US Army Corps of Engineers®
Buffalo District

FUSRAP

FINAL

TECHNICAL MEMORANDUM

SYNOPSIS OF VOLUME CALCULATIONS FOR SEAWAY SITE AREAS A, B, AND C

TONAWANDA, NEW YORK

JUNE 7, 1999

200.1e

Seaway_04.09_0001_a

TABLE OF CONTENTS

1. INTRODUCTION 1
   1.1 PURPOSE AND OBJECTIVE 1

2. BACKGROUND INFORMATION 1
   2.1 DISPOSAL OF MED-RELATED RESIDUE AT SEAWAY AREAS A, B, AND C 1
   2.2 INVESTIGATIONS OF EXTENT OF MED-RELATED RESIDUE 2
      2.2.1 ORNL Study - 1976 2
      2.2.2 FBDU Study - 1981 3
      2.2.3 BNI Studies - 1988-1990 3
      2.2.4 SAIC/SEC-1998 4
      2.2.5 SAIC-1998 4

3. PREVIOUS VOLUME ESTIMATES 5
   3.1 1981 VOLUME ESTIMATES 5
   3.2 1993 FS VOLUME ESTIMATES - BNI 5
   3.3 1996 MODELING ESTIMATES 6
   3.4 1997/1998 MODELING ESTIMATES 6

4. VOLUME ESTIMATES - Th-230 >40 pCi/g CLEANUP CRITERIA 7
   4.1 3-DIMENSIONAL MODEL 8
      4.1.1 Model Data Set 8
      4.1.2 Numerical Modeling 9
      4.1.3 Model Sensitivity Analysis and Validation 9
      4.1.4 Changing Site Conditions 10
   4.2 IN-SITU VOLUMES 10
   4.3 EXCAVATION CONSIDERATIONS 11
      4.3.1 Slope Stability 11
      4.3.2 Landfill Gas Monitoring 11
      4.3.3 Depth of Excavation - Area A 12
      4.3.4 Excavation - Areas B and C 12
   4.4 EXCAVATION VOLUMES 13
      4.4.1 Area A 13
      4.4.2 Areas B and C 13
   4.5 DISPOSAL VOLUMES 14

5. SUMMARY 15

6. REFERENCES 16

FIGURES

Figure 2-1 Plan View of Seaway Industrial Park
Figure 2-2 1998 Aerial Photograph of Seaway Landfill
Figure 2-3 Additional Characterization of Seaway Site Areas B and C Sampling Locations
Figure 2-4 Gamma Walkover Data for Seaway Site Areas A, B, and C
Figure 4-1 Average Th-230 Distribution within 0-2 Foot Lift
Figure 4-2 Average Th-230 Distribution within 2-4 Foot Lift
Figure 4-3 Average Th-230 Distribution within 4-6 Foot Lift
Figure 4-4 Average Th-230 Distribution within 6-8 Foot Lift
Figure 4-5 Seaway Site Area A Cross Section - Th-230 “plus” Distribution
Figure 4-6 Seaway Site Areas B and C Cross Section - Th-230 “plus” Distribution
Figure 4-7 Seaway Site Area C Cross Section - Th-230 “plus” Distribution
Figure 4-8 Seaway Site Area A - Depth to Top of Landfill Material
Figure 4-9 Location of Excavation Boundary for 0-2 Foot Lift
Figure 4-10 Location of Excavation Boundary for 2-4 Foot Lift
Figure 4-11 Location of Excavation Boundary for 4-6 Foot Lift
Figure 4-12 Location of Excavation Boundary for 6-8 Foot Lift
Figure 4-13 Location of Area A Excavation Boundary Below 8 Feet

TABLES

Table 4-1 Summary of Th-230 Analytical Data
Table 4-2 Summary of Data Points, In-situ Volumes, and Concentrations Based on Modeled Th-230
Table 4-3 Conditions That May Impact Excavation Efforts
Table 4-4 Summary of Information on Depth to Landfill Material
Table 4-5 Summary of Volumes for Full Excavation of Modeled Th-230 Area A
Table 4-6 Summary of Partial Excavation and Disposal Volumes for Area A
Table 4-7 Summary of Volumes for Full Excavation Area B
Table 4-8 Summary of Volumes for Full Excavation Area C
Table 4-9 Summary of Excavation and Disposal Volumes for Full and Partial Excavation Areas B and C

APPENDICES

Appendix A Table 1-10 from 1993 Remedial Investigation Report by Bechtel National, Inc.
Appendix B Relevant Figures and Tables - ORNL Study
Appendix C Relevant Figures and Tables - FDBU Study
Appendix D Relevant Figures and Tables - BNI Studies
Appendix E Boring Logs

ACRONYMS AND ABBREVIATIONS

BNI	Bechtel National Incorporated
cy(s)	cubic yard
DOE	U.S. Department of Energy
EPA	Environmental Protection Agency
FBDU	Ford, Bacon, and Davis of Utah
FS	Feasibility Study
FUSRAP	Formerly Utilized Sites Remedial Action Program
ft	Foot (feet)
g	Gram(s)
MED	Manhattan Engineer District
NYSDEC	New York State Department of Environmental Conservation
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
pCi	Pico Curie(s)
PP	Proposed Plan
Ra	Radium
RI	Remedial investigation
ROD	Record of Decision
SAIC	Science Applications International Corporation
SOR	Sum of Ratio
Th	Thorium
U	Uranium

1. INTRODUCTION

1.1 PURPOSE AND OBJECTIVE

Over the years several estimates of the volume of Manhattan Engineer District (MED)-related contamination have been reported for the Seaway Site (Seaway Areas A, B, and C). This document provides a summary of those estimates and the basis for each of the estimates. This document also provides information regarding the three-dimensional model currently being used to estimate volumes and presents volume estimates for in-situ contamination, excavation, and disposal based on the model.

The objective of this document is to provide clarification on the volume estimates that will be used in preparation of the addenda to the Feasibility Study (FS) and Proposed Plan (PP) for Seaway. This document does not provide information on cost estimates for remediation. Costing information will be provided in the Addendum to the FS and PP.

2. BACKGROUND INFORMATION

This section presents a brief discussion on the history and nature of the disposal of MED-related residue at the Seaway Site. This information is derived primarily from the Remedial Investigation (RI) report prepared for the Tonawanda Sites (BNI 1993); information is also derived from the December 1981 report by FBDU entitled "Preliminary Engineering and Environmental Evaluation of the Remedial Action Alternatives for the Seaway Industrial Park, Tonawanda, New York." The reader is referred to the original documents for additional detailed information regarding the site. Relevant figures and tables from the studies referenced are presented in Appendices of this document.

2.1 DISPOSAL OF MED-RELATED RESIDUE AT SEAWAY AREAS A, B, AND C

In 1974, approximately 6,000 cubic yards (cy) of MED-related residues (comprised mostly of low grade uranium ore tailings) were disposed of at the Seaway Industrial Park sanitary landfill. The residues were disposed of on three areas of the active landfill. The three areas, referred to as Areas A, B, and C, are shown in Figure 2-1 (Figure 1 from ORNL report; ORNL, 1978) and comprise a total combined area of 13 acres.

The landfill continued to remain operational following placement of the MED-related residue in Seaway Areas A, B, and C. As a result of continued landfilling, some of the residue was buried under refuse and fill materials. It is reported that some of the residue in Areas B and C may be

covered with up to 40 ft of landfill material and approximately 40 % of Area A may be covered with a thinner layer (0 to 10 ft) of landfill material (BNI 1993).

The landfill, used to dispose of waste since 1930, is known to have received a variety of municipal, commercial, construction, and industrial wastes, including fly ash; waste oils; spent solvents; sludges; oil sludges; DuPont's "Corian," "Vexar", and "Tedlar" wastes; and miscellaneous industrial wastes (refer to RI Table 1-10 presented in Attachment A). It is reported that some of the industrial wastes may be classified as hazardous (FBDU 1981).

In 1993, landfilling at Seaway ceased and significant portions of the Seaway landfill were closed in 1995 in accordance with New York State Department of Environmental Conservation's (NYSDEC) Solid Waste Regulations. As suggested by the 1998 aerial photograph (Figure 2-2), the closure/capping of the landfill did not include Seaway Areas A, B, and C.

2.2 INVESTIGATIONS OF EXTENT OF MED-RELATED RESIDUE

Characterization studies have been conducted at Seaway several times over the years. The most recent characterization involved a walkover gamma scan performed in 1998 by SAIC/SEC. These studies have provided information on the extent of radioactive contamination resulting from the disposal of residue in the landfill.

2.2.1 ORNL Study - 1976

The first studies of the site were conducted by ORNL in 1976, approximately two years following the deposition of MED-related residue in the Seaway landfill. During the ORNL study, the depth and extent of contamination in Areas A, B, and C were investigated by collecting soil samples from 60 locations for analysis of Radium-226 (Ra-226) and Uranium-238 (U-238). Samples were typically collected from a depth of about 2 ft; however, samples collected at some locations extended to a depth of 6.5 ft. (Sampling locations and results from the ORNL study are presented in Appendix B.)

At the time of ORNL's study, contamination (i.e., soils with concentrations of Ra-226 above EPA criterion[1] was found to be in the upper 2 ft of soil, located generally in the areas of original residue deposition. A small area of contamination was also identified in the drainage ditch leading

---

[1] EPA soil concentration limits for RA-226 for inactive uranium processing sites (40 CFR Part 192 Subpart B; July 1980: "The average concentration of Ra-226 attributable to residual radioactive material from a designated processing site in any 5 cm thickness of soils or other materials on open land within 1 ft of the surface or is a 15 cm thickness below 1 ft, shall not exceed 5 pCi/g."

north from Area A. The contamination in Areas B and C was limited to small isolated piles of residue materials. Sampling in Areas B and C was limited to those piles.

The ORNL study also included a radiological survey of the site to determine radiation levels. The results of this survey indicated that external gamma radiation, radon, and radon daughter levels exceeded guideline levels over small isolated areas of the landfill. Surface beta-gamma measurements showed the distribution of elevated readings closely approximated the distribution of elevated external gamma readings.

2.2.2 FBDU Study - 1981

The study conducted by FBDU in 1981 (approximately seven years following deposition of the MED-related residue in the landfill) generally confirmed the findings of the ORNL study. The FBDU report indicates that the residue deposited in Area A (10 acre area) was generally spread to a depth of less than 2 ft. In Areas B and C, the residue had been left in small isolated mounds. The report also indicates that at the time of the study, most of the residue was not covered, but had been partially mixed with clean soil during recent years due to earth moving associated with landfill operations.

FBDU also reported that a comparison of the results of the external gamma radiation survey performed by FBDU and the early survey by ORNL indicates that radioactive material in Area A was apparently stable between the period of time of the ORNL and FBDU studies. Soil sampling results indicated that in Area A, contamination was located within the upper 2 ft of the landfill. Areas B and C contained contaminated soils to a depth of approximately 3 ft. The results of the study suggested that Area C seemed to have increased in size possibly due to erosion down the slope to the south approaching the access road at the back of the landfill.

FBDU also concluded from their study that contaminants in Area B seem to have been dispersed based on the facts that soils samples in Area B were not elevated and external gamma readings were only slightly elevated. It is further noted that soil samples obtained at the side of the access road had only background concentrations of Ra-226 and U-238, suggesting that the residue was not spread onto the road area. (Refer to Appendix C for relevant figures and tables from the FBDU study.)

2.2.3 BNI Studies - 1988-1990

In 1988 (approximately 15 years following deposition), a walkover gamma scan of the Seaway property was performed to gain information on the distribution of radioactive materials in the landfill. The findings of the gamma scan indicated that radioactive contamination had extended down the northern slopes of Area A as much as 75 ft. Areas B and C could not be found by surface scanning. Based on comparisons of topographic maps of the landfill made in 1976 and

1986, it was estimated that landfilling had occurred in Areas B and C with some areas covered with up to 40 ft of landfilled material and that approximately 40% of Area A had been covered with a similar, but thinner (0 to 10 ft), layer of material.

Sampling was also conducted in 1988 and 1990 to investigate the thorium (Th-230) contamination in Area A (samples were analyzed for U-238, Ra-226, and Th-230). Because landfill material covered Areas B and C, samples could not be collected to gain direct information on the Th-230 concentrations in these areas.

The results of the sampling in Area A indicated that Th-230 was present at higher concentrations than either U-238 and Ra-226 and identified radioactive contamination primarily in the shallow soils (0 to 8 ft) in Area A. The extent of radioactive contamination, as determined from the BNI studies, is shown on Figure 4-13 of the RI (refer to Appendix D).

2.2.4 SAIC/SEC-1998

In the summer of 1998, SAIC/SEC conducted a walkover gamma survey, covering approximately 26 acres which comprised Areas A, B and all but 2 acres in the easternmost portion of Area C. In December 1998, SEC completed the gamma walkover of the remaining 2 acres of Area C. The results of the 1998 walkover gamma surveys are shown in Figure 2-3. A comparison of Figure 2-3 with Figure 1-14 of the RI (refer to Appendix D) indicates fairly good correlation on the limits of contamination. As indicated in Figure 2-3, only a few very small, isolated points of elevated gamma readings were noted in Areas B and C.

2.2.5 SAIC-1998

In December 1998, SAIC conducted a limited subsurface investigation in Areas B and C. The investigation focused primarily on the three small areas of elevated activity (i.e. anomaly locations) identified during the gamma walkover surveys (refer to Figure 2-3). The goal was to determine if there was elevated radioactivity within the upper 4 feet of the ground surface at the anomaly locations and to determine if any elevated activity was MED-related. Four soil samples were collected at each of the anomaly locations. Soil samples were also collected from six random locations (refer to Figure 2-4). In total, the investigation involved completion of 18 Geoprobe® soil borings and analysis of 44 samples. Samples were analyzed for U-234, U-235, U-238, Th-230, Th-232, Ra-226, Protactinium-231, and Actinium-227.

Results for Area B indicated that the elevated readings detected in the gamma walkover surveys (anomaly location) were attributed to an igneous rock buried approximately 4-6 inches beneath ground surface. A sample from this rock exhibited a gamma reading of 55 uR/h. Laboratory results for the rock sample indicated the presence of elevated levels of Radium, Uranium, and Thorium. None of the soil samples collected from area B contained Th-230 concentrations in

excess of 40 pCi/g. It is noted that refuse and/or refusal was encountered at most of the sampling locations in Area C.

Sample results for Area C indicated the presence of radiological contamination at one of the areas of elevated radiological activity identified in the Gamma walkover surveys. Analytical data suggested that radiological contamination in this area extends from 3 to 4 feet below ground surface. None of the soil samples from the second anomaly location or the four random sampling locations contained Th-230 at concentrations exceeding 40 pCi/g.

3. PREVIOUS VOLUME ESTIMATES

Volume estimates for evaluation of remedial alternatives have been provided by various sources and are discussed briefly in the following sections.

3.1 1981 VOLUME ESTIMATES

In the 1981 report entitled, "Preliminary Engineering and Environmental Evaluation of the Remedial Action Alternatives for the Seaway Industrial Park, Tonawanda, New York" (FBDU, 1981), it is stated "because of moving and spreading of the residue, much mixing has occurred with clean soil, greatly increasing the volume of contaminated material from the 6,000 cy of disposed residue." According to the ORNL soil data, Area A was reported to contain contamination above EPA criteria to a depth of approximately 2 ft. Areas B and C contained contaminated soil to a depth of approximately 3 ft.

Based on the results of the ORNL and FBDU studies, FBDU estimated that the total in-place (in-situ) volume of contamination in or near Areas A, B, and C was 49,400 cy (based on exceedance of EPA criteria, "5 and 15"). This estimate was based on a surface area of Area A equal to 49,300 square yards (yd^2); 2,200 yd^2 for Area B; and 14,400 yd^2 for Area C. The total volume of contaminated material upon excavation was estimated to be 61,700 cy based on a bulk volume with a 25% swell.

3.2 1993 FS VOLUME ESTIMATES - BNI

Volume estimates were also provided in the 1993 FS. These estimates were developed utilizing a two-dimensional model. The model was used to interpolate (predict) the surface area of contamination based on available data for total uranium. The area of contamination was defined in accordance with DOE Orders and a uranium cleanup criteria for the Tonawanda sites (including Seaway) of 60 pCi/g total uranium.

Based on the results of the two-dimensional modeling, the total volume of (in-situ) contaminated soils at Seaway (A, B, and C) exceeding DOE generic guidelines was estimated to be 117,000 cy. However, in evaluating removal options, it was concluded in the FS that the radioactively contaminated soils buried within or under the landfill are considered "access-restricted" (soils that exceed the cleanup levels for radionuclides, but access is currently constrained by landfill debris). Radioactively contaminated soils buried within (or under) the commercial landfill at Seaway Areas B and C were considered to be "access-restricted." The volume of contaminated soils in Areas B and C was estimated to be 25,900 cy.

3.3 1996 MODELING ESTIMATES

In 1996, a three-dimensional model of the radioactive contamination at Seaway was developed and used to calculate the total volume of in-situ contamination. The site database developed by BNI for the 1993 estimates was electronically transferred to SAIC for direct input into the three-dimensional model. In addition to utilization of a "3-D" versus "2-D" model, DOE decided to assess extent and volume of contamination based on Sum of Ratio (SOR) values greater than three (SOR>3). This change in SOR values was based on DOE's determination that SOR>3 constituted a value that represented a Th-230 value of 40 pCi/g, which was the site-specific cleanup criteria for Seaway.

The SOR values are based on ratios of the maximum value of Ra-226 or Th-230 divided by the Ra-226 cleanup standard of 5/15 pCi/g plus the value of U-238 divided by the uranium cleanup standard established by DOE for Tonawanda. Much of the pre-1988 studies did not include analysis of Th-230. The SORs used were computed using only measured values with no accounting or corrections made when Th-230 or U-238 data were missing. These SOR values were used to develop the three-dimensional model.

The volume estimates based on that model of SOR>3 are presented in Table 3-1. As indicated in Table 3-1, the total (combined) estimate of in-situ contamination within Areas A, B, and C with SOR values >3 was 13,323 cy. This volume, and associated calculation package, was included in the Administrative Record as part of the Ashland 1 and 2 PP and Record of Decision (ROD).

3.4 1997/1998 MODELING ESTIMATES

During1997, the FUSRAP program began utilizing radionuclide concentrations for cleanup criteria rather than SOR values and the decision was made to utilize Th-230 values greater than 40 pCi/g to estimate volumes. In revising the three-dimensional model, the lack of Th-230 data for the early data sets was discussed. During updating of 3-D modeling for the Ashland 1 and 2 Sites, a regression analysis was performed using sample data where both Ra-226 and Th-230 results were

available. This regression analysis was used to generate predicted Th-230 values (referred to in this report as Th-230 “plus” values) for sample locations that did not have the Th-230 data. The Th-230 data and predicted Th-230 values were used in developing a new SOR data set (Th-230 “Plus” data set). The Th-230 “Plus” data set was then used to generate new volume estimates for Th-230 concentrations exceeding 40 pCi/g (SOR>3). The Th-230 “Plus” data set for Ashland 1 and 2 resulted in only a minor change in volume calculations. Based on these findings, it was believed that there would also be only a minor change in volumes for Seaway. As a result, DOE concluded that no additional modeling would be performed for the Tonawanda Sites beyond the 1996 modeling.

In late 1997, following transfer of FUSRAP to USACE, questions arose regarding the volume estimates and, as a result, it was determined that additional modeling was required. In 1998, the Seaway model was updated to utilize the regression analysis to predict Th-230 values for sample locations that did not include Th-230 data. Based on the updated model, the total estimated in-situ volume of Th-230 exceeding 40 pCi/g in Areas A, B, and C was estimated to be about 61,000 cy. The significant increase in the estimated in-situ volume from the 1997 value is due primarily to the addition of predicted Th-230 values. (The previous estimates using SOR>3 were under-estimates based on the fact that a concentration of zero had been assumed in 1997 for data points where Th-230 data did not exist.)

Detailed discussion of the volume estimates using the 1998 model and Th-230 >40 pCi/g are presented in Section 4.

4. VOLUME ESTIMATES - Th-230 >40 pCi/g CLEANUP CRITERIA

Volume estimates were developed using the three-dimensional model[(2)] of Th-230 concentrations (actual and predicted). Since all volume estimates have been made using the model, a brief discussion of the model is initially presented as a basis for the later discussion of the volume estimates.

4.1 3-DIMENSIONAL MODEL

This section discusses some of the considerations that the reader should be aware of related to the volume estimates.

[(2)]Modeling software used was EarthVision© version 4.1

4.1.1 Model Data Set

As previously noted, the three-dimensional model was developed to derive the volume estimates. The model presents a representation of predicted subsurface conditions based on interpolation between widely spaced data points. Therefore, the model is limited in part to the degree of three-dimensional coverage of the data set of Th-230 values. The distribution of "clean" data points also impact the ability of the model to accurately predict the distribution and volumes of contamination (discussed further in Section 4.1.2). Further, because the model was developed using actual Th-230 data and predicted Th-230 data, the accuracy of the model and volume estimates is also based on the accuracy of the predicted Th-230 values.

Table 4-1 provides a summary of the number of actual Th-230 data points that exist for Areas A, B, and C. The table also notes the vertical distribution of the data. As shown on Table 4-1, actual Th-230 data are limited to Area A and the upper 10 ft at Areas B and C[3]. For Area A, approximately 80% of the data are limited to a depth of 4 ft.

Table 4-2 provides a summary of the total number of Th-230 data points within the model based on the Th-230 "Plus" data set (i.e., actual and predicted Th-230 values). Again, for Area A, approximately 80% of the data are limited to a depth of 4 ft. It is also important to note from Table 4-2 that there are only four (predicted) data points that define Area B below a depth of 8 ft.

A series of figures were created to illustrate the vertical distribution of data within the model. Figure 4-1 shows the distribution of data points and the interpreted extent of Th-230 contamination[4] for the depth interval of 0 to 2 ft below the ground surface[5] for Areas A, B, and C. Figures 4-2 through 4-4 provide the same information for the depth intervals of 2 to 4, 4 to 6, and 6 to 8 ft, respectively. It is noted that the data point locations indicated in these figures include locations of both the actual and predicted Th-230 data points.

4.1.2 Numerical Modeling

There are also inherent limitations associated with numerical modeling that can impact the depiction of the extent of contamination and the accuracy of the volume estimates. For example, an inherent assumption in utilizing the modeling software is that the material being modeled is

---

[3]Data collection for Areas B and C generally limited to the upper 4 ft with limited sampling to a depth of 8 feet.

[4]Extent of Th-230 contamination shown represents the average Th-230 distribution for the specified depth interval.

[5]The topographic data in the model is based on 1991 site conditions.

homogeneous and isotropic for the defined units of the model (i.e., it can not simulate landfill debris and the sequencing of landfill debris and daily cover materials).

In addition, it is difficult to model a drastic change in concentration such as that associated with the placement of contaminated media on top of "clean or non-contaminated material." The existing data set is based on a "biased" sampling approach (i.e., sampling locations were selected to obtain data in areas believed to be contaminated); very little data exists that confirms "clean" locations. Therefore, there are a limited number of "boundary" points for the model to control the interpolation of the aerial and vertical extent of contamination. The impact of this is that at locations where there was a sample with a fairly high concentration of Th-230 and no deeper sampling indicating a lower concentration, the model likely overestimates the extent (depth) of contamination. "Artificial" control can be placed in the model to limit the interpolation and resulting modeled extent of contamination. Therefore, consistent with the 1996 modeling effort, minimal control was included in the model; control points were inserted into the model at a depth of 30 ft below the 1978 topographic surface.

4.1.3 Model Sensitivity Analysis and Validation

A sensitivity analysis is not appropriate for static models, such as the model used in this study. Therefore, no sensitivity analysis was conducted.

The modeling software used (EarthVision™) is a proven, commercially available, state-of-the-art 3D geospatial data analysis software package. The algorithm used to develop the 3D model in EarthVision is known as Minimum Surface Tension Gridding (MSTG). Industry experience suggests that MSTG typically honors the sampling data better than other gridding algorithms. In the case of this model, quantitative measures of the degree to which the model honors the data are within acceptable limits (the average absolute error between the sampling data results and the modeled values at sampling locations was 0.011 pCi/g or 0.25%).

In addition to the quantitative measures stated above, the model QC process involves qualitative visual verification of the model with respect to the input sampling data and with respect to the conceptual model features (i.e., contamination not extending below some depth, beyond some lateral boundary, etc.).

Model validation in the case of this 3D static model would consist of comparing actual contaminant locations from further sampling (or from remedial activities) to the model predictions for those same areas. The December 1998 characterization efforts conducted following development of the model did confirm the prediction of near surface contamination in the northern portion of Area C; this finding provides some validation of the modeled system. Further validation would depend on comparison of the results from additional sampling/remedial activities to the model predictions for those same areas.

4.1.4 Changing Site Conditions

It is also important to note that the model utilizes available data dating back to 1978. Since 1978, there have been changes at the site including additional landfilling, landfill grading, and capping. The model has taken into account changes in elevation; however, if concentrations changed as a result of additional landfilling, grading, and capping, the model will not necessarily reflect this change because no data was removed from the data set; therefore, it is possible that the earlier data set contained higher concentrations than may currently be present.

This issue of changing site conditions may have the greatest impact on Areas B and C where there is evidence of significant landfilling over the residue, as indicated in the FS. Analytical data collected from Areas B and C following placement of landfill material over the residue is generally limited to the upper 4 feet of the landfill surface.

4.2 IN-SITU VOLUMES

The term "in-situ volume" refers to the "modeled" volume of contamination with Th-230 values exceeding the 40 pCi/g Th-230 cleanup criteria. A summary of the estimated in-situ volumes for Areas A, B, and C is presented in Table 4-2.

The volume estimates for Area A indicate the model predicts approximately 60% of the in-situ volume of Th-230 is located within 4 feet of the surface (based on 1991 topographic conditions), and 80% of the volume is within the upper 6 ft. The information in Table 4-2 also indicates that the average concentration of Th-230 data set below 4 ft in Area A is less than the 40 pCi/g cleanup criteria. As indicated on Table 4-2, there are no data points in Area A below 8 ft and the volumes of contamination (i.e., Th-230 >40 pCi/g) at depths below 8 ft are based on the modeled distribution of contamination. To aid in visualization of the vertical distribution of the modeled contamination in Area A, the reader is referred to Figure 4-5 (cross-section/"slice through" the modeled contamination showing the orientation of the 2 ft lifts parallel to the (1991) topographic surface).

The data in Table 4-2 also indicates that excavation to a depth of at least 40 ft in Area B, and >50 ft in Area C, would be required to remove all soils exceeding 40 pCi/g Th-230. The model indicates that there is no contamination within the upper 10 ft and there is less than 10% of the total volume of contamination within the upper 18 ft of Area B. At Area C, the model indicates that there is contamination at and near the surface; however, less than 25% of the total volume is within the upper 8 ft. To aid in visualization of the vertical distribution of the contamination in Areas B and C, the reader is referred to Figures 4-6 and 4-7 (cross-sections/slices of the modeled contamination in Areas B and C).

4.3 EXCAVATION CONSIDERATIONS

As indicated by the historical data and the modeling effort, excavation to considerable depth within the landfill would be required to completely excavate the contamination material. The depths of excavation and excavation within landfill debris requires additional consideration for the remedial efforts. This section briefly discusses some of the conditions that will require consideration during excavation efforts.

Table 4-3 presents a listing of typical conditions that could be expected during excavation in the landfill which may impact the ability to continue excavation efforts; however, it does not represent all possible conditions. It is recommended that a qualified Health Physicist, Environmental and Structural Engineers, and qualified Industrial Hygienist be present during excavation activities to monitor and identify "access-restricted" conditions. Documentation of when, where, and the site conditions defining the "access-restriction" should be required.

4.3.1 Slope Stability

Slope stability is a consideration for excavation. OSHA requires that excavation in any material to depths >5 ft include shoring or side sloping. Due to the variability of the materials that have been landfilled, including sludges and other industrial refuse, the mass of the landfilled area is considered to be a Type C soil as defined under OSHA. Excavations in Type C soils to depths < 20 ft must have a maximum side slope of 1.5 to 1. Any excavation >20 ft, regardless of soil type, requires a special design by a registered engineer. SAIC recommends a 2:1 slope for excavations to depths <20 ft.

4.3.2 Landfill Gas Monitoring

With respect to hazards to workers associated with releases of landfill gases into the work area during excavation, the experience of the drillers having to cease operations during drilling into the landfill during the RI was noted (refer to Table 4-4). A health and safety plan would be required for all excavation work at the landfill and would include health and safety monitoring (volatile organic compounds, methane, H_2S, LEL, O_2, and gamma radiation) to identify dangerous conditions that would further define access restrictions. The Health and Safety Plan should also include monitoring stations designed to monitor the impacts to the surrounding area as well as remediation workers. Consideration would also be given to nuisance conditions (i.e., odors, fugitive dust, vermin) if they could not be satisfactorily controlled.

4.3.3 Depth of Excavation - Area A

Historical information suggests that radioactively contaminated residue was placed at the surface of the landfill in Area A. Available information also suggests that portions of Area A have been

landfilled (covered with landfill refuse) since the residue was disposed of in Area A; however, the assumption was made that the topography in Area A remained unchanged between 1978 and 1991. This seems reasonable since the 1998 gamma scan survey suggests near surface contamination continues to exist in area A. Based on this assumption, Th-230 in Area A is modeled as being at or near the surface of the landfill. Therefore, the contaminated material is accessible from the surface. The modeled distribution of contamination in Area A suggests that contamination in excess of the cleanup criteria extends from the surface to a depth of 16 ft. (refer to Table 4-2); however, 80% of total volume exists within the upper 6 feet. A review of boring logs from the RI was conducted to determine the extent of contamination that is reasonably accessible (i.e., no or limited landfill refuse) A summary of the information obtained from the boring logs is presented in Table 4-4 (copies of boring logs are presented in Appendix E). Drilling health and safety conditions noted during drilling and documented in the logs are also noted in Table 4-4.

As indicated in Table 4-4, the depths at which landfill refuse was encountered ranged from approximately 1.5 ft to approximately 5 ft. As indicated in Figure 4-8, which shows the borings and depths to landfill refuse in Area A, the average depth to landfill refuse in Area A is approximately 4 ft. This suggests that access restrictions or “access-restricted” conditions may be encountered at a depth of 4 ft in Area A.

4.3.4 Excavation - Areas B and C

There were no borings drilled in Areas B and C to evaluate the thickness of landfill refuse overlying the MED-related material. Information presented in the RI indicates that MED-related contamination in Areas B and C may be covered with up to 40 ft of landfill refuse. Based on this information, it is likely that access-restricted conditions will be encountered in any attempts to excavate the contaminated material.

The 1998 limited subsurface characterization provided information on shallow (depth of 0-8 ft) subsurface conditions in Areas B and C. No radioactive material was found near the surface in Area B. Therefore, it is believed that access-restrictions will be encountered in any attempts to excavate contamination in Area B.

Material with Th-230 concentration exceeding 40 pCi/g was found a depth of 3- 4 ft at one area of Area C (defined by 3 sampling locations). The total depth to which contamination at these locations extends is not known. It may be possible to remove the near-surface contamination in Area C; however, access-restricted conditions may be encountered at greater depths. Volume estimates have been made for Area C, but data on current topography would be required to establish the appropriate cut slopes and develop more accurate volume and disposal estimates. Reassessment of volume estimates will be conducted during the design phase where the slope stability and the construction methods will be defined in detail for implementation of remedial efforts.

4.4 EXCAVATION VOLUMES

4.4.1 Area A

During excavation of the in-situ contamination, additional material (landfill rubble or daily cover material and other landfill material) overlying and adjacent to the contamination will be removed. The current excavation volume estimates for Area A were developed for a given lift by superimposing a 20 x 20 ft grid over the maximum aerial extent of Th-230 > 40 p Ci/g within or below that lift. The excavation boundary for each lift was defined by outlining the grid that encompassed the boundaries of the Th-230 contamination in excess of 40 pCi/g. [For the 0-2 ft lift in Area A, the excavation boundary also encompassed the boundaries of surface contamination identified by the 1998 gamma walkover survey (i.e., areas with readings >16,000 cpm)]. The excavation boundaries developed for each of the two-ft lifts using this approach are shown in Figures 4-9 through 4-12.

Table 4-5 presents the estimates for full excavation of Area A. Assuming removal of all contamination (Th-230 in excess of 40 pCi/g) in Area A, the excavation volume is estimated to be 75,700 cy**.** Based on assumed accessibility (i.e., 0 to 4 ft), the excavation volume (in-situ volume plus overcutting) is estimated to be approximately 49,100 cy (refer to Table 4-6).

4.4.2 Areas B and C

Excavation volumes estimates for Areas B and C were developed following similar procedures used for Area A with one exception. For Areas B and C, estimates of excavation beyond a depth of 8 ft were based on ratios of excavation to in-situ volumes developed from the first four lifts. Estimates of overburden were based on vertical cuts (rather than side sloping). However, it is noted that the significant volume of overburden (landfill) material in Areas B and C will require a special design by a registered professional engineer to assess side slope stability, particularly in the vicinity of the access road and the capped areas of the landfill. Because the assumption of vertical cuts has been used, it is likely that the actual volume of overburden to be removed will be much greater.

Different from Area A, excavation activities in Areas B and C will require removal of overburden (non-MED-related material); for the full excavation scenario, the volume of overburden is significant. Based on volume information presented in later discussions, approximately 90,000 cy of material would have to be excavated to remove the roughly 35,000 cy of MED-related material (including overcutting) contained in Areas B and C. Therefore, it has been assumed that during excavation activities, the overburden material will be removed and temporarily staged on-site for backfilling in the landfill upon removal of the MED-related material (i.e., contamination).

Rough estimates of overburden and excavation (in-situ contamination plus overcutting) volumes for Areas B and C are provided in Tables 4-7 and 4-8. [The volumes presented on this table are based on the Full Excavation scenario only. Because the excavation footprints would vary depending on maximum proposed depth of excavation, the volumes in this table can NOT be used to estimate volumes for other excavation (removal) scenarios.]

As indicated in Tables 4-7 and 4-8, the estimated excavation volumes for Areas B and C are 6,600 cy and 28,500 cy, respectively. As suggested by the data presented in the tables, under the Full Excavation scenario, a minimum of 34,000 cy of material would have to be removed (based on vertical cuts) from Area B and a minimum of 56,000 cy of material in Area C in order to fully excavate the MED-residue. As previously noted, the actual volumes of material to be removed will likely be much greater due to the side sloping that will be required to ensure slope stability. It is assumed that overburden material will be segregated during the excavation activities and will be returned to the landfill once the MED-related residue is removed.

Partial excavation estimates would be lower than the full excavation scenario; however, because the majority of the contaminated material in Areas B and C is covered by landfill debris, it is likely that access-restricted conditions will be encountered. Therefore, the assumption was made that partial excavation to a depth of 4 ft could be accomplished. Based on the 1998 sampling efforts (SAIC 1998) and the model, there is no contamination (Th-230 greater than 40 pCi/g) within the upper 4 ft in Area B, therefore, partial excavation estimates are provided only for Area C. These estimates are provided in Table 4-9.

4.5 DISPOSAL VOLUMES

Disposal volumes were estimated assuming a 25% increase in volume due to expansion during excavation and a factor accounting for over-excavation of the contaminated area. This approach is consistent with the approach used in the FS.

The estimated disposal volumes for partial and full excavation at Area A are presented in Tables 4-6 and 4-5, respectively. As indicated in the tables the estimated disposal volume assuming partial excavation (i.e., to a depth of 4 ft) of Area A is approximately 61,400 cy and the estimated disposal volume for the full excavation is approximately 94,700 cy. The estimated disposal volumes for full and partial excavation (i.e., to a depth of 4 ft) at Areas B and C are presented in Table 4-9. Disposal volume for full excavation of Area B is estimated at 7,900cy, while no disposal material would be generated in the partial excavation scenario. Disposal volume for full excavation of Area C is estimated at 35,600cy, while partial excavation would require disposal of 11,200cy.

5. SUMMARY

Various volume estimates have been presented for Areas A, B, and C in the past. All of the estimates have been based on exceedences of some criteria; however, as the criteria changed and the approach to defining the contamination changed, the volume estimates changed. It is recommended that the reader consider Section 4.1 of this report when evaluating volume estimates presented in this document. The current volume estimates are based on three-dimensional modeling of actual and predicted values for Th-230 with a cleanup criteria of 40 pCi/g. These estimates are summarized below.

Summary of Volume Estimates (Cubic Yards)

	In-Situ	Excavation Volume		Disposal Volume	
		Full Excavation(1)	Partial Excavation(2)	Full Excavation	Partial Excavation
Area A	39,500	75,100	48,600	93,800	60,800
Area B	2,000	6,600	0	7,900	0
Area C	13,400	28,500	8,900	35,600	11,200

(1) Excavation and disposal volumes for Areas B and C do not include overburden (overlying landfill material). Volume estimates assume that overburden will be segregated during excavation and replaced in the landfill. Total volumes of material that would have to be moved for the Full Excavation scenario for Areas B and C are approximately 34,000 cy and 56,000 cy, respectively.

(2) Partial excavation volumes for Area C is based on an assumed excavation limit of 4 ft and do not include overburden material. Volume estimates assume that overburden will be segregated during excavation and replaced in landfill. Total volumes of material that would have to be moved for the Partial Excavation scenario (excavation to 4 ft) for Area C is 10,800 cy.

This document also discusses the use of the numerical modeling used for developing the volume estimates and identifies some of the limitations associated with the modeling. As discussed, the data limitations will impact the accuracy of the calculations. The volume estimates are based solely on interpolation between the available Th-230 and predicted values of Th-230, as noted in Section 4.1. Based on a review of the modeling interpolation of the available data set and the historical description of the placement of the MED-related residue, it is likely that the in-situ volume estimates, and subsequent excavation and disposal volume estimates, are over estimates.

6. REFERENCES

BNI (Bechtel National Incorporated) 1993. *Remedial Investigation for the Tonawanda Site*. DOE/OR21949-300, Oak Ridge, TN.

Ford, Bacon and Davis Utah (FBDU) 1981. *Preliminary Engineering and Environmental Evaluation of the Remedial Action Alternatives for Seaway Industrial Park, Tonawanda, New York.* Report No. 409-312. December

Oak Ridge National Laboratory (ORNL) 1978. *Radiological Survey of the Seaway Industrial Park, Tonawanda, New York*, DOE/EV-0005/6, May

FIGURES

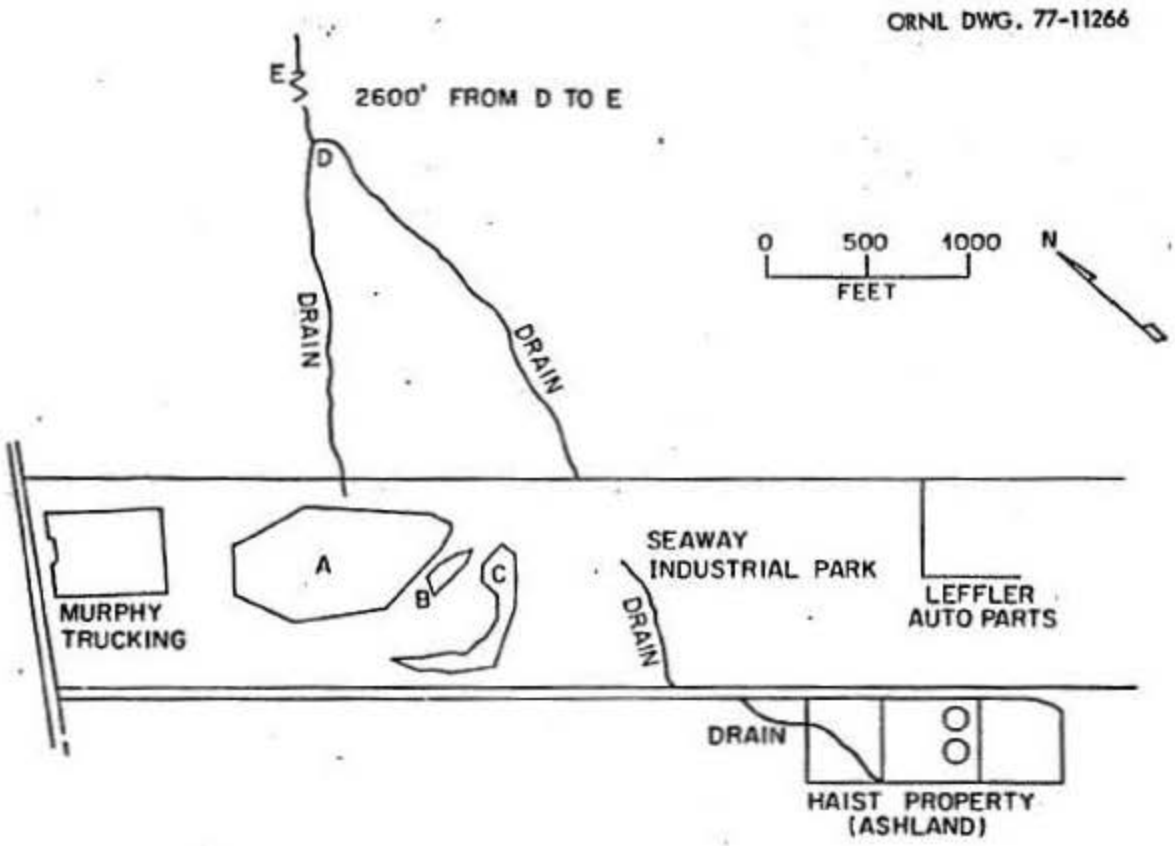


FIGURE 2-1
PLAN VIEW OF SEAWAY INDUSTRIAL PARK SHOWING THREE AREAS (A, B, C) WHERE RADIOACTIVE RESIDUES DUMPED

FIGURE 2-2
1998 AERIAL PHOTO - SEAWAY LANDFILL

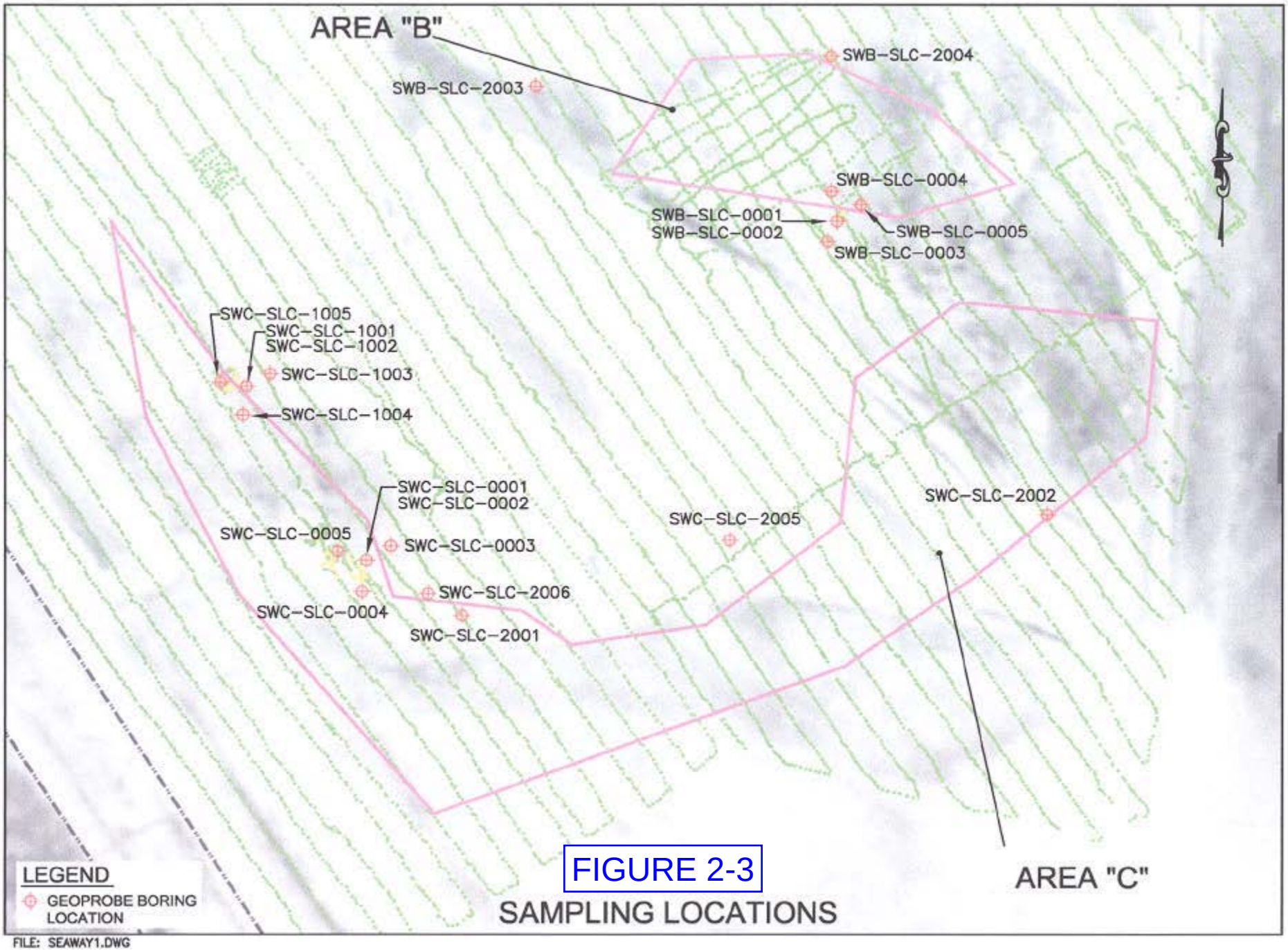


FIGURE 2-3

SAMPLING LOCATIONS

FILE: SEAWAY1.DWG

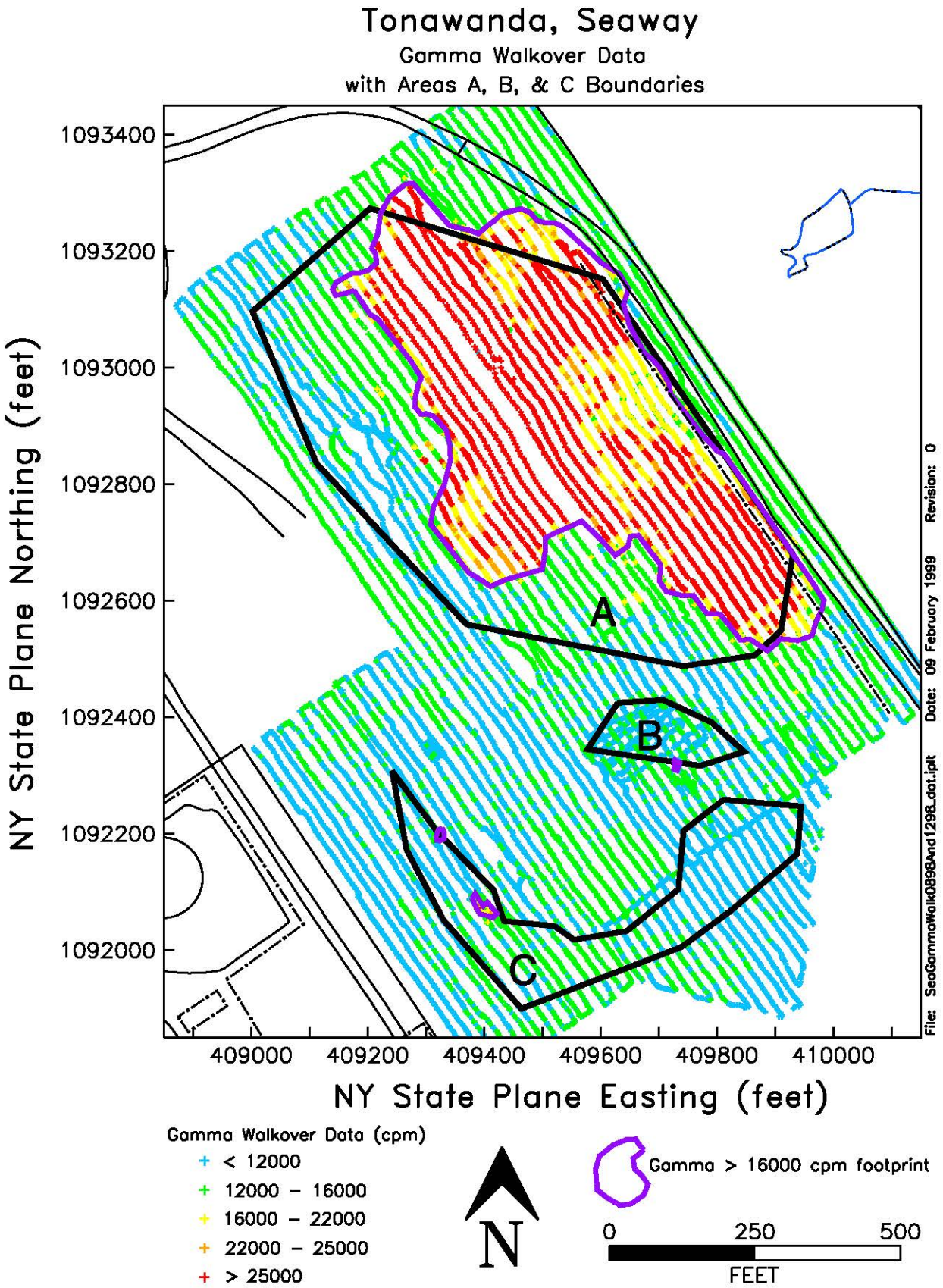

Tonawanda, Seaway
Gamma Walkover Data
with Areas A, B, & C Boundaries
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
NY State Plane Northing (feet)
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
File: SeaGammaWalk0898And1298_dat.iplt
Date: 09 February 1999
Revision: 0
Gamma Walkover Data (cpm)
< 12000
12000 – 16000
16000 – 22000
22000 – 25000
> 25000
N
Gamma > 16000 cpm footprint
0
250
500
FEET

FIGURE 2-4

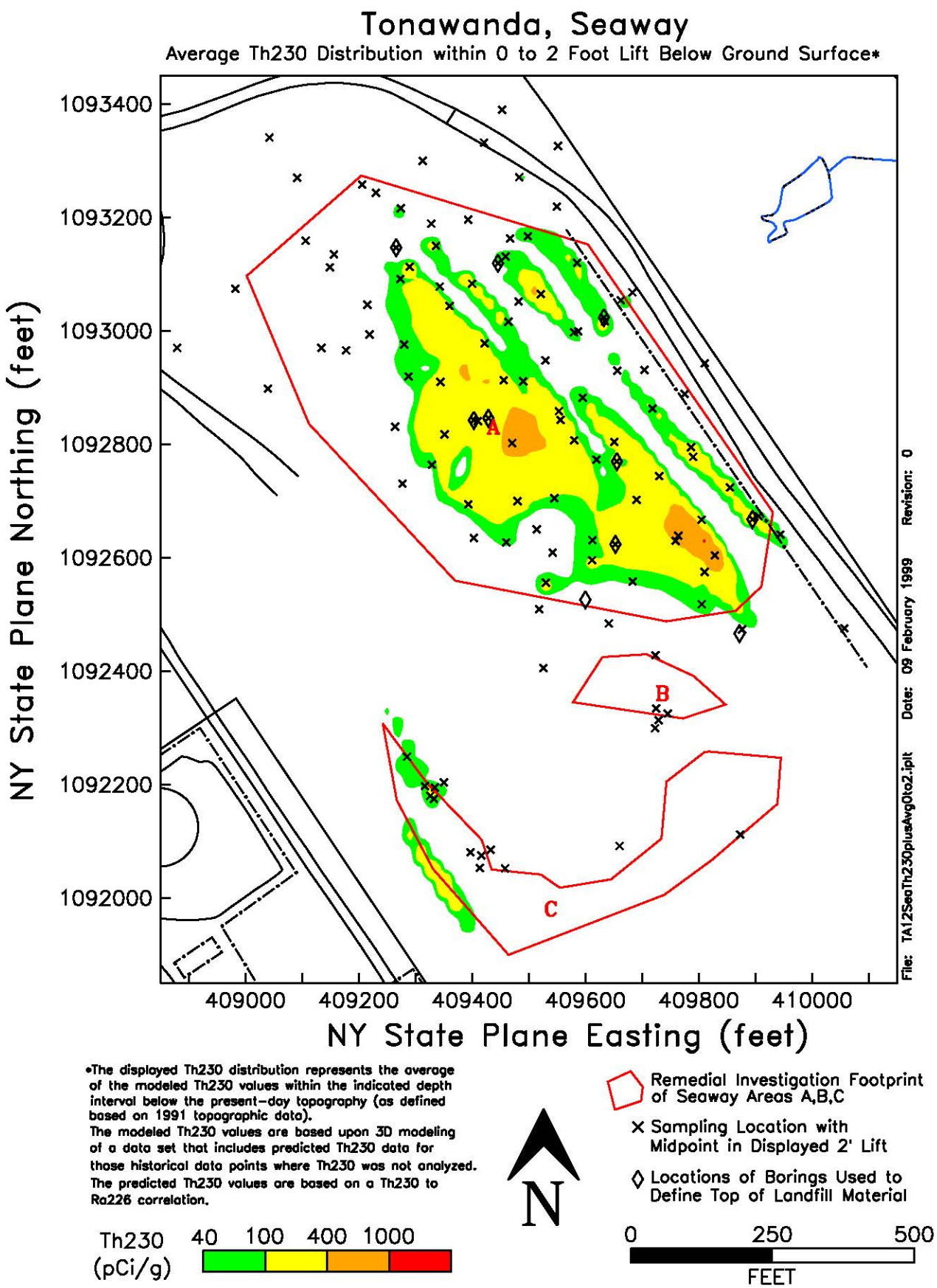
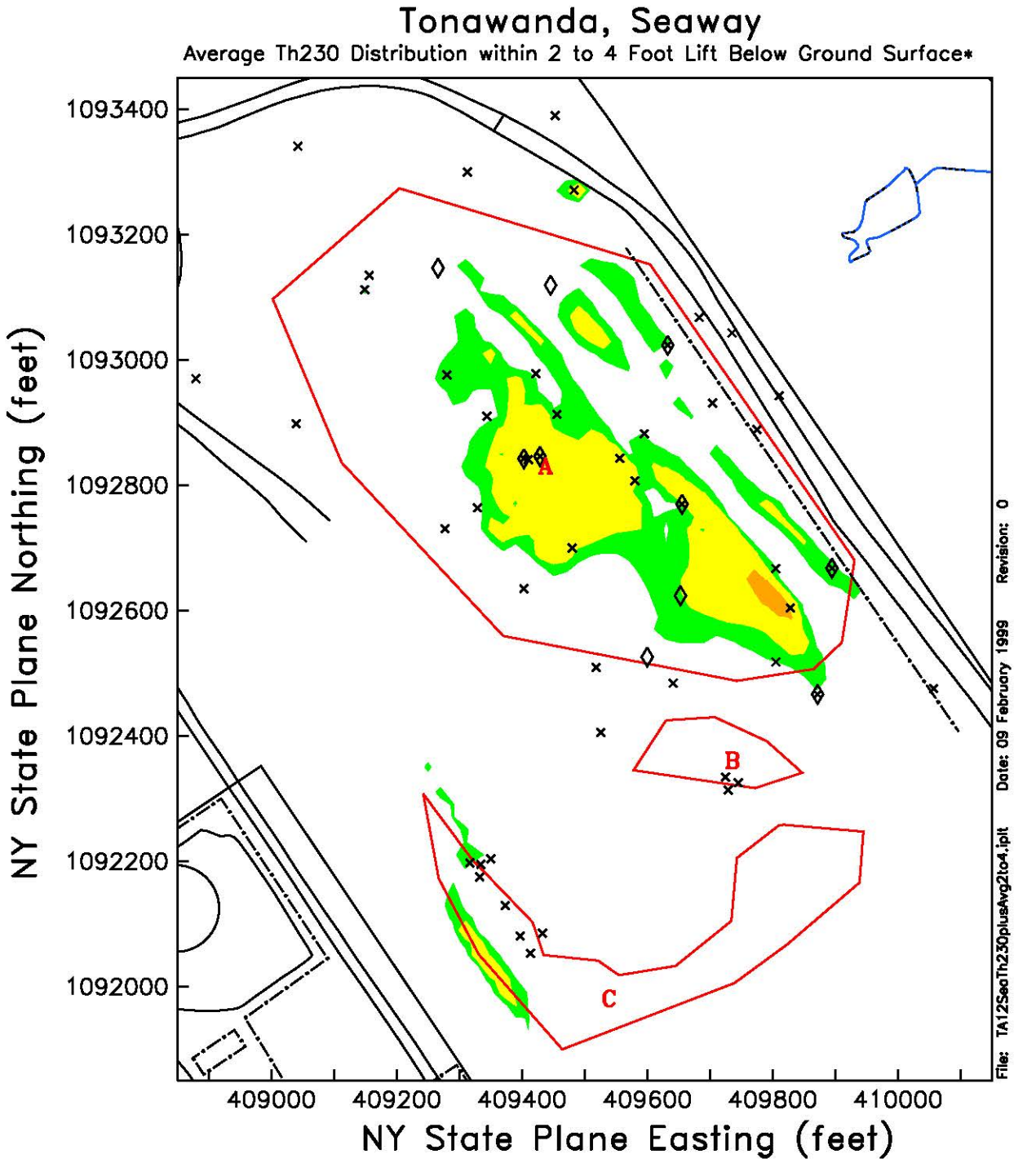

Tonawanda, Seaway
Average Th230 Distribution within 0 to 2 Foot Lift Below Ground Surface*
NY State Plane Northing (feet)
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
File: TA12SeaTh230plusAvg0to2.iplt
Date: 09 February 1999
Revision: 0
*The displayed Th230 distribution represents the average of the modeled Th230 values within the indicated depth interval below the present-day topography (as defined based on 1991 topographic data).
The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.
Th230 (pCi/g)
40
100
400
1000
N
Remedial Investigation Footprint of Seaway Areas A,B,C
Sampling Location with Midpoint in Displayed 2' Lift
Locations of Borings Used to Define Top of Landfill Material
0
250
500
FEET

FIGURE 4-1



*The displayed Th230 distribution represents the average of the modeled Th230 values within the indicated depth interval below the present-day topography (as defined based on 1991 topographic data).
The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.

Th230 (pCi/g) 40 100 400

N

Remedial Investigation Footprint of Seaway Areas A,B,C

× Sampling Location with Midpoint in Displayed 2' Lift

◊ Locations of Borings Used to Define Top of Landfill Material

0 250 500
FEET

FIGURE 4-2

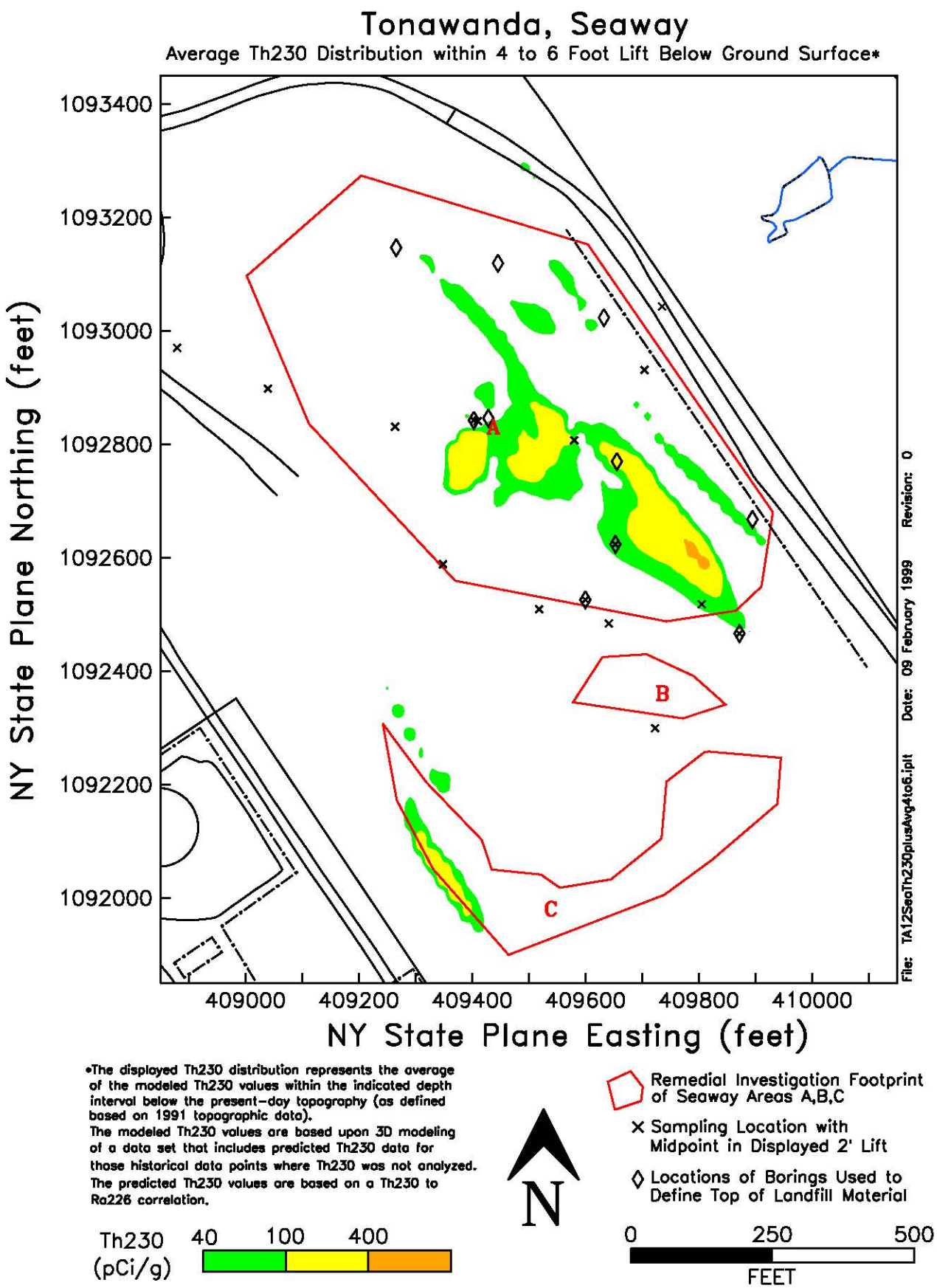

Tonawanda, Seaway
Average Th230 Distribution within 4 to 6 Foot Lift Below Ground Surface*
NY State Plane Northing (feet)
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
File: TA12SeaTh230plusAvg4to6.iplt
Date: 09 February 1999
Revision: 0
*The displayed Th230 distribution represents the average of the modeled Th230 values within the indicated depth interval below the present-day topography (as defined based on 1991 topographic data).
The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.
Th230 (pCi/g)
40
100
400
N
Remedial Investigation Footprint of Seaway Areas A,B,C
Sampling Location with Midpoint in Displayed 2' Lift
Locations of Borings Used to Define Top of Landfill Material
0
250
500
FEET

FIGURE 4-3

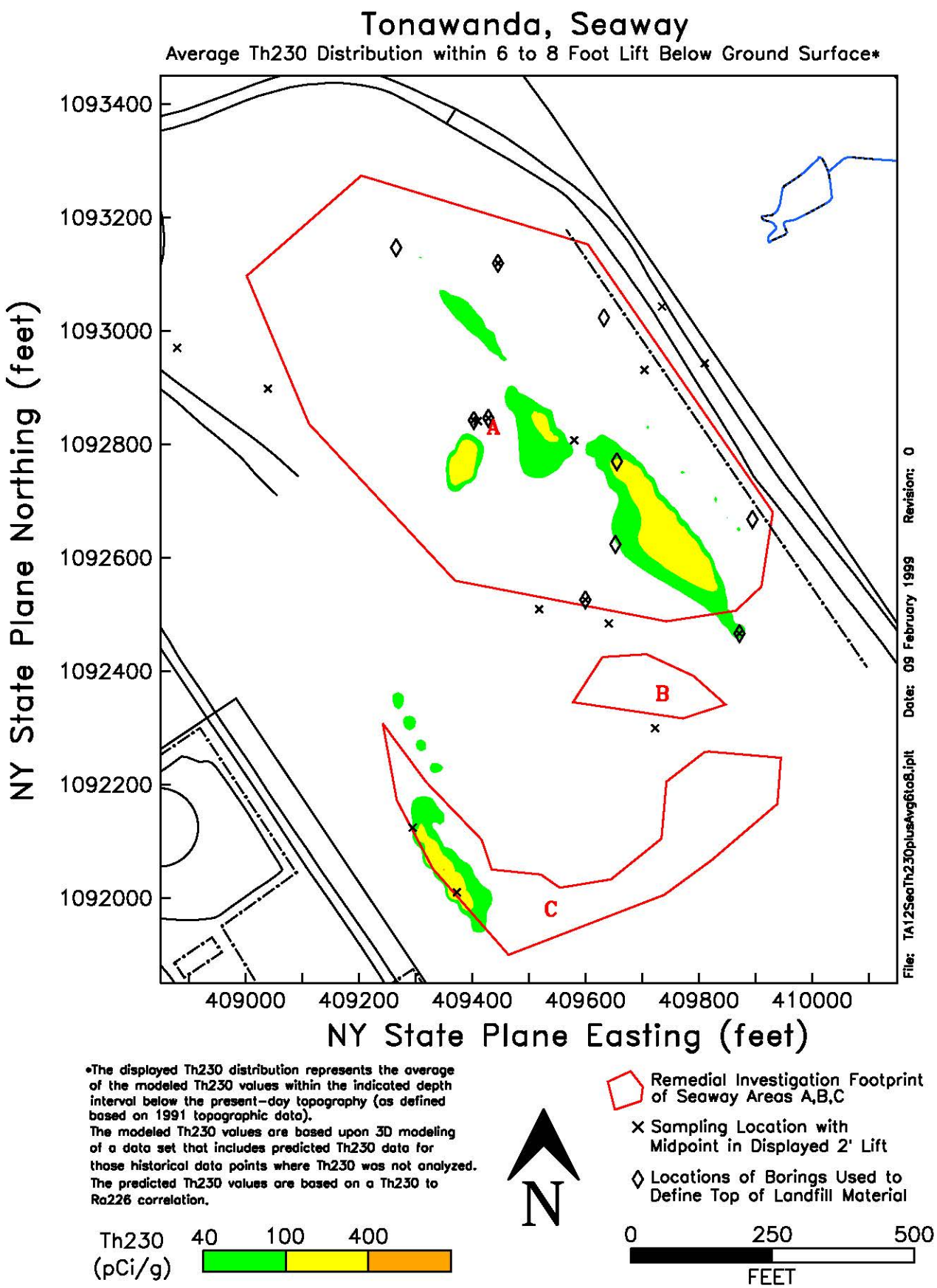

Tonawanda, Seaway
Average Th230 Distribution within 6 to 8 Foot Lift Below Ground Surface*
NY State Plane Northing (feet)
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
File: TA12SeaTh230plusAvg6to8.iplt
Date: 09 February 1999
Revision: 0
*The displayed Th230 distribution represents the average of the modeled Th230 values within the indicated depth interval below the present-day topography (as defined based on 1991 topographic data).
The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.
Th230 (pCi/g)
40
100
400
N
Remedial Investigation Footprint of Seaway Areas A,B,C
Sampling Location with Midpoint in Displayed 2' Lift
Locations of Borings Used to Define Top of Landfill Material
0
250
500
FEET

FIGURE 4-4

Tonawanda Seaway Th−230 "Plus" Distribution
Area A Cross Section

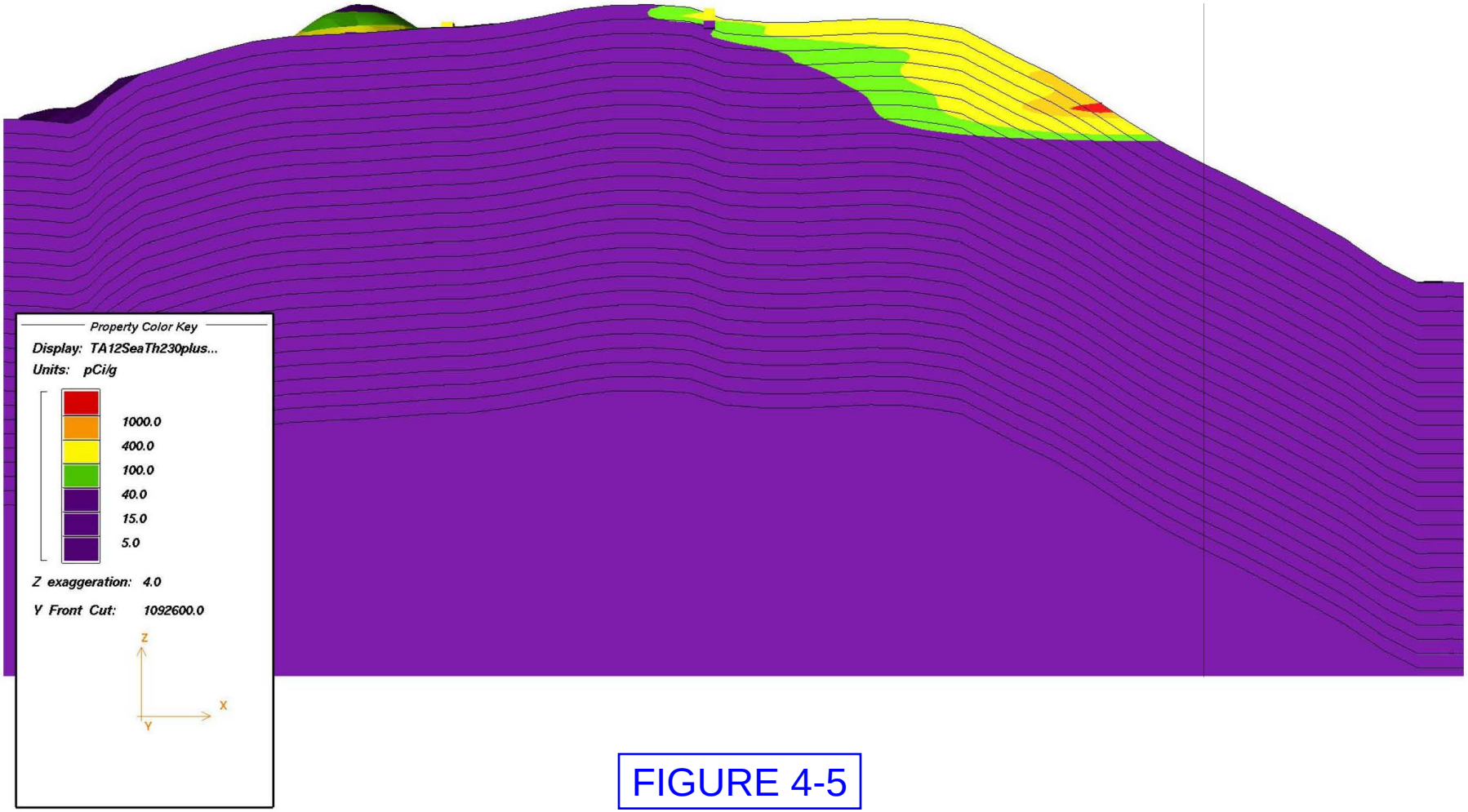


FIGURE 4-5

Tonawanda Seaway Th−230 "Plus" Distribution

Area B (at left) and Area A (at right) Cross Section

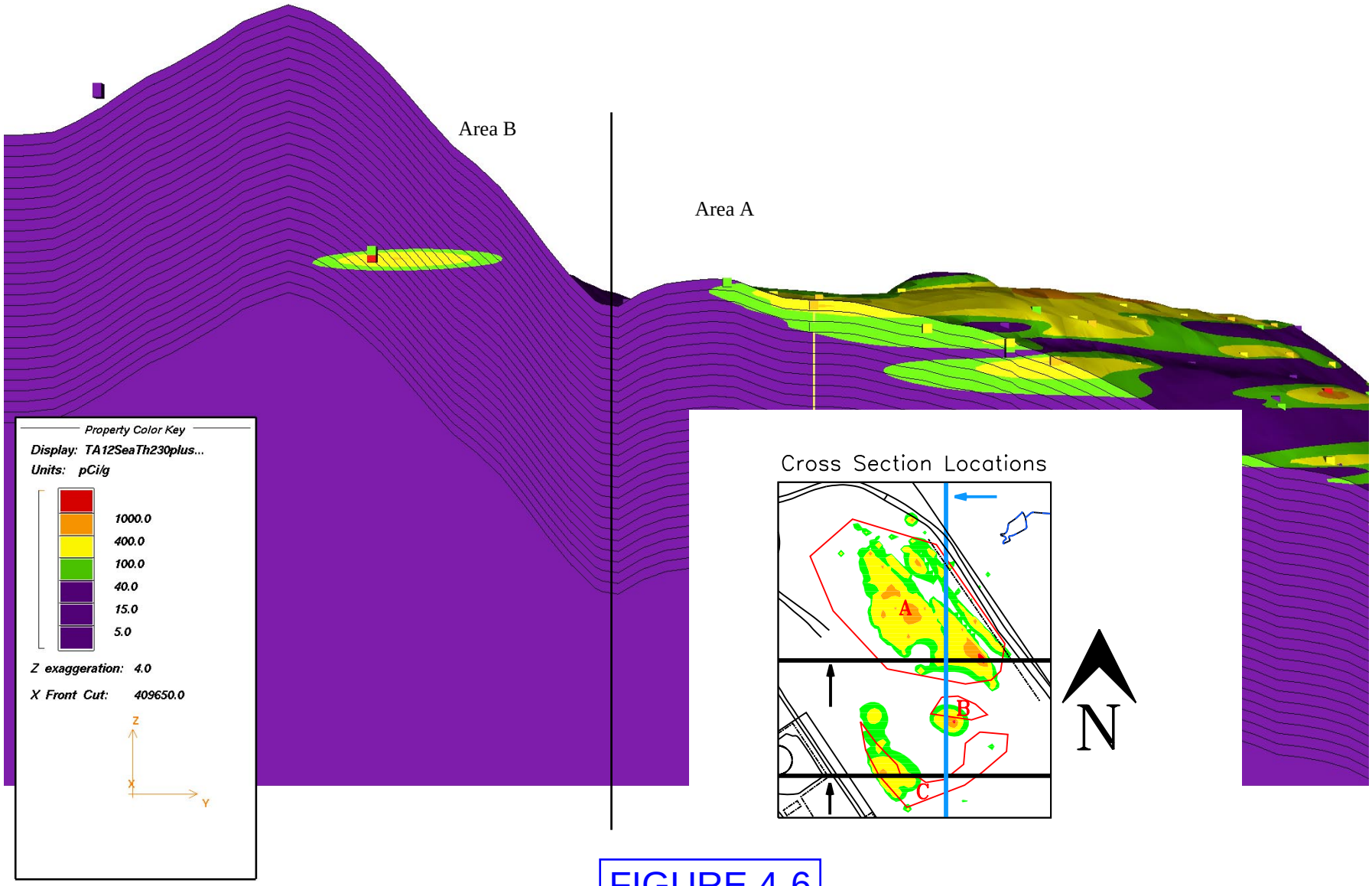


FIGURE 4-6

Tonawanda Seaway Th−230 "Plus" Distribution

Area C Cross Section

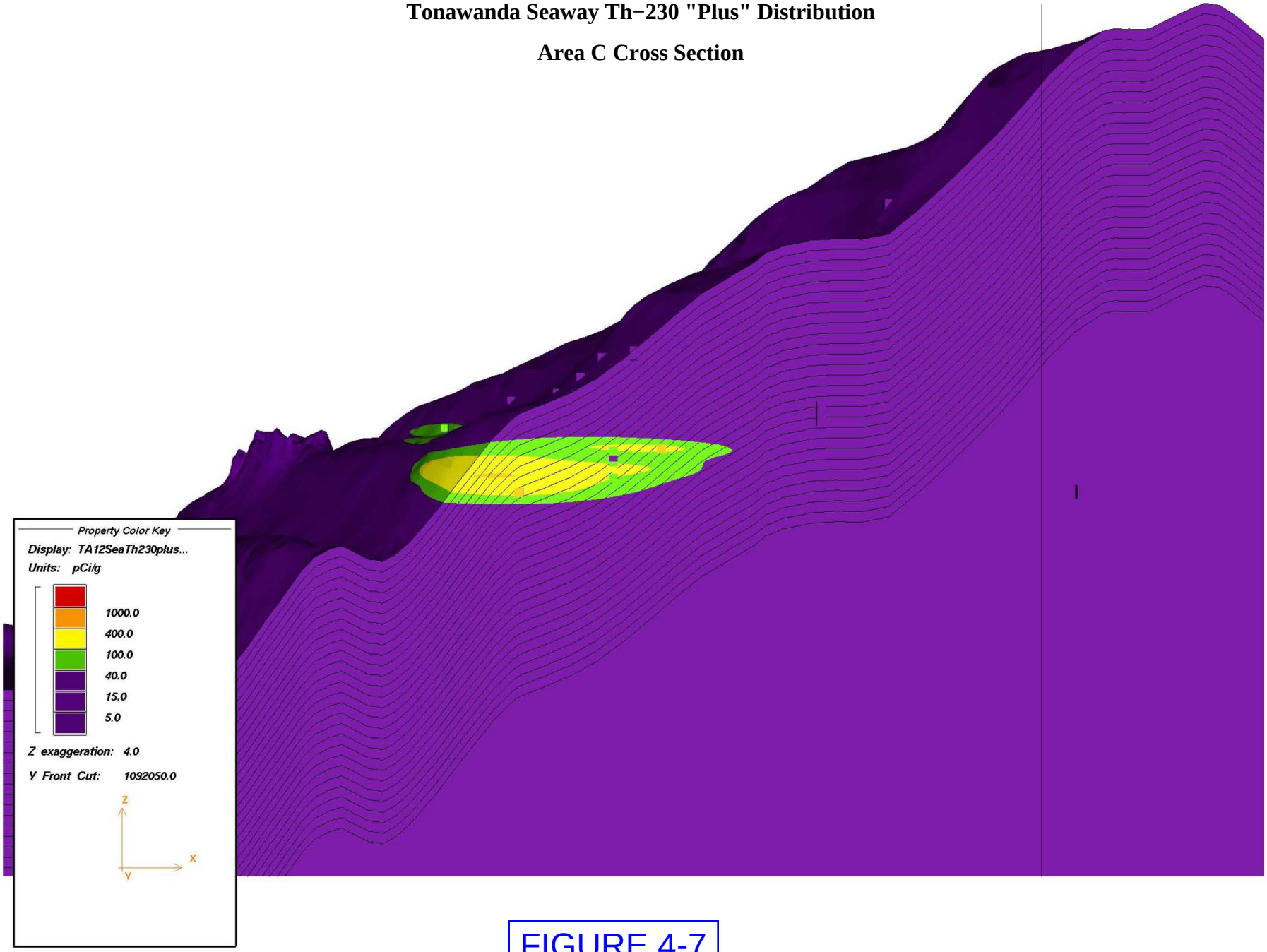


FIGURE 4-7

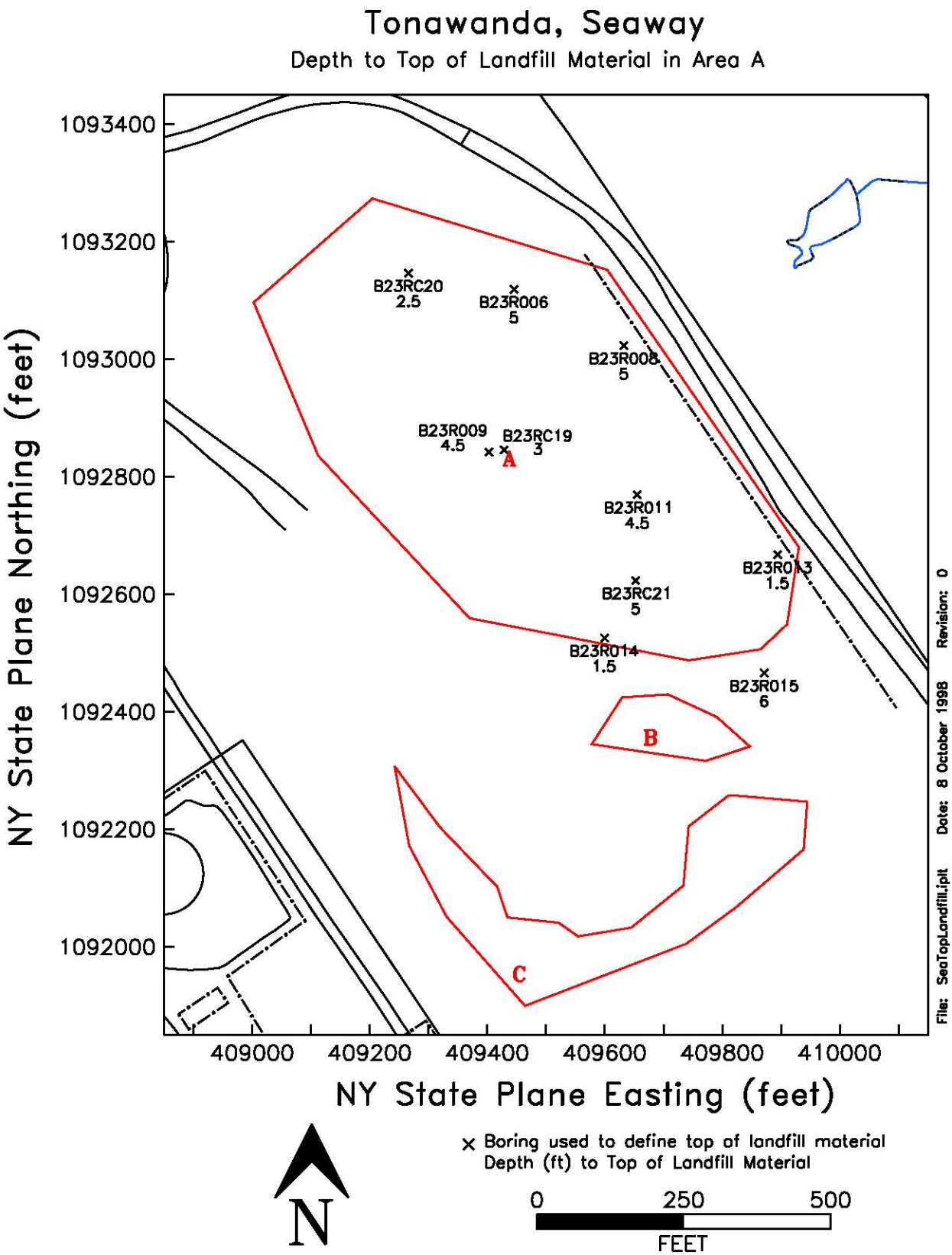

Tonawanda, Seaway
Depth to Top of Landfill Material in Area A
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
NY State Plane Northing (feet)
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
B23RC20
2.5
B23R006
5
B23R008
5
B23R009
4.5
B23RC19
3
A
B23R011
4.5
B23R013
1.5
B23RC21
5
B23R014
1.5
B23R015
6
B
C
File: SeaTopLandfill.iplt
Date: 8 October 1998
Revision: 0
N
× Boring used to define top of landfill material
Depth (ft) to Top of Landfill Material
0
250
500
FEET

FIGURE 4-8

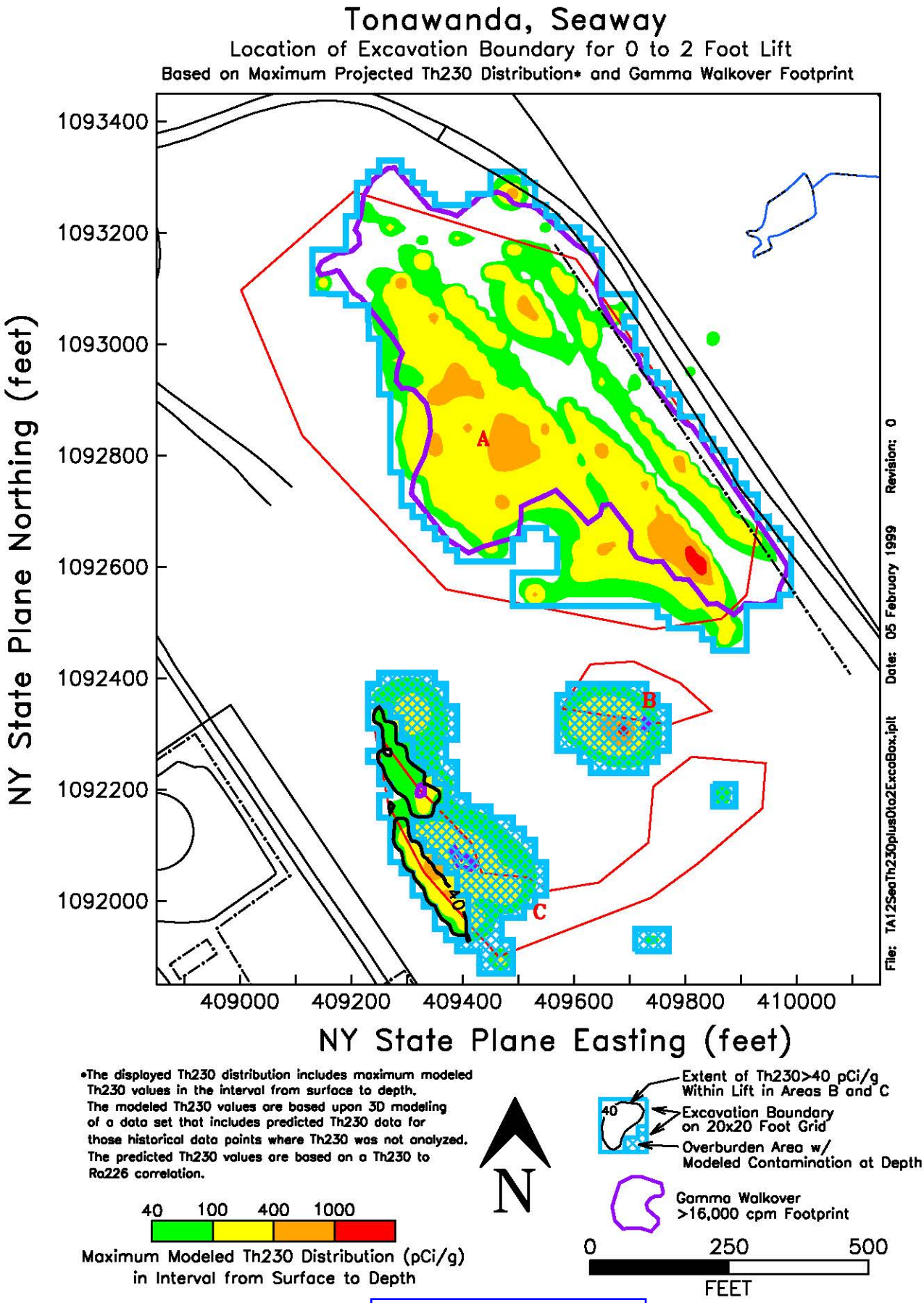

Tonawanda, Seaway
Location of Excavation Boundary for 0 to 2 Foot Lift
Based on Maximum Projected Th230 Distribution* and Gamma Walkover Footprint
NY State Plane Northing (feet)
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
40
File: TA12SeaTh230plusOto2ExcaBox.iplt
Date: 05 February 1999
Revision: 0
*The displayed Th230 distribution includes maximum modeled Th230 values in the interval from surface to depth. The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.
40
100
400
1000
Maximum Modeled Th230 Distribution (pCi/g) in Interval from Surface to Depth
N
Extent of Th230>40 pCi/g Within Lift in Areas B and C
Excavation Boundary on 20x20 Foot Grid
Overburden Area w/ Modeled Contamination at Depth
Gamma Walkover >16,000 cpm Footprint
0
250
500
FEET

FIGURE 4-9

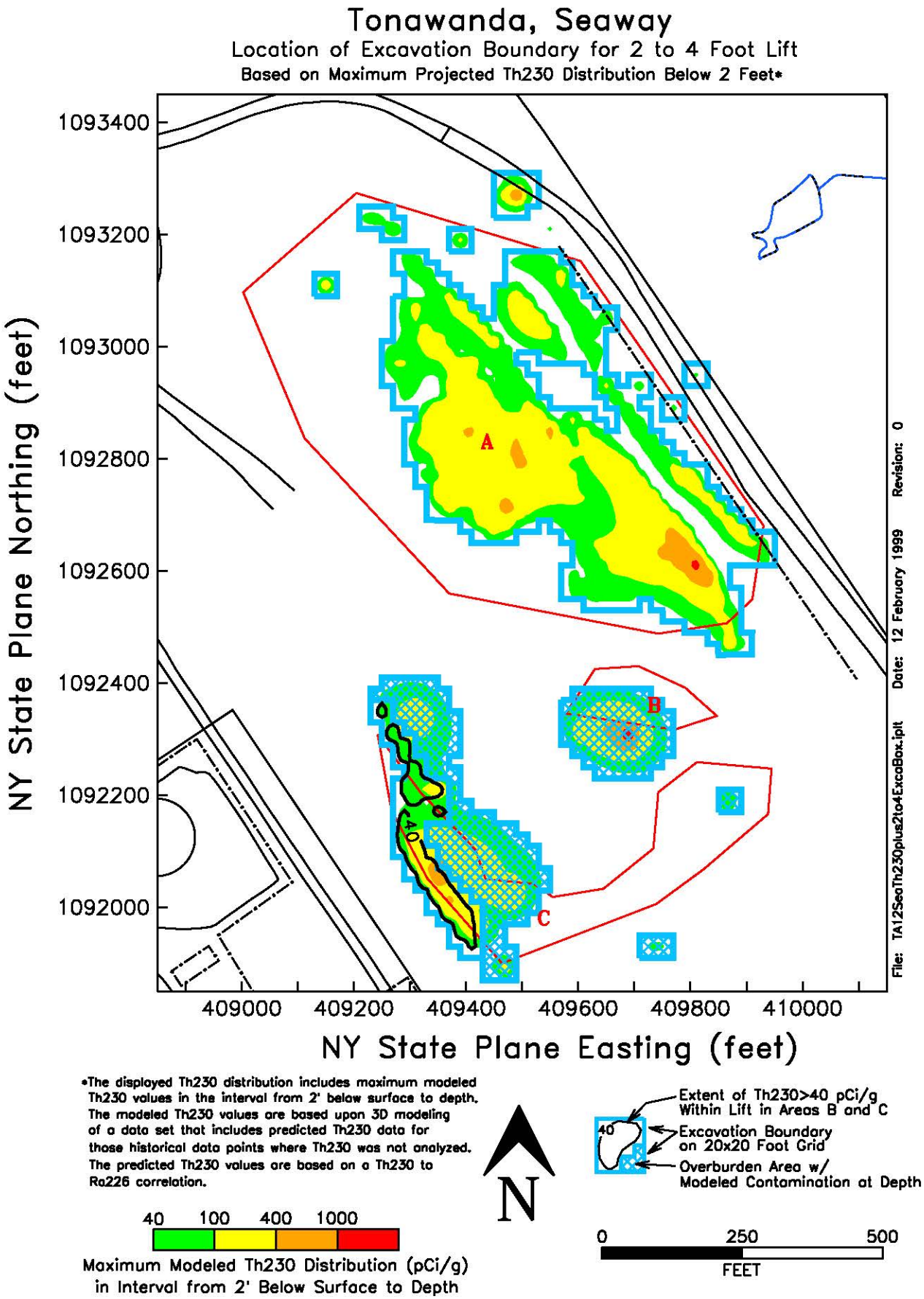

Tonawanda, Seaway
Location of Excavation Boundary for 2 to 4 Foot Lift
Based on Maximum Projected Th230 Distribution Below 2 Feet*
NY State Plane Northing (feet)
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
40
File: TA12SeaTh230plus2to4ExcaBox.iplt
Date: 12 February 1999
Revision: 0
*The displayed Th230 distribution includes maximum modeled Th230 values in the interval from 2' below surface to depth. The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.
40
100
400
1000
Maximum Modeled Th230 Distribution (pCi/g) in Interval from 2' Below Surface to Depth
N
Extent of Th230>40 pCi/g Within Lift in Areas B and C
Excavation Boundary on 20x20 Foot Grid
Overburden Area w/ Modeled Contamination at Depth
0
250
500
FEET

FIGURE 4-10

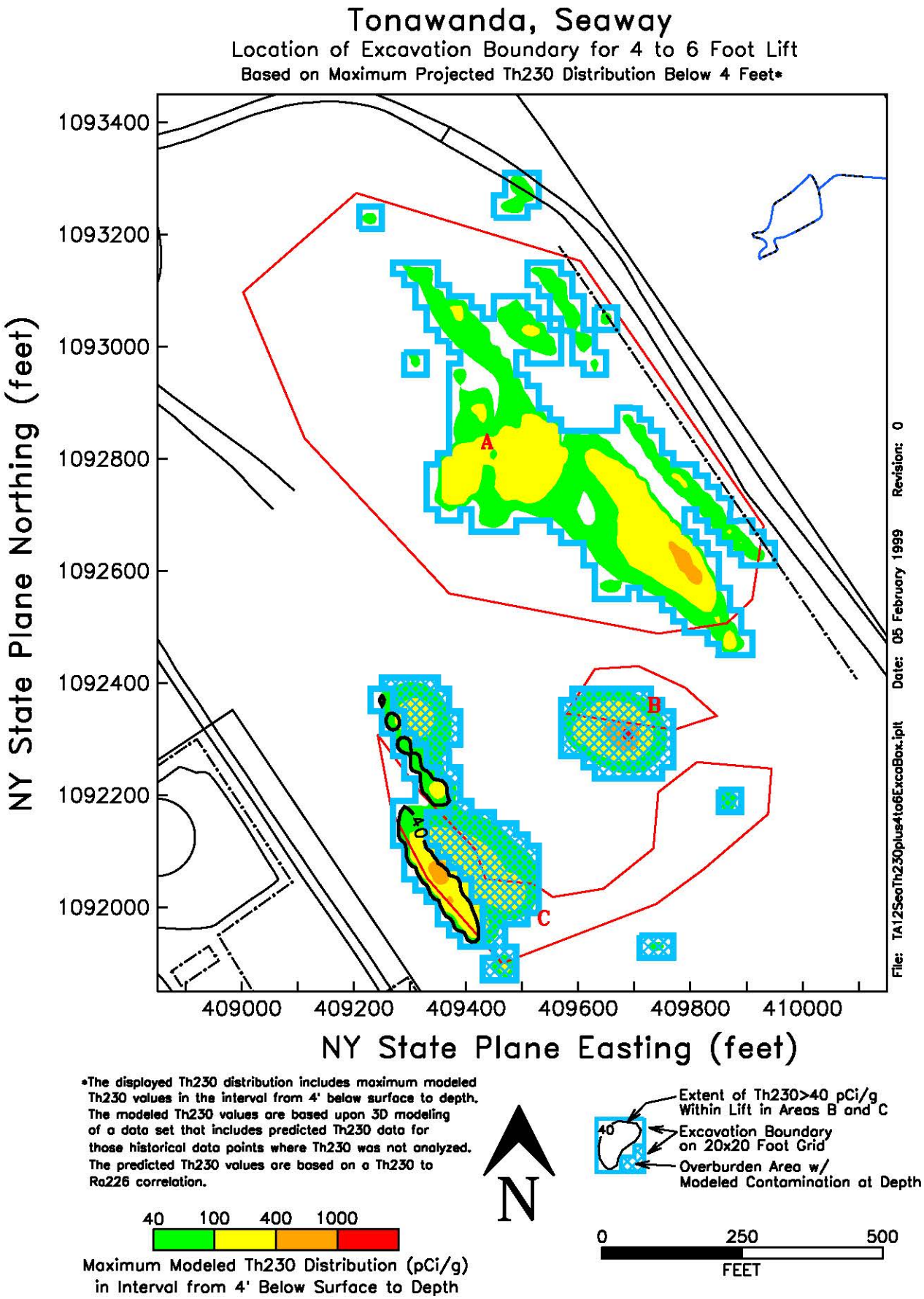

Tonawanda, Seaway
Location of Excavation Boundary for 4 to 6 Foot Lift
Based on Maximum Projected Th230 Distribution Below 4 Feet*
NY State Plane Northing (feet)
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
40
File: TA12SeaTh230plus4to6ExcaBox.iplt
Date: 05 February 1999
Revision: 0
*The displayed Th230 distribution includes maximum modeled Th230 values in the interval from 4' below surface to depth. The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.
40
100
400
1000
Maximum Modeled Th230 Distribution (pCi/g) in Interval from 4' Below Surface to Depth
N
Extent of Th230>40 pCi/g Within Lift in Areas B and C
Excavation Boundary on 20x20 Foot Grid
Overburden Area w/ Modeled Contamination at Depth
0
250
500
FEET

FIGURE 4-11

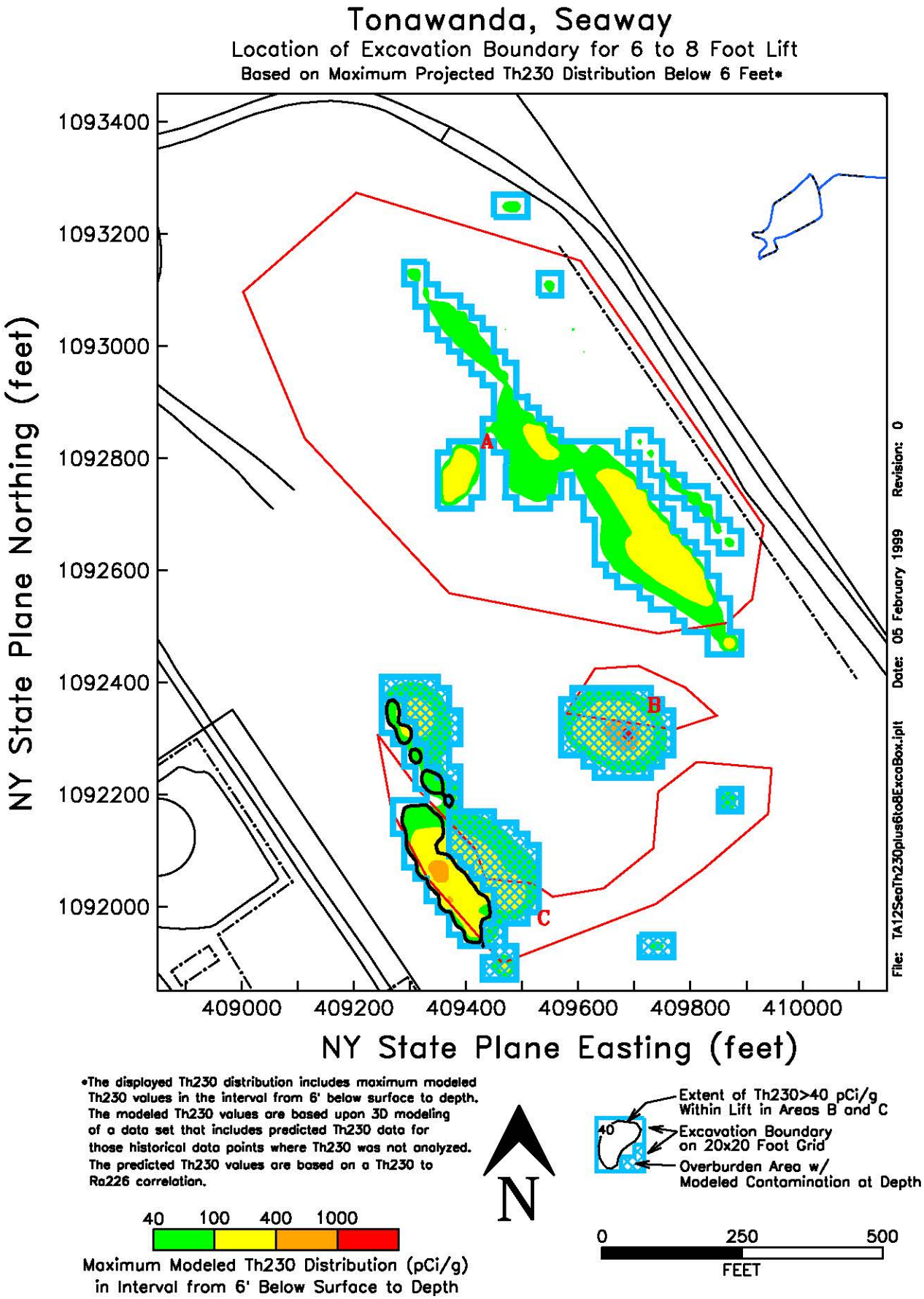
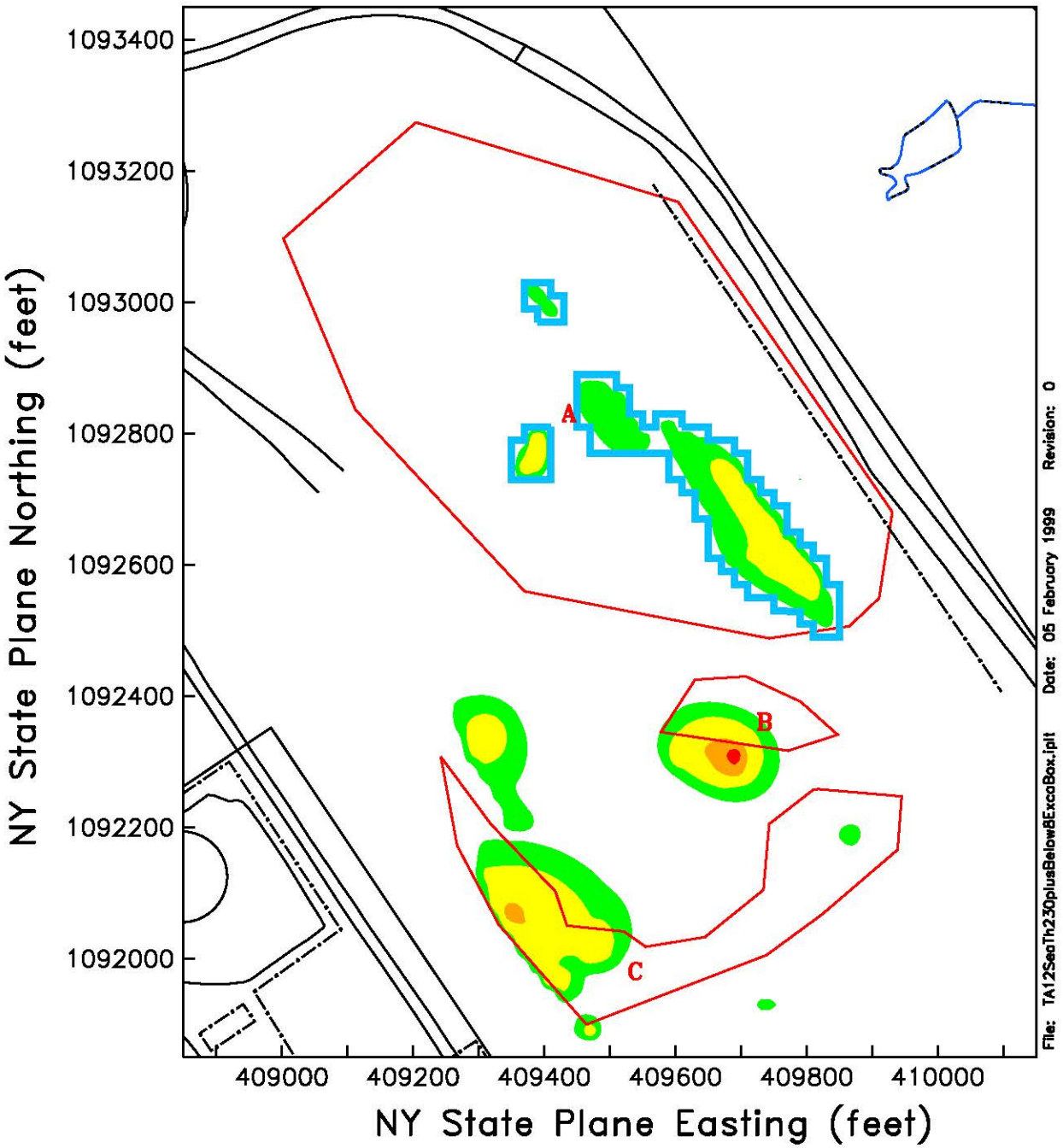

Tonawanda, Seaway
Location of Excavation Boundary for 6 to 8 Foot Lift
Based on Maximum Projected Th230 Distribution Below 6 Feet*
NY State Plane Northing (feet)
1093400
1093200
1093000
1092800
1092600
1092400
1092200
1092000
409000
409200
409400
409600
409800
410000
NY State Plane Easting (feet)
A
B
C
File: TA12SeaTh230plus6to8ExcaBox.jplt
Date: 05 February 1999
Revision: 0
*The displayed Th230 distribution includes maximum modeled Th230 values in the interval from 6' below surface to depth. The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.
40
100
400
1000
Maximum Modeled Th230 Distribution (pCi/g) in Interval from 6' Below Surface to Depth
N
40
Extent of Th230>40 pCi/g Within Lift in Areas B and C
Excavation Boundary on 20x20 Foot Grid
Overburden Area w/ Modeled Contamination at Depth
0
250
500
FEET

FIGURE 4-12

Tonawanda, Seaway

Location of Area A Excavation Boundary Below 8 Feet

Based on Maximum Projected Th230 Distribution Below 8 Feet*



*The displayed Th230 distribution includes maximum modeled Th230 values in the interval from 8' below surface to depth. The modeled Th230 values are based upon 3D modeling of a data set that includes predicted Th230 data for those historical data points where Th230 was not analyzed. The predicted Th230 values are based on a Th230 to Ra226 correlation.

40 100 400 1000

Maximum Modeled Th230 Distribution (pCi/g) in Interval from 8' Below Surface to Depth

N

Area A Excavation Boundary on 20x20 Foot Grid

0 250 500

FEET

FIGURE 4-13

TABLES

TABLE 4-1

SUMMARY OF Th-230 ANALYTICAL DATA
SEAWAY LANDFILL AREAS A, B, AND C

AREA A					AREA B					AREA C				
Lift (ft)	Number of Data Points	Max. Concen. Th-230 (pCi/g)	Min. Concen. Th-230 (pCi/g)	Average Concen. Th-230 (pCi/g)	Lift (ft)	Number of Data Points	Max. Concen. Th-230 (pCi/g)	Min. Concen. Th-230 (pCi/g)	Average Concen. Th-230 (pCi/g)	Lift (ft)	Number of Data Points	Max. Concen. Th-230 (pCi/g)	Min. Concen. Th-230 (pCi/g)	Average Concen. Th-230 (pCi/g)
0-2	84	880	0.8	117.9	0-10	15	3.09	0.78	1.77	0-5	24	411.60	1.06	39.27
2-4	25	700	1.1	78.5	10-20	0	-	-	-	5-10	0	-	-	-
4-6	9	220	1.4	40.1	20-30	0	-	-	-	10-15	0	-	-	-
6-8	9	180	1.5	28.1	30-40	0	-	-	-	15-20	0	-	-	-
>8 ft	7	5.7	0.7	1.9	40-50	0	-	-	-	20-25	0	-	-	-
					50-60	0	-	-	-	>25 ft	0	-	-	-
					>60 ft	0	-	-	-					
TOTAL	**134**				TOTAL	**15**				TOTAL	**24**			

TABLE 4-2

SUMMARY OF DATA POINTS, IN-SITU VOLUMES AND CONCENTRATIONS BASED ON MODELED Th-230*

SEAWAY AREAS A, B, AND C

AREA A

Lift	Number of Data Points	Volume (cubic yards)	Max. Concen. Th-230 (pCi/g)	Min. Concen. Th-230 (pCi/g)	Average Concen. Th-230 (pci/g)
0-2	165	14000	2825.7	0.8	170
2-4	48	11000	786.7	1.1	106.1
4-6	23	6600	220	1.4	36.4
6-8	19	3700	180	1.4	14.1
8-10	-	2200	-	-	-
10-12	-	1300	-	-	-
12-14	-	600	-	-	-
14-16	-	100	-	-	-
TOTAL**	**271**	**39500**			

AREA B

Lift	Number of Data Points	Volume (cubic yards)	Max. Concen. Th-230 (pCi/g)	Min. Concen Th-230 (pCi/g)	Average Concen. Th-230 (pci/g)
0-2	8	0	3.09	0.78	1.72
2-4	4	0	2.41	1.19	1.93
4-6	2	0	2.33	1.35	1.84
6-8	1	0	1.45	1.45	1.45
8-10	0	0	-	-	-
10-12	0	5	-	-	-
12-14	0	30	-	-	-
14-16	0	50	-	-	-
16-18	0	90	-	-	-
18-20	0	100	-	-	-
20-22	0	200	-	-	-
22-24	0	200	-	-	-
24-26	0	200	-	-	-
26-28	1	100	427.37	427.37	427.37
28-30	0	100	-	-	-
30-32	0	100	-	-	-
32-34	0	100	-	-	-
34-36	0	100	-	-	-
36-38	2	100	1848.60	51.87	950.24
38-40	1	100	1426.67	1426.67	1426.67
40-42	0	100	-	-	-
42-44	0	100	-	-	-
44-46	0	100	-	-	-
46-48	0	100	-	-	-
48-50	0	50	-	-	-
> 50	0	0	-	-	-
TOTAL**	**19**	**2000**			

AREA C

Lift	Number of Data Points	Volume (cubic yards)	Max. Concen. Th-230 (pCi/g)	Min. Concen Th-230 (pCi/g)	Average Concen. Th-230 (pci/g)
0-2	18	900	399.10	1.06	29.75
2-4	9	700	411.60	1.06	99.97
4-6	0	800			
6-8	3	1000	445.54	17.55	170.31
8-10	3	1300	697.89	1.40	235.58
10-12	6	1400	423.33	96.28	234.23
12-14	2	1400	51.87	17.55	34.71
14-16	4	1200	92.25	1.40	32.69
16-18	6	1000	475.82	1.40	164.25
18-20	2	800	86.19	1.40	43.79
20-22	0	600	-	-	-
22-24	0	500	-	-	-
24-26	0	400	-	-	-
26-28	0	300	-	-	-
28-30	0	300	-	-	-
30-32	1	300	1.40	1.40	1.40
32-34	2	200	3.42	1.40	2.41
34-36	1	200	1.40	1.40	1.40
36-38	0	40	-	-	-
38-40	0	0	-	-	-
40-42	0	0	-	-	-
42-44	0	3	-	-	-
44-46	1	7	4.43	4.43	4.43
46-48	2	7	49.85	1.40	25.63
48-50	2	3	61.96	15.53	38.75
> 50	12	5	98.30	1.40	25.63
TOTAL**	**74**	**13400**			

TOTAL VOLUME (Areas A, B, and C): 54,900

NOTES:

*Model based on measured Th-230 and calculated Th-230 (Th-230 "Plus") values using regression analysis. Volumes based on actual and calculated Th-230 >40 pCi/g.

**Totals rounded to nearest 100 cubic yards

TABLE 4-3

CONDITIONS THAT MAY IMPACT EXCAVATION EFFORTS[1]

Issue	Description	Accessible	Access Restricted/ Inaccessible[2]
Materials			
Rubble	pieces of brick, glass, wood chips, metal shards, plastic, paper, landfill daily cover material	X	
Large Items	large items such as lumber, refrigerators, industrial materials, etc. that would cause void spaces greater than approximately 3 foot in diameter.		X
Liquid	pooled liquids and sludges with estimated volumes greater than 10 gallons.		X
Drums	plastic or metal drums of any size; requires immediate notification to USACE		X
Health and Safety			
LEL	readings of less than 10%	X	
	readings of 10% or greater		X
PID/Hnu (11.7 eV)	readings less than 5 ppm	X	
	readings between 5 and 25 ppm	X **(with respiratory protection)**	
	readings of greater than 25 ppm		X
Radiological	Less than than twice background in cpm	X	
	Greater than twice background in cpm		X **(investigate)**
	Potential exposure greater than 100 mrem/yr		X **(radiological program implementation)**
H2S	readings of less than 20 ppm	X	
	readings of greater than 20 ppm		X
O2	readings of less than 19.5%	X **(with supplied air respirator)**	
	greater than 23.5%		X
Airborne Dust	greater than 15 mg/m^3 total	X **(with respiratory protection)**	
Engineering Considerations			
Depths of Excavation	Depths of less than 20 feet	X **(with a maximum side slope of 1.5 to 1)**	
	Depths of greater than 5 feet		X **(special engineering design required)**
Sensitive Site Features	Access road and landfill cap		X
Proximity to Sensitive Site Features	Proximity to site access road	X **(with engineering design to ensure no undermining of sensitive feature)**	

NOTES:

[1] Other conditions may be encountered in the field are not addressed in this matrix. Services of a Health Physicist, Environmental and Structural Engineer, and Certified Industrial Hygenist should be available during construction to make field determination on accessibility and access-restrictions.

[2] These conditions may impact the ability to continue excavation at locations or may require altering the excavation program.

TABLE 4-4

SUMMARY OF INFORMATION ON DEPTH TO LANDFILL MATERIAL
SEAWAY LANDFILL

Boring[1]	Year[2]	Area A, B, or C	Depth to Landfill Refuse[3]	Basis for Determination of Accessible Soil	Comment
B23R006	1988	A	5	Change from rubble (soil mixed with brick, plastic, tile, metal shards) to non-compactible fill of metal and lumber	Horrible smell and high LEL values from approx. 7.5 ft
B23R008	1988	A	4+	Boring ends at 4 ft; all rubble	0-4 ft 10% LEL and 150 ppm Toxic on ENMET
B23R009	1988	A	4.5	Change from rubble (silty soil matrix with wood) to predominantly wood and paper products	0-2.5 ft 50% LEL and 0 toxic; 3-5 ft elevated radiological values; organic odor from 4.5 ft
B23R011	1988	A	4	Change from rubble to predominantly lumber	0-4 ft 50% LEL and full scale toxics; elevated scan values at 1 ft.
B23R013	1988	A	1.5	Change from rubble to sludge with plastic, metal, glass, wood	0-1 0% LEL, 0 toxic and elevated scan at 1 ft; from 1.5 ft strong, foul, odor and 50% LEL and 0 toxic
B23R014	1988	A	1.5	Change from rubble to predominantly lumber; black sludge-like liquid encountered in lumber	From approx. 1.5 ft strong petroleum odor and up to 30% LEL; perched water at 7 ft
B23R015	1988	A	6	Change from rubble to lumber and sludge-like water	4-6 ft elevated gamma; 10-15 ft strong hydrocarbon odor and LEL values of 50% with 0 toxic; perched water at 10 ft
B23RC19	1990	A	3	Change from rubble to residential and industrial trash	12 ft drillers go to respirators, 50 ppm gas detected at borehole; at 19 ft 100% LEL with 1ppm H2S; at 20 ft standby for 15 minutes to let hole vent; drilling discontinued at 21 ft because of dangerous conditions
B23RC20	1990	A	2.5	Change from rubble to mostly wood and building material	approx. 12 ft encounter 50 ppm gas and drillers go into respirators
B23RC21	1990	A	5	Change from rubble to mostly wood and building material	approx. 19 ft standby 15 minutes to vent hole and drillers go into respirators

NOTES:

1. Only borings that are located within the area defined as concentrations >40 pCi/g of Th-230 are included in table.
2. Year boring was completed.
3. Depth to landfill material at the time of boring (i.e., depth to lanfill material as determined from boring log).

TABLE 4-5

SUMMARY OF VOLUMES
FOR FULL EXCAVATION OF MODELLED Th-230
AREA A [1]

(units: cubic yards)

Lift	In-Situ Volume [2]	Excavation Volume[3]	Disposal Volume[4]
0-2	14,000	29,300	36,700
2-4	11,000	19,700	24,700
4-6	6,600	14,200	17,800
6-8	3,700	8,200	10,200
>8	4,200	4,300	5,300
TOTAL[5]	**39,500**	**75,700**	**94,700**

Notes:

1. Refer to cross-section/slice through Area A shown in Figure 4-5.
2. Volume of residue with modeled Th-230 (actual and Th-230 "plus") >40 pCi/g.
3. Volume of material to be excavated (includes overburden, overcutting, and footprint from gamma walkover).
4. Volume of material excavated with 25% expansion/bulking.
5. Totals rounded to nearest 100 cy.

TABLE 4-6

SUMMARY OF EXCAVATION AND DISPOSAL VOLUMES FOR AREA A (PARTIAL EXCAVATION)

(units: cubic yards)

Lift (ft)	In-Situ Volume [1]	Overburden[2]	Excavation Volume [3]	Disposal Volume[4]
0-2	14,000	0	29,300	36,700
2-4	11,000	0	19,800	24,700
4-6	6,600	NA(5)	NA	NA
6-8	3,700	NA	NA	NA
8-10	2,200	NA	NA	NA
10-12	1,300	NA	NA	NA
12-14	600	NA	NA	NA
14-16	100	NA	NA	NA
TOTAL[6]	**39,500**	**0**	**49,100**	**61,400**

Notes:

[1] Volume of modeled residue with Th-230 greater than 40 pCi/g.

[2] Volume of landfill material within a 2-ft lift assuming full excavation. Overburden material in Area A assumed to be of limited thickness and would be included in excavation volume estimate.

[3] Volume of in-situ modeled residue with Th-230 >40 pCi/g plus landfill material, overcutting, and footprint from gamma walkover survey.

[4] Excavation volume with 25% expansion factor (i.e., volume used for estimate of disposal costs).

[5] Not applicable; Volumes below 4 feet not included as the partial excavation scenario is for excavation from 0 to 4 feet only. Approximately 4 feet of the material encountered was landfill refuse which was defined in this document to be access-restricted material.

[6] Totals rounded to nearest 100 cubic yards.

TABLE 4-7

SUMMARY OF VOLUMES
FOR FULL EXCAVATION
AREA B[1][2]

(units: cubic yards)

Lift (ft bgs)	In-Situ Volume [3]	Excavation Volume[4]	Overburden Volume[5]
0-2	0	0	2,000
2-4	0	0	2,000
4-6	0	0	2,100
6-8	0	0	2,000
8-10	0	0	2,100
10-12	5	10	2,100
12-14	30	80	1,900
14-16	50	200	1,800
16-18	90	300	1,600
18-20	100	400	1,400
20-22	200	500	1,200
22-24	200	500	1,200
24-26	200	500	1,000
26-28	100	400	800
28-30	100	400	800
30-32	100	400	700
32-34	100	400	600
34-36	100	400	500
36-38	100	400	400
38-40	100	400	300
40-42	100	300	200
42-44	100	300	100
44-46	100	300	0
46-48	90	300	0
48-50	50	100	0
> 50	0	0	0
TOTAL[6]	**2,000**	**6,600**	**26,800**

Notes:

[1] Refer to the cross-section/slice through Area B shown in Figure 4-6.

[2] The volumes presented in this table are for the Full Excavation scenario only. Volumes presented in this table can NOT be used to estimate other excavation (removal) scenarios. Totals rounded to the nearest hundred cubic yards.

[3] Volume of residue with modeled Th-230 (actual and predicted) >40 pCi/g.

[4] Volume of residue with Th-230 >40 pCi/g plus overcutting; these volumes are the basis for the disposal volumes, Figures 4-9 through 4-12 show the boundaries for excavation for lifts 0-2, 2-4, 4-6, and 6-8 ft. For each of these four lifts, the ratio of excavation volume to in-situ volume was calculated. This ratio represents the increase in the in-situ volume due to over-cutting on a 20 X 20 ft grid. This ratio was then applied to the in-situ volumes for lifts below 8 ft to estimate excavation volumes for the lifts below 8 ft. The ratio of the first four lifts decreased from approximately, 7 to 4 as the in-situ voume increased relative to the 20 X 20 ft over-cutting grid. On this basis, a ratio of 3 was applied to lifts below 8 ft, where volumes were generally slightly greater than those in the lifts above 8 ft. The excavation volumes presented are the basis for the disposal volumes presented in Table 4-9.

[5] Volume of landfill material within the 2-ft lift that would have to be excavated to access excavation volume. It is assumed that this volume could be segregated and later put back in the landfill. The volumes are based on the total material to be removed minus excavation volume. Total material to be moved was calculated directly for 0-2, 2-4, 4-6 and 6-8 ft lifts For each of the 4 lifts, the ratio of total material to be moved to in-situ and vertical cut volume was 1:3. This factor of 1.3 was applied to the in-situ and vertical cut volume for the remaining lifts below 8 ft to determine a volume of total material to be moved within each lift. For each lift, the excavation volume was subtracted from this total material to be moved volume to yield the overburden volume.

[6] Total volume of material to be moved (i.e., excavation plus overburden) for full excavation (assuming vertical cuts) is estimated to be approximately 34,000 cy. The actual volume is likely to be greater due to the required side sloping.

TABLE 4-8

SUMMARY OF VOLUMES
FOR FULL EXCAVATION
AREA C[1][2]

(units: cubic yards)

Lift (ft bgs)	In-Situ Volume [3]	Excavation Volume[4]	Overburden Volume[5]
0-2	900	2,200	4,600
2-4	700	2,300	4,100
4-6	800	2,100	3,800
6-8	1,000	2,300	3,300
8-10	1,300	2,600	2,700
10-12	1,400	2,800	2,000
12-14	1,400	2,800	1,300
14-16	1,200	2,400	800
16-18	1,000	1,900	800
18-20	800	1,600	700
20-22	600	1,200	500
22-24	500	900	500
24-26	400	800	400
26-28	300	600	300
28-30	300	600	200
30-32	300	500	100
32-34	200	500	40
34-36	200	300	30
36-38	40	100	90
38-40	0	0	100
40-42	0	0	100
42-44	3	5	100
44-46	7	14	80
46-48	7	14	60
48-50	3	6	40
> 50	5	9	400
TOTAL[6]	**13,400**	**28,500**	**27,100**

Notes:

[1] Refer to the cross-section/slice through Area C shown in Figure 4-7.

[2] The volumes presented in this table are for the Full Excavation scenario only. Volumes presented in this table can NOT be used to estimate other excavation (removal) scenarios. Number provided to the nearest 100 cy.

[3] Volume of residue with modeled Th-230 (actual and predicted) >40 pCi/g.

[4] Volume of residue with Th-230 >40 pCi/g plus overcutting; these volumes are the basis for the disposal volumes, Figures 4-9 through 4-12 show the boundaries for excavation for lifts 0-2, 2-4, 4-6, and 6-8 ft. For each of these four lifts, the ratio of excavation volume to in-situ volume was calculated to be approximately 1.9. This ratio represents the increase in the in-situ volume due to over-cutting on a 20 X 20 ft grid. This ratio was then applied to the in-situ volumes for lifts below 8 ft to estimate excavation volumes. The excavation volumes presented are the basis for the disposal volumes presented in Table 4 9.

[5] Volume of landfill material within the 2-ft lift that would have to be excavated to get to excavation volume. It is assumed that this volume could be segregated and later put back in the landfill. The volumes per 2-4 ft lifts are based on the ratio of total material to be moved to total volume of in-situ and overburden. Total material to be removed minus excavation volume. Total material to be moved was calculated directly for 0-2, 2-4, 4-6 and 6-8 ft lifts for each of the 4 lifts, the ratio of total material to be moved to in-situ and vertical cut volume was 1:3. This factor of 1.3 was applied to the in-situ and vertical cut volume for the remaining lifts below 8 ft to determine a volume of total material to be moved within each lift. For each lift, the excavation volume was subtracted from this total material to be moved volume to yield the overburden volume.

[6] Total volume of material to be moved (i.e., excavation plus overburden) for full excavation (assuming vertical cuts) is estimated to be approximately 56,000 cy. The actual volume is likely to be greater due to the required side sloping.

TABLE 4-9

SUMMARY OF EXCAVATION AND DISPOSAL VOLUMES FOR FULL AND PARTIAL EXCAVATIONS AREAS B & C

	Area B		Area C	
	Full Excavation	**Partial Excavation to 4'**	**Full Excavation**	**Partial Excavation to 4'**
In-Situ Volume[1]	2,000	0	13,400	3,300
Excavation Volume[2]	6,600	0	28,500	8,900
Disposal Volume[3]	7,900	0	35,600	11,200

Notes:

[1] Volume of residue with modeled Th-230 (actual and predicted) >40 pCi/g.

[2] Volume of residue with Th-230 >40 pCi/g plus overcutting based on 20 ft x20 ft grid (does NOT include overburden). This volume DOES NOT INCLUDE OVERBURDEN that would be returned to the landfill.

[3] Volume of In-Situ Plus Overexcavation Volume with 25% expansion/bulking factor.

[4] The total volumes of material (I.e., excavation volume plus overburden volume) to be removed from Areas B and C for the Full Excavation scenario are approximately 34,000 cy and 56,000 cy, respectively. The total volumes of material to be removed from Area C for the Partial Excavation scenario (0-4 ft) is 5,000 cy; there is no Th-230 >40 pCi/g within the upper 4 ft at area B. The actual total volume of material from Area C will likely be greater with the incorporation of side sloping.

APPENDIX A

Table 1-10 from the 1993 Remedial Investigation Report by Bechtel National, Incorporated

Table 1-10

Industrial Wastes Disposed of at Seaway Industrial Park

Generator	Type of Waste	Disposal Period
Western Electric	Misc. paper products PVC plastic Misc. plastic Rubber Restaurant waste Fly ash Spent cleaning solvent Waste oils Drums and pallets Continental enamel	1967-1977
Carborundum Co. (coated abrasives)	Wood, paper, rags, abrasive-grain and scrap sandpaper Incinerator ash and solidified resins Floor sweepings and waste filler, including calcium carbonate and clay	1948-1972
Ford Motor Co. (sampling plant)	Garbage and rubbish	1972
Chevrolet Forge Plant	Pit sludge (steel sealer, graphite, oil, resin, and sodium carbonate)	1974-1979
Chevrolet Metal Casting Plant	Waste sand (clay, insoluble metal compounds, trace oil, resins, and corn flour)	1975-1979
	Sand slurry	1971-1975
Chevrolet Motor Plant	Fly ash Pit sludge	1970-1975
Trico Products	General solid bulk refuse	1960-1979
Union Carbide/Linde	Misc. trash	1966-1979
FMC	Yard trash, floor sweepings, scrap perborate, misc. garbage, and lauryl peroxide	1962-1979
Pennwalt	Sludge	1976-1978

Table 1-10
(continued)

Generator	Type of Waste	Disposal Period
Bernal Foam Prod.	Scrap polyurethane foam, toluene Diisocyanate A liquid drummed mixture of polyether, polyol, chloroethene, and catalysts Misc. wood and paper rubbish	1975-1979
Allied Chemical Specialty Chemical Div. (plastics)	Scrap and chlorinated polyethylene, trash wood, garbage, ceramic saddle packing, and catalyst	1960-1977
Allied Chemical Specialty Chemical Div. (dye plant)	Pretreatment sludge, filter sludges containing organics, colors, metals, and liquid still bottom	1968-1972 or 1974
Allied Chemical Semet-Solvay Div.	Plant scrap	1930-1978
DuPont (Tonawanda)	Dry "Corian" wastes, "Vexar" netting, and "Tedlar" wastes	1974-1976
Spaulding Fibre	Scrap vulcanized fibre, vulcanized fibre sheet, and thermosetting plastic and trimmings	1969-1974
Hooker (Durez)	Rubbish (paper, wood, and cardboard)	early 1970's
F. N. Burt	Waste paperboard, waste cellophane, waste gold leaf, scrap wood, waste plastic garbage, waste adhesive (animal glue, polyvinyl, acetate, dextrins), waste cans, and metal	Not available

Source: Wehran 1979.

APPENDIX B

Relevant Figures and Tables

ORNL Study

Table 1. Results[a] of water sample analyses

Sample	^{226}Ra	^{234}U	^{235}U	^{238}U	^{228}Th	^{230}Th	^{232}Th
W1	4.0×10^{-4}	2.8×10^{-2}	1.5×10^{-3}	2.8×10^{-2}	3.9×10^{-4}	1.8×10^{-4}	7.2×10^{-5}
W2	1.0×10^{-3}	2.0×10^{-2}	1.0×10^{-3}	2.0×10^{-2}	3.7×10^{-4}	9.0×10^{-5}	$\leq4.0\times10^{-5}$
W3	6.3×10^{-3}	4.1×10^{-3}	3.4×10^{-4}	4.2×10^{-3}	3.6×10^{-4}	7.6×10^{-5}	1.1×10^{-4}
W6	1.6×10^{-3}	4.1×10^{-2}	1.3×10^{-2}	5.3×10^{-2}	3.2×10^{-4}	9.0×10^{-4}	6.8×10^{-5}
W7	9.0×10^{-4}	1.0×10^{-2}	4.4×10^{-4}	1.0×10^{-2}	3.0×10^{-4}	1.4×10^{-4}	$\leq3.0\times10^{-5}$
W8	5.8×10^{-4}	4.0×10^{-2}	1.4×10^{-3}	3.9×10^{-2}	3.7×10^{-4}	1.1×10^{-4}	4.1×10^{-5}
W9	8.0×10^{-4}	5.0×10^{-2}	2.1×10^{-3}	5.0×10^{-2}	3.2×10^{-4}	8.6×10^{-5}	$\leq3.0\times10^{-5}$
W10	1.1×10^{-3}	1.4×10^{-2}	7.6×10^{-4}	1.1×10^{-2}	3.2×10^{-4}	7.2×10^{-5}	$<3.0\times10^{-5}$
MPC_w (Soluble)	3×10^{-2}	30	30	40	7	2	2

[a]Concentrations given in pCi/ml.

Table 2. Radium concentrations[a] in the soil

Sample[b]	Depth (ft)	^{226}Ra	Sample	Depth (ft)	^{226}Ra
2-1	0-1	16.2	13-1	0-1	12.4
2-2	1-2	8.2	13-2	1-2	17.3
2-3	2-4	12.8	13-3	2-3	30.6
2-4	4.5-5.5	1.1	13-4	3-4	20.8
2-5	5.5-6.5	0.8	14-1	0-2	9.9
3-1	0-1	27.8	14-2	2-3	1.7
3-2	1-2	9.0	15-1	0-1	1.0
3-3	2-4	1.3	15-2	1-2	0.8
4-1	0-1	3.3	16-1	0-1	17.9
4-2	1-2	3.0	16-2	1-2	1.4
4-3	2-4	8.2	17-1	0-1	40.5
5-1	0-2	1.6	17-2	1-2	1.0
6-2	1-2	1.0	18-1	0-1	15.0
6-3	2-4	7.3	18-2	1-2	1.9
9-1	0-1	32.0	19-1	0-1	11.5
9-2	1-2	1.5	19-2	1-2	1.3
10-1	0-1	40.9	22-1	0-1	1.2
10-2	1-2	1.2	24-1	0-1	1.3
11-1	0-2	20.5	24-4	4-4.5	1.8
11-2	2-3	1.3	25-1	0-1	3.3
12-1	0-2	6.3	25-3	2-3	4.4
			25-7	Surface	8.0

Table 2. (cont'd.) Radium concentrations[a] in the soil

Sample	Depth (ft)	^{226}Ra	Sample	Depth (ft)	^{226}Ra
65P	0-1	23.1	77-1	0-1	1.0
66-1	0-1.5	13.0	77-2	1-2	1.0
67-1	0-1	7.2	79-1	0-1	22.2
68-1	0-1	5.8	80-1	0-0.5	3.6
70-1	0-0.5	2.6	80-P1	0-1	92.6
72-1	0-1	3.4	80-P2	1-2	71.7
72-2	1-2	1.9	81-2	1-2	1.0
75-1	0-1	24.6	82-1	0-1	6.5
76P	Surface	5.9	82-2	1-2	1.1
			82-3	2-3	40.0

[a]Measurements given in pCi/g.

[b]The first number in the sample designation refers to the sample location (see Figs. 4 and 5).

Table 3. Concentrations[a] of ^{238}U in selected samples

Sample[b]	^{238}U (pCi/g)
3-1	63.0
5-1	2.9
11-1	17.0
13-1	40.0
28-1	2.5
30-2	2.8
31-2	56.0
33-2	2.4
34-1	4.3
36-1	4.2
47-3	3.5
48-1	44.0
53-1	46.0
63-1	34.0
65P	21.0
66-1	12.0
68-1	12.0
77-1	2.5
79-1	N.F.
80-P2	102
82-3	59.0

[a]Radium concentrations and depth of these samples are given in Table 2.

[b]The first number in the sample name refers to the sample location (see Figs. 4 and 5).

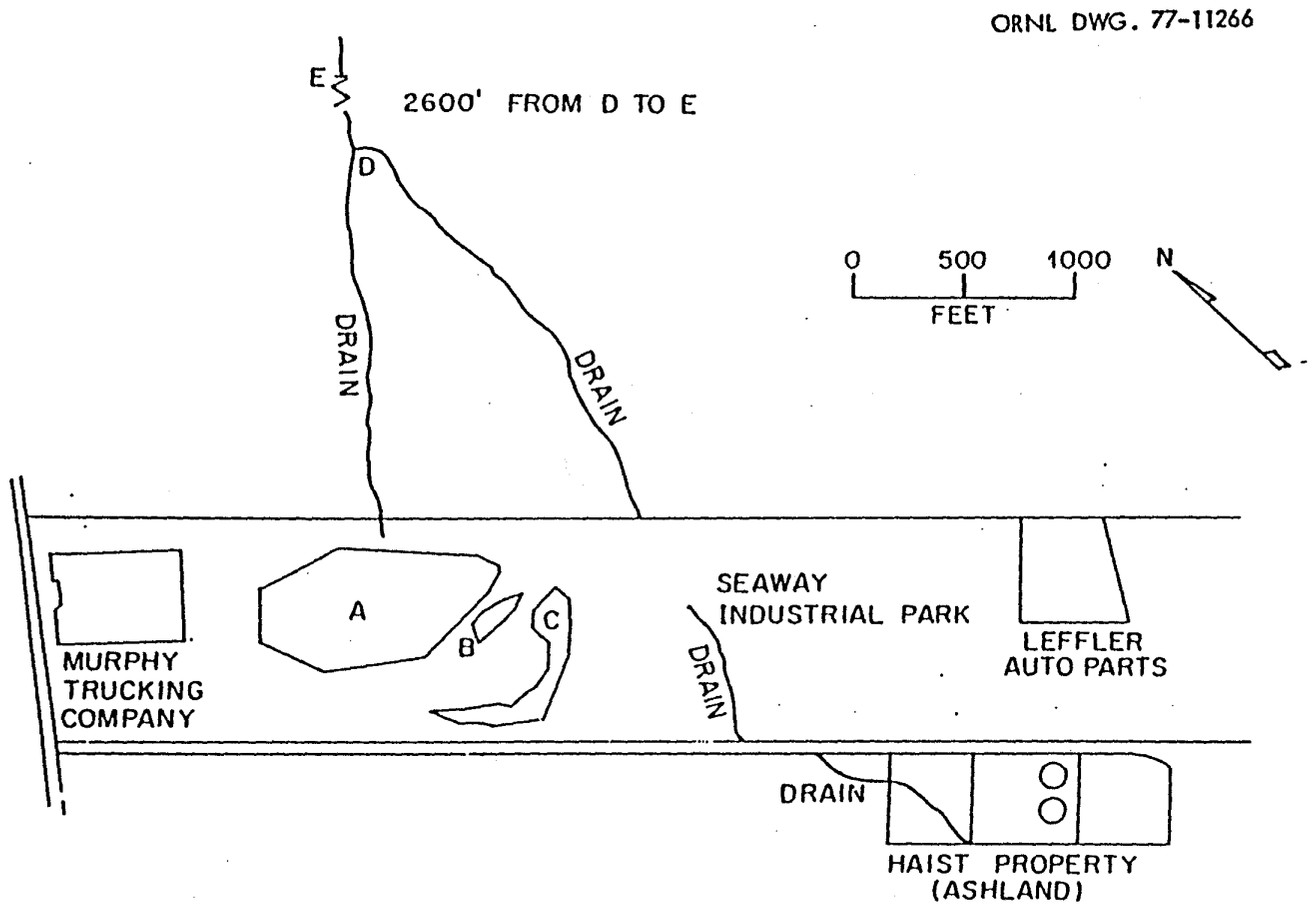


Fig. 1. Plan view of Seaway Industrial Park showing three areas (A, B, C) where radioactive residues were dumped.

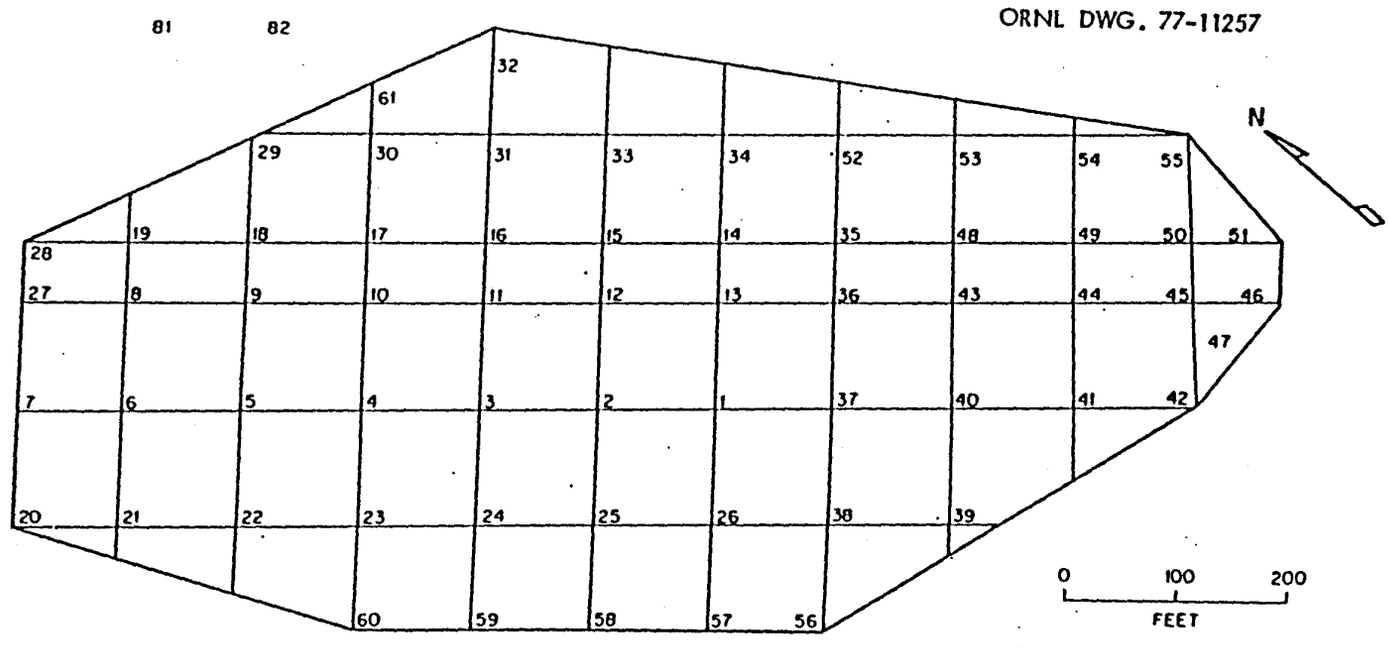


Fig. 4. Points on and near area of known contamination at which measurements were taken (Area A).

ORNL-DWG 76-19879

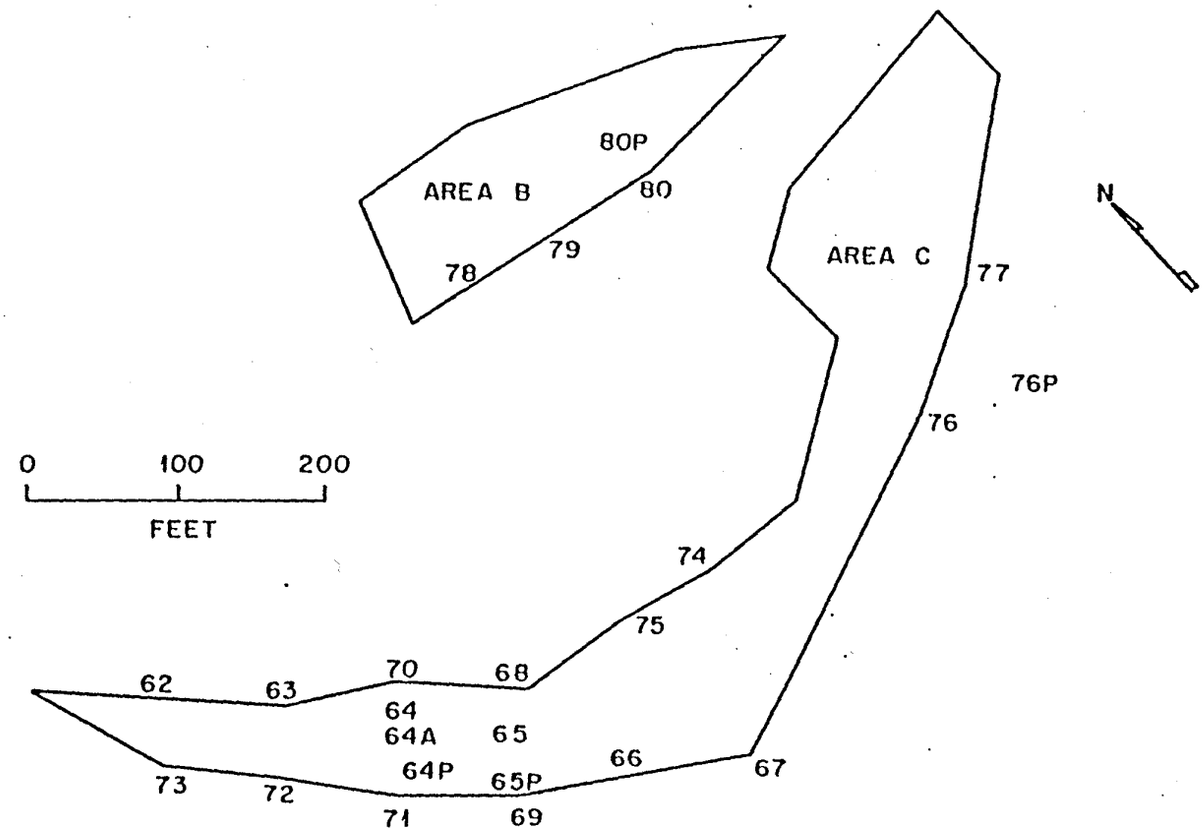


Fig. 5. Points on and near area of known contamination at which measurements were taken (Areas B and C).

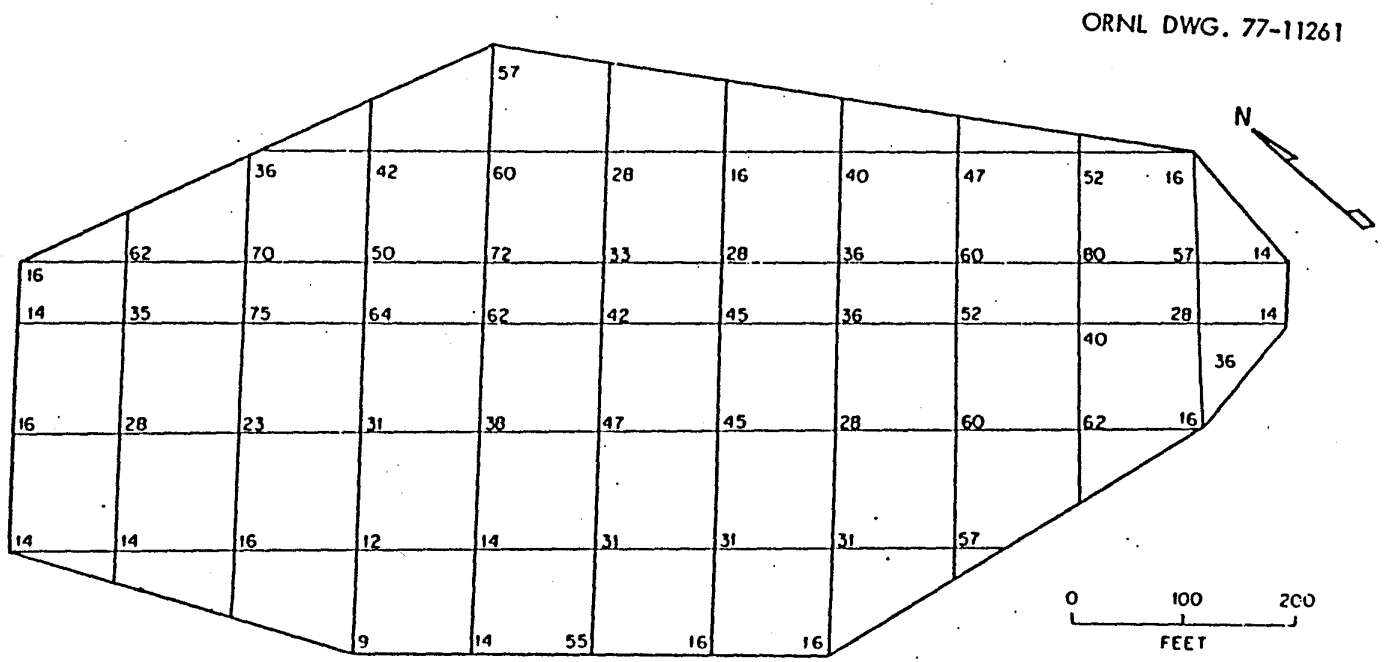


Fig. 7. External gamma radiation levels (in μR/hr) at 1 m above surface (Area A).

ORNL DWG. 77-11255

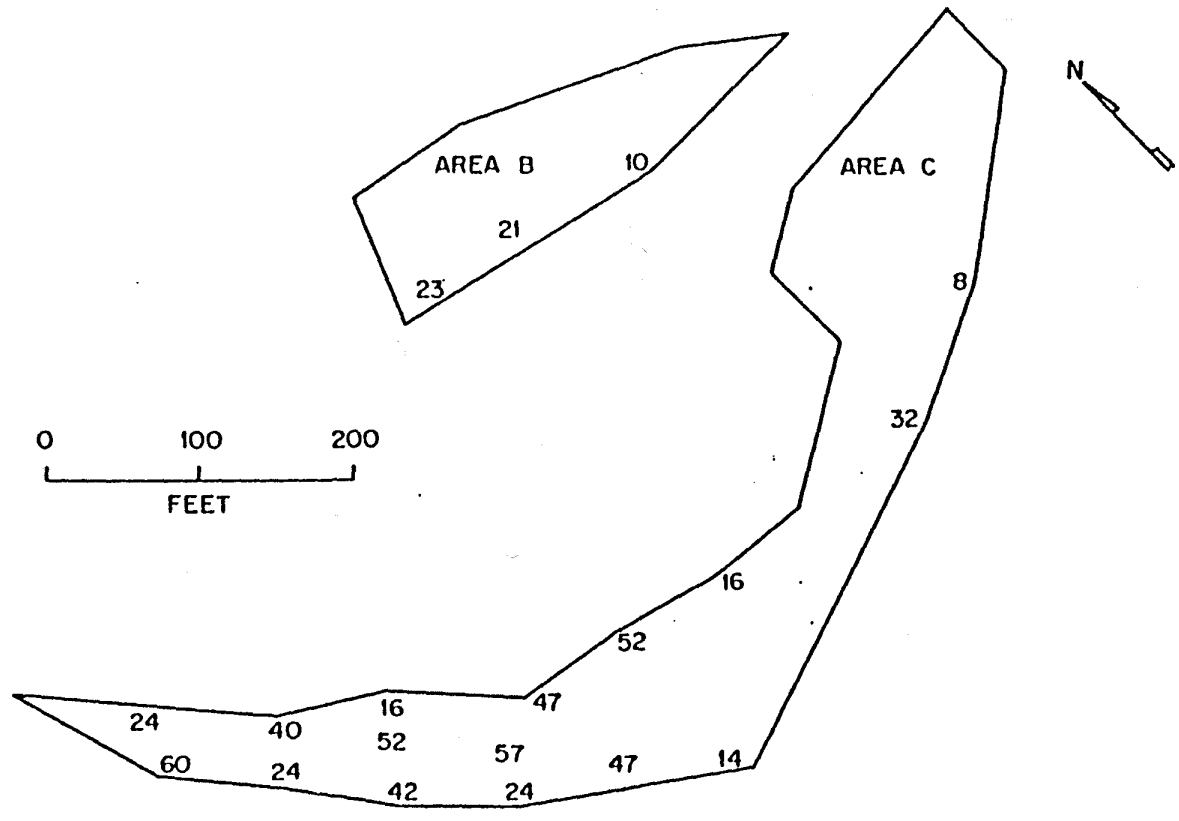


Fig. 8. External gamma radiation levels (in μR/hr) at 1 m above surface (Areas B and C).

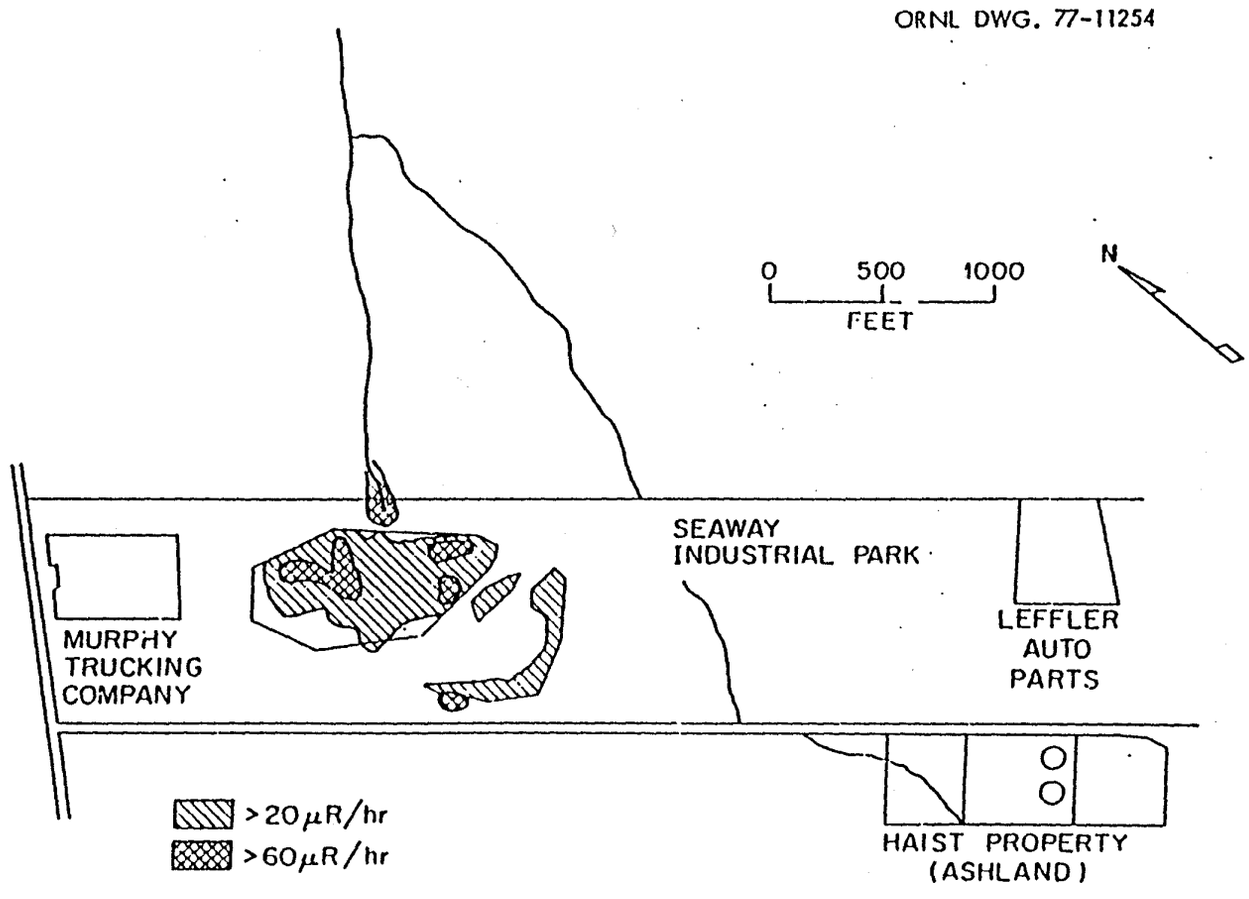


Fig. 9. Area of elevated external gamma radiation.

ORNL DWG. 77-11264

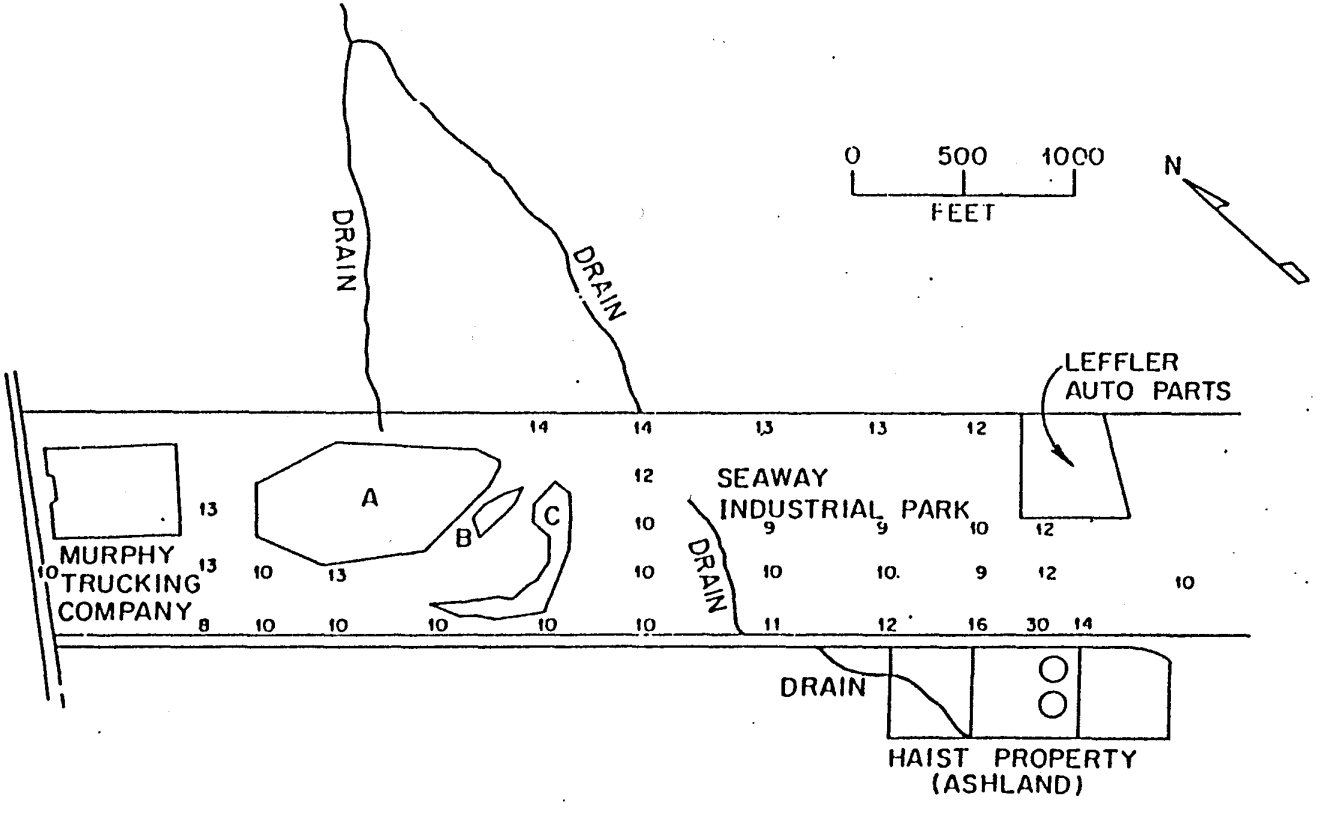


Fig. 10. External gamma radiation levels (in μR/hr) at 1 m above surface on 400-ft grid.

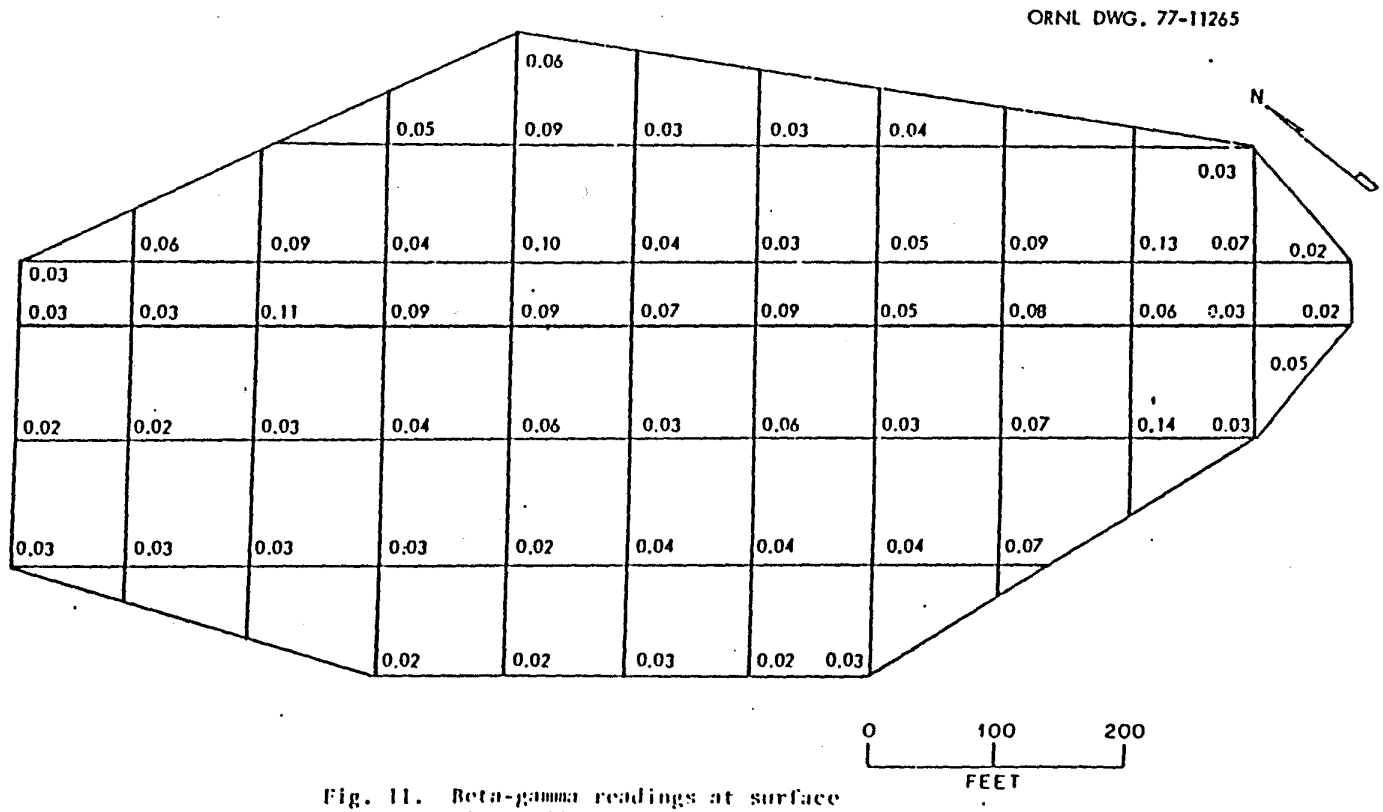


Fig. 11. Beta-gamma readings at surface (in mrad/hr).

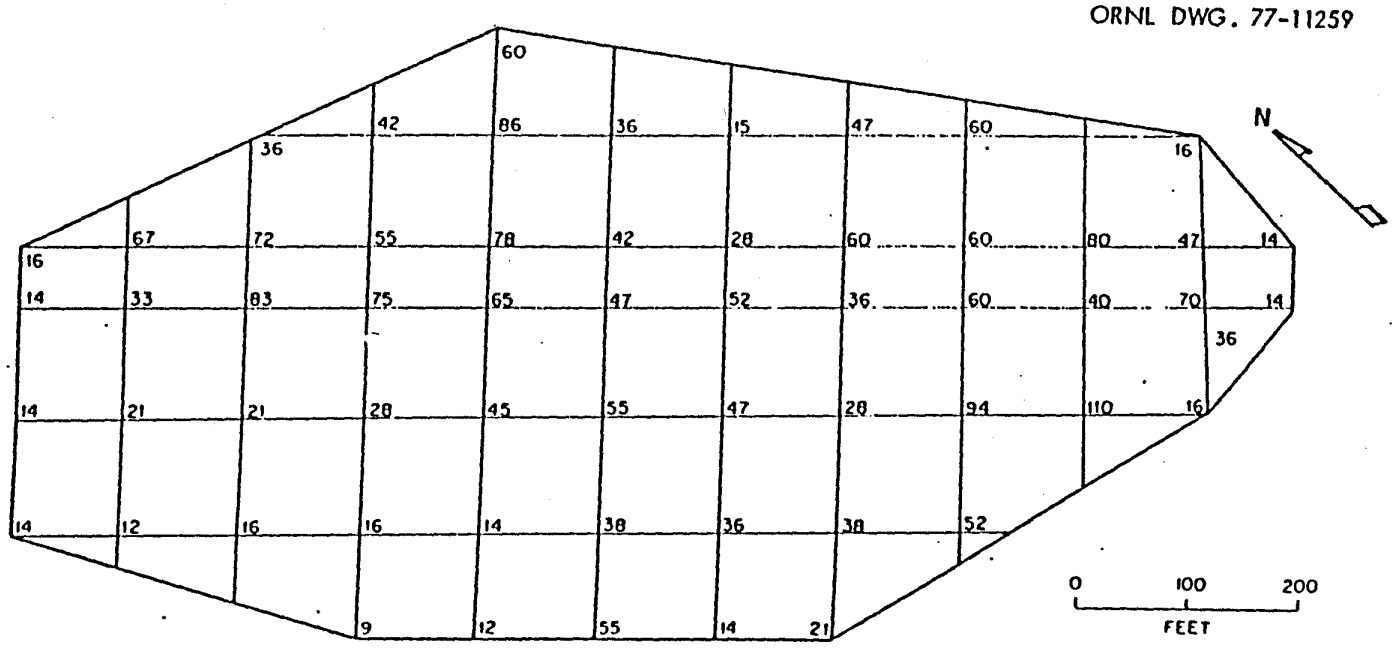


Fig. 12. External gamma radiation (in μR/hr) at the surface on Area A.

ORNL DWG. 77-11258

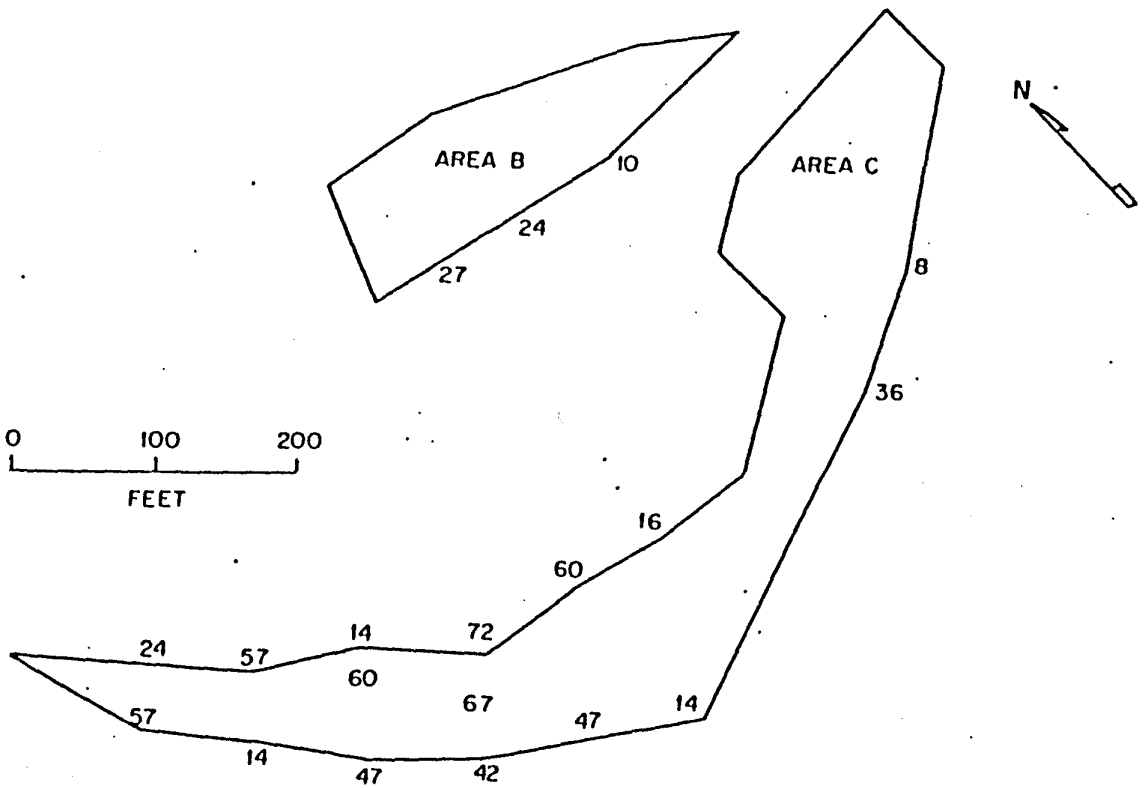


Fig. 13. External gamma radiation levels (in μR/hr) at the surface on and near Areas B and C.

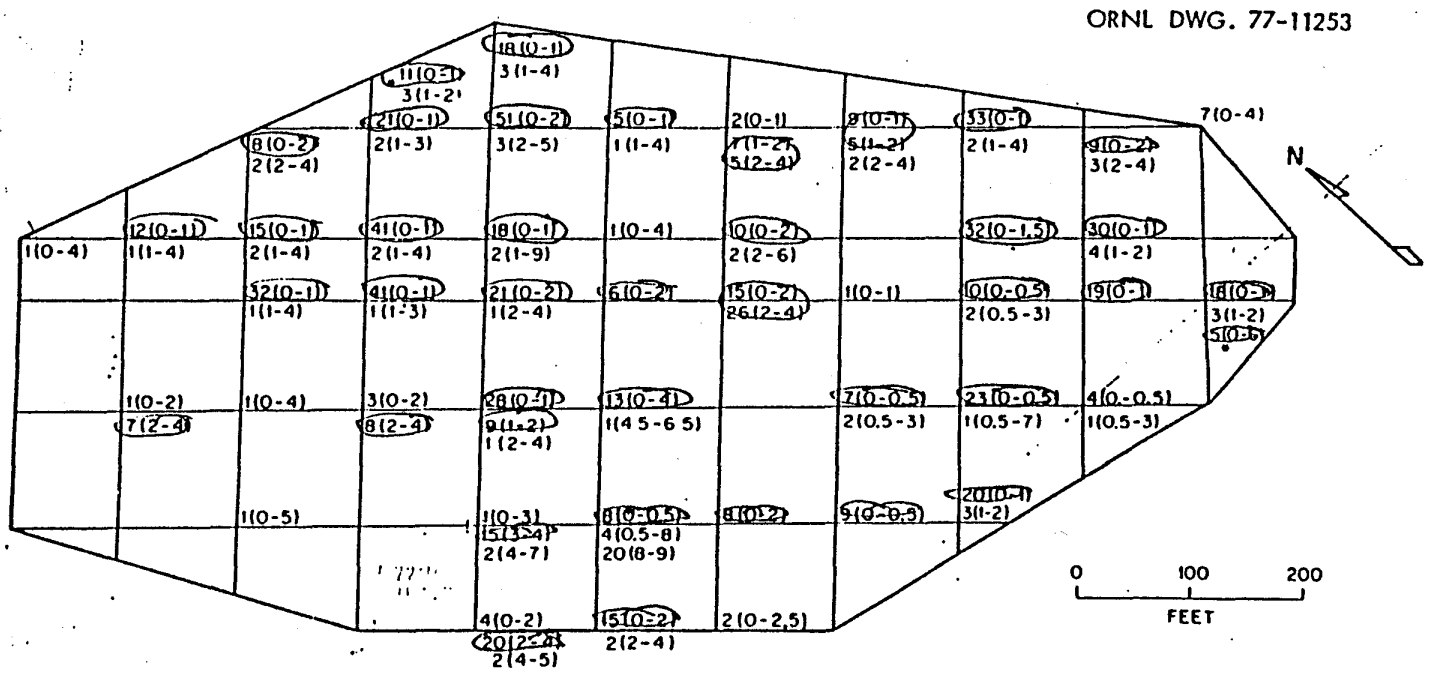


Fig. 14. Radium concentrations in Area A estimated from loggings and soil sample analyses [legend u(v-w) indicates u pCi/g from a depth of v ft to a depth of w ft].

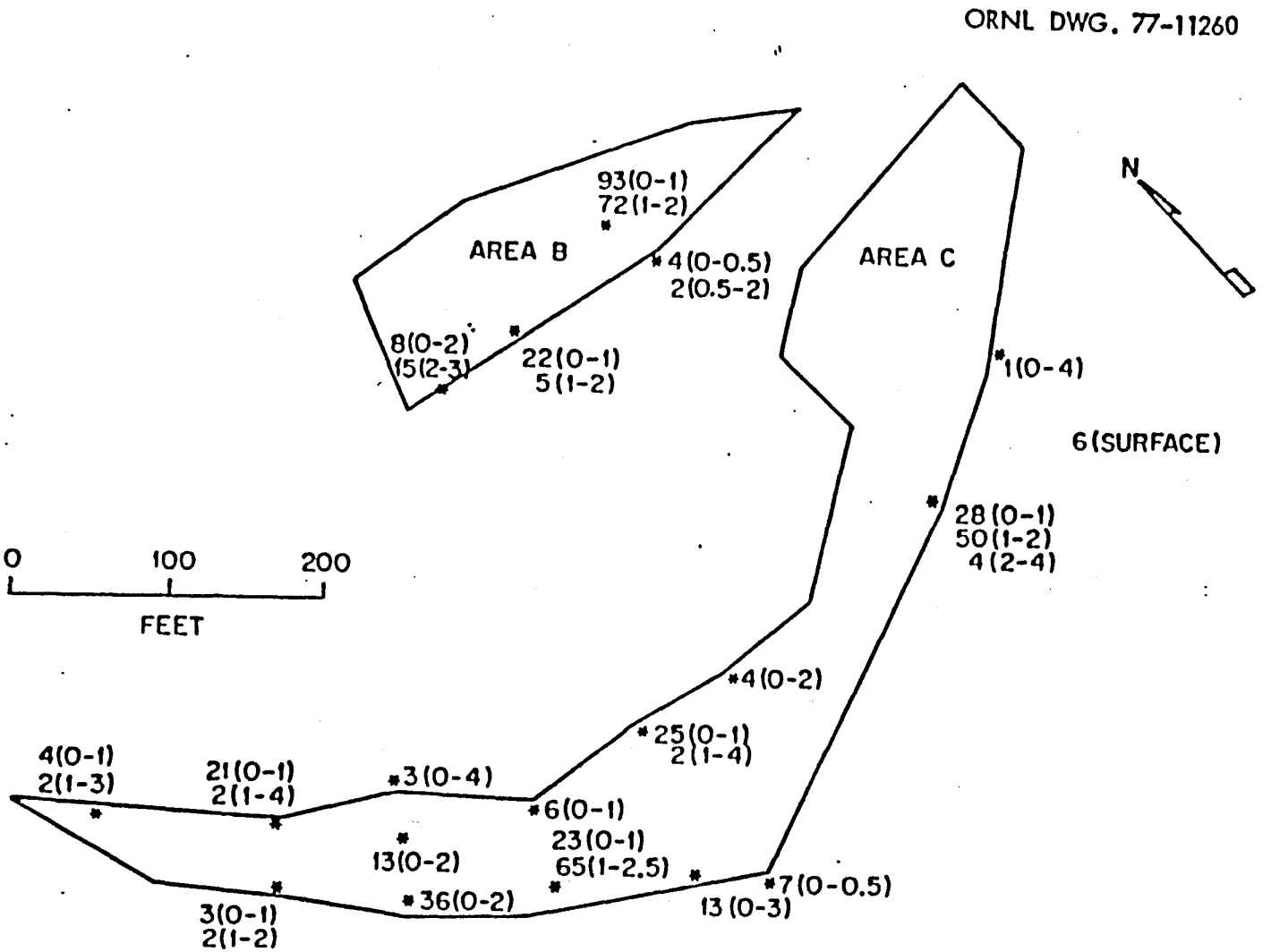


Fig. 15. Radium concentrations in Areas B and C estimated from loggings and soil sample analyses [legend u(v-w) indicates u pCi/g from a depth of v ft to a depth of w ft].

APPENDIX C

Relevant Figures and Tables

FDBU Study

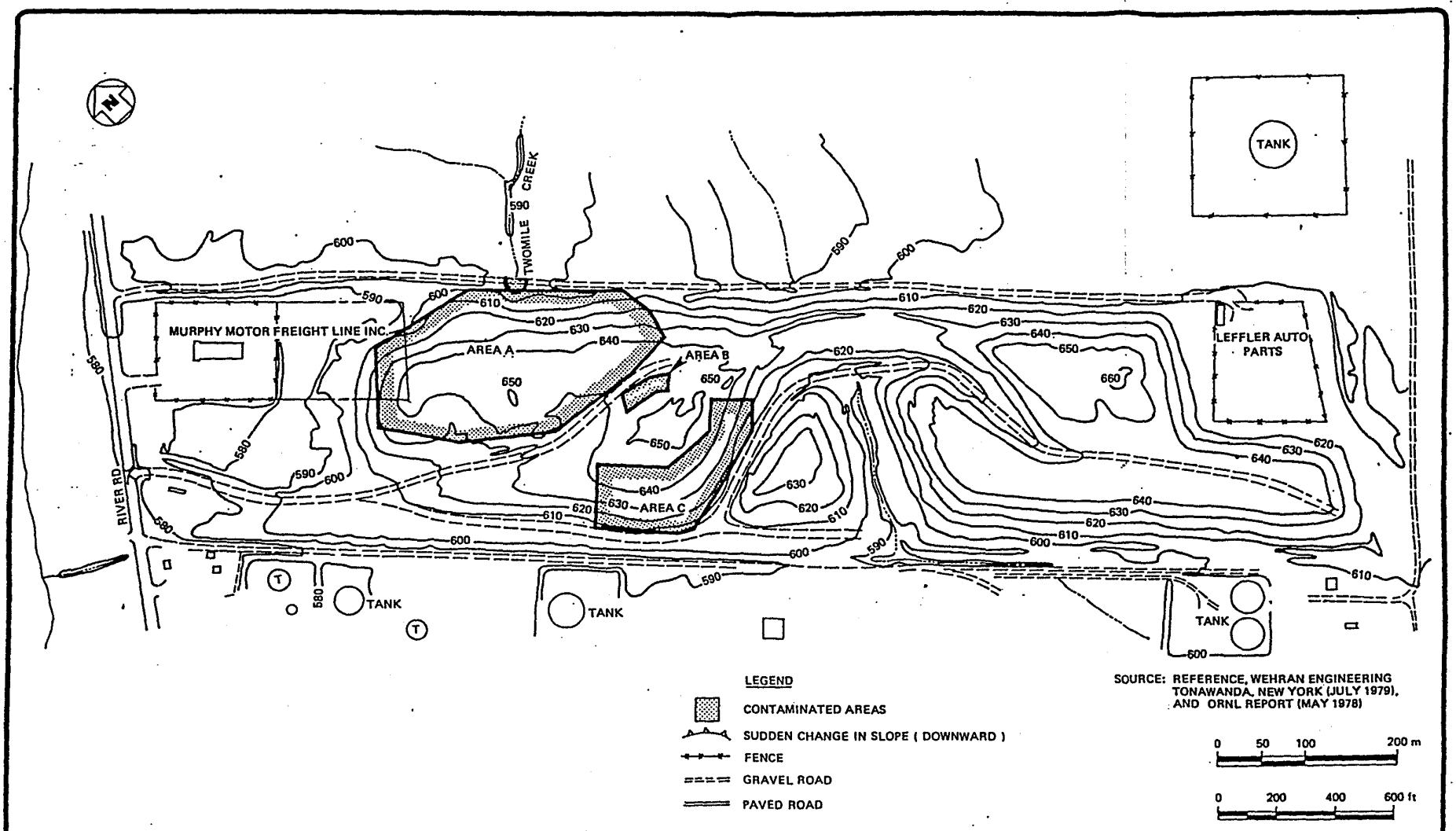


FIGURE 3-5. TOPOGRAPHIC MAP

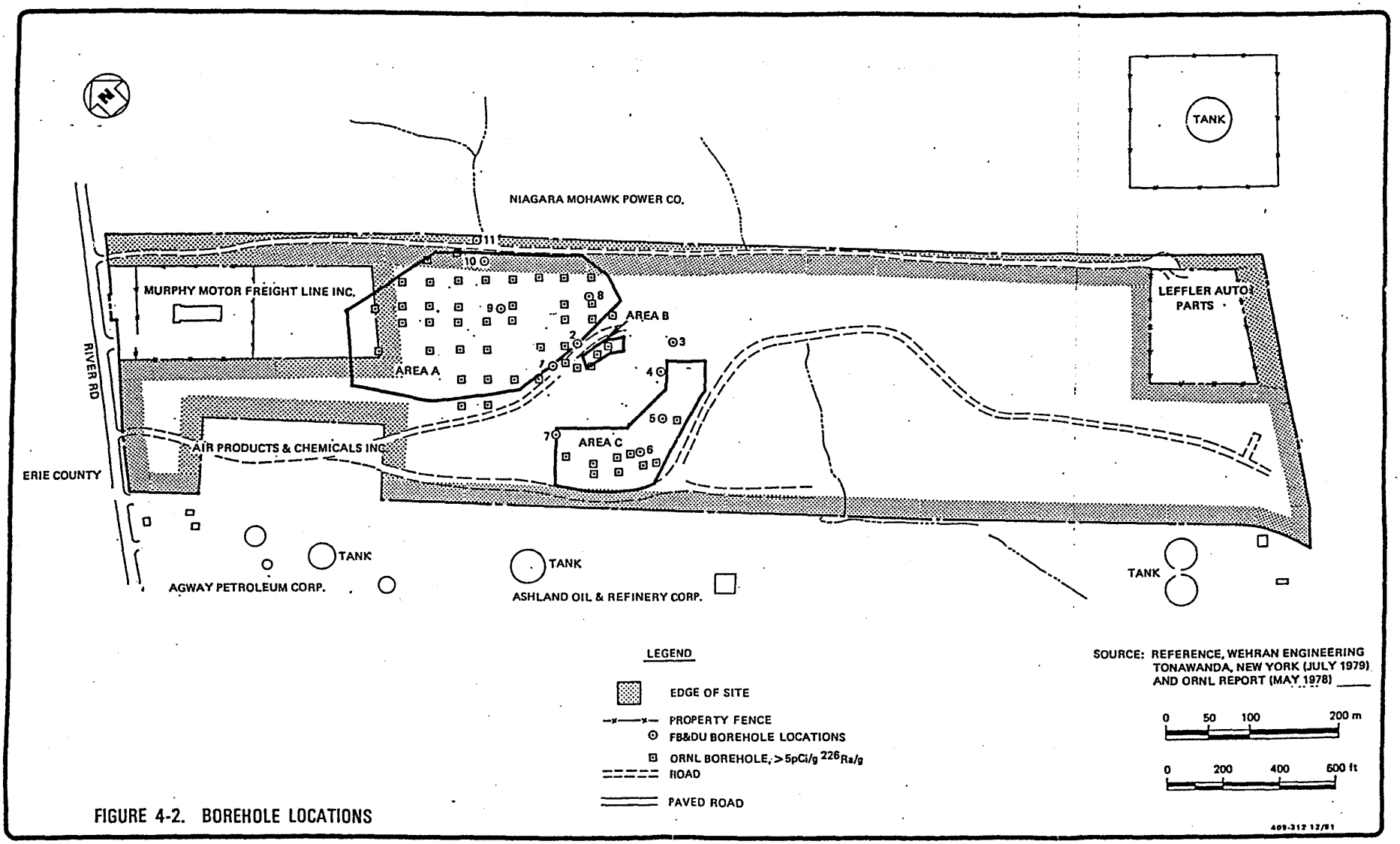


FIGURE 4-2. BOREHOLE LOCATIONS

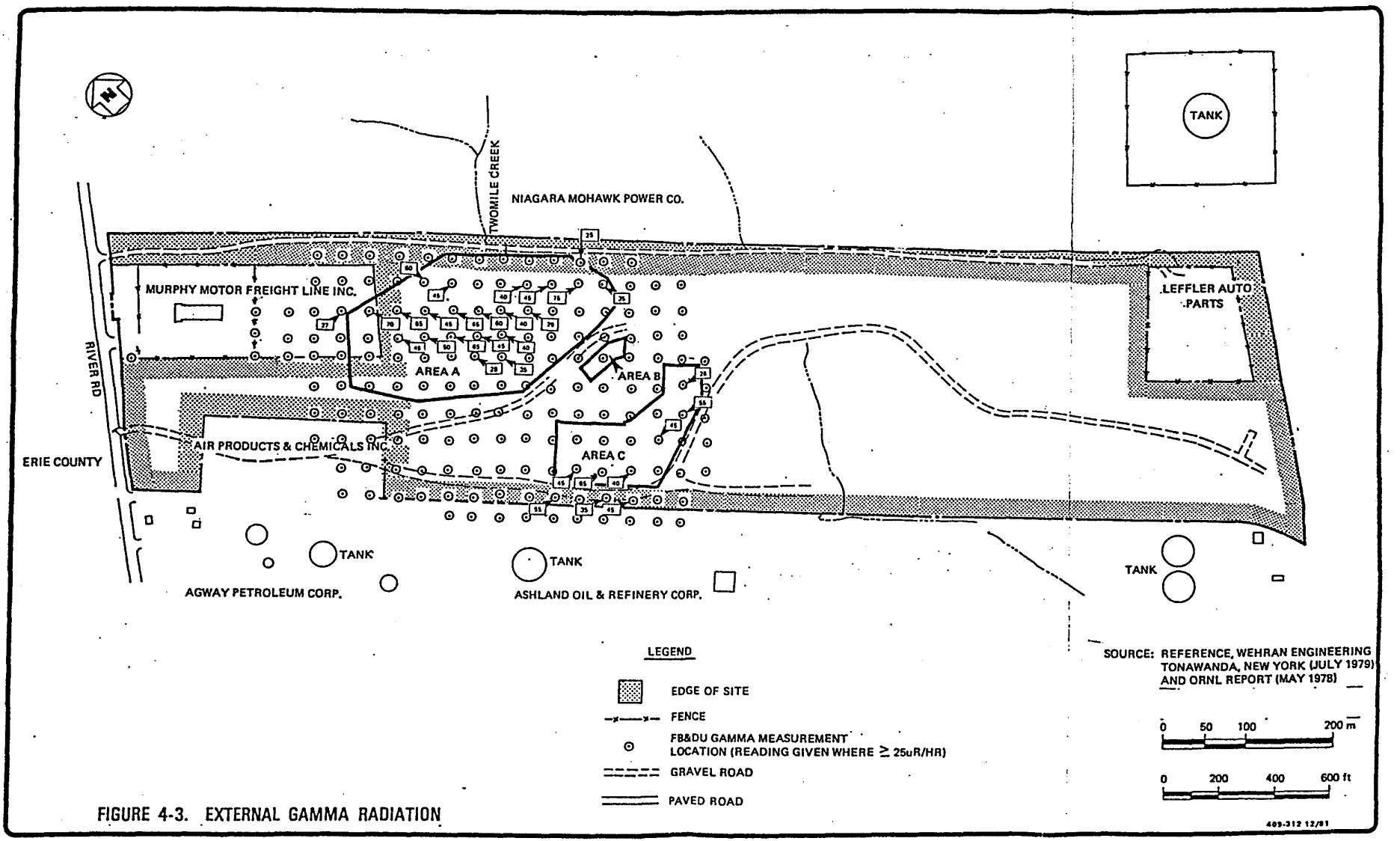


FIGURE 4-3. EXTERNAL GAMMA RADIATION

TABLE 4-4

SOIL SAMPLE CONCENTRATIONS*

Sample No.	Borehole No.	Sample Depth (ft)	^{226}Ra (pCi/g)	^{238}U (pCi/g)
1	DH-1	0-1	0.26	0.83
2		1-2	0.28	0.43
3		2-3	0.40	0.20
4		3-4	0.18	0.03
5		4-5	0.19	0.17
6		5-6	0.42	0.33
7		6-7	0.57	0.20
8		7-8	0.30	0.40
9		8-9	0.16	0.17
10		9-10	0.46	0.30
11		10-11	0.55	0.10
12	DH-2	0-1	0.44	1.03
13		1-2	0.30	1.2
14		2-3	0.37	0.47
15		3-4	0.55	2.3
16		4-5	0.45	0.20
17		5-6	0.51	2.6
18		6-7	0.32	0.33
19		7-8	0.15	1.2
20	DH-3	0-1	1.25	0.37
21		1-2	0.82	5.7
22		2-3	3.5	9.7
23		3-4	4.1	2.8
24		4-5	1.8	1.8
26	DH-4	0-1	1.5	2.2
27		1-2	2.0	2.3
28		2-3	1.6	3.7
29		3-4	1.7	1.2
30		4-5	0.95	0.60
31		5-6	0.25	0.13
32	DH-5	0-1	0.62	0.77
33		1-2	1.2	0.87
34		2-3	0.97	1.1
35		3-4	0.84	3.3
37	DH-6	0-1	5.6	5.7
38		1-2	2.3	13.0
39		2-3	4.2	6.7
40		3-4	15.0	6.3
42		5-6	5.3	9.3

TABLE 4-4 (Cont)

Sample No.	Borehole No.	Sample Depth (ft)	^{226}Ra (pCi/g)	^{238}U (pCi/g)
43	DH-7	0-1	0.74	0.77
44		1-2	1.4	0.90
45		2-3	8.2	5.7
46		3-4	22.0	13.0
47		4-5	3.6	4.3
48		5-6	1.9	2.1
49		6-7	0.56	1.3
50		7-8	1.6	1.7
51		8-9	2.9	1.7
52		9-10	0.72	2.1
53		10-11	0.29	1.0
54	DH-8	0-1	141.0	74.0
55		1-2	46.0	25.0
56		2-3	9.6	29.0
57		3-4	15.0	21.0
65	DH-9	0-1	4.8	26.0
66		1-2	22.0	21.0
67		2-3	5.8	8.0
68		3-4	4.1	4.0
69		4-5	6.9	17.0
70		5-6	10.4	12.0
71		6-7	<0.20	9.7
72	DH-10	0-1	0.79	19.0
73		1-2	5.5	5.7
74		2-3	3.0	1.8
75		3-4	0.12	0.87
76		4-5	1.6	0.67
77		5-6	0.40	1.2
78		6-7	0.32	0.63
79		7-8	0.50	0.40
80		8-9	0.60	0.33
81		9-10	0.20	0.67
82		10-11	0.57	0.33
83	DH-11	3-4	0.61	0.93
84		4-5	1.6	1.4
85		5-6	0.52	0.77
86		6-7	0.66	0.57
87		7-8	0.36	0.57
88		8-9	0.64	0.43
89		9-10	0.97	0.43
90		10-11	0.68	1.5

TABLE 4-4 (Cont)

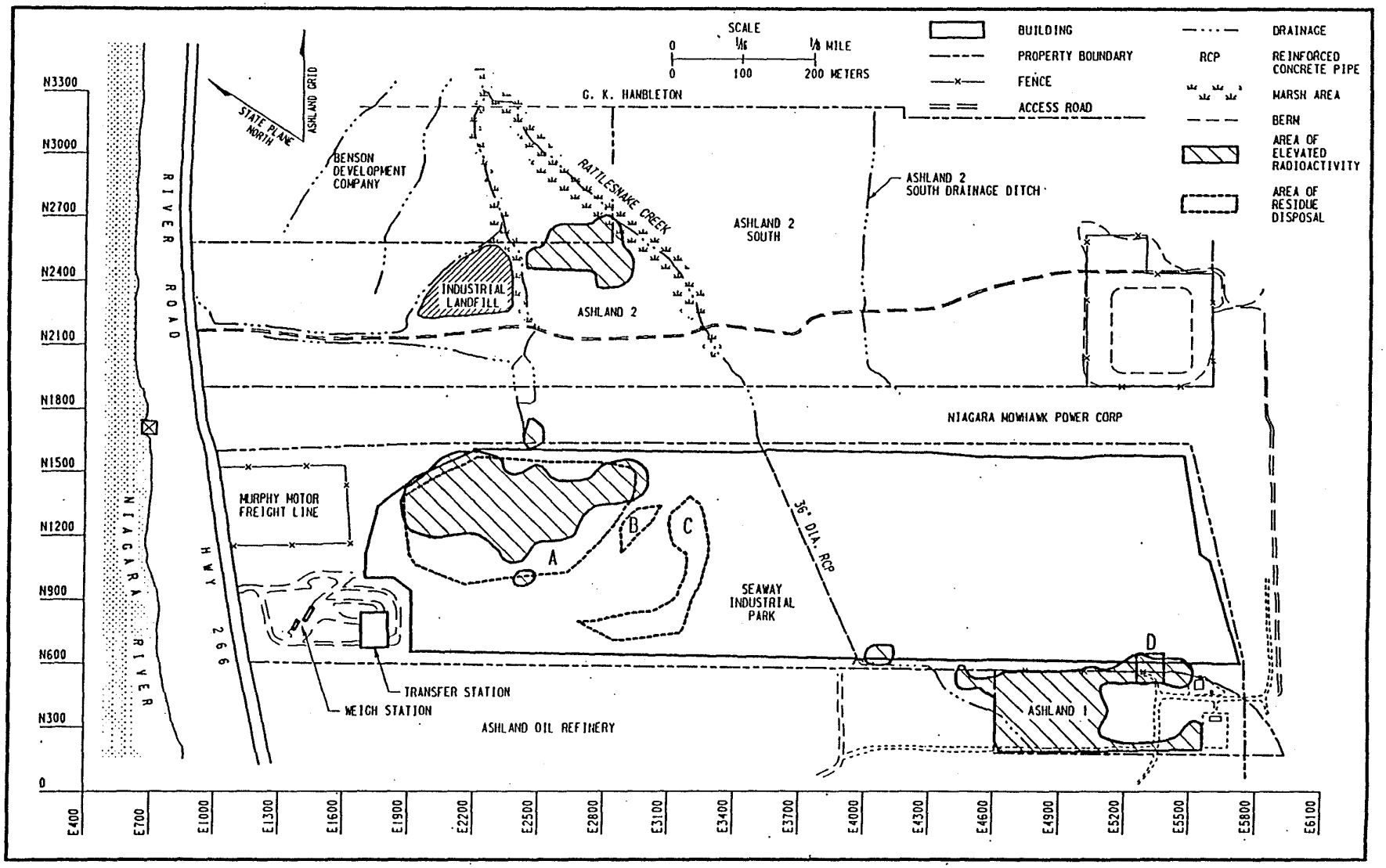
Sample No.	Borehole No.	Sample Depth (ft)	^{226}Ra (pCi/g)	^{238}U (pCi/g)
SS-1		Surface	3.8	2.9
SS-2		Surface	1.2	1.3
SS-3		Surface	0.78	0.27
SS-4		Surface	1.04	0.43
SS-5		Surface	0.75	0.37
SS-6		Surface	0.60	0.27

*See Figure 4-2 for locations.

APPENDIX D

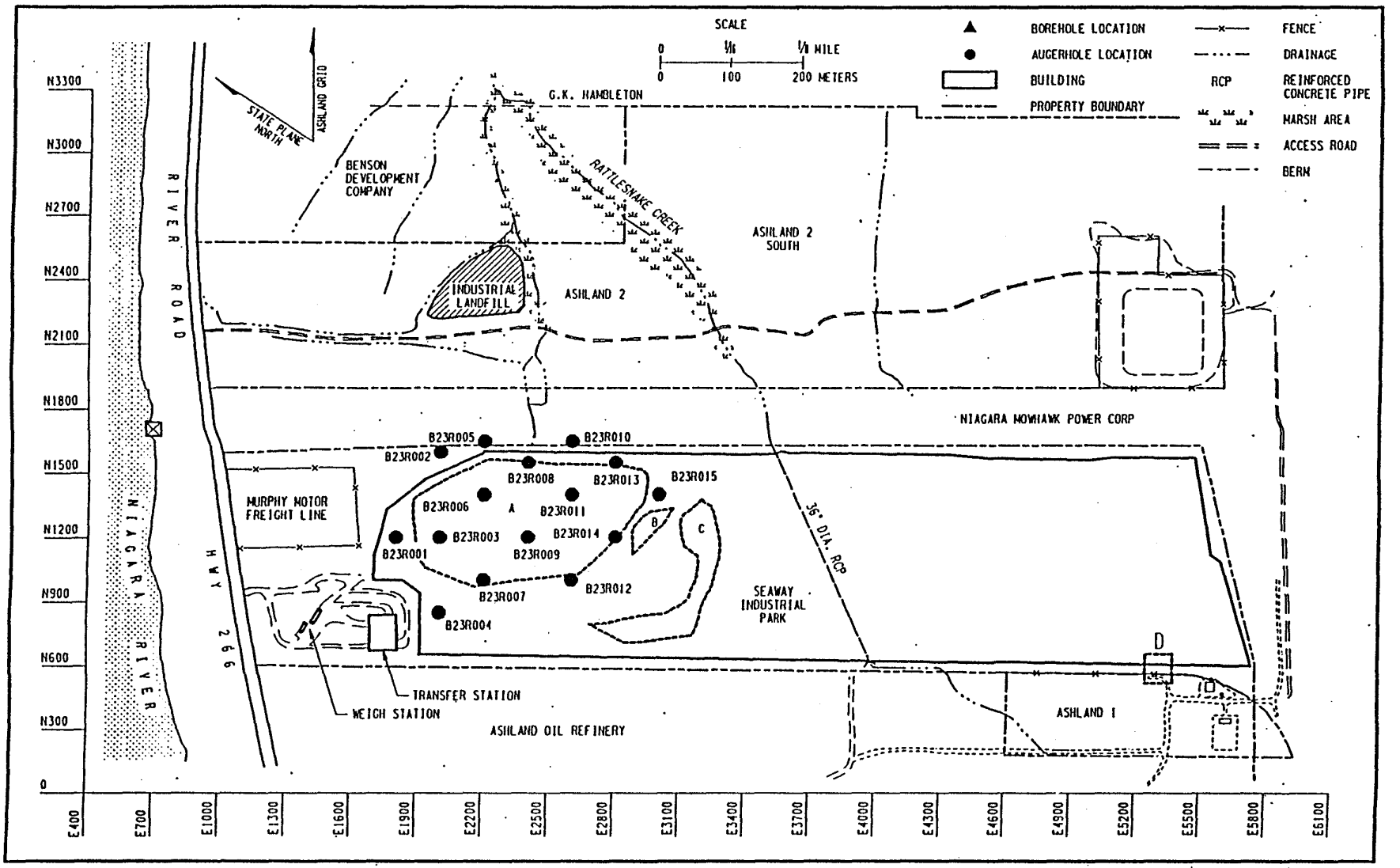
Relevant Figures and Tables

BNI Studies



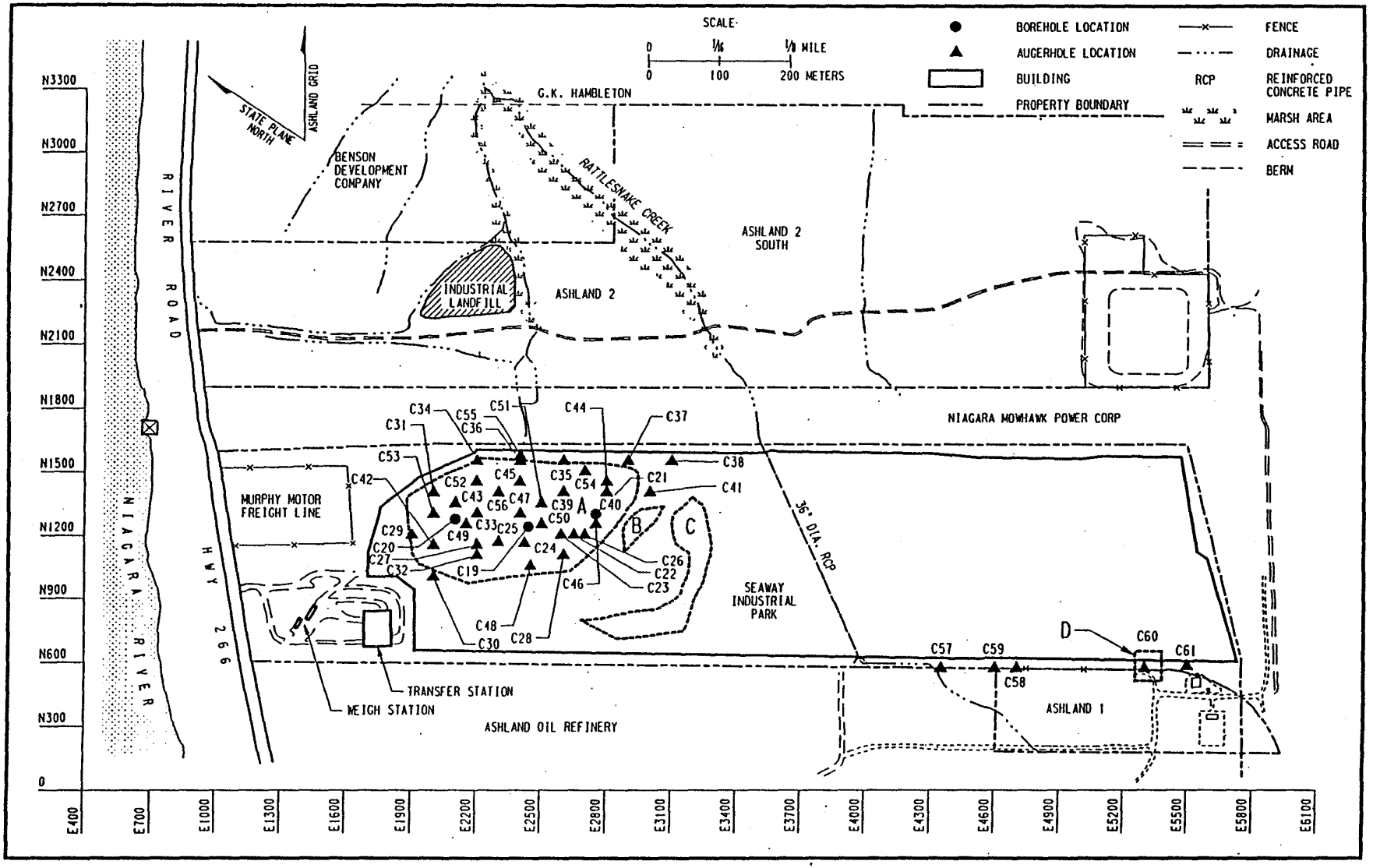
132 R15F079.DGN

Figure 1-14
Plan View of Ashland 1, Ashland 2, and Seaway



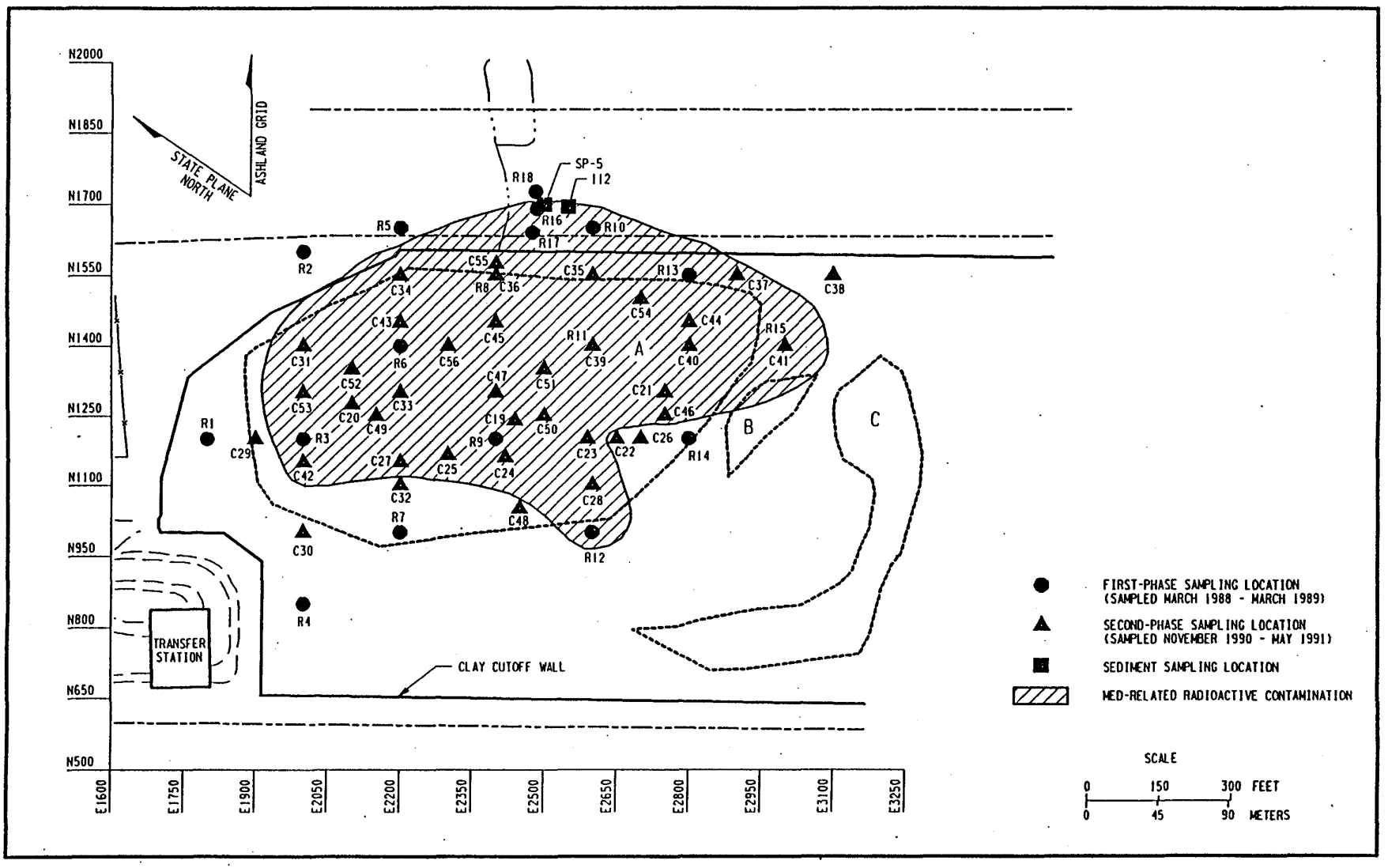
132 R15F014.DGN

Figure 2-13
First-Phase Radiological Soil Sampling Locations at Seaway



132 R15F013.DGN

Figure 2-14
Second-Phase Radiological Soil Sampling Locations at Seaway



155 R15F084.DGN

Figure 4-13
Area A of Radioactive Contamination in Soil at Seaway

Table 2-16
First-Phase Radiological Borehole Summary for Seaway

Sampling Location[a]	Grid Coordinate North	Grid Coordinate East	Borehole Depth (ft)
B23R001	1800	1200	4
B23R002	2000	1600	3
B23R003	2000	1200	4
B23R004	2000	850	8
B23R005	2200	1650	3
B23R006	2200	1400	12
B23R007	2200	1000	8
B23R008	2400	1550	12
B23R009	2400	1200	9
B23R010	2600	1650	0.5
B23R011	2600	1400	3
B23R012	2600	1000	5
B23R013	2800	1550	4
B23R014	2800	1200	7
B23R015	3000	1400	7
B23R016	2475	1640	2
B23R017	2485	1690	2
B23R018	2485	1740	2

[a]Sampling locations are shown in Figure 2-13.

Table 2-17
Second-Phase Radiological Borehole
Summary for Seaway

Sampling Location[a]	Grid Coordinate East	Grid Coordinate North	Borehole Depth (ft)
B23RC19[b]	2440	1240	12
B23RC20[b]	2100	1275	24
B23RC21[b]	2750	1300	30
B23RC22[c]	2650	1200	2
B23RC23[c]	2590	1200	2.5
B23RC24[c]	2420	1160	1
B23RC25[c]	2300	1165	2
B23RC26[c]	2700	1200	2
B23RC27[c]	2200	1150	1
B23RC28[c]	2600	1100	2.5
B23RC29[c]	1900	1200	2
B23RC30[c]	2000	1000	1
B23RC31[c]	2000	1400	4
B23RC32[c]	2200	1100	2
B29RC33[c]	2200	1300	2
B23RC34[c]	2200	1550	2
B23RC35[c]	2600	1550	4
B23RC36[c]	2400	1550	2
B23RC37[c]	2900	1550	2
B23RC38[c]	3100	1550	3
B23RC39[c]	2600	1400	1
B23RC40[c]	2800	1400	1
B23RC41[c]	3000	1400	1
B23RC42[c]	2000	1150	2
B23RC43[c]	2200	1450	1.5
B23RC44[c]	2800	1450	2.5
B23RC45[c]	2400	1450	1
B23RC46[c]	2750	1250	2

(continued)

Sampling Location[a]	Grid Coordinate East	Grid Coordinate North	Borehole Depth (ft)
B23RC47[c]	2400	1300	2.5
B23RC48[c]	2450	1050	2.5
B23RC49[c]	2150	1250	1.5
B23RC50[c]	2500	1250	1
B23RC51[c]	2500	1350	2
B23RC52[c]	2100	1350	1
B23RC53[c]	2000	1300	3
B23RC54[c]	2700	1500	2
B23RC55[c]	2400	1575	3
B23RC56[c]	2300	1400	1
B23RC57[c]	4350	570	3
B23RC58[c]	4700	570	2
B23RC59[c]	4600	570	2
B23RC60[c]	5300	570	4
B23RC61[c]	5500	580	2

[a]Sampling locations are shown in Figure 2-14.

[b]Borehole location.

[c]Location sampled with a hand auger.

Table 4-37

Summary of Radionuclide Concentrations in Soil at Seaway

Borehole Number[a]	Coordinate East	Coordinate North	Depth (ft)	Concentration (pCi/g) Uranium-238	Radium-226	Thorium-232	Thorium-230
Background (mean)				3.1	1.1	1.2	1.4
B23R03	2000	1200	0 - 1[b]	8	2.4	1.3	33
	2000	1200	1 - 2	6	1.4	1.2	7.7
	2000	1200	2 - 3	10	1.4	2.5	1.3
	2000	1200	3 - 4	13	1.5	3	1.5
B23R06	2200	1400	0 - 2	5	1.3	1.1	2.6
	2200	1400	6 - 8[b]	24	4	2	2.3
	2200	1400	11 - 12	18	2.2	5	1
B23R08	2400	1550	1 - 2[b]	8	4.8	4	29
	2400	1550	2 - 3[b]	6	1.7	1.7	21
	2400	1550	3 - 4[b]	6	3	1.4	85
	2400	1550	11 - 12	11	3	3	3
B23R09	2400	1200	0 - 2[b]	3	16.2	3	170
	2400	1200	2 - 3[b]	2	21	2	330
	2400	1200	3 - 4[b]	1	37	1	700
	2400	1200	4 - 6[b]	1	14	1	220
	2400	1200	6 - 9	0.8	2	0.8	16
B23RC10	2600	1650	0 - 0.5[b]	18	2.5	2	2.3
B23R11	2600	1400	0 - 1[b]	13	13	1.2	275
	2600	1400	1 - 2[b]	9	3.1	1	65
	2600	1400	2 - 3	10	1.6	1.2	5.7
B23R12	2600	1000	4 - 5[b]	7	4.1	1	25
B23R13	2800	1550	0 - 1[b]	20	19	1	249
	2800	1550	1 - 2[b]	17	17	2	307
	2800	1550	2 - 5	8	1.3	1.6	11
B23R15	3000	1400	2 - 5[b]	8	6	2.3	55
	3000	1400	5 - 6[b]	10	3.5	1	30
	3000	1400	6 - 7[b]	1	17	1	180
B23R16	2475	1640	0 - 0.5[b]	9	10	1	170
	2475	1640	0.5 - 1[b]	9	36	1	450
	2475	1640	1 - 2	10	2.9	3	2.2
B23R017	2485	1690	0 - 0.5[b]	15	2.3	4	52
	2485	1690	0.5 - 1	10	1.1	2	1.6
	2485	1690	1 - 2	10	0.6	2	1.4
B23RC19	2440	1240	0 - 2[b]	20	7.5	2.3	230
	2440	1240	2 - 4[b]	20	9.6	1.3	86
	2440	1240	6 - 8[b]	4.1	2.7	1	40
	2440	1240	10 - 12	5.9	2.5	0.6	5.7
B23RC20	2100	1275	0 - 2	8.7	2.1	1.4	3.7
	2100	1275	14 - 17	4	0.4	1	1
	2100	1275	22 - 24	1.7	1.5	2	0.7

Borehole Number[a]	Coordinate East	Coordinate North	Depth (ft)	Concentration (pCi/g) Uranium-238	Radium-226	Thorium-232	Thorium-230
B23RC49	2150	1250	0 - 1[b]	14	20	1.7	215
	2150	1250	1 - 1.5	6.2	2	0.8	11
B23RC50	2500	1250	0 - 1[b]	36	11	0.9	633
B23RC51	2500	1350	0 - 1[b]	23	14	1.6	500
	2500	1350	1 - 2[b]	13	13	1.1	72
B23RC52	2100	1350	0 - 1[b]	7	3.5	1.3	70
B23RC53	2000	1300	0 - 1[b]	11	8.6	1.2	50
	2000	1300	1 - 2[b]	6	2.5	1.1	97
B23RC54	2700	1500	0 - 1[b]	27	14	0.8	690
	2700	1500	1 - 2[b]	4.9	1	0.8	35
B23RC55	2400	1575	0 - 1	4.2	1	0.9	8.2
	2400	1575	1 - 2[b]	5.7	1.1	0.7	88
	2400	1575	2 - 3[b]	6.5	4	1.3	16
B23RC57	4350	570	0 - 1	6.1	1.2	1.1	2.2
	4350	570	1 - 2[b]	12	2.2	1	22
	4350	570	2 - 3	11	0.9	1.3	1.6
B23RC59	4600	570	0 - 1[b]	5.8	1.5	1.7	18
	4600	570	1 - 2[b]	9.9	1.2	1.2	17
B23RC60	5300	570	0 - 1[b]	52	7.8	1.9	190
	5300	570	2 - 3[b]	6.5	1.4	1.2	32
	5300	570	3 - 4[b]	5.6	1.4	1.1	13
AVERAGE				11.0	7.0	1.6	122.3
MINIMUM				0.8	0.4	0.5	0.7
MAXIMUM				52.0	72.0	21.0	880.0
STANDARD DEVIATION				9.2	9.9	2.1	186.1

[a]Sampling locations are shown in Figures 2-13 and 2-14.

[b]Radioactively contaminated interval.

APPENDIX E

Boring Logs

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R001

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,199.70 E 1,813.60	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-20-88	1-20-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	10.0		10.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		5			/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.3	3-11-11 9								0.0 - 0.8 FT. SILTY CLAY FILL, light reddish brown (5 YR 6/4) silty clay fill material, with 50% brick rubble, gravel, and wood fragments. Clay fraction is stiff, brittle, dense, nearly dry. 0 LEL, 0 TOXICS. Gamma scan did not detect any significant elevated values.	HOLE ADVANCED 0-10 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
SS	2.0	0.7	8-6-4-10									
SS	2.0	0.0	10-16-16 18					5			0.8 - 10.0 ft. INDUSTRIAL FILL, black (N2) dry sandy silt and clay soil fill matrix. Crumbly, loose, dry to the bottom. 0 LEL & toxics detected by ENMET. The fill materials are assumed to be predominantly lumber and concrete. No recovery for the last 6 ft. and the driller remarked that the spoon and stem felt like they were squeezing through hard objects.	
SS	2.0	0.0	17-18-18 19									
SS	2.0	0.0	17-15-20 26									
								10			Borehole was backfilled with spoils, 11-20-88. Total depth of 10.0 ft.	NO GROUND WATER OBSERVED IN BORING.

DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: SEAWAY INDUST. PARK

HOLE NO. B23R001

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R002

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,566.50 E 2,004.40	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-21-88	1-21-88	HYDRO DRILL	ML ACKER ATV DRILL	8"	4.0		4.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		2			/	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.9	4-6-6 8								0.0 - 4.0 ft. SILTY CLAY (CL), Moderate reddish brown (10 R 4/6) rock flour clay with occasional gravel pieces. Dense, compact, undisturbed, moist, plastic glacial till.	HOLE ADVANCED 0-4 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
SS	2.0	2.0	17-17-17 17									
											Total depth of borehole, 4.0 ft. Backfilled with bentonite grout, 1-20-88. Spoils deposited within the clay cutoff wall of the landfill. Boring is located in a recent excavation.	UNDISTURBED SOIL AT THE SURFACE; RECENTLY EXCAVATED.

DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: SEAWAY INDUST. PARK

HOLE NO. B23R002

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R003

TE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,177.70 E 2,047.90	Vertical	N0E

GUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
-19-88	1-20-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	10.0		10.0

RE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		5			/	/

MPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S	2.0	1.7	4-5-5-4								0.0 - 1.7 ft. SILTY CLAY FILL, moderate reddish brown (10 R 4/6) to light brown (5 YR 6/4) silty clay with mottled ash and organic blebs. Dense, cohesive, slightly moist, frozen near the surface, brittle. 0% LEL and 0 toxics on the ENMET. .M=FILL	HOLE ADVANCED 0-10 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
S	2.0	1.0	90-8-8-5								1.7 - 10.0 ft. INDUSTRIAL FILL, black to dark gray (N2) silty sludge and organic muck. Fill includes plastic, metal, glass, ash, lampblack?, and wood. 50+% LEL, 0 toxics detected by ENMET.	
S	2.0	0.0	5-5-6-4					5				
S	2.0	0.1	7-7-5-15									
S	2.0	0.1	2-60-20 14									
								10			Total depth of borehole, 10 ft. Borehole backfilled with spoils, 1-20-88	SPOON AND AUGER REFUSAL AT 2.5 FT. MOVE HOLE 2 FT.
												NO GROUND WATER OBSERVED.
												DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

S = SPLIT SPOON; ST = SHELBY TUBE;
= DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R003

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R004

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 856.30 2,028.20	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-20-88	1-20-88	HYDRO DRILL	ML ACKER AND DRILL	8"	10.0		10.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		5			/	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.7	9-9-7-7								0.0 - 3.3 FT. SILTY CLAY FILL, light reddish brown (5 YR 6/4) silty clay fill material, with 50% brick rubble, gravel, metal pieces, gaskets, paper, and wood fragments. Clay fraction is stiff, brittle, dense, nearly dry. 0 LEL, 0 TOXICS. Gamma scan did not detect any significant elevated values. 3.0-3.3 ft., white, dry compacted flyash.	HOLE ADVANCED 0-10 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
SS	2.0	1.3	7-12-23 12									
SS	2.0	1.8	8-9-13 12					5			3.3 - 10.0 ft. INDUSTRIAL FILL, black (N2) slightly moist to dry sandy silt and clay soil fill matrix. Crumbly, loose, dry to slightly moist at the bottom. 0 LEL & toxics detected by ENMET. The fill materials include predominantly LUMBER.	
SS	2.0	0.0	10-7-8-7									
SS	2.0	1.3	11-10-6 5									
								10			Borehole was backfilled with spoils, 11-20-88. Total depth of 10.0 ft.	NO GROUND WATER OBSERVED IN BORING.

DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: SEAWAY INDUST. PARK

HOLE NO. B23R004

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R005

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,612.00 E 2,112.80	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-21-88	1-21-88	HYDRO DRILL	ML ACKER ATV DRILL	8"	6.0		6.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		3			▽ / /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.8	2-5-8-5								0.0 - 4.0 ft. SILTY CLAY FILL, Moderate reddish brown (10 R 4/6) rock flour clay with occasional gravel pieces and traces of trash. Dense, uncompacted, disturbed, moist, plastic glacial till.	HOLE ADVANCED 0-6 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
SS	2.0	1.0	8-7-5-5									
SS	2.0	2.0	6-13-14 15					5			4.0 - 6.0 ft. SILTY CLAY, (CL). Moderate reddish brown (10 YR 4/6) silty glacial clay with occasional dark gray gravel pieces. compact, plastic, slightly moist, plastic. Undisturbed soil.	
											Total depth of borehole, 6.0 ft. Backfilled with bentonite grout, 1-20-88. Spoils deposited within the clay cutoff wall of the landfill.	UNDISTURBED SOIL REACHED AT 4 FT.
												DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: SEAWAY INDUST. PARK

HOLE NO. B23R005

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R006

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,407.90 E 2,223.90	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-18-88	1-18-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	15.0		15.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		8			/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140/24"	NONE	[redacted]

SHPT. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S	2.0	1.0	31-112 36-23								0.0 - 5.0 FT. FILL, pale reddish brown (10 YR 5/4) and dark gray (N2) silty clay soil matrix for municipal garbage consisting of glass, brick, plastic, tile bits, metal shards, organic muck, etc.	HOLE ADVANCED 0-15 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
S	2.0	0.1	5[illegible]0-34 [illegible]3									
S	2.0	0.1	13-15-6 5					5			5.0 - 7.4 ft. POSSIBLE VOID SPACE. Spoon may have been going through gaps in lumber or metal or other such non-compactable fill.	
S	2.0	0.3	2-2-3-11									
S	2.0	0.5	10-10-12 9								7.4 - 15.0 ft. INDUSTRIAL FILL, black (N1) silty clay soil matrix saturated with oily water; horrible smell, high LEL values. Fill consists of metal, wood, and large chunks of paraffin.	
S	2.0	1.3	5-5-4-10					10				
S	2.0	0.9	11-5-8 14									
S	1.0	0.0	6-8									
								15			Bottom of boring at 15.0 ft. Boring backfilled with spoils, 1-18-88.	NO GROUND WATER OBSERVED.

DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

S = SPLIT SPOON; ST = SHELBY TUBE; = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R006

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R007

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 948.00 E 2,177.70	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-20-88	1-20-88	HYDRO DRILL	ML ACKER ATV DRILL	8"	10.0		10.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		5			▽ / ▼ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.3	4-7-7-4								0.0 - 4.5 FT. SILTY CLAY FILL, light reddish brown (5 YR 6/4) silty clay fill material, with 50% brick rubble, gravel, metal pieces, gaskets, paper, and wood fragments. Clay fraction is stiff, brittle, dense, nearly dry. 0 LEL, 0 TOXICS. Gamma scan did not detect any significant elevated values.	HOLE ADVANCED 0-10 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
SS	2.0	1.4	3-3-3-4									
SS	2.0	2.0	4-5-6-5					5			4.5 - 10.0 ft. INDUSTRIAL FILL, black (N2) slightly moist to dry sandy silt and clay soil fill matrix. Crumbly, loose, dry to slightly moist at the bottom. 0 LEL & toxics detected by ENMET. The fill materials are predominantly LUMBER.	
SS	2.0	1.4	5-6-6-10									
SS	2.0	0.6	10-42-12 7									
								10			Borehole was backfilled with spoils, 11-20-88. Total depth of 10.0 ft.	NO GROUND WATER OBSERVED IN BORING.

DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: SEAWAY INDUST. PARK

HOLE NO. B23R007

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R008

ITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,508.40 E 2,408.40	Vertical	N0E

EGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-18-88	1-18-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	4.0		4.0

ORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		2			/ /	/

AMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NO	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.1	5-5-5-10						[redacted]		0.0 - 4.0 FT. SILTY CLAY FILL, pale reddish brown (10 YR 5/4) and dark gray (N2) silty clay soil matrix for municipal garbage consisting of glass, brick, plastic, tile bits, metal shards, organic muck, etc. 10% LEL; 150 ppm Toxic on ENMET.	HOLE ADVANCED 0-4 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP. AUGER REFUSAL AT 4 FT. BOREHOLE B23R016 IS 7 FT. TO THE SE.
SS	1.6	0.0	8-9-12 40/2"									
											Bottom of boring at 4.0 ft. Boring backfilled with spoils, 1-18-88. Boring was abandoned after spoon and auger refusal at 4.0 ft. Probably a tire. Drill moved 7 ft. SE and drilled borehole B23R016.	NO GROUND WATER OBSERVED.
												DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R008

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R009

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,216.80 E 2,428.80	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-15-88	1-15-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	8.3		8.3

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		4			/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140/24"	NONE	[redacted]

SAMP. TYPE AND DIAM."	SAMP. ADV. / LEN CORE	SAMPLE REC. / CORE REC.	SAMPLE BLOWS "N" / % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	0.8	15-20-12 17								0.0 - 4.5 ft. SANDY CLAY FILL, dark yellowish orange (10 YR 6/6) to light brown (5 YR 6/4) silty sandy clay with mottled ash and organic blebs. Dense, cohesive, slightly moist, frozen near the surface, brittle. 50+% LEL and 0 toxics on the ENMET.	HOLE ADVANCED 0-8.3 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP. ELEVATED PROBE VALUES FROM 3-5 FT.
SS	2.0	1.3	2-10-13 13								2.3-4.5 ft. gray (N4) silty clay with wood in a dark brown (5 YR 2/2) clay matrix. Moist, dense, plastic, cohesive. ZONE OF ELEVATED RADIOLOGICAL VALUES.	
SS	2.0	1.0	48-24-31 24					5			4.5 - 6.3 ft. INDUSTRIAL FILL, predominantly wood and paper products with some plastic and black (N1) saturated to moist soil. Organic odor, 50+% LEL values. No toxics on ENMET. No elevated radiological values.	
SS	2.0	1.0	24-20-21 48								6.3-8.3 ft. SANDY FILL, light olive brown (5 Y 5/6) well-sorted, medium-grained sand with blebs of black soil. moist, non-cohesive, with an organic smell.	NO GROUND WATER OBSERVED.
											Borehole was backfilled with spoils, 1-15-88. Total depth of 8.3 ft. 8.3 ft. Auger and split spoon refusal; cardboard and lumber plugging spoon mouth.	

DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R009

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R011

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,384.30 E 2,630.90	Vertical	N0E

SUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
19-88	1-19-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	6.0		6.0

E RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		3			/	/

PLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
2.0	1.1	7-10-7-3								0.0 - 4.0 ft. SILTY CLAY FILL, moderate reddish brown (10 R 4/6) to light brown (5 YR 6/4) silty clay with mottled ash and organic blebs. Dense, cohesive, slightly moist, frozen near the surface, brittle. 50+% LEL and full scale toxics on the ENMET. Elevated scan values at 1 ft.	HOLE ADVANCED 0-6 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP. TO 4 FT.
2.0	0.9	1-2-2-3									
2.0	0.0	3-6-4-4					5			4.0 - 6.0 ft. INDUSTRIAL FILL?, low blow count and one plug of black saturated wood returned to the surface indicate similar material to the INDUSTRIAL FILL described in other logs for this project.	
										Total depth of borehole, 6.0 ft. Borehole backfilled with spoils, 1-19-88. Borehole abandoned after 6.0 ft. due to high LEL and Toxics present; venting with nitrogen for one hour did not decrease gas levels.	NO GROUND WATER OBSERVED
											GAMMA LOG SHOWS ELEVATED READINGS AT 1 FT. DEPTH.
											DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SPLIT SPOON; ST = SHELBY TUBE; DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R011

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R012

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,028.90 E 2,607.70	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-14-88	1-15-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	13.5		13.5

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		9			▽ 7.0/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140/24"	NONE	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	2.0	26-18-15 11								0.0 - 4.4 FT. SAND, dusky yellow (5 Y 6/4) to light brown (5 YR 6/4) medium grained sand. Well sorted, dry, non-cohesive fill sand. 0.0 - 1.8 ft.included a small gravel fraction (<5%) of well rounded pebbles.	HOLE ADVANCED 0-13.5 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA. CORP.
SS	2.0	2.0	10-9-10 11									
SS	0.6	0.6	9-23 72/1"-0									
SS	1.0	0.0	9-13 50/1"-0					5			4.4 - 13.5 FT. INDUSTRIAL FILL. Lumber and black silty clay (N3). Moist to saturated, petroleum odor, but liquid is not irridescent or viscous. 50+% LEL and 100 ppm toxic ENMET readings for 4.4-8.0 ft. Few samples recovered, probably due to the split spoon mouth being blocked by plugs of wood. 8.0-10.0 ft. 5 pieces of SHALE recovered; small fragments less than 1" in diameter, gray (N5), brittle, fresh surfaces; probably an interval of large boulders or riprap.	
SS	2.0	0.8	9-11-13 13									
SS	2.0	0.0	15-40-47 18									
SS	1.0	0.3	12-17 43/0"-0					10				
~~SS~~	~~0.3~~	~~0.3~~	~~50/3"~~									
AU	2.2	0.0										PERCHED GROUND WATER AT 7.0 FT.
											Borehole backfilled with spoils, 1-14-88. Total depth 13.5 ft.	
												DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: SEAWAY INDUST. PARK

HOLE NO. B23R012

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R013

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,524.40 E 2,850.00	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-19-88	1-19-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	14.0		14.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		7			/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
300 LB./24"	NONE	[redacted]

TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S	2.0	1.3	7-9-9-11								0.0 - 1.3 ft. SILTY CLAY FILL, moderate reddish brown (10 R 4/6) to light brown (5 YR 6/4) silty clay with mottled ash and organic blebs. Dense, cohesive, slightly moist, frozen near the surface, brittle. 0% LEL and 0 toxics on the ENMET. Elevated scan values at 1 ft.	HOLE ADVANCED 0-14 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
S	2.0	0.8	4-3-3-4									
S	2.0	0.6	7-15-14-3					5			1.3 - 14.0 ft. INDUSTRIAL FILL, black to dark gray (N2) silty sludge and organic muck. Fill includes plastic, metal, glass, ash, lampblack?, and wood. Strong organic, foul odor; 50+% LEL, 0 toxics detected by ENMET.	
S	2.0	0.0	2-4-6-3									
S	2.0	0.1	4-2-2-2									
S	2.0	0.3	2-3-3-5					10				
S	2.0	0.2	3-2-2-3									NO GROUND WATER OBSERVED
											Total depth of borehole, 14.0 ft. Borehole backfilled with spoils, 1-19-88.	GAMMA LOG SHOWS ELEVATED READINGS AT 1 FT. DEPTH.
												DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

S = SPLIT SPOON; ST = SHELBY TUBE; = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R013

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R014

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,201.00 E 2,801.20	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-14-88	1-14-88	HYDRO DRILL	ACKER ML ATV DRILL	8"	14.8		14.8

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		8			▽ 7.0/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140/24"	NONE	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.8	47-107 28-25								0.0 - 1.3 FT. SILTY CLAY FILL, light reddish brown (5 YR 6/4) silty clay fill material, with 50% brick rubble, gravel, metal pieces, gaskets, paper, and wood fragments. Clay fraction is stiff, brittle, dense, nearly dry.	HOLE ADVANCED 0-14.8 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP.
SS	2.0	1.9	36-38-35 21								1.3 - 14.8 ft. INDUSTRIAL FILL, black (N2) slightly moist to saturated sandy silt and clay soil fill matrix. Cohesive, plastic, loose to sludge-like, with a strong petroleum odor. up to 30% LEL values in the hole; no toxics detected by ENMET. The liquid is black, and water-like in appearance. No irridescence, and not viscous. The fill materials were LUMBER with linoleum, metal, gravel, plastic and paper products.	
SS	2.0	1.0	13-8-19 18					5			4.0-5.7 ft. Very gravelly.	
SS	2.0	1.4	42-13-18 27					▽			5.7-6.1 ft. Layer of black silty clay; no fill materials, but still saturated.	
SS	2.0	1.4	10-11-9 20								8.0-14.8 ft. Samples recovered were mostly wood (lumber) that was saturated with water and a petroleum residue. Strong hydrocarbon odor. LEL values of 30+%. Liquid was not viscous or irridescent, but appeared to be a black sludge-like water. No toxic readings with the Enmet.	
SS	2.0	0.3	14-38-57 16					10				
SS	2.0	0.8	4-8-15 17									
SS	0.8	0.2	12-99/3"									
											Borehole was backfilled with spoils, 11-14-88. Total depth of 14.8 ft.	PERCHED GROUND WATER OBSERVED AT 7.0 FT.
												DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R014

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23R015

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
SEAWAY INDUST. PARK	N 1,392.10 E 3,003.40	Vertical	N0E

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
1-12-88	1-13-88	HYDRO DRILL	ML ACKER ATV DRILL	8"	15.0		15.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		9			▽ 10.0/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140/24"	NONE	[redacted]

SAMPLE TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
S	0.9	0.9	38-99/5"								0.0 - 2.9 FT. INDUSTRIAL FILL, dark gray (N3) soil matrix with 30 to 45% brick rubble, metal bits, wood, glass, and ass't fill. Moist, brittle.	HOLE ADVANCED 0-15 FT. USING 8" HOLLOW-STEM AUGERS. SAMPLED AND RADIOLOGICALLY SCANNED BY EBERLINE-TMA CORP. ELEVATED GAMMA PROBE LEVELS FROM 4 TO 6 FT.
S	1.5	0.7	47-64-39									
S	2.0	1.2	32-15-16 18								2.9 - 10.0 FT. SILTY CLAY FILL, dark yellowish brown (10 YR 4/2) soil matrix with brick rubble, gravel, and fly ash. Moist, brittle, with mottled patches of dark gray (N3) clay. 4-6 ft. Elevated gamma log readings. Moderate brown, disturbed clay with no rubble, but a few pieces of gravel.	
S	2.0	1.5	14-16-16 20					5				
S	2.0	0.0	12-19-28 15									
S	1.5	0.1	20-18-29 35/1"									
S	2.0	0.3	6-5-5-46					▽ 10			10.0 - 15.0 FT. INDUSTRIAL FILL. Samples recovered were lumber that was saturated with water and a petroleum residue. Strong hydrocarbon odor. LEL values of 50+%. Liquid was not viscous or irridescent, but appeared to be a black sludge-like water. No toxic readings with the Enmet.	
S	2.0	1.4	36-16-13 21									GAMA PROBE DID NOT ADVANCE PAST 13 FT.
S	1.0	0.1	13-19									
								15			Borehole was backfilled with spoils, 1-13-88. Total depth of borehole, 15 ft.	PERCHED GROUND WATER OBSERVED, 10.0 FT.

DESCRIPTION AND CLASSIFICATION OF SOILS BY VISUAL IDENTIFICATION.

S = SPLIT SPOON; ST = SHELBY TUBE; = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
SEAWAY INDUST. PARK	B23R015

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23RC19

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
Seaway Industrial Landfill	N 1,240.00 E 2,440.00	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-29-90	11-30-90	B & B Drilling	Mobile Drill B-61	8"	21.0	0.0	21.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
0.0/0	0	11		643.9	▽ / NA ▼ /	NA/NA

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 lb/ 30-inch	None	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							643.9					
SS	2.0	1.8	5-7 8-15				643.6				0 - 0.2 Ft TOPSOIL;Grass covered topsoil. 0.2 - 3.0 Ft CLAY COVER; Reddish brown silty clay fill with mixed trash.	Advanced borehole using 8 inch OD. hollow stem augers to a depth of 21.0 ft. Samples were taken with 3 inch ID stainless steel split spoon.
SS	2.0	1.8	8-39 38-46								2.5 ft Black sandy clayey silt.	
SS	2.0	0.3	15-17 37-16					5			3.0 - 21.0 Ft FILL; Dark gray to black residential and industial trash. Damp to wet moisture. Wet zones are local areas of perched water. 3.0-4.0 ft., black sand with orange brick mixed with soil.	
SS	2.0	0.9	6-7 14-60								4.5-6.0 ft., mostly wood 6.0-8.4 ft., black fill, orange cloth, wood and plastic, damp.	Near borehole environment monitored for radioactivity and explosive gas. Sampled and gamma logged by TMA/Eberline Inc. to a depth of 21.0 ft.
SS	2.0	2.0	28-31 19-42								8.4-12.0 ft., dark gray fill, mostly wood, paper and sand, damp.	
SS	2.0	1.3	23-16 25-30					10				
SS	2.0	1.0	17-119 106-30								12.0-14.5 ft., black fill, mostly wood, moist. Split spoon is wet from a localized pocket of water (Not water table).	Drillers go into respirators 50 ppm gas detected at borehole.
SS	2.0	0.5	12-13 13-26					15			14.5-17.0 ft., black fill, mostly wood, damp.	Description and classification of soils based on visual examination of split spoon samples.
SS	2.0	0.8	11-15 18-20								17.0-19.0 ft., black fill, mostly wood, moist, styro-foam, 5-10% clay.	
SS	1.0	0.0	50/1"									
SS	2.0	0.4	111-24 11-90					20			19.0-21.0 ft., gray fill, cardboard and wire. Large volume of gas discharging from the borehole.	100% LEL and 1 ppm H2S at 19 ft. Hole purged with Nitrogen then vented to reduce danger of explosion.
							623.0				Bottom of Borehole at 21.0 Ft. Borehole gamma logged then backfilled with bentonite cement grout.	Drilling discontinued at 21.0 ft because of dangerous conditions.
												Borehole backfilled with cement/bentonite grout 11-30-90.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
Seaway Industrial Landfill	B23RC19

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501	1 OF 1	B23RC20

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
Seaway Industrial Landfill	N 1,275.00 E 2,100.00	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-28-90	10-30-90	B & B Drilling	Mobile Drill B-61	8"		0.0	26.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
0.0/0	0	14		638.6	▽ / NA ▼ /	NA/NA

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 lb/ 30-inch	None	[redacted]

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							638.6					
SS	2.0	1.8	4-7 15-13				637.7				0.0 - 1.0 Ft TOPSOIL Reddish brown silty clay.	Advanced borehole using 8 inch OD. hollow stem augers to a depthof 26.0 ft. Samples were taken with 3 inch ID stainless steelsplit spoon. Sampled and gamma logged by TMA/Eberline Inc. to a depth of 26.0ft. Near borehole environment monitored for radioactivity and explosive gas.
SS	2.0	1.9	10-17 21-15				636.1				1.0 - 2.5 Ft ORGANIC RICH SAND; Black (N1), carbonatious sand fill. 2.5 - 26.0 Ft FILL; Black or black stained mixed-trash fill, mostly wood and building material.	
SS	2.0	1.8	6-14 12-13					5				
SS	2.0	1.0	4-14-33 150/3"									
SS	2.0	1.4	14-13 15-10									
SS	2.0	1.4	4-5 10-22					10				
SS	2.0	1.2	15-13 10-12									Drillers go into respirators 50 ppm gas detected at borehole.
SS	1.0	0.7	27-50/1"									
SS	2.0	1.4	5-10 11-82					15				
SS	2.0	0.4	13-22 58-142									Description and classification of soils based on visualexamination of split spoon samples.
SS	1.0	0.4	60/2"									
SS	2.0	0.4	48-47 30-82					20				Standby 15 minutes to allow hole to vent.
SS	2.0	1.7	11-11 13-17									Install 3 inch ID PVC casing to gamma log borehole from bottom.
SS	2.0	0.2	40-14 11-20					25				
							612.7				Bottom of borehole 26.0 Ft. Borehole gamma logged through 3" PVC casing, casing pulled then backfilled with bentonite cement grout to the surface.	Borehole backfilled with cement/bentonite grout 11-30-90.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
Seaway Industrial Landfill	B23RC20