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VERIFICATION OF 1985 AND 1986 REMEDIAL ACTIONS NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES LEWISTON, NEW YORK

J. D. BERGER

Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

DRAFT REPORT
MAY 1990

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DRAFT REPORT

May 1990

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VERIFICATION
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INTRODUCTION

Beginning in 1944, the Manhattan Engineer District (MED) and its successor, the Atomic Energy Commission (AEC), used portions of the Lake Ontario Ordnance Works, presently referred to as the Niagara Falls Storage Site (NFSS) and vicinity properties, near Lewiston, New York (Figure 1), for storage of radioactive wastes. These wastes were primarily residues from uranium processing operations; however, they also included: contaminated rubble and scrap from decommissioning activities, biological and miscellaneous wastes from the University of Rochester, and low-level fission-product waste from contaminated-liquid evaporators at the Knolls Atomic Power Laboratory (KAPL). Receipt of radioactive waste was discontinued in 1954, and, following cleanup activities by Hooker Chemical Company, 525 hectares (approximately 1297 acres) of the original 612-hectare site were declared surplus. This property was eventually sold by the General Services Administration to various private, commercial, and governmental agencies.[1]

From 1970-1971 and again from 1981-1984, radiological surveys were conducted of the approximately 525 hectares comprising the vicinity (off-site) properties. The latter surveys, performed by Oak Ridge Associated Universities (ORAU), were in response to a Department of Energy (DOE) request to determine if any of these properties contained residual contamination above current DOE guidelines. During 1985 and 1986, Bechtel National, Inc. (BNI), the Project Management contractor for the Formerly Utilized Sites Remedial Action Program (FUSRAP), conducted additional surveys, where appropriate, to more accurately define the boundaries of contamination on eleven properties identified by ORAU. These properties were designated as B, C', D, E, E', F, G, N/N' North, P, T, and W. The locations of these properties, relative to the Niagara Falls Storage Site, are shown on Figure 2. In addition, surveys by ORAU had

identified residual contamination along portions of Pletcher Road, and Oak Ridge National Laboratory had identified three small off-site locations of contamination along possible haul routes between Tonawanda, New York, and the Storage Site (Figure 3). Information on the radiological survey findings is presented in ORAU, ORNL, and Battelle documents.[2-20]

During 1985 and 1986, BNI remediated the eleven properties, Pletcher Road, and the off-site anomalies described above. Cleanup consisted primarily of excavation of contaminated surface and subsurface soil and rock. However, remedial efforts also included backfilling and regrading of roads and restoration of water and sewer lines, fencing, and culverts. Upon completion of remedial actions, a follow-up survey was performed by BNI to demonstrate compliance with the cleanup guidelines. Remedial actions at each of the properties and results of the follow-up surveys are described in a post-remedial action report prepared by BNI.[21] Activities to identify and remove contamination on additional vicinity properties at NFSS were performed in 1983 and 1984 and are documented separately.[22].

It is the policy of the DOE to perform independent (third party) verifications of the effectiveness of remedial actions conducted within FUSRAP. The Environmental Survey and Site Assessment Program (ESSAP) of ORAU was designated by the DOE as the organization responsible for this task at the NFSS vicinity properties. Beginning in April 1986, ORAU performed verification activities for the vicinity properties, Pletcher Road, and off-site anomalies where remedial actions were conducted in 1985 and 1986. This report describes the procedures and findings of that verification.

PROCEDURES

Objectives

The objectives of the verification were to confirm that the surveys, sampling, analyses and associated project documentation provided an accurate and complete description of remedial actions and the conditions of the vicinity properties at the NFSS and, thereby, confirm that remedial actions have been effective in meeting established criteria.

Procedures

1. Radiological characterization reports (References 2-20), engineering drawings for each of the areas undergoing remediation, and the post-remedial action report (Reference 21) were reviewed. Data were evaluated to assure that areas exceeding guidelines were identified and had undergone remedial action. Post-remedial action radionuclide concentrations in soil and exposure-rate data were compared to guidelines and the post-remedial action report was reviewed for general thoroughness and accuracy.

2. One hundred and sixteen (116) soil samples, collected during the 83/84 post-remedial action survey, were obtained from BNI. Thirty-four (34) of these samples, representing eight of the eleven properties and the West and Central Drainage Ditches, were selected at random and analyzed for radionuclides of interest (Ra-226, U-238, and Th-232) by the ORAU laboratory to confirm the accuracy of BNI analyses.

3. Survey teams from ORAU visited the NFSS vicinity properties and performed visual inspections, gamma scans, direct measurements, and surface (0-15 cm) and subsurface sampling on representative portions of the excavated areas. Measurement and sampling locations were referenced to the New York State grid; reference grid lines are shown on Figure 4.

4. Sixteen soil samples were collected from the Lewiston area (but not on the NFSS or associated off-site properties) to provide baseline concentrations of radionuclides for comparison purposes. Background radiation levels were measured at locations where baseline soil samples were collected. The locations of the baseline samples and background measurements are shown on Figure 5.

5. Findings of the inspections and radiological surveys were compared with the post-remedial action report and the established NFSS vicinity

property criteria (Appendix A). Measurement and analytical equipment and procedures are described in further detail in Appendices B and C.

FINDINGS AND RESULTS

Document Reviews

Cleanup of the eleven properties, Pletcher Road, and anomalies was appropriate, based on the characterization surveys performed by ORAU, ORNL, and Battelle Columbus Laboratories. Each of these properties had contained isolated and/or general areas of Ra-226, U-238, and/or Th-232 contamination in excess of the guidelines established for the NFSS vicinity properties. Efforts were made in these reports to distinguish those locations and areas, where contamination was due to activities associated with the Manhattan Engineer District, from those areas with materials of other origin. For example, slags and crushed rock, containing elevated levels of naturally occurring uranium and thorium, have been used as construction fill at various locations throughout the Buffalo/Niagara Falls area. Analyses of samples provided information which was used by the cleanup contractor, BNI, to design remediation plans for such areas. Further characterization data collected by BNI more precisely defined those areas already designated for remediation and identified a few additional small areas warranting cleanup. The post-remedial action report accurately describes the remedial activities performed on these areas, and the data presented confirms that the guidelines have been met.

Confirmatory Sample Analyses

Table 1 presents the results of gamma spectrometry analyses performed independently by ORAU and BNI on thirty-four soil samples collected from the remediated Niagara Falls Storage Site vicinity properties. For the major radionuclide of concern, Ra-226, data are in agreement within their respective 95% confidence levels for 29 of the 34 samples and within 99% confidence levels for 31 of the 34 samples. Large differences were noted in Ra-226 levels measured in two of the samples. Sample 4 from Property M (S2260, E920) was

reported to contain 24.1 pCi/g by ORAU, but only 10.6 pCi/g by BNI. In addition, sample 128 collected from the West Ditch (N1600, W160), was reported to contain 78.7 pCi/g by ORAU, but less than the minimum detectable activity (MDA - no value stated) by BNI. Reasons for these differences in the ORAU and BNI analyses could not be identified; however, it should be noted that verification surveys of the areas from which these samples were obtained did not identify residual activity exceeding guidelines. With exception of seven samples, all results for U-238 analyses, reported by BNI, were less than the detection sensitivity of the procedure (i.e. <MDA). For the seven samples, having both ORAU and BNI values, six were in agreement within the 95% confidence intervals and all seven were within the 99% confidence intervals. Thorium-232 data pairs were within the 95% confidence levels for 32 of the 34 samples. For the two samples not within the 95% confidence levels, BNI reported less than the minimum detectable activity and, therefore, a direct comparison of the ORAU and BNI data could not be performed. These findings indicate, that with only a few isolated exceptions, the ORAU and BNI data are statistically indistinguishable; it is therefore, ORAU's opinion that the BNI data is accurate and should be accepted.

Background Levels and Baseline Concentrations

Background exposure rates and baseline radionuclide concentrations in soil, determined for 16 locations in the vicinity of the NFSS, are presented in Table 2. Exposure rates ranged from 7 to 9 μR/h (typical levels for this area of New York). Concentrations of radionuclides in soil were: Ra-226, <0.1 to 1.2 pCi/g (picocuries per gram); U-238, <4.2; Th-232, 0.3 to 1.2 pCi/g; and Cs-137, <0.1 to 1.1 pCi/g. These concentrations are typical of the radionuclide levels normally encountered in surface soils.

Verification Surveys

Property B

Gamma scans, conducted at locations originally identified by the ORAU characterization survey, indicated that remedial action had been effective in removing areas of contamination. Exposure rates at 1 m above the surface

ranged from 6 to 12 μR/h - well within the guideline value of 20 μR/h above the background of 7-9 μR/h. Soil samples were obtained from six locations, where remedial action had been performed. Results, presented in Table 3, indicate that residual soil activity is in the range of baseline values..

Remedial actions were not performed inside the Warehouse building. Because of contamination by PCB's, resulting from recent building use to store non-radiological hazardous wastes, remediation to remove the chemical contamination will be required before future unrestricted use of the facility. It was decided that the PCB contamination is of greater potential hazard than the radiological (Ra-226) contamination, and, if the Warehouse were to be demolished, the concentration of Ra-226 in rubble would be within the DOE guidelines for disposal without radiological restrictions.[23] No further action is therefore needed for this building.

Property C'

Gamma scans of the remediated areas identified small isolated locations of residual elevated direct radiation. Sampling of these locations indicated the presence of residual Ra-226 and U-238 contamination. At three of the areas, sampling itself was effective in removing the contaminant. Other locations were brought to the attention of the remedial action contractor, and additional cleanup was performed. Results of initial and followup sampling are presented in Table 4. With two exceptions, samples after further remediation were below guideline levels. At grid coordinate N77, E4920 the post remedial action sample contained 18.4 pCi/g of Ra-226, which slightly exceeds the guideline level of 15 pCi/g (above background) for soil below 15 cm^2. The sample from N150, E4723 contained 211 pCi/g of U-238, which is above the guideline level of approximately 45 pCi/g (above background). Direct measurements at these locations confirmed that the contamination was limited to areas of less than 1 m^2. The hot-spot criteria (for 1 m^2) of 150 pCi/g Ra-226 and 450 pCi/g U-238 were therefore satisfied, as were the average concentration guidelines when other ORAU and BNI sampling locations within contiguous 100 m^2 areas of these grid coordinates were averaged with the samples containing the highest concentrations. Exposure rates, measured at 1 m above the surface, ranged from 8 to 10 μR/h following the final remediation.

Property D

Residual isolated pieces of slag-like material, having associated elevated direct radiation levels, were identified by gamma scans of a pile of dirt on the west central portion of the site. ORAU and BNI personnel worked together to locate and remove these pieces of material. Followup gamma monitoring confirmed the effectiveness through the absence of additional elevated readings. Exposure rates at remediated areas ranged from 7 to 8 μR/h at 1 m above the surface. Radionuclide concentrations in samples collected from several remediated areas were in the ranges of baseline soil (see Table 5).

Property E

No remediation was conducted on Property E during 1985 and 1986. The major area of radiological contamination or potential contamination on this property was in a section of the berm, surrounding a lagoon used to retain PCB-contaminated liquids. The ORAU characterization survey and an additional survey by BNI identified the contaminant as Ra-226, associated with small pieces of scrap metal and plaster-like chips - likely lead cake residues.[6,24] Gamma scans indicated that the contaminants are not near the surface, i.e. they are located at depths of greater than 15 cm. The pieces of contaminated material that do remain in the berm are very small and scattered; based on the ORAU and BNI data the average concentration of Ra-226 over any area of 100 m^2 is less than the guideline value of 15 pCi/g. Gamma exposure rates in this area range from 7 to 9 μR/h. Because of the possibility that some additional contamination may be present beneath the lagoon or in portions of the lagoon berm which could not be disturbed without jeopardizing the integrity of the lagoon construction, DOE has expressed a willingness to conduct further surveys, after the lagoon is decommissioned.

Property E'

Several locations of elevated contact radiation were identified by gamma scans of remediated areas. At locations in Section 1, 2, and 4 of the property (Figure 9) the elevated levels were associated with small, isolated areas, primarily on the outer edges of excavations. These areas were brought to the

attention of BNI and, following additional remediation, scans indicated reductions in direct gamma levels. Samples from remediated areas in Sections 1, 2, and 4 (Table 6) contained radionuclide levels within guideline values, with two exceptions. These exceptions are at grid coordinate N1993, E1444 and N2259, E9072, where the Ra-226 concentrations were 16.2 pCi/g and 20.6 pCi/g. These concentrations are only slightly above the 15 pCi/g (above background) guideline value. Based on direct monitoring these areas are small (<1 m^2) and therefore the hot-spot criterion is satisfied; averaging with BNI and ORAU samples from contiguous 100 m^2 areas results in average concentrations well within the guideline levels.

A portion of Section 3 of the property was remediated and resurveyed in 1984, during installation a new waste storage/treatment facility.[25] No further verification of that area was performed as part of this activity. This section of the property contains several PCB storage tanks, around and beneath which remedial action could not be performed without the possibility of damage to the tanks. There is also a small access road that covers an area of contamination which was not remediated. Initial gamma scans of this portion of Property E' identified an area of elevated contact radiation and residual Ra-226 contamination up to 258 pCi/g (Table 6) in the area between the unremediated roadbed and PCB storage tanks. This area was in the vicinity of grid coordinates N2030-2040, E2168-2170. Further remediation of this area was performed and followup gamma scans confirmed that the source of elevated radiation had been effectively removed; no followup samples were collected.

On the basis of surveys of adjacent areas, BNI has assumed that the residual contamination beneath the PCB storage tanks and the access road consists primarily of the small pieces of plaster-like chips of lead-cake. Because these are small isolated sources, the associated hazard is negligible and the average concentration of Ra-226 over 100 m^2 areas likely will satisfy the DOE criteria of 5 pCi/g, surface, and 15 pCi/g, subsurface.

Following final remediation the gamma exposure rates at 1m above the surface ranged from 7 to 17 μR/h. The higher levels were in the vicinity of the unremediated areas beneath the access road and the PCB storage tanks.

Property F

Gamma exposure rates ranged from 8 to 9 μR/h at 1 m above the surface at remediated areas. One small area of elevated contact radiation was noted at N1820, E1913. Sampling removed the source of the radiation and followup sample results, presented in Table 7, indicated that surface soil concentrations in this area were well below the 5 pCi/g guideline value.

Property G

Gamma scans of remediated locations and surfaces immediately adjacent to the remediation identified several areas of residual contamination. Most of these were small isolated spots near the periphery of excavations; however, one more extensive area was identified in the vicinity of coordinates N1000-1040, E1230-1270. BNI conducted further remediation and followup scans confirmed the effectiveness of the remediation. Gamma exposure rates after final remediation ranged from 7 to 12 μR/h at 1 m above the surface. Table 8 presents the results of sampling at selected locations in the remediated areas. Samples from coordinates N946, E1023; N949, E0124; N962, E1052; N972, E1032; N985, E1172; N1015, E1271; N1055, E1353; and N1326, E1440 contained Ra-226 concentrations above the DOE guideline level for subsurface soils (excavations were backfilled) of 15 pCi/g above background. With exception of the locations at coordinates N985, E1172 and N1326, E1440, direct measurements and/or sampling after further remediation confirmed acceptable residual activity levels. The extent of residual contamination at the other two locations was limited to areas of less than 1 m^2 and these locations therefore satisfy both the hot-spot guidelines (150 pCi/g) for areas of such size and the average guideline, considering radionuclide concentrations in other samples from contiguous 100 m^2 areas.

At the time of the ORAU characterization survey and the remediation activities, the eastern portion of Property G was covered by a large liquid treatment facility (pond). The surface beneath this pond was therefore inaccessible and has not been evaluated for possible residual contamination.

Because the former Linde Scrap Yard facility was located on a portion of the site covered by the pond, there is a potential for contamination in this area, and evaluation is recommended at such time that the pond is removed from service.

Property N/N' North

Small isolated locations of elevated contact gamma radiation were identified by the surface scans of remediated areas. Sampling of several of these areas was effective in removing small individual pieces of material which contained the radioactivity, thus reducing the direct radiation to ambient levels. At other locations BNI conducted further remediation and followup direct monitoring and/or sampling confirmed the effectiveness of cleanup. Table 9 presents the results of verification sampling in the vicinity of the railroad tracks on Property N' North. After final remediation the samples from coordinate S1550, E4900 still contained an U-238 concentration of 176 pCi/g, which exceeds the 45 pCi/g guideline level. Other samples collected by ORAU and BNI from nearby coordinates contained well below the guideline level and averaging for the 100 m^2 contiguous area results in a level well within the guideline; because the area of elevated is less than 1 m^2, based on direct measurements, the hot-spot criterion is also satisfied.

A triangular-shaped section in the extreme northwest corner of the property was remediated and resurveyed in the early 1980s. [12,26,27] This portion of land was released for use, and at the time of the 85/86 remedial action and verification a sanitary landfill operation occupied the area. This portion of the site was therefore not included in this verification activity.

The ORAU characterization survey had identified a small area of uranium contamination along the northern boundary of Property N North.[10] BNI conducted further surveys of this location and concluded that the extent of contamination was limited to an area of less than 100 m^2 and residual radionuclide concentrations therefore satisfied the DOE guidelines; no further remedial action or verification surveys were performed.[28]

Gamma exposure rates after completion of remediation ranged from 10 to 18 μR/h. These levels are slightly higher than on most of the site vicinity properties due to the presence of railroad track ballast, containing elevated concentrations of naturally occurring uranium.

Property P

The one remediated area on Property P was scanned and found to have radiation levels comparable to background. The gamma exposure rate at 1 m above the surface at this location was 4 to 5 μR/h, and the radionuclide concentrations in one sample from the area (Table 10) contained baseline levels of Ra-226, U-238, and Th-232.

Property T

Gamma scans identified regions of elevated contact radiation along the banks of the Drainage Ditch and the haul road areas adjacent to the Central Drainage Ditch. These areas were remediated further by BNI and followup direct monitoring and/or sampling confirmed that efforts were generally effective in reducing residual activity to acceptable levels. Final gamma exposure rates at 1 m above the surface ranged from 7 to 17 μR/h. Results of verification sampling, resented in Table 11, identified small areas of residual Ra-226 activity in excess of the 15 pCi/g guideline levels for subsurface soil (excavations backfilled) at grid coordinates N2516, E76; N2814, E273; N2475, E495; N2720, E365; N2795, E435; N2905, E355; N2905, E395; and N2910, E430. The maximum Ra-226 level in samples from these locations was 103 pCi/g. Direct monitoring and additional samples from contiguous 100 m^2 areas at these locations demonstrated that the residual contamination was confined to small (<1 m^2) isolated areas and that the hot-spot criterion (150 pCi/g for areas of 1 m^2 or less) and average guideline level were both satisfied by the remediation.

Property W

Gamma scans did not identify any locations of significantly elevated direct radiation at remediated areas. Samples (Table 12) from excavated areas

contained a maximum of 5.2 pCi/g of Ra-226; this is within the 15 pCi/g guideline for subsurface soil (excavations were later backfilled). Exposure rates ranged from 7 to 8 μR/h.

Pletcher Road

gamma scans identified several small areas of residual elevated contact radiation, primarily on the periphery of excavations. Further remediation was performed by BNI and followup verification scans, direct measurements, and sampling performed. Two isolated locations (grid coordinates S3180, W2260 and S3115, W3985) were noted to have residual Ra-226 concentrations above the guideline level of 15 pCi/g, above background; concentrations at these locations were 29.9 pCi/g and 32.8 pCi/g, respectively (Table 13). Because of their small size (<1 m^2) and the lower activity levels in samples collected by BNI and ORAU from adjacent areas, the hot-spot criterion and the average guideline for Ra-226 have been satisfied by the remedial action. Gamma exposure rates along Pletcher Road ranged from 8 to 16 μR/h, following remediation but before backfilling of excavations.

Off-site Anomalies

Locations of elevated contact radiation were identified by gamma scans of excavated areas at each of the three off-site anomalies; these locations were primarily along the edges of the excavations. Results of sampling at these properties, presented in Table 14, indicated above-guideline levels of Ra-226 at all sampled locations of Property AA and at several isolated locations on Properties BB and CC. Because the extent of residual contamination was small and averaging across contiguous 100 m^2 areas would result in an average level of less than 15 pCi/g of Ra-226, both of the hot-spot and average guidelines were satisfied for Properties BB and CC. Further remediation was conducted at Property AA and BNI results indicate the action was effective in meeting the DOE guidelines. No followup verification measurements or samples were performed by ORAU at Property AA.

SUMMARY

Beginning in April 1986, the Environmental Survey and Site Assessment Program of Oak Ridge Associated Universities performed activities to independently verify the adequacy of remedial actions on eleven NFSS vicinity properties, Pletcher Road, and three off-site anomalies. The verification activities included document reviews, confirmatory laboratory analyses, and independent measurements and sampling. Initial measurements and samples indicated that the remediation had been generally effective in satisfying the established DOE guidelines for this project; however, small isolated areas of residual contamination were identified on some of the properties. Further remediation was performed, followed by additional verification measurements and samples, continuing into mid 1987. Based on the results and findings of these activities, it is ORAU's opinion that the remedial action has been effective in satisfying the established DOE guidelines and that the documentation supporting the remedial action process is adequate and accurate.

Property use at the time of the characterization, remediation, and verification activities prevented access to several small areas of the site. These areas are the (1) soil beneath Lagoon 6 and the berm for that Lagoon on Property E, (2) soil beneath a roadway, and PCB storage tanks on Property E', and (3) soil beneath the liquid treatment pond on the western portion of Property G. Each of these areas either has a potential for residual contamination, based on historic data, or is known to contain contamination which may be in excess of the DOE guidelines. It is recommended that DOE continue to work with the owner of those properties to provide evaluation and remediation, if required, as facilities are decommissioned and the questionable areas become accessible.

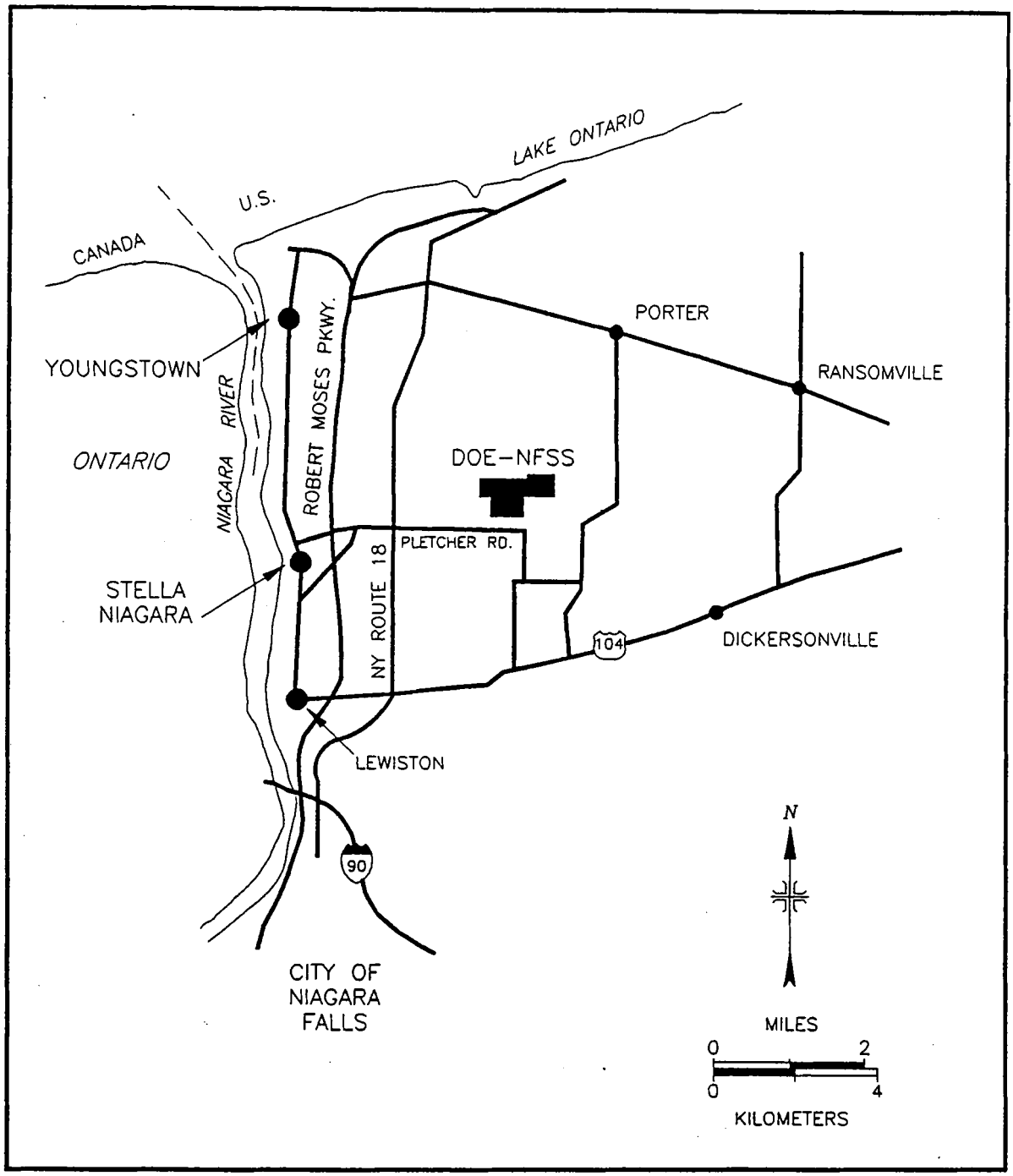


FIGURE 1: Map of Northern Niagara County, New York Indicating the Location of the Niagara Falls Storage Site

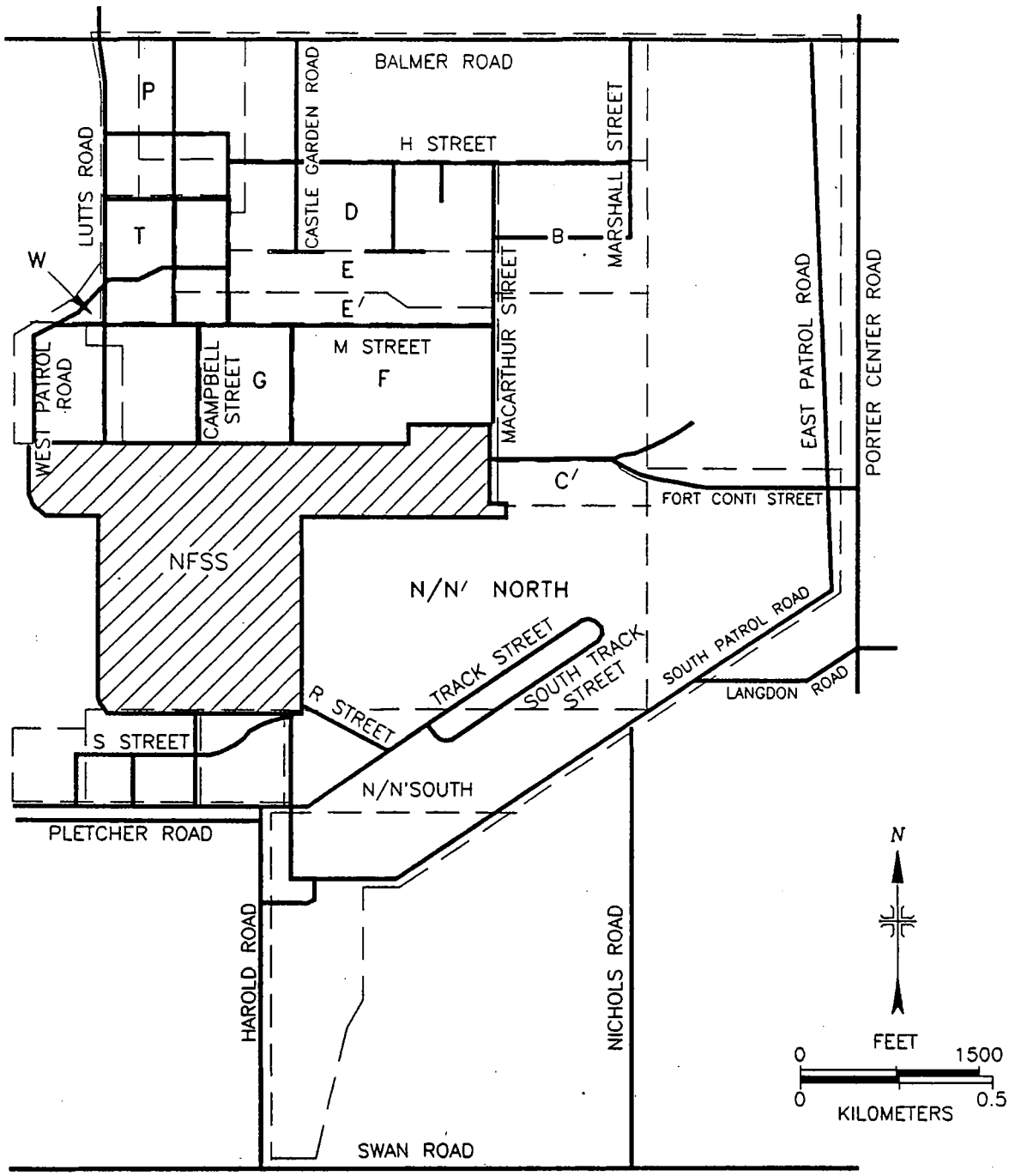


FIGURE 2: Plot Plan of NFSS Vicinity Properties Receiving Remedial Action in 1985 and 1986

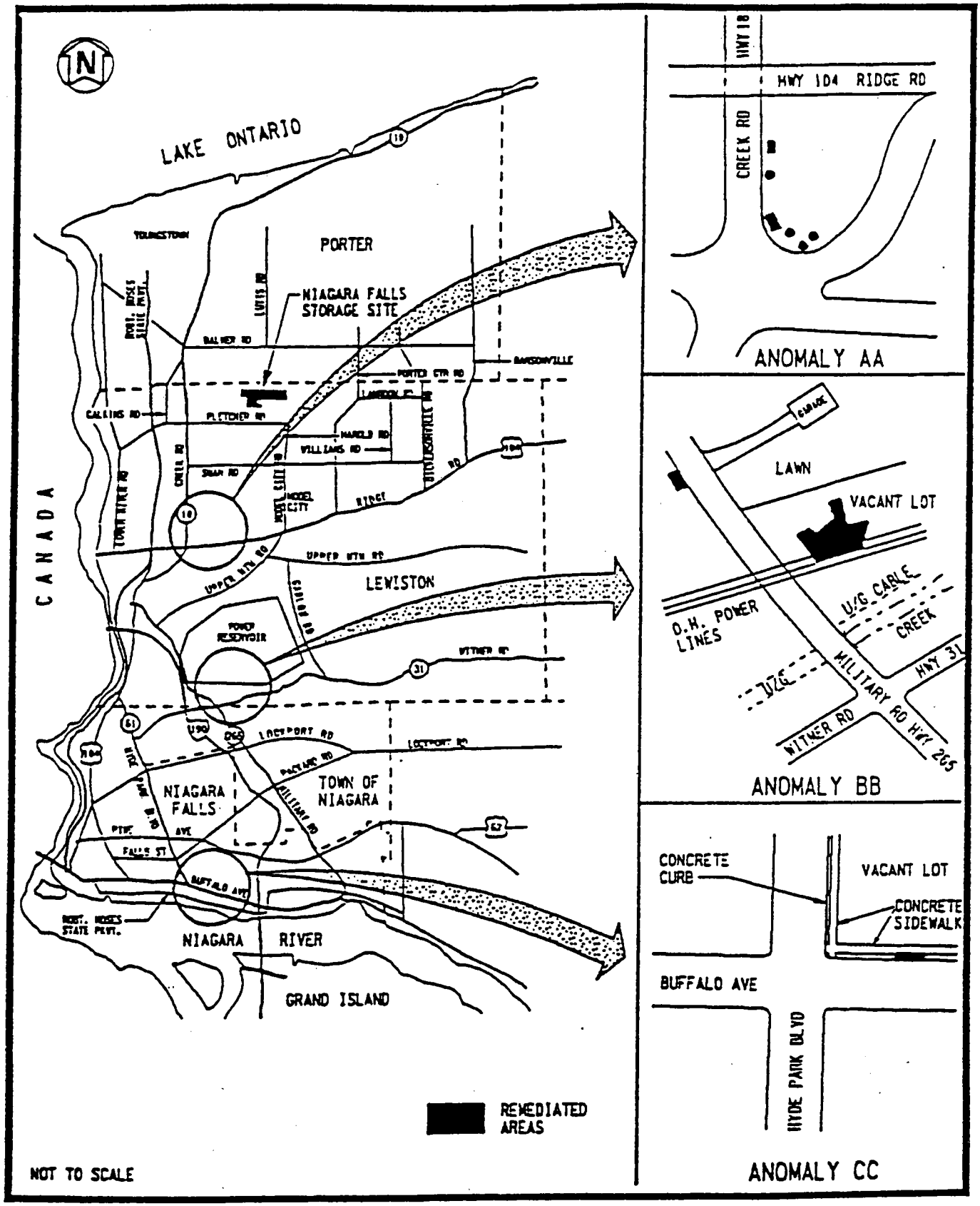


FIGURE 3: Niagara Falls Area Indicating the Locations of Anomalies AA, BB, and CC

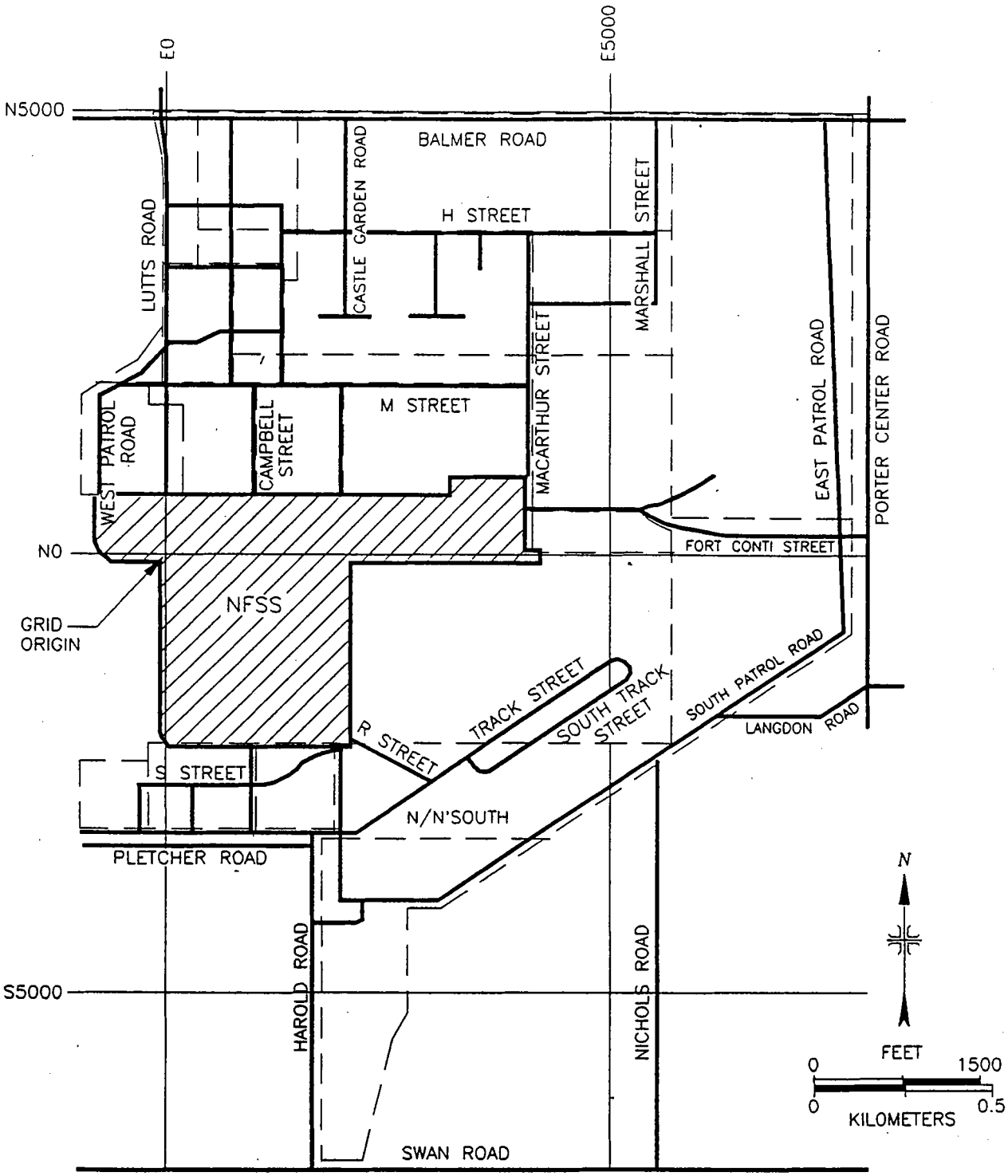


FIGURE 4: Plot Plan of NFSS Vicinity Properties Indicating Reference Grid Lines

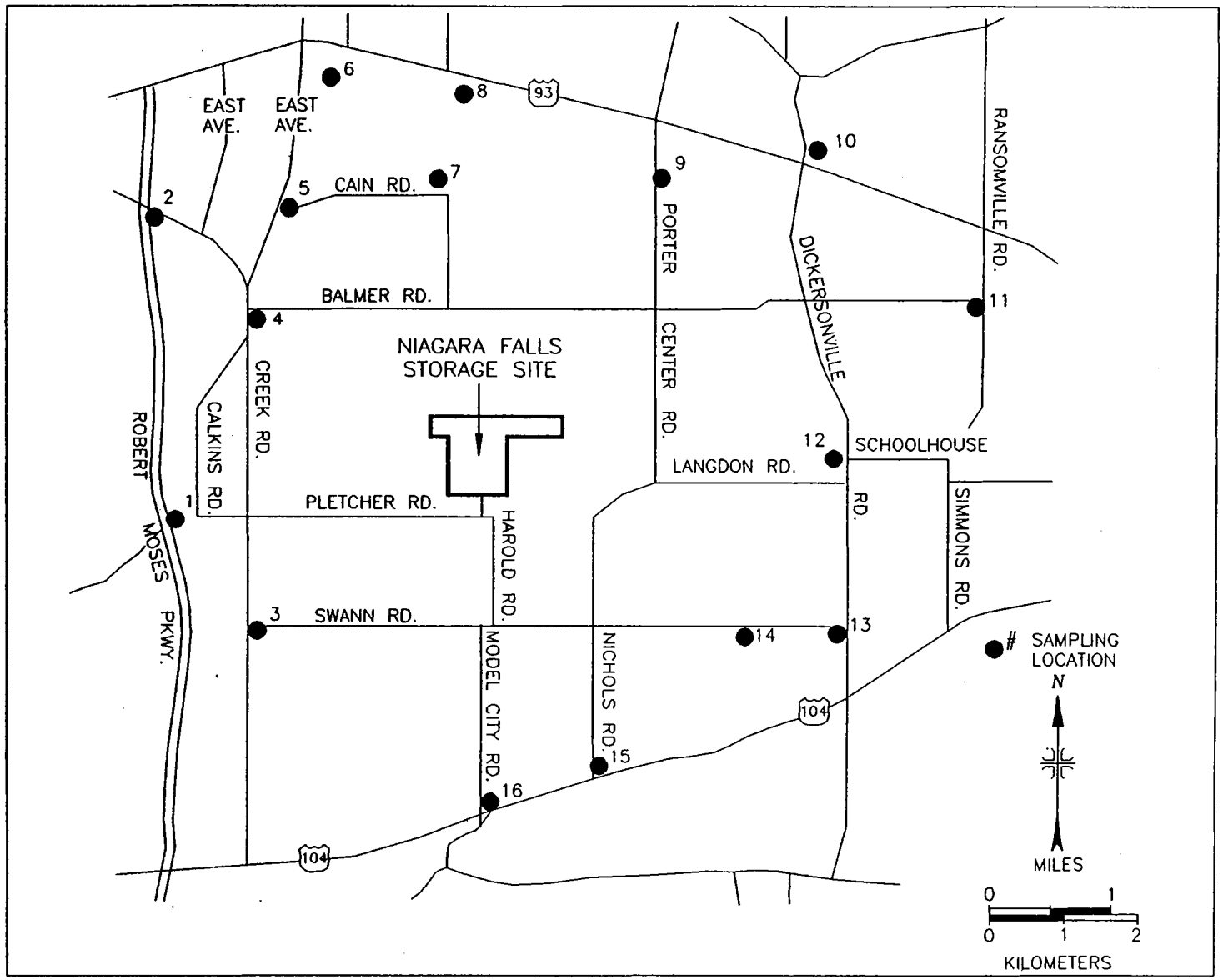


FIGURE 5: Map of Northern Niagara County, New York, Showing Locations of Background Measurements and Baseline Samples

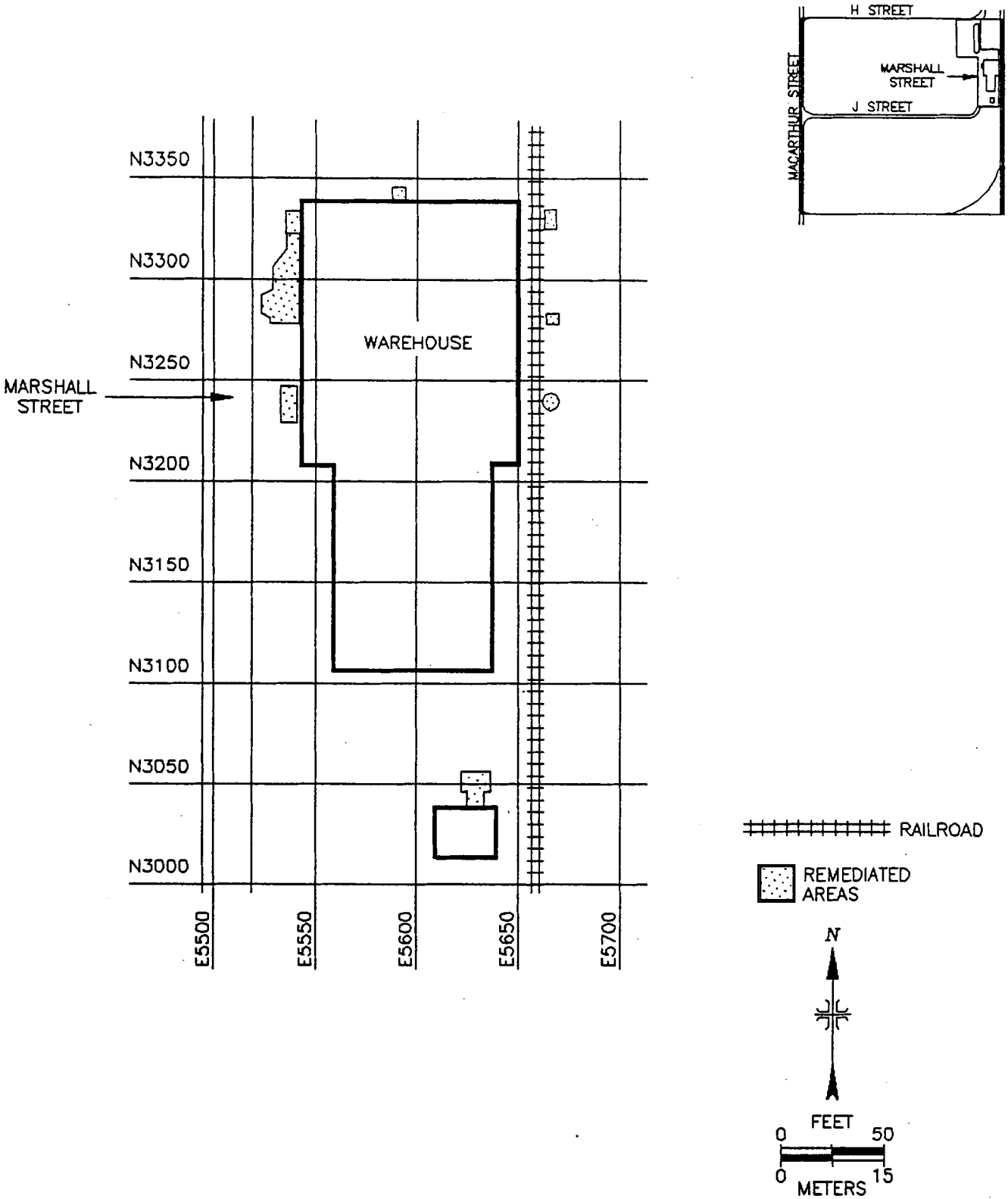


FIGURE 6: Plot Plan of Remediated Areas on Vicinity Property B

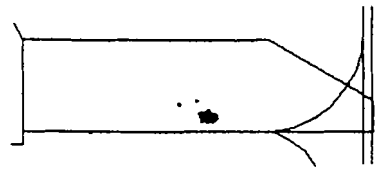


FIGURE 7: Plot Plan of Remediated Areas of Vicinity Property C'

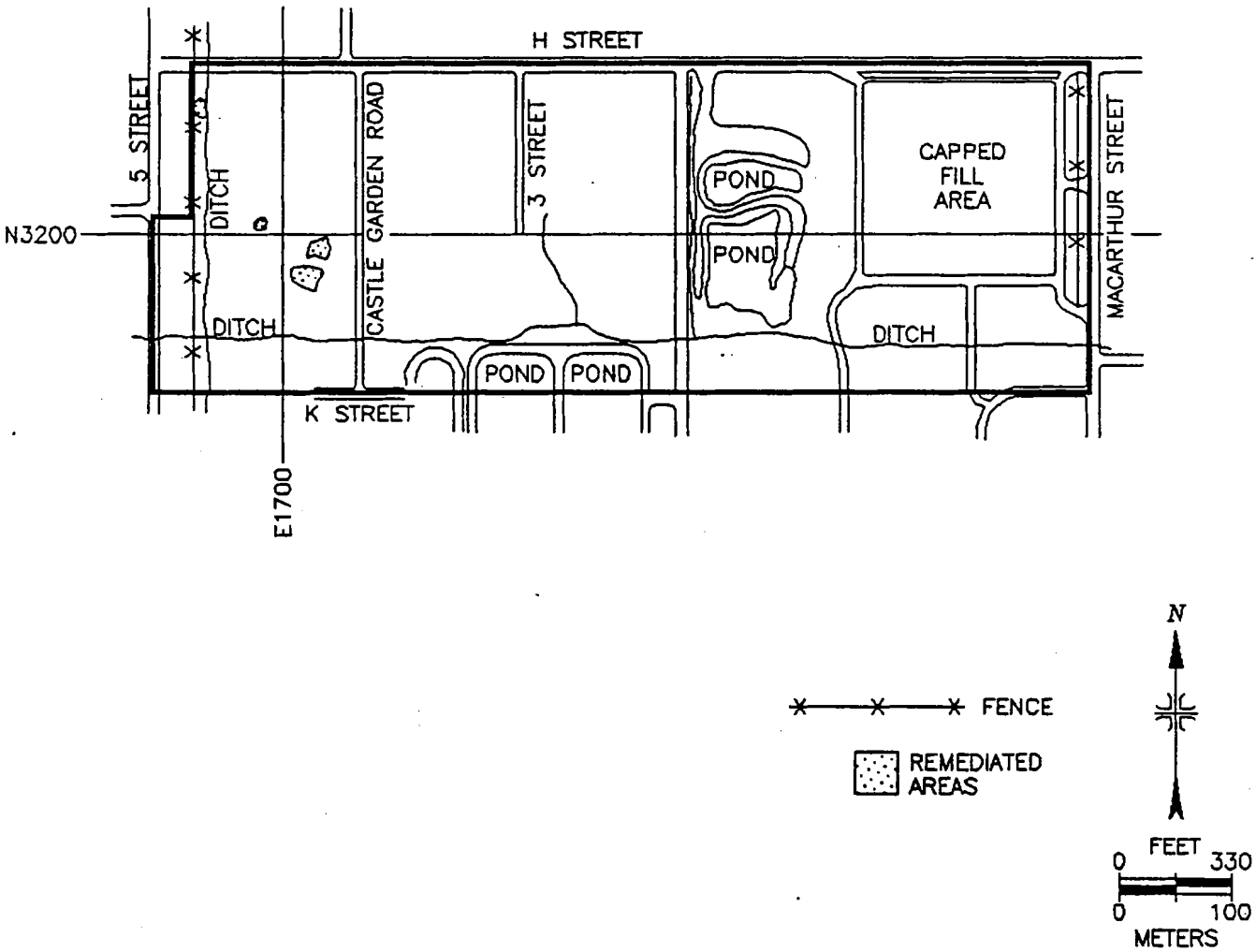


FIGURE 8: Plot Plan of Remediated Areas of Vicinity Property D

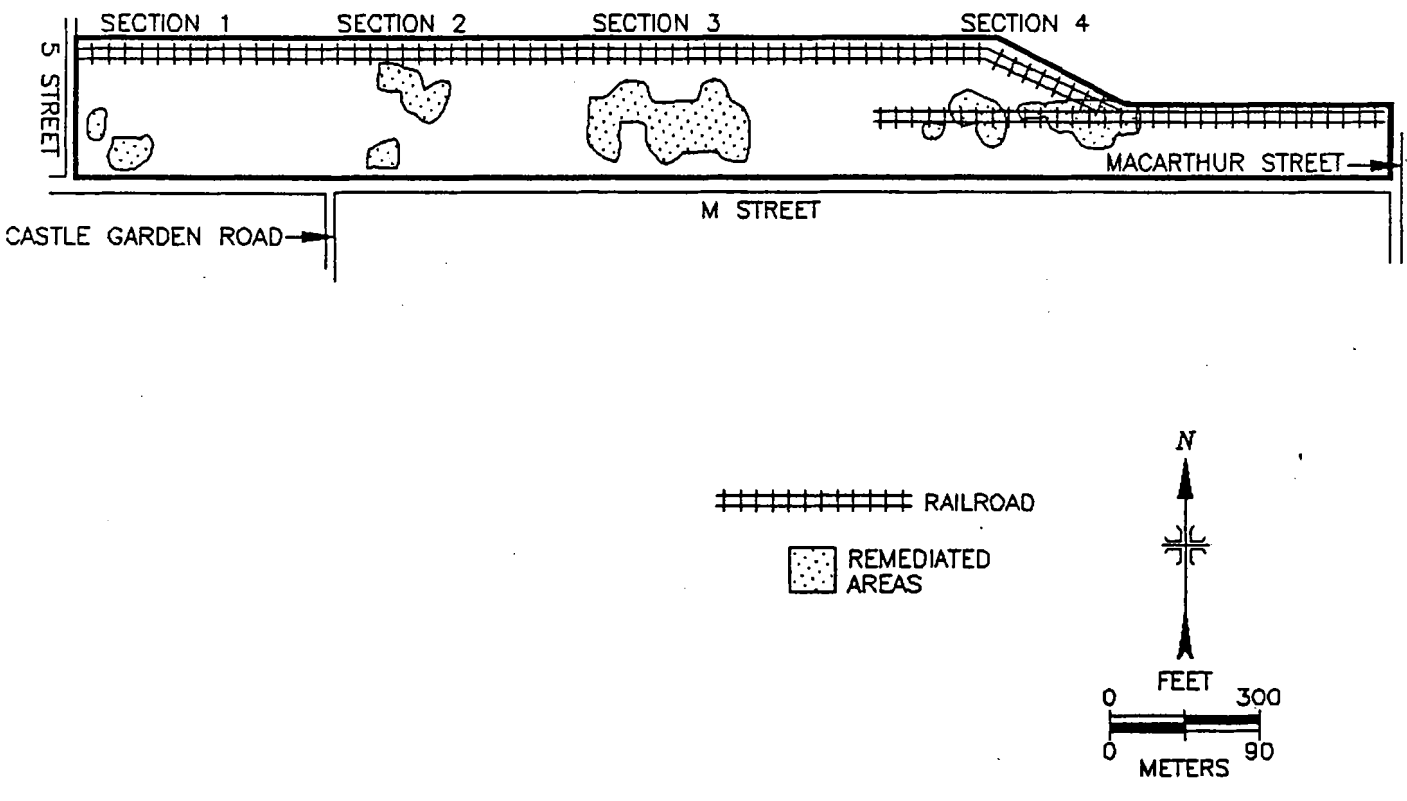


FIGURE 9: Plot Plan of Property E' Indicating Locations of Remedial Action

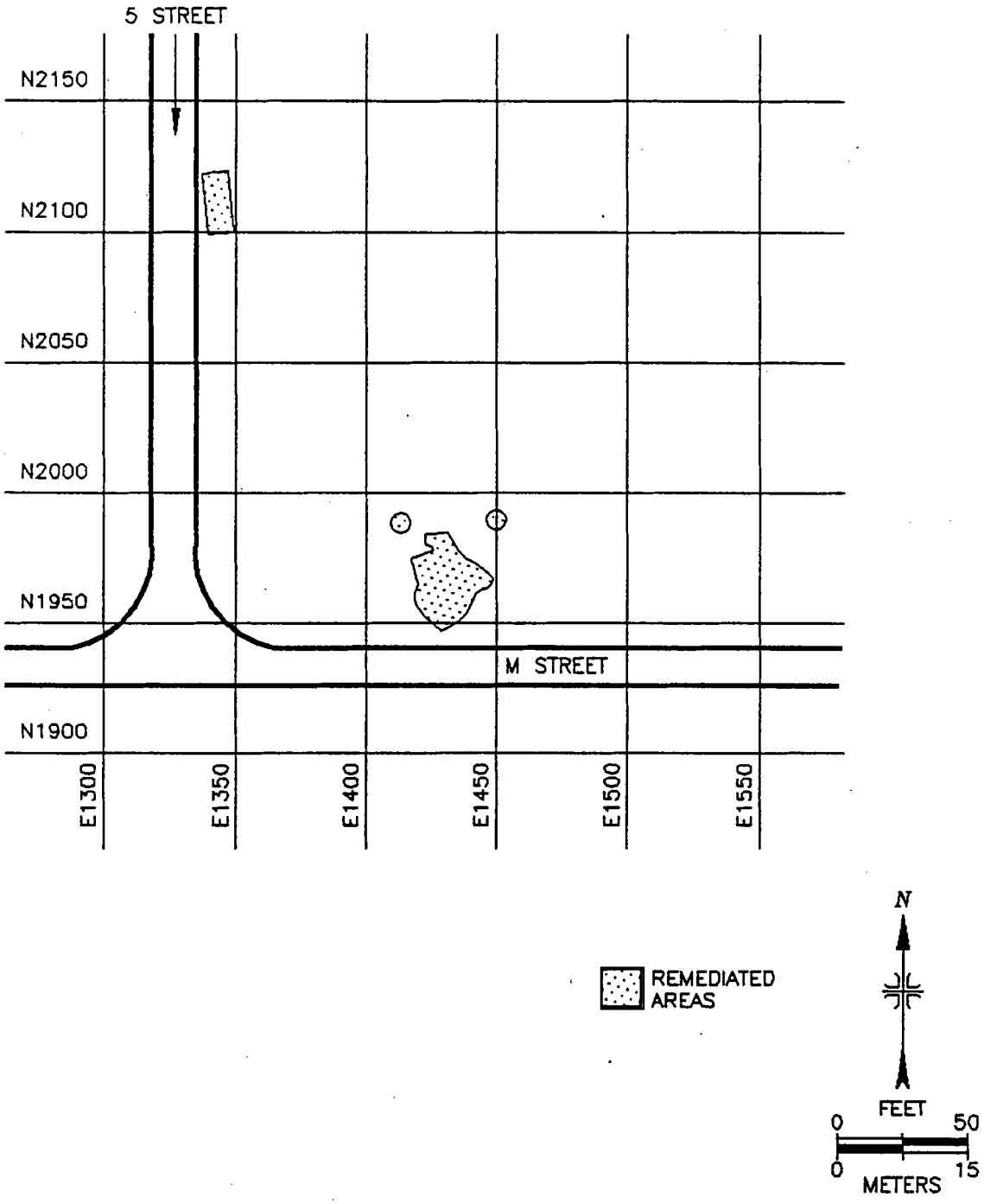


FIGURE 10: Plot Plan of Property E/—Section 1 Indicating Locations of Remedial Action

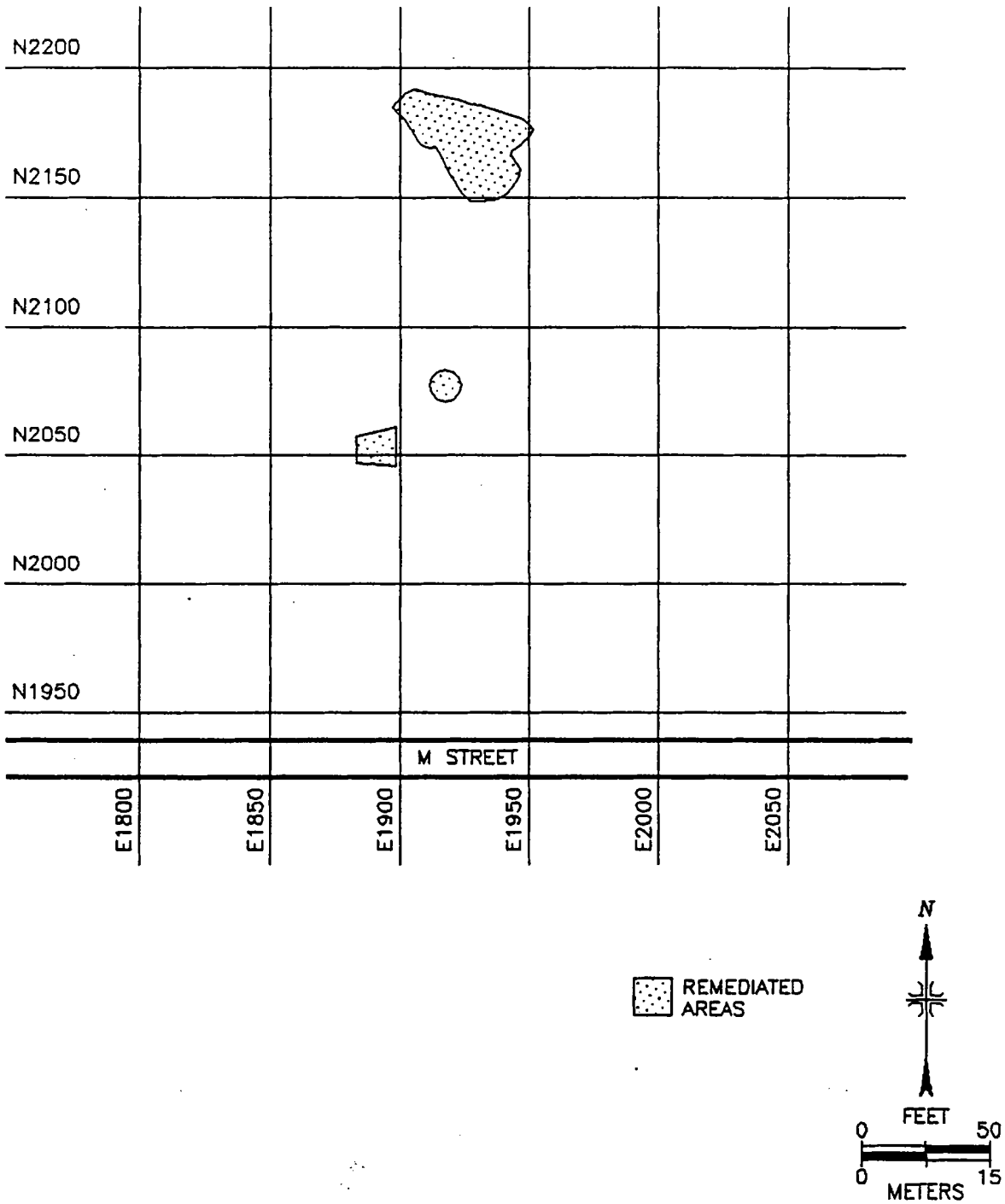


FIGURE 11: Plot Plan of Property E/—Section 2 Indicating Locations of Remedial Action

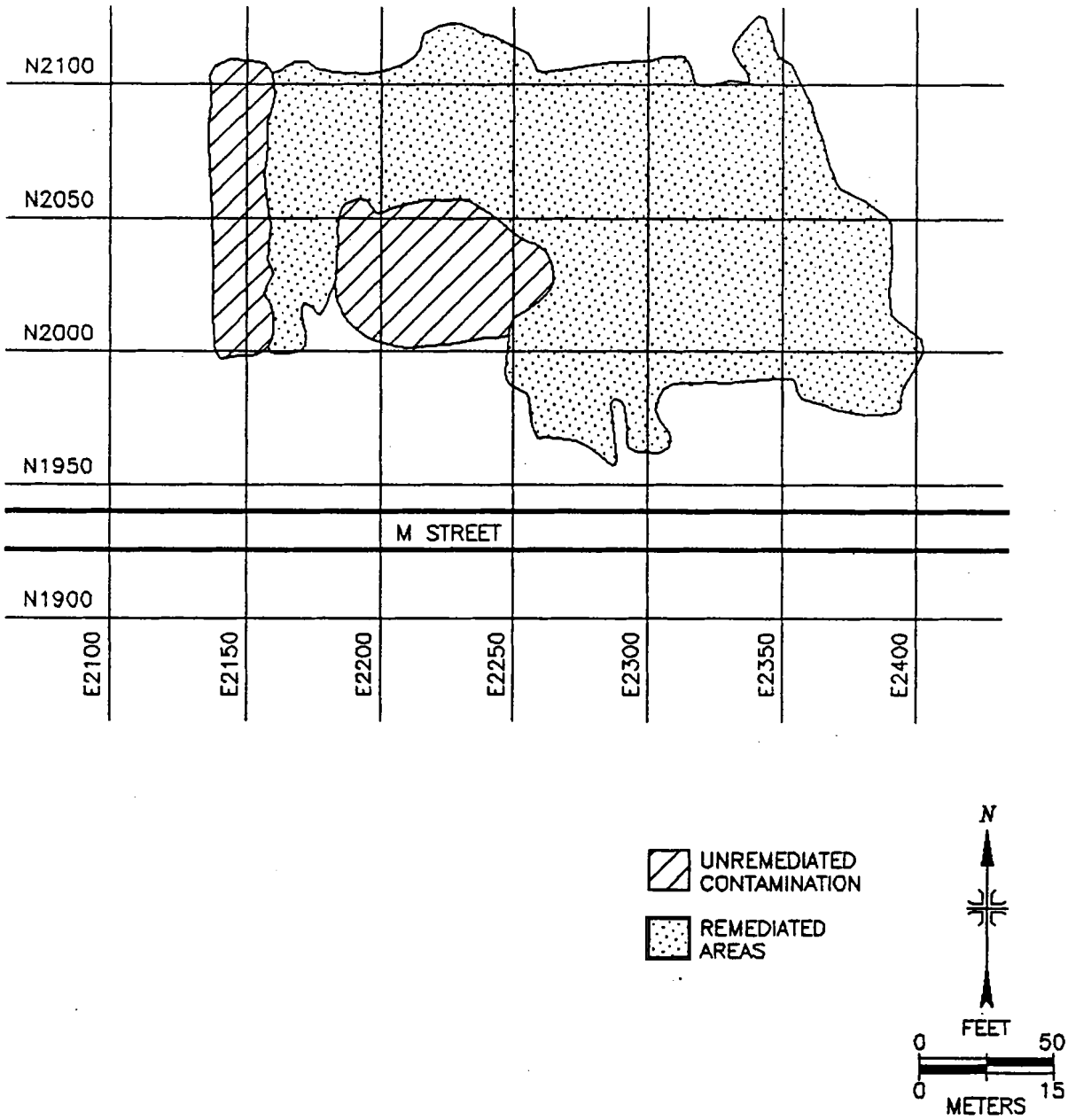


FIGURE 12: Plot Plan of Property E/—Section 3 Indicating Locations of Remedial Action

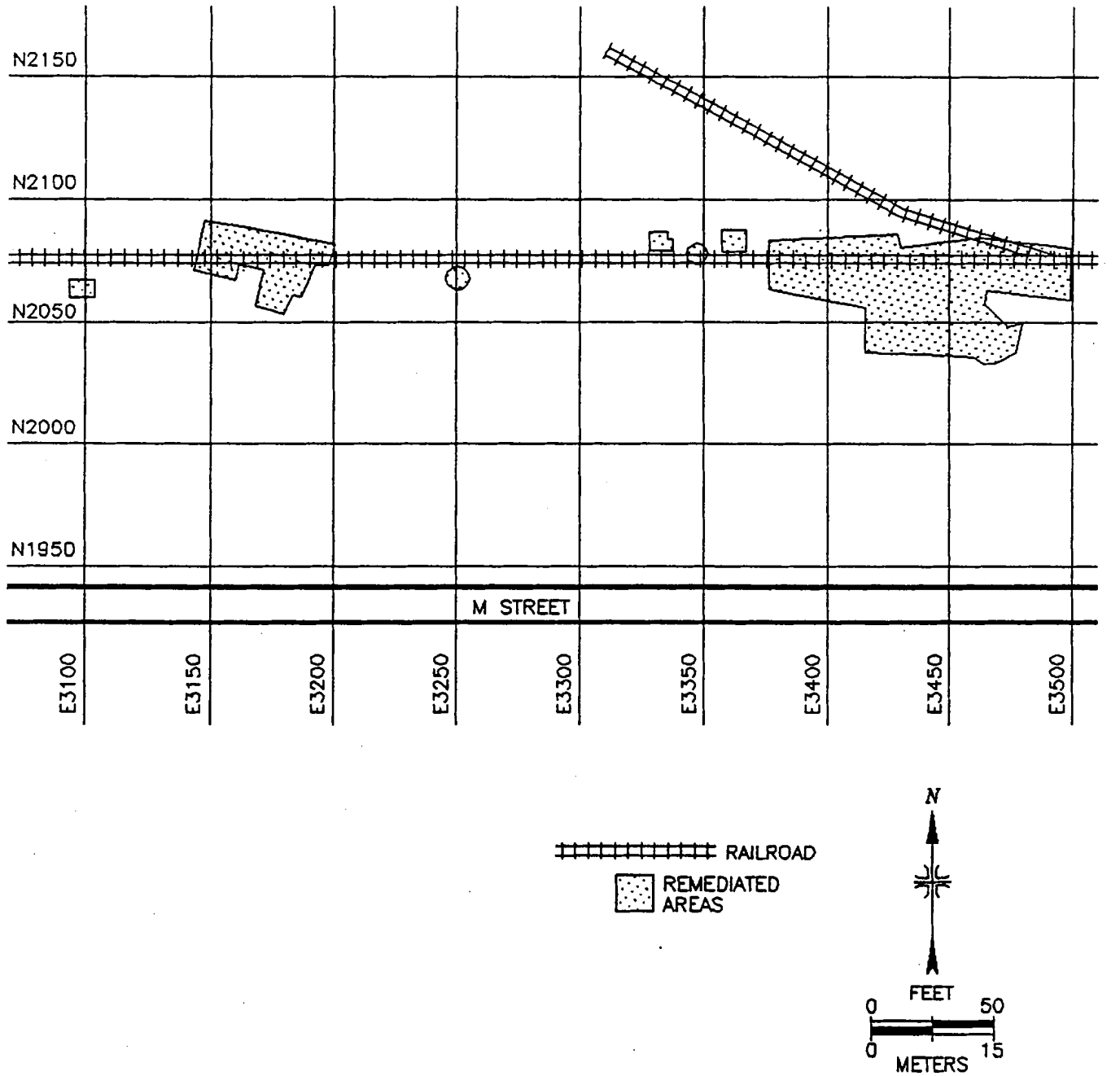


FIGURE 13: Plot Plan of Property E/—Section 4 Indicating Locations of Remedial Action

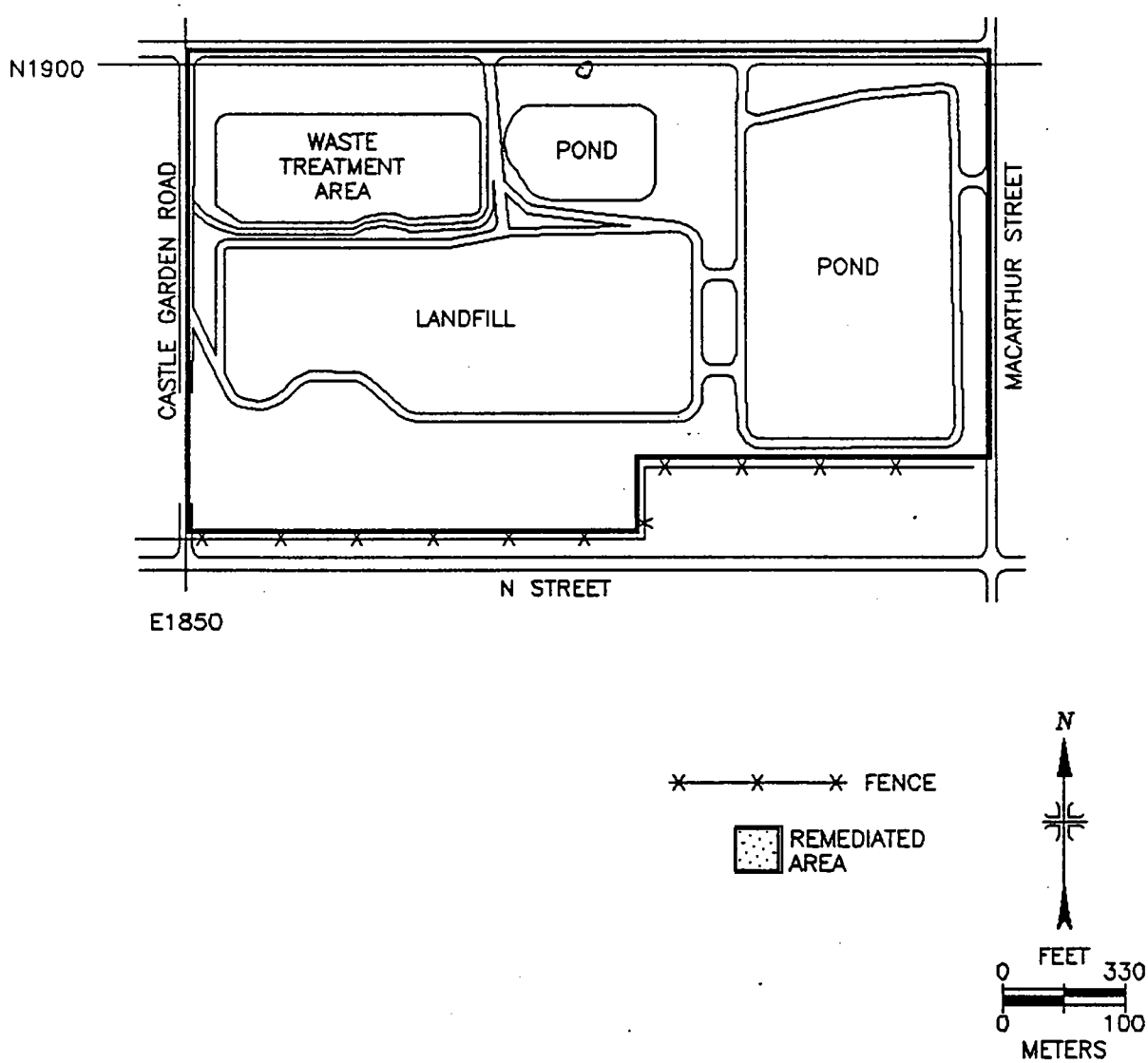


FIGURE 14: Plot Plan of Remediated Areas of Vicinity Property F

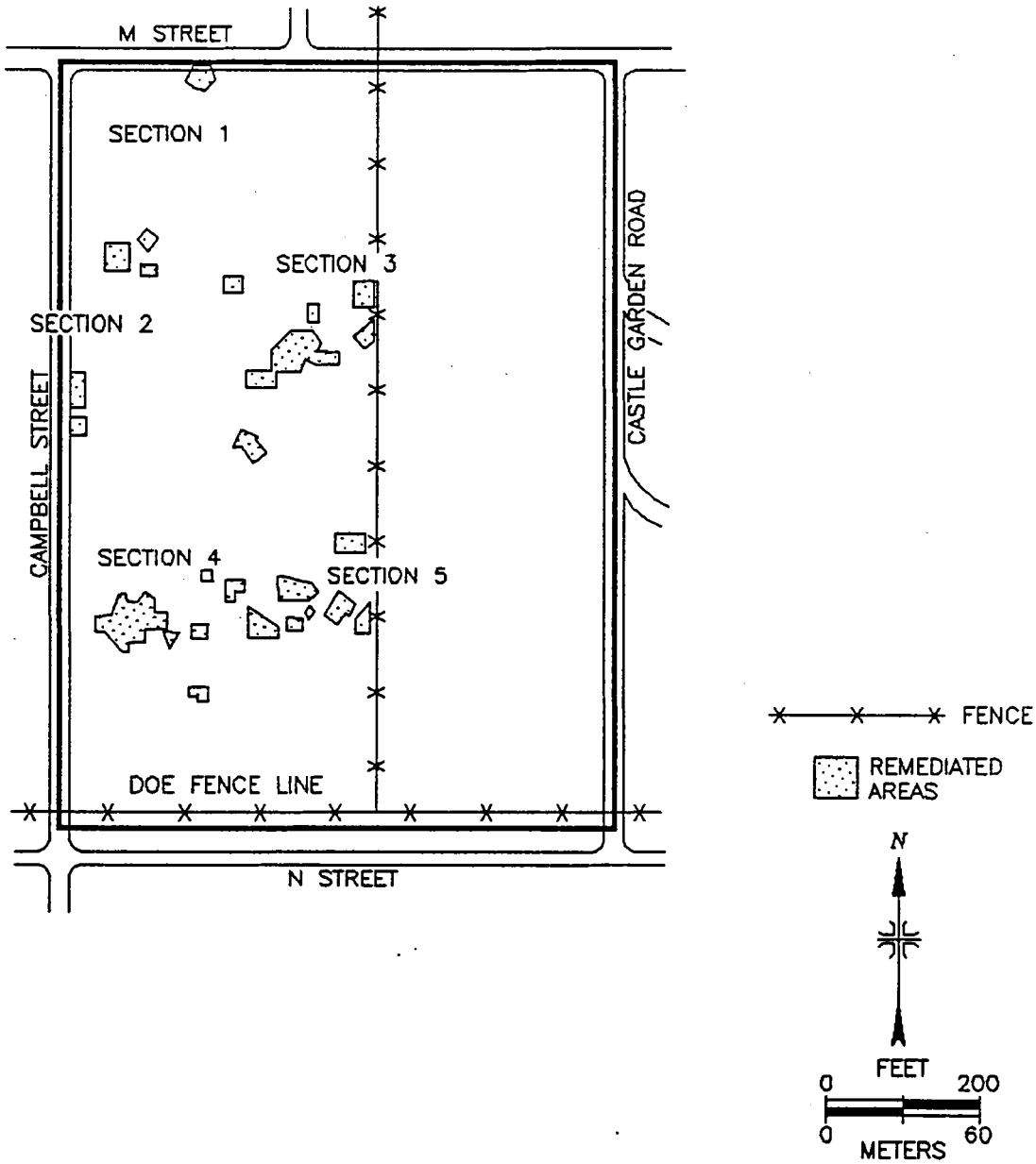


FIGURE 15: Plot Plan of Property G Indicating Locations of Remedial Action

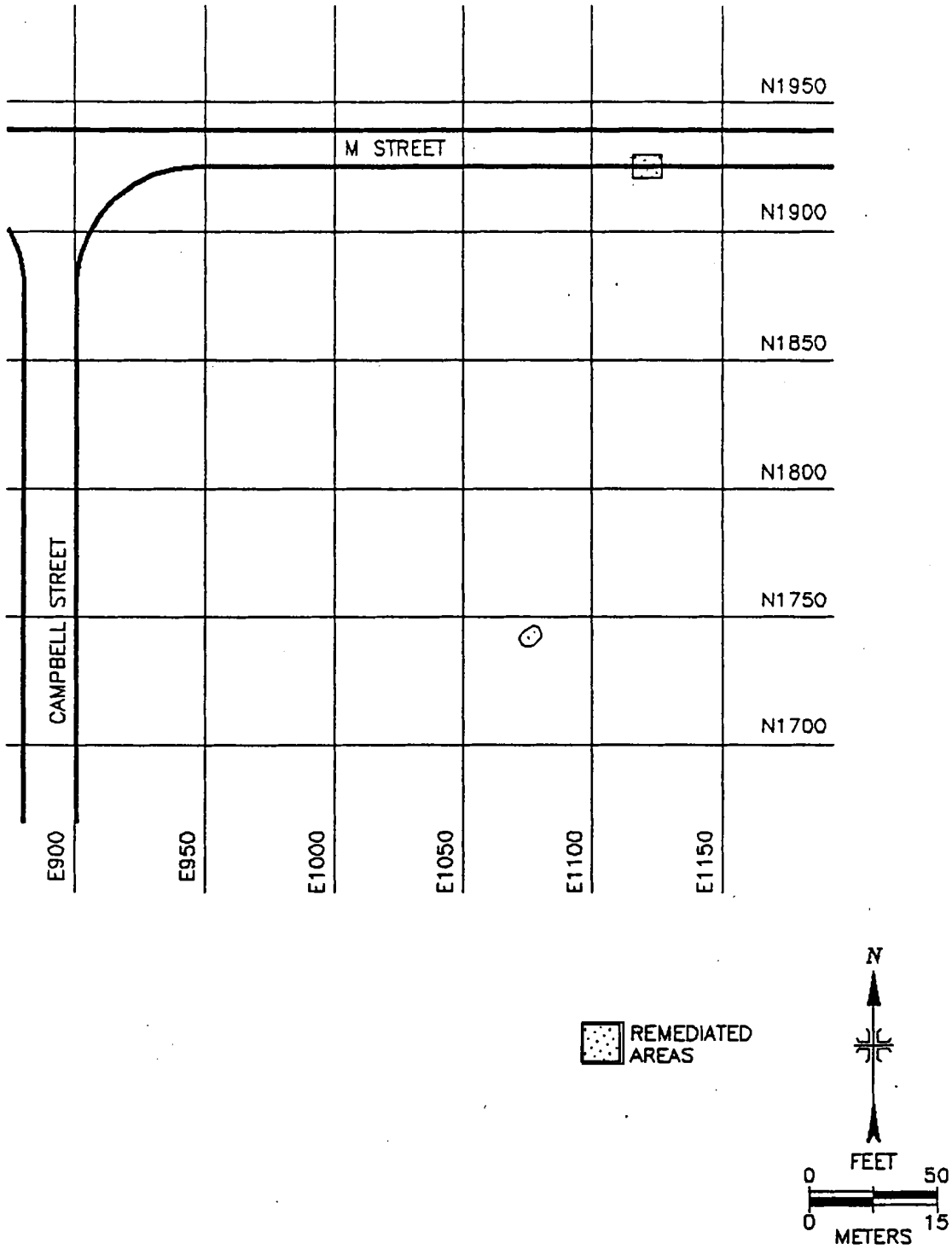


FIGURE 16: Plot Plan of Property G—Section 1 Indicating Locations of Remedial Action

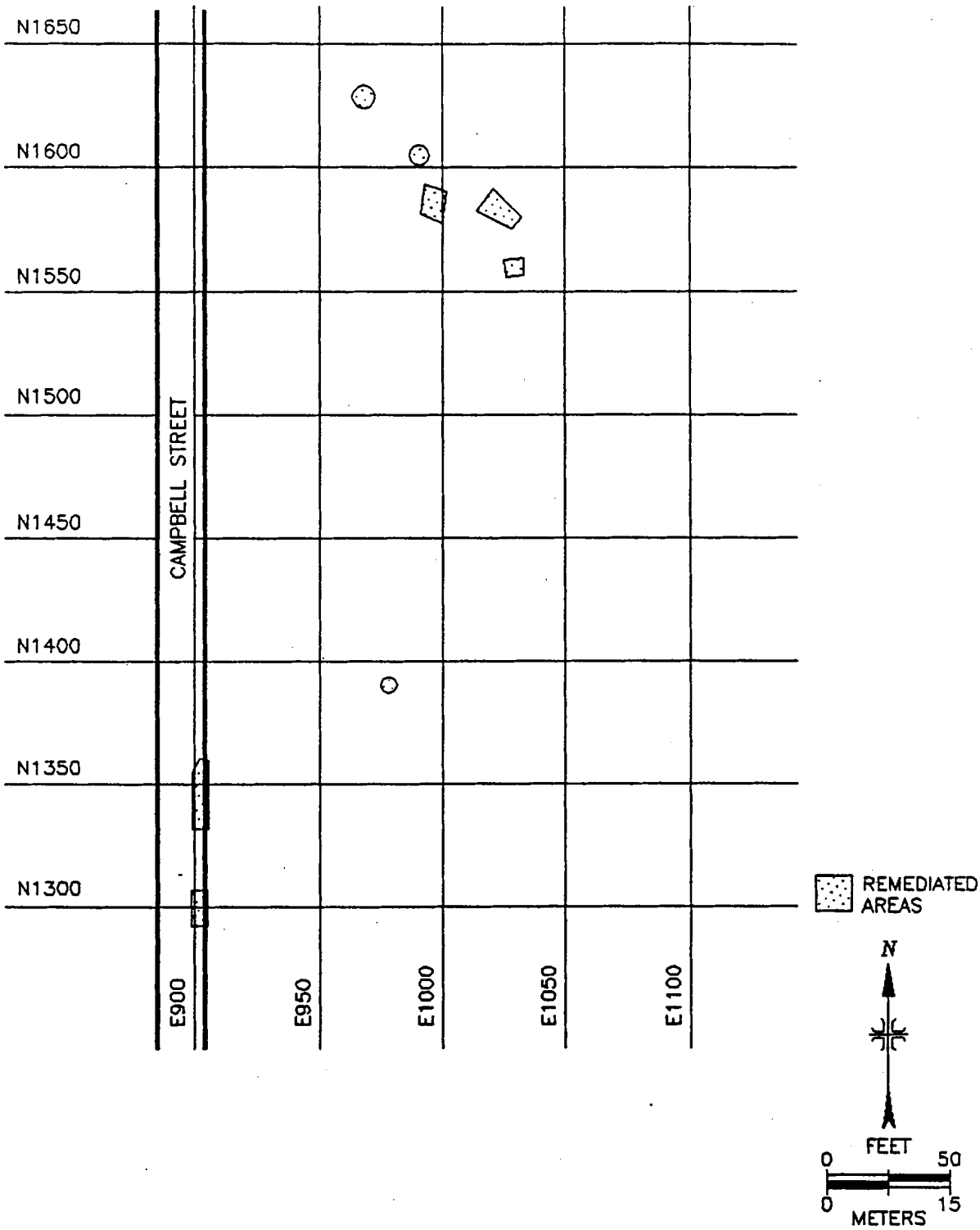


FIGURE 17: Plot Plan of Property G–Section 2 Indicating Locations of Remedial Action

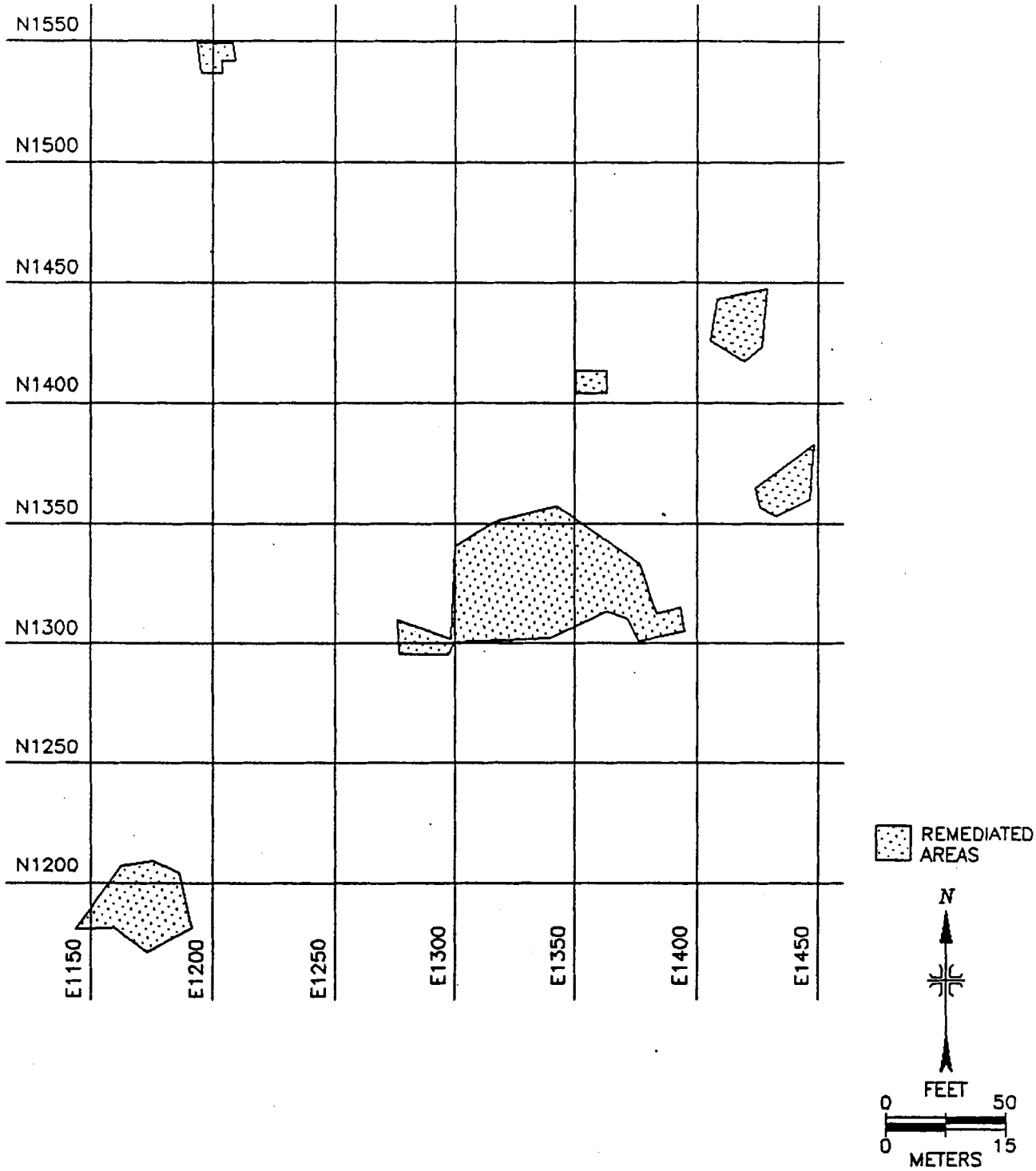


FIGURE 18: Plot Plan of Property G—Section 3 Indicating Locations of Remedial Action

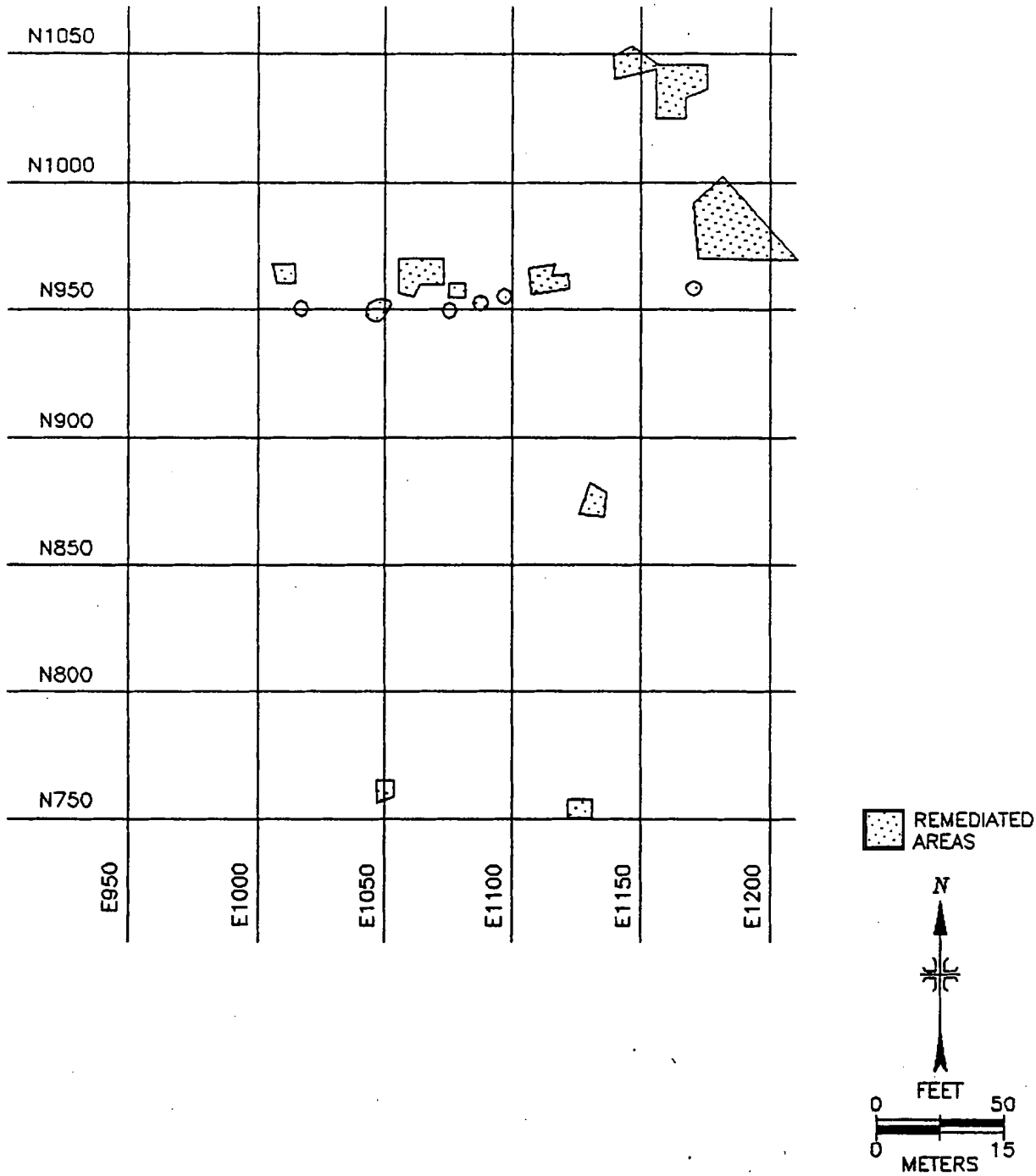


FIGURE 19: Plot Plan of Property G—Section 4 Indicating Locations of Remedial Action

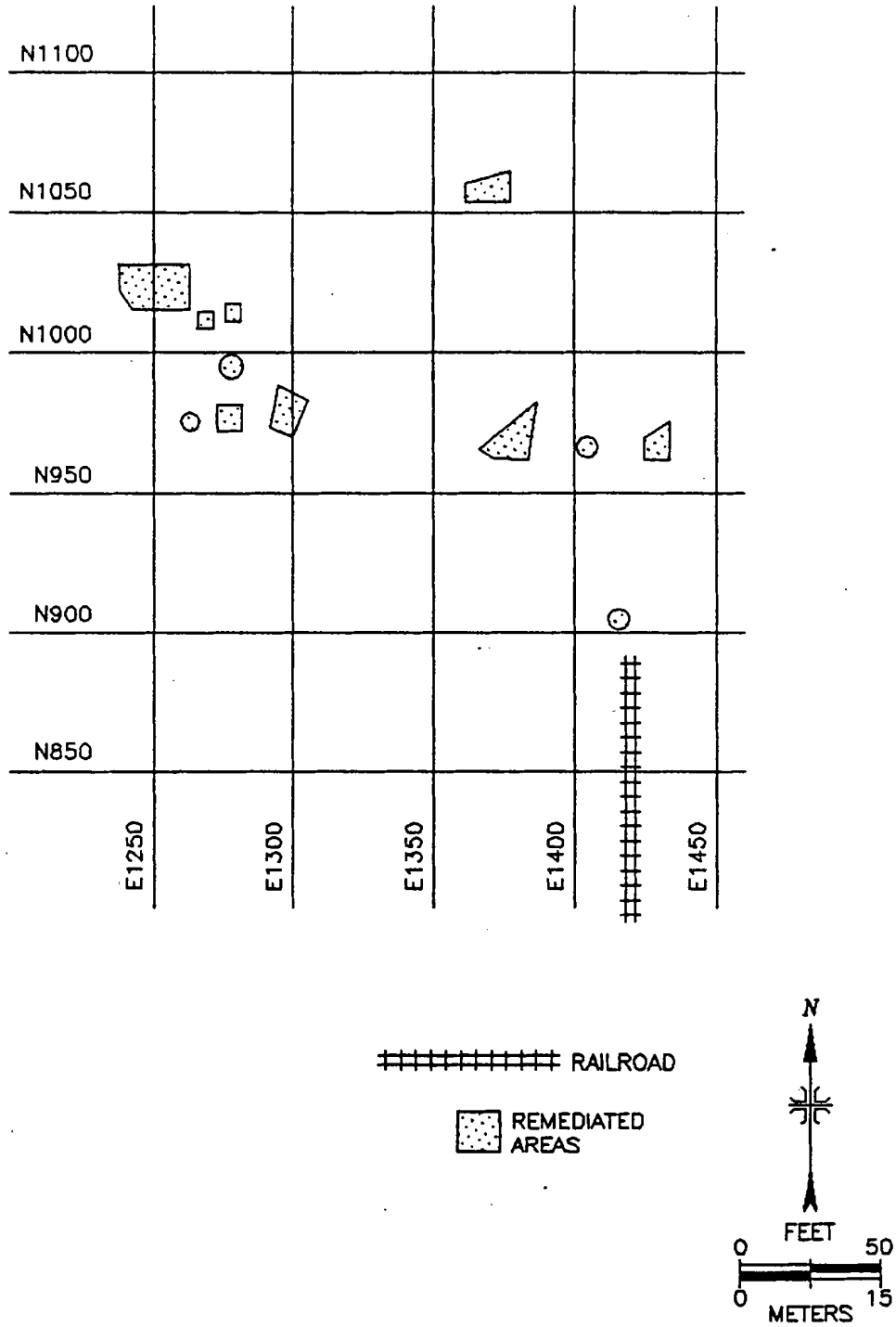


FIGURE 20: Plot Plan of Property G–Section 5 Indicating Locations of Remedial Action

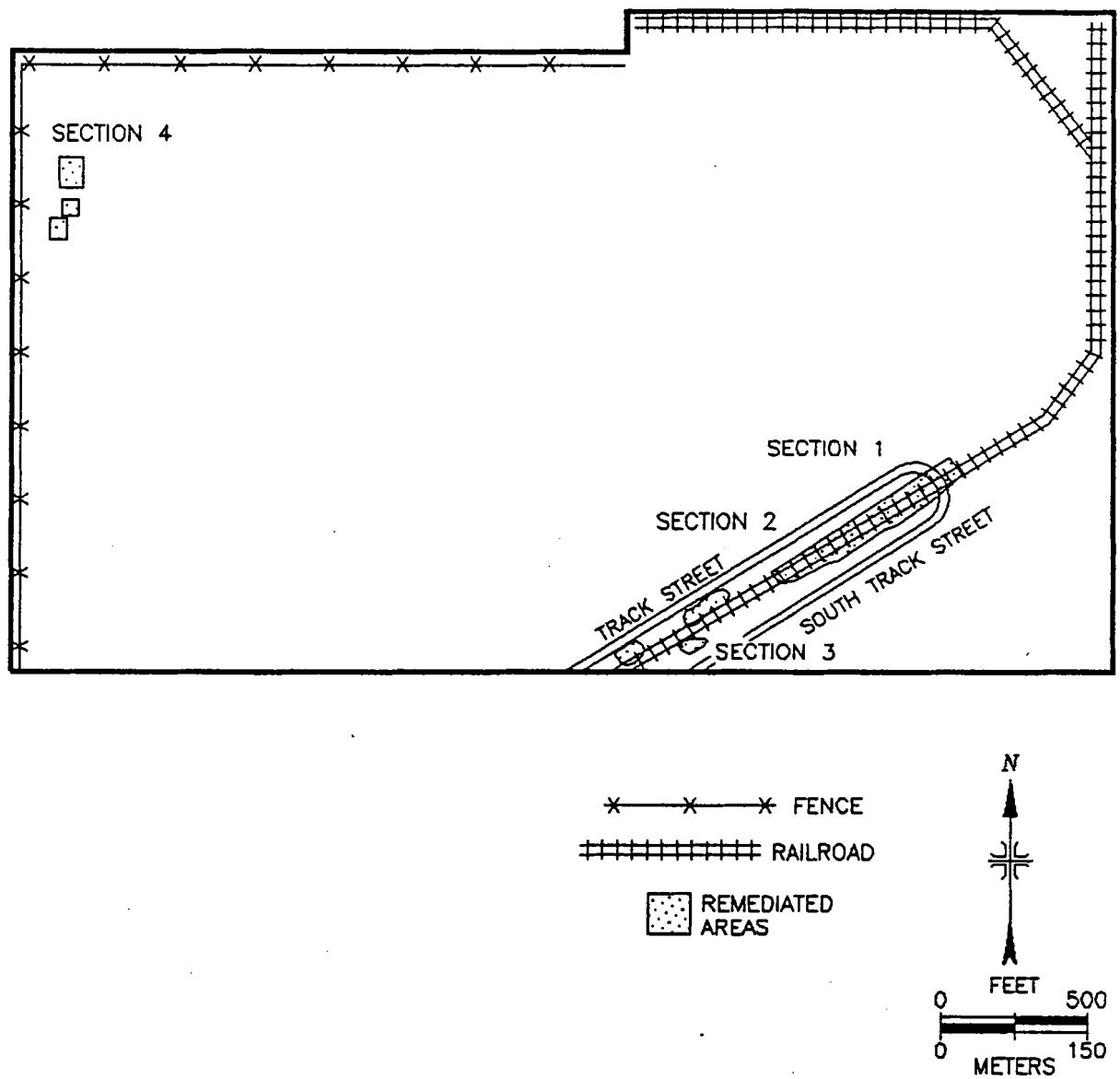


FIGURE 21: Plot Plan of Property N/N' North Indicating Locations of Remedial Action

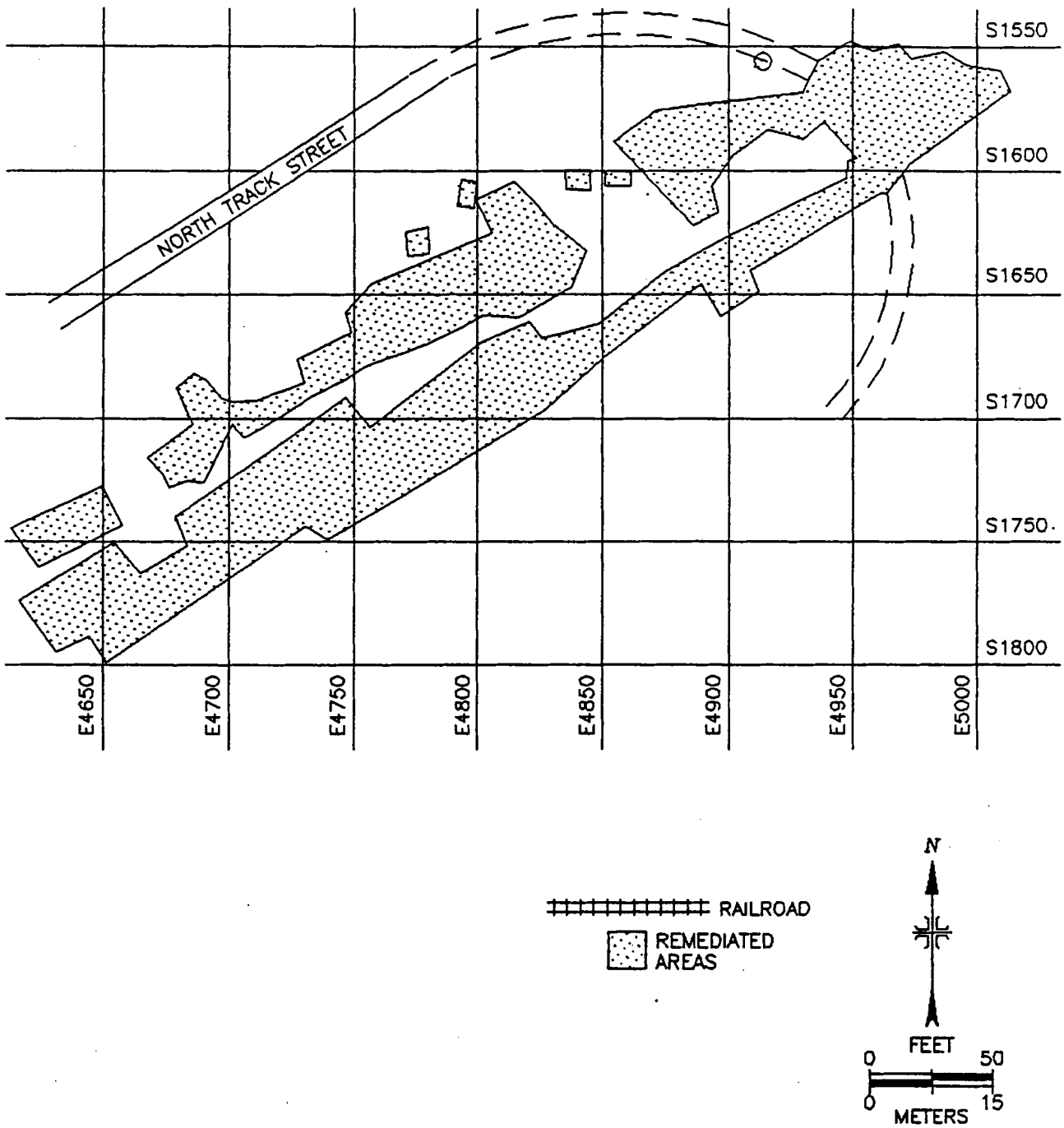


FIGURE 22: Plot Plan of Property N/N' North–Section 1 Indicating Locations of Remedial Action

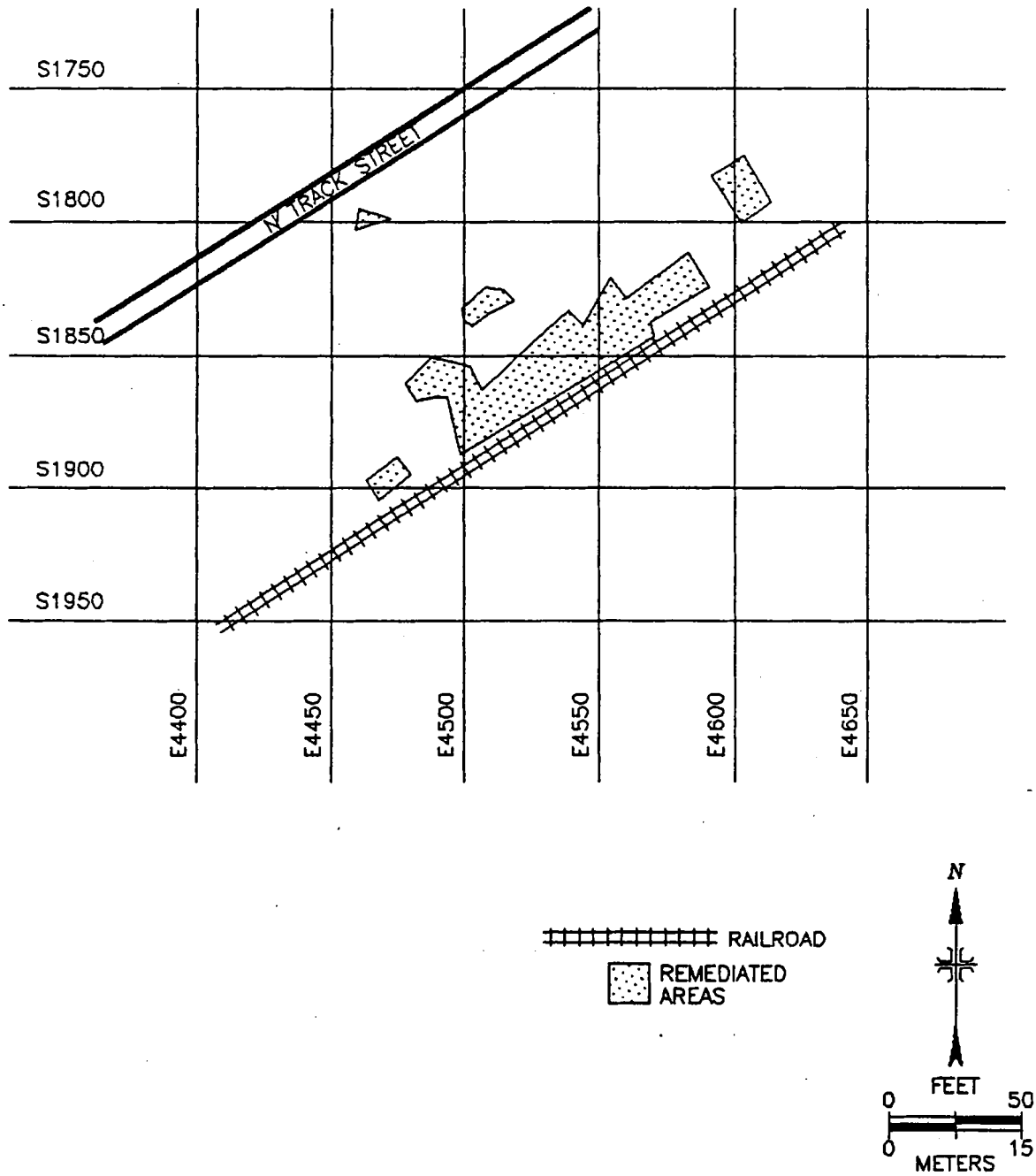


FIGURE 23: Plot Plan of Property N/N' North–Section 2 Indicating Locations of Remedial Action

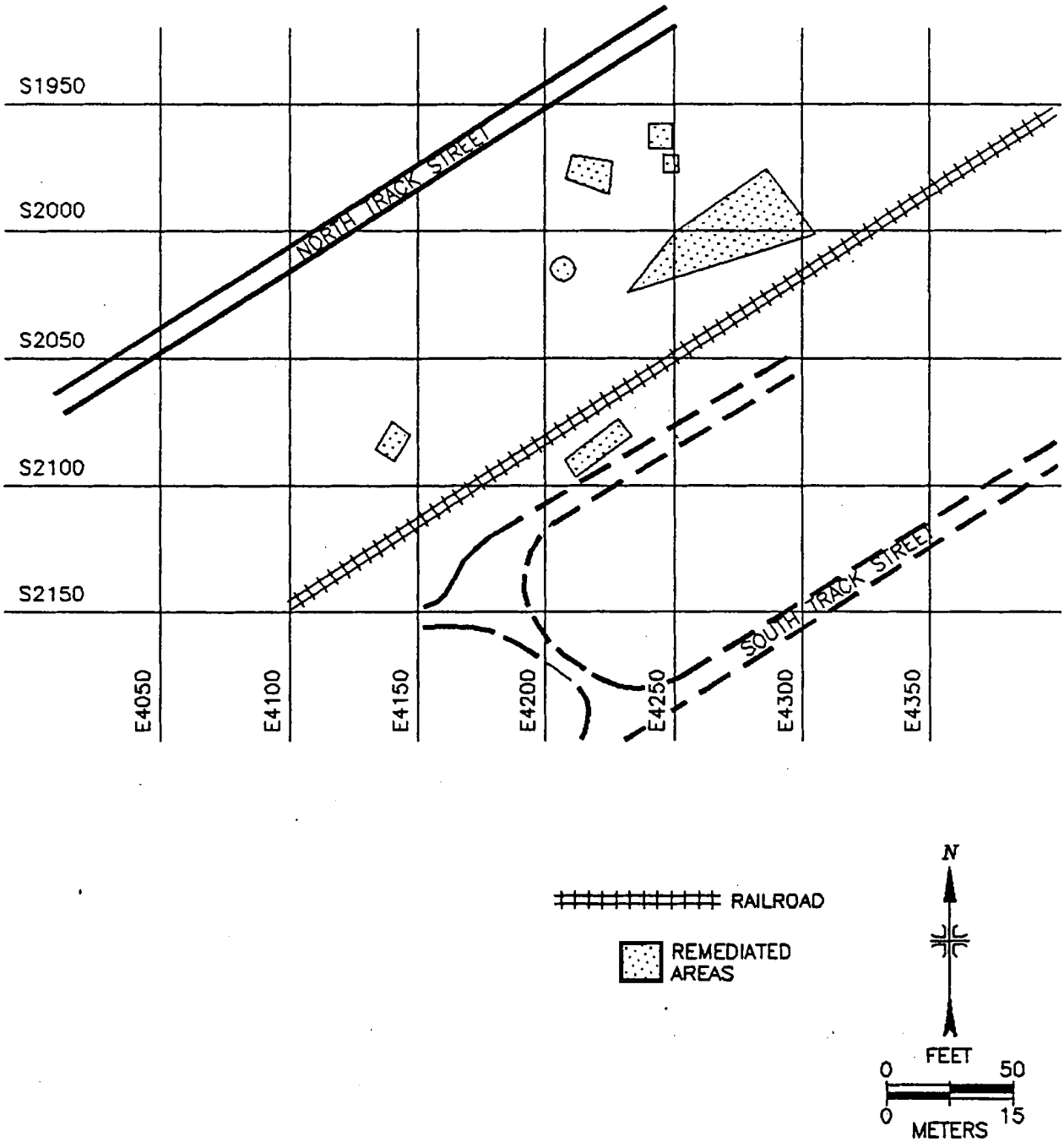


FIGURE 24: Plot Plan of Property N/N' North—Section 3 Indicating Locations of Remedial Action

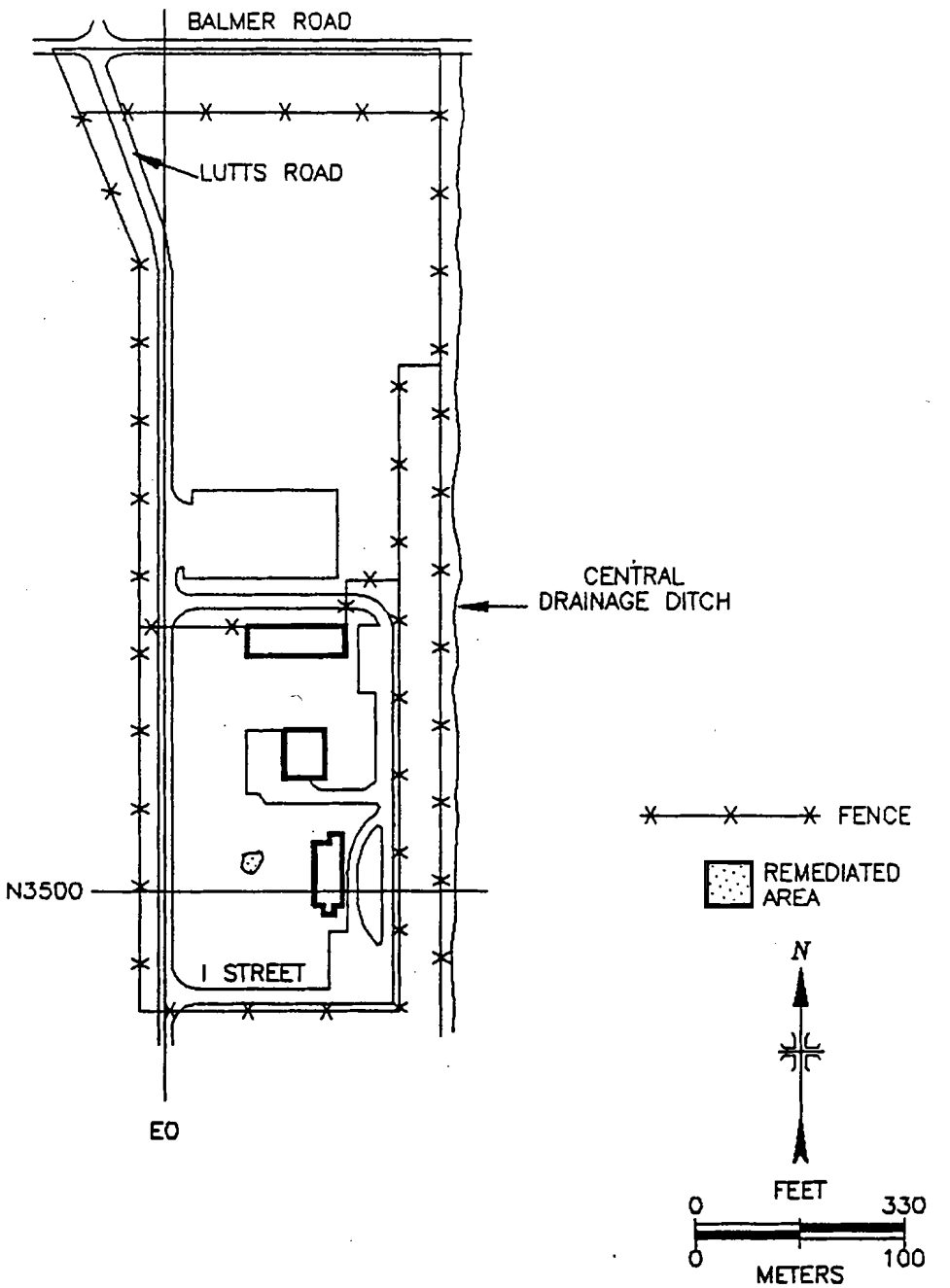


FIGURE 25: Plot Plan of Remediated Area of Vicinity Property P

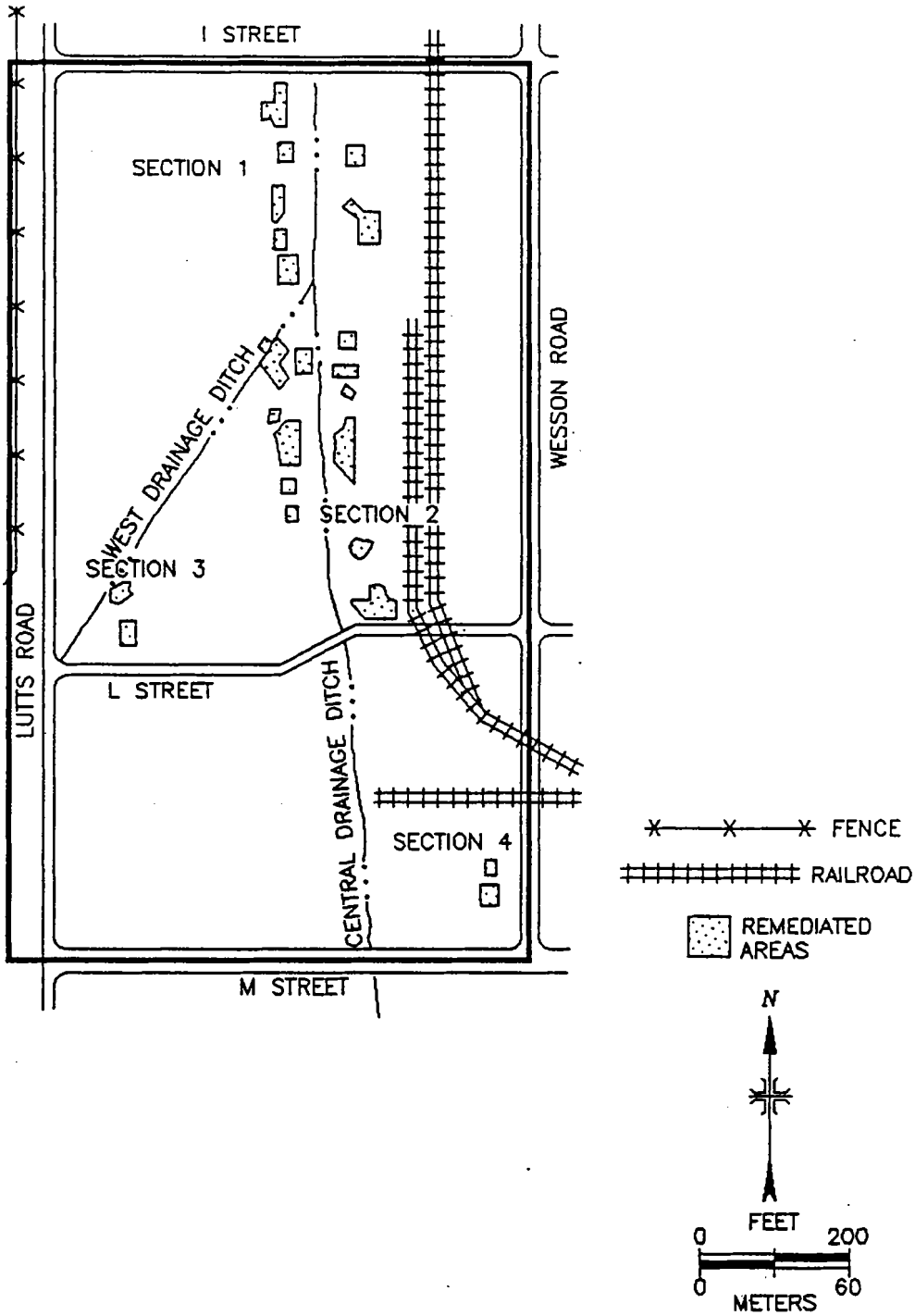


FIGURE 26: Plot Plan of Property T Indicating Remediated Areas

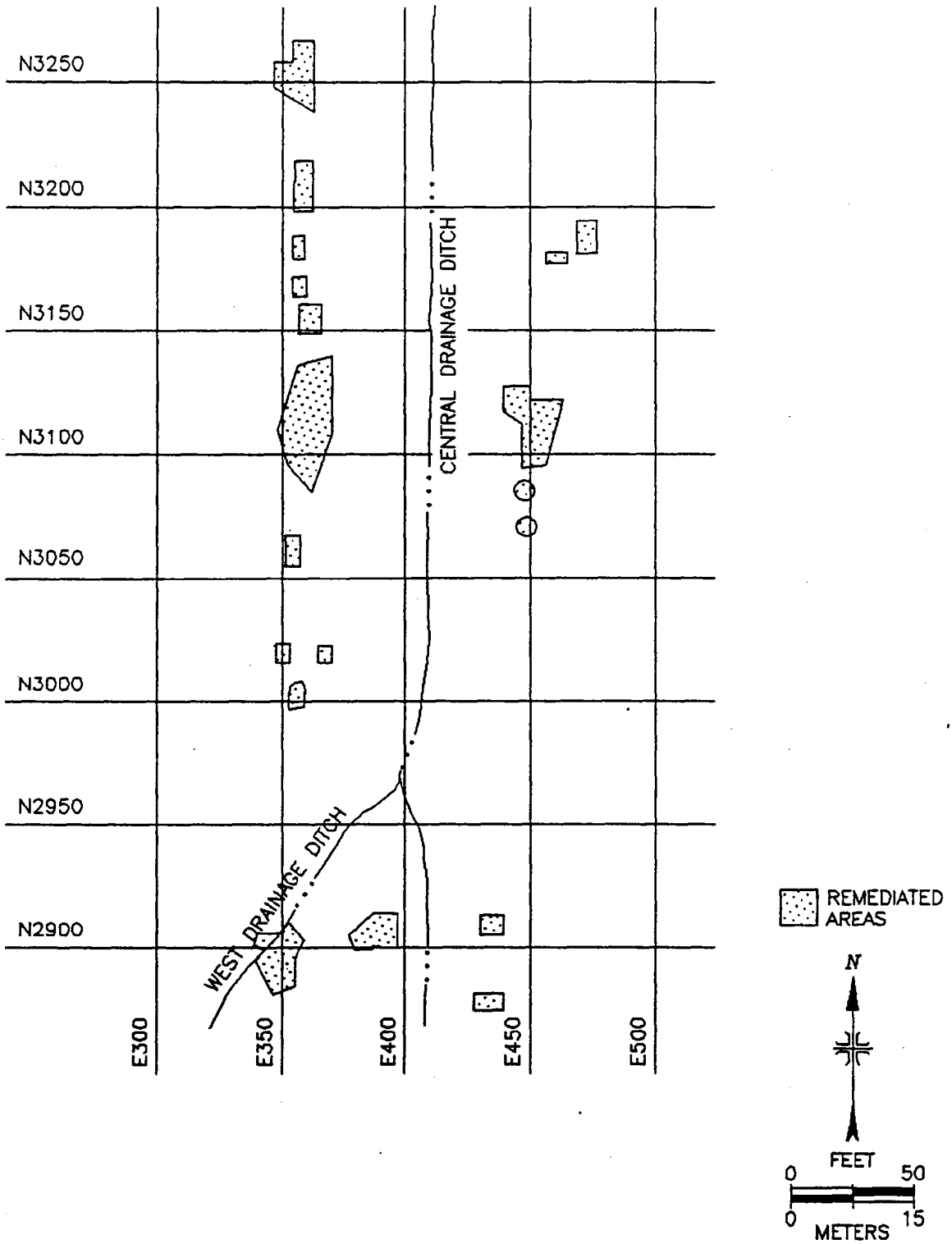


FIGURE 27: Plot Plan of Property T–Section 1 Indicating Remediated Areas

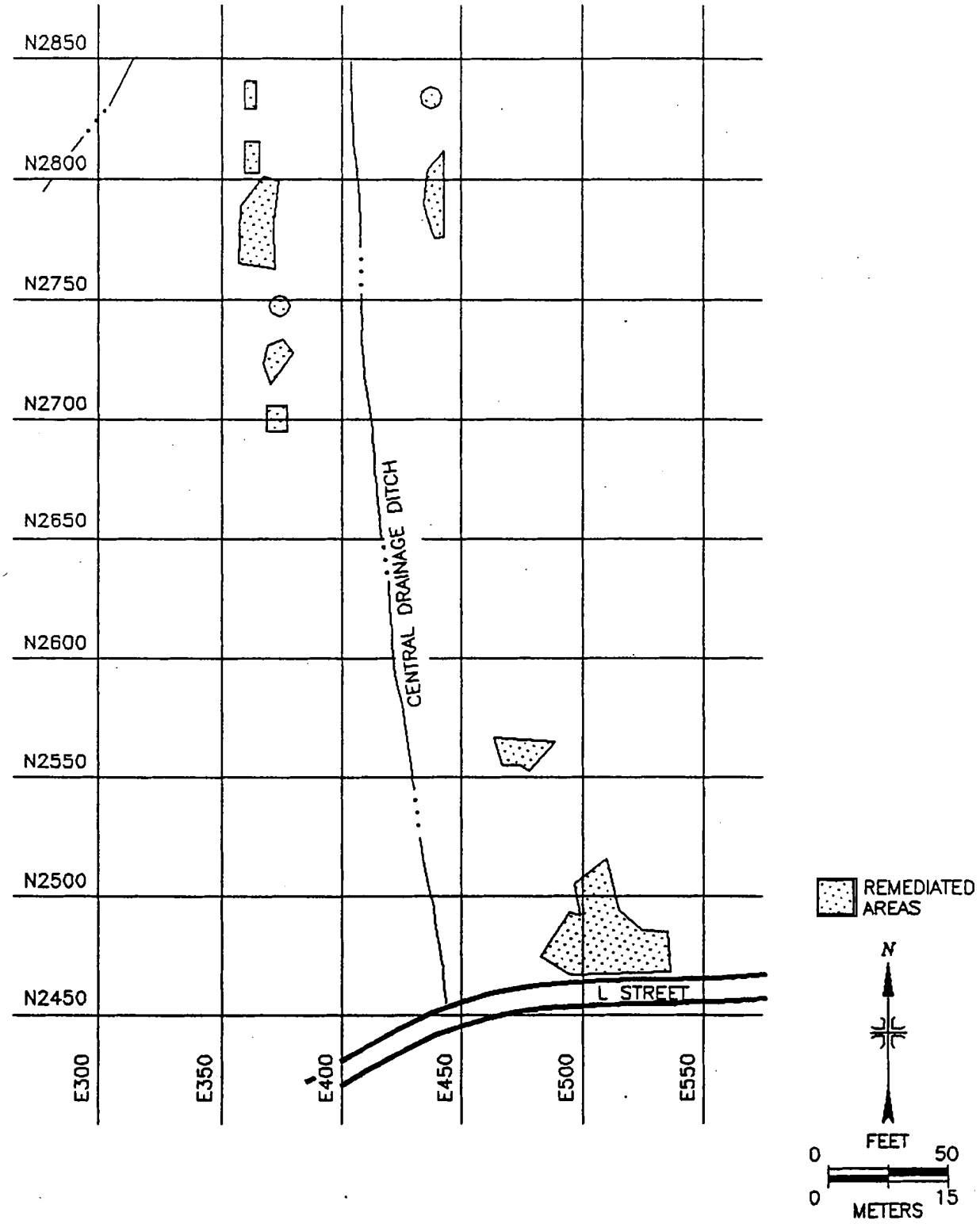


FIGURE 28: Plot Plan of Property T–Section 2 Indicating Remediated Areas

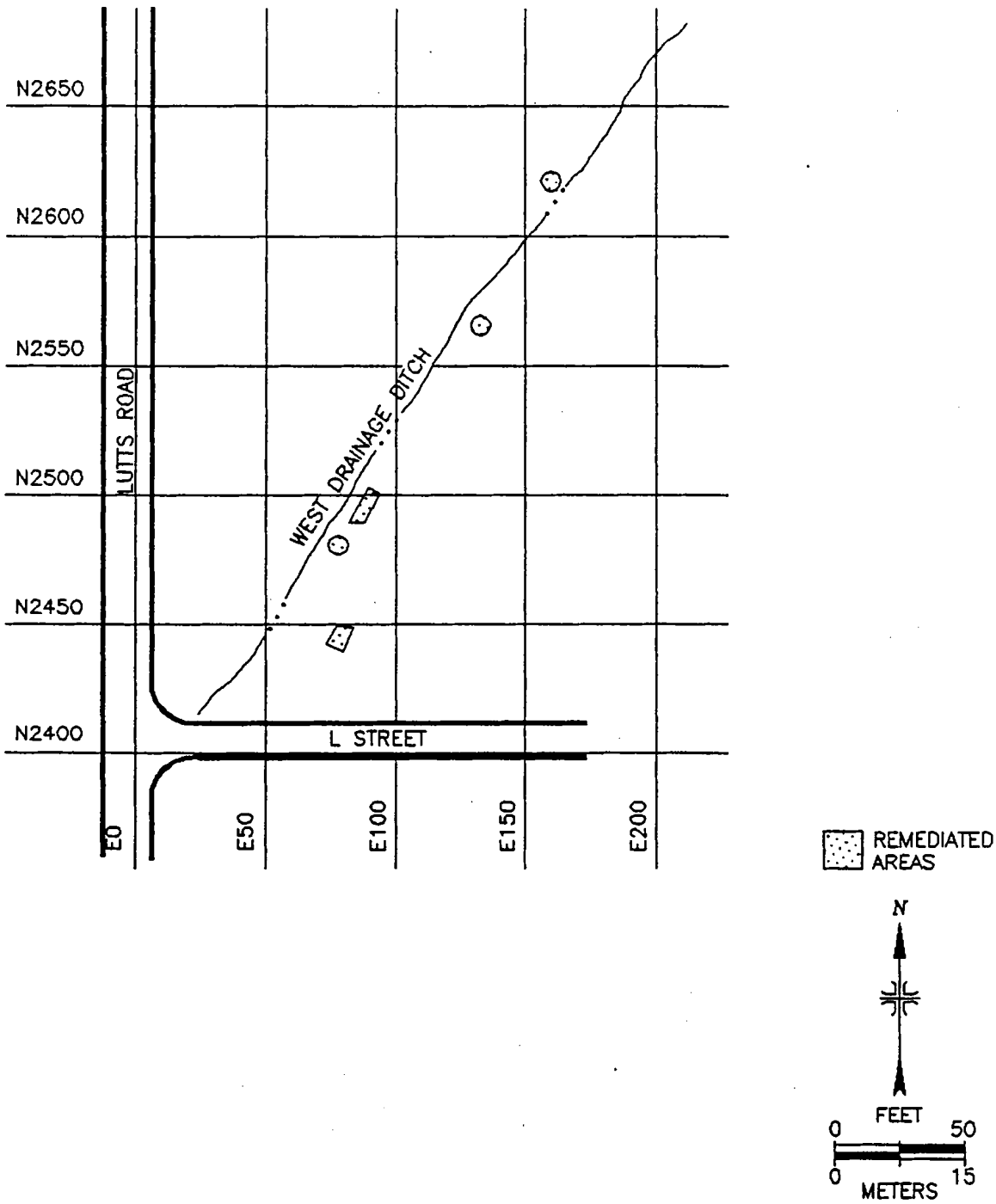


FIGURE 29: Plot Plan of Property T—Section 3 Indicating Remediated Areas

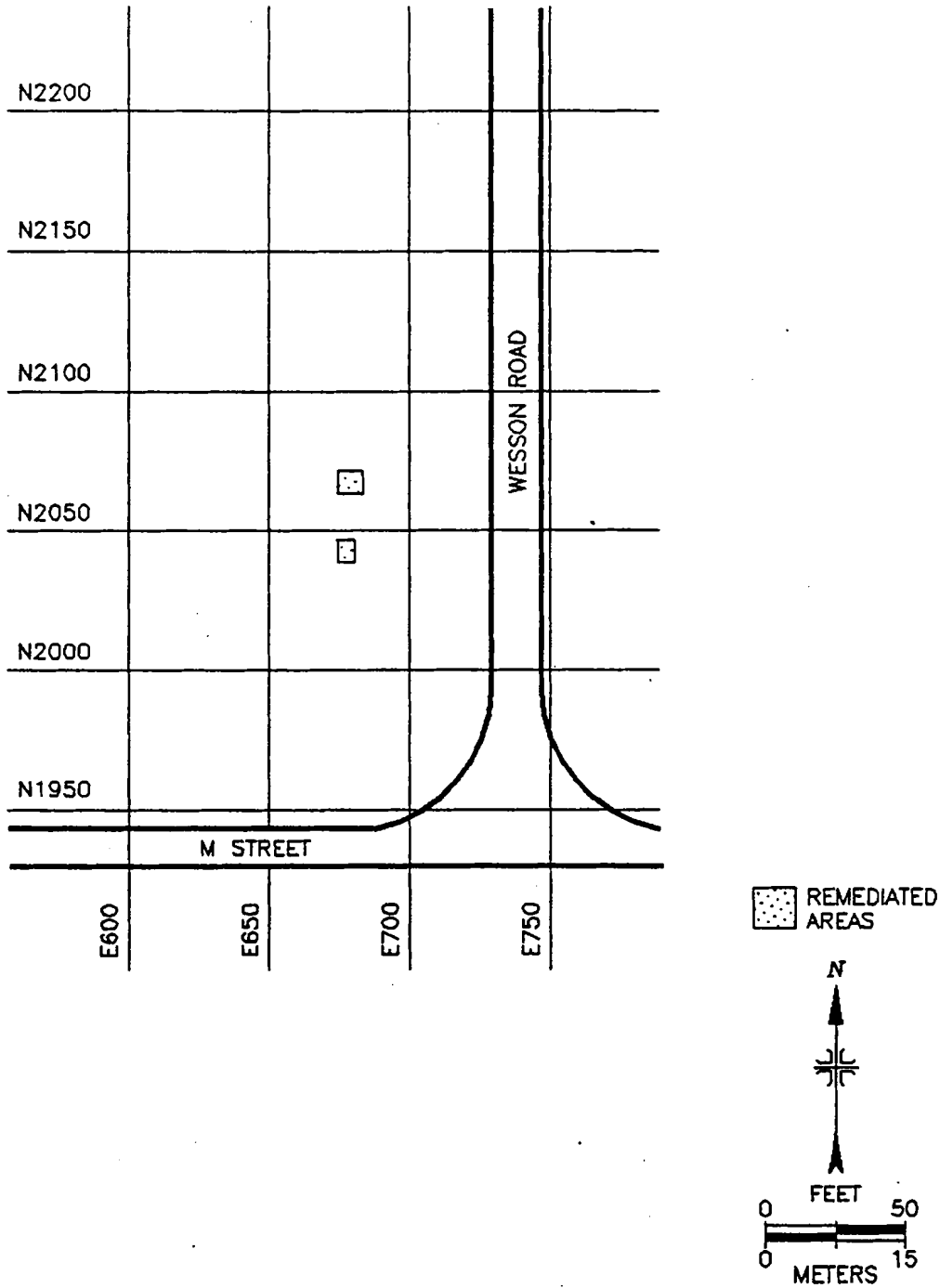
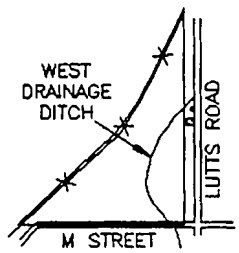


FIGURE 30: Plot Plan of Property T–Section 4 Indicating Remediated Areas



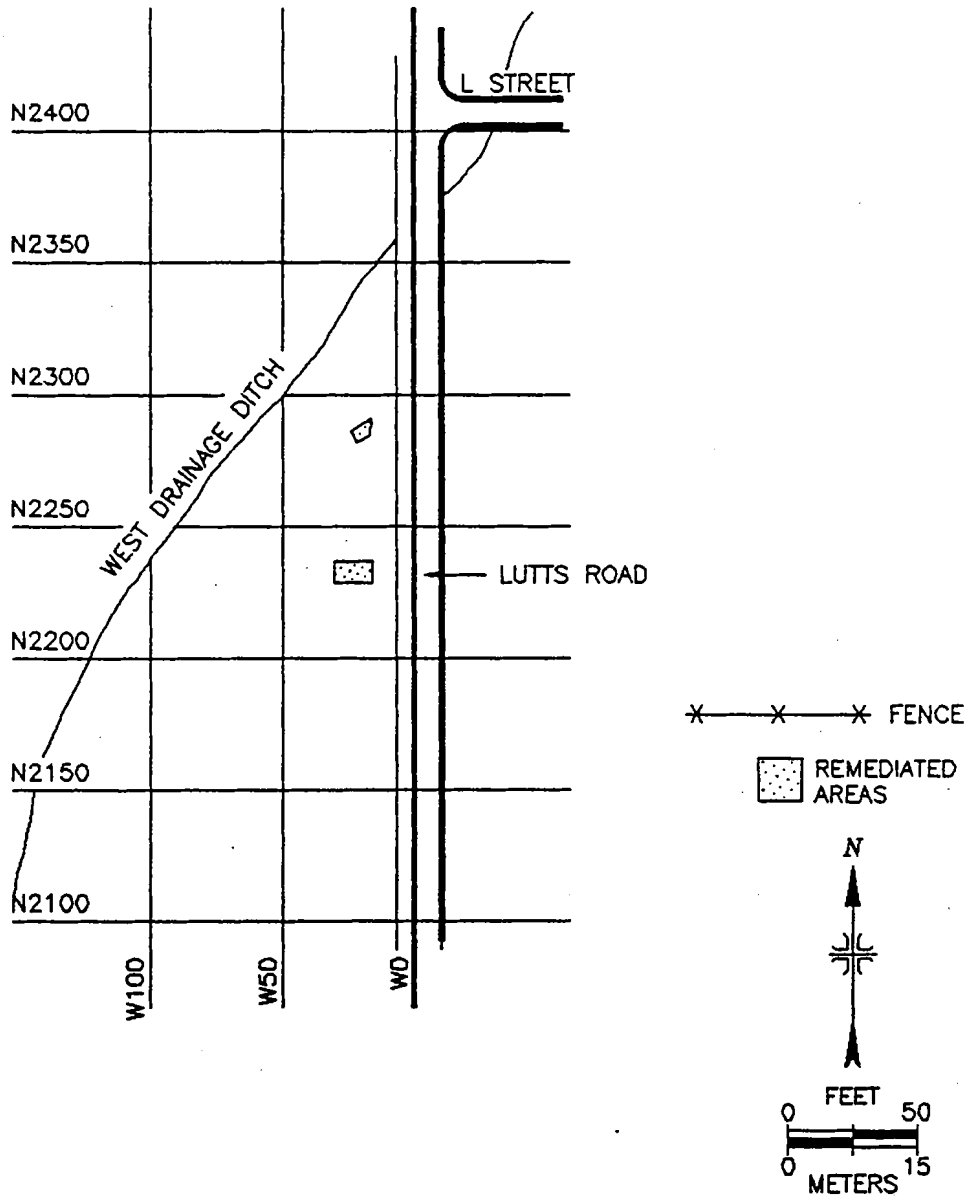


FIGURE 31: Plot Plan of Remediated Areas of Vicinity Property W

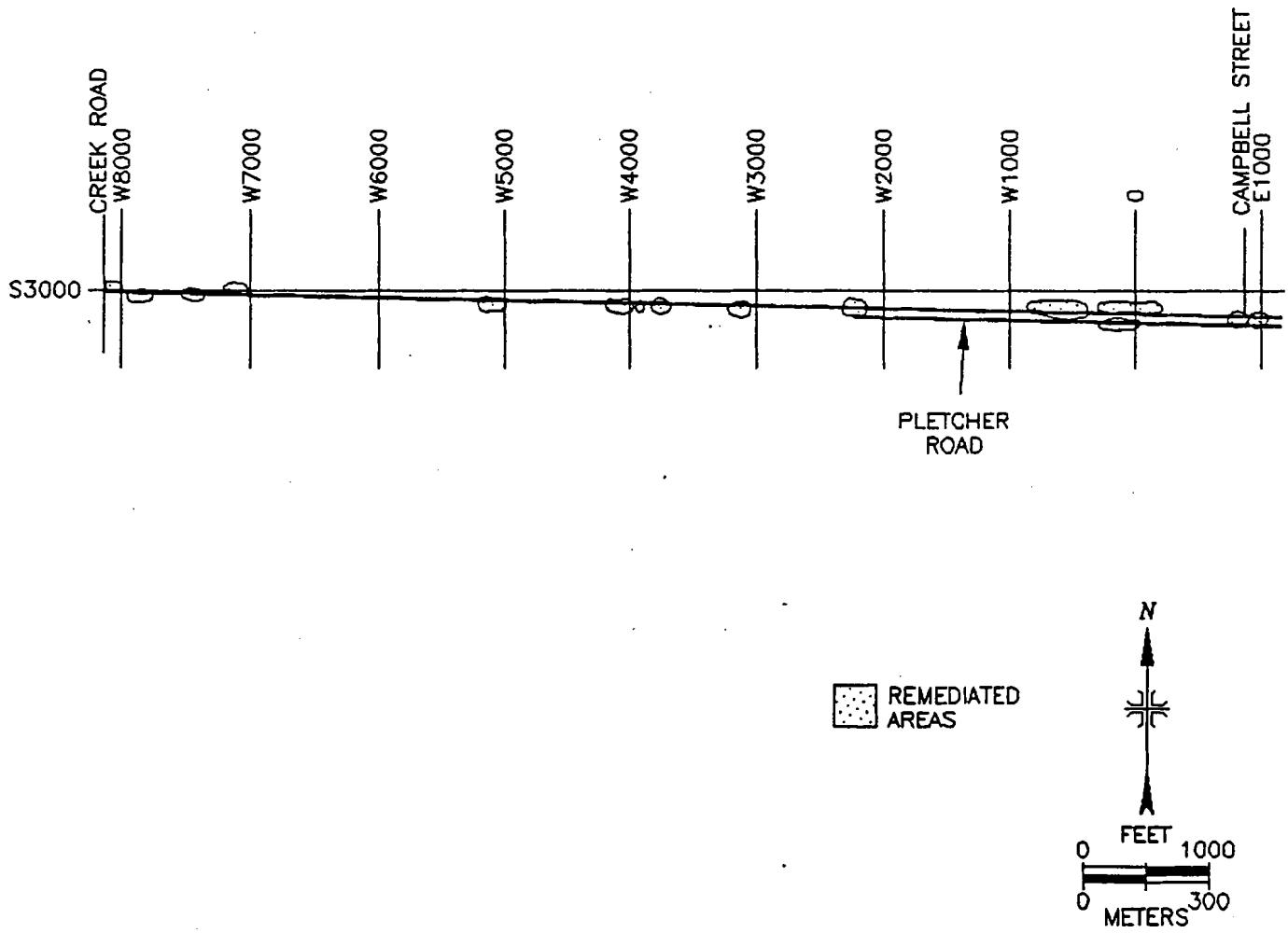


FIGURE 32: Drawing of Pletcher Road, Indicating Remediated Areas

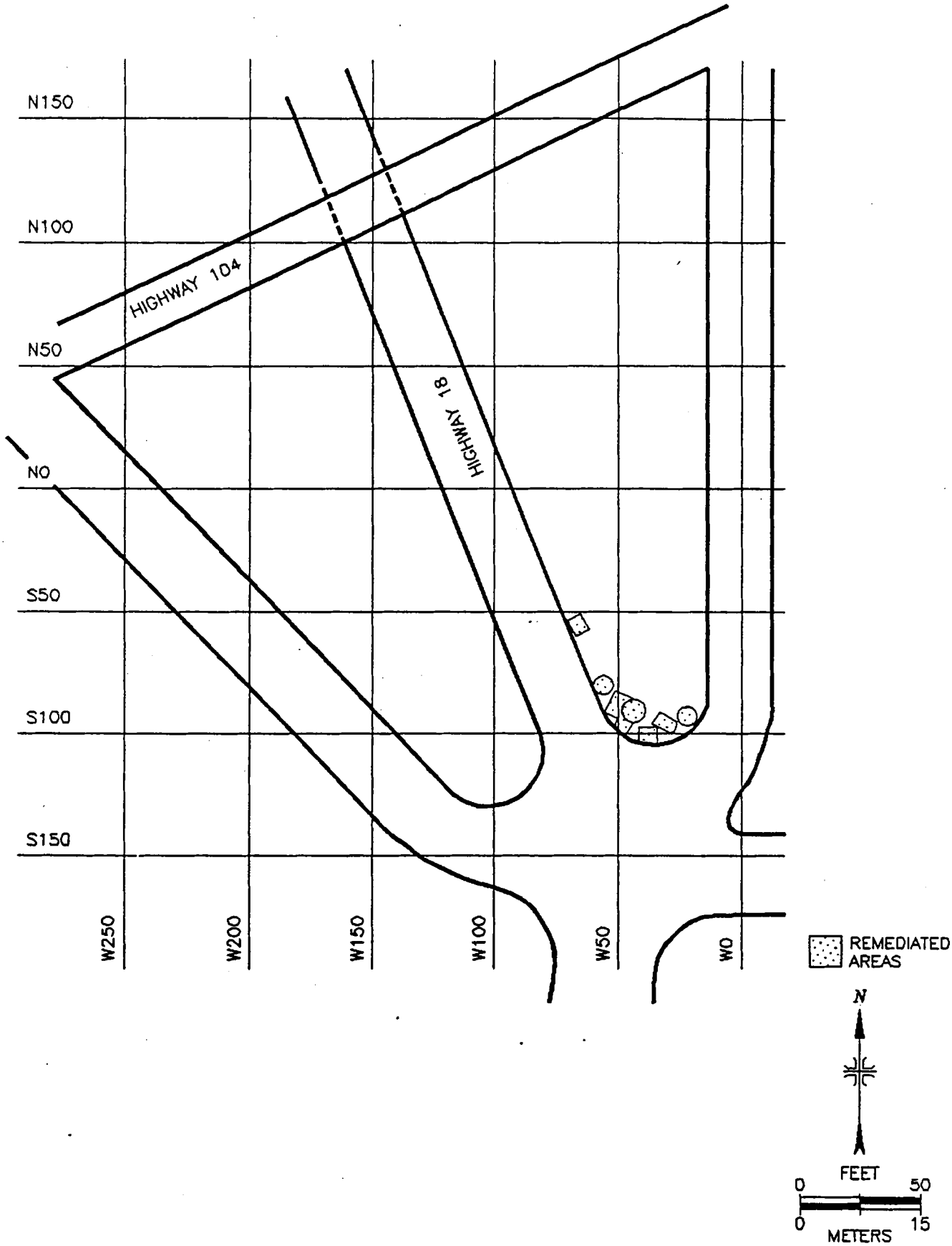


FIGURE 33: Plot Plan of Anomaly AA Indicating Remediated Areas and Survey Reference Grid

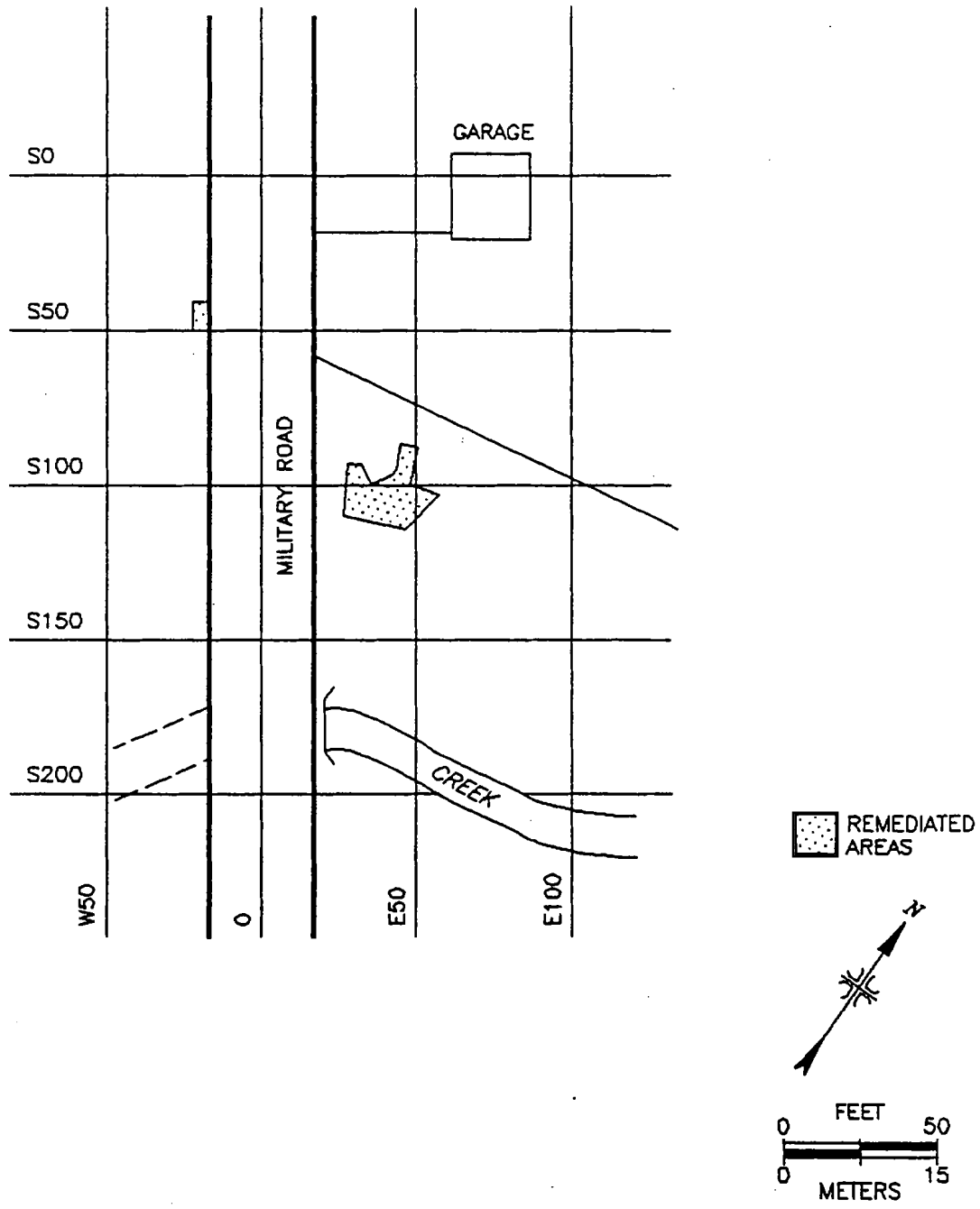


FIGURE 34: Plot Plan of Anomaly BB Indicating Remediated Areas and Survey Reference Grid

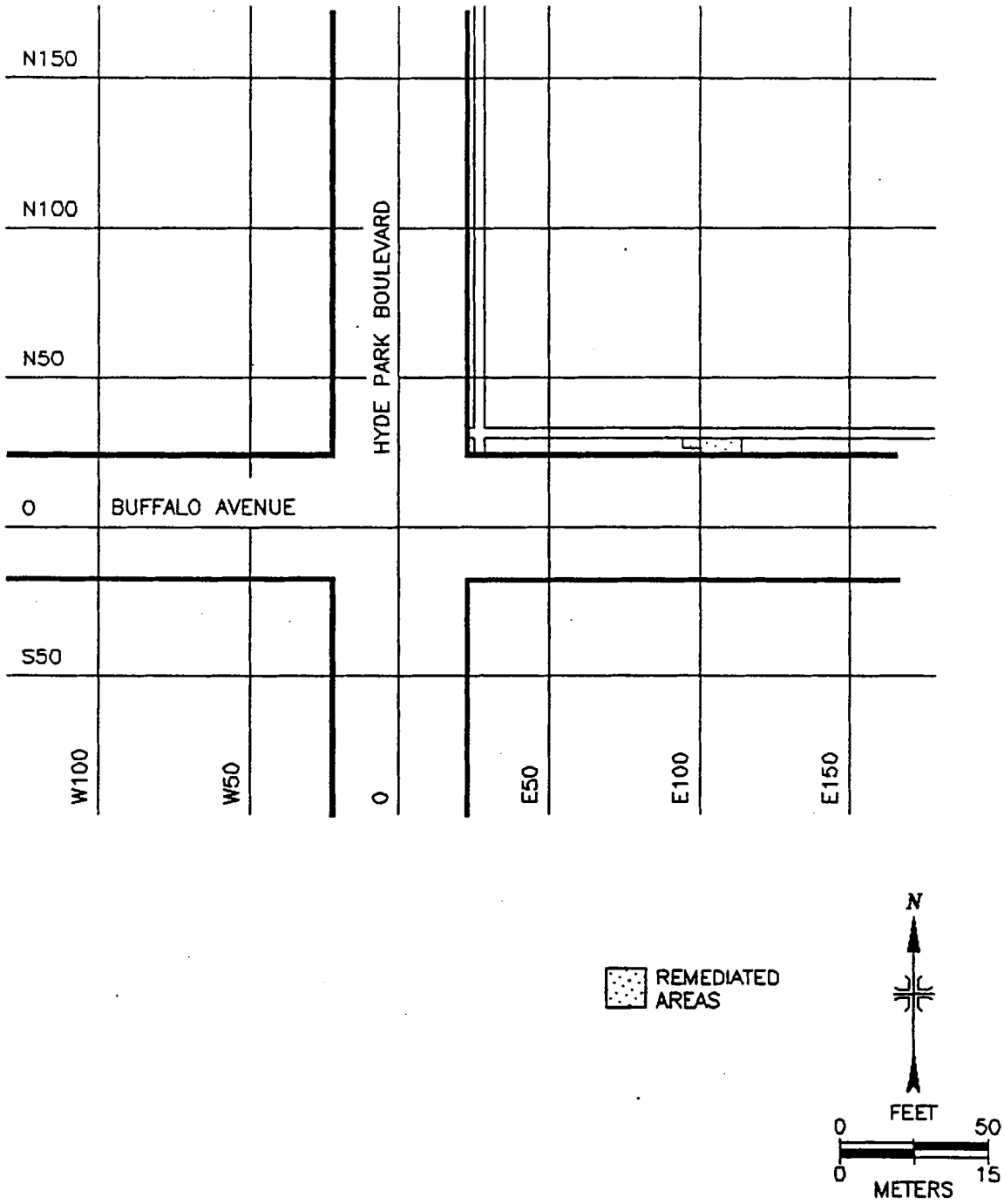


FIGURE 35: Plot Plan of Anomaly CC Indicating Remediated Area and Survey Reference Grid

TABLE 1

RESULTS OF CONFIRMATORY ANALYSES ON SOIL SAMPLES
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

erty	Sample ID[a]	Grid Location	Analysis By	Radionuclide Concentration(pCi/g)[b] Ra-226	U-238	Th-232
	102	N2020, E1130	BNI	0.6 ± 0.2[c]	<MDA[d]	0.4 ± 0.4
			ORAU	1.4 ± 0.4	1.7 ± 1.3	1.2 ± 0.5
	105	N2020, 1200	BNI	1.1 ± 0.2	2.5 ± 2.2	1.6 ± 0.4
			ORAU	0.9 ± 0.3	2.1 ± 1.5	1.3 ± 0.6
	117	N2030, E1230	BNI	1.0 ± 0.2	<MDA	0.9 ± 0.4
			ORAU	0.9 ± 0.2	1.7 ± 1.4	1.1 ± 0.4
	146	N2070, E1050	BNI	1.1 ± 0.2	1.3 ± 1.8	1.0 ± 0.4
			ORAU	1.3 ± 0.2	1.8 ± 1.4	1.2 ± 0.5
	346	N2070, E1110	BNI	1.2 ± 0.4	<MDA	1.6 ± 0.4
			ORAU	2.1 ± 0.4	1.7 ± 2.8	1.1 ± 0.7
	325	N2130, E1010	BNI	0.7 ± 0.2	<MDA	0.6 ± 0.2
			ORAU	0.9 ± 0.3	1.9 ± 0.8	1.1 ± 0.3
	28	N2130, E1230	BNI	1.0 ± 0.2	3.2 ± 3.6	1.0 ± 0.4
			ORAU	0.9 ± 0.2	1.9 ± 0.8	1.1 ± 0.3
	5	S2680, E 880	BNI	6.4 ± 0.4	4.8 ± 4.8	1.4 ± 0.4
			ORAU	6.2 ± 0.4	3.4 ± 1.8	1.2 ± 0.9
	10	S2780, E 880	BNI	0.8 ± 0.2	<MDA	0.8 ± 0.2
			ORAU	0.9 ± 0.2	1.0 ± 1.2	0.5 ± 0.3
	4	S2260, E 920	BNI	10.6 ± 0.6	<MDA	<MDA
			ORAU	24.1 ± 1.1	8.7 ± 3.9	0.6 ± 0.5
	29	S2440, E 925	BNI	1.4 ± 0.2	<MDA	1.2 ± 0.4
			ORAU	1.7 ± 0.3	1.0 ± 1.5	0.9 ± 0.5
South	14	S2210, E3870	BNI	0.9 ± 0.2	<MDA	1.3 ± 0.4
			ORAU	0.9 ± 0.2	1.6 ± 2.5	0.9 ± 0.3
	2	S2240, E2160	BNI	1.2 ± 0.4	<MDA	1.0 ± 0.4
			ORAU	1.3 ± 0.2	0.9 ± 1.4	0.9 ± 0.4
	31	S2250, E3790	BNI	1.0 ± 0.2	<MDA	1.3 ± 0.4
			ORAU	0.9 ± 0.3	1.3 ± 1.7	1.0 ± 0.4

TABLE 1 (continued)

RESULTS OF CONFIRMATORY ANALYSES ON SOIL SAMPLES
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

erty	Sample ID[a]	Grid Location	Analysis By	Radionuclide Concentration(pCi/g)[b] Ra-226	U-238	Th-232
	63	S2320, E3660	BNI	0.6 ± 0.2	<MDA	0.7 ± 0.2
			ORAU	0.6 ± 0.2	1.1 ± 0.6	0.7 ± 0.4
	69	S2330, E3690	BNI	0.6 ± 0.2	<MDA	0.7 ± 0.2
			ORAU	0.6 ± 0.2	1.1 ± 0.6	0.7 ± 0.4
	2	S3140, W 607	BNI	4.0 ± 0.4	<MDA	1.1 ± 0.6
			ORAU	3.8 ± 0.5	<0.8	0.5 ± 0.3
	6	S3140, W 527	BNI	1.3 ± 0.2	<MDA	<MDA
			ORAU	1.2 ± 0.3	<0.7	1.6 ± 0.5
	3	N1305, E 885	BNI	2.8 ± 0.6	<MDA	0.9 ± 0.4
			ORAU	2.1 ± 0.3	1.5 ± 0.9	1.0 ± 0.4
	2	N3709, E1138	BNI	0.8 ± 0.2	<MDA	1.1 ± 0.4
			ORAU	0.9 ± 0.3	6.9 ± 1.3	1.0 ± 0.5
	312	N 640, W 410	BNI	1.2 ± 0.2	1.3 ± 3.6	0.8 ± 0.4
			ORAU	1.0 ± 0.3	4.3 ± 2.0	1.4 ± 0.4
	4	N 690, W 420	BNI	1.0 ± 0.2	<MDA	0.7 ± 0.2
			ORAU	0.9 ± 0.3	2.9 ± 1.4	0.7 ± 0.3
	9	N 710, W 400	BNI	1.1 ± 0.2	<MDA	1.3 ± 0.4
			ORAU	0.8 ± 0.2	2.1 ± 2.2	1.3 ± 0.3
)itch	67	N 820, W 170.5	BNI	0.9 ± 0.2	<MDA	1.2 ± 0.6
			ORAU	1.0 ± 0.2	0.3 ± 1.1	0.9 ± 0.4
	125	N1560, W 170	BNI	1.3 ± 0.4	<MDA	1.2 ± 0.6
			ORAU	1.5 ± 0.3	1.5 ± 1.3	1.0 ± 0.3
	128	N1600, W 160	BNI	<MDA	<MDA	0.9 ± 1.2
			ORAU	78.7 ± 1.8	9.3 ± 12.5	0.9 ± 1.1
	200	N2220, W 110	BNI	1.3 ± 0.4	<MDA	0.6 ± 0.4
			ORAU	1.4 ± 0.3	1.3 ± 1.1	1.1 ± 0.4
	252	W2500, E 090	BNI	1.0 ± 0.2	<MDA	0.8 ± 0.4
			ORAU	1.0 ± 0.3	2.2 ± 1.4	1.2 ± 0.4

TABLE 1 (continued)

RESULTS OF CONFIRMATORY ANALYSES ON SOIL SAMPLES
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

›perty	Sample ID[a]	Grid Location	Analysis By	Radionuclide Concentration(pCi/g)[b] Ra-226	U-238	Th-232
ɜntral Ditch	142	N 660, E 480	BNI	1.3 ± 0.6	<15	1.2 ± 0.6
			ORAU	1.4 ± 0.3	<0.9	0.4 ± 0.2
	248	N1020, E 490	BNI	1.1 ± 0.2	0.8 ± 0.4	0.6 ± 0.2
			ORAU	1.1 ± 0.2	2.2 ± 0.8	0.8 ± 0.3
	469	N2160, E 461	BNI	1.0 ± 0.2	<MDA	1.0 ± 0.4
			ORAU	1.0 ± 0.2	0.7 ± 0.9	1.0 ± 0.3
	33	N5330, E 415	BNI	1.0 ± 0.2	<MDA	0.6 ± 0.2
			ORAU	0.9 ± 0.2	< 0.5	0.8 ± 0.4
	1302	N7590, E 410	BNI	0.9 ± 0.2	<MDA	1.0 ± 0.4
			ORAU	0.8 ± 0.2	2.1 ± 1.2	1.1 ± 0.3
	1761	N10190, W 650	BNI	0.8 ± 0.2	<MDA	0.9 ± 0.4
			ORAU	3.8 ± 0.5	1.8 ± 1.9	1.7 ± 0.8

ɯple Identification as presented in the BNI post-remedial action report.[14]
›orted data includes background contributions from naturally occurring materials in soil.
ɔertainties represent the 95% confidence levels, based only on counting statistics:
ɜtematic ORAU laboratory uncertainties, estimated at ± 6 to 10%, are not included in the
›orted values for the ORAU analyses.
›orted as less than the minimum detectable activity (no values given).

TABLE 2

BACKGROUND EXPOSURE RATES
AND
BASELINE RADIONUCLIDE CONCENTRATIONS IN SOIL
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a]	Exposure Rate[b] (μR/h)	Radionuclide Concentrations (pCi/g)			
		Ra-226	U-238	Th-232	Cs-137
1	7	0.7 ± 0.7[c]	<2.9	0.7 ± 0.5	0.3 ± 0.1
2	7	0.8 ± 0.2	<3.4	0.8 ± 0.2	0.2 ± 0.1
3	8	0.7 ± 0.2	<4.1	1.2 ± 0.4	0.1 ± 0.1
4	8	0.5 ± 0.2	<2.3	0.5 ± 0.4	0.2 ± 0.1
5	8	0.6 ± 0.1	<2.7	0.8 ± 0.2	0.4 ± 0.1
6	8	0.6 ± 0.1	<2.2	0.5 ± 0.2	<0.1
7	7	0.6 ± 0.2	<4.2	0.8 ± 0.4	0.7 ± 0.1
8	7	0.7 ± 0.2	<3.0	0.6 ± 0.3	0.7 ± 0.1
9	7	<0.1	<2.8	0.5 ± 0.3	0.5 ± 0.1
10	7	0.5 ± 0.1	<2.8	0.7 ± 0.3	0.7 ± 0.1
11	7	0.7 ± 0.2	<3.2	0.7 ± 0.3	0.7 ± 0.1
12	8	0.7 ± 0.1	<3.2	0.7 ± 0.4	0.2 ± 0.1
13	7	0.9 ± 0.2	<3.6	0.8 ± 0.3	0.6 ± 0.1
14	7	0.5 ± 0.1	<2.7	0.3 ± 0.2	0.4 ± 0.1
15	9	1.2 ± 0.2	<3.8	1.1 ± 0.5	1.1 ± 0.1
16	9	0.8 ± 0.2	<3.0	0.8 ± 0.3	0.1 ± 0.1
Range	7 to 9	<0.1 to 1.2	<2.3 to <4.2	0.3 to 1.2	<0.1 to 1.1

[a] Refer to Figure 5.
[b] Measured at 1 m above the surface.
[c] Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated in these data.

TABLE 3

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY B
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
3052	5627	0.3 ± 0.1[b]	0.6 ± 0.5	0.2 ± 0.2
3237	5533	0.6 ± 0.2	<2.1	<0.1
3237	5666	0.5 ± 0.2	0.6 ± 0.3	<0.1
3328	5663	0.6 ± 0.1	<0.4	<0.1
3337	5655	0.8 ± 0.2	1.1 ± 0.6	1.3 ± 0.5
3343	5542	0.4 ± 0.2	<0.4	<0.1

[a]Refer to Figure 6.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 1

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY C
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	E	Depth (cm)	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232	Remarks
57	4727	Surface	2.1 ± 0.4[b]	<0.1	1.1 ± 0.5	
60	4932	Surface	102 ± 3	<30	<0.1	
			11.9 ± 1.5	<2.5	1.5 ± 1.7	After additional remediation
63	4857	Surface	2.1 ± 0.3	8.3 ± 1.4	0.8 ± 0.3	
75	4752	Surface	4.9 ± 0.4	8.3 ± 1.2	1.1 ± 0.5	
77	4920	Surface	105 ± 3	7.0 ± 7.1	1.1 ± 2.7	
		20-30	12.6 ± 0.7	7.9 ± 2.8	0.8 ± 0.4	After additional remediation
		40-60	18.4 ± 0.9	14.3 ± 1.7	1.8 ± 0.8	After additional remediation
79	4773	Surface	2.7 ± 0.5	3.9 ± 2.1	1.7 ± 0.6	
		Surface	0.9 ± 0.3	2.4 ± 1.4	1.4 ± 0.4	
82	4798	Surface	573 ± 7	<10	2.7 ± 3.6	Sampling removed source
		Surface	4.6 ± 0.5	11.6 ± 1.8	0.8 ± 0.7	
82	4816	Surface	5.7 ± 0.5	45.2 ± 3.9	1.7 ± 0.7	
83	4832	Surface	2.7 ± 0.4	28.4 ± 3.3	1.4 ± 0.4	
84	4805	Surface	3.3 ± 0.4	123 ± 4	1.2 ± 0.7	
		15-30	3.9 ± 0.6	28.1 ± 5.5	1.3 ± 0.5	After additional remediation
		30-45	1.4 ± 0.3	15.0 ± 2.5	1.2 ± 0.5	After additional remediation
		45-60	1.5 ± 0.3	2.0 ± 1.0	1.0 ± 0.4	After additional remediation

TABLE 4 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY C'
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E	Depth (cm)	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232	Remarks
84	4816	Surface	3.5 ± 0.6	32.3 ± 6.1	1.6 ± 0.9	
		15-30	1.2 ± 0.3	14.9 ± 3.9	1.3 ± 0.7	
		30-45	0.8 ± 0.3	6.9 ± 2.2	1.3 ± 0.4	
85	4742	Surface	52.5 ± 2.1	66 ± 10	2.2 ± 1.4	
		Surface	59.3 ± 1.6	<2.8	1.0 ± 1.3	
		15-30	2.1 ± 0.3	1.4 ± 1.2	1.2 ± 0.4	After additional remediation
		30-40	4.6 ± 0.4	3.5 ± 1.3	0.8 ± 0.4	After additional remediation
85	4870	Surface	1.3 ± 0.3	4.7 ± 0.8	1.2 ± 0.4	
90	4862	Surface	1.0 ± 0.3	3.0 ± 2.0	1.6 ± 0.6	
		7-15	476 ± 5	<4.9	2.7 ± 3.0	
		Surface	1.8 ± 0.4	9.9 ± 2.9	0.9 ± 0.4	Sampling removed source
		Surface	1.1 ± 0.3	4.6 ± 1.2	1.1 ± 0.4	Sampling removed source
		Surface	2.6 ± 1.3	5.8 ± 1.2	1.4 ± 0.5	Sampling removed source
95	4920	Surface	2.3 ± 0.5	5.3 ± 3.2	1.4 ± 0.5	
100	4740	Surface	12.2 ± 1.1	<12.4	1.9 ± 0.8	
107	4905	Surface	6.0 ± 0.6	8.4 ± 2.5	1.5 ± 0.6	
		Surface	3.6 ± 0.4	5.9 ± 1.2	1.4 ± 0.6	
110	4744	Surface	143 ± 2	<25.3	1.6 ± 1.6	Sampling removed source
115	4861	Surface	1.7 ± 0.5	19.9 ± 3.1	1.1 ± 0.6	
120	4728	Surface	1416 ± 13	<120	<4.1	
		Surface	5.5 ± 0.6	9.6 ± 1.4	0.9 ± 0.8	After removal of hot spot

TABLE 4 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY C'
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	E	Depth (cm)	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232	Remarks
132	4800	Surface	2.5 ± 0.4	8.7 ± 2.3	1.6 ± 0.6	
138	4736	Surface	1.0 ± 0.4	6.8 ± 2.6	1.2 ± 0.5	
140	4798	Surface	557 ± 6	<9.8	<2.1	Sampling removed source
		30-45	6.6 ± 0.6	1.8 ± 2.0	0.9 ± 0.6	
		45-60	3.3 ± 0.4	2.0 ± 1.2	1.5 ± 0.8	
142	4816	Surface	2.5 ± 0.6	3.8 ± 2.7	0.9 ± 0.6	
150	4723	Surface	6.6 ± 0.9	1833 ± 19	0.7 ± 1.0	
		Surface	7.7 ± 1.0	211 ± 12	0.7 ± 0.5	After removal of hop spot
168	4765	Surface	2.7 ± 0.5	9.5 ± 2.5	1.7 ± 0.6	
177	4742	Surface	868 ± 10	<11	<3.0	
		Surface	4.5 ± 0.5	19.2 ± 2.5	1.3 ± 0.5	After removal of hop spot
183	4732	Surface	4.0 ± 0.5	17.1 ± 2.1	1.2 ± 0.5	

[a]Refer to Figure 7.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY D
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
3080	1847	0.9 ± 0.2[b]	0.8 ± 1.3	0.9 ± 0.4
3146	1716	0.9 ± 0.3	<0.8	0.6 ± 0.4
3550	1460	1.1 ± 0.3	<0.8	0.8 ± 0.4
3562	1462	0.8 ± 0.2	1.2 ± 1.0	0.8 ± 0.5
3562	1468	1.3 ± 0.2	0.6 ± 0.8	0.8 ± 0.5
3572	1460	1.0 ± 0.2	0.9 ± 1.2	0.6 ± 0.3

[a]Refer to Figure 8.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 6

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY E'
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
SECTION 1				
1974	1437	22.5 ± 3.7[b]	<5.9	2.1 ± 0.2
1974	1437 (after further remediation)	2.0 ± 0.3	1.5 ± 0.9	0.6 ± 0.6
1992	1403	2.2 ± 0.5	1.6 ± 2.5	0.7 ± 0.5
1993	1444	16.2 ± 0.8	6.1 ± 2.8	1.3 ± 0.8
2000	1442	6.0 ± 0.5	3.4 ± 2.5	0.9 ± 0.3
2012	1393	3.2 ± 0.4	4.8 ± 3.8	1.1 ± 0.4
2073	1344	25.7 ± 1.1	2.8 ± 3.0	0.8 ± 0.8
2073	1344 (after further remediation)	13.6 ± 0.6	5.0 ± 0.6	1.2 ± 0.5
2100	1340	1.8 ± 0.3	3.4 ± 0.8	0.8 ± 0.5
SECTION 2				
2035	1943	6.3 ± 0.7	<1.4	0.8 ± 0.4
2134	2072	2.5 ± 0.4	<0.8	0.9 ± 0.5
2259	2072	20.6 ± 0.8	<10.5	1.2 ± 0.6
2279	2085	1.3 ± 0.3	2.6 ± 2.1	1.1 ± 0.4
SECTION 3				
2034	2169	115 ± 2	6.6 ± 2.5	1.9 ± 1.3
2039	2168	156 ± 3	35.0 ± 9.3	<1.0
2039	2170	258 ± 3	<33	<1.1
2093	2185	8.0 ± 0.7	18.3 ± 2.8	0.8 ± 0.6
2093	2223	13.8 ± 0.7	2.0 ± 1.4	0.9 ± 0.4
2107	2174	2.2 ± 0.4	1.3 ± 1.7	0.5 ± 0.4
SECTION 4				
2024	3463	1.0 ± 0.3	<0.8	1.0 ± 0.3
2029	3456	1110 ± 10	<7.9	<2.4
2029	3456 (after further remediation)	0.7 ± 0.2	<3.9	0.9 ± 0.3

TABLE 6 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY E'
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
2034	3467	1.2 ± 0.2	<0.6	1.0 ± 0.4
2044	3445	0.8 ± 0.3	1.1 ± 1.1	0.8 ± 0.5
2056	3505	2.0 ± 0.3	1.4 ± 1.6	0.7 ± 0.6
2067	3167	0.6 ± 0.2	0.7 ± 1.1	0.7 ± 0.3
2082	3424	1.2 ± 0.2	1.3 ± 1.3	1.3 ± 0.6

[a]Refer to Figures 9-13.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 7

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY F
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
1819	1913	1.1 ± 0.2[b]	2.4 ± 1.9	1.0 ± 0.4
1820	1912	1.3 ± 0.3	1.7 ± 0.8	1.0 ± 0.3
1820	1914	1.7 ± 0.3	1.0 ± 1.1	0.4 ± 0.5
1821	1913	1.6 ± 0.3	2.0 ± 0.6	1.3 ± 0.4

[a]Refer to Figure 14.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 8

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY G
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
946	1023[c]	138 ± 3[b]	<3.1	<0.9
947	1071	1.0 ± 0.2	3.3 ± 0.9	0.9 ± 0.5
948	1026	2.7 ± 0.3	1.2 ± 1.9	0.8 ± 0.5
949	1024[c]	63.4 ± 1.9	<3.2	<0.7
949	1048	1.9 ± 0.3	1.2 ± 2.0	1.4 ± 0.5
950	1157	3.2 ± 0.5	2.0 ± 2.0	0.6 ± 0.5
962	1046	11.8 ± 0.7	<1.5	0.5 ± 0.6
962	1052[c]	30.1 ± 1.2	3.8 ± 1.3	0.7 ± 0.8
964	1198	1.7 ± 0.3	1.3 ± 1.3	1.0 ± 0.4
966	1026	1.1 ± 0.3	<0.7	1.0 ± 0.5
970	1113	6370 ± 34	<34.8	<10.9
970	1113 (after further remediation)	5.7 ± 0.8	3.8 ± 3.9	1.9 ± 0.8
970	1170	2.1 ± 0.5	2.6 ± 2.1	1.3 ± 0.4
970	1295	1.5 ± 0.3	1.1 ± 1.7	1.1 ± 0.6
971	1168	2.5 ± 0.3	<0.9	1.0 ± 0.5
971	1199	1.3 ± 0.2	1.2 ± 1.4	1.5 ± 0.4
972	1032[c]	23.7 ± 1.1	<1.8	0.9 ± 0.8
974	1078	2.2 ± 0.3	1.5 ± 1.6	0.6 ± 0.3
975	1192[c]	12.9 ± 0.7	5.0 ± 2.8	1.1 ± 0.8
977	1190	1.0 ± 0.2	0.8 ± 1.8	1.4 ± 0.4
978	1068	1.1 ± 0.3	1.0 ± 1.2	0.9 ± 0.4
981	1057	6.2 ± 0.6	<1.3	0.7 ± 0.6
983	1249	1.2 ± 0.3	<0.6	1.1 ± 0.3
985	1172	16.3 ± 0.9	<1.4	0.6 ± 0.6
988	1175	1.9 ± 0.3	2.7 ± 1.3	1.2 ± 0.5
992	1173 (after further remediation)	11.1 ± 0.7	1.8 ± 1.6	1.4 ± 0.6
992	1173	1.6 ± 0.4	<1.0	1.3 ± 0.6
1000	1170	2.5 ± 0.5	1.1 ± 1.4	0.8 ± 0.3
1000	1230	2.2 ± 0.3	7.1 ± 2.0	1.5 ± 0.5
1000	1240	1.3 ± 0.3	3.8 ± 0.8	1.1 ± 0.4
1000	1250	1.6 ± 0.3	1.6 ± 1.3	1.3 ± 0.4
1000	1260	1.5 ± 0.2	4.1 ± 1.0	1.1 ± 0.6
1000	1270	1.2 ± 0.3	4.2 ± 1.0	1.0 ± 0.4
1004	1172	2.3 ± 0.4	0.7 ± 1.8	0.8 ± 0.4
1010	1230	1.0 ± 0.2	3.5 ± 0.7	1.1 ± 0.4
1010	1240	1.8 ± 0.3	1.9 ± 1.7	1.2 ± 0.4
1010	1250	1.7 ± 0.3	7.1 ± 1.0	0.8 ± 0.4
1010	1260	2.0 ± 0.3	6.9 ± 2.1	0.8 ± 0.4

TABLE 8 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY G
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
1010	1270	1.1 ± 0.3	2.7 ± 0.8	1.0 ± 0.4
1015	1271[c]	531 ± 5	<52	<1.6
1018	938	2.0 ± 0.4	<1.2	0.6 ±0.3
1020	1230	1.3 ± 0.3	3.5 ± 1.0	1.1 ± 0.5
1020	1240	1.1 ± 0.2	1.8 ± 0.6	0.9 ± 0.4
1020	1250	1.2 ± 0.4	2.9 ± 1.8	0.9 ± 0.3
1020	1260	1.2 ± 0.3	3.7 ± 1.0	0.9 ± 0.3
1020	1270	1.4 ± 0.3	5.1 ± 1.1	1.0 ± 0.4
1028	1249	11.2 ± 1.0	4.0 ± 3.6	1.1 ± 0.8
1030	1230	1.2 ± 0.4	4.4 ± 0.9	1.2 ± 0.6
1030	1240	1.9 ± 0.4	0.9 ± 1.3	1.4 ± 0.3
1030	1250	1.0 ± 0.2	2.3 ± 0.5	0.9 ± 0.5
1030	1260	1.1 ± 0.3	3.9 ± 1.6	1.1 ± 0.3
1030	1270	1.5 ± 0.8	3.6 ± 1.2	1.1 ± 0.5
1032	1249	1.0 ± 0.3	2.5 ± 1.5	0.7 ± 0.5
1040	1230	1.2 ± 0.5	4.6 ± 1.4	1.0 ± 0.4
1040	1240	1.0 ± 0.3	1.7 ± 0.8	0.9 ± 0.6
1040	1250	0.8 ± 0.2	3.6 ± 1.3	0.8 ± 0.5
1040	1260	0.8 ± 0.3	4.4 ± 1.1	0.9 ± 0.3
1040	1270	1.9 ± 0.4	2.9 ± 2.0	0.9 ± 0.4
1051	1356	0.8 ± 0.2	1.0 ± 1.1	1.3 ± 0.3
1051	1358	2.2 ± 1.0	2.3 ± 1.9	0.7 ± 0.5
1055	1353[c]	806 ± 6	<6.4	<2.1
1062	1308	1.6 ± 0.3	<0.9	0.5 ± 0.3
1196	1161	1.3 ± 0.3	1.8 ± 1.7	1.4 ± 0.5
1304	1341	1.0 ± 0.3	1.7 ± 2.0	0.8 ± 0.5
1307	997	2.0 ± 0.4	1.2 ± 1.1	0.8 ± 0.6
1326	1440	35.1 ± 1.1	2.5 ± 3.5	<0.4
1350	950	0.6 ± 0.3	<0.6	1.4 ± 0.5
1357	1298	1.1 ± 0.2	3.8 ± 1.9	0.9 ± 0.3
1427	1395	1.2 ± 0.2	33.8 ± 2.6	0.8 ± 0.4
1583	1010	9.8 ± 0.6	2.2 ± 1.2	1.5 ± 0.5
1600	990	4.9 ± 0.5	1.9 ± 0.2	0.8 ± 0.5

[a]Refer to Figures 15-20.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.
[c]Further remediation performed; direct gamma monitoring verified effectiveness of cleanup in removing contamination.

TABLE 9

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY N/N' NORTH
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] S	Location[a] E		Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232	REMARKS
1515	4960		6.8 ± 0.5[b]	4.7 ± 0.9	0.9 ± 0.3	
1545	4907		1.2 ± 0.1	2.2 ± 1.6	1.4 ± 0.2	
1550	4900		3.0 ± 0.4	176 ± 12	0.9 ± 0.5	
1555	4920		40.5 ± 1.5	<2.0	1.1 ± 1.0	
1555	4920	(10-15 cm depth)	40.3 ± 1.4	4.8 ± 3.0	0.6 ± 0.6	
1555	4920	(15-25 cm depth)	29.0 ± 1.6	<14.1	6.0 ± 1.7	
1555	4920		1.2 ± 0.3	3.4 ± 7.1	0.7 ± 1.4	After additional remediation
1555	5028		1.3 ± 0.1	2.8 ± 0.3	1.2 ± 0.2	
1558	4913		448 ± 7	<9.2	<2.1	Sampling removed source
1570	5040		1.3 ± 0.2	2.4 ± 1.0	1.1 ± 0.2	
1602	4845		790 ± 8	<80	<2.7	
1602	4845	(15-30 cm depth)	2.8 ± 0.5	12.8 ± 1.4	1.2 ± 0.6	
1602	4845		0.8 ± 0.2	3.8 ± 1.5	0.7 ± 0.5	After additional remediation
1603	4865		30.9 ± 1.3	<14.1	0.9 ± 0.6	
1603	4865	(15-30 cm depth)	2.7 ± 0.4	2.6 ± 0.9	1.3 ± 0.6	
1603	4865		1.0 ± 0.2	1.9 ± 0.9	1.1 ± 0.4	After additional remediation
1612	4796		46.3 ± 2.0	61.9 ± 9.4	1.8 ± 1.4	
1612	4796		0.8 ± 0.2	1.1 ± 0.5	0.8 ± 0.4	After additional remediation
1620	4790		1.1 ± 0.4	5.8 ± 1.0	0.9 ± 0.2	
1623	4880		1.6 ± 0.3	0.5 ± 0.6	1.1 ± 0.2	
1630	4774		157 ± 3	<30	<1.0	
1630	4774		1.0 ± 0.3	1.7 ± 1.2	0.9 ± 0.5	After additional remediation
1630	4955		5.5 ± 0.3	1.5 ± 1.3	1.2 ± 0.3	
1655	4730		6.2 ± 0.3	5.4 ± 1.3	0.7 ± 0.2	

TABLE 9 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY N/N' NORTH
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] S	Location[a] E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232	REMARKS
1662	4815	1.5 ± 0.1	1.5 ± 0.4	1.1 ± 0.2	
1665	4720	1.2 ± 0.2	4.0 ± 0.7	1.3 ± 0.3	
1705	4732	1.4 ± 0.2	4.1 ± 1.0	1.0 ± 0.2	
1740	4665	3.2 ± 0.2	10.3 ± 0.9	0.9 ± 0.3	
1750	4776	31.2 ± 1.2	69.4 ± 3.3	1.5 ± 0.8	Sampling removed source
1785	4685	1.4 ± 0.2	1.6 ± 0.8	1.3 ± 0.2	
1807	4685	1.6 ± 0.1	2.0 ± 0.4	1.1 ± 0.2	
1891	4467	4.4 ± 0.2	3.9 ± 0.5	1.2 ± 0.2	
1970	4178	12560 ± 320	<3500	<110	Sampling removed source
1970	4178	1.9 ± 0.4	<0.8	0.4 ± 0.4	
1970	4214	3.3 ± 0.6	19.2 ± 2.8	1.1 ± 0.5	Also contained 103 pCi/g Cs-137.
1970	4214	1.7 ± 0.3	1.0 ± 0.8	0.8 ± 0.3	After additional remediation, Cs-137 reduced to 15.3 pCi/g.
1973	4224	1029 ± 8	<12.5	<2.9	
1973	4224	73.9 ± 2.1	22.7 ± 19.0	2.0 ± 1.2	
1973	4224	1.1 ± 0.3	3.3 ± 0.8	1.2 ± 0.3	After additional remediation
1973	4227	4.7 ± 0.3	16.7 ± 1.8	1.0 ± 0.3	
2049	4336	3.3 ± 0.2	1.2 ± 1.6	1.3 ± 0.3	
2081	4172	2.2 ± 0.2	2.6 ± 0.9	1.1 ± 0.2	

Refer to Figures 21-24.
Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 10

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLE
FROM PROPERTY P
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
3565	140	1.1 ± 0.4[b]	2.1 ± 1.1	1.1 ± 0.4

[a]Refer to Figure 25.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 11

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY T
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E		Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
ALONG WEST DITCH					
2457	83		1.0 ± 0.3[b]	1.1 ± 1.5	0.5 ± 0.3
2473	37		0.9 ± 0.2	0.7 ± 1.8	0.8 ± 0.5
2516	76		103 ± 2	<18.8	<0.6
2516	76	(15-30 cm depth)	10.4 ± 0.5	0.5 ± 2.3	1.0 ± 0.4
2519	73		1.0 ± 0.2	<0.7	1.1 ± 0.5
2558	89		1.1 ± 0.2	1.2 ± 0.7	0.6 ± 0.4
2558	148		1.0 ± 0.2	0.9 ± 1.2	1.1 ± 0.3
2646	154		0.9 ± 0.2	1.4 ± 1.2	1.2 ± 0.3
2706	197		1.3 ± 0.3	1.5 ± 1.3	0.8 ± 0.4
2706	161		1.1 ± 0.2	0.7 ± 1.1	0.9 ± 0.3
2788	227		1.1 ± 0.2	0.8 ± 1.7	1.3 ± 0.4
2814	273		21.2 ± 0.8	2.8 ± 1.9	0.7 ± 0.7
2814	273	(15-30 cm depth)	14.3 ± 0.7	<1.0	1.4 ± 0.6
2836	278		0.7 ± 0.2	1.6 ± 0.5	0.6 ± 0.3
2903	342		0.8 ± 0.2	1.3 ± 0.5	0.7 ± 0.3
2942	322		0.6 ± 0.2	<0.7	0.8 ± 0.5
2947	328		2.9 ± 0.4	<0.7	0.7 ± 0.7
2952	322		1.0 ± 0.2	0.9 ± 1.2	0.6 ± 0.5
ALONG CENTRAL DITCH					
2475	495		17.4 ± 0.9	13.8 ± 3.0	0.5 ± 0.6
2555	475		6.2 ± 0.5	<0.8	0.9 ± 0.4
2560	465		1.1 ± 0.2	0.8 ± 1.0	0.9 ± 0.5
2570	475		1.7 ± 0.2	0.6 ± 1.0	0.7 ± 0.3
2700	370		2.1 ± 0.3	1.9 ± 1.1	1.2 ± 0.4
2720	365		48.3 ± 1.3	10.6 ± 3.0	1.6 ± 0.9
2735	365		2.2 ± 0.3	2.3 ± 1.4	1.7 ± 0.5
2745	370		1.1 ± 0.2	1.7 ± 0.6	0.8 ± 0.3
2755	440		1.9 ± 0.3	1.1 ± 0.9	0.6 ± 0.3
2765	370		6.5 ± 0.5	1.3 ± 1.9	0.7 ± 0.5
2775	365		2.3 ± 0.3	1.4 ± 1.2	1.0 ± 0.4
2795	430		1.1 ± 0.2	1.0 ± 0.6	0.7 ± 0.4
2795	435		62.7 ± 1.7	<2.2	1.5 ± 1.0
2800	365		1.2 ± 0.2	<0.5	0.8 ± 0.4
2810	355		1.3 ± 0.2	1.2 ± 1.1	0.9 ± 0.5
2810	360		0.9 ± 0.2	0.8 ± 1.3	0.9 ± 0.4
2810	440		1.3 ± 0.3	0.9 ± 1.8	0.9 ± 0.3
2835	360		1.0 ± 0.2	0.6 ± 1.3	0.7 ± 0.4

TABLE 11 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY T
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] E	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
2835	365	5.0 ± 0.5	<5.7	1.6 ± 0.8
2870	425	1.8 ± 0.3	0.4 ± 1.3	1.1 ± 0.3
2875	435	1.9 ± 0.3	<0.6	0.6 ± 0.4
2880	350	0.9 ± 0.2	<0.6	0.9 ± 0.5
2890	360	8.5 ± 0.5	<0.8	0.9 ± 0.5
2905	355	17.3 ± 0.8	8.0 ± 2.4	1.0 ± 0.6
2905	380	1.8 ± 0.2	0.9 ± 1.2	1.2 ± 0.4
2905	395	18.2 ± 0.8	3.7 ± 3.5	1.2 ± 0.4
2910	430	43.6 ± 1.3	<1.6	2.2 ± 1.1
2910	440	1.8 ± 0.3	0.9 ± 0.5	0.7 ± 0.4
2915	390	1.4 ± 0.3	<0.5	0.6 ± 0.3
2915	435	4.9 ± 0.4	1.0 ± 1.6	1.0 ± 0.3
3020	350	1.5 ± 0.2	0.8 ± 0.7	0.9 ± 0.4
3020	355	5.9 ± 0.4	<0.8	1.1 ± 0.5
3110	350	3.0 ± 0.3	1.7 ± 1.3	0.9 ± 0.4
3110	365	2.0 ± 0.3	1.8 ± 0.6	1.0 ± 0.4
3245	360	7.5 ± 0.6	1.4 ± 1.6	1.0 ± 0.4
3250	355	11.5 ± 0.6	<0.8	0.8 ± 0.6
OTHER AREAS				
2034	399	1.8 ± 0.3	2.0 ± 2.0	0.5 ± 0.4
2041	399	0.8 ± 0.2	<0.6	1.0 ± 0.4
2058	399	1.7 ± 0.7	11.4 ± 8.8	0.9 ± 0.3

[a]Refer to Figures 26-30.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 12

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM PROPERTY W
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a] N	Location[a] W	Radionuclide Concentrations (pCi/g) Ra-226	U-238	Th-232
2188	121	3.4 ± 1.2[b]	1.8 ± 1.3	1.2 ± 0.4
2227	55	1.0 ± 0.3	0.6 ± 1.2	0.9 ± 0.3
2227	111	0.8 ± 0.3	<0.6	0.7 ± 0.3
2250	65	1.3 ± 0.3	1.5 ± 1.7	1.0 ± 0.4
2267	72	1.1 ± 0.3	<0.8	1.1 ± 0.4
2272	34	5.2 ± 0.5	<0.8	0.9 ± 0.6
2276	49	1.7 ± 0.3	0.5 ± 1.3	0.6 ± 0.5

[a]Refer to Figure 31.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 13

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM REMEDIATED AREAS ALONG PLETCHER ROAD
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a]	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-238	Th-232
S3207, E935	1.3 ± 0.3	1.9 ± 1.0	0.8 ± 0.7
S3220, E935	1.1 ± 0.3	0.6 ± 1.3	0.7 ± 0.5
S3197, E935	1.3 ± 0.3	<0.8	0.6 ± 0.4
S3208, E948	2.9 ± 0.4	<0.7	0.3 ± 0.2
S3210, E919	10.8 ± 0.6	2.8 ± 1.9	1.0 ± 0.4
S3149, W223	7.5 ± 2.5	0.7 ± 2.5	1.2 ± 0.4
S3151, W60	1.3 ± 0.3	<0.9	0.4 ± 0.3
S3145, E39	1.2 ± 0.3	1.3 ± 1.1	1.0 ± 0.7
S3153, E90	1.3 ± 0.3	1.9 ± 1.6	1.4 ± 0.5
S3155, E189	4.7 ± 0.4	<0.7	1.1 ± 0.4
S3125, W2216	2.1 ± 0.3	<0.8	0.5 ± 0.4
S3170, W2250	0.6 ± 0.7	2.2 ± 1.9	0.9 ± 1.3
S3180, W2260	29.9 ± 1.3	<2.4	0.6 ± 1.2
S3117, W3885	1.3 ± 0.2	0.6 ± 1.6	0.8 ± 0.4
S3118, W3875	13.4 ± 0.9	<1.7	0.6 ± 0.9
S3100, W4122	12.1 ± 0.7	1.6 ± 1.9	1.1 ± 0.4
S3112, W4055	2.1 ± 0.4	<4.4	0.8 ± 0.4
S3114, W4055	3.3 ± 0.4	<0.6	0.6 ± 0.4
S3115, W3985	32.8 ± 1.3	<2.3	1.1 ± 0.9
S3098, W5202	6.6 ± 0.6	<1.0	1.2 ± 0.6
S3098, W5164	1.3 ± 0.3	<0.8	0.7 ± 0.4
S3100, W5155	5.2 ± 0.5	1.1 ± 1.8	0.5 ± 0.5
S3098, W5125	1.6 ± 0.3	<0.9	1.1 ± 0.8
S3098, W5120	15.7 ± 0.8	<1.1	0.6 ± 1.3
S3050, W7184	1.0 ± 0.2	1.0 ± 1.4	1.4 ± 0.5
S3053, W7164	5.5 ± 0.4	<5.9	1.3 ± 0.5
S3050, W7143	0.9 ± 0.3	<0.8	0.9 ± 0.3
S3045, W7455	1.4 ± 0.2	1.3 ± 1.1	1.0 ± 0.3
S3045, W7446	5.2 ± 0.5	<1.0	0.4 ± 1.0
S2890, W8092	0.8 ± 0.2	0.9 ± 0.7	0.6 ± 0.2
S2990, W8086	12.5 ± 0.7	<1.3	0.6 ± 0.6
S3041, W7927	0.4 ± 0.1	0.3 ± 0.7	<0.1
S3040, W7892	1.0 ± 0.3	<0.6	0.5 ± 0.3

[a]Refer to Figure 32.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.

TABLE 14

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM OFFSITE ANOMALIES
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a]	Radionuclide Concentrations (pCi/g)[c] Ra-226	U-238	Th-232
PROPERTY AA			
S90, W30	44.2 ± 1.3[b]	<1.7	2.0 ± 0.9
S98, W50	1.2 ± 0.2	0.4 ± 0.4	0.5 ± 0.3
S98, W50 (8-15 cm depth)	81.1 ± 1.8	<3.1	1.2 ± 1.0
S98, W50 (15-30 cm depth)	27.5 ± 1.0	<1.3	0.8 ± 0.7
S85, W55	31.4 ± 1.0	2.9 ± 4.1	1.3 ± 0.7
S85, W55 (10-20 cm depth)	40.9 ± 1.4	<2.3	<0.5
S85, W55 (20-30 cm depth)	21.3 ± 0.9	<1.2	0.9 ± 0.8
PROPERTY BB			
S87, E25	1.4 ± 0.3	0.9 ± 1.2	1.3 ± 0.6
S85, E45	1.1 ± 0.3	0.9 ± 2.9	1.0 ± 0.4
S100, E60	1.4 ± 0.3	<0.8	1.1 ± 0.5
S120, E55	1.0 ± 0.3	1.5 ± 0.6	1.1 ± 0.5
S120, E30	1.0 ± 0.2	1.0 ± 0.6	1.0 ± 0.4
S100, E35	1.7 ± 0.3	<4.8	0.5 ± 0.3
S100, E48	2.4 ± 0.4	1.5 ± 1.4	1.5 ± 0.4
S110, E40	1.7 ± 0.3	1.2 ± 1.1	0.9 ± 0.4
S115, E35	1.1 ± 0.4	<1.0	0.9 ± 0.5
S115, E50	0.1 ± 0.1	0.7 ± 0.6	<0.1
S35, W22	0.8 ± 0.2	0.8 ± 0.8	0.5 ± 0.4
S55, W22	1.3 ± 0.3	<0.7	0.6 ± 0.4
S45, W22	0.4 ± 0.2	<0.3	0.2 ± 0.2
S110, E24	4.3 ± 0.4	2.5 ± 0.8	1.0 ± 0.3
S105, E24	20.8 ± 1.1	8.8 ± 4.6	1.0 ± 1.1
S105, E24 (15-30 cm depth)	20.3 ± 1.0	19.9 ± 3.6	1.2 ± 0.7
S105, E24 (30-40 cm depth)	12.2 ± 0.7	10.2 ± 1.6	0.9 ± 0.6
S50, W24	7.9 ± 0.8	4.3 ± 2.1	0.9 ± 0.5
S50, W24 (20-30 cm depth)	17.7 ± 0.9	7.6 ± 3.8	0.7 ± 0.7
PROPERTY CC			
N25, E95	10.5 ± 0.6	<0.8	0.6 ± 0.6
N24, E100	0.2 ± 0.2	<0.4	0.1 ± 0.1
N26, E110	0.3 ± 0.1	<0.2	0.2 ± 0.2

TABLE 14 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES
FROM OFFSITE ANOMALIES
NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES
LEWISTON, NEW YORK

Location[a]	Radionuclide Concentrations (pCi/g)		
	Ra-226	U-238	Th-232
N25, E115	1.5 ± 0.2	1.0 ± 0.4	0.5 ± 0.3
N24, E97	18.7 ± 1.0	<1.8	<0.4
N24, E97 (10-15 cm depth)	6.3 ± 0.6	<1.2	<0.3
N24, W97 (20-30 cm depth)	3.1 ± 0.3	0.9 ± 2.1	0.4 ± 0.4

[a]Refer to Figures 33-35.
[b]Uncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ± 6 to 10% have not been propagated into these data.
[c]Data are for samples collected prior to further remediations; no followup sampling was performed.

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APPENDIX A

SUMMARY OF RADIATION GUIDELINES APPLICABLE TO NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES

APPENDIX A

SUMMARY OF RADIATION GUIDELINES
APPLICABLE TO NIAGARA FALLS STORAGE SITE VICINITY PROPERTIES[1]

BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr.

SOIL (LAND) GUIDELINES

Radionuclide	Soil Concentration (pCi/g above background)[a,b,c]
Radium-226 Radium-228 Thorium-232 Thorium-232	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Uranium (total)	90 pCi/g[2,3] (assume natural isotopic ratio for U-234, U-238, and U-235 of 1:1:0.046)
Other radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES

Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guidelines (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, a reasonable effort shall be made to achieve an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.[d] In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μR/h and shall comply with the basic dose limit when an appropriate-use scenario is considered.

INDOOR/OUTDOOR STRUCTURE SURFACE ACTIVITY

Radionuclide[e]	Allowable Residual Surface Activity (dpm/100 cm^2)[d] Average[f,g]	Maximum[g,h]	Removable[g,i]
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β - γ	15,000 β - γ	1,000 β - γ

Applicable guidelines within various ARC buildings will vary, depending upon the primary contaminant. For the majority of building surfaces, the major contaminant is Th-232. Guidelines associated with radionuclide decay series are 1000 dpm/100 cm^2, average; 3000 dpm/100 cm^2, maximum; and 200 dpm/100 cm^2, removable. For areas where uranium is the primary contaminant, the guidelines are 5000 dpm/100 cm^2, average; 15000 dpm/100 cm^2, maximum; and 1000 dpm/100 cm^2, removable.

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[a]These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If either thorum-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentrations. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that the dose of the mixtures will not exceed the basic dose limit.

[b]These guidelines represent unrestricted-use residual concentrations above background averaged across any 15-cm-thick layer at any depth and over any contiguous 100-m^2 surface area.

[c]Localized concentrations in excess of these limits are allowable provided that the average concentration over a 100-m^2 area does not exceed these limits. For areas of less than 25 m^2 localized concentrations ("hot spots") may exceed the guideline limits by a factor of (100/A)1/2, where A is the area of the elevated region in square meters. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate soil limit, irrespective of the average concentration in the soil.

[d]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[e]Where surface contamination by both alpha-and beta-gamma-emitting radionuclides exists, the limits established for alpha-and-beta-gamma-emitting radionuclides should apply independently.

[f]Measurements of average contamination should not be averaged over more than 1 m^2. Of objects of less surface area. The average shall be derived for each such object.

[g]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[h]The maximum contamination level applies to an area of not more than 100 cm^2.

[i]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of know efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the neither surface should be wiped. The numbers in this column are maximum amounts.

[1]U.S. Department of Energy, U.S. Department of Energy Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites, Revision 2, March 1987.

[2]Argonne National Laboratory, Derivation of a Uranium and Cesium-137 Residual Radioactive Material Guidelines for the Niagara Falls Storage Site, Chicago, IL, August 1988.

[3]Memorandum for P.J. Gross, Technical Services Division, Department of Energy, Oak Ridge Operations, to J. Fiore (GTN-HQ 2), August 1988.

APPENDIX B

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

APPENDIX B

MAJOR SAMPLING AND ANALYTICAL EQUIPMENT

The display or description of a specific product is not to be construed as an endorsement of that product or its manufacturer by the authors or their employer.

A. Direct Radiation Measurements

Eberline PRM-6
Portable Ratemeter
(Eberline, Santa Fe, NM)

Victoreen NaI Gamma Scintillation Probe
Model 489-55
(Victoreen, Inc., Cleveland, OH)

Reuter-Stokes Pressurized Ionization Chamber
Model RSS-111
(Reuter-Stokes, Cleveland OH)

B. Laboratory Analysis

Ge (Li) Detector
Model LGCC2220SD, 23% efficiency
(Princeton Gamma-Tech, Princeton, NJ)

Used in conjunction with:
Lead Shield, SPG-16
(Applied Physical Technology, Smyrna, GA)

High Purity Germanium
Model GMX-23195-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield, G-16
(Gamma Products Inc., Palos Hills, IL)

High Purity Germanium Detector
Model IGC25, 25% efficiency
(Princeton, Gamma-Tech, Princeton, NJ)

Used in conjunction with:
Lead Shield
(Nuclear Data, Schaumburg, IL)

High Purity Germanium Coaxial Well Detector
Model GWL-110210-PWS-S, 23% efficiency
(EG&G ORTEC, Oak Ridge, TN)

Used in conjunction with:
Lead Shield Model G-16
(Applied Physical Technology, Atlanta, GA)

Multi-channel analyzer
ND-66/ND-680 System
(Nuclear Data, Inc., Schaumburg, IL)

APPENDIX C

MEASUREMENT AND ANALYTICAL PROCEDURES

APPENDIX C

MEASUREMENT AND ANALYTICAL PROCEDURES

Gamma Surface Scans

Walkover surface scans were performed using Eberline Model PRM-6 portable ratemeters with Victoreen Model 489-55 gamma scintillation probes, containing 3.2 cm (1.25 M) x 3.8 cm (1.50 M) NaI(Tl) scintillation crystals. Relative count rates were monitored using earphones, and increased rates above the ambient background levels were noted.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using Eberline PRM-6 portable ratemeters with Victoreen Model 489-55 gamma scintillation probes. Count rates were converted to exposure rates (μR/h) by cross-calibrating with a Reuter Stokes Model RSS-111 pressurized ionization chamber.

Soil and Sediment Sample Analysis

Soil and sediment samples were dried, mixed, and a portion placed in a 0.5 l (0.53 qt) Marinelli beaker. The quantity placed in each beaker was chosen to reproduce the calibrated counting geometry and ranged from 600 to 900 g (1.3 to 2.0 lb) of soil. Net soils weights were determined and the samples counted using germanium detectors coupled to a Nuclear Data Model ND-680 pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks reviewed for determination of radionuclides of concern were:

Ra-226 - 0.609 MeV from Bi-214*
U-238 - 0.094 MeV or 0.063 MeV from Th-234 or 1.001 MeV from Pa-234m*
Th-232 - 0.911 MeV from Ac 228*

*Secular Equilibrium Assumed

Uncertainties and Detection Limits

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence levels based only on counting statistics. Other sources of error associated with the sampling and analyses introduce an additional uncertainty of ± 6 to 10% in the results. When the net sample count was less than the statistical deviation of the background count, the sample concentration was reported as less than the detection capabilities of the procedure. Because of variations in background levels, sample weights, detector efficiencies, and the effects of the Compton continuum, caused by other constituents in the samples, the detection sensitivities for specific radionuclides differ from sample to sample and from instrument to instrument.

Calibration and Quality Assurance

The Environmental Survey and Site Assessment Program conducted the survey and analytical activities according to laboratory and field survey procedures specified in manuals developed specifically for the Oak Ridge Associated Universities' Environmental Survey and Site Assessment Program to meet the requirements of ANSI/ASME NQA-1. The specific manuals and procedures applicable to this survey were the "Survey Procedures Manual,", Revision 2, and the "Laboratory Procedures Manual," Revision 2.

With the exception of the measurements conducted with portable gamma scintillation survey meters, instruments were calibrated with NIST-traceable standards. The calibration procedures for the portable gamma instruments are performed by comparison with a NIST calibrated pressurized ionization chamber.

Quality control procedures on all instruments included daily background and check-source measurements to conform equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA and EML Quality Assurance Programs.

In accordance with the requirements of DOE Order 1324.2, Attachment V-1, which specifies retention times for DOE contractor records related to environmental contamination measurements, all samples and records are to be retained five years beyond the completion date of the project or upon publication of the certification docket. At the end of the five-year retention period, ORAU will request permission from DOE/EM, for permission to make final disposition of the non-permanent records. Permanent records will be retained by ORAU unless otherwise directed by DOE.