MONSERCO

CHARACTERIZATION

SURVEY OF

SAFETY LIGHT CORPORATION SITE

AT

BLOOMSBURG, PENNSYLVANIA

U.S.A.

Report Number Monserco/96/NB/1821

by

MONSERCO LIMITED

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September 5, 1996

Ron Bellamy

U.S. NUCLEAR REGULATORY COMMISSION
REGION I
475 ALLENDALE ROAD
KING OF PRUSSIA, PA 19406

Dear Mr. Bellamy:

Per our conversation of today's date, please find enclosed one (1) copy of the characterization document per our settlement agreement.

Should you have further questions, please contact the undersigned.

Sincerely,
SAFETY LIGHT CORPORATION

Larry Harmon

Larry Harmon
Plant Manager

M O N S E R C O

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TORONTO MONTREAL

EXECUTIVE SUMMARY

This report documents the characterization activities conducted at the Safety Light Corporation (SLC) site, Bloomsburg, Pennsylvania USA The site characterization program was started in May 1995 and completed in December 1995. The work was carried out on behalf of the SLC by Monserco Limited, Ontario, Canada under a Site Characterization Study Agreement signed by both parties on April 28, 1994. The characterization work was conducted under the U.S. Nuclear Regulatory Commission License No. 37-00030-02 (the -02 License), held by SLC.

The general objective of the site characterization program was to provide sufficient information to allow a site decommissioning/remediation plan to be written at a later date. One objective of the eventual decommissioning plan would be the release of all or part of the SLC site for unrestricted use. The NRC and SLC instructed that the characterization data were not to be interpreted by Monserco. Limits on radiological concentrations found in the SLC site are based on NRC limits current as of December, 1995. Future changes to the regulations could invalidate data interpretation.

The specific objectives of the SLC site characterization program are summarized below.

1. **Task 1:** Determine the extent of radiological contamination on the SLC ground surfaces.

2. **Task 2:** Determine whether radioactive contaminated items are buried under the SLC grounds.

3. **Task 3:** Gain access to the two underground silos and obtain information on their contents.

4. **Task 4:** Sink new boreholes and wells on the SLC site and sample and analyze the subsurface soils and waters.

5. **Task 5:** Determine the extent of radiological contamination inside the SLC buildings.

Section 3 provides general information on the Safety Light Corporation site including the location, description, history, general physical setting and physical characteristics of the SLC site.

Section 4 provides a summary of the management of safety, quality assurance and data.

Section 5 provides information on the methodologies used by Monserco to characterize outdoor areas of the SLC site.

Section 6 provides information on the methodologies used by Monserco to characterize the buildings on the SLC site.

Section 7 describes the laboratory techniques used by Monserco for analyses of samples taken from the SLC site.

Section 8 describes the work undertaken to complete Task 1. The primary objective of Task 1 was to determine the extent of radiological contamination of the ground surfaces of the Safety Light site. A secondary objective was to determine if non radiological contamination was present in selected areas of the site.

Approximately two thirds of the grounds were surveyed using the Bicron survey meter. The results provided evidence of radiation fields within those grids. The radiation fields were identified either as hot spots or higher than average background radiation. The hot spots are defined as contamination of the soil within the grid. The high background readings could be from contamination within the grid or shine from neighboring grids.

Approximately one third of the grounds was surveyed using a portable gamma spectrometer. The results provided evidence of three gamma emitting parent radionuclides within the grids. The principal gamma emitters were Cs-137 and Ra-226 with small amounts of Am-241. The peak used to track the parent Ra-226 was from the Bi-214 daughter.

Up to 5 soil samples were taken from each grid on the SLC site. The samples were analyzed by gamma spectrometry and by gross beta counting. The gamma spectrometry results provided evidence of three gamma emitting parent radionuclides: Cs-137, Ra-226 and Am-241. Reasonable visual correlation was obtained between the site activity maps (isopleths) from the soil analyzes and from gamma spectrometry. Reasonable visual correlation was obtained between the isopleths from the gross beta counts and the Cs-137 and Bi-214 gamma spectrometry results.

Section 9 describes the work undertaken to complete Task 2. The purpose of Task 2 was to determine whether radioactive contaminated items were buried under the SLC site.

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1. INTRODUCTION

This report documents the characterization activities conducted at the Safety Light Corporation site, Bloomsburg, Pennsylvania USA. The Safety Light Corporation (SLC) site is located in central Pennsylvania, about 5 miles east of Bloomsburg and about 7 miles west of Berwick.

The site characterization program was started in May 1995 and completed in December 1995. The work was carried out on behalf of the SLC by Monserco Limited, Ontario, Canada under a Site Characterization Study Agreement signed by both parties on April 28, 1994.

The work was conducted in accordance with the Characterization Working Document (CWD) which was prepared by Monserco in March 1994. The CWD was approved by the U.S. Nuclear Regulatory Commission (NRC) in August 9, 1994. The NRC letter to Safety Light Corporation approving the CWD is reproduced in Appendix 1.

The characterization work was conducted under the U.S. Nuclear Regulatory Commission License No. 37-00030-02 (the -02 License), held by SLC.

This report addresses the characterization by Monserco of the SLC site. The site includes the SLC property, buildings and selected areas outside the perimeter fence. These external areas include the wooded areas to south of the site and open areas to the north of the site.

2 SITE CHARACTERIZATION PROGRAM OBJECTIVES

The general objective of the site characterization program was to provide sufficient information to allow a site decommissioning/remediation plan to be written at a later date. One objective of the eventual decommissioning/remediation plan would be the release of all or part of the SLC site for unrestricted use. The specific objectives of the SLC site characterization program are summarized below.

1. **Task 1:** Determine the extent of radiological contamination on the SLC ground surfaces.

2. **Task 2:** Determine whether radioactive contaminated items are buried under the SLC grounds.

3. **Task 3:** Gain access to the two underground silos and obtain information on their contents.

4. **Task 4:** Sink new boreholes and wells on the SLC site and sample and analyze the subsurface soils and waters.

5. **Task 5:** Determine the extent of radiological contamination inside the SLC buildings.

2.1 VARIATIONS TO THE MONSERCO CHARACTERIZATION WORKING DOCUMENT

As work progressed, it was necessary to invoke the guidance provided to surveyors in page 6.2 of Reference 1, i.e.,

"Be flexible and adaptable; be prepared to modify the plan, based on situations and findings as the survey progresses".

During the course of the work, the Characterization Working Document (reproduced in Appendix 2) was modified in part to meet changing requirements. The changes to the CWD were managed by ensuring that both SLC and NRC were aware of pending variations and by obtaining their written or verbal agreement to implement the changes. For example, daily meetings were held between Monserco and SLC staff to discuss the daily work schedule. SLC approval was obtained before the daily work schedule was implemented. Also, two management meetings were held at the SLC site to discuss and agree variations to the CWD. These management meetings were attended by representatives from SLC, NRC and Monserco. The main variations to the CWD (all approved by SLC and/or NRC) and the principal reasons for these variations are highlighted below in Table 2.1.

TABLE 2.1
MAIN VARIATIONS FROM THE CHARACTERIZATION WORKING DOCUMENT

No.	ITEM	REASON FOR VARIATION
1.	Penetration of the East and West Silos.	To obtain more information on the contents of the silos. The CWD did not address this.
2.	Parts of the canal region were excavated by backhoe.	To obtain more information on buried objects. The CWD did not address this.
3.	Ground Penetrating Radar was used to monitor the dump.	To determine whether large items were buried in the dump. The CWD did not address this.
4.	Gamma spectroscopy was conducted on about one third of the outdoor grids.	To obtain nuclide specific information. Gamma spectroscopy of outdoors grids was not addressed in the CWD.
5.	13 boreholes sunk and 13 wells created.	To obtain more information on radionuclide contamination of groundwater. The CWD (p40) stated that 10 wells would be sunk.
6.	The non radiological analysis of solid and water samples varied from that described in the CWD.	The non radiological sampling and analysis were carried out in selected areas downstream of affected or potentially affected areas. This was judged sufficient to allow the scope of the non radiological contamination to be determined
7.	Nuclear Building not surveyed.	Building is relatively new, is used only for tritium and is used daily. The long term validity of a survey was doubtful. (See CWD p 42)
8.	Rooms in Acid Etching Building not surveyed.	Safety reasons (See CWD p 55)
9.	Externals of buildings not surveyed for loose contamination.	Location of contamination on external surfaces would be affected by weather. Chances of widespread external contamination low.
10.	Barringer Laboratory used for limited soil analyses.	Monserco procured its own intrinsic germanium gamma detector for soil analyses. (See CWD p 63)
11.	Concrete floors of buildings were not sampled.	Possible permanent damage to the concrete floor. Where possible, samples were taken from other locations nearby.
12.	No data interpretation.	If the regulations change, the interpretation could be out of date.

2.2 DATA QUALITY OBJECTIVES

The site characterization program was conducted to provide data for use in the documentation of the radiological and non radiological characteristics of the SLC property. The data collected during the Monserco site characterization program are used in this report to describe the extent of contamination on the SLC site at the time of the characterization. At a later stage, the site characterization data will be used to construct a decommissioning/remediation plan. If such a plan is implemented, the characterization data and other measurements will be used as an information base to support final termination surveys. The quality of the data collected during the site characterization survey must therefore be fit for purpose and must meet specific characterization, quality assurance and final termination survey objectives. The NRC and SLC instructed that the characterization data were not to be interpreted by Monserco. Limits on radiological concentrations found in the SLC site are based on NRC limits current as of December, 1995. Future changes to the regulations could invalidate data interpretation.

Where relevant the guidelines on the collection of characterization survey data contained in Reference 1 were followed, i.e.:

- *"The characterization survey should be in sufficient detail to provide data for planning the decontamination effort, including the decontamination techniques, schedules, costs and waste volumes and necessary health and safety considerations during decontamination. Characterization is typically concentrated on those portions of the site which are known to have been or are suspected of having been affected by site operations involving radioactive materials. The type of information obtained from a characterization survey is often limited to that necessary to differentiate a surface or area as contaminated or non contaminated. A high degree of accuracy may not be required for such a decision, when the data indicate levels well above the guidelines. On the other hand, when data are near the guideline values, a higher degree of accuracy is usually necessary to assure the appropriate decision regarding the true radiological conditions. Also, one category of radiological data, such as soil radionuclide concentration or total surface activity may be sufficient to determine the status as contaminated, and other measurements, e.g. exposure rates or removable contamination levels, may therefore not be performed during characterization. .....the choice of survey technique should be commensurate with the intended use of the data, including considerations for possible future use of the results to supplement the final status survey data".*

The methodologies for surveying, sampling, analyzing and reporting which are presented in this report conform to the applicable advice, regulations and guidelines contained in References 1 and 2.

3. SITE INFORMATION

This section provides general information on the Safety Light Corporation site. The topic addressed are listed below:

- Location of the site.
- Description of the site.
- History of the site.
- General physical setting.
- Physical site characteristics.

3.1 SITE LOCATION AND DESCRIPTION

The official address of the Safety Light site is: Safety Light Corporation, 4150-A Old Berwick Road, Bloomsburg, Pennsylvania 17815.

The SLC site lies within the South Central Township of Columbia County and is located in central Pennsylvania, USA, about 5 miles east of Bloomsburg and about 7 miles west of Berwick. The north site boundary is the Old Berwick Road (previously Route 11) and the south site boundary is the Susquehanna River. The Vance/Walton property located along the southeast corner of the site is owned by SLC. Other residential tracts of land are adjacent to the east and west boundaries of the site. Figures 3.1 and 3.2 illustrate the location of the Safety Light site.

The site can be located on the United States Geological Survey (U.S.G.S) Bloomsburg, Pennsylvania quadrangle topographic map at North 40° 00' 55" latitude and West 76° 22' 35" longitude or by measuring 2.75 inches north and 0.25 inches west from the south-eastern corner of the quadrangle.

The site occupies approximately 10 acres. SLC occupies approximately 2 acres and the remaining 8 acres are leased to USR Metals, Inc. and Multimetals Products Corporation. The site contains a number of buildings and these are shown in Figure 3.3.

FIGURE 3.1
SITE LOCATION MAP

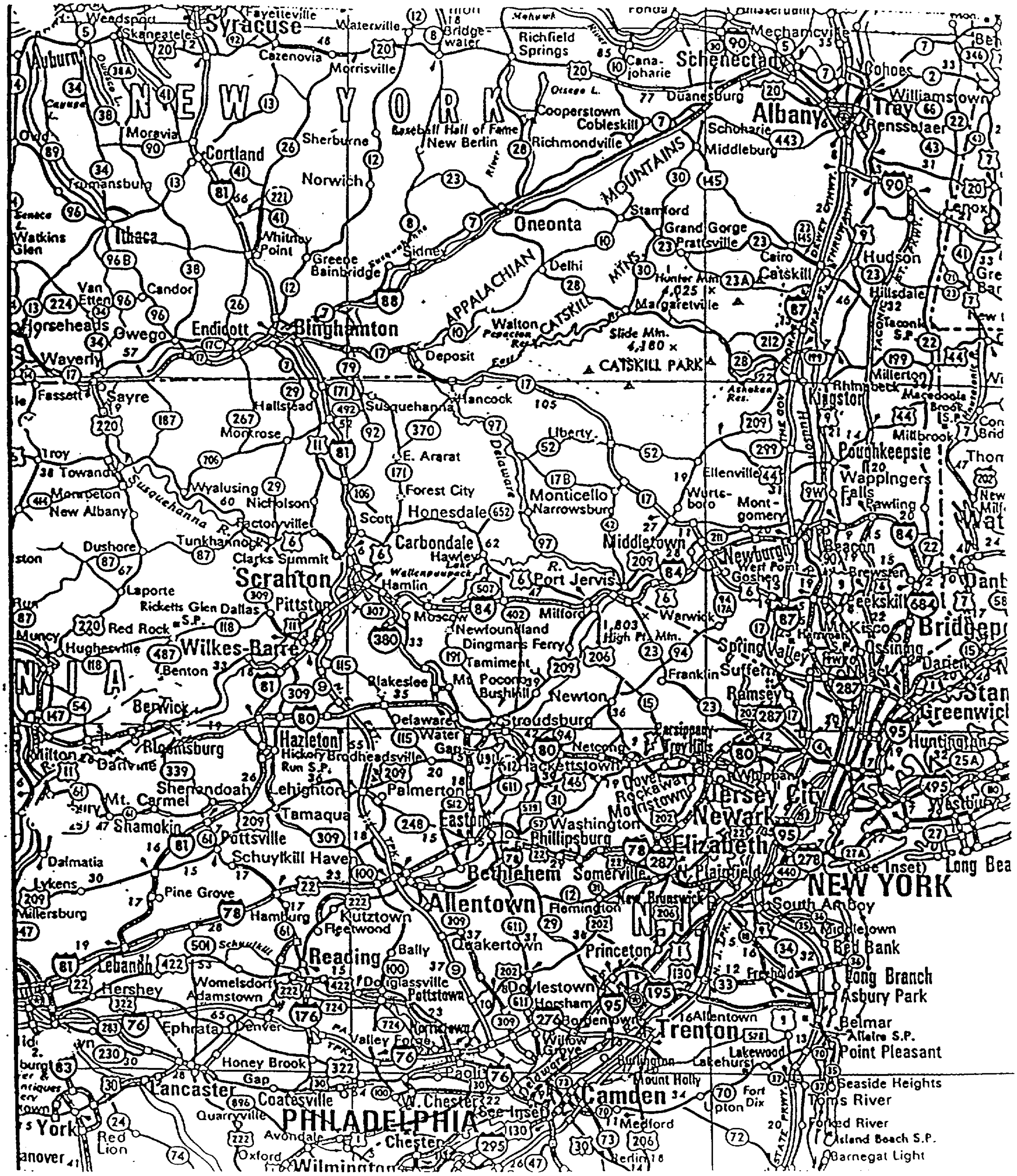
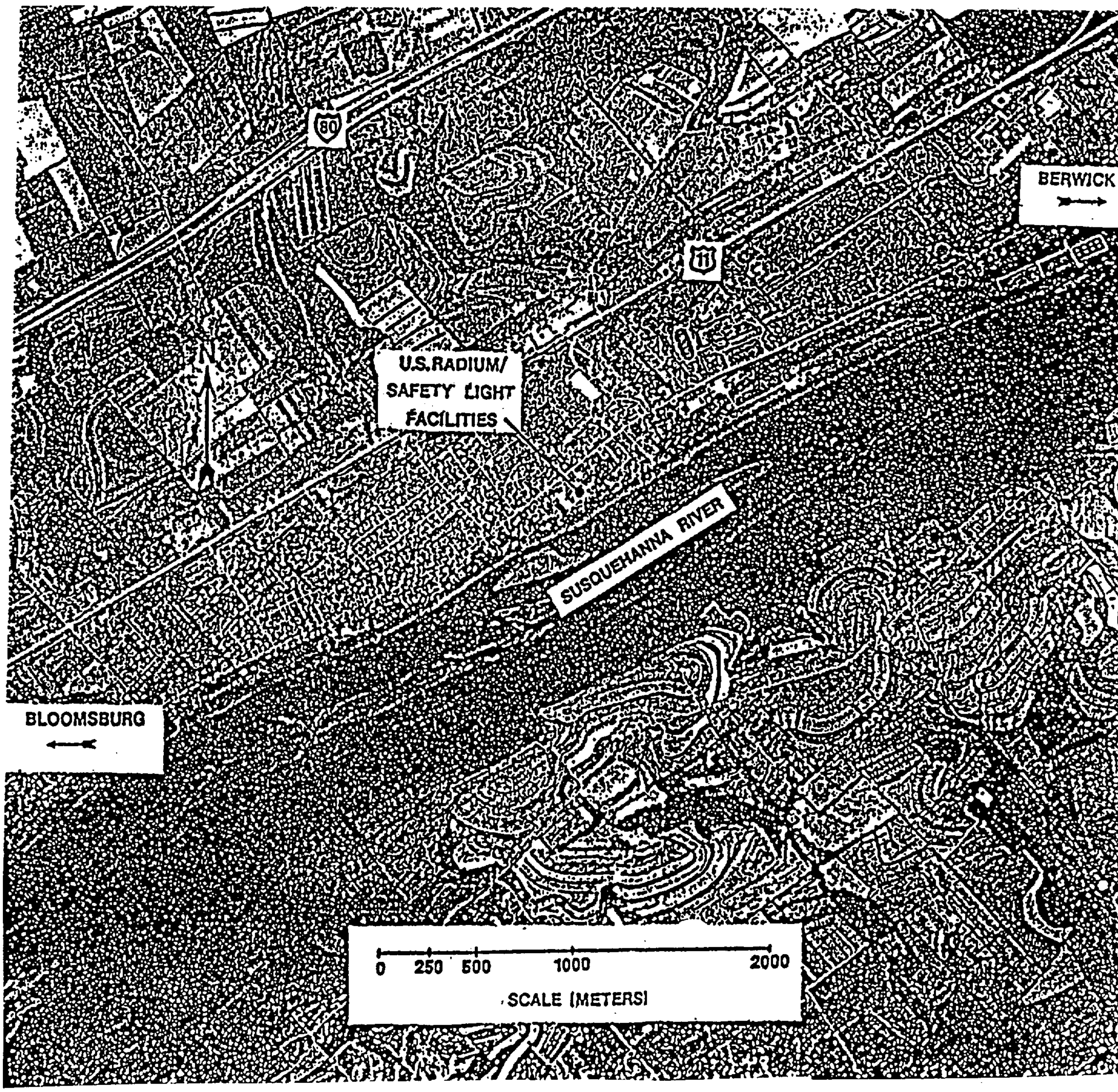
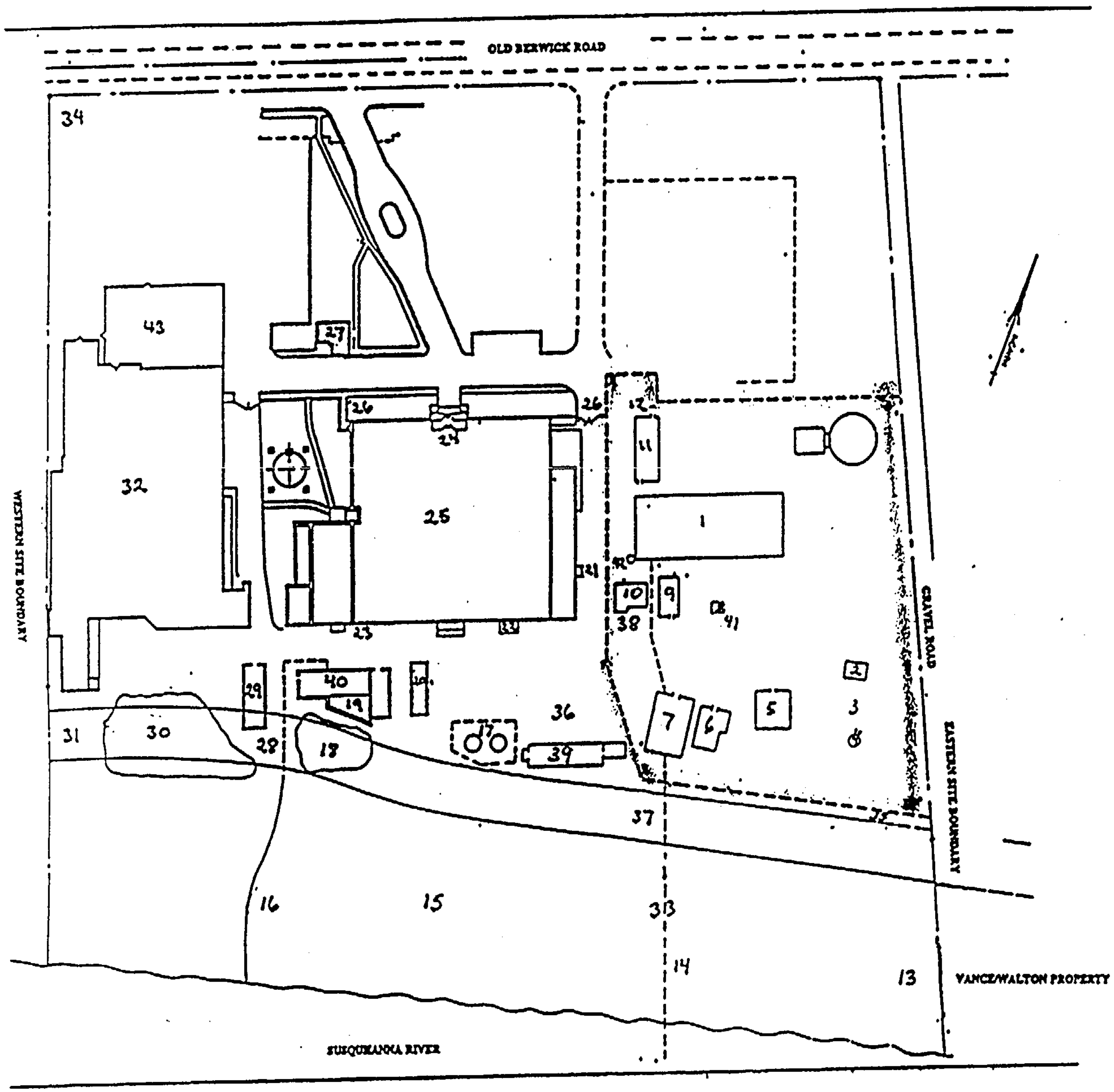


FIGURE 3.2
PHOTO OF AN AREA OF COLUMBIA COUNTY, PENNSYLVANIA, SHOWING THE LOCATION OF THE U.S. RADIUM/ SAFETY LIGHT CORPORATION SITE





EXPLANATION

1 NUCLEAR BUILDING
2 GARAGE
3 CONTAMINATED SOIL AREA (IN FRONT OF ABOVE GROUND SILO)
4 METAL SILO (ABOVE GROUND)
5 SOLID WASTE BUILDING
6 OLD HOUSE
7 LIQUID WASTE BUILDING
8 8' X 8' BUILDING
9 UTILITY BUILDING
10 RADIUM VAULT
11 MACHINE SHOP
12 CONTAMINATED SOIL AREA (NORTH OF MACHINE SHOP)
13-16 CONTAMINATED SOIL AREAS (BETWEEN ABANDONED CANAL AND RIVER)
17 UNDERGROUND SILOS
18 EAST LAGOON
19 CARPENTER SHOP
20 WELL HOUSE
21 CESIUM ION EXCHANGE UNIT
22 CONTAMINATED SOIL AREA (UNDER LOADING DOCK)
23 CEMENT TROUGH/SEWER GRATE (BEHIND MAIN BUILDING)
24 HAND APPLICATION AREAS (SECOND FLOOR OF MAIN BUILDING)
25 MAIN BUILDING (FIRST FLOOR)
26 SIDEWALK AREAS
27 PERSONNEL OFFICE BUILDING
28 EAST PLANT DUMP
29 PIPE SHOP
30 WEST LAGOON
31 WEST PLANT DUMP
32 ETCHING BUILDING
33 DRAIN LINES
34 CONTAMINATED SOIL AREA (ADJACENT TO OLD BERWICK ROAD)
35 CONTAMINATED SOIL AREA (FROM VANCE/WALTON PROPERTY)
36 CONTAMINATED SOIL AREA (NORTH OF LACQUER STORAGE BUILDING)
37 APPROXIMATE LOCATION OF ABANDONED CANAL
38 CONTAMINATED SOIL AREA (SOUTH OF RADIUM VAULT)
39 LACQUER STORAGE BUILDING
40 MULTIMETALS WASTE TREATMENT PLANT
41 CONTAMINATED SOIL SOUTH EAST OF 8' X 8' BUILDING
42 TRITIUM STACK
43 ANNEX TO ETCHING BUILDING

FIGURE 3.3 STUDY AREA LOCATION MAP

3.2 SITE HISTORY

The history of the site is summarized below. The history was compiled from publications (mainly References 3-8) and from dialogue with past and present SLC employees. Appendix 3 provides notes on the site, written after conversations with past and present SLC employees and also additional information provided by Egmond Geospheric Associates Ltd. Attempts have been made to provide accurate information, but since detailed documentation on the history of the site is not available, the accuracy of some of the historical information cannot be guaranteed.

1800's: Old House built.

1940's: Original Acid Etching Building constructed.

Pre-1945: During World War II the site was used to manufacture wooden toys.

1948-49: The United States Radium Corporation (USRC) radium operations were relocated from Brooklyn, New York to the Bloomsburg site. USRC started work on the site. The radioisotopes in use were mainly Radium-226 and minor amounts of Polonium-210.

West Dump may have been used for disposal of solid waste.

A portion of the canal was used to dispose of Radium-226 contaminated duct work.

The Pipe Shop was constructed over the filled portion of the Abandoned Canal and used for the disposal of radium contaminated duct work from the USRC Brooklyn, New York facility.

The Garage was used to store radioactive materials.

Construction of a one story addition to part of the Main Building.

1948-54: East Lagoon used for the disposal of sewage and process waste water from the old Radium Laboratory in the Main Building.

Early 1950's: Expansion of USRC's radioactive products including civil defense check sources and radiation sources utilizing Cesium-137 in large quantities. Production of approximately 500,000 deck markers for the US navy involving an extensive Strontium-90 production line (Project F).

Radium-226 was used during this period primarily for clock and watch dials and hands. Radium rope and high level neutron and radiation therapy sources were also being manufactured.

1950's: Development work with approximately twenty different isotopes. Most radioisotopes were handled only in small quantities, but several became major sources of revenue for the company.

Light Sources: Tritium, Carbon-14, Thallium-204, and Krypton-85.
Low level ionization sources: Nickel-63 and Tritium.
Radiation and Beta sources: Krypton-85.

1950-60: Radioactive solid waste was disposed of in the two buried underground Silos. Following the closure of the Silos (ca.1960) the radioactive solid waste was shipped off-site for disposal at approved low-level radioactive disposal facilities.

1952: Silo #1 used for disposal of Radium-226, Strontium-90 and possibly Cesium-137.

1952-60: Silo #2 used for disposal of Strontium-90, Cesium-137 and possibly Radium-226.

1956: License No. 37-00030-02 covering the whole of the site was issued by the AEC to U.S. Radium Corporation (June 20, 1956).

1958: South end of Well House decontaminated.

1960: All liquid waste from radioactive production activities was routed to open portions of the canal. The major isotopes were Cesium-137, Strontium-90 and Radium-226. USRC decided to route all liquid effluents from the production building to a holding tank and then to an evaporator.

Plans were made to precipitate out the radioactive constituents in the canal water and discharge the treated water to the Susquehanna River. The contaminated sediments were then to be excavated and disposed. This may have been completed during 1960.

A holding tank and evaporator were constructed in the location of the Liquid Waste Building.

Early 1960's: Replacement of Radium-226 by Americium-241 for certain applications.

It was discovered that the three eastern lagoons had considerable amounts of radioactivity suspended in the water and the water was treated to precipitate out the radionuclides. The two most easterly lagoons were backfilled.

1968: All operations which used Radium-226 were discontinued.

Partial decontamination of Hand Application Area in second floor of Main Building.

1969: USRC sold all the radioisotope business, except the tritium production.

AEC amended the -02 License for decontamination of the site and preparation for eventual release for unrestricted release.

AEC issued a second License (No. 37-00030-08) to U.S. Radium Corporation for the work involving tritium.

The Nuclear Building was erected to house the Tritium production operations.

Decontamination operations in Main Building and on roof of Main Building.

1971-72: Twelve thousand pounds (78 drums) of soil contaminated with Radium-226 was removed from the West Plant Dump area and shipped off site for disposal.

1972: The Susquehanna River flooded the site, including the east lagoon. This is believed to have contributed to the contamination of the surrounding soils.
The holding tank and the evaporator (constructed in 1960) were destroyed during the flood.

1970's: The below grade holding tank and evaporator structures were filled in. The present Liquid waste Building was constructed over the location.

Diesel fuel spill near monitoring Well #11.

1974: Manufacturing addition to Acid Etching Building.

1976-78: The third most easterly lagoon was backfilled.

1978: Groundwater monitoring initiated by installation of three monitoring wells by Giles Drilling Corporation.

1978: Groundwater monitoring initiated by installation of three monitoring wells by Giles Drilling Corporation.

1979: Meiser and Earl (Reference 4) conducted a hydrogeological investigation including installation of thirteen monitoring wells with soil cores and excavation of backhoe test pits.

Radiation Management Corporation conducted a radiological investigation using soil and groundwater collected both by themselves and by Meiser and Earl.

1981: Oak Ridge Associates (ORAU) performed an extensive radiological survey of the site. On site soil sampling indicated elevated levels of Radium-226, Cesium-137 and Strontium-90 and on site groundwater sampling showed levels of Tritium and Strontium-90 which exceeded NRC or EPA guidelines. Evidence was found that radioactive materials that remained from USRC operations were migrating into soil and groundwater.

1982: November 24: U.S. Radium Corporation changed its name to Safety Light Corporation.

1984: SLC submitted an application to renew the -02 License (February 29, 1984).

1984: January 29: Safety Light Corporation issued with NPDES Permit No. 0111848 to discharge effluent into the north branch of the Susquehanna river.

1987: The -08 License amended (January 8, 1987). SLC submitted an application for renewal of the -08 License (November 23, 1987).

1988: NRC performed an environmental evaluation of the site. One of the NRC conclusions was that disposal of radioactive waste on the site had caused "extensive contamination of groundwater on and off-site and soil on-site".

1989: March 16: NRC issued an Order Modifying Licenses and Demand for information.

August 9: Site Characterization Plan submitted by Safety Light and accepted by NRC with written reservations.

1980's: During the late 1980's SLC purchased the Vance/Walton property to the east of the site.

1990: CNSI performed soils coring, monitoring well installations, groundwater sampling and rainwater sampling as part of a hydrogeologic and radiological evaluation of the site. The groundwater flow appeared to be from the northern portion of the site southward toward the Susquehanna River. Groundwater flow was primarily controlled by the topography of the land and surface. There was no strong evidence to support lateral groundwater flow along the abandoned canal. Elevated Tritium was detected in soil, groundwater and rainwater. Strontium-90 was detected in both soil and groundwater. The major source of Strontium-90 was concluded to be from the underground Silos.

1991: NUS Corporation Superfund Division prepared a summary document using all existing Safety Light reports. One conclusion was that a "... large section of the site remained contaminated with Radium-226, Cesium-137, Strontium-90 and Tritium".

1994: Site Characterization Study Agreement signed by Monserco Limited and Safety Light Corporation (April 28, 1994).

Monserco Characterization Plan approved by NRC (August 9, 1994).

1995: Characterization work started by Monserco in May 1995 and completed in December 1995.

3.3 GENERAL PHYSICAL SETTING

The 10 acre site is shown in Figure 3.3. It contains buildings, open areas, two underground silos and other structures. The site is situated in a valley that is 1 to 2 miles wide and is bordered by 2 high ridges. The north branch of the Susquehanna river flows down this valley and forms the southern border of the site. The site is bordered to the north by Old Berwick Road and to the east and west by residential areas with relatively low population densities.

3.4 PHYSICAL SITE CHARACTERISTICS

3.4.1 Geology

The nearest national Oceanic and Atmosphere Administration climatic data station to the site is located in Freeland, Pennsylvania, which is less than 25 miles east of the site. Climatic conditions are expected to be similar to the site. The average annual temperature for the site area is 47° F. The coldest month is January, with an average temperature of 23.3° F and the warmest month is July, with an average temperature of 96.4° F. The average annual precipitation is 46.49 inches, and the mean annual lake evaporation is about 32 inches. There, the net annual precipitation is approximately 14.5 inches per year. A 2-year, 24-hour rainfall will produce an estimated 3.0 inches of precipitation. The wind predominantly blows toward the south-east in this area.

The site is located with the Appalachian Mountain Section of the Valley and Ridge Physiographic Province of Pennsylvania. This province is characterized by a north-east to south-west trending series of parallel sharp-crested ridges and narrow valleys. The valleys tend to be underlain by limestones and shales, and the ridges tend to be formed by the more resistant quartzite and sandstone. The ridges are only slightly dissected by drainages and, for the most part, are uninterrupted along their length. The majority of the streams and smaller tributaries flow along the valley floors. Within the study area, the north branch of the Susquehanna river flows in a westwardly direction. This river does cut through some of the ridges, often forming water gaps. The river valleys are frequently filled with glacial outwash deposits of Pleistocene age. These unconsolidated deposits unconformably overlie the older bedrock units. The site is located on an intermediate terrace of the Susquehanna river. The regional structure consists of alternating series of anticlines and synclines. The site is located on the southern limb of the east-northeast trending Berwick anticline.

The bedrock unit beneath the site is the Devonian age Hamilton Group. This group is composed of the Mahantango formation and the underlying Marcellus formation.

The Mahantango formation is composed of olive-gray to medium olive gray fossiliferous siltstone and shale that is interbedded with fine-grained, medium dark gray sandstone. Secondary sulfide minerals may be present in the dark colored shales that are present near the base of the unit. The basal member, the Marcellus formation, contains medium to dark gray siltstone and dark gray to black fissile shale. Bedding in this unit is generally well developed and ranges from thin to fissile in the shales to thin, flaggy and medium bedded in the sandstones. Joints are typically well developed, closed spaced, open and steeply dipping. The thickness of this group ranges from 1,450 to 1,850 feet.

Stratigraphically underlying the Hamilton Group are the early Devonian age Onondaga and Old Port formations. A number of other formations lie underneath these beds.

3.4.2 Soils

There are two soil types present under the site. The Chenango gravelly silt loam underlies approximately 75 percent of the site. It is a deep, well-drained soil that forms on glacial outwash gravel and sand. The Chenango soil typically has a surface layer composed of dark brown gravelly sandy loam approximately nine inches thick. The subsoil is a dark yellowish-brown gravelly sandy loam that ranges in thickness from 11 to 51 inches. The substratum is composed of stratified sand and gravel, with some large cobbles. The substratum may be as great as 26 feet in thickness. The permeability of this soil type is rapid (6.3 inches per hour) for each of the horizons. The soil reaction in the surface layer and the subsoil is acid (5.4 pH) and slightly less acid (5.8 pH) in the substratum.

The Middlebury silt loam underlies approximately 15 percent of the site in a narrow strip along the river. It is a deep, moderately well-drained to poorly drained soil that has formed on recent alluvium. The Middlebury silt loam is composed of a dark grayish-brown silt loam surface layer that is approximately nine inches thick. The subsoil is very similar to the surface layer but includes mottling at a depth of approximately 18 inches. The depth to mottling may range from 15 to 30 inches below surface. The substratum is composed of stratified sand and gravel. The permeability of this soil type ranges from moderately rapid to rapid (two to 6.3 inches per hour) in each of the soil horizons. The soil reaction is strongly acid (5.4 pH) throughout the soil profile.

3.4.3 Groundwater

Groundwater within the Hamilton Group occurs in sufficient quantity for small to moderate supplies. The groundwater occurs under water-table and locally semi-confined conditions.

The storage and flow of groundwater occur within the primary intergranular pore space of the rock and within the fracture-induced secondary porosity. Due to the presence of fracturing within all the lithologic units in the study area and the lack of any identifiable continuous confining layers, all the formations in the study area are assumed to be hydraulically interconnected.

Regionally, the yields of 132 wells producing from the Hamilton Group range from 1 to 900 gallons per minute. Approximately 95 per cent of wells penetrate at least 1 water bearing zone within 51 to 100 feet below surface. The deepest reported zone penetrated is 470 feet below the surface. Naturally occurring groundwater contaminants commonly found in this unit include iron, manganese, and some hydrogen sulfide.

25 monitoring wells were located on the site prior to the characterization carried out by Monserco.

Another 13 wells were added by Monserco during 1995, making a total of 38 wells. The wells range in depth from 11.0 to 80.1 feet. The depth to groundwater ranges from 0.7 to 24.1 feet below ground surface. The surface of the groundwater table approximates the topography of the site. The direction of groundwater flow is to the south, toward the north branch of the Susquehanna river.

The recharge of groundwater in the study area is from the infiltration of precipitation. Water that is not absorbed in this manner flows as run-off to streams and wetlands or returns to the atmosphere through evaporation. The discharge of groundwater in the study area is to wells or to the maintenance of baseflow in streams and wetlands.

4 MANAGEMENT OF SAFETY, QUALITY ASSURANCE AND DATA

A summary is given below of the main considerations relating to the management of safety, quality assurance and data. More detailed information is given in the relevant sections of the report.

4.1 MANAGEMENT OF SAFETY

Management of safety was the responsibility of the Monserco project manager. His responsibilities included ensuring that both the radiological and also non radiological aspects of safety were effectively managed on the SLC site. His primary responsibility was to ensure the safety of the operational field crews, without comprising the safety of the site workforce or members of the public. The advice of both NRC and SLC was sought and taken into account where applicable. Sometimes aspects of conventional safety for a particular operation (e.g. drilling) was the responsibility of a specialist (e.g. the drilling manager). In these situations the Monserco project manager maintained a close working relationship with conventional safety specialist to ensure that overall safety was not compromised. During the characterization work, the Monserco project manager was also the senior health physicist.

4.1.1 Health Physics Controls

Direct Reading Dosimeters (DRDs) were carried by all operational and contract staff. These were read at the end of either the shift or the operation and allowed on line recording of external dose.

Thermal Luminescent Dosimeters (TLDs) from Landauer Inc (2 Science Rd., Glennwood, Ill 60425, USA) were carried at all times by all operational and contract staff. These were capable of measuring X-ray/gamma/beta and neutron doses. The TLDs were provided monthly to the operational staff and processed by Landauer in the early stages of the following month. The Landauer output provided a permanent record of external doses accrued.

Urine samples were provided by all operational and contract staff every week. These samples were analyzed for tritium using Liquid Scintillation Counting.

4.1.2 Hazard Identification and Minimization

Before the survey work commenced, the hazards associated with the contents of each gridded area and each building were identified by the field crew and/or project manager. About seventy potential hazards were recognized, including:

- Contamination (fixed, loose).
- Radiation.
- Radiochemicals.
- Heavy metals.
- Organic chemicals.
- Acids.
- Unsound buildings.
- Water.
- Poisonous plants.
- Confined spaces.
- Electrical equipment.
- Adverse temperature.
- Slip hazard.

Once the potential hazards had been identified, the steps required to be taken to minimize the hazards were addressed. These included:

- Wearing coveralls.
- Wearing hard hats.
- Wearing boots.
- Wearing gloves.
- Personnel contamination monitoring.
- Radon air monitoring.
- Personal air sampling.
- Distributing body weight carefully over unsound floors.

4.1.3 Safety during Drilling Operations

Conventional safety during drilling operations was the responsibility of the drilling manager. Radiological safety was the responsibility of the Monserco project manager. The drilling area was designated as a radiological zone and appropriate requirements for entry were established. Monserco staff and the drill operators wore TLDs and DRDs when working on the boreholes and wells.

4.1.4 Safety during Excavation Operations

Conventional safety during excavation operations was the responsibility of the excavation manager. Radiological safety was the responsibility of the Monserco project manager. Monserco staff and the backhoe operator wore TLDs and DRDs when working on the excavations.

4.1.5 Safety during Building Surveys

The building survey radiological safety issues were similar to those associated with other operations and were managed in a similar manner.

The building survey conventional safety issues were mainly collapsed roofs, unsafe buildings and heights. These were managed mainly through the daily meetings between SLC and Monserco.

4.1.6 Respiratory Protection

Monserco personnel were not normally allowed to work in areas where the airborne activity was in excess of 1 DAC (Derived Air Concentration) for radioactivity or 1 TLV (Threshold Limiting Value) for other hazardous materials. The only Monserco personnel who wore respiratory protection were those who were certified by a physician as being physically able to do so.

The respiratory protection equipment held by Monserco for use on the SLC site consisted of Scott Air Pacs and Easi-Air 3M Half Mask Respirators.

The Scott Air Pac is a self contained pressure demand breathing apparatus for use with particulates, gases or vapors. A protection factor of 10,000 was assumed for airborne hazardous material other than those which penetrate the skin. A protection factor of 2 was assumed for tritium. The Scott Air Pac was on hand for use in work situations where there was the possibility of an uncontrolled airborne release of hazardous material (other than tritium).

The 3M half mask respirator was used with a 7251 filter for organic vapors or a 7255 filter for radioactive particulates. A protection factor of 10 was assumed.

Monserco personnel who were required to wear respiratory protection equipment were trained in its use by a qualified person from the 3M Occupational Health and Environment Safety Division (3M Center Building 220-3E-04, St. Paul, Min 55144, U.S.). When wearing respiratory equipment, personnel were required to work either in pairs or to be observed by a person who was in a position to communicate satisfactorily with them.

During work periods, intakes were assessed from suitably placed static air samplers or if these were not likely to be representative of any intake, by the use of personal air samplers.

Urine sampling for tritium was performed in support of the assessment of intakes by air sampling.

4.1.7 Equipment Clearance

Equipment which had been used in performing radiological work was checked for contamination using the following instrumentation and techniques:

- Fixed beta/gamma contamination: an Eberline ESP-1 or ESP-2 monitor with an HP260 probe.
- Fixed and loose beta/alpha contamination: Berthold LB122.
- Loose alpha/beta contamination: cloth swipes and polyfoam.

4.2 QUALITY ASSURANCE MANAGEMENT

Management of all aspects of quality assurance (QA) was the responsibility of the Monserco project manager. His responsibilities included ensuring that an effective QA system was implemented to ensure traceability of data. He was assisted by other members of the Monserco staff.

4.2.1 Documentation

A documented quality assurance system was implemented for the site characterization program. Quality assurance documentation was written for all operations on the site and approved prior to implementation. The top tier document was the project Quality Program which described the project deliverables, the organization, the responsibilities of the project team, and management of the interface organizations. The other types of quality assurance procedures and instructions are listed below:

- Operating procedures.
- Operating instructions.
- Health and safety instructions.
- Building instructions.
- Administration instructions.

4.2.2 Audits

The project was internally audited on August 15, 1995 and three observations were noted:

- Wrong units on one of the grid survey sheets.
- Incomplete training records.
- Difficult to read calibration sticker.

These deficiencies were rectified very soon after the audit.

An inspection/audit relating to field measurements was carried out by NRC on September 13, 1995. The same soil samples were analyzed by both Monserco and NRC and the results compared to each other. An acceptable statistical agreement was achieved for Cs-137, but not initially for Bi-214. This reflected the poor resolution of the Monserco sodium iodide gamma spectrometer. The situation was resolved through the purchase by Monserco of an intrinsic germanium gamma detector, and repeat measurements of all soil samples previously assayed on the sodium iodide system.

An audit was conducted by NRC on the safety of the operations, from September 13, 1995 to October 12, 1995. No safety concerns were identified. The NRC report is reproduced in Appendix 4.

4.3 DATA MANAGEMENT

During field operations, survey, sample and other information was recorded on customized Monserco forms. The information was subsequently transferred to either a computer database (Microsoft Access), spreadsheet (Microsoft Excel) or other proprietary software packages. Sufficient data were recorded on the survey sheets/software to ensure that traceability of information was maintained. The data entered onto the computer were compared to the original data and any erroneous entries corrected.

4.3.1 Data Conversion

Radiological survey data read directly from field and laboratory instrumentation has no intrinsic meaning relative to the NRC guideline values. The survey data were therefore converted to units which enabled comparisons with guideline values. The surface contamination clearance levels are given below in Table 4.1.

TABLE 4.1
SURFACE CONTAMINATION CLEARANCE LEVELS

The average surface contamination clearance level for beta/gamma emitters is 5,000 dpm/100cm^2 which is equivalent to 2.72 counts per second on the ESP-1 meter with the HP260 probe. The HP260 equivalent was derived by checking the efficiency of the probe using a Cs-137 source of known strength and taking into account the probe surface area. The calculation is shown below in Table 4.1.

TABLE 4.1
DERIVATION OF SURFACE CONTAMINATION CLEARANCE LEVELS FOR THE HP260 PROBE

		VALUE	UNITS
	ESP-1/HP260		
A	Clearance Limit for beta/gamma contamination	5,000	dpm/100 cm^2
B	Detection area of HP260	15.5	cm^2
C	Clearance limit for HP260	{(A * B)/100}=775	dpm per 15.5 cm^2
D	Activity of Cs-137 check source	1040 i.e. 1040	Becquerels dps
E	Cs-137 check source background	1.2	cps
F	Cs-137 check source gross	220	cps
G	Cs-137 check source net	(220-1.2) =218.8	cps
H	Efficiency of ESP-1 for Cs-137	{(G)/(D)}*100 = 21.04	%
I	Clearance Level	{(H)*(C)}/100= 163.06 2.72	cpm cps

4.3.2 Quality Control

The quality of the output from the analytical instrumentation was monitored by use of quality control charts. Sources of known strength were periodically measured and the results plotted on a chart which contained warning and action lines at a distance of 2 standard deviations and 3 standard deviations respectively from the mean value. The results were continuously monitored to provide an assessment of whether the instrumentation was functioning correctly. The quality control outputs are discussed in more detail in Section 7..

4.3.3 Measurement Uncertainties

Each reported value will have an uncertainty attached to it, associated with a number of factors including the statistics of counting, instrument efficiency, instrument surface area and sampling statistics. In this report, measurement uncertainties are not reported with each value.

4.3.4 Minimum Detectable Activity

Calculations showing the derivations of the minimum detectable activities (MDAs) are presented in the relevant sections of the report.

4.3.5 Comparison of Data with Guideline Values

Where applicable, data were compared to the relevant radiological limit or clearance level to determine their significance.

The surface contamination clearance levels and the radiological limits for soil and groundwater, taken from the CWD (Appendix 2) are shown in Tables 4.2 and 4.3 below.

TABLE 4.2
SURFACE CONTAMINATION CLEARANCE LEVELS

Nuclides	Average dpm/100cm^2	Maximum dpm/100cm^2	Removable dpm/100cm^2
Transuranics	100	300	20
Strontium-90	1000	3000	200
Beta/gamma emitters	5000	15000	1000

TABLE 4.3
SOIL AND GROUNDWATER RADIOLOGICAL LIMITS

Nuclide	Soil Limit pCi/gram	Groundwater Limit pCi/liter
H-3	Not known	20,000
Co-60	8	100
Sr-90	5	8
Cs-137	15	200
Am-241	30	Not known
Ra-226	5	5
Gross alpha	Not known	15

Where applicable, the data contained in this report are compared to the above clearance levels to determine the significance of the results.

4.3.6 Units

The radiological units used in this report are generally those used in current NRC guidelines (Reference 1).

The length measurements used in this report include both cgs units (e.g. feet, inches) and SI units (e.g. meters, centimeters).

5. CHARACTERIZATION METHODOLOGIES FOR OUTDOOR WORK

Information is provided below on the methodologies used by Monserco to characterize outdoor areas of the SLC site.

Management of the contractors used for some of the work discussed below was subcontracted to Egmond Geospheric Associates Ltd, (EGAL) 174 Poplar Avenue, Acton, Ontario L7J 2E4, Canada.

5.1 OUTDOOR LEGAL SURVEY

The study area consisted of locations both on and off the SLC site. The study area included the SLC property and selected areas outside the perimeter fence, principally the wooded areas to the south of the site and the open areas to the north of the site. The purpose of gridding the study area was to allow radiological and non radiological surveys to be undertaken and samples to be taken in a methodical and reproducible manner. The guidelines for gridding areas for radiological surveys provided in Reference 1 were followed.

The open spaces of the study area were gridded by Tim A Jones P.L.S., Land Surveyor, into two types of square grids as described below.

The first type of grid measured 25 meters long by 25 meters wide, which were located in areas where contamination was not anticipated (unaffected areas). The second type of grid measured 10 meters long by 10 meters wide, which were located in areas where radioactive contamination was anticipated (affected areas).

The legal surveyor used nails (60 penny) and one meter long hardwood stakes to mark the grid locations. The intention was not to leave permanent fixtures in the ground but rather to provide temporary gridded areas only for the duration of the Monserco characterization work. The gridding system is reproducible, if the same methodology used by the legal surveyor is followed. The coordinates and elevations were based upon the same coordinates used in the survey map drawn up by Bafile, James and Associates, titled "Draft showing well locations for Safety Light Corporation", dated 8/20/90.

When the legal survey was being undertaken (May, 1995) parts of the study area near the Susquehanna river were virtually inaccessible due to shrub and tree growth. It was necessary to prune these overgrown areas both for the legal survey work and for the radiation surveys and soil sampling. The relevant areas were cleared by both Monserco staff and by contract labourers.

The scope of the legal survey did not include the internals of buildings, but parts of some buildings were located in some of the grids.

The referencing system used to identify locations within a grid is described below.

In a two dimensional system, it is only necessary to specify a zero point and X- and Y- coordinates to describe any location within the grid. The zero point in all cases is the south-west corner of the grid. The X-coordinate starts at the zero point and runs along the south-facing border, towards the east-facing border. The Y-coordinate starts at the zero point and runs along the west-facing border towards the north-facing border. Figure 5.1 shows the grid reference system and the X/Y coordinates within a grid. Figure 5.2 illustrates the referencing system with respect to a hypothetical grid containing 3 hot spots.

Figure 5.1
Illustration of Grid Referencing System

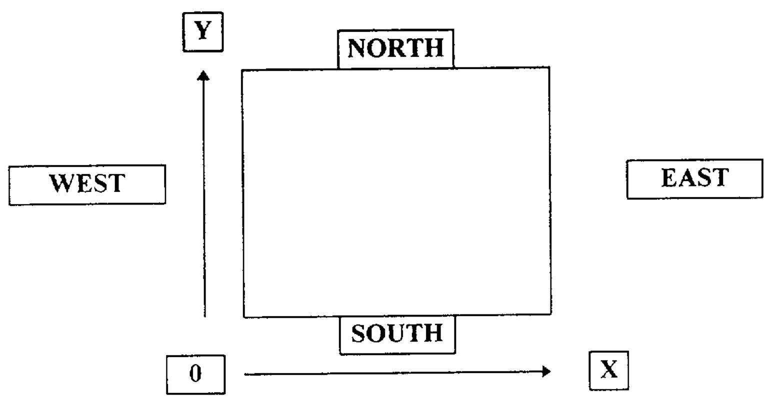
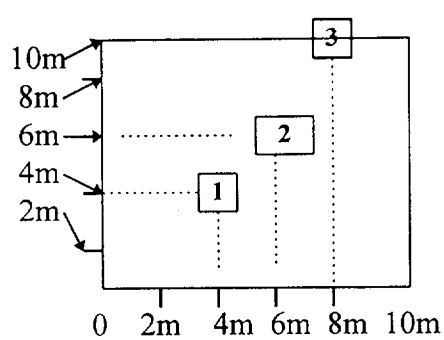


Figure 5.2
Hypothetical Grid containing 3 Hot Spots



With reference to Figure 5.2, hot spot #1 has the coordinates, X = 4, Y = 4, hot spot #2 has the coordinates X = 6, Y = 6 and hot spot #3 has the coordinates X = 8, Y = 10.

5.2 OUTDOOR ELECTROMAGNETIC SURVEY

Electromagnetic (EM) survey instrumentation was used to locate and map metallic objects underneath soil surfaces. The instrumentation and methodology is described below.

EM survey instrumentation measures subsurface electrical conductivities. The EM transmitter coil radiates an electromagnetic field which induces eddy currents in the earth below the instrument. Each of these eddy current loops, in turn, generates a secondary magnetic field which is proportional to the magnitude of the current flowing within that loop. A part of the secondary magnetic field from each loop is intercepted by the receiver coil and produces an output voltage which bears an approximate linear relationship to the subsurface conductivity. The reading is a bulk measurement of conductivity. Thus a positive EM reading indicates subsurface conductivity which itself indicates a subsurface conductor (e.g. metallic objects).

Geomar Physics Ltd., 3044 Bloor Street West, Suite 266, Toronto, Ontario, was contracted by Monserco/EGAL to conduct the electromagnetic survey. Geomar Physics used two instruments: a Geonics EM31-DL and a Geonics EM61.

The Geonics EM31-DL electromagnetic induction instrument was used in a vertical dipole mode during the survey. In this mode, the instrument has a depth penetration of over 3 meters. Two components of the secondary magnetic field were measured simultaneously. The first was the quad-phase component which indicated soil electrical conductivity and was measured in millisiemens per meter. The second was the inphase component which is related to the soil magnetic susceptibility (i.e. the ratio between the primary and secondary magnetic fields) and was measured in parts per thousand (ppt). Data was recorded using a 16 bit digital data logger.

The Geonics EM61 is a high sensitivity high resolution time-domain instrument which is used to detect both ferrous and non-ferrous metallic objects. It consists of a powerful transmitter that generates a pulsed primary magnetic filed, which induces eddy currents in nearly metallic objects. The decay of these currents is measured by two receiver coils mounted on the coil assembly. The responses are recorded and displayed by an integrated digital data logger as a two channel information. By making the measurement at a relatively long time after termination of the primary pulse, the response is practically independent of the electrical conductivity of the ground.

The EM31-DL in plan view can detect a single 55 U.S. gallon drum at a depth of over 3 meters. The EM61 is excellent in pinpointing a target and can be used in close proximity to metallic fences or buildings. The instrument is equipped with an opto-counter which triggers the instrument every 19 cm. It can be also triggered in fixed time intervals with the maximal speed 3 readings per second.

Data files were transferred from the digital data logger to a computer and reviewed in the field. Both Geonics and Geomar programs were used in data reduction and preparation for contouring. A Geosoft Mapping system was used in the production of colour contour maps of EM31 Quad-phase and Inphase component and EM61 Channel B and Differential Channel response.

5.3 OUTDOOR GROUND PENETRATING RADAR SURVEY

R.E. Wright Environmental Inc, Pennsylvania was contracted to conduct the Ground Penetrating Radar (GPR) survey. GPR instrumentation was used to screen the subsurface of selected locations on the SLC site for the presence of metallic drums and estimate the target depths. The depth of penetration of GPR is about 3 meters. The operating principles of GPR are described below.

GPR survey instrumentation is a reflection technique using high frequency radio waves which are bounced off subsurface features. A GPR survey produces a vertical profile of the section of interest.

GPR uses the high frequency radio waves to acquire subsurface information from a small antenna which is moved slowly across the surface of the ground. Energy signals are radiated downward into the subsurface, then reflected back to the receiving antenna. Features such as voids and soft spots cause different responses in the reflected or returning signal. Variations in the returning signal are continuously recorded.

The signals are analyzed using reflection theory to produce a continuous cross-sectional profile of the subsurface conditions.

5.4 OUTDOOR RADIATION SURVEY METHODOLOGY

The steps detailed below provide an outline summary of the methodology used to conduct the radiological survey of the SLC ground surfaces.

- The four corners of each grid were marked using nails, stakes and fluorescent paint.
- A sketch was made of the area, transposing the grid referencing system from the legal survey blueprint.
- Ropes or other markers were used as necessary to assist identifying the grid areas.
- The two instruments utilized during the survey were the Bicron survey meter and the gamma spectrometer.
- The Bicron survey meter was kept as close as possible to the ground and moved back and forth while walking over the surface at a maximum speed of about 0.2 meters per second.
- The gamma spectrometer exposures were conducted at 1 meter above the ground.
- Affected areas required 100% coverage. This meant walking with the instrumentation over the complete surface.
- Unaffected areas required 10% coverage. This was usually accomplished by making three passes over each grid block.
- If the 25m by 25 m grid was found to have a higher than anticipated reading, the grid block was re-classified to an affected area, regridded to 10m x 10m and a 100% survey was conducted.

5.5 OUTDOOR RADIATION SURVEY INSTRUMENTATION

The two types of instrumentation used for the outdoor radiation survey are discussed below.

- The Bicron survey meter was used to give an quantitative assessment of radiation.

- The SCOUT gamma spectrometer was used to provide a qualitative indication of the presence of gamma emitting radionuclides.

5.5.1 Bicron Radiation Survey Meter

The Bicron meter gives tissue equivalent photon response from 0 - 200 mrem/h full scale in five linear ranges. It uses an internally mounted tissue-equivalent organic scintillator for photon detection. Instruments reading in both millirem/hour and microsieverts/hour were used for the SLC work. All units were subsequently converted to millirem/hour.

The detectors were calibrated over their complete working range prior to use on the SLC site. The calibrations were performed at McMaster University, Canada.

Calibrations were performed using Cs-137 sources of varying strengths. The energy response to emissions from other isotopes with different radiation energies has been demonstrated by the manufacturers to be identical to that of Cs-137.

The high voltage and battery responses of the Bicron were checked prior to use. The response of each Bicron survey meter to the same radioactive source of known strength was checked daily prior to use and a record kept of the results. This allowed timely identification of any instrument problems. If a monitor was found or suspected not to be functional, it was withdrawn from service until the problem was resolved. The serial number of each Bicron survey meter was noted and indicated on the Monserco survey sheets.

The Bicron meter was held either in the radiological surveyor's hand or on an assembly at the end of a pole. The meter was scanned over the surface area to be surveyed at a low enough rate to allow it to fully respond to the signals. The walking speed was about 0.2 meters per second. The Bicron readings were noted by the surveyor and recorded in the survey report sheets by the surveyor.

Background radiation readings were taken in the vicinity of the study area by taking a total of ten radiation measurements at ground level and at one meter in the vicinity of the open land. In addition, background readings were taken to the north, south, east and west of the SLC site. The background measurements were subtracted from the actual field values to produce background corrected radiation results. These are the results reported in the relevant tables of this report. Where the readings are in excess of relevant NRC guidelines, these are noted in the relevant column(s) of the tables.

5.5.2 Gamma Spectrometer

Gamma spectroscopy determines the energy of gamma rays and was used to provide evidence of the presence of gamma emitting radionuclides on the SLC site.

In scintillation gamma spectrometers, incident gamma rays cause excitations of the electrons in the detector crystal. When the excited electrons return to their valences states fluorescent radiation (light) is emitted. The light is detected by a photomultiplier tube, which converts the light into electrical pulses which are then amplified. The size of the pulse is proportional to the energy deposited in the detector crystal by the gamma photon.

The system used for the SLC characterization work was a Quantrad Sensor battery-operated portable nuclear spectrometer system, the Gamma SCOUT. The detector was a 3 inch diameter, 3 inch deep sodium iodide crystal connected to an HP 100LX Palmtop computer.

The system was calibrated by Monserco staff using sources of known strengths. Prior to use, Cs-137 and Co-60 sources were placed individually in front of the detector and the channel number noted. If the channel had drifted above or below the preset value recommended by the manufacturer, the spectrometer was adjusted to bring it back into line with the original calibration. On the days the gamma spectrometer was being used, calibration was performed in the morning before use, in the afternoon, and other times for example, if either the batteries or the external temperature were low.

The spectrometer was held by hand at the measurement locations and spectra collected, normally for at least 30 seconds. The survey of each grid consisted of taking a 30 second gamma spectrum at 1 meter above 8 identified points in each 10 meter by 10 meter grid.

Trials conducted before grid survey work started showed that this was sufficient to cover the whole of the grid area.

Each point was referenced by measuring and recording the distances from the west side of the grid and the south side of the grid in meters. Thus the reference 2.5/7.5 denotes a distance 2.5 meters from the west side of the grid and 7.5 meters from the south side of the grid.

The data were saved on the spectrometer portable computer and downloaded at a later stage onto a PC for spectral analysis. This enabled permanent records of the spectra to be maintained. Details of the location and dates were recorded on survey forms at the time of recording the spectra. The data were analyzed by comparing the recorded energies with gamma energies from a radionuclide data base.

Quantitative interpretation of the results was not possible since this required knowledge of the location, size and configuration of the radioactive source relative to the detector. A qualitative interpretation was therefore undertaken of the outdoor gamma spectroscopy results.

5.6 OUTDOOR SOIL SAMPLING

Systematic soil sampling was performed within each outdoor grid. The guidance provided in Chapter 4 of Reference 1 was useful when developing the soil sampling methodology. In affected grids, four soil samples were normally taken.

In unaffected grids, one soil sample was normally taken. The procedure for taking the soil samples for radiological measurements is summarized below.

- Hard ground was dug with a pickaxe and then a trowel to a depth of about one foot.
- Soft ground was dug with a manual sampler to a depth of about one foot. Alternatively, a split spoon was driven manually into the ground to a depth of about one foot.
- The soil sample was placed in a tray on a plastic sheet.
- The soil sample was monitored for contamination using the HP260 probe.
- Rocks and debris were removed from the sample, leaving only soil.
- The sampling equipment was monitored for contamination and decontaminated if required.
- The sample was put into a 500 ml plastic container and labelled with the date, grid number and location within the grid.
- Bicron measurements were taken at the hole surface.
- HP260 measurements were taken at surface level above the hole and also down the hole at varying depths.
- The Monserco survey form was completed.
- The hole was backfilled with any soil left over plus any clean soil in the vicinity of the hole.

Soil samples taken for non radiological measurements were taken in a similar manner to that described above, but were contained in 60 ml glass containers and stored in a refrigerator before analyses.

5.7 OUTDOOR WELLS AND BOREHOLES

The procedure for establishing a borehole and a well is shown below.

- The drilling rig was positioned in accordance with the requirements of the drilling manager.
- Polythene sheets were laid on the ground to contain the drilling cuttings.
- The drilling area was cordoned off using yellow barrier tape.
- The borehole was drilled using a hollow stem auger with a split spoon sampler and sampler retainer.
- Drilling commenced when the project manager (or his nominated deputy) and the drilling manager were satisfied that all the necessary controls and equipment were in place.
- The drill was hammered into the ground using a 500 lb mechanized hammer.
- Cored material was taken down to a minimum of about 20 feet (about 6 meters) and/or to the water table.
- The cored material was monitored every two feet in depth for radiation without removing it from inside the split spoon sampler.

- After monitoring for radiation, the samples of the cored material were removed from the split spoon sampler and taken for further analyses by gamma spectroscopy.
- The soil from the excavations was put inside a plastic bag and stored inside a 55 U.S. gallon drum.
- On completion of the drilling operations, non contaminated soil was returned to the hole around the borehole and seals placed at appropriate depths.
- Some contaminated soil from boreholes was placed inside either the east or west silo as instructed by SLC.
- On completion of the borehole a well was sunk to the depth achieved:
- A plastic or metal pipe about 2 inches diameter was inserted into the hole to the depth achieved .
- Bentonite was put down the hole, outside the plastic or metal pipe.
- A larger diameter metal locking cap was driven down the hole, over the plastic or metal pipe.
- Dedicated balers were installed in the wells to allow the water inside the metal or plastic pipe to be sampled.
- A sample of the water in the well was taken.
- The split spoon sampler was checked for contamination and if found to be contaminated, was decontaminated on the SLC site.
- The wells were subsequently numbered (M1 - M13).

5.8 OUTDOOR SILO PENETRATION AND SAMPLING

5.8.1 Exposing the Silo Roof

The objective was to expose the silo roof. The boundaries of the roof were not obvious from the surface contours on the grass above the silo. The steps described below were undertaken to create two trenches which would intersect at the center of the silo.

- The ground surfaces above the silos were probed with strong wires to try and determine the boundaries of the roof.
- The wires were left in position to provide an outline of the silo roof.
- A weatherproof covering was constructed over the silos.
- Polythene sheeting was placed on the ground to contain the soil removed.
- Two intersecting trenches, each 4 - 6 feet long were dug.
- The ground was removed from a four foot by four foot area near the anticipated center of the silo lid, exposing approximately sixteen square feet of the lid surface.

5.8.2 Silo Penetration

The objective was to penetrate both silos to be able to gain an appreciation of their contents. An outline of the steps taken to achieve this objective is given below.

Preparation: Preparation for silo penetration included ensuring that the drill operators and the Monserco team had the necessary radiological protection equipment (coveralls, respirators, DRDs, TLDs, boot covers, gloves etc).

Coring: The concrete cap was drilled using a vertically orientated coring machine. The coring machine was powered by compressed air taken from a mobile compressor. The core bit consisted of a centrally located spindle attached to an eight inch diameter coring bit. Water was used to lubricate the bit. The drill was supported on a lightweight monopod anchored to the silo lid concrete. When a core length had been drilled, the compressor was stopped. The core was removed from the hole, monitored for contamination and put into a plastic bag. An extension was added between the drive and the bit to allow drilling at a deeper level.

Containment: The lower end of the drilling machine was enclosed in a box with a capacity of about 2 cubic feet. The air was continuously extracted from the box using a negative air unit and routed through a HEPA filter. The filtered air was discharged to the atmosphere, about 50 feet from the coring operations. The water from the coring machine was put into a 55 U.S. gallon drum and monitored for contamination. If no contamination was found, the intention was to discharge the water into the ground beside the silo. If contamination was found, the intention was to add a proprietary diamataceous earth to the drum(s) and absorb the water. The absorbed water would then be stored on the SLC site at a location to be decided by local management.

Visual Inspection: A remote video system using an illuminated fiber optic lens was set up to allow monitoring of the internals of the silo. A continuous video image of the interior of the silo was displayed and recorded.

Sampling and Analyses: Three methods were investigated for removal of material from the inside of the silos. The first two methods were unsuccessful and the third method was eventually adopted. The first method involved driving a hollow two inch diameter pipe vertically downward into the silo using a motor driven hammer. The second method involved driving the same hollow pipe vertically downward into the silo using manual effort.

The third method involved manual insertion of a hollow pipe into the silo and twisting it to force some of the silo contents up into the tube. This method was successful and was used to obtain small samples from both the east and west silos. The samples were monitored for radiation and put into plastic 500 ml containers.

In situ Measurements: The following in situ measurements were made during the silo operations:

- The cement cores were monitored for contamination.
- The drill cooling water was measured for contamination.
- Gamma spectroscopy measurements were made at the silo penetration.
- Equipment used to view the silo contents was monitored for contamination.

Resealing: When the silo operations were finished, the bottom of the penetration hole was sealed and the original cores put back into their holes. Grout was poured over the areas to ensure that they were properly sealed. The ground above the excavated areas was replaced and the original signs reconditioned and reinserted into the ground at their previous locations.

5.9 OUTDOOR EXCAVATIONS

The Characterization Working Document initially required boreholes to be excavated in the canal region of the site. The requirement was discussed with NRC and SLC and it was agreed that the objective should be to obtain an understanding of the nature and extent of possible buried materials on the site. Agreement was given by the NRC to excavate in selected areas of the site in addition to sinking boreholes and creating wells.

The excavation procedure is shown below.

- A plastic sheet was placed over the area on which the soil was to be excavated and the corners of the sheet were staked to hold it down.
- A frontwheel drive CAT excavator (tractor) was driven on to the area, over the plastic sheet.
- An excavation was made approximately 3-4 feet wide, 8 - 10 feet long and 5 feet deep.
- When a bucket full of earth was obtained, the accessible surfaces of the bucket contents were monitored for radiation using both the Bicron survey meter and the HP260 contamination probe.
- The contents of the bucket were placed onto the plastic sheet and the excavations were continued.

- Any small items of waste would be removed and not returned to the excavation.
- Any large items of waste (e.g. 55 U.S. gallon drums) would be photographed.
- Radiation measurements and gamma spectrometer readings would be taken as close as possible to any buried objects.
- Water samples would be taken if any water was encountered.
- When an excavation was complete, radiation and contamination measurements would be taken of the tractor bucket.
- If the bucket was contaminated it would be decontaminated before allowing it offsite.
- Diggers logs would be kept of the site excavation activities. This would include details of dates, times, areas excavated, contamination and radiation found and objects uncovered.

6 CHARACTERIZATION METHODOLOGIES FOR BUILDINGS

6.1 BUILDING GRIDDING SYSTEM

The building gridding system described below was devised by Monserco personnel during the course of the characterization work.

Before any building survey work started, the Monserco radiological surveyors inspected each room within a building and divided the room into manageable sections. These gridded sections of a room were identified by numbered labels temporarily attached to the walls, floor and ceiling. The room radiological surveys were then carried out with reference to the grid numbers.

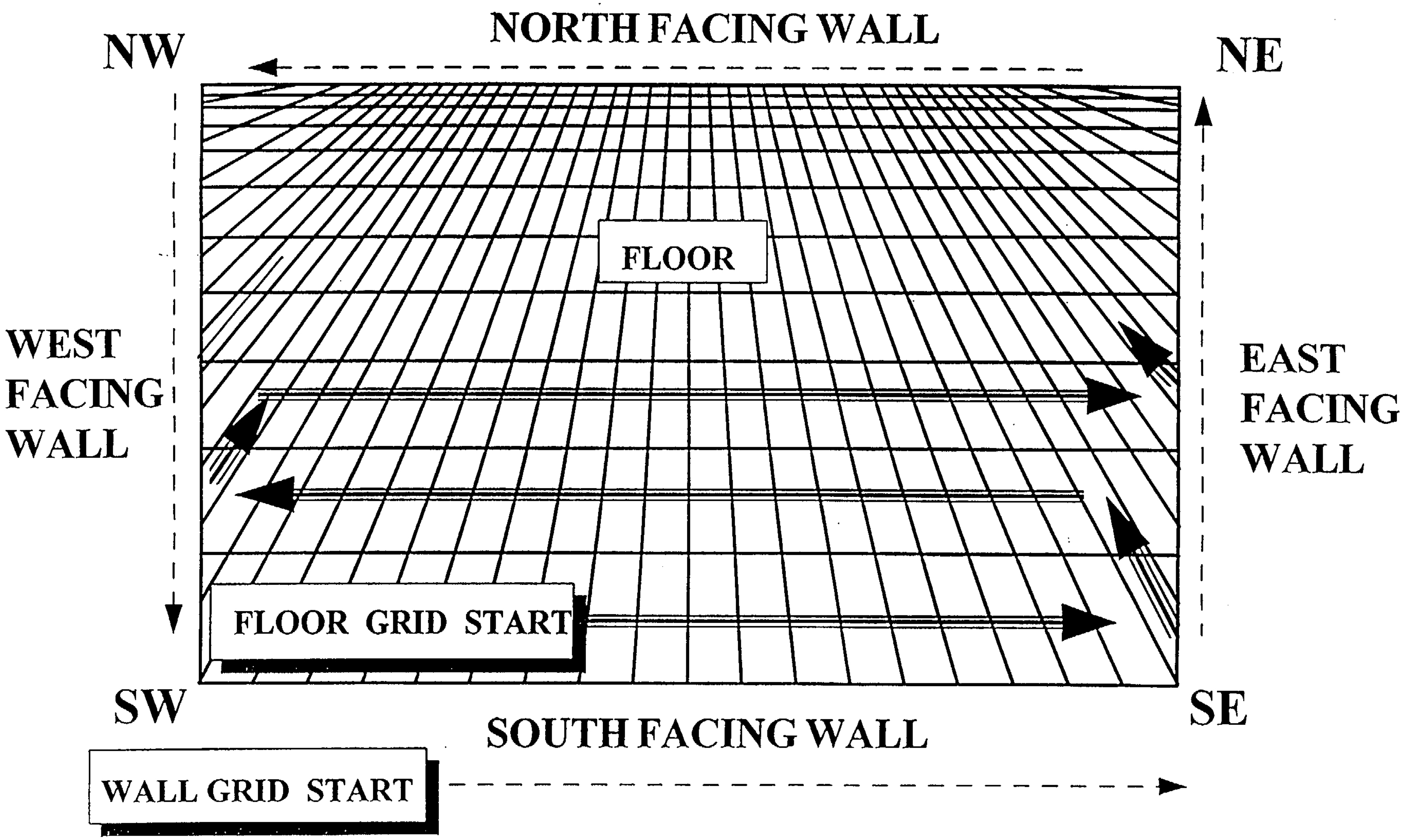
In a number of cases, it was not practical to follow the unified grid numbering system set out below, and variations were used. For ease of understanding of this report, grid numbers (and associated data) which deviated from the unified grid numbering system were changed after the survey to new numbers. These new numbers were consistent with the unified grid numbering system. Both the old and the new numbers have been retained on the Monserco data bases to allow traceability of results. Those grid numbers which are consistent with the unified grid numbering system, i.e., the normalized numbers are reported here. Any exceptions to this are clearly indicated in the relevant sections of the report.

One of the purposes in providing a detailed description of the gridding arrangement is to allow areas of high radiation and/or contamination to be identified at a later date for decontamination and/or decommissioning. Many of the labels showing the grid numbers will no longer be in their original positions, especially on the floors of rooms where day to day operations are still being performed. For this reason and because of the normalization of the numbering system, caution is advised to anyone who might attempt to locate gridded areas inside the buildings. Any markings which might remain on the walls, floors or ceilings of the rooms should be disregarded. The areas should be regridded according to the normalized gridding system described in this report.

6.1.1 Room Walls Gridding System

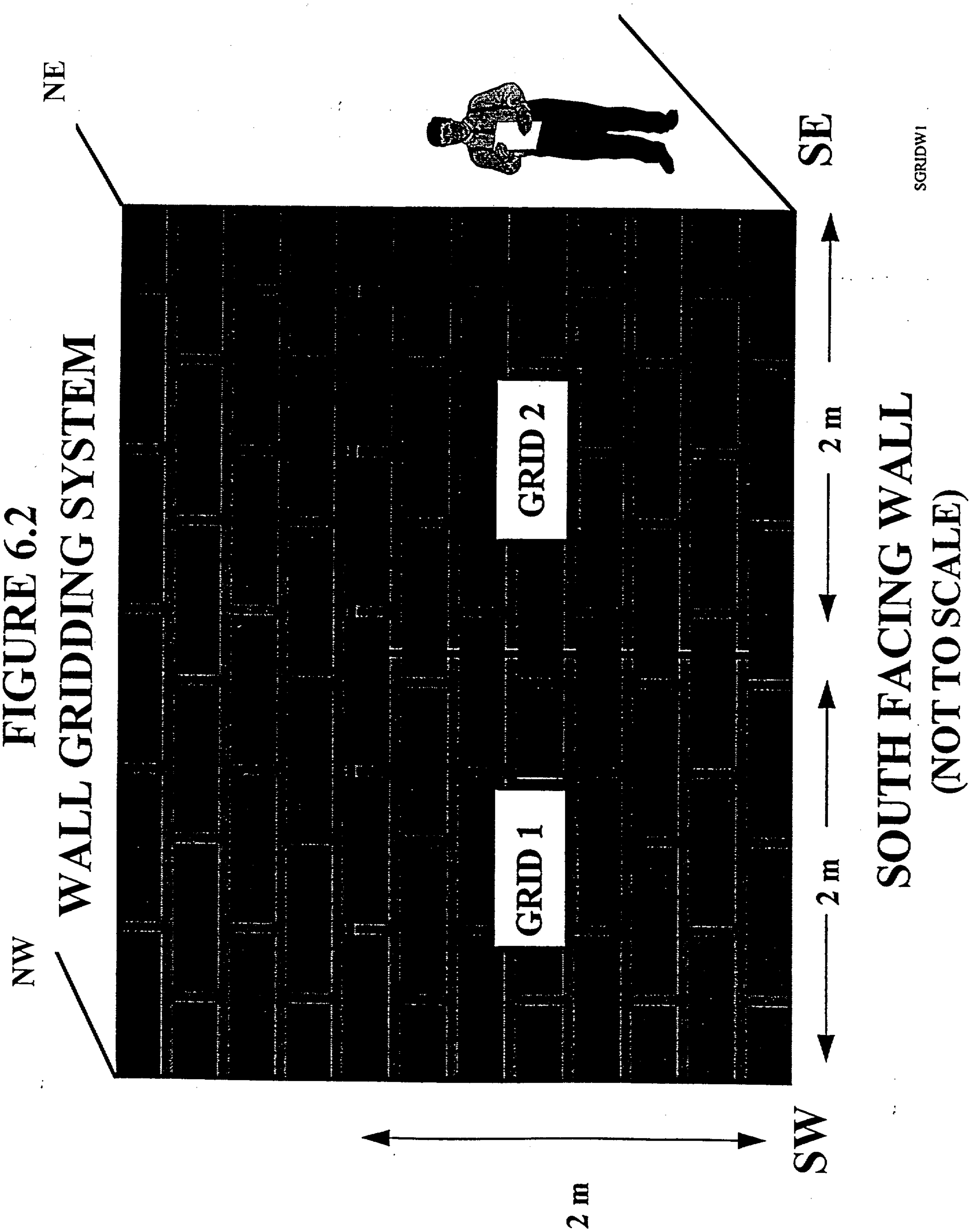
Figure 6.1 shows that, starting at the southwest (SW) corner of a room, the Monserco surveyor sections the south facing wall into gridded areas of approximately equal length. The surveyor moves in a counter clockwise direction until all wall surfaces have been gridded. Figure 6.2 shows that the horizontal distance between the grids is 2 meters and the vertical distance is the reach of the surveyor which is about 2 meters. The error on the horizontal distance can be up to 0.5 meters.

FIGURE 6.1
FLOOR AND WALL GRIDDING SYSTEM



SGRIDSY1

FIGURE 6.2
WALL GRIDDING SYSTEM



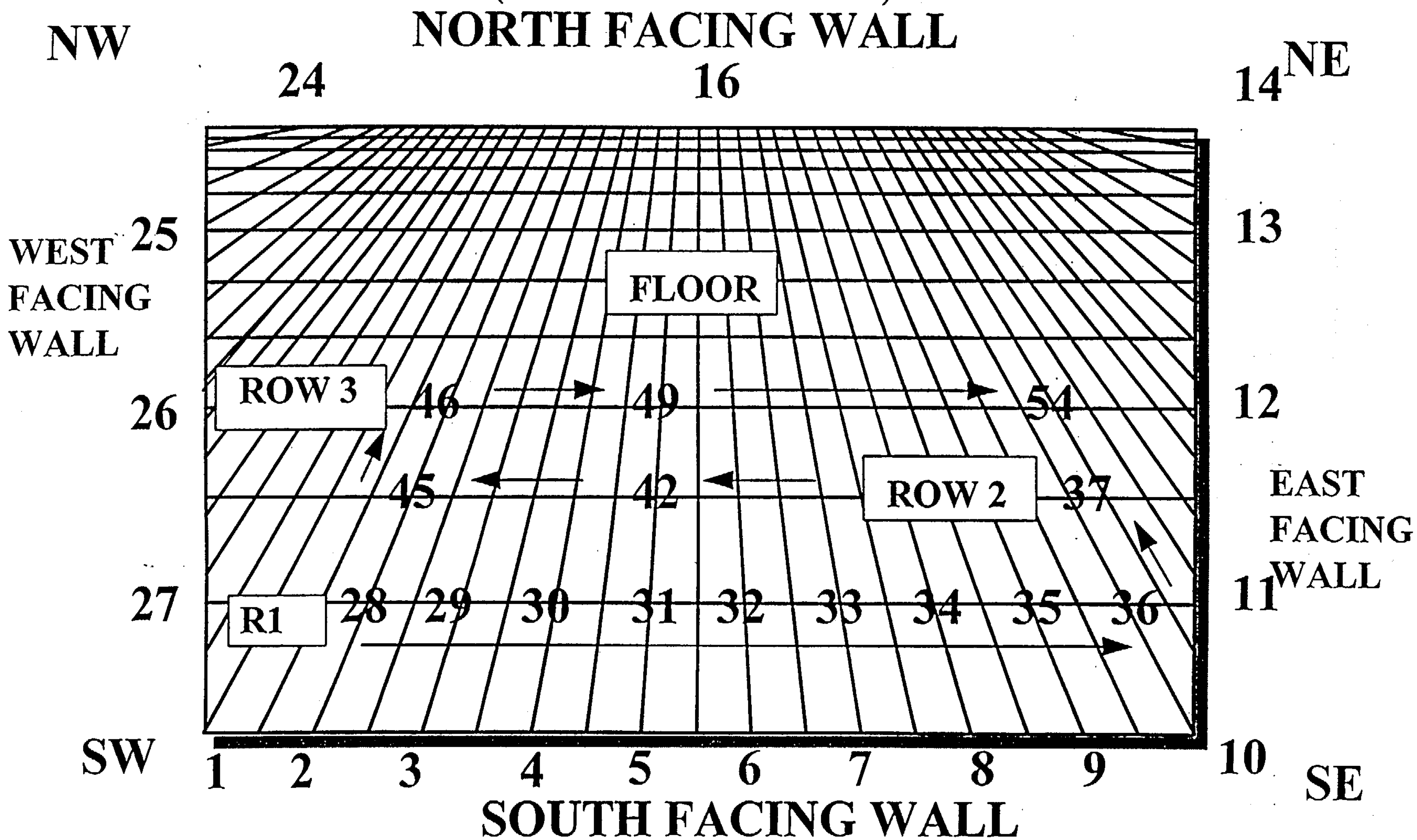
The variations were caused by the presence of installed or movable equipment inside the room. Figure 6.3 shows a hypothetical example of the gridding plan for the walls and floor of a room. The first wall grid is number 1 on the SW corner, and the last wall grid is number 27 on the west facing wall of the room.

Table 6.1 shows a tabular representation of the wall information contained in Figure 6.3.

TABLE 6.1
TABULAR PRESENTATION OF THE WALL GRID NUMBERS SHOWN IN FIGURE 6.3

A	B
SAMPLE ID	**GRID #**
SW Corner	1
S. Wall	2
S. Wall	3
S. Wall	4
S. Wall	5
S. Wall	6
S. Wall	7
S. Wall	8
S. Wall	9
S. E. Corner	10
E. Wall	11
E. Wall	12
E. Wall	13
NE Corner	14
N. Wall	15
N. Wall	16
N. Wall	17
N. Wall	18
N. Wall	19
N. Wall	20
N. Wall	21
N. Wall	22
N. Wall	23
N. Wall	24
W. Wall	25
W. Wall	26
W. Wall	27

FIGURE 6.3
EXAMPLE OF ROOM GRIDDING SYSTEM
(NOT DRAWN TO SCALE)



SGRIDEX1

South-facing Wall: Grid number 1 on the SW corner is the first grid on the south-facing wall. Grid number 10 on the SE corner is the last grid on the south-facing wall.

East-facing Wall: Grid number 10 at the SE corner is the first grid on the east facing wall. Grid numbers 10 -14 are on the east facing wall. Grid number 14 on the NE corner is the last number on the east facing wall.

North-facing Wall: Grid number 14 at the NE corner is the first grid on the north-facing wall. Grid numbers 14 - 24 are on the north facing wall.

West-Facing Wall: Grid number 25 is the first grid on the north-facing wall and grid numbers 26 and 27 are on the west facing wall. grid number 27 is the last grid on the north-facing wall. Note that although grid number 1 is on the SW corner, for ease of presentation and understanding it is not considered necessary to specify grid number 1 as the last grid on the west-facing wall.

Representation of Wall Hot Spots: Hot spots on the walls of rooms are described in the relevant Tables with reference to the gridded area. Thus with reference to Figure 6.2, a hot spot on the south-facing wall, at a point 2 meters due east of the SW corner and 1 meter high would be designated as being inside grid number 1, with an X coordinate of 2m and a Y coordinate of 1m.

6.1.2 Room Floor Gridding System

The Monserco surveyor sectioned the floor into gridded areas of approximately equal length as shown in Figures 6.1 and 6.3. The gridded floor rows are parallel to the south-facing wall and the grid spacing is approximately 2 meters. For example, row 1 is gridded by starting at the SW corner of the room and moving across the floor from west to east. When the surveyor comes to the end of row 1, he moves 2 meters northwards and starts row 2, this time moving from east to west. The surveyor effectively works his way through the room until all of the available floor surface area has been allocated a grid number. Figure 6.3 shows an example of a gridded floor. The first floor grid is number 28 near the SW corner, and the last floor grid is number 54. Table 6.2 shows how this is represented in tabular form.

TABLE 6.2
REPRESENTATION OF FLOOR GRIDDING SYSTEM

A	B
SAMPLE ID	**GRID No.**
Floor, r1	28
Floor, r1	29
Floor, r1	30
Floor, r1	31
Floor, r1	32
Floor, r1	33
Floor, r1	34
Floor, r1	35
Floor, r1	36
Floor, r2	37
Floor, r2	38
Floor, r2	39
Floor, r2	40
Floor, r2	41
Floor, r2	42
Floor, r2	43
Floor, r2	44
Floor, r2	45
Floor, r3	46
Floor, r3	47
Floor, r3	48
Floor, r3	49
Floor, r3	50
Floor, r3	51
Floor, r3	52
Floor, r3	53
Floor, r3	54

Row 1: Grid number 28 is the first grid on row 1 of the floor. Grid number 29 is located approximately 2 meters nearer the east-facing wall, and grid number 36 is at the end of row 1 near the east-facing wall.

Row 2: Grid number 37 is the first grid on row 2 of the floor. Grid number 38 is located approximately 2 meters nearer the west-facing wall. Grid number 45 is at the end of row 2, near the west-facing wall.

Row 3: Grid number 46 is the first grid on row 3 of the floor. Grid number 47 is located approximately 2 meters nearer the east-facing wall. Grid number 54 is at the end of row 3, near the east-facing wall.

Last Row: The last row in the floor of a room will touch the north-facing wall.

Representation of Floor Hot Spots: Hot spots inside floor grids are described with reference to the NE corner of each grid. For instance, with reference to Figure 6.3, a hot spot with the coordinates 1 meter due east and 1 meter due north of the SW corner would be designated as being inside grid 28.

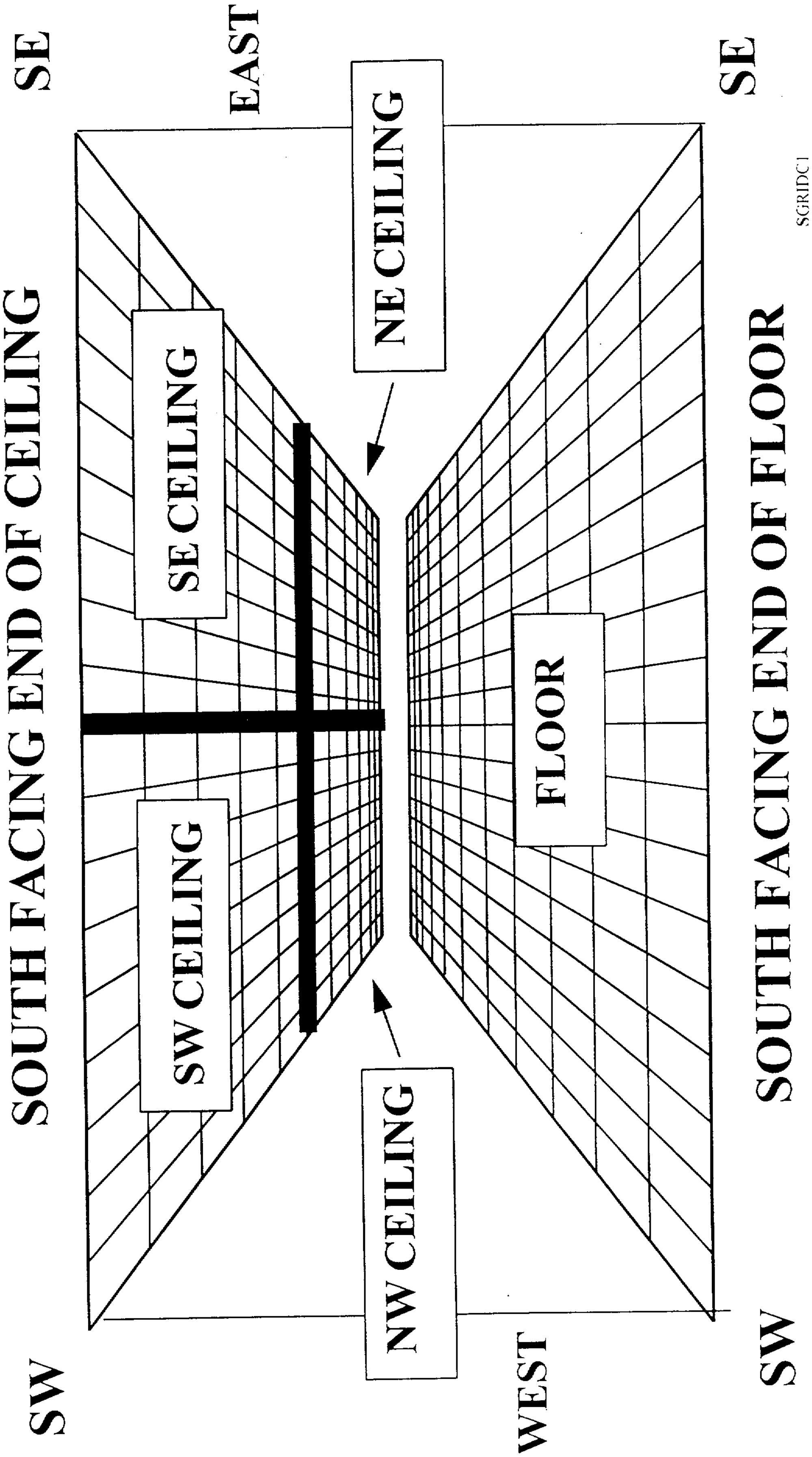
6.1.3 Room Ceiling Gridding System

The ceilings were normally sectioned into 1, 2 or 4 gridded areas since it was not practical to section them into larger numbers of grids. Occasionally larger numbers of grids were used. Figure 6.4 shows an example of a ceiling sectioned into four grids. Examples of ceiling gridding systems used by Monserco are shown in Table 6.3.

TABLE 6.3
FIVE EXAMPLES OF CEILING GRIDDING SYSTEMS

No.	Ceiling Grid Notation	Meaning
1	Ceiling	*1 Grid only.*
2	N ceiling S ceiling	*2 Grids.* Separated by an EW line.
3	E Ceiling W Ceiling	*2 Grids.* Separated by a NS line.
4	SW ceiling SE ceiling NW ceiling NE ceiling	*4 Grids.* Separated by EW and NS lines. This case is illustrated in Figure 6.4.
5	SW ceiling SE ceiling SW ceiling SE ceiling CW ceiling CE ceiling CEW ceiling CE ceiling CW ceiling CE ceiling CW ceiling CE ceiling NE ceiling NE ceiling NW ceiling NE ceiling NW ceiling NE ceiling	*18 Grids.* Center West Center East West

FIGURE 6.4
EXAMPLE OF CEILING GRID SYSTEM
CEILING SECTIONED INTO FOUR GRIDS



6.2 RADIOLOGICAL SURVEY METHODOLOGY

Based on historical information, rooms were categorized either as having a high probability of being contaminated (affected) or a low probability of being contaminated (unaffected). These categorizations were agreed with SLC before work commenced in a room. 100% of the accessible areas of affected rooms were monitored, and approximately 10% of the accessible areas of the unaffected rooms were monitored. These values varied where safety concerns were encountered.

The radiological surveys of the rooms were undertaken using the instrumentation and techniques listed below.

- Radiation fields: Bicron survey meter.
- Gamma energy radiation identification: portable gamma spectrometer.
- Fixed beta/gamma contamination: an Eberline ESP-1 or ESP-2 monitor with HP260 probes.
- Fixed alpha/beta contamination: Berthold LB122
- Loose alpha/beta contamination: cloth swipes.
- Loose tritium contamination: polyfoam swipes.

The various techniques used to perform the radiological surveys are described below.

6.2.1 Bicron Radiation Survey Methodology

One Bicron reading was usually taken within each grid of an affected or unaffected room.

6.2.2 Gamma Spectroscopy Survey Methodology

Gamma spectroscopy was not used in every building or room. When used, the gamma spectrometer was taken into the center of a room and data collected for 30 seconds. These gamma spectroscopy snapshots did not differentiate between gamma emissions from the room structure and the equipment/fixtures inside the room.

6.2.3 ESP1/ESP2 Contamination Survey Methodology

ESP1 and ESP2 meters coupled to HP260 detectors were used to perform the contamination surveys of the walls, floors and ceilings of the rooms. The available room surface area was scanned using the HP260 detectors at a rate of approximately 1 foot per second. Variations in the loudspeaker clicks and/or increases in the digital output indicated the presence of contamination. When hot spots were encountered, their X and Y coordinates within a grid were recorded.

6.2.4 LB122 Contamination Survey Methodology

The LB122 was normally used for the measurement of contamination on room floors. It was also used occasionally for wall measurements. Care had to be taken not to penetrate the Mylar film on the window of the LB122 monitor. This made it difficult to use the monitor on uneven surfaces especially those which also had protrusions. The available surface area was scanned using the LB122 at a rate of approximately 1 foot per second. Variations in the loudspeaker clicks and/or digital movements of the instruments indicated the presence of contamination. When hot spots were encountered, their X and Y coordinates within a grid were recorded.

6.2.5 Cloth Smear Contamination Survey Methodology

Rad-Wipe smears, (also called cloth smears) were used to sample loose alpha, beta and gamma contamination from walls, floors and ceilings of a room. An outline of the sampling procedure is given below.

- The smear was held between the thumb and second or third finger of the hand. Pressure was applied by the fingertips to the center of the smear.
- The smear was brought into contact with about 100 square centimeters of each grid.
- The smear was given a unique number which contained information on the origin of the sample.
- The smear was taken to the laboratory and counted for total alpha and total beta content.
- The calculation for determination of loose contamination using cloth smears is shown in Section 7.

6.2.6 Polyfoam Smear Survey Methodology

Smears made from polyfoam were used to sample loose tritium contamination from the walls, floor and ceiling of a room. An outline of the sampling procedure is given below.

- The smear was held between the thumb and second or third finger of the hand. Pressure was applied by the fingertips to the center of the smear.
- The smear was brought into contact with about 100 square centimeters of each grid.
- The smear was given a unique number which contained information on the origin of the sample.
- The smear was taken to the laboratory and counted for tritium using the Liquid Scintillation Counter.

- The calculation for determination of loose contamination using polyfoam smears is shown in Section 7.

6.3 RADIATION SURVEY INSTRUMENTATION

6.3.1 Bicron Survey Meter

Information on the Bicron survey meter is given in Section 5.5.1.

6.3.2 Portable Gamma Spectrometer

Information on the portable gamma spectrometer is given in Section 5.5.2.

6.4 CONTAMINATION SURVEY INSTRUMENTATION

The monitors shown below were used for the outdoors contamination survey.

TABLE 6.4
MONITORS USED FOR THE OUTDOORS CONTAMINATION SURVEY

METER	PROBE
LB 122	Alpha/beta probe
LB 122	Beta/gamma
ESP 1	HP 260
ESP 2	HP 260

The contamination monitors were calibrated over their complete working range prior to use on the SLC site. The efficiencies of the contamination probes were determined before start of the survey work.

The responsibilities of each person conducting a contamination survey included:

- Ensuring that there was a calibration certificate with the monitor.
- Using the appropriate check source to perform the daily functional checks.
- Checking the instrument batteries and replacing them if necessary.
- Using the proper forms to record the information gathered.
- Reporting any discrepancies to his immediate supervisor.

6.4.1 HP260 Contamination Monitor

Eberline ESP 1 and ESP 2 systems coupled to HP260 detectors were used to monitor buildings for contamination.

The HP260 is a pancake Geiger Muller gas filled detector, manufactured by Eberline with a surface area of approximately 15 cm^2. The instrument is sensitive to beta and gamma radiation.

The ESP series are data logging, microcomputer based radiation survey instruments. They have two basic operating modes: ratemeter and scaler. The ratemeter mode provides the operator with events per unit time, for example, counts per second. The scaler mode allows the operator to select a counting period over which the computer integrates the detector's signals. The ESP instruments were used only in ratemeter mode during the characterization of the SLC site.

The average surface contamination clearance level for beta/gamma emitters is 5,000 dpm/100cm^2. This is the equivalent of 2.72 counts per second on the ESP-1 meter with the HP260 probe. The HP260 equivalent was derived by checking the efficiency of the probe using a Cs-137 source of known strength and taking into account the probe surface area. The calculation is shown in Section 4.

6.4.2 LB122 Contamination Monitor

The LB122 was used for detecting and measuring radioactive alpha and beta contamination. The LB122 contamination monitor consists of a display unit including microprocessor electronics and a large area proportional counter tube with an effective window area of 160 cm^2 installed at the bottom of the instrument. The alpha/beta detector is a butane filled tube (LB6358) and the beta/gamma detector is a xenon filled tube (LB 6357). The detector tubes are interchangeable. During operations, there was an ongoing requirement to ensure that the alpha/beta detector tube was filled with gas.

The LB122 contamination readings were recorded in counts per second (cps) and converted to disintegrations per minute per 100 square centimeters (dpm/100cm^2).

7 LABORATORY TECHNIQUES

The sections below describe the laboratory techniques used by Monserco for sampling and analyses of samples taken from the SLC site.

7.1 GAMMA SPECTROSCOPY

7.1.1 Soil Sample Preparation

Ten empty plastic containers were weighed and the average weight of a plastic container recorded. Soil samples were collected in 500 ml plastic containers. The soil and the plastic container were weighed and the gross weight recorded. The weight of soil was calculated by subtracting the average weight of the plastic container from the gross weight.

7.1.2 Soil Sample Analyses Using a Sodium Iodide Gamma Spectrometer

During the early stages of the project, soil samples were analyzed for gamma emitting radionuclides using a BTI portable gamma spectrometer. The resolution was not sufficient to separate the two major peaks of interest, the 609 keV Bi-214 peak and the 662 keV Cs-137 peak. The implications of this deficiency were recognized by Monserco and by NRC during the audit of September 13, 1995. It was agreed that Monserco would purchase an intrinsic germanium detector with the capability of resolving the above peaks. When the intrinsic germanium system was purchased and commissioned, it was considered prudent to re-analyze all soil samples previously analyzed using the sodium iodide detector. All soil gamma spectrometer results contained in this report were obtained using the intrinsic germanium detector.

7.1.3 Analyses of Soil Samples Using an Intrinsic Germanium Gamma Detector

Soil samples were analyzed by intrinsic germanium detector using the methodology described below.

1. Turn the balance power on and let balance warm up for 30 minutes.
2. Perform daily Quality Control check by weighing 100g standard weight.
3. Record results in black notebook and plot mean weight on the QC graph.
4. Check that the result is within 2 standard deviations from the mean weight before proceeding. If more than 3 standard deviations from the mean. stop and check equipment.
5. Turn gamma spectrometer power on and load default worksheet into the program titled "Spectroscopy Assistant".
6. Run background on gamma spectrometer for about 5 minutes.
7. Analyze the background results using "Peak Analysis With Report".
8. Do not print out results.
9. Save analysis under an appropriate filename e.g. "112895bk.cnf" for a background measured on 28 November, 1995.
10. Open the Quality Assurance file "backgrnd.qaf".
11. Transfer to the QA file the cnf file just saved.
12. View background counts plot to ensure that background counts are within 2 standard deviations from the mean background. If more than 3 standard deviations from the mean, stop and check equipment.
13. Run soil calibration standard for 1 minute.
14. Analyze the spectrum using "QA-MDA Analysis with Report".
15. Do not print out results.
16. Save analysis under filename e.g. "11-28-95.cnf" for QA check performed on 28 November 1995.
17. Open Quality Assurance file "Cs-137.qaf".
18. Transfer the cnf file just saved.
19. View four plots to ensure all parameters checked are within 2 standard deviations of the mean.
20. Weigh the soil sample and subtract blank soil container weight of 63.37 g.
21. Record weight and other sample information into the gamma spectrometer.
22. Run sample on the gamma spectrometer for 10 minutes.
23. Save results under filename e.g. "123-1.cnf" for sample 123-1.
24. Repeat the above steps for the next sample.
25. Load stored file into the gamma analysis screen.
26. Analyze using "MDA Analysis With Report" with automatic blank correction.
27. Record results manually and save data.
28. At the end of analysis, visually check the spectrum to see if there are any other major peaks not identified.
29. If so, try to identify the unknown peaks using the list of nuclides and their energies more commonly found in the samples. For example: K-40 - 1460.81 keV (long half-life) and U-235 - 143.76 keV (long half-life)
30. If the unknown peaks have still not been identified, analyze data using "stdlib.nlb" library and record additional data obtained.

7.1.4 Analyses of Water Samples Using an Intrinsic Germanium Detector

Water samples were analyzed by instrinsic germanium detector using the methodology described below.

1. Transfer a 500 ml aliquot of the water sample to an empty plastic container. Put the lid on the container.
2. Turn gamma spectrometer power on and load default worksheet into the program titled "Spectroscopy Assistant".
3. Run background on gamma spectrometer for about 5 minutes.
4. Analyze the background results using "Peak Analysis With Report".
5. Do not print out results.
6. Save analysis under an appropriate filename e.g. "112895bk.cnf" for a background measured on 28 November, 1995.
7. Open the Quality Assurance file "backgrnd.qaf".
8. Transfer to the QA file the cnf file just saved.
9. View background counts plot to ensure that background counts are within 2 standard deviations from the mean background. If more than 3 standard deviations from the mean, stop and check equipment.
10. Run water calibration standard for 1 minute.
11. Analyze the spectrum using "QA-MDA Analysis with Report".
12. Do not print out results.
13. Save analysis under filename e.g. "11-28-95.cnf" for QA check performed on 28 November 1995.
14. Open Quality Assurance file "Cs-137.qaf".
15. Transfer the cnf file just saved.
16. View four plots to ensure all parameters checked are within 2 standard deviations of the mean.
17. Record volume and other sample information into the gamma spectrometer.
18. Run sample on the gamma spectrometer for 1 hour.
19. Save results under filename e.g. "1101.cnf" for sample 1101.
20. Repeat the above steps for the next sample.
21. Load stored file into the gamma analysis screen.
22. Analyze using "MDA Analysis With Report" with automatic blank correction.
23. Record results manually and save data.
24. At the end of analysis, visually check the spectrum to see if there are any other major peaks not identified.
25. If so, try to identify the unknown peaks using the list of nuclides and their energies more commonly found in the samples. For example: K-40 - 1460.81 keV (long half-life) and U-235 - 143.76 keV (long half-life)
26. If the unknown peaks have still not been identified, analyze data using "stdlib.nlb" library and record additional data obtained.

7.2 GROSS ALPHA COUNTING OF CLOTH SMEAR SAMPLES

The Eberline Scintillation Alpha Counter, Model SAC-4 (the Gross Alpha Counter) is a complete system consisting of a two inch detector, high voltage power supply, charge sensitive amplifier, timer and six decade readout. All circuits are solid state, except the detector.

The detector is a scintillation phosphor made from zinc sulfide. Background is typically less than 0.3 counts per minute. An accuracy of better than 0.05% is quoted by the manufacturer. The manufacturer used Pu-239 as the calibration source.

Counting was performed in preset times ranging from 0.1 to 50 minutes. The sample was inserted into the adjustable sample holder and the sample drawer closed. Counting was then commenced. After the preset time, counting was terminated and the scaler displayed the total count for that time. The activity of the sample was then obtained by subtracting the background and dividing by the counting efficiency.

The counting efficiency was determined by placing a source of known activity in the sample holder and counting it for a long enough period of time to satisfy the statistical accuracy requirements.

The Gross Alpha Counter was checked for proper functioning at the beginning of each day. The background and an Am-241 source of known strength were counted for 1 minute and the results recorded. The same Am-241 source was used to determine the counting efficiency. The counting efficiency of the Gross Alpha Counter was 35%.

The Gross Alpha Counter was used to analyze cloth smears which had been used for the controlled removal of contamination from structures and objects. Analysis of the cloth smear by Gross Alpha Counting thus provided a measure of the amount of removable alpha contamination on a structure or object. Each sample was counted for one minute and the results recorded.

The sample activity for gross alpha counting was calculated using the following equation:

$$\text{SAMPLE ACTIVITY (Bq/cm}^2\text{)} = \frac{\text{Net Sample Total Counts}}{T * E * 100 \times 1.0}$$

where:

T	=	Counting time in seconds.
E	=	Counting efficiency as a decimal fraction.
100	=	100 cm^2 smear area.
1.0	=	The assumed 100% smear collection efficiency.

The Minimum Detectable Activity (MDA) for gross alpha in smears was calculated from the following equation:

$$\text{MDA (Bq/cm}^2\text{)} = \frac{2.71 + 4.65\sqrt{\text{Blank}}}{T * E * 100 \times 1.0}$$

where:

MDA	=	Minimum Detectable Activity for gross alpha in smears.
BLANK	=	Total counts for an unused smear.
T	=	Counting time in seconds.
E	=	Counting efficiency as a decimal fraction.
100	=	100 cm^2 smear area.
1.0	=	The assumed 100% smear collection efficiency.

The MDA for gross alpha in smears was 0.002 Bq per square centimeter of smear. This is the equivalent of 0.054 picoCuries per square centimeter of smear.

7.3 GROSS BETA COUNTING

The Eberline model BC-4 Beta Counter is a complete assay system consisting of a 2 inch detector, high voltage power supply, pulse amplifier and associated circuitry. The detector is a Geiger Muller tube with a 1.75 inch diameter window which is 1.4 to 2.0 mg/cm^2 thick. The Geiger Muller tube is shielded from the top and sides by a minimum of 7/8 inches (2.2 cm) thick lead. The manufacturer used Tc-99 as the calibration source. The background is about 50 counts per minute and the gamma sensitivity is typically less than 1200 counts per minute per mR/h Co-60. The Sr-9-/Y-90 2 pi efficiency is approximately 80%. Counting is performed in preset times ranging from 0.1 to 50 minutes, and an accuracy of better than 0.05% is quoted by the manufacturers. The sample is inserted into the adjustable sample holder and the sample drawer is closed.

Counting is then commenced. The instrument will stop counting after the preset time and the scaler will display the total count for that time. The activity of the sample is then obtained by subtracting the background and dividing by the counting efficiency.

The counting efficiency is determined by placing a source of known activity in the sample holder and counting it for a long enough period of time to satisfy the statistical accuracy requirements.

7.3.1 Gross Beta Counting of Cloth Smear Samples

The Gross Beta Counter was used to analyze cloth smears which had been used for the controlled removal of contamination from structures and objects. Analysis of the cloth smear by Gross Beta Counting thus provided a measure of the amount of removable beta contamination on a structure or object.

The Beta Counter was checked for proper functioning at the beginning of each working day. The background and a Cs-137 source of known strength were counted for 1 minute and the results recorded. Two counting efficiencies were determined based on measurements on two different beta emitting isotopes (Cs-137 and Sr-90). The lower efficiency of 21% of Cs-137 was used and provided a conservative bias to the results. Each sample was counted for one minute and the results recorded.

The sample activity for gross beta counting was calculated using the following equation:

$$\text{SAMPLE ACTIVITY (Bq/cm}^2\text{)} = \frac{\text{Net Sample Total Counts}}{T * E * 100 \times 1.0}$$

where:

T	=	Counting time in seconds.
E	=	Counting efficiency as a decimal fraction.
100	=	100 cm^2 smear area.
1.0	=	The assumed 100% smear collection efficiency.

The Minimum Detectable Activity (MDA) for gross beta in smears was calculated from the following equation:

$$MDA\ (Bq/cm^2) = \frac{2.71 + 4.65\sqrt{Blank}}{T * E * 100 \times 1.0}$$

where:

MDA	=	Minimum Detectable Activity for gross beta in smears.
BLANK	=	Total counts for an unused smear.
T	=	Counting time in seconds.
E	=	Counting efficiency as a decimal fraction.
100	=	100 cm^2 smear area.
1.0	=	The assumed 100% smear collection efficiency.

The MDA for gross beta in smears was 0.02 Bq per square centimeter of smear. This is the equivalent of 0.54 picoCuries per square centimeter of smear.

7.3.2 Gross Beta Counting of Soil Samples

The soil samples were collected in 500 ml plastic containers. Small portions of these samples were counted directly for gross beta using the Gross Beta Counter.

The soil samples were dried using a Baxter TempCon oven. This involved transferring soil from the 500 ml plastic container to an 8 inch diameter aluminum container. The soil samples were then placed in the oven and dried. The oven temperature was about 150°C. No evidence was found of a loss of radioactivity from the soil samples during heating. The samples were stirred occasionally until each entire sample was dry and then allowed to cool before weighing. About 5 g of a sample was place inside a small plastic container and weighed using a Mettler-Toledo balance.

The Beta Counter was checked for proper functioning at the beginning of each day. The background and a Cs-137 source of known strength were counted for 1 minute and the results recorded on a data sheet. Each sample was counted for five minutes and the results recorded.

The sample activity for gross beta was calculated as follows:

$$\text{SAMPLE ACTIVITY (Bq/g)} = \frac{\text{Net Sample Total Counts}}{T * E * W}$$

where:

T = Counting time in seconds.
E = Counting efficiency as a decimal fraction.
W = The sample weight in grams.

The Minimum Detectable Activity (MDA) for gross beta in soil was calculated from the following equation:

$$\text{MDA (Bq/g)} = \frac{2.71 + 4.65\sqrt{\text{Blank}}}{T * E * W}$$

where:

MDA = Minimum Detectable Activity for gross beta in soil.
BLANK = Total counts for a blank soil sample.
T = Counting time in seconds.
E = Counting efficiency as a decimal fraction.
W Sample weight in grams.
E = $\frac{\text{cpm of spiked soil}}{\text{dpm of spike}} \times 100 = 20\%$

Attenuation counting efficiency was determined by adding a known aliquot of a Sr-90 liquid standard to 5 grams of blank soil. The standard was mixed thoroughly in the soil which was then counted on the Gross Beta counter

When the results were corrected for attenuation the MDA for gross beta in soil was 0.26 Bq per gram of soil. This is the equivalent of 7.03 picoCuries per gram of soil.

7.4 LIQUID SCINTILLATION COUNTING

A Liquid Scintillation Counter (LSC) was used to measure the beta content of samples. The sample was dissolved in a liquid and a scintillant cocktail added to absorb the radiation energy and emit a photon of light. The light was detected and amplified by photomultiplier tubes, protected from visible light inside the LSC. The voltage pulse obtained was directly proportional to the energy absorbed in the scintillant, which was directly proportional to the energy of the beta emission.

7.4.1 Liquid Scintillation Counting of Water Samples

The water samples from the SLC site were analyzed for H-3 and Sr-90 using an LKB Wallac RacBeta Liquid Scintillation Counter. A 2 ml aliquot of each water sample was transferred to a borosilicate glass scintillation vial and mixed with 15 ml of the Amersham ACS scintillation cocktail. After an initial count of 1 hour, the samples were spiked with a known amount of H-3 and Sr-90 liquid standards. The samples were then counted a second time for 1 hour each. The counting efficiency for each sample was calculated as follows:

$$E = \frac{(C + s) - C}{S} = \frac{s}{S}$$

where:

E = Counting efficiency.
C = Total counts for the unspiked sample.
S = Activity of Spike.
s = Difference between total counts for spiked and unspiked samples.

Counting efficiencies of approximately 26% and 98% were determined for H-3 and Sr-90 respectively.

The sample activity was calculated using the following equation:

$$\text{SAMPLE ACTIVITY (Bq/litre)} = \frac{\text{Net Sample Total Counts}}{T * E * 0.002}$$

where:

T = Counting time in seconds.
E = Counting efficiency as a decimal fraction.
0.002 = The aliquot of the sample (in liter(s)) analyzed.

The Minimum Detectable Activities (MDA) for H-3 and Sr-90 in water samples were calculated from the following equation:

$$\text{MDA (Bq/litre)} = \frac{2.71 + 4.65\sqrt{\text{Blank}}}{T * E * 0.002}$$

where:

MDA	=	Minimum Detectable Activities for H-3 or Sr-90 in water.
BLANK	=	Total counts for a blank water sample.
T	=	Counting time in seconds.
E	=	Counting efficiency as a decimal fraction.
0.002	=	The aliquot of the sample (in liter(s)) analyzed.

The MDA for H-3 in water was 86 Bq/litre (2324 picoCuries per litre) and the MDA for Sr-90 in water was 34 Bq/litre (919 picoCuries per litre).

7.4.2 Liquid Scintillation Counting of Polyfoam Smear Samples

The polyfoam smear samples from the SLC site were analyzed for H-3 using an LKB Wallac RacBeta Liquid Scintillation Counter. Each sample was dissolved completely in 15 ml of the Amersham ACS cocktail in a borosilicate glass scintillation vial. The samples were then counted for 1 minute each.

The tritium activity in smears was calculated using the equation shown below.

$$\text{SAMPLE ACTIVITY } (Bq/cm^2) = \frac{\text{Net Sample Total Counts}}{T * E * 100 \times 1.0}$$

where:

T	=	Counting time in seconds.
E	=	Counting efficiency as a decimal fraction.
100	=	100 cm^2 smear area.
1.0	=	The assumed 100% smear collection efficiency.

The Minimum Detectable Activity (MDA) for tritium in smear samples was calculated from the following equation:

$$\text{MDA (Bq/cm}^2) = \frac{2.71 + 4.65\sqrt{\text{Blank}}}{T * E * 100 \times 1.0}$$

where:

MDA	=	Minimum Detectable Activity for gross alpha in smears.
BLANK	=	Total counts for an unused smear.
T	=	Counting time in seconds.
E	=	Counting efficiency as a decimal fraction.
100	=	100 cm^2 smear area.
1.0	=	The assumed 100% smear collection efficiency.

The MDA for tritium in smear samples was 0.01 Bq per square centimeter (0.27 picoCuries per square centimeter).

7.5 CONTROL CHARTS

Control charts were used to determine whether the analytical methodology was producing biased or imprecise results. The control chart data are shown in Appendix 5.

8 TASK 1: DETERMINE THE EXTENT OF RADIOLOGICAL CONTAMINATION ON THE SLC GROUND SURFACES

8.1 INTRODUCTION

The primary objective of Task 1 was to determine the extent of radiological contamination of the ground surfaces of the Safety Light site. A secondary objective was to determine if non radiological contamination was present in selected areas of the site.

The methodologies used to conduct the various surveys are explained in Section 5.

The surveys, sampling and analyses performed are shown below.
- The legal survey.
- The Bicron radiation survey.
- The portable gamma spectrometer survey.
- Soil sampling and analyses.

Below is an account of the results of each of the above surveys.

8.2 RESULTS OF LEGAL SURVEY

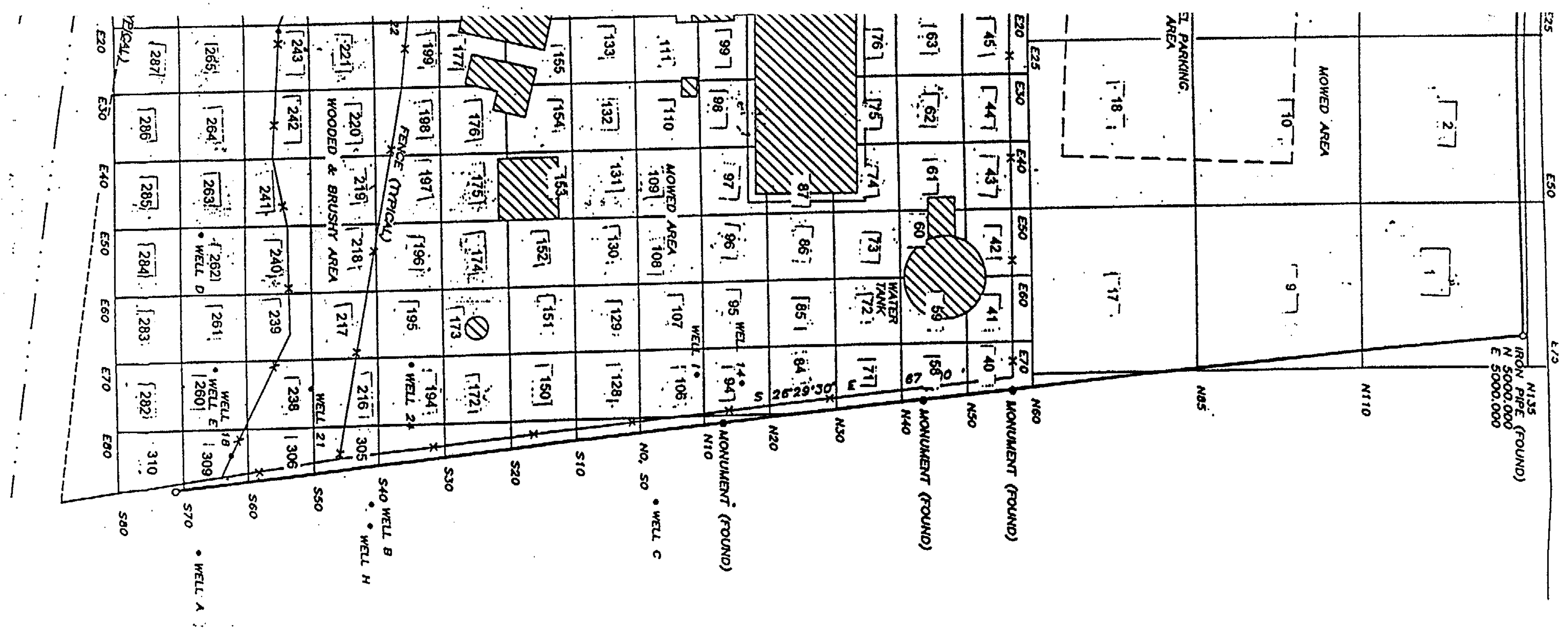
The objective of the outdoor legal survey was to provide the Monserco operational teams with gridded areas to allow them to conduct outdoor radiological surveys and other work in a methodical and reproducible manner.

The legal surveyor gridded the areas as described in Section 5. The surveyor's starting point was south of the Main Building. This was designated the zero point, i.e. the north, south, east and west axes started from here. Starting from the zero point, the surveyor sectioned the grounds into discrete areas, giving each of them a unique latitude (east or west) and longitude (north and south) identifier. Figure 8.1 (in a separate sleeve) shows the drawing provided by the surveyor.

Subsequently, Monserco gave each of the gridded areas a unique number starting with 1 and ending at 310. The numbers 304, 307 and 308 were not used, making the total number of grids 307. Figure 8.2 shows the numbered gridded areas superimposed on a map of the site. For example, grid #1 is a 25 x 25 meter square area at the right hand corner of the site.

FIGURE 8.2

NUMBERED GRIDS SUPERIMPOSED ON A MAP OF THE SLC SITE



The south west corner of grid #1 is the intercept between the grid lines E50 and N110. Grid #1 is therefore designated as E50, N110. This report also uses the notation 50E, 110N.

The Tables in Appendix 6 show the latitude and longitude and the X/Y lengths of each grid. For example, the X length of grid #1 is the horizontal distance of the south/west facing line, i.e. 25 meters. The Y length is the vertical distance of the north/south facing line, i.e. 25 meters. Grid #1 - #23, are all nominal 25 x 25 meter grids since they are on the unaffected parts of the survey site. All of the other grids, i.e. grids #24 to #310 are nominal 10 x 10 meter grids. Some of the dimensions of the grids are fractions of the nominal measurements because of obstructions like buildings and roads. Appendix 6 also shows details of the grid contents for most of the grids which were surveyed using the Bicron radiation meter. For example, with reference to the Tables in Appendix 6, there was grass, but no bushes or trees inside grid #1.

8.3 RESULTS OF BICRON SURVEY

The objective of the radiation survey was to determine which outdoor areas of the site were contaminated.

A radiation survey of about two thirds of the surface area of the SLC site was carried out by Monserco using the methodology described in Section 5. The results are shown in Appendix 7. A total of 262 outdoor grids were surveyed using the Bicron meter. The format of the Tables is explained below.

TABLE 8.1
EXPLANATION OF THE NOTATION USED IN THE TABLES IN APPENDIX 7

COLUMN	EXPLANATION
A	The grid number.
B	The X coordinate of hot spots within the grid.
C	The Y coordinate of hot spots within the grid.
D	The hot spot readings on the Bicron survey meter at 0 meters, i.e. at ground level. Positive readings indicate that radiation fields higher than background were found at the coordinates shown in columns B and C.
E	The hot spot readings on the Bicron survey meter at 1 meter above ground level. Positive readings indicate that radiation fields higher than background were found at the coordinates shown in columns B and C.
F	The average dose rate over the grid in microrem per hour.
G	Comments.

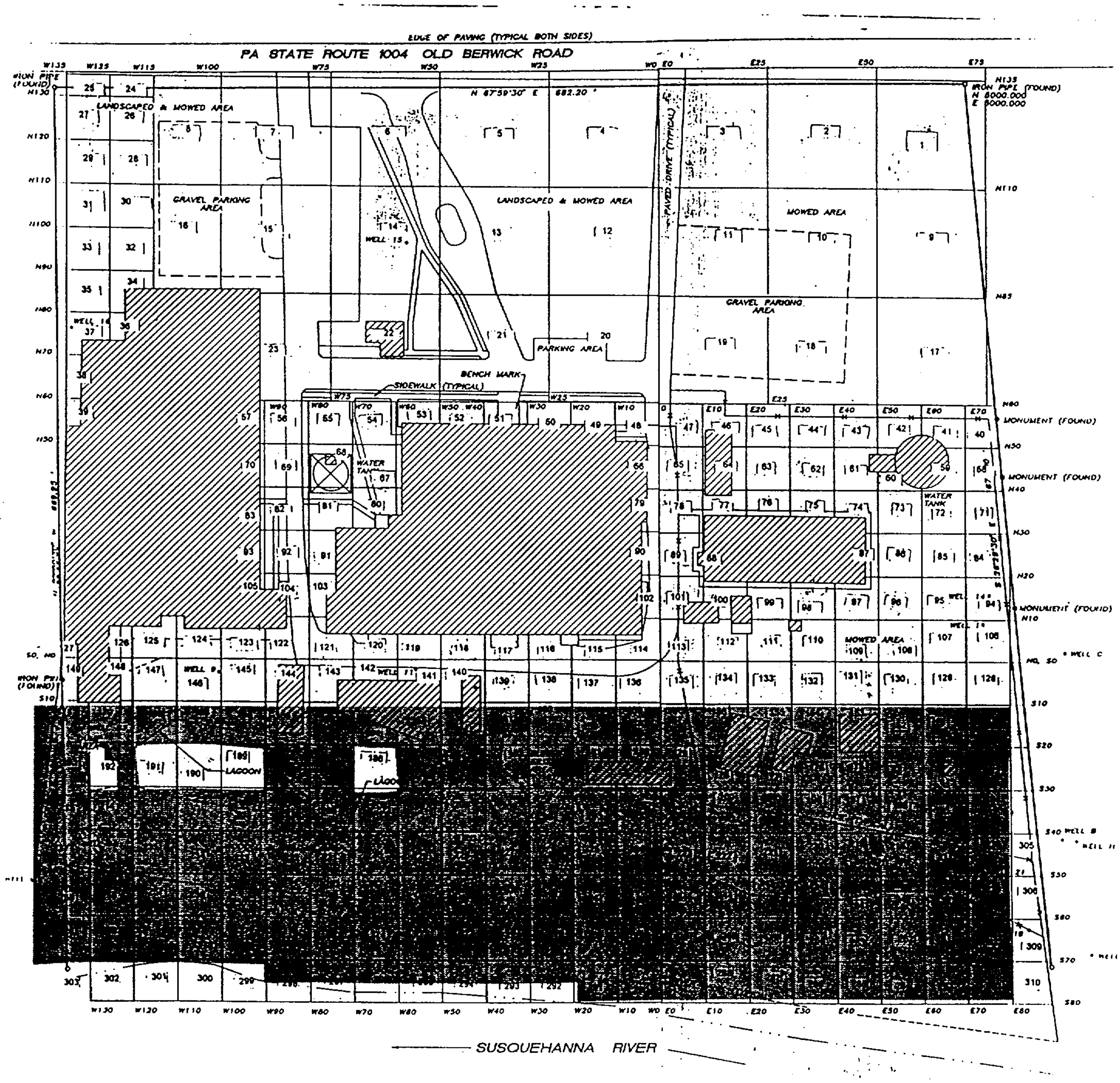
8.4 RESULTS OF PORTABLE GAMMA SPECTROMETER SURVEY

The objective of the gamma spectrometer survey was both to determine which outdoor areas of the site were contaminated and to identify any gamma emitters which were present.

A gamma spectrometer survey of about one third of the surface area of the site was carried out by Monserco using the methodology outlined in Section 5 of this report. The area covered by the gamma spectroscopy survey is shown in Figure 8.3. The survey area can be described as approximately that which is to the south of the Main Building, and includes some of the buildings, the east dump, the east and west lagoons, the underground silos and the wooded areas near the river.

FIGURE 8.3

GRIDS SURVEYED BY GAMMA SPECTROMETRY



The gamma spectrometer output data was processed using a software package titled: Surfer Access Systems 4.15, Golden Software Inc 1990. This software package manipulates the gamma spectroscopy data to produce a series of contour lines. The points with identical values are joined together as a series of isopleths. The positive values are shown as black areas. The advantage of using this software package is that it provides an overview of the areas where radiation/contamination has been found. The disadvantage of this software package is that it distorts the data to show phantom ripples round areas with positive values. The isopleth data should therefore be interpreted with caution and regarded only as a signpost to where the activity was found.

The gamma spectroscopy results are summarized in isopleth form in Figures 8.4 to 8.6 and discussed below.

- Figure 8.4 shows the distribution of Bi-214 at concentrations greater than 1 count per second above background. Bi-214 is a daughter product of Ra-226 which can be inferred from these isopleths. The major Bi-214 concentrations are in the wooded areas south of the lagoons and near the east dump. There are some low concentration Bi-214 peaks throughout the south part of the site.

- Figure 8.5 shows the distribution of Cs-137 at concentrations greater than 1 count per second above background. The black area close to grids #150 and #151 is the garage. The dark area within grid #223 is a log which was found to be contaminated with Cs-137.

- Figure 8.6 shows the distribution of Cs-137 at concentrations greater than 1 count per second above background. This figure is identical to Figure 8.5, except that the Cs-137 contaminated log has been removed.

FIGURE 8.4

DISTRIBUTION OF Bi-214 AT CONCENTRATIONS GREATER THAN 1 COUNT PER SECOND

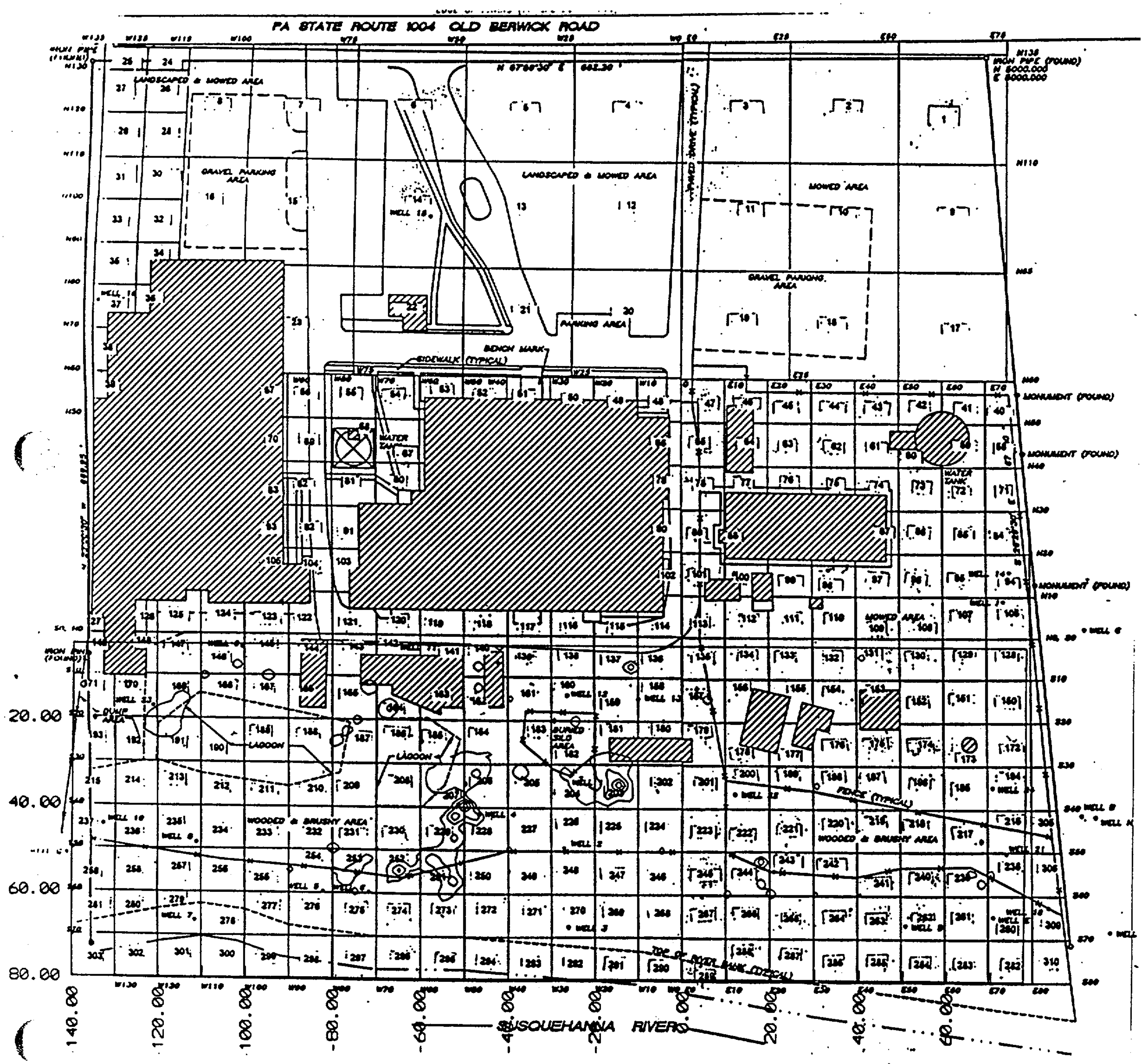


FIGURE 8.5

DISTRIBUTION OF Cs-137 AT CONCENTRATIONS GREATER THAN 1 COUNT PER SECOND (WITH CONTAMINATED LOG INCLUDED)

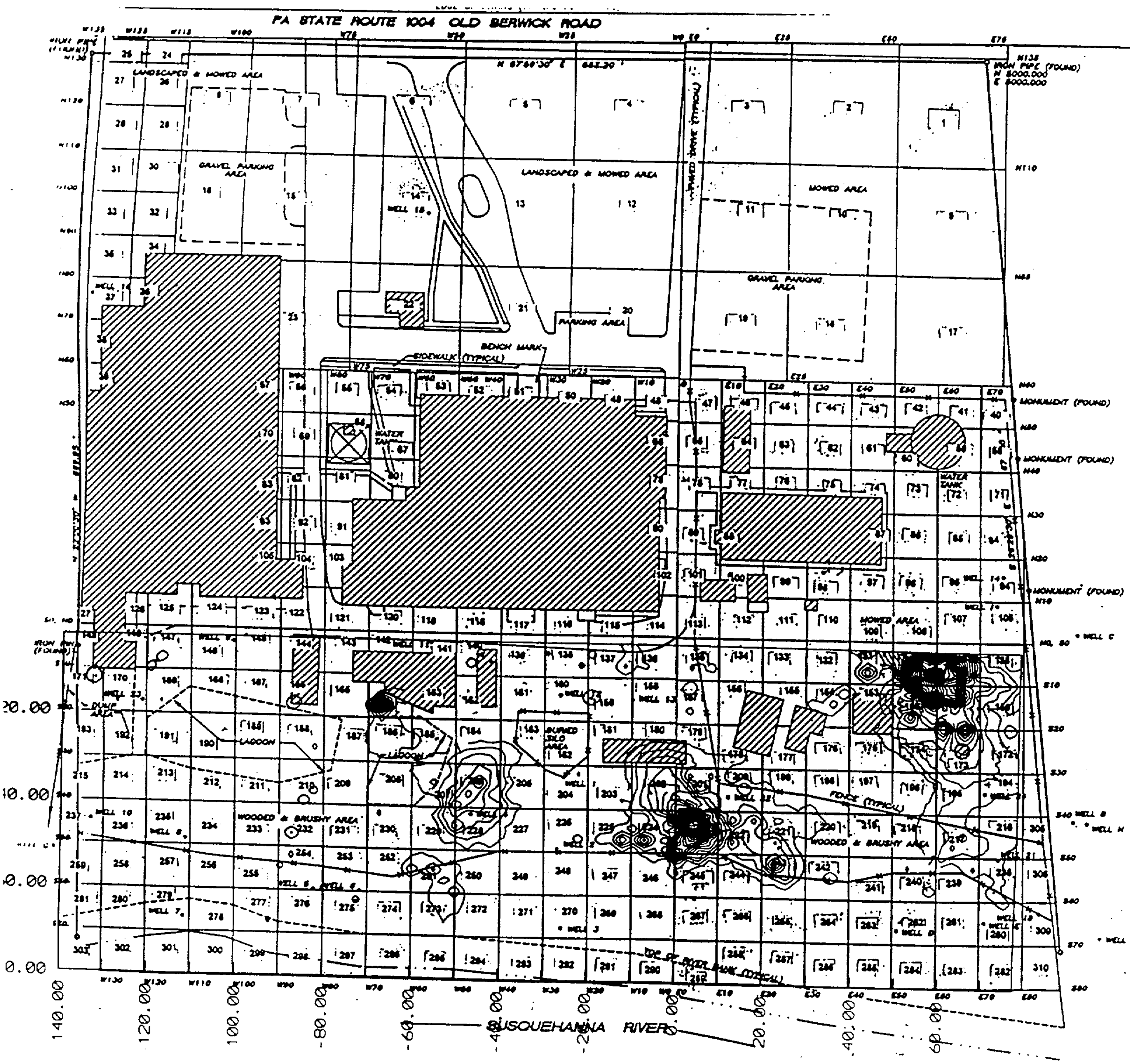
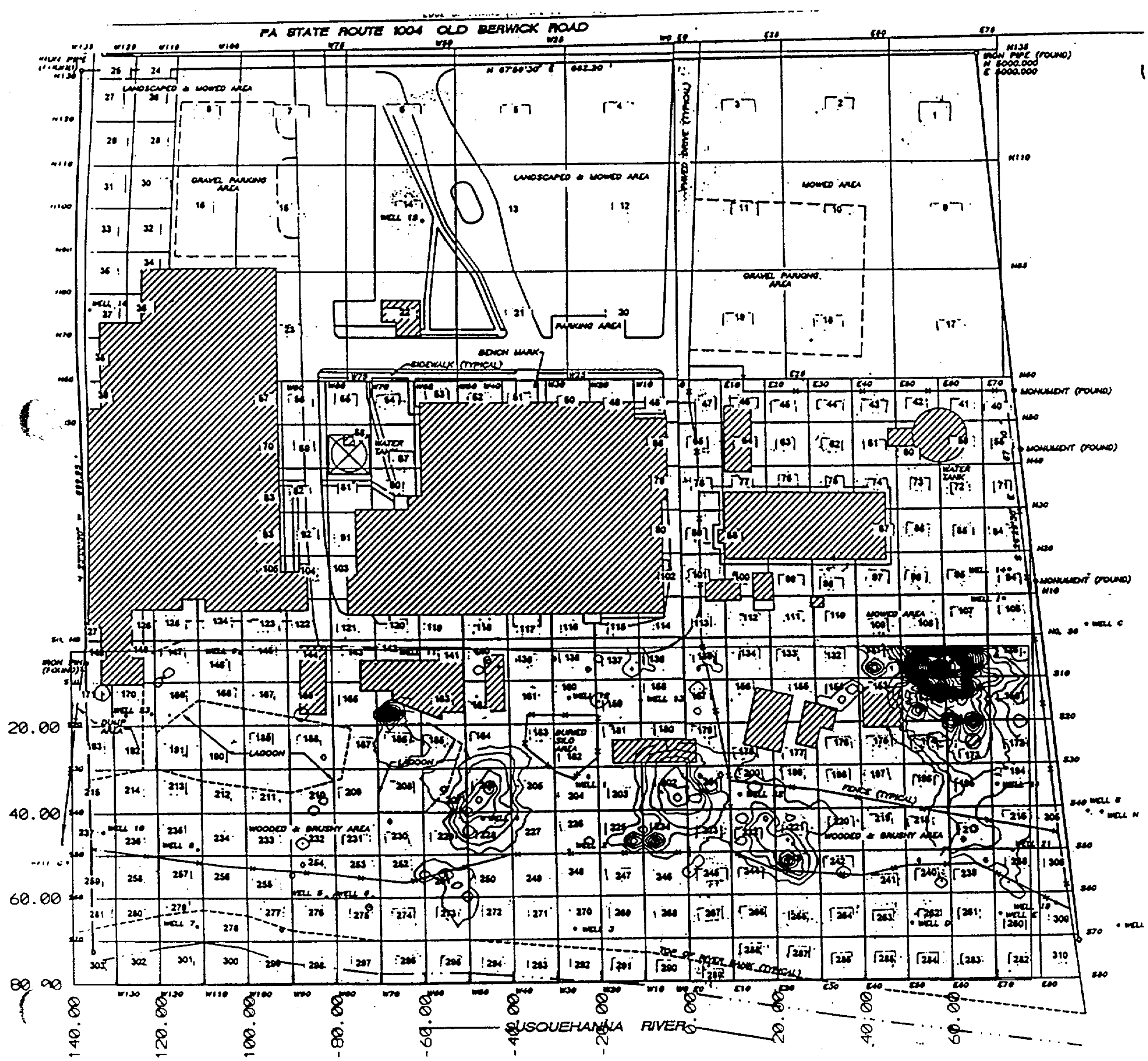


FIGURE 8.6

DISTRIBUTION OF Cs-137 AT CONCENTRATIONS GREATER THAN 1 COUNT PER SECOND (AFTER REMOVAL OF THE Cs-137 CONTAMINATED LOG)



8.5 RESULTS OF RADIOLOGICAL ANALYSES OF SOILS

Soil samples were taken from each grid using the methodology explained in Section 5. The field results are presented in Appendix 8. The format is similar to that used in Appendix 7. Column H represents the HP200 readings at the depths shown in column C. All of these samples were analyzed for gross beta activity and by gamma spectrometry. The results are presented and discussed below.

8.5.1 Analyses of Soils by Gross Beta Counting

The results from analyses of soil samples by gross beta counter are shown in the Tables in Appendix 9. The format of the Tables is explained below.

TABLE 8.2
EXPLANATION OF THE TABLES IN APPENDIX 9

COLUMN	EXPLANATION
A	The sample identification number. The first number is the grid number and the second number is that of the sample taken from that grid.
B	The sample weight in grams.
C	The gross counts on the beta counter.
D	Net counts once the background counts have been subtracted from the gross counts in column C.
E	The activity in picoCuries per gram.
F	Results in this column are positive values.
G	If the sample was analyzed twice, the word "repeat analysis" appears in this column. If the word "duplicate" appears, two samples from the same location were analyzed.

A summary of the information contained in the Tables in Appendix 9 is given below.

- 523 samples were taken of the soil on the SLC site.
- All soil samples were analyzed by gross beta counting.
- 113 results had positive readings above the Minimum Detectable Activity.

The results contained in Appendix 9 are summarized in isopleth form in Figure 8.7.

8.5.2 Analysis of Soils by Gamma Spectrometry

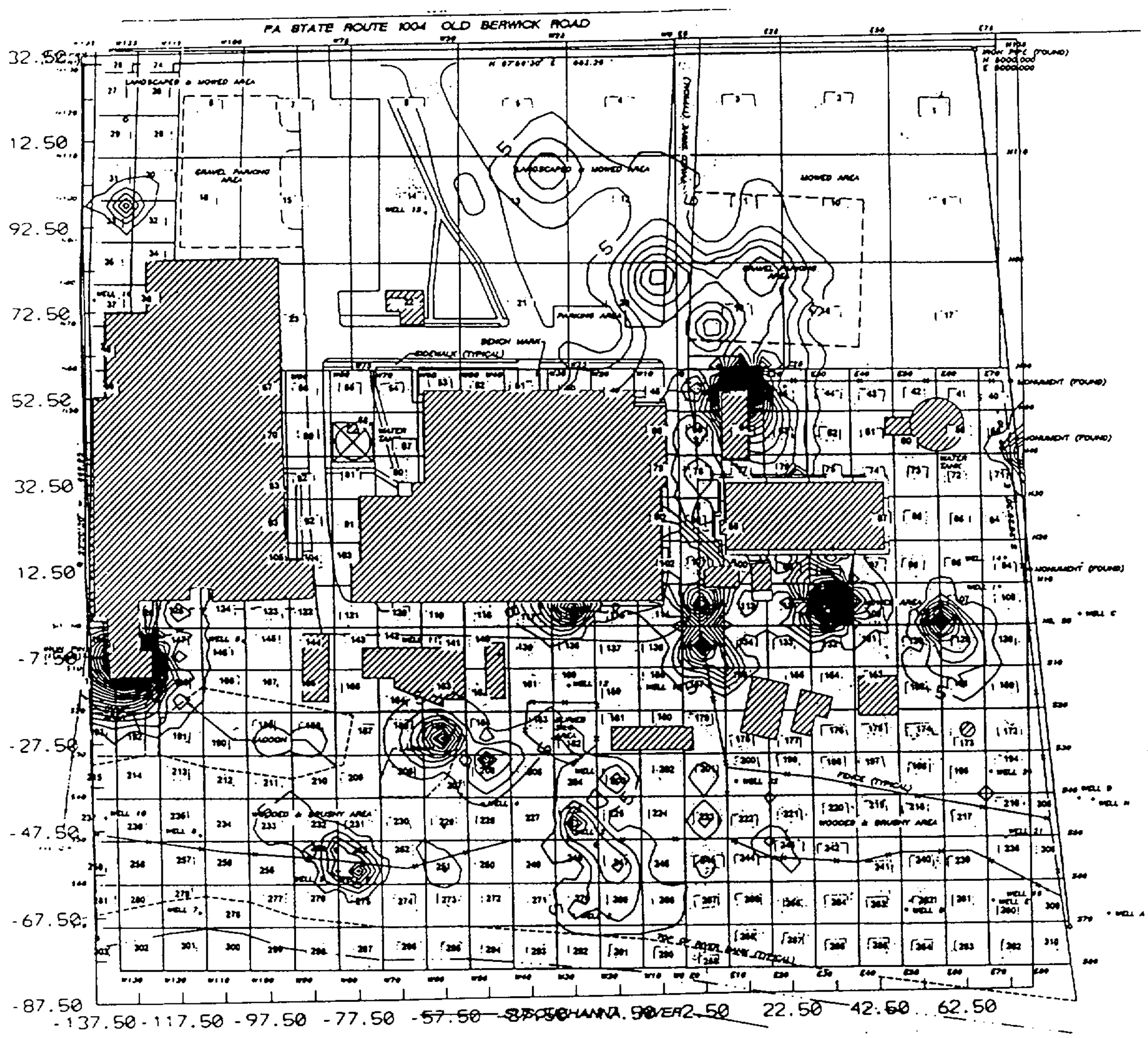
The results of analysis of soil samples by gamma spectroscopy are shown in the Tables in Appendix 10. The format is explained below.

TABLE 8.3
EXPLANATION OF THE TABLES IN APPENDIX 10

COLUMN	EXPLANATION
A	The sample identification number. The first number is the grid number and the second is the number of the sample taken from that grid.
B-G	The activity of the various isotopes in Becquerels per gram of soil.
H	Comment column.
I-N	The activity of the various isotopes in picoCuries per gram of soil. All positive values are recorded here, and those values which exceed current NRC radiological limits are in bold format. The others in italics.
O	A "yes" in this column shows that the values in columns I-N exceed current NRC guideline values.

FIGURE 8.7

BETA SOIL CONCENTRATION ISOPLETH
(Minimum value = 5 pCi/g)
(1 line increment = 5 pCi/g)



8.5.2 Analysis of Soils by Gamma Spectroscopy (Continued)

A summary of the information contained in the Tables in Appendix 10 is given below.

- 505 soil samples were taken from the outdoor grids
- All were analyzed by gamma spectroscopy
- Cs-137, Bi-214, Pb-214, Ra-226 and Am-241 were detected.
- Bi-214 and Pb-214 are taken as an indication of the presence of Ra-226.
- 181 positive Cs-137 results were reported. 61 were above current NRC guideline values.
- 154 positive Bi-214 results were reported. 112 were above current NRC guideline values.
- 94 positive Pb-214 results were reported. 94 were above current NRC guideline values.
- 21 positive Ra-226 results were reported. 21 were above current NRC guideline values.
- 8 positive Am-241 results were reported. 3 were above current NRC guideline values.
- No positive Co-60 results were reported.

The results contained in Appendix 10 are summarized in isopleth form in Figures 8.8 - 8.10.

FIGURE 8.8

Cs-137 SOIL CONCENTRATION ISOPLETH
(Minimum value =15 pCi/g)
(1 line increment = 5 pCi/g)

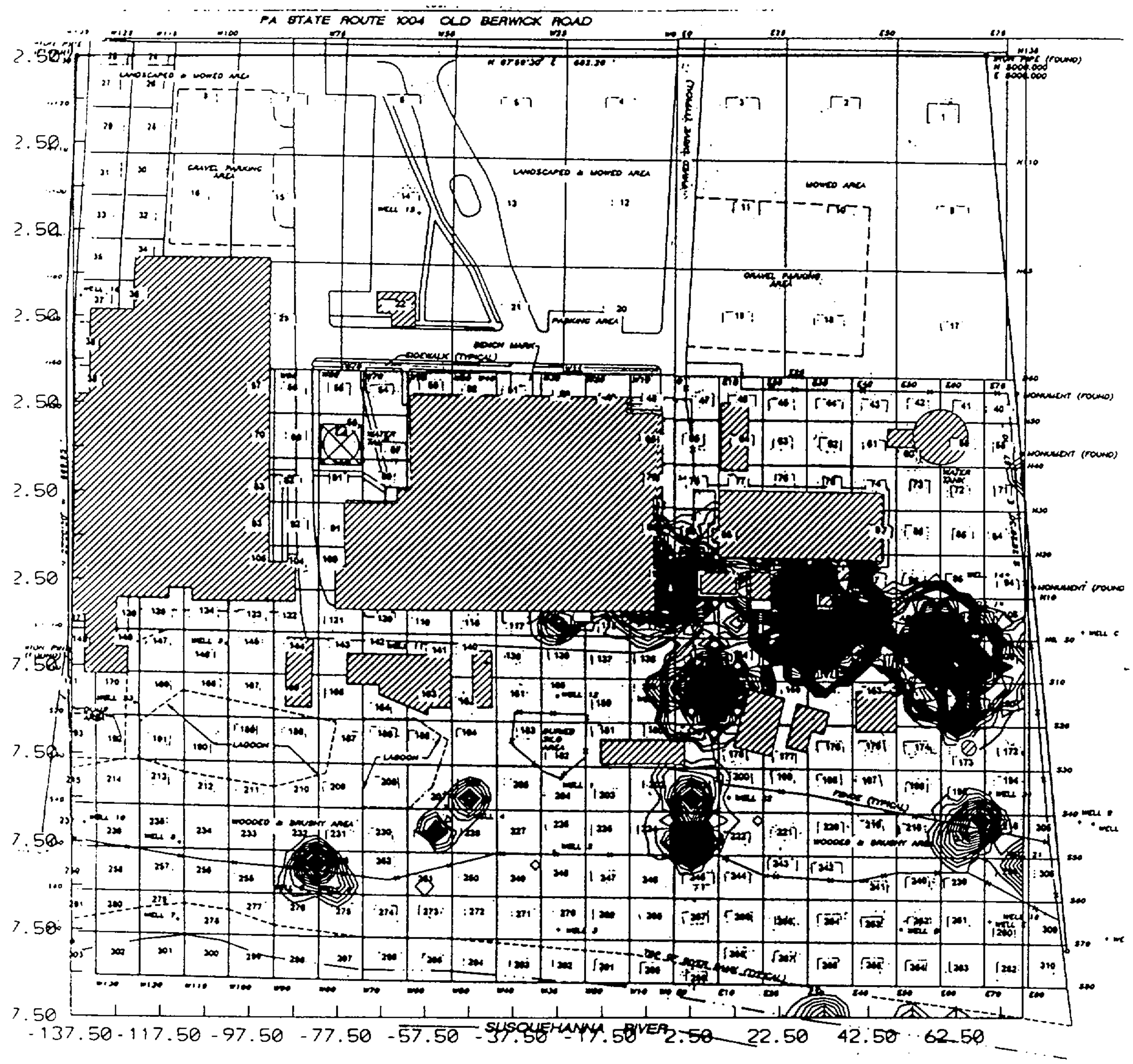


FIGURE 8.9

Bi-214 SOIL CONCENTRATION ISOPLETH
(Minimum value = 5 pCi/g)
(1 line increment = 5 pCi/g)

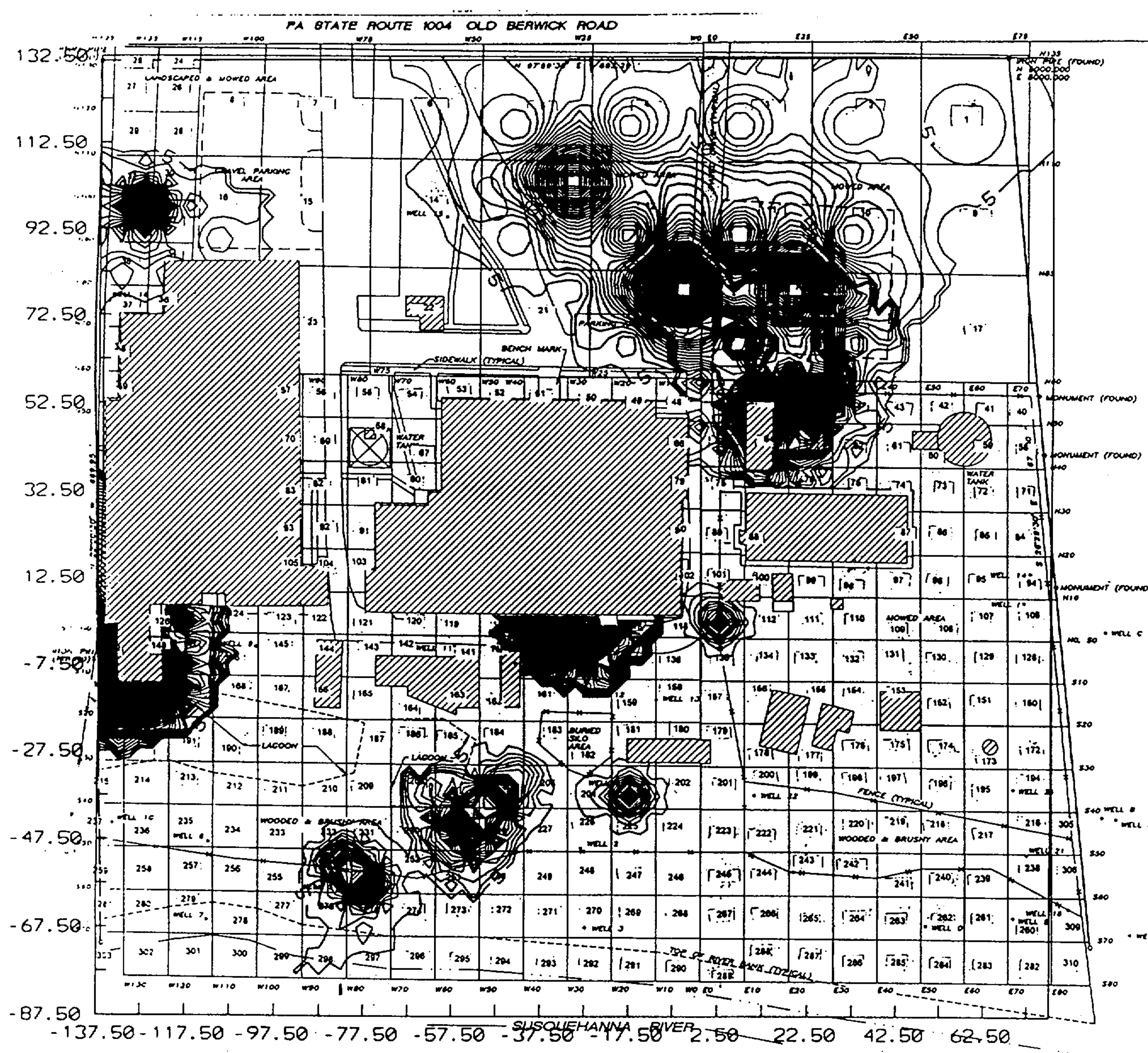
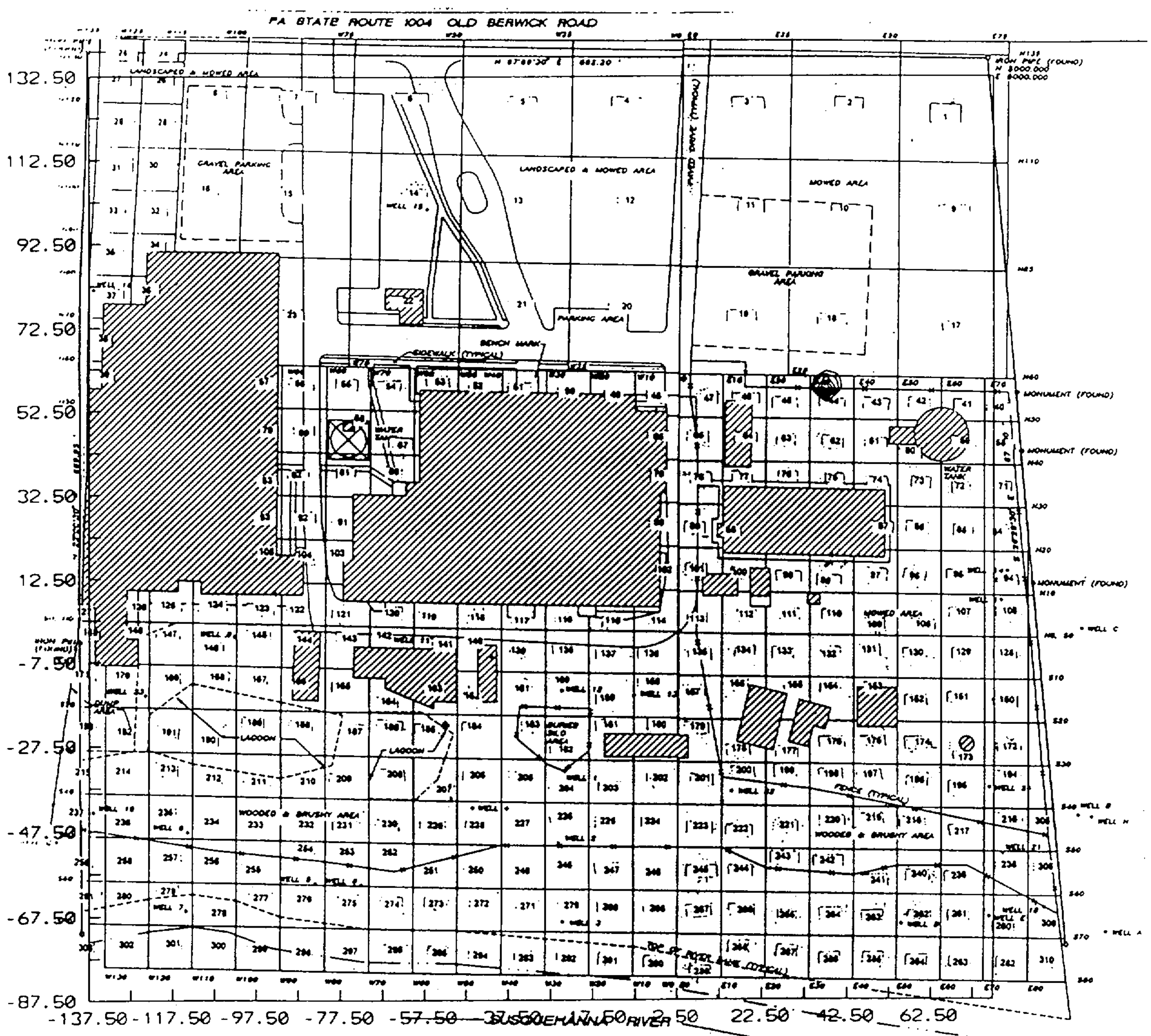


FIGURE 8.10

Am-241 SOIL CONCENTRATION ISOPLETH
(Minimum value = 30 pCi/g)
(1 line increment = 5 pCi/g)



8.6 RESULTS OF NON RADIOLOGICAL ANALYSES OF SOIL

Soils were sampled using the methodology described in Section 5 and analyzed by the Canadian Barringer Laboratories for volatile organic compounds and heavy metals. The locations of the samples are shown below.

TABLE 8.3
LOCATION OF SAMPLES TAKEN
FOR NON RADIOLOGICAL ANALYSES

SAMPLE TITLE	GRID #
Behind Lagoon	230
East Lagoon	207
Loading Dock	115
Side Wall	139
Side Wall Duplicate	139
Behind Lacquer Storage Building	202
Canal	220
Beside Well 7	161

Appendix 11 shows the Barringer report for volatile organics and heavy metals in the soil samples provided by Monserco.

Volatile Organics: 5 samples were provided. The only sample which showed positive results was the soil sample from the loading dock. The organics reported in the loading dock sample were 1,1,1- Trichloroethylene, Toluene, Tetrachloromethane, meta-Xylene/para-Xylene and ortho-Xylene.

Hydrocarbons: One Sample titled "Behind the Lacquer Storage Building" was analyzed for organics. This had 461 micrograms of total extractable hydrocarbons per gram of soil. It is reported as being the equivalent of a heavy oil.

Heavy Metals: Four samples were analyzed for heavy metals. Values in excess of 1000 parts per million heavy metal values were obtained for the elements shown below.

- aluminum
- calcium
- iron
- magnesium
- phosphorus
- zinc

Of the four samples analyzed the sample from the loading dock had the highest concentrations of silver, barium, calcium, cadmium, chromium, copper, iron, magnesium, molybdenum, nickel, phosphorus, lead, strontium, titanium, vanadium, and zinc.

8.7 SUMMARY AND CONCLUSIONS

8.7.1 Radiological Contamination

The extent of radiological contamination of the ground surfaces of the Safety Light site was determined using both portable survey instrumentation and also sampling and analyses of soils taken from the SLC grounds..

Approximately two thirds of the grounds were surveyed using the Bicron radiation meter. The results provided evidence of radiation fields within those grids shown in Appendix 7. The radiation fields were identified either as hot spots or higher than average background radiation. The hot spots are interpreted as contamination of the soil within the grid. The high background readings could be from contamination within the grid or shine from neighboring grids. The Bicron survey technique was not capable of providing isotopic information.

Approximately one third of the grounds were surveyed using a portable gamma spectrometer. The results provided evidence of three gamma emitting parent radionuclides (Cs-137, Ra-226 and Am-241), within the grids shown in Figures 8.4 to 8.6. The principal gamma emitters were Cs-137 and Ra-226 with small amounts of Am-241. The peak used to track Ra-226 was the Bi-214 daughter.

Up to 5 soil samples were taken from each grid on the SLC site. The samples were analyzed by gamma spectrometry and by gross beta counting. The gamma spectrometry results shown in Appendix 10 and Figures 8.8 to 8.10 provided evidence of three gamma emitting parent radionuclides: Cs-137, Ra-226 and Am-241. Reasonable visual correlation was obtained between the isopleths from the soil analyzes and from gamma spectrometry. Reasonable visual correlation was obtained between the isopleths from the gross beta counts and the Cs-137 and Bi-214 gamma spectrometry results.

8.7.2 Non Radiological Contamination

The extent of non radiological contamination of the ground surfaces of the Safety Light site was determined by sampling and analyses of a small number of samples taken from the SLC grounds. Evidence was found for volatile organics, hydrocarbons and heavy metals. The sample taken from the loading dock had the highest concentration of heavy metals.

9 TASK 2: DETERMINE WHETHER RADIOACTIVE CONTAMINATED ITEMS ARE BURIED UNDER THE SLC GROUNDS

9.1 INTRODUCTION

The purpose of Task 2 was to determine whether radioactive contaminated items were buried under the SLC site.

Historical evidence indicates that the areas of the SLC site were used for temporary storage of large items. For example, Figure 9.1 (thought to be taken in the 1950s) shows large objects inside excavated areas of the abandoned canal. The dump at the west end of the site was used for temporary storage of contaminated items. These were later removed and disposed.

Electromagnetic and ground penetrating radar surveys were carried out to determine whether buried or surface metallic objects existed on the site. In addition, the radiation surveys, gamma spectrometer measurements and soil surveys indicated which of these areas contained radioactivity. In discussion with SLC and NRC, specific areas were chosen for further investigation by excavation.

Details of the methodologies used for Task 2 are given in Section 5 of this report.

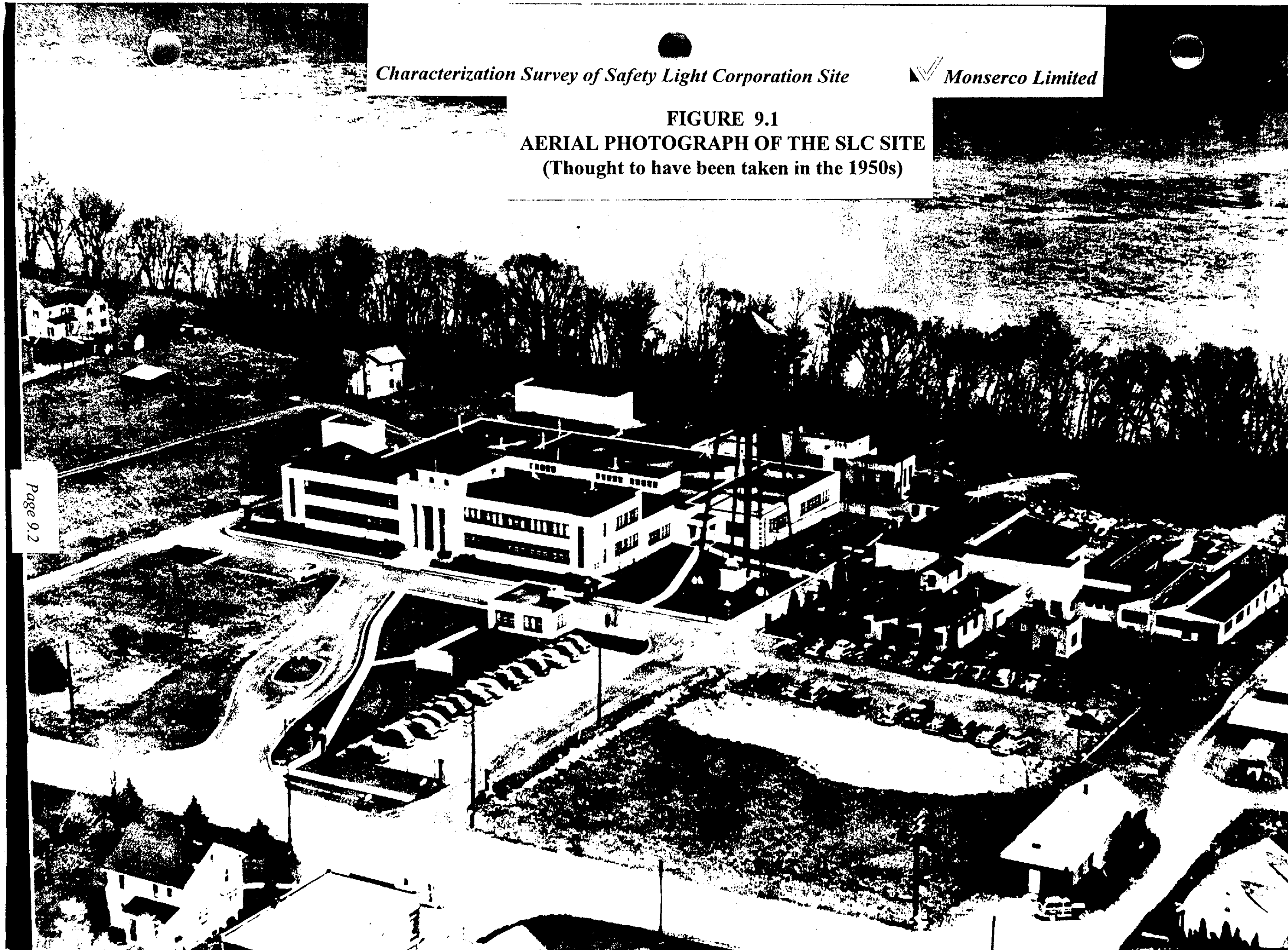
9.2 RESULTS OF ELECTROMAGNETIC SURVEY

The electromagnetic (EM) survey was conducted during June 1995. The report provided by the contractor is shown in Appendix 12 and summarized below.

EM31 surveys were conducted over all the outdoor gridded areas established by the legal surveyor. Survey lines for the EM31 were established, using the existing legal surveyor's grids. The grids were 2.5 meters apart along the west-east direction of the site and 5 meters apart in the most southerly portion of the property.

EM61 surveys were conducted only in specific areas of the site. The EM61 survey lines were laid out 0.5 meters apart. The EM61 survey readings were collected using an opto-counter at 19.3 cm intervals between data points. The very narrow line separation and fine spacing between readings resulted in excellent resolution of the computer generated maps.

FIGURE 9.1
AERIAL PHOTOGRAPH OF THE SLC SITE
(Thought to have been taken in the 1950s)



The EM61 survey was conducted to provide complementary information to the EM31 survey and to provide additional information to resolve any ambiguities or anomalies in the EM31 data. The specific areas covered by the EM61 survey are shown below.

- The fenced area of the underground silos.
- North of silos where an underground storage tank was detected by the EM31 survey.
- Two asphalt-paved driveways adjacent to the Main Building.

Approximately thirty-three thousand data points were used in the preparation of final site interpretation maps. Thirty thousand of these were measured with the EM31 survey meter and three thousand were measured with the EM61 survey meter.

EM31: The EM31 survey results are shown in Appendix 12. The EM31 survey revealed relatively uniform distributions of soil conductivity within the surveyed property. Values of measured conductivities were relatively low, especially in the northern portion of the surveyed area. The conductivities were interpreted as indicating coarse to medium grain sandy soil material. Soil conductivity values increased (but not significantly) southward. which may be associated with shallower ground water level near the Susquehanna River. Three areas of elevated soil conductivity and anomalies associated with buried metallic objects were detected.

EM61: The EM61 survey results are shown in Appendix 12. The results indicated buried pipes adjacent to the underground storage tank and also that the silo tanks could be different in size.

9.3 RESULTS OF GROUND PENETRATING RADAR SURVEY

The ground penetrating radar (GPR) survey was carried out on September 5, 1995, to obtain a profile of the subsurface conditions in two main areas. Area 1 was in the accessible parts of the west dump. Area 2 was to the south of the Liquid Waste Building. The latter had produced anomalous results when surveyed using the EM31 survey meter and the GPR survey was used to try to resolve these anomalies. At the request of SLC management GPR was also used to locate underground discharge pipework from the Liquid Waste building. The GRP survey contractor emphasized that the GPR survey was completed using standard and routinely accepted practices of the geophysical industry. It was necessary to recognize that site-specific conditions could have obscured subsurface objects of interest. The report provided by the contractor is shown in Appendix 13 and summarized below.

Area 1: Area 1 was located in the west dump area and had a surface area of approximately 900 square feet. About 10% of the west dump area was surveyed. The area surveyed within the west dump (located south west of the Acid Etching Building) was thought to have been used previously for disposal of radium dials. GPR reflections, characteristic of metallic objects/drums were observed primarily on the north, east and west sides of area 1. Fewer GPR reflections characteristic of metallic objects were observed on the south side of the dump. Several GPR scans were attempted on the actual dump area; however the presence of surface metallic debris interfered and limited the effectiveness of the GPR in this area. About 10% of the west dump surface area was surveyed. The GPR survey showed that there were small metallic objects (typically with diameters of several inches) below the ground surface, to a depth of about 10 feet. The GPR survey did not show any large buried metallic objects. It is possible that the base of the canal was identified by the survey.

The survey findings were consistent with the understanding of SLC staff that drummed waste had never been buried in the west dump. SLC staff indicated that the dump had been used in the past for burial of radium dials and that a large number of the dials had subsequently been retrieved and put into 55 U.S. gallon drums. The verbal recollection from SLC staff was that about seventy 55 U.S. gallon drums had been filled up with material (including dials) from the dump. Some of these dials might still be buried in the dump.

Area 2: Area 2 was located over a small surface depression adjacent to the south side of the Liquid Waste Building. A surface area of approximately 50 square feet was scanned with the GPR in this area. GPR reflections characteristic of metallic objects/drums were observed near the north-central part of area 2. The anomalies were estimated at 6 to 8 feet below grade level and approximately 3 to 4 feet wide. Although no absolute identification of metallic drums was possible. buried objects in area 2 had GPR reflections characteristic of metallic drums.

9.4 RESULTS OF EXCAVATIONS BY BACKHOE

Excavations by backhoe were carried out according to the procedure shown in Section 5. A video recording of the excavations was made.

Grid No. 221: Six parallel trenches (numbers 1-6) were excavated inside grid no. 221, located to the west of the SLC site. The orientation of the trenches was approximately from north to south. The dimensions of each trench were approximately 8 to 10 feet long, 3 to 4 feet wide and about 5 feet deep.

Trench No. 1: The excavations revealed slab rock at a depth of approximately 5 feet. Since bedrock was not expected at this depth, it was conjectured at the time that the slab rock could have been the bottom of the abandoned canal.

Trench No. 2: A drum ring and a curved metal plate were found inside trench no. 2. Neither of these objects were radioactive. These metals could have been the cause of the EM signals which indicated buried objects at this location.

Trench No. 3: Glass was found at a depth of 5 feet.

Trench No. 4: No objects were found inside trench 4.

Trench No. 5: No objects were found inside trench 5.

Trench No. 6: No objects were found inside trench 6.

Grid No. 240: Two parallel trenches (numbers 7-8) were excavated inside grid no. 240, located to the east of the SLC site. The orientation of the trenches was approximately from north east to south west. The dimensions of each trench were approximately 15 feet long, 3 to 4 feet wide and about 5 feet deep.

Trench No. 7: No objects were found inside trench 7.

Trench No. 8: No objects were found inside trench 8.

The Table below summarizes the findings of the excavations, including the excavation depth, the contamination and dose rate readings at the depth excavated and any objects uncovered.

TABLE 9.1
SUMMARY OF EXCAVATIONS OF SELECTED AREAS ON THE SLC SITE

No.	DEPTH (Feet)	HP260 READINGS (cps)	DOSE RATES AT DEPTH (μrem/h)	COMMENTS
1	5	Not taken.	10	Flat rock (canal bottom?) at depth of 5 feet.
2	2	Not taken.	10	Drum Ring found (not contaminated)
	3	2.3	5	Curved metal plate found at 4 feet (not contaminated).
	5	1.5	6	
3	1	Not taken.	12	
	4	2.5	30	
	5	2.3	50	Glass found at 5 ft.
4	3	1.5	130	
	5	6.0	120	
5	3	2.0	9	5 cps on south end of the trench on ground surface.
	5	2.0	50	
6	5	1.2	15	
7	5	1.8	12	
8	5	3.5	30	

9.5 SUMMARY AND CONCLUSIONS

The EM31 and EM61 electromagnetic surveys showed that metallic objects were present on the SLC site, but the techniques did not give unequivocal information on either the depths of apparent buried objects or their dimensions. Visual examination of the areas that were excavated by backhoe showed that metallic objects were present at surface level. Only two metal objects were found under the surface by backhoe excavation. Neither of these was radioactive.

The ground penetrating radar (GPR) survey of the west dump indicated possible small metallic objects (typically about several inches in diameter) below the ground surface, to a depth of about 10 feet. SLC staff indicated that the dump had been previously used for disposal of radium dials, but a large number of these had been dug up and put into 55 U.S. gallon drums. The verbal recollection of SLC staff was that about seventy 55 U.S. gallon drums had been filled up with material from the dump. SLC staff postulated that some of these dials could still be inside the dump. The ground penetrating radar survey did not show any large buried items, for example, 55 U.S. gallon drums under the soil surface. The findings were consistent with the recollections of SLC staff who indicated that drummed waste had never been buried in the west dump. It was concluded that no buried drums of waste were inside the areas surveyed.

The main conclusions relating to Task 2 are presented below.

- Excavations of selected areas of the SLC site did not reveal the presence of buried radioactive items.
- The electromagnetic survey results were consistent with surface metallic objects rather than buried objects.
- The ground penetrating radar survey showed that small metallic objects (thought to be radium dials) could be buried inside the west dump.
- The ground penetrating radar survey did not indicate buried drums inside the west dump.

10 TASK 3: GAIN ACCESS TO THE TWO UNDERGROUND SILOS AND OBTAIN INFORMATION ON THEIR CONTENTS

10.1 INTRODUCTION

Two underground silos on the SLC site had been used in the 1950s for disposal of materials surplus to requirements. Both silos are adjacent to one another at the south end of the site. Detailed records of the construction were not available, but present and past SLC staff speculated that the construction might be similar to that of the existing metallic above ground silo located in grid #173. If this speculation is correct, the underground silos consist of metal tanks, either with no base or with a metal or concrete base. Details of the construction of the tops of the silos were unknown. It was speculated that the lid consisted of concrete, with metal reinforcement bars or layers of metal between layers of concrete and wood. Materials surplus to requirements were probably put into the silos via a trap door at the top.

The Monserco Characterization Working Document discussed the silos but the contract between Monserco and SLC did not include penetration of the silos and examination of the silo contents. The discussions with SLC and NRC made Monserco aware that there was very little information on the contents of both silos. There was also growing concern regarding the integrity of the structure of the silos. These concerns resulted in Monserco including in their work schedule the penetration of both silos and where possible, the examination of the contents of the silos.

Commercial Coring/Sawing of Philadelphia was contracted to penetrate and visually inspect both the East and West Silos. Staff from Monserco and Egmond Geospheric Associates Ltd. supervised and supported the work. Details of the methodologies used for Task 3 are given in Section 5.

10.2 PENETRATION AND EXAMINATION OF THE CONTENTS OF THE EAST SILO

Penetration of the East Silo: The East Silo (grid #182) was penetrated during September 1995 using the drilling methodology described in Section 5. Penetration was achieved by drilling an 8 inch diameter hole through 1 foot 8 inches of concrete. No metal plates or reinforcement bars were found, indicating either that metals were never present or that the testhole penetration was through the former hatch in the East Silo roof.

Visual Inspection of the East Silo: The contents of the East Silo were visually inspected using a small Mitsibushi optical fibre camera. The camera with light attachment was placed down the penetration hole into the East Silo. The camera was moved both vertically and horizontally to view the silo contents. A video of the findings was made during the inspection. The verbatim transcript of the video sound commentary is reproduced in Appendix 14. A summary of the results is provided below.

- About 1 foot 8 inches of concrete had to be drilled to obtain access to the East Silo. The drillers expressed the opinion that concrete had been poured over the existing lid to seal the silo. Discrete boundaries had probably not been established when pouring the lid concrete and this could mean variable concrete thicknesses over the silo top.
- The metal top of the tank was discernible. The metal was thin and corroded in places and holes in the metal were visible.
- A vertical wall of the tank was discernible.
- Crystalline material was evident inside the tank. The driller reported that its colour was green but the colours are not clear in the video recording.
- The impression gained from the orientation and position of the crystalline material was that recrystallization had probably taken place. One possible mechanism would involve dissolution of some of the silo contents and evaporation of the dissolving medium leaving crystalline material on the surfaces of objects.
- The crystalline material was reported by the driller to glow in the dark when the camera light was switched off. This was not obvious from the video recording.
- Loose dials and sheets of dials were found inside the East Silo. These were almost certainly radium dials.
- TIMEX watch dials were found inside the East Silo.
- Glass jars and a bottle were found down the East Silo.
- Objects that resembled deck markers were found inside the East Silo. (Deck markers used Sr-90 to activate the phosphor.)
- The date "1957" was written on the lid of a container. The full text was difficult to read but could have been "August 14, 1957". This means that the East Silo was still operational during 1957.
- The objects at the top of the East Silo were within about 1 foot from the bottom of the concrete lid.
- A box was found inside the East Silo.
- Evidence of voidage was found inside the East Silo. This is consistent with loose objects rather than containerized materials being place in the silo and could be indicative of materials settling within the silo. The silo may not have been completely filled during its operational lifetime.

Radiological Measurements of the East Silo: Contamination was found on the concrete lid of the East Silo. The exit water from the coring bit lubricant was contaminated.

10.3 PENETRATION AND EXAMINATION OF THE CONTENTS OF THE WEST SILO

Penetration of the West Silo: The West Silo (grid # 183) was penetrated during September 1995 using the drilling methodology described in Section 5. The day before the silo lid was penetrated, an unsuccessful attempt was made to drill through the concrete.. The drilling was stopped when it was thought that the drilling hole was not above the silo. Penetration was eventually achieved by drilling an 8 inch diameter hole through 3 feet 4 inches of concrete. No metal plates or reinforcement bars were found, indicating either that metals were never present or that the testhole penetration was through the former hatch in the West Silo roof.

Visual Inspection of the West Silo: The contents of the West Silo were visually inspected using the Mitsibushi camera with light attachment in a similar manner to that described above for the East Silo. A video of the findings was made during the inspection. The verbatim transcript of the video sound commentary is reproduced in Appendix 14. A summary of the results is provided below.

- About 3 feet 4 inches of concrete had to be drilled to obtain access to the West Silo. The drillers expressed the opinion that concrete had been poured over the existing lid to seal the silo. Discrete boundaries had probably not been established when pouring the lid concrete and this could mean variable concrete thicknesses over the silo top.
- Crystalline material was evident inside the tank. The driller reported that its color was green but the colors are not clear in the video recording.
- The impression gained from the orientation and position of the crystalline material was that recrystallization had probably taken place. One possible mechanism would involve dissolution of some of the silo contents and evaporation of the dissolving medium leaving crystalline material on the surfaces of objects.
- Glass jars, broken glass and a bottle were found down the West Silo.
- Evidence of voidage was found inside the West Silo. This is consistent with loose objects rather than containerized materials being place in the silo and could be indicative of materials settling within the silo. The silo may not have been completely filled during its operational lifetime.

Radiological Measurements of the West Silo: Contamination was found on the concrete lid of the West Silo. The exit water from the coring bit lubricant was contaminated.

10.4 SUMMARY AND CONCLUSIONS

Access was gained to both the East and West Silos during September 1995. Photographs of some of the operations are shown in Figures 10.1 to 10.4. A drawing indicating the possible configuration of a silo was provided by Egmond Geospheric Associates Ltd. and is shown in Figure 10.5. The contents of the silos were visually inspected using a small Mitsibushi optical fibre camera The camera with light attachment was placed down the penetration hole into the silos. The camera was moved both vertically and horizontally to view the contents of the silos. The verbatim transcript of the video sound commentary is reproduced in Appendix 14. The main conclusions of Task 3 are summarized below.

- The silo concrete had been poured rather than set and was up to 40 inches thick in places.
- No evidence was found for steel reinforcement bars or steel plates within the silo lid.
- The concrete silo lids were contaminated.
- The metal top of the East Silo tank was discernible. The metal was thin and corroded in places and holes in the metal were visible.
- A vertical wall of the East Silo tank was discernible. This looked like thin corrugated steel.
- TIMEX watch dials were found inside the East Silo.
- The list of items found inside both silos included watch dials, jars, bottles, broken glass, and a box.
- The date "1957" was written on an item inside the East Silo.
- Evidence for recrystallization inside both silos was found, indicating that the internal environment had previously been moist.
- Loose items rather than packaged items had been placed inside the silos.

FIGURE 10.1
PHOTOGRAPHS OF SILO SAMPLING OPERATIONS

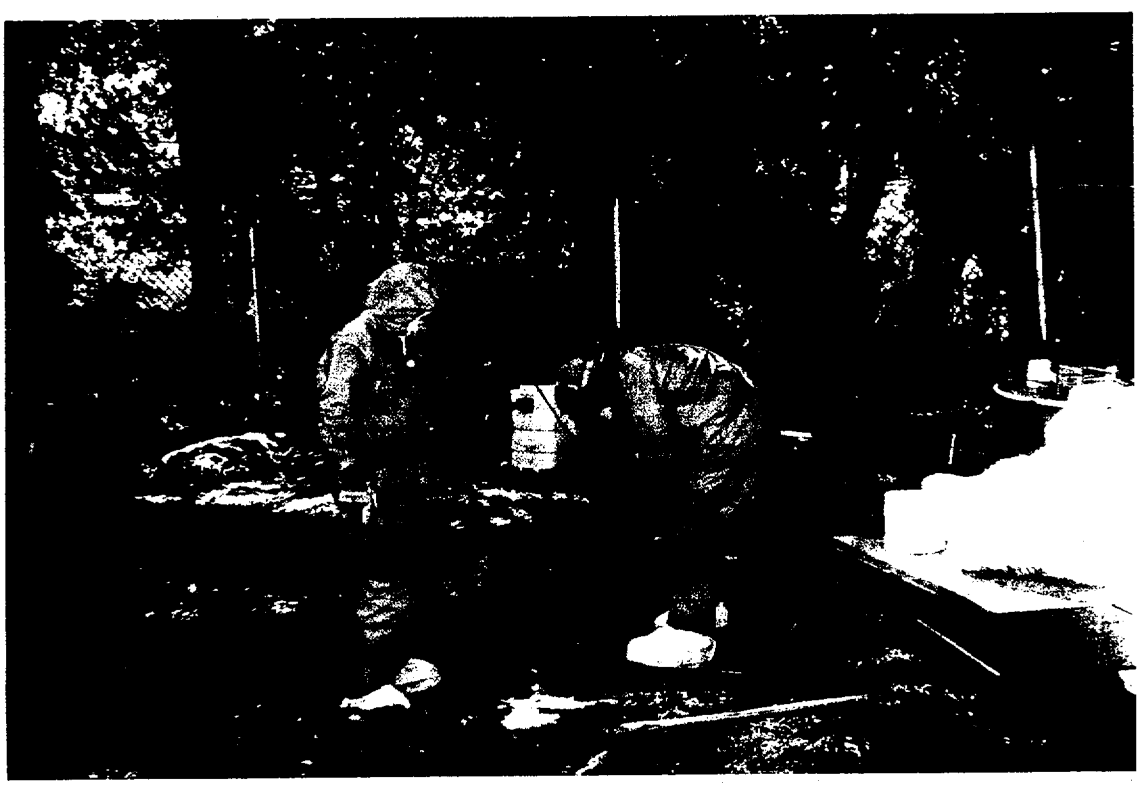
Pulling up split,spoon sampler.

Removing sample from split spoon.

FIGURE 10.2

Shows equipment used to get into
the Silo.

PHOTOGRAPHS OF SILO PENETRATION OPERATIONS



Filling silo drilling hole
after removal of samples

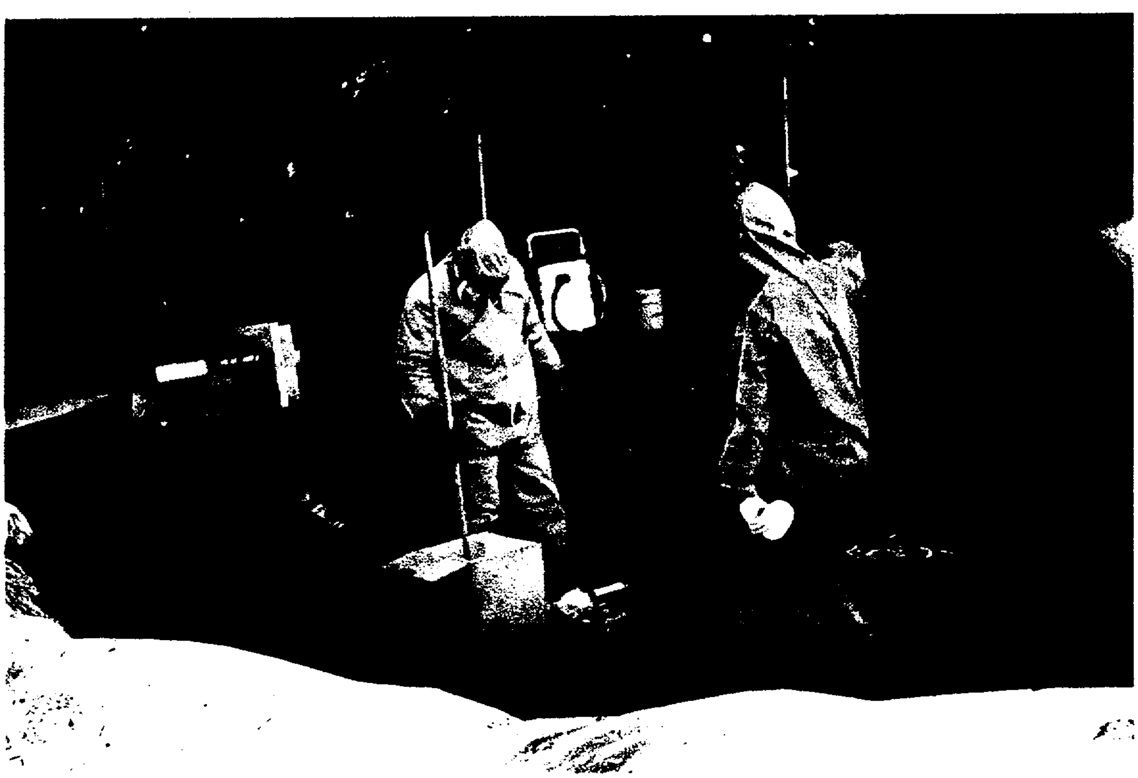
FIGURE 10.3
PHOTOGRAPHS OF SILO DRILLING OPERATIONS

Drilling well in south of east Silo.

Drilling for a core sample.

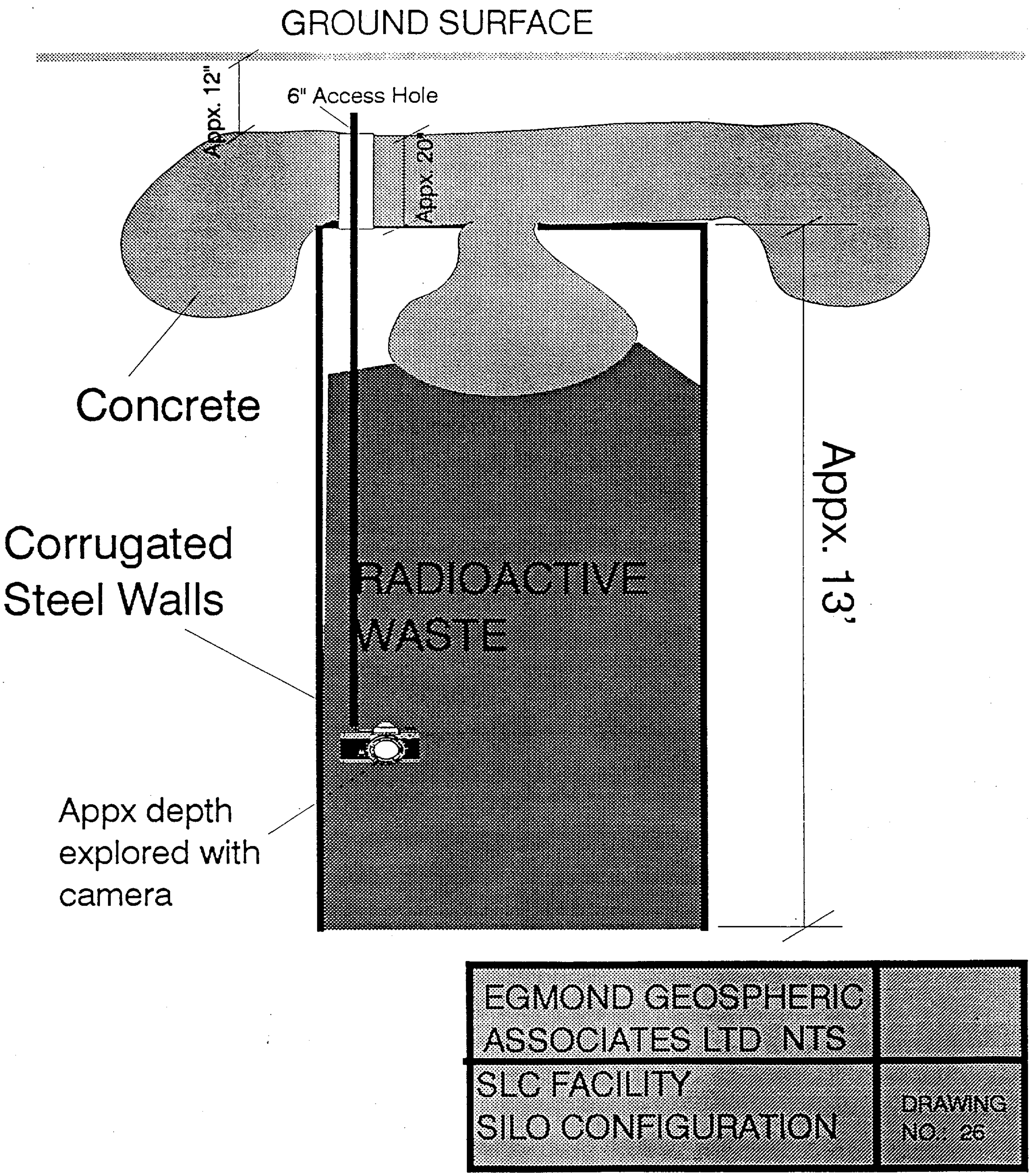
FIGURE 10.4
PHOTOGRAPHS OF SILO CORING AND SAMPLING OPERATIONS

This is a cement core taken from the top of the west Silo.



Taking a solid sample from within the Silo.

FIGURE 10.5
A POSSIBLE CONFIGURATION OF A SILO



11 TASK 4: SINK NEW BOREHOLES AND WELLS ON THE SLC SITE AND SAMPLE AND ANALYZE THE SUBSURFACE SOILS AND WATERS

11.1 INTRODUCTION

The primary objective of Task 4 was to drill new boreholes and sink new wells at various locations on the SLC site and assess the radiological condition of both the subsurface soils and waters. A secondary objective was to assess the non radiological status of the subsurface soils and waters.

The main purpose of drilling additional boreholes was to allow soil measurements and samples to be taken at varying depths. This would provide information on the radiological condition of the grounds as a function of depth. The main purpose of establishing additional wells was to allow water samples to be taken and provide information on the radiological condition of the subsurface waters.

Task 4 is complementary to Task 1: *"The determination of the extent of radiological contamination on the SLC ground surfaces and non radiological contamination on selected areas of the site"*. Task 1 provides information relating to surface soils and waters, whereas Task 4 provides similar information but in relation to subsurface soils and waters.

Prior to the Monserco characterization, 25 boreholes/wells existed on the site. After discussion with SLC and NRC, Monserco agreed to establish an additional 13 boreholes on the site and to convert each of these into wells. The intention was to establish boreholes/wells to the south of affected (or potentially affected) areas and thus provide soil and water samples and sampling points downstream of these areas. The locations of the new boreholes/wells were agreed with SLC and NRC before work commenced. The field work associated with the drilling of the boreholes and sinking the wells was subcontracted to Warren George Inc.

11.2 BOREHOLES

The methodology for choosing the borehole locations is summarized below.

- The existing site radiological information was reviewed by Monserco.
- A number of areas downstream of affected areas were considered by Monserco as candidate borehole/well locations.
- Proposals were put forward by Monserco to SLC and NRC on the number and locations of boreholes/wells required.
- The Monserco proposals were modified during discussions with SLC and NRC.
- Agreement was reached between Monserco, SLC and NRC to sink 13 boreholes/wells at the locations shown in Table 11.1 below.

The 13 boreholes were drilled during September and October 1995 using the methodology described in Section 5.

Each borehole was given a unique log number by the engineer. Table 11.1 provides a cross reference of the borehole log number with well number, grid number and the location on the site.

TABLE 11.1
LOCATIONS OF BOREHOLES AND WELLS

BOREHOLE LOG No.	WELL No.	GRID No.	DESCRIPTION OF LOCATION
101	M1	180	North of the Lacquer Storage Building
201	M2	240	South East corner of the SLC property. South East of Excavation Site No. 2
301	M3	233	South West corner of SLC property, beside effluent stream
401	M4	229	East of East Lagoon
501	M5	250	South East of East Lagoon
502	M6	244	South West of Excavation Site No. 1
601	M7	161	South East of Well House. North West of buried Silos
701	M8	178	South of Liquid Waste Building
801	M9	183	South of West Silo
802	M10	182	South of East Silo
901	M11	203	South of Lacquer Storage Building
902	M12	223	Beside the Cs-137 log hot spot
1001	M13	170	West Dump

The information recorded by the engineers during the drilling operations is shown in Appendix 15. The content of the engineer's drilling logs is explained below with reference to the information contained in Appendix 15, borehole log number 101.

- Borehole 101 was drilled on September 12, 1995 using a Hollow Stem Auger.
- It took 54 blows with a 300 lb. hammer to penetrate the first meter of ground.
- The first 3.15 meters of ground consisted of gravel, brown silty sand, dry cobbles and boulders.
- A sample of the drilled material was taken by split spoon at a depth of 3.15 meters and given the sample number 9055.
- Positive Photoionization Detector readings (PID, shown by black squares in the column titled "Field Tests") were obtained from soil samples taken

to a depth of 4.88 meters. This indicated the presence of volatile organic vapors in the soil.

- No readings were taken using the HP260 contamination monitor since there are no black triangles in the column titled: "Field Tests".
- Water was encountered at about 4 meters (shown by the triangle in the column titled Description).
- About 5.9 meters of ground was drilled.
- Borehole number 101 was converted to a well and given the well number M1.
- Bentonite was used when converting the borehole to a well.

During the drilling, hydrocarbon odors were occasionally reported by the field crew. The summary below contains more details. Soil samples were brought to the surface every 2 to 2.5 feet drilled and checked for contamination using the HP260 contamination probe. The samples were subsequently analyzed for radiological and non radiological constituents.

11.3 WELLS

The 13 boreholes were used to construct wells during September and October 1995 using the methodology presented in Section 5. More details are given in Appendix 15. Each well was given a unique alphanumeric identifier from M1 to M13 and the identifier was painted on each wellhead.

Water samples were brought to the surface once the well had been prepared. The samples were subsequently analyzed for radiological and non radiological constituents.

11.4 SUMMARY OF RESULTS FROM DRILLING THE BOREHOLES AND SINKING THE WELLS

13 new boreholes and wells were established on the SLC site during September and October 1995. Soil samples were brought to the surface for every 2 to 2.5 feet drilled and checked for contamination using the HP260 contamination probe. The salient points from the 13 engineer's logs reproduced in Appendix 15 are summarized below.

- Gravel, silt, clay, cobbles, coal and sand were encountered during the drilling operations.
- Hydrocarbons odors were reported by the field crew when drilling boreholes/wells 101/M1, 701/M8, 801/M9 and 1001/M13.
- Positive PID results (indicating organic vapors) were obtained from measurements on soils from boreholes/wells 101/M1 and 601/M7.

- The water level varied from about 1 meter in borehole/well 301/M3 to about 4.7 meters in borehole/well 1001/M13.
- Positive radiation readings were recorded down the following boreholes/wells: 201/M2, 301/M3, 401/M5, 501/M5, 502/M6, 601/M7, 801/M9, 802/M10, 901/M11, 902/M12 and 1003/M13.

11.5 RESULTS OF RADIOLOGICAL ANALYSES OF THE BOREHOLE SOIL SAMPLES

Soil samples were brought to the surface for every 2 to 2.5 feet drilled. The samples were analyzed by gross alpha and gross beta counting and by gamma spectroscopy using the methodologies described in Section 7. The results are shown in the Tables in Appendix 16. The format of the Tables in Appendix 16 is explained below.

TABLE 11.2
EXPLANATION OF THE TABLES IN APPENDIX 16

COLUMN No.	EXPLANATION
A	The well number.
B	The sample identification number. These identification numbers are also on the engineer's logs reproduced in Appendix 15.
C	The depth of the sample in meters.
D	The gross beta activity of the sample in picocuries per gram of soil.
E-J	The isotopic content of the soil, in Becquerels per gram of soil. U.S. NRC guideline values for each isotope are given above the letters E to J.
K	Comments.
L-Q	The isotopic content of the soil, in picocuries per gram of soil. U.S. NRC guideline values for each isotope are given above the letters L to Q. Only those values which are positive are recorded here. Limits of detection are not recorded here.
R	If any of the values in columns L to Q exceed the current U.S. NRC. guideline values, a "yes" is recorded.

The results of the radiological analyses contained in Appendix 16 are summarized below in Table 11.3.

TABLE 11.3
SUMMARY OF RESULTS OF RADIOLOGICAL ANALYSES OF BOREHOLE SOIL SAMPLES CONTAINED IN APPENDIX 16
(The highest Gross Beta, Cs-137 and Ra-226 results are in italics)

WELL No.	HIGHEST GROSS BETA COUNT	DEPTH	HIGHEST GAMMA EMITTER	VALUE	DEPTH
	PicoCuries per gram of Soil	Meters		PicoCuries per gram of Soil	Meters
M1	< LoL	N/A	< LoL	N/A	N/A
M2	< LoL	N/A	Cs-137	48	1.83
M3	8.8	1.22	Ra-226	>48	1.22
M4	37.4	4.27	Ra-226	>30	1.22
M5	46.2	0.61	***Ra-226***	***215***	***0.61***
M6	36.8	0.61	Ra-226	102	0.61
M7	< LoL	N/A	Cs-137	4	2.44
M8	2.98	3.66	Ra-226	>4	0.61
M9	55.5	3.66	Ra-226	>3	0.61
M10	***249.5***	***4.88***	Cs-137	82	0.61
M11	9.6	2.58	Ra-226	>28	2.58
M12	18.6	1.22	***Cs-137***	***99***	***1.22***
M13	< LoL	N/A	Ra-226	>10	0.61

LoL is the limit of detection of the analytical method.

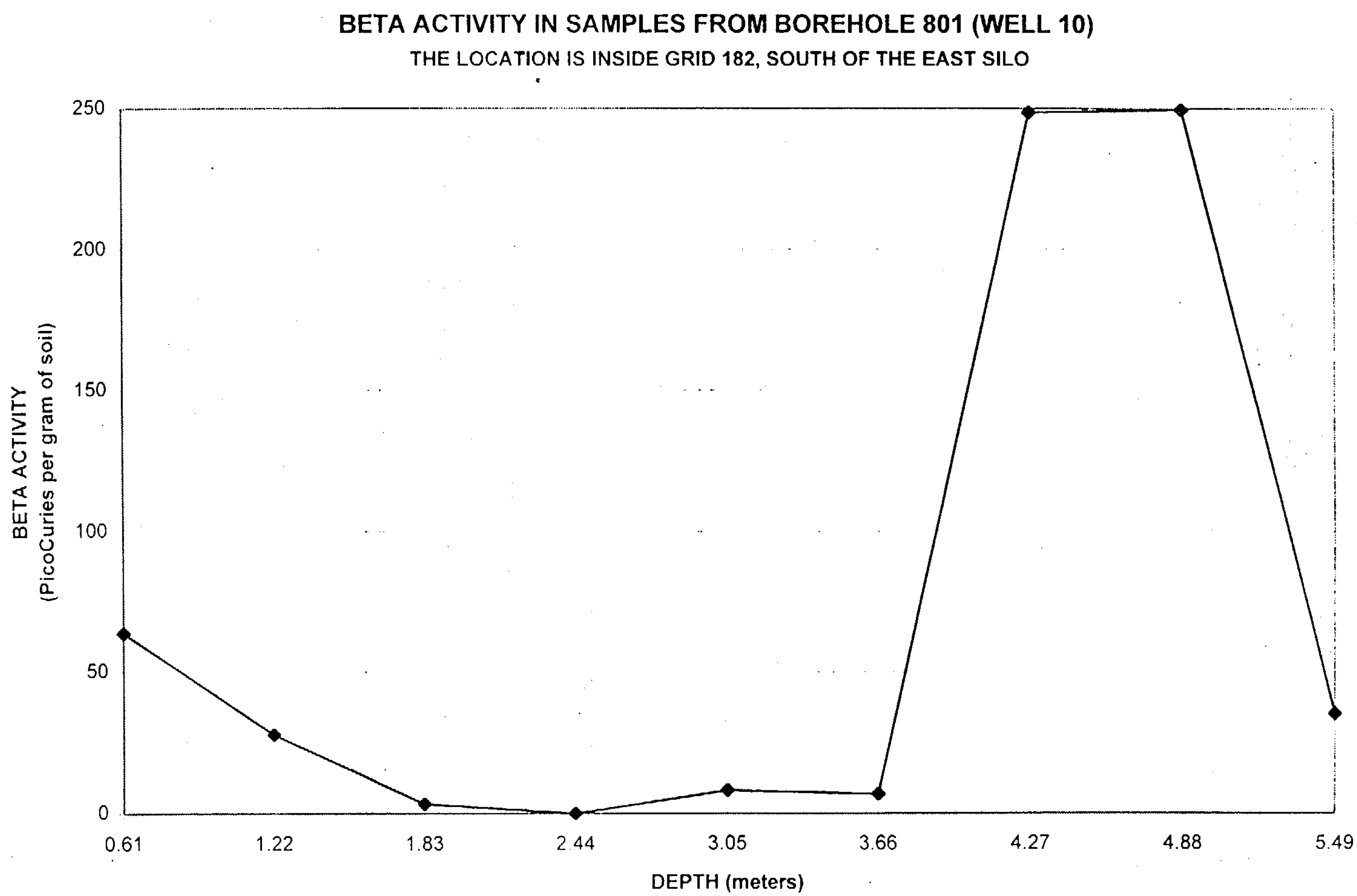
Gross Beta: The highest gross beta result was from well M10, inside grid 182, south of the East Silo.

Cs-137: The highest Cs-137 result was from well M12, inside grid 223.

Ra-226: The highest Ra-226 result was from well M5, inside grid 250, south of the East lagoon. Gamma spectrometry of soil samples reports the Ra-226 daughter products (e.g., Bi-214 and Pb-214) at values less than that of the Ra-226 parent value. This is because Radon-222 is lost as a gas to the atmosphere and all subsequent daughter products are not in equilibrium with Ra-226. Where Ra-226 daughters were detected, the results are reported in Table 11.3 as Ra-226. Ra-226 is therefore reported as greater than the measured value of the daughter products.

Figure 11.1 shows a plot of the gross beta count for well M10 as a function of depth. This shows elevated beta counts at depths greater than approximately 4 meters.

FIGURE 11.1
RESULTS OF ANALYSES OF BOREHOLE GROUND SAMPLES SOUTH OF THE EAST SILO



11.6 RESULTS OF RADIOLOGICAL ANALYSES OF THE WELL WATER SAMPLES

Water samples were taken from each of the 13 wells and analyzed for H-3, Sr-90 and gamma emitters. The results are shown in Appendix 17. H-3 results above current NRC guidelines values were found in the waters from wells M9, M10 and M11. Sr-90 results above current NRC guidelines were found in the waters from wells M4, M9, and M10. Cs-137 results above current NRC guideline values were found in the waters from wells M2, M5, M10 and M12.

11.7 SUMMARY OF RESULTS OF RADIOLOGICAL ANALYSES

Radioactivity in soils and water: Samples of soil and water were taken and analyzed for radioactivity. The main results are summarized below.

- Soil: Radioactivity above current NRC guidelines was found in soil samples from Well Numbers: M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12 and M13.
- Soil: The highest radium levels were found in Well Number M6.
- Soil: The highest Cs-137 levels were found in Well Number M12.
- Soil: The highest beta concentrations were found in Well Number M10.
- Soil: Contaminated soil was found to a depth of 5.49 meters.
- Water: Radioactivity above current NRC guidelines was found in water samples from Well Numbers M2, M4, M5, M9, M10, M11, and M12.

11.8 NON RADIOLOGICAL ANALYSES OF SOIL SAMPLES

Soil samples were brought to the surface for every 2 to 2.5 feet drilled. Hydrocarbons odors were reported by the field crew when drilling boreholes/wells 101/M1, 701/M8, 801/M9 and 1001/M13. Positive PID results (indicating organic vapors) were obtained from measurements on soils from boreholes/wells 101/M1 and 601/M7. The samples were not analyzed further for volatile organics or heavy metals.

11.9 RESULTS OF NON RADIOLOGICAL ANALYSES OF THE WELL WATER SAMPLES

Water samples were taken from each well using the methodology described in Section 5 of this report. The samples were analyzed by Barringer Laboratories for volatile organics and heavy metals.

Volatile Organics: 15 samples were provided to Barringer. These consisted of one sample from each of the 13 wells: one from the effluent stream water and a duplicate sample from the same location. The samples were analyzed for 39 VOCs by gas chromatography/mass spectrometry.

The results are shown in Appendix 18. The results are not background corrected. None of the 39 VOCs were detected in any of the samples; therefore background was interpreted as less than the limit of quantification (LOQ). For example, toluene is found in most of the samples at concentrations ranging from 0.4 to 1.9 micrograms per liter. The limit of quantification for the sample from well 12 was 0.5 micrograms per liter, but toluene was not detected in this sample. Toluene could be present at values below 0.5 micrograms per liter.

Table 11.4 provides a summary of the Barringer results. The Table does not include values less than 1 microgram per liter of sample. Chlorethane and 1,1, Dichlorethane were the most common organic impurities. The highest VOC value was from well 8 (grid 178, south of the Liquid Waste Building) which had 175 micrograms of Chloroethane per liter of sample. Well 8 also had the most VOCs, a total of 8. The water samples from wells 2 and 6 did not have VOC concentrations above 1 microgram per liter of sample.

TABLE 11.4
SUMMARY OF VOLATILE ORGANIC COMPOUNDS IN WELL WATERS

WELL No.	VOLATILE ORGANIC COMPOUNDS	Micrograms per liter of Sample
M1	***Chloroethane***, 1,1,Dichloroethane	30.2
M2	None	
M3	Vinyl chloride, ***1,1,Dichloroethane***	4.1
M4	***1,1,Dichloroethane***	1.3
M5	***1,1,Dichloroethane***	4.1
M6	None	
M7	***Chloroethane***, 1,1,Dichloroethane, Benzene, Toluene	7.1
M8	Vinyl chloride, ***Chloroethane***, 1,1,Dichloroethane, cis-1,2 Dichlorethene, 1,1,1-Trichlorethane, Ethylbenzene, o-Xylene	**175**
M9	Vinyl chloride, ***1,1,Dichloroethane***, cis-1,2 Dichlorethene, Toluene	6.2
M10	***Chloroethane***, 1,1,Dichloroethane, Toluene, Tetrachloroethane	4.2
M11	Vinyl chloride, ***1,1,Dichloroethane***, cis-1,2 Dichlorethene, 1,1,1-Trichlorethane, o-Xylene	33.3
M12	***Chloroethane***, 1,1,Dichloroethane, cis-1,2 Dichlorethene, 1,1,1-Trichlorethane, Tetrachloroethene	31.6
M13	cis-1,2 Dichlorethene, ***Tetrachloroethene***	1,5

Notes

1. The volatile organic compounds (VOCs) quoted above were found in the samples at values greater than 1 microgram per liter of water.
2. VOCs in italics are those at the highest concentrations in the sample.
3. The highest VOC value above is underlined.
   For example, the highest concentration of volatile organic compounds in the sample "M8" is 1,1, chlorethane at a concentration of 175 micrograms per liter of sample.

Heavy Metals: 16 samples were analyzed for heavy metals. The positive values ranged from about 0.1 to 796 milligrams of metal per liter of water. Values in excess of 100 milligrams of metal per liter of water were obtained for the elements shown below.

- aluminum
- calcium
- iron
- manganese
- sodium
- sulphur
- silicon
- zinc

Of the 13 well samples, M9 had the highest metal concentrations.

Well 10 (east silo) had the highest concentrations of cobalt, iron, potassium and magnesium.

11.10 SUMMARY OF RESULTS OF NON RADIOLOGICAL ANALYSES AND DRILLING OBSERVATIONS

13 boreholes were drilled on the SLC site at the locations indicated in Table 11.1.

Hydrocarbons: Hydrocarbons odors were reported by the field crew from boreholes/wells 101/M1, 701/M8, 801/M9 and 1001/M13. Positive PID results (indicating organic vapors) were obtained from measurements on soils from boreholes/wells 101/M1 and 601/M7. Quantities of oil were drawn from borehole/well 601/M7.

Volatile Organics in water: Samples of water were taken and analyzed for volatile organics. Volatile organics were found in water samples from all 13 wells.

Heavy Metals in water: Samples of well and effluent stream water were taken and analyzed for heavy metals. Heavy metals were found in water samples from all 13 wells.

11.11 SUMMARY OF ALL SOIL AND WATER RESULTS

Table 11.5 below provides an outline summary of the results from the radiological and non radiological analyses of the borehole soil samples.

TABLE 11.5
SUMMARY OF SOIL RESULTS

WELL No.	GROSS BETAS	GAMMA EMITTERS	HYDRO-CARBONS/ ORGANICS	HEAVY METALS
M1	***< LoL***	***YES***	***YES***	Not Assayed
M2	< LoL	YES	NO	Not Assayed
M3	YES	YES	NO	Not Assayed
M4	YES	YES	NO	Not Assayed
M5	YES	YES	NO	Not Assayed
M6	YES	YES	NO	Not Assayed
M7	***< LoL***	***YES***	***YES***	Not Assayed
M8	***YES***	***YES***	***YES***	Not Assayed
M9	***YES***	***YES***	***YES***	Not Assayed
M10	YES	YES	NO	Not Assayed
M11	YES	YES	NO	Not Assayed
M12	YES	YES	NO	Not Assayed
M13	***< LoL***	***YES***	***YES***	Not Assayed

Notes

LoL is the Limit of Detection of the analytical method.
"Yes" means gross betas, gammas and/or hydrocarbons were found.
"No" means gross betas, gammas and/or hydrocarbons were not found.

Table 11.6 below provides an outline summary of the results from the radiological and non-radiological analyses of the well water samples.

TABLE 11.6
SUMMARY OF WELL WATER RESULTS

WELL No.	BETA EMITTERS	GAMMA EMITTERS	VOLATILE ORGANIC COMPOUNDS	HEAVY METALS
M1	**YES**	**NO**	**YES**	**YES**
M2	YES	YES	NO	YES
M3	***YES***	***NO***	***YES***	***YES***
M4	***YES***	***NO***	***YES***	***YES***
M5	***YES***	***YES***	***YES***	***YES***
M6	YES	NO	NO	YES
M7	NO	NO	YES	YES
M8	NO	NO	YES	YES
M9	***YES***	***NO***	***YES***	***YES***
M10	***YES***	***YES***	***YES***	***YES***
M11	***YES***	***NO***	***YES***	***YES***
M12	***YES***	***YES***	***YES***	***YES***
M13	***YES***	***NO***	***YES***	***YES***

Notes

"Yes" means gross betas, gammas, hydrocarbons and/or heavy metals were found.
"No" means gross betas, gammas, hydrocarbons and/or heavy metals were not found.

12 TASK 5: DETERMINE THE EXTENT OF RADIOLOGICAL CONTAMINATION INSIDE THE SLC BUILDINGS

The objective of Task 5 was to determine the extent of radiological contamination inside the buildings on the SLC site.

The main elements of Task 5 are described below.

- Agree with SLC management which buildings and rooms required to be surveyed.
- Undertake a visual inspection of the areas and identify any hazards which the Monserco surveyors might encounter.
- Put procedures in place to minimize the above hazards.
- Grid the areas to be surveyed according to the methodology described in Section 6 of this report.
- Perform radiation and contamination surveys as described in Section 6 of this report.
- Analyze any associated survey samples.
- Take photographs of selected areas.
- Collate the building survey information.

The locations of the SLC buildings are shown in Figure 3.3. The buildings were surveyed by Monserco staff between June and December 1995.

The results of radiological analyses of soil and solid samples are shown in Appendix 19 and the building and room survey results are shown in Appendix 20.

Table 12.1 below lists the buildings and where to find the results within Appendix 20.

TABLE 12.1
INFORMATION ON SLC BUILDINGS

Section No. in Appendix 20	Building (See Figure 3.3 for building locations)	Number of Rooms/Survey Areas
1	Acid Etching Building	80
2	Main Building	77
3	Personnel Office Building	1
4	Pipe Shop	1
5	Multimetals Waste Treatment Plant	3
6	Carpenter Shop	1
7	Well House	3
8	Lacquer Storage Building	1
9	Cesium Ion Exchange Hut	1
10	Nuclear Building	Not Surveyed
11	Garage	1
12	Above Ground Metal Silo	1
13	Solid Waste Building	1
14	Old House	7
15	Liquid Waste Building	1
16	8 by 8 Building	1
17	Utility Building	1
18	Radium Vault	1
19	Plastics Machine Shop	1

The Tables in Appendix 20 show the building and room survey results. The layout of the Tables in Appendix 20 is explained in Table 12.2 below.

TABLE 12.2
FORMAT OF TABLES USED IN APPENDIX 20

LOCATION	EXPLANATION
BOX 1	• Gives information on the instrumentation used for the radiation and contamination surveys. • The "location" is where the instrument was used.. Thus "all" means that the instrument was used on all grids. • The "serial number" of the various instruments is recorded here. • The "average background" at the center of each room is recorded here. • The average contamination meter background is converted from counts per second into dpm/100cm^2. The average radiation meter background is converted from microSieverts per hour into millirems per hour.
BOX 2	• Records the gamma emitting radioisotopes which could be present both from written historical records and in conversation with present and past SLC employees. • The radioisotopes identified using the Monserco gamma spectrometer are recorded here under the column titled "Currently Present".
COLUMN A	• Records the sample identification number.
COLUMN B	• Records the grid number. • The grid numbering system is explained in Section 6.
COLUMN C	• Records the radiation survey results obtained using the Bicron survey meter. • The units are millirems per hour. • More information on the Bicron survey meter is given in Box 1.

TABLE 12.2
FORMAT OF TABLES USED IN APPENDIX 20 Continued

COLUMN D	• Records the "fixed average contamination" in the grid or on equipment using the HP260 detector. • The units are disintegrations per minute per one hundred square centimeters of grid/equipment surface area. • More information on the HP260 is given in Box 1.
COLUMN E	• Records the "fixed average contamination" in the grid or on the equipment using the LB122 detector. • The units are disintegrations per minute per one hundred square centimeters of grid/equipment surface area. • More information on the LB122 is given in Box 1
COLUMN F	• Records the "loose tritium contamination" in a grid or piece of equipment. • The tritium was removed from surfaces using polyfoam swipes which were subsequently treated and counted for tritium using a liquid scintillation counter. • The units are disintegrations per minute per one hundred square centimeters of grid/equipment surface area. • The minimum detectable activity was less than 60 disintegrations per minute per one hundred square centimeters of grid/equipment surface area.
COLUMN G	• Records the "loose alpha contamination" in a grid or piece of equipment. • The alpha contamination was removed from surfaces using cloth swipes which were subsequently counted for alpha emissions using an alpha counter. • The units are disintegrations per minute per one hundred square centimeters of grid/equipment surface area.

TABLE 12.2
FORMAT OF TABLES USED IN APPENDIX 20 Continued

COLUMN H	• Records the "loose beta contamination" in a grid or piece of equipment. • The beta contamination was removed from surfaces using cloth swipes which were subsequently counted for beta emissions using a beta counter. • The units are disintegrations per minute per one hundred square centimeters of grid/equipment surface area.
COLUMN I	• Records the hot spots found in the grid or on the equipment using the HP260. • If more than one hot spot was found, each was recorded. • The units are disintegrations per minute per one hundred square centimeters of grid/equipment surface area.
COLUMN J	• Records the hot spots found in the grid or on the equipment using the LB122. • If more than one hot spot was found, each was recorded. • The units are disintegrations per minute per one hundred square centimeters of grid/equipment surface area.
COLUMN K	• If a hot spot in Columns I or J is inside a grid, this describes the x, y coordinates of the hot spot in units of meters, feet or inches. • If the hot spot is on a piece of equipment or a fixture, this provides a description of the item.
COLUMN L	• If the loose contamination recorded in Columns F, G or H of a grid exceeds the current NRC beta/gamma guideline values, a "yes" is written in Column L. • The current NRC guideline values for loose beta/gamma contamination are greater that one thousand disintegrations per minute per hundred square centimeters of grid or equipment surface area. This value is also assumed for loose tritium contamination. • The purpose of this column is to make data interpretation easier and only addresses NRC guidelines on beta/gamma contamination. It does not address Sr-90 or transuranic contamination.

TABLE 12.2
FORMAT OF TABLES USED IN APPENDIX 20 Continued

COLUMN M	• **If the average contamination recorded in Columns D or E of a grid exceeds the current beta/gamma NRC guideline values, a "yes" is written in Column M.** • **The current NRC guideline values for average beta/gamma contamination are greater that five thousand disintegrations per minute per hundred square centimeters of grid or equipment surface area. The purpose of this column is to make data interpretation easier and only addresses NRC guidelines on beta/gamma contamination. It does not address Sr-90 or transuranic contamination.**
COLUMN N	• **If hot spots recorded in Columns I or J of a grid exceed the current NRC beta/gamma guideline values, a "yes" is written in Column N.** • **The current NRC guideline values for hot spots are greater that fifteen thousand disintegrations per minute per hundred square centimeters of grid or equipment surface area. The purpose of this column is to make data interpretation easier and only addresses NRC guidelines on beta/gamma contamination. It does not address Sr-90 or transuranic contamination.**

Building summary tables for the Acid Etching Building and the Main Building are included in the text. These building summary tables show the rooms surveyed, the number of grids in each room, and the number of measurements which exceed the current NRC guideline values on contamination. The building summary tables use identical notation to that described above. Examples of typical notation are given below.

- Column L indicates where the highest loose contamination value within a room exceeds the current NRC guideline values of 1,000 dpm/100cm^2.
- Column M indicates where the highest fixed average contamination value within a room exceeds the current NRC guideline values of 5,000 dpm/100cm^2.
- Column N indicates the number of hot spots within a room which exceed the current NRC guideline values of 15,000 dpm/100cm^2.

12.1 ACID ETCHING BUILDING

12.1.1 Introduction

The original Acid Etching Building was constructed in the 1940s and had a floor surface area of approximately 16,025 ft^2. A separate building, the Radium Measuring Building, had a floor surface area of an additional 350 ft^2. The Radium Measuring Building does not presently exist as a separate structure. Between 1949 and 1976 the Acid Etching Building was expanded to 32,000 ft^2. This does not include a 6,000 ft^2 manufacturing addition built in 1974 on the northernmost end of the building.

Many different activities took place in the Acid Etching Building. The primary radioactive processes involved the assembly and manufacture of radium and tritium instruments and dials. Some areas of the building were used for support services, such as silverplating, chemical storage, maintenance activities, machining tools and dies, and office space.

Soil is present directly underneath some of the floors of this building. In some rooms, parts of the wooden floors are no longer there and soil is exposed.

The attic of the building is currently used to store documents, records and contaminated filing cabinets. Parts of the attic are known to be contaminated with alpha activity.

At present, approximately 25% of the Acid Etching Building is leased to USRC Metals. SLC uses some of the building for assembly of non radioactive components for exit signs. Portions of the remaining floor space are used for storage purposes.

The main areas of radiological concern to the SLC staff include those shown below:

- The Tritium Screening Room.
- The Watch Dial Screening Room.
- The Maintenance Area.
- The former Shipping Room Area.

The isotopes used at various times in the past in the building include H-3 and Ra-226.

12.1 ACID ETCHING BUILDING Continued

12.1.2 Survey Results

The survey results, building layouts and photographs are shown in Section 1 of Appendix 20.

Some of the rooms inside the Acid Etching Building had partially collapsed roofs and there was concern for the safety of the Monserco surveyors. SLC staff therefore instructed the Monserco staff not to survey some of the rooms. For operational reasons, Monserco staff numbered the areas within the Acid Etching Building and these are shown in Appendix 20.

Table 12.3 provides a summary of the survey results for the Acid Etching Building rooms. This Table shows the rooms and fixtures/equipment surveyed, the number of grids in each room, and the number of measurements which exceed the current NRC guideline values on contamination and hot spots.

Figures 12.1 to 12.3 summarize the distribution of contamination in the Acid Etching Building.

TABLE 12.3
SUMMARY OF SURVEY INFORMATION FOR THE ACID ETCHING BUILDING

"n/s" indicates that the room was not surveyed due to safety considerations.
"----" indicates that the number is not attributed to any room in the building.

	ACID ETCHING BUILDING SURVEY SUMMARY				EQUIPMENT/FIXTURES SURVEY SUMMARY			
Room Number	Number of grids	Loose >1,000 dpm/100cm² *L*	Average>5,000 dpm/100cm² *M*	Hot Spot >15,000 dpm/100cm² *N*	Number of items	Loose >1,000 dpm/100cm² *L*	Average>5,000 dpm/100cm² *M*	Hot Spot >15,000 dpm/100cm² *N*
1	80	0	0	0	0	0	0	0
2	12	0	3	0	4	0	0	0
3	15	0	2	6	8	1	0	0
4	—	—	—	—	—	—	—	—
5	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
6	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
7	53	0	1	0	1	0	0	0
8	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
9	9	0	2	0	2	0	0	0
10	44	0	0	3	7	0	0	1
11	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
12	26	0	0	0	1	0	0	0
13	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
14	35	1	0	0	11	0	0	0
15	11	0	0	0	2	0	0	0
16	—	—	—	—	—	—	—	—
17	6	0	0	0	3	0	0	0
17A	6	0	1	0	2	0	0	0
18	22	0	0	0	0	0	0	0
19	16	0	0	0	4	0	0	0
20	48	0	0	1	7	0	0	0
21	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
22	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
23	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
24	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
25	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
26	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
27	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
28	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
29	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
30	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
31	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
32	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
33	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
34	37	0	0	0	5	0	0	0
35	9	0	0	0	0	0	0	0
36	20	0	0	0	2	0	0	0
37	—	—	----	—	—	—	—	—
38	34	0	0	0	4	0	0	0
39	----	----	----	----	----	----	----	----
40	37	0	0	0	6	0	0	0
41	52	0	0	0	0	0	0	0
42	----	----	----	----	----	----	----	----
43	----	----	----	----	----	----	----	----
44	----	----	----	----	----	----	----	----
45	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
46	----	----	----	----	----	----	----	----

TABLE 12.3
SUMMARY OF SURVEY INFORMATION FOR THE ACID ETCHING BUILDING

Room Number	ACID ETCHING BUILDING SURVEY SUMMARY: Number of grids	Loose >1,000 dpm/100cm² *L*	Average>5,000 dpm/100cm² *M*	Hot Spot >15,000 dpm/100cm² *N*	EQUIPMENT/FIXTURES SURVEY SUMMARY: Number of items	Loose >1,000 dpm/100cm² *L*	Average>5,000 dpm/100cm² *M*	Hot Spot >15,000 dpm/100cm² *N*
47	—	—	—	—	—	—	—	—
48	92	0	0	3	11	0	0	0
49	108	1	0	0	0	0	0	0
50	13	0	0	0	1	0	0	0
50A	73	0	0	0	0	0	0	0
50B	96	0	0	0	0	0	0	0
50C	95	0	0	0	0	0	0	0
51	91	0	0	0	2	0	0	0
52	—	—	—	—	—	—	—	—
53	—	—	—	—	—	—	—	—
54	—	—	—	—	—	—	—	—
55	63	0	8	14	0	0	0	0
56	23	1	2	0	0	0	0	0
57	—	—	—	—	—	—	—	—
58	14	0	0	0	1	0	0	0
59	17	0	0	0	0	0	0	0
60	6	0	0	0	0	0	0	0
61	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
62	70	0	0	12	14	0	0	0
63	11	1	0	0	0	0	0	0
64	—	—	—	—	—	—	—	—
65	29	0	0	1	6	0	0	0
66	24	0	0	0	5	0	0	0
67	27	0	0	2	9	0	0	0
68	—	—	—	—	—	—	—	—
69	20	0	1	0	2	0	1	0
70	14	0	2	6	8	0	0	8
71	19	0	0	2	4	0	0	0
72	8	0	0	0	1	0	0	0
73	21	1	0	0	2	0	0	0
74	16	0	0	0	2	0	0	0
75	18	0	0	0	3	0	0	1
76	21	0	0	6	8	0	0	0
76A	7	0	0	0	1	0	0	0
76B	9	0	0	0	1	0	0	0
77	—	—	—	—	—	—	—	—
78	12	0	0	0	2	0	0	0
79	16	0	0	0	2	0	0	0
79A	13	0	0	0	1	0	0	0
80	17	0	0	0	5	0	0	0
81	24	0	0	1	2	0	0	2
82	6	0	0	0	1	0	0	0
83	25	0	0	2	8	0	0	2
84	10	0	0	1	3	0	0	1
Attic 1	60	0	0	4	6	0	0	0
Attic 2	93	0	1	10	8	2	0	8
Attic 3	22	1	2	4	5	0	0	5
Attic ramp	17	0	0	3	3	0	0	0
TOTAL:	1892	6	25	81	196	3	1	28

FIGURE 12.1

DISTRIBUTION OF LOOSE CONTAMINATION IN THE ACID ETCHING BUILDING

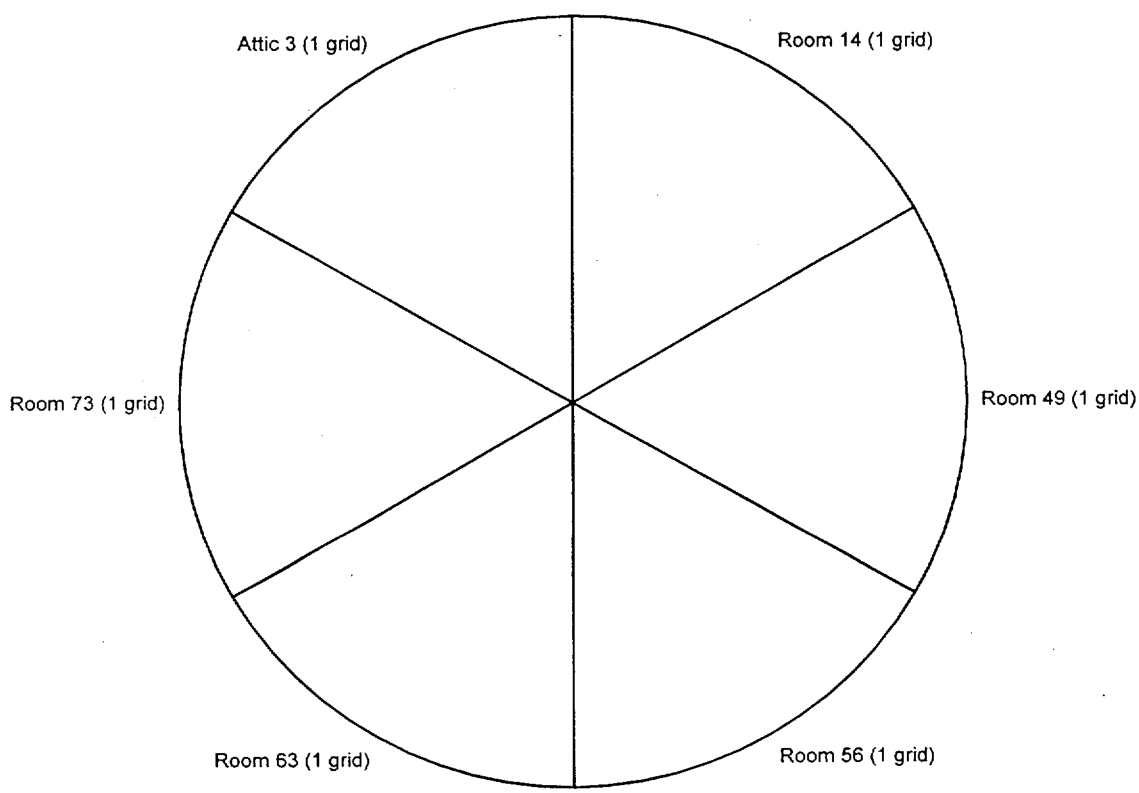


FIGURE 12.2

DISTRIBUTION OF AVERAGE CONTAMINATION IN THE ACID ETCHING BUILDING

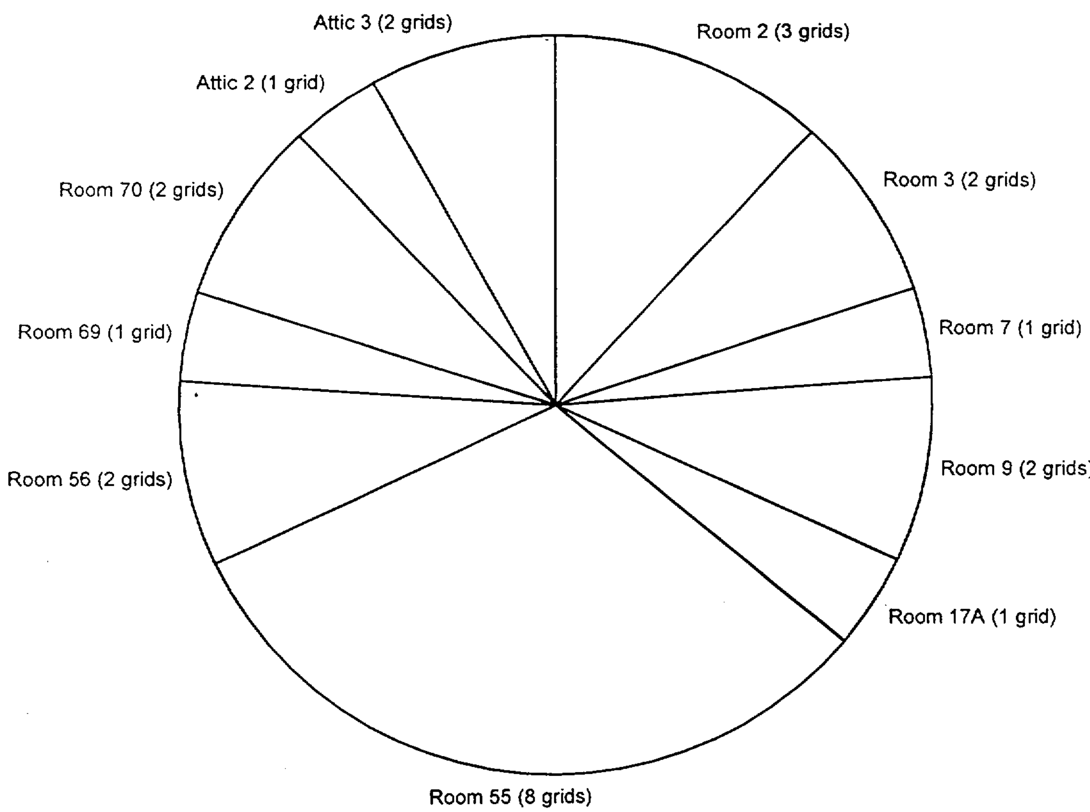
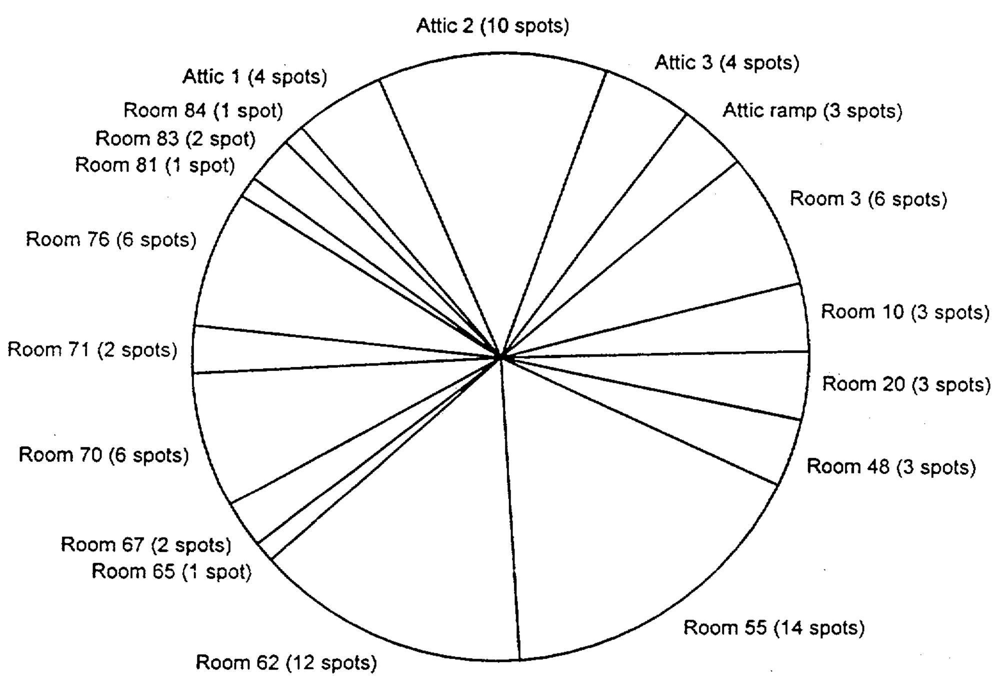


FIGURE 12.3

DISTRIBUTION OF HOT SPOT CONTAMINATION IN THE ACID ETCHING BUILDING



12.2 MAIN BUILDING

12.2.1 Introduction

The Main Building has undergone several structural expansions since it was built. The original building had a surface area of 8,000 ft^2 on the first floor, 5,000 ft^2 on the second floor and a 600 ft^2 lunch room on the third floor. Ra-226 and H-3 painting operations took place in the east half of the second floor of the original building. In 1969, SLC hired a contractor to decontaminate areas within the Main Building and on the roof. The decontamination was sufficiently successful to allow unrestricted access to the first and second floors of the Main Building.

During the late 1940s a one story addition was added to the south of the three-story main structure and east of the mechanical application room. This addition added about 14,000 ft^2. Sometime between the late 1940s and 1959, a one-story 2,000 ft^2 expansion was added to the east side of the 14,000 ft^2 expansion. Currently the Main Building encompasses about 30,000 ft^2.

About 5,000 ft^2 of the first floor of the original Main Building has been extensively renovated and now houses offices for SLC and USR Metals. For the most part, the remaining 3,000 ft^2 of the original Main Building first floor is utilized by USR Metals for non radioactive processes. The one-story, 14,000 ft^2 addition is also currently used by USR Metals for certain non radioactive processes. The 2,000 ft^2 addition on the east side of the Main Building is utilized primarily for storage.

The second and third floors of the Main Building are not used for operations which involve radioactivity. The east half of the second floor is used for storage of documents and equipment and the west half is predominantly as it existed during former work with H-3 and Ra-226.

Operations involving radioactivity were relocated with time to specific areas within the 14,000 ft^2 and 2,000 ft^2 additions.

The former Hand Painting Department occupied the second floor front of the Main Building. This area has been decontaminated, but the attic above the area still contains contaminated ducts from the old radium painting operations. In 1978, NRC reported widespread alpha contamination within the attic areas. Subsequently, alpha contamination was also reported between the floor of the former Hand Painting Department and the ceiling below.

12.2.2 Survey Results

The survey results, building layouts and photographs are shown in Section 2 of Appendix 20.

For operational reasons, Monserco staff numbered the areas within the Main Building and these are shown in Appendix 20.

Table 12.4 provides a summary of the survey results for the Main Building rooms. This Table shows the rooms and equipment/fixtures surveyed, the number of grids in each room, and the number of measurements which exceed the current NRC guideline values on contamination and hot spots.

Figures 12.4 to 12.6 summarize the distribution of contamination in the Main Building.

TABLE 12.4
SUMMARY OF SURVEY INFORMATION FOR THE MAIN BUILDING

"n/s" indicates that the room was not surveyed due to safety considerations.
"----" indicates that the number is not attributed to any room in the building.

	MAIN BUILDING SURVEY SUMMARY				EQUIPMENT/FIXTURES SURVEY SUMMARY			
Room Number	Number of grids	Loose >1,000 dpm/100cm²	Average>5,000 dpm/100cm²	Hot Spot >15,000 dpm/100cm²	Number of items	Loose >1,000 dpm/100cm²	Average>5,000 dpm/100cm²	Hot Spot >15,000 dpm/100cm²
		L	*M*	*N*		*L*	*M*	*N*
85	29	0	0	2	3	0	0	0
86	80	4	15	43	60	0	0	37
87	17	0	0	13	10	0	0	0
88	70	28	14	35	28	0	1	2
88A	29	0	0	7	5	0	0	0
88B	14	0	0	9	4	0	0	4
89	----	----	----	----	----	----	----	----
90	----	----	----	----	----	----	----	----
91	16	1	0	1	2	2	0	0
92	29	8	0	5	12	0	0	4
93	89	1	1	15	21	0	0	7
94	----	----	----	----	----	----	----	----
95	38	0	16	6	13	0	2	2
96	----	----	----	----	----	----	----	----
97	55	0	1	2	19	0	1	3
98	23	0	0	0	6	0	4	0
99A	17	0	0	0	0	0	0	0
99B	6	0	0	0	0	0	0	0
100	138	3	7	7	39	0	0	3
101	30	0	0	0	6	0	0	0
102	27	0	0	0	3	0	0	0
103	30	0	0	2	2	0	0	0
104	26	0	1	3	12	0	0	1
105	31	0	0	0	3	0	0	2
106	101	1	0	7	20	0	0	0
107	27	0	1	1	4	0	1	2
108	33	1	10	1	9	0	0	0
109	----	----	----	----	----	----	----	----
110	17	0	0	0	4	0	0	0
111	15	0	0	0	3	0	0	0
112	16	0	0	0	2	0	0	0
113A	11	1	0	1	1	0	0	0
113B	18	0	0	1	0	0	0	0
113C	12	0	0	0	0	0	0	0
114	21	0	0	2	5	0	0	0
115	20	0	0	0	4	0	0	0
116	15	0	0	0	0	0	0	0
117	24	0	0	0	4	0	0	0
118	----	----	----	----	----	----	----	----
119	9	0	0	0	0	0	0	0
120	57	0	0	2	5	0	0	0
121	13	0	0	0	3	0	0	1
122	6	0	0	0	0	0	0	0
123	40	0	0	0	3	0	0	0
124	25	0	0	0	3	0	0	0

TABLE 12.4
SUMMARY OF SURVEY INFORMATION FOR THE MAIN BUILDING

125	27	0	0	0	2	0	0	0
125S	18	0	0	2	5	0	0	2
126	13	0	0	0	2	0	0	0
127	53	0	0	1	6	0	0	0
128	----	----	----	----	----	----	----	----
129	20	0	0	0	4	0	0	0
130	17	0	0	0	2	0	0	0
131	17	0	0	0	3	0	0	0
132	17	0	0	0	3	0	0	0
133	----	----	----	----	----	----	----	----
134	----	----	----	----	----	----	----	----
135	14	0	0	1	2	0	0	0
135WR	11	0	0	0	4	0	0	0
136	18	9	0	0	1	0	0	1
137	6	0	0	0	0	0	0	0
138	----	----	----	----	----	----	----	----
139	22	0	0	0	0	0	0	0
201	15	0	0	0	1	0	0	1
202	13	0	4	0	1	0	0	1
203	9	0	0	0	0	0	0	0
204	11	0	0	0	1	0	0	1
205	8	0	0	1	1	0	0	0
206	19	0	0	0	1	0	0	0
207	12	0	0	0	0	0	0	0
208	12	0	0	0	3	0	0	0
209	20	0	2	3	4	0	0	0
210	36	0	0	0	4	0	0	0
211	34	0	0	1	0	0	0	0
212	6	0	0	0	4	0	0	0
213	27	0	0	0	4	0	0	0
214	23	0	0	2	7	1	2	4
215	15	0	0	9	6	0	0	2
216	25	0	0	2	7	0	0	0
217	16	0	0	0	8	0	0	5
218	108	0	1	11	21	1	0	6
301	30	0	0	2	9	0	0	0
301A	12	0	0	2	0	0	0	0
302	10	0	3	0	0	0	0	0
B1	27	0	1	1	2	1	0	0
B2	10	0	0	3	3	0	0	0
B3	12	0	1	1	5	0	0	1
EDock	4	0	0	0	0	0	0	0
WDock	3	0	2	0	0	0	0	0
TOTAL:	2044	57	80	207	444	5	11	92

FIGURE 12.4

DISTRIBUTION OF LOOSE CONTAMINATION IN THE MAIN BUILDING

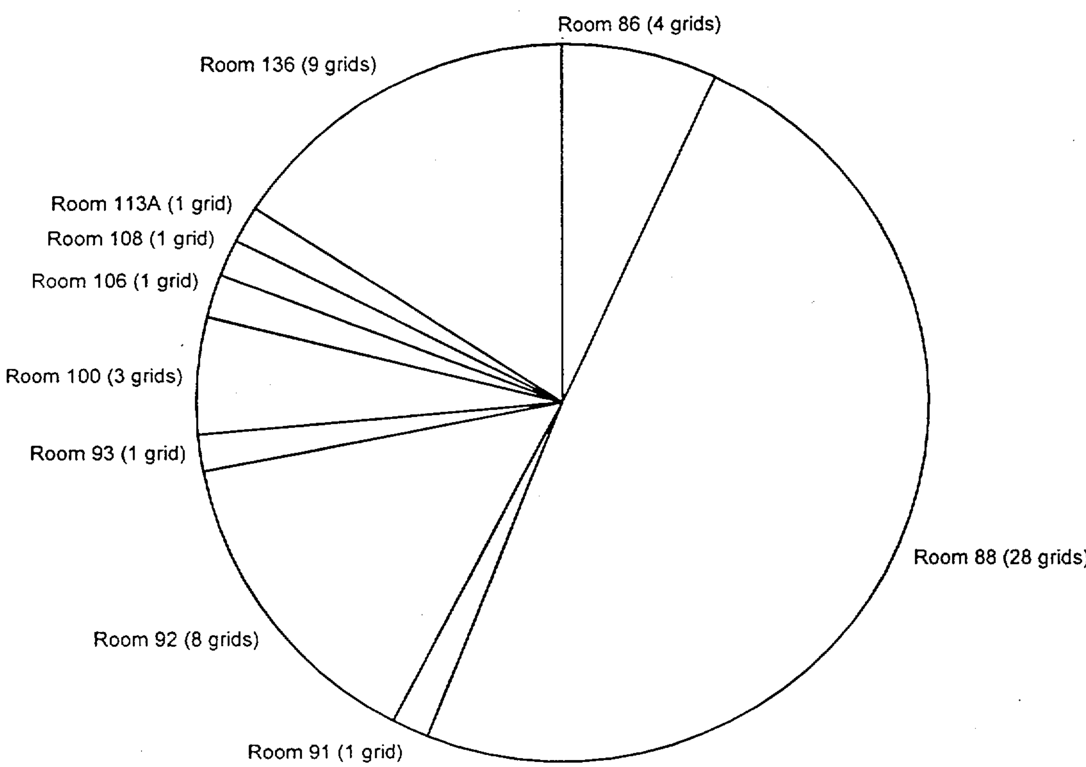


FIGURE 12.5

DISTRIBUTION OF AVERAGE CONTAMINATION IN THE MAIN BUILDING

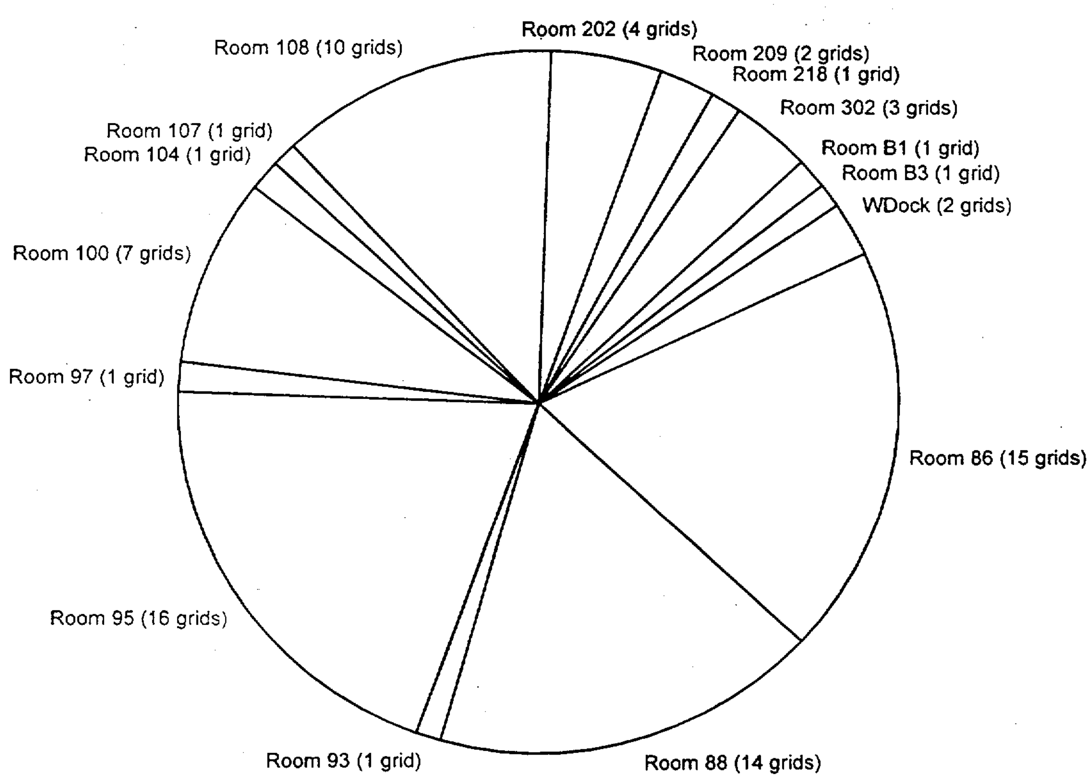
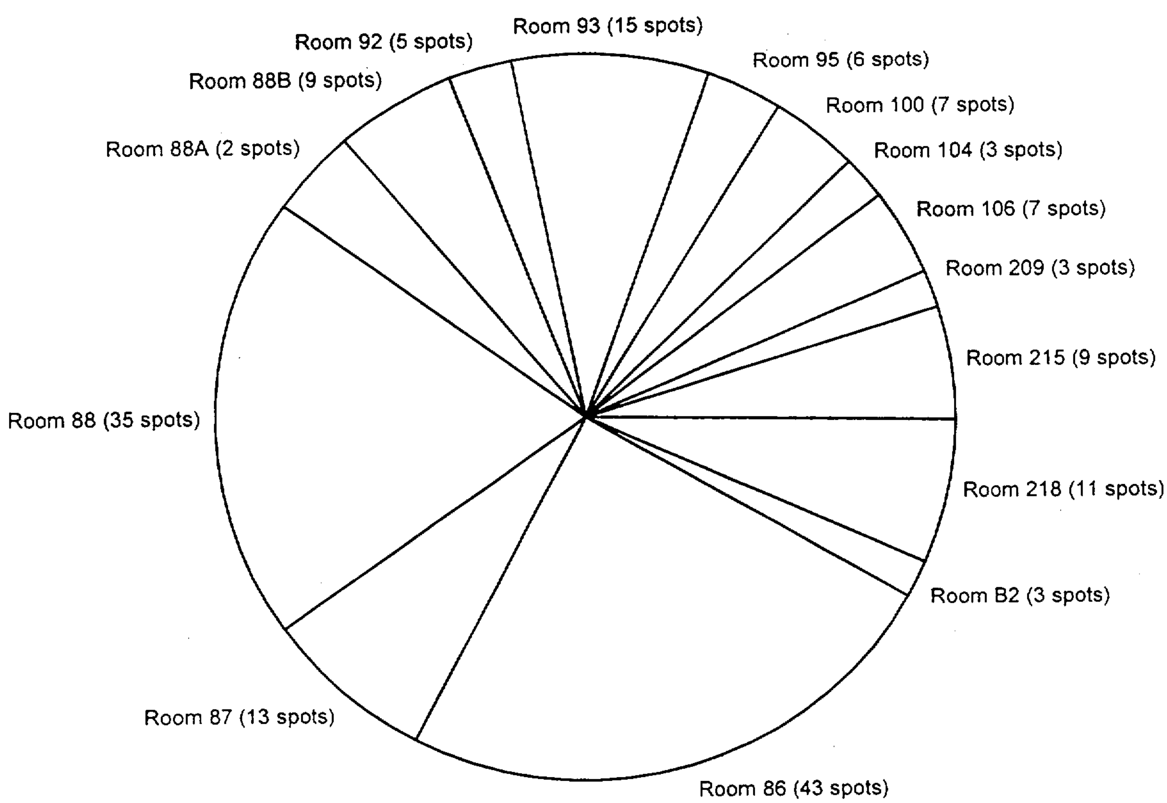


FIGURE 12.6

DISTRIBUTION OF HOT SPOT CONTAMINATION IN THE MAIN BUILDING IN ROOMS WITH MORE THAN 2 HOT SPOTS



12.3 PERSONNEL OFFICE BUILDING

12.3.1 Introduction

The Personnel Office Building consists of one room with a below grade cellar which can be accessed from an external trap door. A two foot diameter hexagonal shaped concrete slab is located on the floor of the cellar directly beneath the trap door. The slab is 2 feet thick and appears to have been poured in places. The Personnel Office Building was originally used as a station for nurses and then for administrative office space and storage of Ra-226 and Sr-90 screening machines and strontium chloride. Materials surplus to requirements may have been disposed of in a "dry well" located in the below grade cellar of the Personnel Office Building. Monserco is not aware of any records of such disposals.

The building is currently in poor structural condition and is used for storage of miscellaneous items.

The isotopes used at various times in the past in the building include Sr-90 and Ra-226.

12.3.2 Survey Results

The survey results and building photographs are shown in Section 3 of Appendix 20.

A summary of the survey results is shown in Table 12.3.1 below.

TABLE 12.3.1
SUMMARY OF PERSONNEL OFFICE BUILDING SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	13	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	Grid number 10 was the only positive value.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	1	Grid number 10.
6.	Number of **hot spots** above current NRC guideline values.	0	
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Cs-137, Bi-214 and Ra-226.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	1	On top of the well in the basement.
9.	Number of items with **fixed contamination** above current NRC guideline values.	1	On top of the well in the basement. The value was >20,000,000 dpm/100cm^2
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	Grid number 10 was the only positive value.
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.4 PIPE SHOP

12.4.1 Introduction

The site now occupied by the Pipe Shop was used in 1948 for the disposal of radium contaminated ductwork from the USRC facility at Brooklyn, New York. The building, then referred to as the Maintenance Shop was built over the disposal area. The Maintenance Shop was used for maintenance work and for lead melting. The building is now referred to as the Pipe Shop and is used for the storage of tritium screening machines, painting tables and lead melting pots. The Pipe Shop is ventilated routinely to reduce radon concentrations.

The Pipe Shop consists only of one room. The enclosed part of the building consists of concrete block walls, a wooden roof and a concrete floor. The north wall contains two large windows and a door. The south wall has only a sliding door at the west end. The east wall contains two large windows at the north end and two large doors with windows at the south end. The west wall contains one doorway which is covered over with plywood.

The isotopes used at various times in the past in the building included H-3 and Ra-226. Non radioactive lead was also used in the building.

12.4.2 Survey Results

The survey results and building photographs are shown in Section 4 of Appendix 20.

A summary of the survey results is shown in Table 12.4.1 below.

TABLE 12.4.1
SUMMARY OF PIPE SHOP SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	34	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	Grid numbers 2 and 4 were the only positive values recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	1	Grid number 6. The value was in excess of 20,000 dpm/100cm^2
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	19	
9.	Number of items with **fixed contamination** above current NRC guideline values.	3	Pipes on east ceiling, equipment in south west corner and east wall lead pots.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	2	Equipment at the center west side and equipment at the center south side.
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.5 MULTIMETALS WASTE TREATMENT PLANT

12.5.1 Introduction

The Multimetals Waste Treatment Plant consists of three rooms:

- **The boiler room** which contains the new oil fired boiler
- **The waste room** where the waste metals are currently treated and which use to contain the old coal fired boiler.
- **The compressor room**.

Boiler Room: The boiler room consists of cinder block walls, a concrete floor and a wooden ceiling which is covered with sheets of asbestos insulation. There is a garage door in the north wall, a large window in the east wall, a large wooden sliding door and a glass window in the west wall. A small section of the lower west wall has been replaced with cement blocks covered with plaster (stucco). There is a 4 feet by 8 feet overflow sump in the northeast quadrant of the concrete floor. A stack from this room, now unused, has been covered over at its inlet end by the ceiling. The equipment in this room includes two empty overflow tanks, approximately 10 feet high with diameters of 8 feet. Stored materials include 20 x 55 U.S. gallon drums, some containing chemicals, and approximately 40 bags of lime. There are also some piping runs above the tanks.

Waste Room: The waste room is currently used for treatment of waste materials. It consists of cinder block walls, a concrete floor which is laid in square sections and a wooden roof. A long sump runs the full length of the floor about two feet parallel to the north wall. There is also a sink and a smaller sump. At the west end of the north wall is a large garage door. A door is located near the center of the north wall. The west wall contains a window and a door, while one door is located at the north end of the east wall. Equipment located on the ground level includes four large waste treatment tanks and electrical control panels. There are several long pipe runs just below the ceiling. There is a small second level platform in the northeast corner of this room containing several small epoxy coated tanks.

Compressor Room: The third room in the Multimetals Waste Treatment Plant is the compressor room. The walls are composed of cinder blocks covered with plaster (stucco). The concrete floor is laid in sections and the roof is wood plank. The north wall contains three tall windows. The east wall contains a door and a large window; the west wall contains two doors and two tall windows and the south wall contains two tall windows and a door. Equipment in this room includes 5 large compressors, two small compressors, an electrical panel, a diesel powered generator and many pipe runs. A metal storage cabinet is located in the southeast corner of the room.

Historically, no radionuclides were either processed or stored in these three rooms. However, the Multimetals Waste Treatment Plant is constructed next to the Carpenter Shop in which radium had been stored and in which a Sr-90 source supposedly exploded. Therefore the isotopes expected are Sr-90 and Ra-226.

12.5.2 Survey Results

The survey results and building photographs are shown in Section 5 of Appendix 20.

Summaries of the survey results are shown in the following Tables:

- Table 12.5.1: Boiler Room.
- Table 12.5.2: Waste Room.
- Table 12.5.3: Compressor Room.

TABLE 12.5.1
SUMMARY OF MULTIMETALS BUILDING
BOILER ROOM SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BOILER ROOM		
1.	**Total** number of grids surveyed.	28	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	1	Grid number 16.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	2	Grid numbers 7 and 16. The value in grid number 16 was > 860,000 dpm/100cm^2.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
	BOILER ROOM EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	8	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded
13.	Number of items with **hot spots** above current NRC guideline values.	0	

TABLE 12.5.2
SUMMARY OF MULTIMETALS BUILDING WASTE ROOM SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	WASTE ROOM		
1.	**Total** number of grids surveyed.	41	Grids number 18, 24, 25, 26 not used.
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	0	Positive values were recorded in grid numbers 6 and 17. The value in grid number 17 was > 4,700 dpm/100cm^2.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
	WASTE ROOM EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	4	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded
13.	Number of items with **hot spots** above current NRC guideline values.	0	

TABLE 12.5.3
SUMMARY OF MULTIMETALS BUILDING COMPRESSOR ROOM SURVEY RESULTS

No.	ITEM	No.	COMMENTS
COMPRESSOR ROOM			
1.	**Total** number of grids surveyed.	26	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	Four positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	5	Grid numbers 3, 11, 12, 18 and 24. The value in grid number 12 was > 69,000 dpm/100cm^2.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
COMPRESSOR ROOM EQUIPMENT AND FIXTURES			
8.	**Total** number of items of fixtures and equipment surveyed.	8	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.6 CARPENTER SHOP

12.6.1 Introduction

The Carpenter Shop, often referred to as the Old Maintenance Shop, is capped by a wooden roof. The Carpenter shop consists of one room with a concrete floor. There are five large windows in the south wall and one large window in the west wall.

The Carpenter Shop was used for the storage of radium in the late 1940s and early 1950s. In 1978 NRC reported contamination on one wall of between 10,000 and 50,000 dpm/100cm^2 alpha. The east wall is also reported to be contaminated from an explosion of a Sr-90 source. Part of the lower left of the east wall (where the supposed Sr-90 explosion took place) has been replaced by new polyblock. Materials and equipment inside the building at the time of the Monserco survey included: contaminated cabinets, steel cupboards, wooden tables and an overhead sprinkler system.

The isotopes used at various times in the past in the building include Sr-90 and Ra-226.

12.6.2 Survey Results

The survey results and building photographs are shown in Section 6 of Appendix 20.

A summary of the survey results is shown in Table 12.6.1 below.

TABLE 12.6.1
SUMMARY OF CARPENTER SHOP SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	33	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	5	Grid numbers 8, 9, 28, 29 and 30.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	Eight positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	Three positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	8	Grid numbers 1, 8, 9, 10, 16, 17, 27 and 30.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Bi-214 and Ra-226.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	10	
9.	Number of items with **fixed contamination** above current NRC guideline values.	3	Hot spot in grid number 10, a light fixture and a vacuum cleaner. The value of the hot spot in grid number 10 was >260,000 dpm/100cm^2.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	1	Grid number 10.
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	1	Grid number 10.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	1	Grid number 10.
13.	Number of items with **hot spots** above current NRC guideline values.	1	Grid number 10.

12.7 WELL HOUSE/ADHESIVES NORTH ROOM/SOUTH ROOM

12.7.1 Introduction

The Well House consists of three rooms. The walls of the Well House consist of cinder block, while the roof is constructed of wood. Torn insulation is hanging from the ceiling. The floor is dirt, with suspected alpha contamination. It has two windows in the east wall.

The north end of the Well House contains the old water supply well. (Monitoring Well 17). This consists of an 8 inch diameter pipe in the floor. The south end of the Well House was referred to as the Adhesive Lab and was used for the formulation of adhesives. The south end was decontaminated in 1958 and is currently used for the storage of shredded packaging paper.

The contents of the Well House include 2 water storage tanks, one with a capacity of 30 gallons and the other of 530 gallons.

The suspected contaminants are Ra-226 and solvents.

12.7.2 Survey Results

The survey results and building photographs are shown in Section 7 of Appendix 20.

Summaries of the survey results are shown in the following Tables:

- Table 12.7.1: Well House.
- Table 12.7.2: Adhesives North Room.
- Table 12.7.3: Adhesives South Room.

TABLE 12.7.1
SUMMARY OF WELL HOUSE SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	WELL HOUSE		
1.	**Total** number of grids surveyed.	10	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	Tritium measurements were not made.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	Four positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	1	Grid number 6.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Cs-137, Bi-214 and Ra-226.
	WELL HOUSE EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	1	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	1	Bottom shelf in grid number 7.

TABLE 12.7.2
SUMMARY OF WELL HOUSE ADHESIVES NORTH ROOM SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	ADHESIVES NORTH ROOM		
1.	**Total** number of grids surveyed.	16	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	Fixed contamination measurements were not made.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	0	
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
	ADHESIVES NORTH ROOM EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	0	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

TABLE 12.7.3
SUMMARY OF WELL HOUSE ADHESIVES SOUTH ROOM SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	ADHESIVES SOUTH ROOM		
1.	**Total** number of grids surveyed.	12	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	0	
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
	ADHESIVES SOUTH ROOM EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	0	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.8 LACQUER STORAGE BUILDING

12.8.1 Introduction

The Lacquer Storage Building consists of one room only. The building contains shelving for the storage of drums of solvent (3 high).

The Lacquer Storage Building has no history of radioactive usage. Any contamination which might be present would presumably come from tramp material brought in by personnel from other areas on site.

The suspected contaminants are solvents.

12.8.2 Survey Results

The survey results and building photographs are shown in Section 8 of Appendix 20.

A summary of the survey results is shown in Table 12.8.1 below.

TABLE 12.8.1
SUMMARY OF LACQUER STORAGE BUILDING SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	20	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	Five positive values were recorded.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	No positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.		
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	3	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	Two positive values were recorded.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	Loose tritium contamination measurements not taken.
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	Loose alpha contamination measurements not taken.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	Loose beta contamination measurements not taken.
13.	Number of items with **hot spots** above current NRC guideline values.	1	Grid number 6.

12.9 CESIUM ION EXCHANGE HUT

12.9.1 Introduction

The Cesium Ion Exchange Hut consists of one room only. The Cesium Ion Exchange Hut once housed cesium ion exchange systems. These were used for the treatment of waste water from the Cesium Laboratory in the Main Building. The Cesium Ion Exchange Hut has been gutted but contamination remains on the wall surfaces and floor.

The suspected contaminant is Cs-137.

12.9.2 Survey Results

The survey results and building photographs are shown in Section 9 of Appendix 20.

A summary of the survey results is shown in Table 12.9.1 below.

TABLE 12.9.1
SUMMARY OF CESIUM ION EXCHANGE HUT SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	9	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	9	Fixed contamination was found inside all grids.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	3	Grid numbers 3, 4 and 5.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	1	Grid number 5.
6.	Number of **hot spots** above current NRC guideline values.	9	Hot spots found within all grids. Multiple hot spots within grids.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	4	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	Fixed contamination measurements not taken.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	1	Contamination on the chimney.
13.	Number of items with **hot spots** above current NRC guideline values.	0	Hot spot measurements not taken.

12.10 NUCLEAR BUILDING

12.10.1 Introduction

The Nuclear Building is the primary production area for current tritium operations.

SLC management instructed Monserco not to survey the Nuclear Building. The reason was that the long term validity of a radiological survey could not be guaranteed since the building is in constant use and there is potential for cross contamination.

12.10.2 Conclusions

The Nuclear Building was not surveyed by Monserco, therefore no information was generated on the radiological status of the building.

12.11 GARAGE

12.11.1 Introduction

The Garage was used for the storage of radioactive materials prior to 1950. The structure has been removed and a partial cement foundation remains. The dimensions of the remaining foundation are approximately 20 feet by 12 feet. It was reported that a Cs-137 source had exploded in the garage.

The suspected contaminants are Sr-90, Cs-137, Po-210 and Ra-226.

12.11.2 Survey Results

The survey results and building photographs are shown in Section 11 of Appendix 20.

A summary of the survey results is shown in Table 12.11.1 below.

TABLE 12.11.1
SUMMARY OF GARAGE SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	6	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	6	Fixed contamination was found inside all grids.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	Loose tritium contamination measurements not taken.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	Loose alpha contamination measurements not taken.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	Loose beta contamination measurements not taken.
6.	Number of **hot spots** above current NRC guideline values.	6	Hot spots found within all grids. Multiple hot spots within grids.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Cs-137, Bi-214 and Ra-226.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	0	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.12 ABOVE GROUND METAL SILO

12.12.1 Introduction

The Above Ground Metal Silo was used for the storage of Ra-226 ionitrons. It is currently used for the storage of tritium contaminated equipment. The Above Ground Metal Silo is approximately 5 feet in diameter and is sitting on a degrading cement foundation. The circular fence enclosure has been removed.

The Above Ground Metal Silo and underlying soil are suspected of being contaminated with H-3 and Ra-226.

12.12.2 Survey Results

The survey results and building photographs are shown in Section 12 of Appendix 20.

A summary of the survey results is shown in Table 12.12.1 below.

TABLE 12.12.1
SUMMARY OF ABOVE GROUND METAL SILO SURVEY RESULTS

No.	ITEM	No.	COMMENTS
BUILDING			
1.	**Total** number of grids surveyed.	8	8 grids were systematically surveyed in addition to 17 random swipe samples.
2.	Number of grids with **fixed contamination** above current NRC guideline values.	5	Grid numbers 1, 2, 3, 4, and 6.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	16	17 random swipes were taken from the walls and floor and 16 of these had loose tritium contamination above current NRC guideline values.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	
6.	Number of **hot spots** above current NRC guideline values.	6	Grid numbers 1, 2, 3, 4, 6 and 7.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy not performed.
EQUIPMENT AND FIXTURES			
8.	**Total** number of items of fixtures and equipment surveyed.	0	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.13 SOLID WASTE BUILDING

12.13.1 Introduction

The Solid Waste Building is a concrete block structure, measuring 30 feet by 30 feet and 12 feet high. The floor was made from poured concrete. Wooden beams support a wooden roof. The building is exhausted to the main stack. It consists of one room which is heated only when persons are working in it. The room is illuminated by three banks of fluorescent lights. Access is by one steel door.

The Solid Waste Building is in current use for the storage and compaction of radioactive waste. Materials and equipment inside the building at the time of the survey included: steel drums, pots contaminated with various nuclides, filing cabinets, waste paper, radioactive waste compactor, a ladder, a fan, a fume hood, pipework, a drill press and a gas heater.

The isotopes used at various times in the past in the building include: H-3, Co-60, Ni-63, Kr-85, Sr-90, Cs-137, Ra-226 and Am-241

12.13.2 Survey Results

The survey results and building photographs are shown in Section 13 of Appendix 20.

A summary of the survey results is shown in Table 12.13.1 below.

TABLE 12.13.1
SUMMARY OF SOLID WASTE BUILDING SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	34	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	4	Grid numbers 9, 14, 16 and 27.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	7	Grid numbers 14, 18, 25, 26 27 and 29.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	2	Grid numbers 22 and 34.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy measurements not taken.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	13	
9.	Number of items with **fixed contamination** above current NRC guideline values.	2	Cabinet inside grid number 14.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	3	Cabinet inside grid number 14, drums and center lights.
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	1	A ladder in grid number 16.
13.	Number of items with **hot spots** above current NRC guideline values.	7	Seven hot spots recorded on five items: drill press, pipe, cabinet, ladder, and HS floor.

12.14 OLD HOUSE

12.14.1 Introduction

The Old House is an 1800s residential two story wood house with a dug out earthen basement. The interior of the Old House is in poor structural condition. The first floor is currently used for the storage of contaminated equipment. The second floor is used for the storage of contaminated records and supplies. In their 1978 status report, NRC indicated the presence of widespread alpha contamination in the range 200 -1000 dpm/cm^2 within some areas of the building.

The suspected contaminants are: H-3, Co-60, Ni-63, Kr-85, Sr-90, Cs-137, Po-210, Ra-226 and Am-241

12.14.2 Survey Results

The survey results and building photographs are shown in Section 14 of Appendix 20.

A summary of the survey results is shown in Table 12.14.1 below.

TABLE 12.14.1
SUMMARY OF OLD HOUSE BUILDING SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	51	Grid numbers 41 and 50 were not used.
2.	Number of grids with **fixed contamination** above current NRC guideline values.	2	Grid numbers 23 and 40.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	2	Grid numbers 23 and 52.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	2	Grid numbers 47 and 49.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy measurements not taken.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	7	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	Fixed contamination measurements not taken.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	2	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	5	Cabinet in family room, HS paper on floor, attic garbage can, 2 drums in kitchen.

12.15 LIQUID WASTE BUILDING

12.15.1 Introduction

Before 1960, the Liquid Waste Building site contained below ground vaults used to dilute low level radioactive waste water from the Main Building and Acid Etching Building prior to discharge to the river. After the 1972 flood, the vaults were capped and the Liquid Waste Building was built over the vaults. The Liquid Waste Building is currently used for the dilution of low level radioactive waste water from the Nuclear Building. The waste water is transported by a below grade drain line to a below grade concrete sump within the Liquid Waste Building. The waste water is pumped from the sump to one of four dilution tanks, each above ground with a capacity of 2,400 gallons. The diluted waste water is discharged to the river through NPDES Discharge Outfall No.1, Permit No. 0111848. The waste water is reported by SLC not to contain any radioisotopes other than tritium. The Liquid Waste Building has been noted to contain elevated radon concentrations.

The suspected contaminants are: H-3, Co-60, Ni-63, Kr-85, Sr-90, Cs-137, Po-210, Rn-222, Ra-226 and Am-241. The organic contaminants are ethylene glycol and acetone.

12.15.2 Survey Results

The survey results and building photographs are shown in Section 15 of Appendix 20.

A summary of the survey results is shown in Table 12.15.1 below.

TABLE 12.15.1
SUMMARY OF LIQUID WASTE BUILDING SURVEY RESULTS

No.	ITEM	No.	COMMENTS
BUILDING			
1.	**Total** number of grids surveyed.	62	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	1	Grid number 42.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	0	
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy measurements not taken.
EQUIPMENT AND FIXTURES			
8.	**Total** number of items of fixtures and equipment surveyed.	4	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	One positive value was recorded on the west sink.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	One positive value was recorded on the west sink.
13.	Number of items with **hot spots** above current NRC guideline values.	4	Four hot spots recorded on 3 items: bench legs, west sink, and scale.

12.16 8 BY 8 BUILDING

12.16.1 Introduction

The 8' by 8' Building was used for the storage of Sr-90 deck markers. The building is currently used for the storage of tritium contaminated equipment. A small localized area of contaminated soil is present in front of the building.

The suspected contaminants are: H-3 and Sr-90

12.16.1 Survey Results

The survey results and building photographs are shown in Section 16 of Appendix 20.

A summary of the survey results is shown in Table 12.16.1 below.

TABLE 12.16.1
SUMMARY OF THE 8 BY 8 BUILDING SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	7	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	2	Grid numbers 2 and 5.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	Five positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	11	Eleven hot spots recorded in 7 grids.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Cs-137, Bi-214 and Ra-226.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	6	
9.	Number of items with **fixed contamination** above current NRC guideline values.	5	Contamination found on: large blue tank, motor red box, light switch wall, outside lock hasp.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	Loose tritium contamination measurements were not taken.
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	Loose alpha contamination measurements were not taken.
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	Loose beta contamination measurements were not taken.
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.17 UTILITY BUILDING

12.17.1 Introduction

The Utility Building was used for the storage of Sr-90 solutions and was formerly referred to as the Sr-90 vault. The building has been partially decontaminated and is currently used for the storage of non radioactive materials and supplies.

The suspected contaminant is Sr-90.

12.17.2 Survey Results

The survey results and building photographs are shown in Section 17 of Appendix 20.

A summary of the survey results is shown in Table 12.17.1 below.

TABLE 12.17.1
SUMMARY OF THE UTILITY BUILDING SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	18	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	7	Grid numbers 11, 12, 13, 14, 15, 16 and 18.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	Five positive values were recorded.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	Two positive values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	8	Grid numbers 5, 11, 12, 13, 14, 15, 16 and 18.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy measurements not taken.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	10	
9.	Number of items with **fixed contamination** above current NRC guideline values.	1	Boxes
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.18 RADIUM VAULT

12.18.1 Introduction

The Radium Vault was used for the pouring of lead, and the handling and storage of radium bromide, radium foil and radium radiation sources. All radioactive materials are thought to have been removed from the building. The roof structure of the building has collapsed, inhibiting entry into the building. The majority of the beams are lying on the floor. Some beams are leaning almost vertically against the south wall where they have not completely collapsed.

In 1970 the NRC reported contamination levels up to 50,000 dpm/100cm^2 fixed alpha and 200 dpm/100cm^2 removable alpha.

The suspected contaminant is Ra-226. Lead is also a suspected non radiological contaminant.

12.18.2 Survey Results

The survey results and building photographs are shown in Section 18 of Appendix 20.

A summary of the survey results is shown in Table 12.18.1 below.

TABLE 12.18.1
SUMMARY OF THE RADIUM VAULT SURVEY RESULTS

No.	ITEM	No.	COMMENTS
BUILDING			
1.	**Total** number of grids surveyed.	34	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	0	Positive fixed contamination values were recorded for every grid surveyed.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	Loose tritium contamination measurements were not taken.
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	Loose alpha contamination measurements were not taken.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	Loose beta contamination measurements were not taken.
6.	Number of **hot spots** above current NRC guideline values.	0	Positive readings were found inside grid numbers 15 and 17.
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy measurements not taken.
EQUIPMENT AND FIXTURES			
8.	**Total** number of items of fixtures and equipment surveyed.	0	
9.	Number of items with **fixed contamination** above current NRC guideline values.	0	
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

12.19 PLASTIC MACHINE SHOP

12.19.1 Introduction

In the early 1960s the plastic machine shop was referred to as the Tritium Building and used for the manufacturing and/or handling of tritium foils and tritium luminous compounds. In 1969, the tritium production operations were moved to the Nuclear Building, allowing partial decontamination of the building. The building is currently used as a Machine Shop involving non radioactive materials. Contamination is known or suspected to remain in the overhead ventilation lines, exhaust fan and under the pavement adjacent to the building. Glove boxes were located along the walls prior to 1969. These were connected to an approximate 3 inch diameter pipe serving as an exhaust duct. Other areas partially contaminated with tritium in this building include a tritium draw near the center of the building and a small tritium pit located to the left on the floor. The tritium drain consists of a small pipe projecting about one foot upward from the floor. This pipe is also capped with masking tape. An electric motor is supported by a small concrete block structure at the southeast corner of the building exterior. The soil under the motor is at ground level. No pit or sump is located there.

The suspected radioactive contaminant is H-3. Toluene is a suspected non radiological contaminant.

12.19.2 Survey Results

The survey results and building photographs are shown in Section 19 of Appendix 20.

A summary of the survey results is shown in Table 12.19.1 below.

TABLE 12.19.1
SUMMARY OF THE PLASTICS MACHINE SHOP SURVEY RESULTS

No.	ITEM	No.	COMMENTS
	BUILDING		
1.	**Total** number of grids surveyed.	45	
2.	Number of grids with **fixed contamination** above current NRC guideline values.	1	Grid number 42. Only a small number of fixed contamination measurements were taken.
3.	Number of grids with **loose tritium contamination** above current NRC guideline values.	0	
4.	Number of grids with **loose alpha contamination** above current NRC guideline values.	0	No positive loose alpha contamination values were recorded.
5.	Number of grids with **loose beta contamination** above current NRC guideline values.	0	No positive loose beta contamination values were recorded.
6.	Number of **hot spots** above current NRC guideline values.	0	
7.	**Gamma emitting isotopes** detected in the room by Monserco gamma spectroscopy.		Gamma spectroscopy measurements not taken.
	EQUIPMENT AND FIXTURES		
8.	**Total** number of items of fixtures and equipment surveyed.	7	
9.	Number of items with **fixed contamination** above current NRC guideline values.	1	Sink in the bathroom.
10.	Number of items with **loose tritium contamination** above current NRC guideline values.	0	
11.	Number of items with **loose alpha contamination** above current NRC guideline values.	0	
12.	Number of items with **loose beta contamination** above current NRC guideline values.	0	
13.	Number of items with **hot spots** above current NRC guideline values.	0	

13 HEALTH PHYSICS RESULTS FOR MONSERCO AND CONTRACT STAFF

13.1 INTRODUCTION

A number of Health Physics controls were exercised during the work associated with the characterization of the SLC site. These included:

1. Provision of weekly urine samples for analyses by SLC.
2. Provision of weekly urine samples for analyses by Monserco.
3. Use of Direct Reading Dosimeters.
4. Use of Thermal Luminescent Dosimeters (TLDs).

An account is given below of the TLD, DRD, and weekly urine analyses results.

13.2 THERMAL LUMINESCENT DOSIMETERS

During all characterization opertions Monserco and contract staff carried Thermal Luminescent Dosimeters, which were read monthly by Landauer Inc. The results are shown in Appendix 21, Table A21.1. In most cases, values below the measurable quantities were reported. Two positive body doses were recorded, both at 10 millirem over a period of one month. One positive skin dose was reported. This was 10 millirem over a period of one month.

13.3 URINE ANALYSES

Monserco and contract staff gave weekly urine samples which were analyzed by Monserco for tritium. The results are shown in Appendix 21, Table A21.2. In most cases, values below the limit of detection were reported. Over 40 urine results were measured to have values greater than the minimum detectable activity. The highest result was 54,189 picoCuries of tritium per liter, which corresponded to a committed dose of 0.15 millirem.

13.4 DIRECT READING DOSIMETERS

Monserco staff, contract staff, and visitors to the site carried Direct Reading Dosimeters during all characterization operations in and around the Safety Light site. The dosimeters were read and recorded prior and following each work day, and were monitored by Monserco staff periodically throughout the day. Daily doses incurred in the characterization of the site were generally less than 1 mrem (the smallest increment of the DRDs) and only very rarely were greater than 1 millirem in one day. The highest results showed a dose of 12 millirem for an employee of Monserco and 10 millirem for a contracted employee.

13.5 CONCLUSIONS

Dose levels incurred in the characterization of the Safety Light property were not sufficiently high enough to warrant any concern. None of the Monserco or contract staff received a radiation dose which approached the annual limit set for the general public.

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