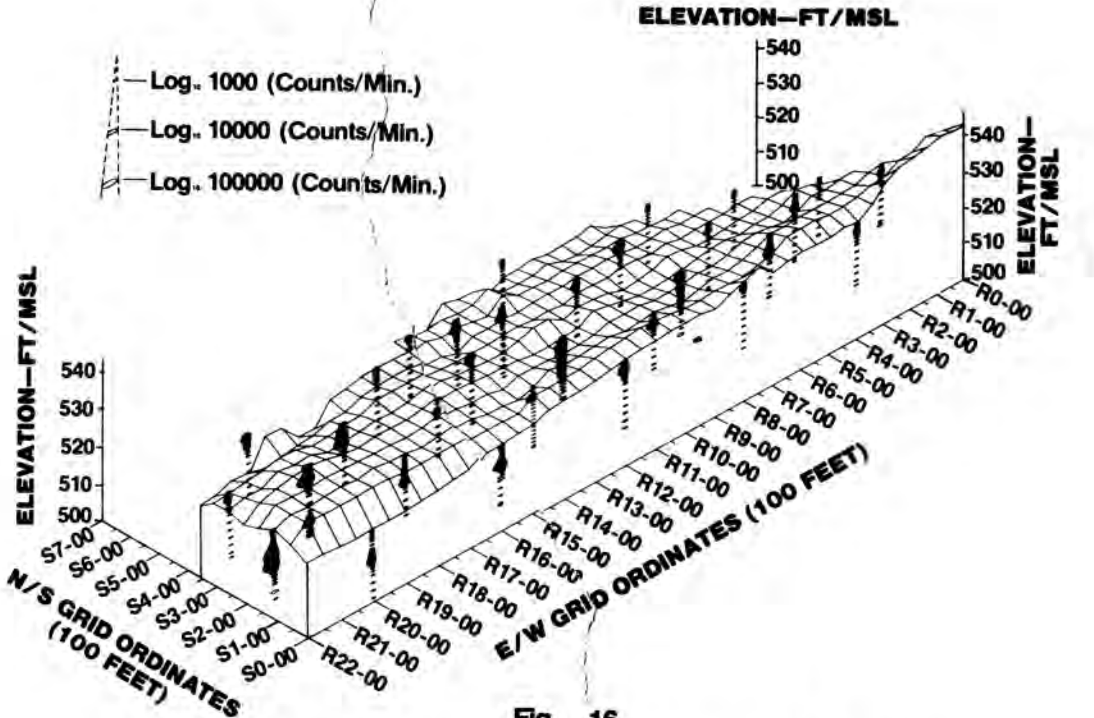


Fig. 16

Three Dimensional Topography with Superimposed Locations of Wells and Gamma Log Readings

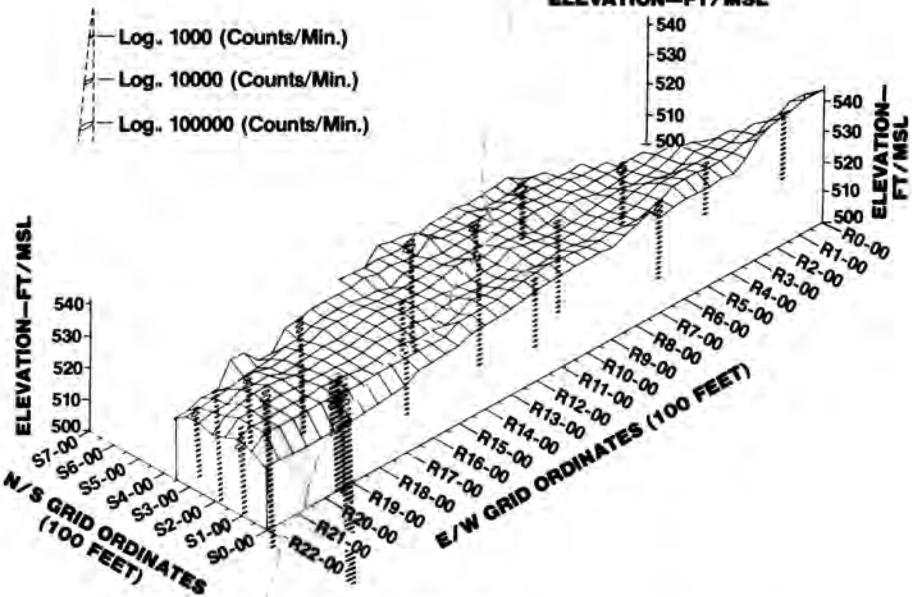


Fig. 17

Three Dimensional Topography with Superimposed Locations of Wells and Gamma Log Readings

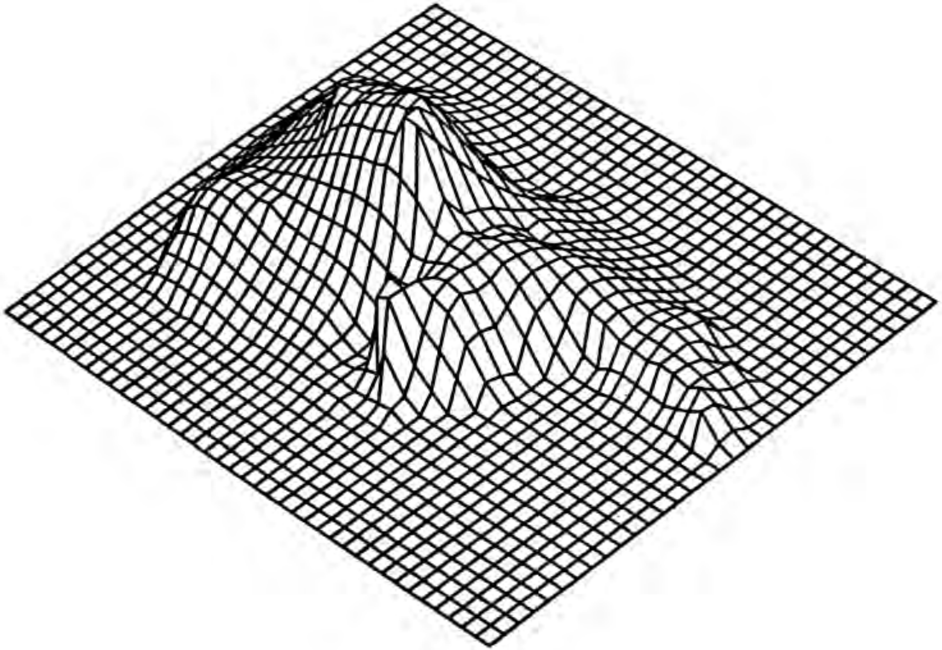


Fig. 18

Rotated Three Dimensional Representation Of Surface Pile

Section Number	Section Volume Cu. Ft.	Volumetric Calculation Cumulative Volume Cu. Ft.	Cumulative Volume Cu. Yd.
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	3.68	3.68	0.14
7	365.07	368.75	13.66
8	1308.49	1677.24	62.12
9	3164.74	4841.97	179.33
10	6658.85	11500.82	425.96
11	10289.13	21789.95	807.04
12	13480.86	35270.82	1306.33
13	16651.71	51922.53	1923.06
14	19481.94	71404.44	2644.61
15	23184.54	94588.94	3503.29
16	27880.42	122469.31	4535.90
17	31154.90	153624.19	5689.78
18	33181.02	186805.19	6918.71
19	33210.52	220015.69	8148.73
20	29668.97	249684.63	9247.58
21	23915.16	273599.75	10133.32
22	17113.77	290713.50	10767.16
23	11108.59	301822.06	11178.59
24	6542.10	308364.13	11420.89
25	3288.03	311652.13	11542.67
26	1371.98	313024.06	11593.48
27	389.20	313413.25	11607.89
28	29.51	313442.75	11608.99
29	0.0	313442.75	11608.99
30	0.0	313442.75	11608.99
31	0.0	313442.75	11608.99
32	0.0	313442.75	11608.99
33	0.0	313442.75	11608.99
34	0.0	313442.75	11608.99
35	0.0	313442.75	11608.99

Fig. 19

Example Of Volume Of Cross-Sectional Segments Of A Given Mass

Fig. 20 1958

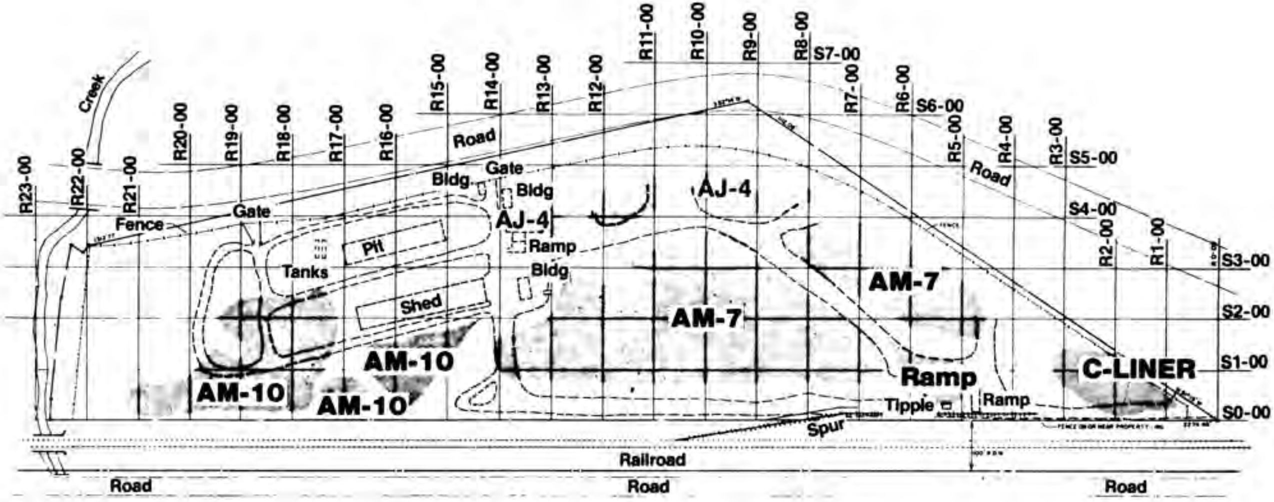


Fig. 21

Waste Piles Building and Road Locations

Fig. 22 1971

To verify the exact location of buried items, we conducted a ground penetrating radar survey (Fig. 23) of the site and validated the location of buried items (Fig. 24). The GPR survey route was based upon information gleaned from the initial characterization analysis.

The results of surface and subsurface surveys of this site fill many volumes. A meaningful understanding of the data by the public, for example, is difficult. Three-dimensional graphics such as those shown have been used to effectively communicate with the public, elected officials and decision makers within the Government. In addition, by our generating these three-dimensional plots of existing contamination and associated statistical analyses, we were able to identify where and how much additional data collection (well drilling, logging and sampling) was required to adequately characterize the site.

Now let's look at application of the system to hazardous waste sites. In a multi-site program, again the first step is site characterization. On-site teams, with appropriate safety equipment, collect soil and ground samples. We have found that a significant portion of our Data Management System is directly applicable to hazardous waste sites. First, we enter the topography of a site. We utilize a standard grid system on all sites and survey the monitoring of well location to enter them into the Data Management System. All samples of soil and groundwater are identified as to the exact location on the site grid and the chemical analysis of each sample in entered into the system. In addition, site ambient air monitoring is conducted and the location of each monitor together with the analytical results are entered into the system. This permits us to utilize the majority of our processing modules. Because of confidentiality agreements and possible future litigation, I cannot show site data or name the clients or sites.

What we have done is describe the system and show you limited examples of the implication of information management and decision-making influences of the system. It is unfortunate that time does not permit a discussion of the significant implications the system had in the areas of:

- Engineering Analysis.
- Legal Analysis.
- Hydrogeologic and Groundwater Modeling.

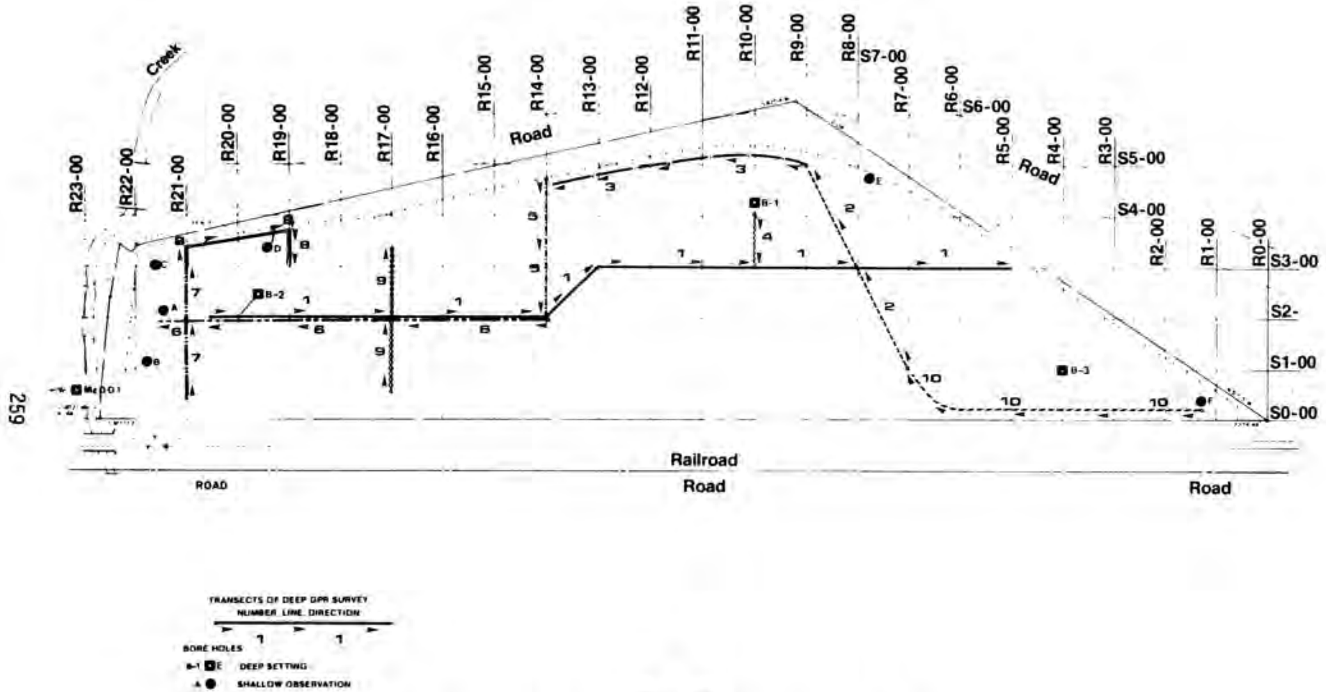


Fig. 23
Location Map of Deep GPR Survey Transects

Shallow GPR Survey Transect Line No. 36

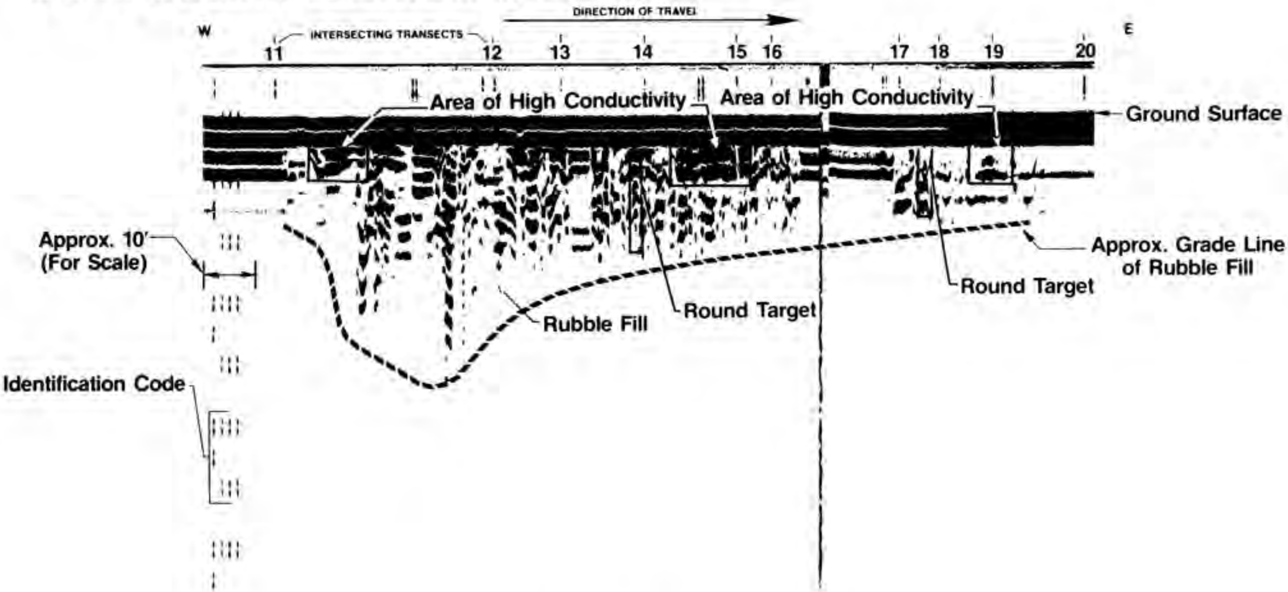


Fig 24

Example Of GPR Readout and Interpretation