Critique of CWM Walkover Survey & Radiological Investigation

By
Jackie Travers and Marvin Resnikoff, Ph.D.
Radioactive Waste Management Associates

On behalf of
Niagara County

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Radioactive Waste Management Associates
526 W. 26th Street, Rm. 517
New York, NY 10001
212-620-0526

Introduction

This report is a review of Chemical Waste Management's (CWM) gamma walkover survey of the Vicinity Properties[1]. CWM's survey and the measurement methodology employed in the survey are examined in detail and compared to several previous surveys.

The purpose of the survey, according to CWM, was to confirm the 1992 findings of the Department of Energy that the CWM property was properly decontaminated and future use would pose no health threat. Though the survey plan was finally approved by NYSDEC August 2007, the actual walk-over survey of 450 acres, according to CWM's log[2], was carried out two year earlier, between October 2005 and July 2006. CWM submitted revisions to its survey plan November 2006, after it had already carried out the survey. Recovering "rocks" or what is properly labeled radioactive slag, took place after the NYSDEC plan was approved. A NYSDEC inspector was present when radioactive slag was recovered, and should have been aware of the obvious, that a radiological survey was not taking place at that time.

As we discuss later, contrary to federally accepted protocols[3], NYSDEC allowed CWM to conduct the walk-over survey with gamma-detecting instruments at a height of 1 foot, rather than 10 cm or 1/3 foot. As we discuss in Section 2 below, this is an important issue that has a direct bearing on the size and radioactive concentrations of what a surveyor sees. Section 1 below discusses the survey itself.

Section 1. Gamma Walk-Over Survey

Vicinity Property D

According to U.S. Department of Energy (DOE), LOOW Vicinity Property D is certified as in compliance with the decontamination criteria and standards applicable to the remedial actions at NFSS[4]. However, during a 1983 walkover survey, elevated areas of direct radiation were measured in LOOW Vicinity Property D[5]. The majority of LOOW Vicinity Property D falls under CWM Investigation Areas 4, 5, and 7 and a small portion of Vicinity Property D falls under Area 6 (Figure 1). CWM has obscured a simple comparison between its latest measurements and DOE findings by adopting an alternative

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[1] CWM, 2008. *Results of Gamma Walkover Survey, Soil Sampling, and Legacy Building Surveys, Model City, New York.* Chemical Waste Management Chemical Services, LLC, December 2008.
[2] CWM, 2008. Appendix F.
[3] EPA, 2000, MARSSIM, EPA 402-R-97-016, Rev. 1, August 2000.
[4] BNI, 1992. *Certification Docket for the Remedial Action Performed at the Niagara Falls Storage Site Vicinity Properties in Lewiston, New York, from 1983 through 1986.* Prepared for Department of Energy by Bechtel National Inc., Former Sites Restoration Division, Oak Ridge Field Office, July 1992.
[5] ORAU, 1984a. *Comprehensive Radiological Survey, Off-Site Property D Niagara Falls Storage Site Lewiston, New York*, Final Report, Oak Ridge Associated Universities, May 1984.

spatial grid to DOE's Vicinity Property scheme. Figure 1 relates CWM's investigation areas to LOOW's Vicinity Properties.

CWM's initial gamma-radiation walkover survey of Areas 4, 5, 6, and 7, found 460 locations with radiation readings above 16,000 cpm. The maximum readings[6] were as high as 91,120 cpm in Area 5, 113,700 cpm in Area 4, 896,900 cpm in Area 7, and 897,200 cpm in Area 6. These 460 locations were revisited by CWM and inexplicably only ten locations were confirmed to contain elevated levels of radiation.

In 1983, a walkover survey performed by Oak Ridge Associated Universities (ORAU) found the portion of LOOW Vicinity Property D that contains landfill SLF-12 to contain elevated levels of surface radiation and radionuclide concentrations in soil (Figures 3 and 4). According to the post-remedial action report published in January of 1989[7], these locations within LOOW Vicinity Property D were subsequently decontaminated, and DOE verified that the vicinity is in compliance with the decontamination criteria and standards applicable to the remedial actions at NFSS[8]. In agreement with ORAU's 1983 findings, CWM's most recent analysis also found elevated areas of radiation over CWM's landfill SLF-12. In its investigation, CWM located and removed three "rocks" with elevated levels of radiation from SLF-12, one rock from the north slope of SLF-12 in Area 4 and two rocks west of SLF-12 in Area 7. Lab results showed that the rock removed from Area 4 contained highly elevated concentrations of four radionuclides[9]: Ra-226, 742 pCi/g; Th-230, 835 pCi/g; U-238, 62.7 pCi/g, and U-234, 62.8 pCi/g. The two rocks found to the west of SLF-12 in Area 7 were not further analyzed. Because samples of soil surrounding the rocks did not contain radionuclide concentrations above background level for this area of New York, CWM declared this area free of radioactive contamination.

It appears that the issue of radiological contamination in SLF-12 is a recurring problem that has not been properly addressed. In 1983, discrete sources of radiation in SLF-12 were located by ORAU, the sources were removed in 1989, and the property was then certified by DOE as free from radiological contamination. In 2008, discrete sources of radiation were again found in the same location of Vicinity Property D by CWM, the sources were removed, and the property was again verified, this time by CWM, as free from radiological contamination. Since elevated direct radiation levels and radionuclide concentrations were measured in the landfill cap of SLF-12 by ORAU in 1983 and again by CWM in 2008, SLF-12 is clearly a location where radioactive materials were previously disposed.

SLF-12 is located approximately 125 meters northwest of the proposed location for RMU-2. In 1983, ORAU measured radiation concentrations in subsurface water at 5

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[6] CWM, 2008. Appendix A, pp. A-14, A-17, A-19, A-25.
[7] Kaye, M.E., and Feldman, A.M., 1989. *Post-Remedial Action Report for the Niagara Falls Storage Site Vicinity Properties-1985 and 1986*. Bechtel National, Inc., Oak Ridge, TN, January 1989.
[8] BNI, 1992.
[9] CWM, 2008, p. 3-2 and 3-3.

locations below SLF-12 (Figure 5). Gross beta concentrations in the subsurface water samples from beneath SLF-12 were as high as 65.4 pCi/L[10], exceeding the EPA guideline of 50 pCi/L. Since we can conclude that there is still a source of radioactivity in SLF-12, radiological contamination emanating from SLF-12 could spread to the nearby RMU-2 Waste Site or to the location just east of landfill SLF-12 where CWM proposes to build Facultative Pond 5 (Figure 2)[11]. Thus, RMU-2 would be unable to meet the criteria of a hazardous waste site.

As seen by the radioactive concentrations mentioned above, the radioactive rocks found in and around the landfill cap of SLF-12 are not naturally occurring, nor did they originate as a part of the landfill cap. Naturally-occurring uranium and its decay product Ra-226 should be in secular equilibrium, that is, the radioactive concentrations should be equal. But the "rocks" discovered by CWM have much lower concentrations of U-238, indicating that the original material was processed and the uranium removed. In addition, surface rocks alone would have slight amounts of U-238 (say 1 pCi/g in New York State[12]) and similarly for Ra-226, not the elevated concentrations found in areas 4 and 7. Surface rocks may also have measurable concentrations of K-40. In our opinion, the "rocks" containing elevated concentrations of radiation in CWM Investigation Areas 4 and 7 are radioactive slag that remained onsite from the earlier disposal of radioactive materials.

Vicinity Property E

LOOW Vicinity Property E lies directly south of LOOW Vicinity Property D. As seen in Figure 1, the majority of LOOW Vicinity Property E is contained within CWM Investigation Areas 7 and 8. Very small portions of LOOW Vicinity Property E lie within CWM Investigation Areas 5 and 9. During the 1983 walkover survey of LOOW vicinity properties, ORAU found two major areas within LOOW Vicinity Property E that contained elevated concentrations of radionuclides in soil that exceeded EPA and/or NRC criteria[13]. These areas are located in the southwest and northwest portions of LOOW Vicinity Property E (Figure 6). In 1992, DOE did not certify LOOW Vicinity Property E as in compliance with applicable decontamination criteria and standards set for the NFSS[14].

The southern boundary of LOOW Vicinity Property E is shaped by an abandoned railway bed. The same railway bed runs through the eastern edges of CWM Investigation Areas 3, 6, 9, 15, and 18. However, CWM does not mention in its report that the railway bed is also located in Investigation Areas 7 and 8. Locations surrounding the abandoned

[10] ORAU, 1984a.
[11] CWM, undated. Graphic from a Work Plan for Soil Borings. Chemical Waste Management Chemical Services, LLC, approximately 3rd or 4th quarter of 2008.
[12] Myrick, T.E., Berven, B.A., and Haywood, F.F., 1982. *Determination of Concentrations of Selected Radionuclides in Surface Soil in the U.S.,* Health Physics, 45(3):631-642, September 1982.
[13] ORAU, 1984b. *Comprehensive Radiological Survey, Off-Site Property E Niagara Falls Storage Site, Lewiston, New York*, Final Report, May 1984.
[14] BNI, 1992.

railway bed in Investigation Areas 3, 6, 15, and 18 were all found to exhibit elevated levels of radiation during the CWM 2008 walkover survey of its investigation areas[15]. The railroad ties and stone bed material from the abandoned railroad in Investigation Area 9 were removed during the construction of RMU-1[16]. Just north of the abandoned railway bed in Vicinity Property E is a closed and capped retention pond that CWM calls Lagoon 6. The soil south of Lagoon 6 was found to contain elevated concentrations of radionuclides by both ORAU in 1983 and CWM in 2008[17].

In 1983, ORAU found elevated concentrations of radiation in the soil of LOOW Vicinity Property E just north of the railway bed and south of Lagoon 6 (Figure 6)[18]. 1983 soil sampling along with southern berm of Lagoon 6 indicated the presence of metal containers buried 20 to 30 centimeters below the surface. Ground penetrating radar indicated the presence of 22 buried targets[19]. Radiation concentrations in the soils from this area indicated that the containers were contaminated or contained contaminated residues. The radioactive contamination in the soils around the containers was found to be small pieces of metal or plaster-like chips. Based on the history of the site, the containers most likely contain or are contaminated with mill tailings from uranium ore processing. No post-remediation report published after 1984 indicates that the containers buried south of Lagoon 6 in Vicinity Property E were ever removed.

The eastern portion of LOOW Vicinity Property E is included in the proposed footprint of RMU-2. The presence of the abandoned railway bed in LOOW Vicinity Property E indicates that Vicinity Property E is more than likely contaminated with radioactive material within the railbed. However, CWM did not investigate the railway bed in LOOW Vicinity Property E during its investigation in 2008 because they did not locate any areas within this vicinity with activities greater than 16,000 cpm. Considering the improper sampling methodology, as discussed below, it is not surprising that elevated radioactive concentrations in soil were missed. Thus, it is more than likely that the areas surrounding the abandoned railway bed in LOOW Vicinity Property E are contaminated with radioactive material as well. Nevertheless, Investigation Areas 3, 6, 15, and 18 all exhibited elevated surface levels and elevated radionuclide concentrations. According to a 1972 Order by the New York State Department of Health (NYSDOH)[20], no soil on the LOOW property can be removed without the Commissioner of Health approving that the levels of radioactivity are acceptably safe. Thus, LOOW Vicinity Property E should not be included in RMU-2 without a thorough radiological investigation of the abandoned railway bed located within the vicinity.

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[15] CWM. 2008, pp. A-10, A-22, A-45, A-52.
[16] *Ibid.*, p. A-31
[17] ORAU, 1984b and CWM, 2008.
[18] ORAU, 1984b.
[19] *Ibid.*
[20] NYSDOH, 1972. *Order In the Matter of Certain Property of the Fort Conti Corporation Located in the Town of Lewiston, Niagara County, State of New York*, New York State Department of Health, April 1972.

Vicinity Property E'

LOOW Vicinity Property E' lies just south of LOOW Vicinity Property E. The aforementioned railway bed serves as the northern boundary of this vicinity. An ORAU 1983 analysis found a large area of elevated radionuclide concentrations in the soil of the western, central, and eastern portions of LOOW Vicinity Property E' (Figures 7-13)[21]. These elevated radionuclide concentrations exceeded EPA and/or NRC criteria. DOE did not certify LOOW Vicinity Property E' as in compliance with applicable decontamination criteria and standards in 1992[22].

The eastern portion of LOOW Vicinity Property E' is completely bounded by CWM Investigation Areas 8 and 9. In 1983, ORAU found that the areas containing elevated surface levels and concentrations of radionuclides in the soil within LOOW Vicinity Property E' completely surrounded a portion of the abandoned railway bed located in Investigation Area 8 (Figures 12 and 13). CWM makes no mention that there is a railway bed in Investigation Area 8 in its 2008 report[23]. During its 2008 walkover survey of Investigation Area 8, CWM did not cross any location with surface radiation levels above 16,000 cpm. Since Area 8 was previously found to contain radionuclide concentrations that exceeded EPA and/or NRC criteria, CWM did not find it necessary to repeat a second walkover survey. CWM would likely obtain similar results for the four other Investigation Areas that contain portions of the abandoned railway bed.

The portion of the abandoned railroad bed in LOOW Vicinity Property E' found by ORAU to contain elevated surface radioactive concentrations lies directly within the boundaries of the proposed RMU-2 Waste Site. As previously discussed, it is highly unlikely that the results from the CWM 2008 Walkover Survey in LOOW Vicinity Property E' are accurate. According to a 1972 Order by the U.S. Department of Health (DOH), CWM cannot excavate any area within its property without prior approval of the DOH[24]. Thus, CWM should perform a more thorough radiological investigation in the area surrounding this abandoned railway bed if it plans to excavate Vicinity Property E' as a part of RMU-2.

According to CWM's 2008 report[25], LOOW Vicinity Property E' also contains four of the six legacy buildings surveyed by CWM. The exact locations of the six buildings were not given in the report, only brief, general descriptions of the buildings' locations were provided. CWM states in its report that the Transformer/Operations, Maintenance/Utility, and Main Compressor buildings are located south of the closed lagoons and that the Laboratory/Maintenance Shop is located east of the Aqueous

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[21] ORAU, 1983a. *Comprehensive Radiological Survey, Off-Site Property E' Niagara Falls Storage Site, Lewiston, New York*, Final Report, September 1983.
[22] BNI, 1992.
[23] CWM, 2008.
[24] NYSDOH, 1972.
[25] CWM, 2008, p. 2-7, Table in Section 2.3.

Wastewater Treatment System, North of "M" Street. Since M Street serves as the southern boundary of Vicinity Property E' and CWM's description of Investigation Area 7 in Appendix A[26] is the only description that includes a closed and capped lagoon (Lagoon 6), we assume that the four buildings are located in Vicinity Property E' which falls mainly under Investigation Areas 7 and partially under Investigation Area 8.

ORAU's 1983 analysis of the LOOW Vicinity Properties found elevated surface radiation levels and soil concentrations surrounding several of the buildings and storage facilities located within the western and central portions of Vicinity Property E' (Figures 7 and 8)[27]. The 1989 remediation report by Bechtel National Inc. states that many of the areas found to be contaminated within Vicinity Property E' were later decontaminated and backfilled, resulting in an average Ra-226 concentrations in the soil of 2.3 pCi/g[28]. However, CWM's 2008 survey measured radionuclide concentrations in dust in the Main Compressor building to be above background soil levels for this area of New York (Ra-226, 1.49 pCi/g, Th-232, 2.05 pCi/g)[29]. Dust present in the Main Compressor building would have resulted from surrounding soil being blown into the building.

Another location within the Main Compressor Building, a shelf containing an oily residue, contained elevated radiation levels of radiation. A surface wipe of this area was taken for further analysis and was found to contain elevated levels of Th-230 (8.49 pCi/wipe) [30]. No analysis of the Ra-226 concentration of the surface wipe was conducted.

CWM has renamed the buildings located in LOOW Vicinity Property E' from what they were previously called. On the basis of the brief description and location of the Main Compressor Building provided by CWM in its 2008 report, we assume that the Main Compressor Building is the same building that was previously called the Boiler/Storage Room Building (Figure 14). We make this assumption based on Figure 1 in the 1982 Detection Science Group report which lists the Boiler/Storage Room Building as two separate buildings, 4a and 4b[31]. CWM states in its 2008 report that the Main Compressor Building is a two room building[32]. The drawing of the Main Compressor Building presented in Appendix B of the 2008 CWM report also led us to believe that the Main Compressor Building is the building that used to be referenced as the Boiler/Storage Room Building[33].

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[26] *Ibid.*, pp. A-24 and A-27
[27] ORAU, 1983a.
[28] Kaye, M.E. and Feldman, A.M., 1989.
[29] CWM, 2008, Appendix B, Report 08-2263, Sample 0805-1122.
[30] *Ibid.,* Appendix B, Report 08-0219, Sample 0801-0549.
[31] Detection Science Group, 1982. *Ground-Penetrating Radar Survey of Areas E' and H' at the Former Lake Ontario Ordnance Works, Lewiston, New York,* Final Report, September 1982.
[32] CWM, 2008, p.2-7, Table in Section 2.3.
[33] CWM, 2008, Appendix C. Note: In CWM's drawing of the Main Compressor Building, it shows that the Main Compressor is a rectangular shaped building, with longest length in NS direction, whereas Detection Science Group, 1982, Figure 1. and ORAU, 1983, Figure 3. have the longest length of rectangular buildings in the EW direction. CWM does not provide the dimensions of the Main Compressor Building or any information regarding whether their drawing of the building is a complete drawing. Our assumption is based only on the available information provided by CWM. Thus, it

The area just south of the Main Compressor Building (Boiler/Storage Room Building) located in LOOW Vicinity Property E' was once used by Mallinckrodt Corporation for the burial of radioactive wastes (Figure 9)[34]. Since the prominent wind direction of the Buffalo/Niagara Falls area is from the southwest[35] and there were elevated radionuclide concentrations in the dust of the Main Compressor Building, the soil surrounding the Main Compressor Building is most likely contaminated from radiological materials once disposed of in the area.

In 2008, CWM measured elevated radionuclide concentrations in a "rock" located in the same area of LOOW Vicinity Property E' in which ORAU measured elevated radionuclide concentrations in soil in 1983. This rock was located south of Lagoon 6 and just north of two round tanks previously used for the storage of PCBs in the northern-central portion of LOOW Vicinity Property E'. The rock located by CWM contained concentrations[36]: Ra-226, 794 pCi/g; Th-230, 421pCi/g; and U-238, 66.3 pCi/g. CWM states that due to the ratio of Ra-226 to U-238, this rock appears to be a residue from previous U.S. Government activities at the site. Therefore, CWM admits that this location is contaminated from the uranium mill tailing disposal activities previously carried out in this area. This rock was removed from Investigation Area 7 and soil from the surrounding areas was sampled. Soil concentrations were found to be within the range of background concentrations for this area of New York. Due to normal radiation concentrations in soil, CWM declared this area clear of radiological contamination.

ORAU's findings in 1983 indicated that there were metal containers buried below the surface along the southern berm of Lagoon 6. The spread of radiological contamination from these buried containers could be the source of the contaminated rock found by CWM in 2008. A memo from an ORAU author released in 1982 details another possible source of radiological contamination in this area. In 1982, a 10-inch thick layer of contamination was found to exist two feet below the surface at a location described to be just north of the two PCB storage tanks located in LOOW Vicinity Property E'[37]. This layer of contamination extends over an approximate area of 30 meters by 15 meters. Ra-226 concentrations in the soil of this contaminated area ranged up to 300 pCi/g. No post-remediation reports released after 1984 indicate that this layer of contamination was ever removed from LOOW Vicinity Property E'. Due to the proximity of this contaminated area to the contaminated "rock" located by CWM in 2008, it is very likely that this subsurface layer of radioactive contamination still exists in LOOW Vicinity Property E'.

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is not clear to us whether the Main Compressor Building is the same building as the previously called Boiler/Storage Room Building.

[34] ORAU, 1983a.

[35] National Resources Conservation Service, 2003. *Buffalo, NY Wind Rose Plots.* National Water and Climate Center, United States Department of Agriculture, May 2003.

[36] CWM, 2008, p. 3-3.

[37] Memorandum from J. Berger to C. Yarbro, ORAU, July 1982.

A 1999 study conducted by the U.S. Army Corps of Engineers[38] also found radioactive contamination in Vicinity Property E' in a location similar to that described in the 1982 ORAU memo. In 1999, the U.S. Army Corps of Engineers disassembled and removed two PCB storage tanks located within Vicinity Property E'. The U.S. Army Corps of Engineers then analyzed the areas previously under the removed tanks. This location was not formerly analyzed by ORAU in 1983. In this study, the U.S. Army Corps of Engineers measured elevated concentrations of Ra-226 in soil surrounding the two tanks, the highest sample reading 230 pCi/g of soil. Radiation exposure rates were constructed for residents who might be exposed to this contamination assuming this area was not excavated or covered, and resident doses were as high as 1,230 mrem/year[39]. This dose is well above the NRC exposure regulation of 25 mrem/year. We have not found any report indicating that the radioactive contamination in the soil under and around the removed PCB tanks has been removed.

The findings of ORAU in 1982 and 1983, the Army Corps of Engineers in 1999 and CWM in 2008 CWM demonstrate that the soil of Vicinity Property E' is most likely contaminated with radioactive material once disposed of at this location. Therefore, the area within Investigation Area 8 that contains Vicinity Property E' should not be included in RMU-2 without a more detailed analysis of the area.

LOOW Vicinity Property F

LOOW Vicinity Property F is located directly south of LOOW Vicinity Property E' and north of NFSS. Several areas within the eastern portion of LOOW Vicinity Property F are included in the proposed RMU-2 Waste footprint. The areas within LOOW Vicinity Property F that are also within the RMU-2 footprint are covered by CWM Investigation Area 14.

A 1984 ORAU survey of LOOW Vicinity Property F found the vicinity to contain several locations of elevated surface radiation and radionuclide concentrations in soil that exceeded the criteria for FUSRAP sites (Figures 16 and 18)[40]. Exposure rates measured in Facultative Pond 3, located along the eastern edge of LOOW Vicinity Property F, exceed 4 μR/h[41] which is approximately equivalent to the NRC regulation of 25 mrem/year (Figure 17). The areas of Facultative Pond 3 found to exhibit elevated exposure rates are within the proposed RMU-2 footprint.

According to a 1989 post-remediation report[42], a contaminated area in Vicinity Property F that will be included in RMU-2 was excavated (Figure 16). However, several locations

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[38] U.S. ACE, 1999. *Technical Memorandum: Radiological Human Health Assessment for the E' Vicinity Property of the Niagara Falls Storage Site,* United States Army Corps of Engineers, March 1999.
[39] *Ibid.*
[40] ORAU, 1984c. *Comprehensive Radiological Survey, Off-Site Property G, Niagara Falls Storage Site, Lewiston, New York*, Final Report, February 1984.
[41] *Ibid.*
[42] Kaye, M.E. and Feldman, A.M., 1989.

indicating elevated surface radiation levels and exposure rates within LOOW Vicinity Property F were not remediated.

Figure 15 displays a map of CWM Investigation Area 14 which encompasses LOOW Vicinity Property F. The white areas in Figure 15 indicate the areas that CWM did not scan or further investigate in its 2008 survey because these areas are wetlands or heavy brush. Two of the white areas included on this map are Facultative Pond 3 and the adjacent area found to exhibit elevated levels of surface radiation by ORAU in 1984.

LOOW Vicinity Property G

LOOW Vicinity Property G is located directly north of the Niagara Falls Storage Site. LOOW Vicinity Property G is contained mostly by CWM Investigation Area 12 and the eastern edge of LOOW Vicinity Property G is covered by Investigation Area 13. In 1992, LOOW Vicinity Property G was one of the vicinity areas that was not certified by DOE when it declared the LOOW site in compliance with applicable decontamination criteria and standards for remedial actions at NFSS[43]. In an ORAU 1984 survey of the LOOW vicinity properties[44], the western portion of LOOW Vicinity Property G was found to contain elevated surface levels of radiological contamination as well as elevated radionuclide concentrations in soil (Figures 20 and 21). Facultative Ponds 1 and 2 are located in LOOW Vicinity Property G, and the areas of elevated radiation contamination were found to be just outside the boundaries of the ponds.

In 2008, CWM located a large boulder west of Facultative Ponds 1 and 2 containing elevated surface levels of radiation. This boulder was about four square feet in size and was too large to be removed from the site. CWM determined that this boulder appeared to be naturally occurring and therefore felt no need to perform any outside radiation analysis on this source of radiation. As previously stated in regard to LOOW Vicinity Property D, rocks and boulders with elevated concentrations of U-238 and Ra-226 are not normally occurring in Western New York. That is, the radioactivity in this rock must be material that was once disposed of at the LOOW site.

It should also be noted that 559 locations within Investigation Area 12 were initially found to contain surface radiation levels above 16,000 cpm, yet only one location within this area was investigated further for radiological contamination. Considering that LOOW Vicinity Property G, which comprises the majority of Investigation Area 12, was rejected by DOE's 1992 certification for not being in compliance with applicable decontamination criteria and standards for remedial actions at NFSS, it is unlikely that 558 of the 559 locations would exhibit surface radiation levels under 16,000 cpm if an additional walkover survey and radiological investigation were performed. The lack of radiological "hits" CWM picked up during a second walkover survey through LOOW

[43] BNI, 1992.
[44] ORAU, 1984d. *Comprehensive Radiological Survey, Off-Site Property G, Niagara Falls Storage Site, Lewiston, New York,* Final Report, February 1984.

Vicinity Property G also leads one to question the integrity of CWM's surveying methods and equipment.

LOOW Vicinity Property H'

LOOW Vicinity Property H' is located west of LOOW Vicinity Properties E and E'. According to Figure 2-1 of the CWM 2008 report[45], Vicinity Property H' is included in CWM Investigation Area 7. However, a more detailed visual depiction of Investigation Area 7 found on page A-16 of Appendix A of CWM's 2008 report shows that LOOW Vicinity Property H' was not actually included in the radiological analysis of Investigation Area 7. The CWM 2008 report states that the radiological survey conducted over the LOOW vicinities "included all the properties zoned M-3 (zone heavy industrial, authorized for hazardous waste activity)," and notes that the property areas surveyed are depicted in Figure 2-1. As seen on page A-16 in Appendix A of the CWM report, the eastern boundary of LOOW Vicinity Property H' which should have been included in Investigation Area 7 was actually used as the western boundary of Investigation Area 7. Therefore, the analysis performed by CWM in its 2008 report completely neglects LOOW Vicinity Property H'.

A similar approach was adopted for CWM Investigation Area 12. Figure 2-1 shows that Investigation Area 12 encompasses all of LOOW Vicinity Property G and the eastern half of LOOW Vicinity Property S. However, page A-37 of Appendix A of the 2008 CWM report shows that the western boundary of Investigation Area 12 does not actually include any part of LOOW Vicinity Property S. Therefore, CWM completely neglected the entire western portion of what appears to be Investigation Area 12.

A 1983 ORAU analysis[46] found LOOW Vicinity Property H' to contain 21 areas of elevated direct radiation levels and almost one half of the soil in LOOW Vicinity Property H' contained radionuclide concentrations in soil that exceeded EPA and/or NRC criteria. Both elevated direct radiation levels and soil radionuclide concentrations were measured in the eastern portion of LOOW Vicinity Property H'. In its 2008 report, CWM states that a source of radiation was located in a grassy field west of the SMP-4 storm water ditch, but this area is located outside the proposed RMU-2 footprint. This contaminated area west of SMP-4 is located within LOOW Vicinity Property H', and would be the same area found to contain elevated direct radiation levels and radionuclide concentrations in soil by ORAU in 1983. CWM measured soil in this contaminated area to contain concentrations of Ra-226 to be 235 pCi/g, Th-230, 18.6 pCi/g, and U-238, 5.47 pCi/g[47].

[45] CWM, 2008, p. 2-1.
[46] ORAU, 1983b. *Comprehensive Radiological Survey, Off-Site Property H', Niagara Falls Storage Site, Lewiston, New York,* Final Report, June 1983.
[47] CWM, 2008.

If CWM Investigation Area 7 does indeed include LOOW Vicinity Property H', then the results presented in the 2008 CWM Report are false. Highly elevated concentrations of radionuclides would be present in the southwestern portion of Investigation Area 7, and therefore, Investigation Area 7 is an area that would not be found to meet DOE criteria. The fact that CWM claimed that Investigation Areas 7 and 12 included LOOW Vicinities H' and S, respectively, while they were actually not included in the walkover survey shows that CWM is inconsistent in its radiological investigation procedures. These inconsistencies suggest that CWM could have improperly investigated other areas during its walkover survey, therefore providing false results in its 2008 report.

Section 2. CWM Methodology

The relationship between survey meter measurements and soil concentrations of radium, in light of CWM's measurement height of 30 cm, is an important issue. It relates importantly to what a surveyor can detect during a gamma walk-over survey. In our opinion, NYSDEC improperly approved of the CWM methodology.

The relationship between what a survey meter detects and the radioactive concentrations of discrete pieces of radioactivity depends strongly on the survey height. This is not a simple problem; books have been written on the subject. What is detected on a survey meter, in terms of counts per minute (cpm), is a function of the characteristics of the detector (efficiency, window area, height), the nature of emissions (type, energy and concentration), the relative distribution of the potential contamination (point, area or volume source), and the human element (the scan rate and ability of the surveyor to see or hear the difference from background counts).[48] The human element for an ideal surveyor can also be quantified, in terms of Type I error (α) and Type II error (β), that is, the false positive rate (α) and true positive rate ($1-\beta$). Generally we would like to increase the true positives, say 95%, and decrease the false positives, say as little as 5%. We narrow the focus to CWM's methodology and the implications of a survey height of 30 cm (CWM) vs MARSSIM's[49] recommended height of 10 cm.

CWM (likely Shaw Environmental who did the work) bases their calculations on NUREG-1507, to arrive at an efficiency for detecting the radionuclide set Ra-226 plus decay products of 847 cpm per µR/h, a minimum scan sensitivity of 1.26 µR/h and a minimum detection of 2.1 pCi/g Ra-226. The efficiency is used to detect the minimum detectable concentration for the Ra-226 set. The efficiency is the ability to detect the radionuclide set, Ra-226 plus decay products.

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[48] NUREG-1507, 1998. Abelquist, E.W., Brown, W.S., Powers, G.E., and Huffert, A.M. *Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG-1507, U.S. Nuclear Regulatory Commission, June 1998, p. 6-1.

[49] EPA, 2000. MARSSIM, EPA 402-R-97-016, Rev. 1, August 2000.

Two critical assumptions by CWM will lead to overestimates of the sensitivity of their measurements, that is, it is our opinion that CWM is measuring Ra-226 to a much greater minimum detection concentration than 2.1 pCi/g.

Measurement Height

CWM assumes a detection elevation of 30 cm or one foot and a background count rate of 10,000 cpm. Assuming an infinite plane, the count rate for background at 10 cm and 30 cm should be the same. However, for a finite piece of radioactive material, the height, 30 cm, is important.

In estimating the sensitivity of their measurements, CWM chose a cylindrical hot spot with 1 square meter in area and 15 cm depth. This is a large piece of radioactive material, weighing more than 500 lbs. However, to make the calculation, CWM employs data from NUREG-1507, Table 6.3, the detector count rate based on the emitted energy. Table 6.3 is based on a detector response to a smaller object, with surface area 0.25 m^2, or ¼ the size of CWM's reference material. The difference between CWM's measurement height and assumed surface area and the measurement height and surface area assumed in NUREG-1507, Table 6.3, results in a detector response difference of about 35%.

Surface Areas

As noted above, detection sensitivity is also affected by the surface area of contaminated material. In the table below, we compare the emanated radiation measured at heights H1, 30 cm and H2, 10 cm as a function of the surface area.

Table. Ratio of Gamma Emanation at Height 10 cm and 30 cm as a Function of Surface Area

radius rock (ft)	radius rock (cm)	Ratio[a] (H1/H2)
40	1200	0.770584
4	120	0.569292
2	60	0.445714
1	30	0.30103
0.333333	10	0.152003
0.033333	1	0.111604

[a] H1 is 30 cm height H2 is 10 cm height

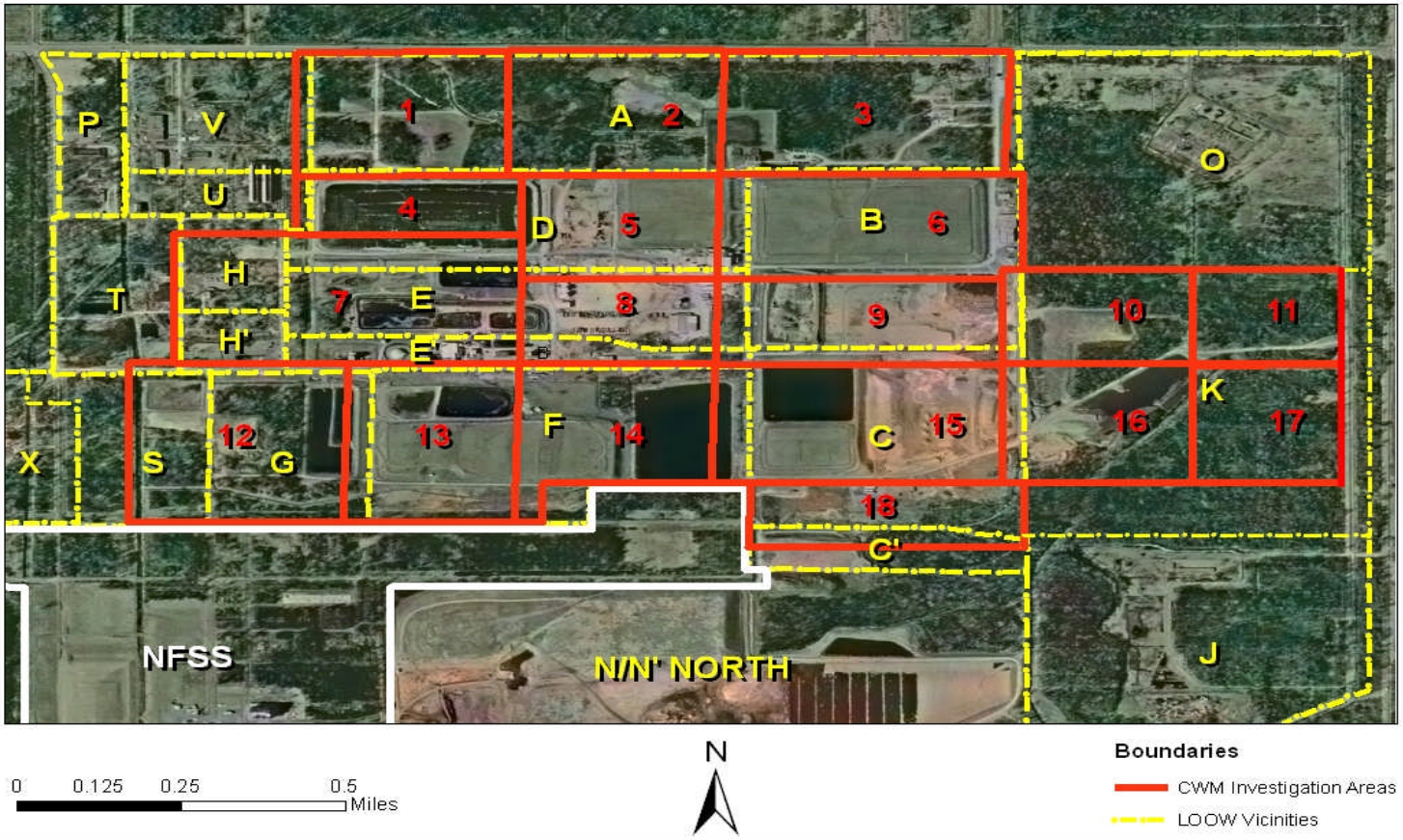
As seen, for small particles, with radius 1 cm, the measured radioactivity declines by a factor of 9 when the height of the detector changes from 10 cm to 30 cm. These particles will not be seen by CWM surveyors. In general, an experienced surveyor can detect a count rate 25% to 50% above background of 10,000 cpm. Slag, with radius on the order of 100 cm and Ra-226 concentrations on the order of 700 pCi/g have been seen by CWM

surveyors. This very likely leaves a very large amount of slag remaining on the CWM property that was not seen by CWM surveyors.

It is contrary to the standard measurement techniques to survey property at a height of 30 cm. The standard surveying references, NUREG-1507 and MARSSIM, advise a height of 10 cm. It is likely that CWM has missed smaller and/or less radioactive pieces of slag by use of a 30 cm measurement height. Unfortunately one cannot work backwards to produce data that was not originally seen by CWM surveyors. The only way to detect the missing radioactive material is to resurvey the CWM property correctly, at a height of 10 cm.

Figures

Figure 1. Comparison of CWM Investigation Areas and LOOW Vicinities



Note: Diagram is for visual purposes. Boundaries are approximate only.

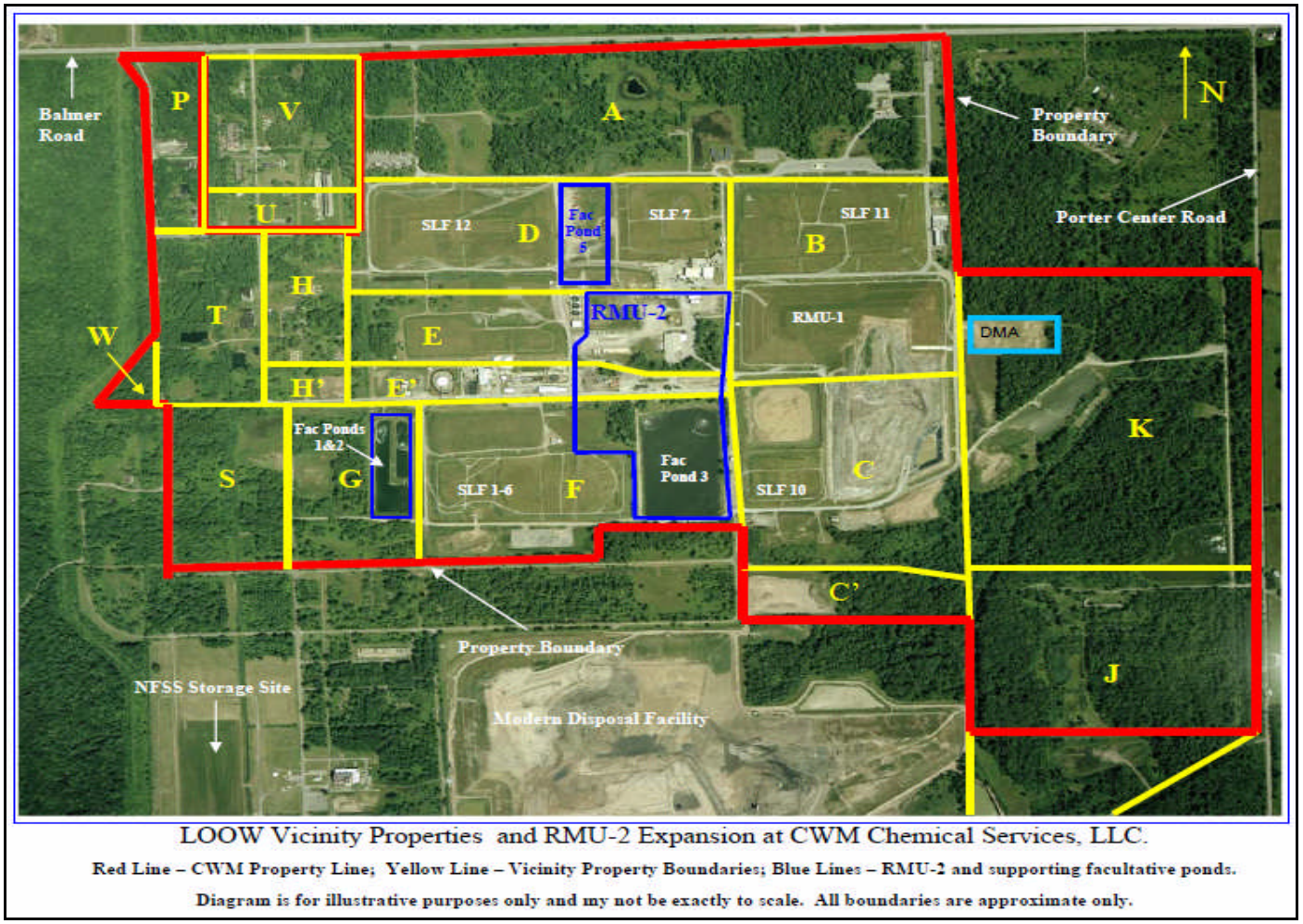


Figure 2. Aerial photograph of CWM property displaying proposed location of Fac Pond 5[50]

[50] CWM, undated.

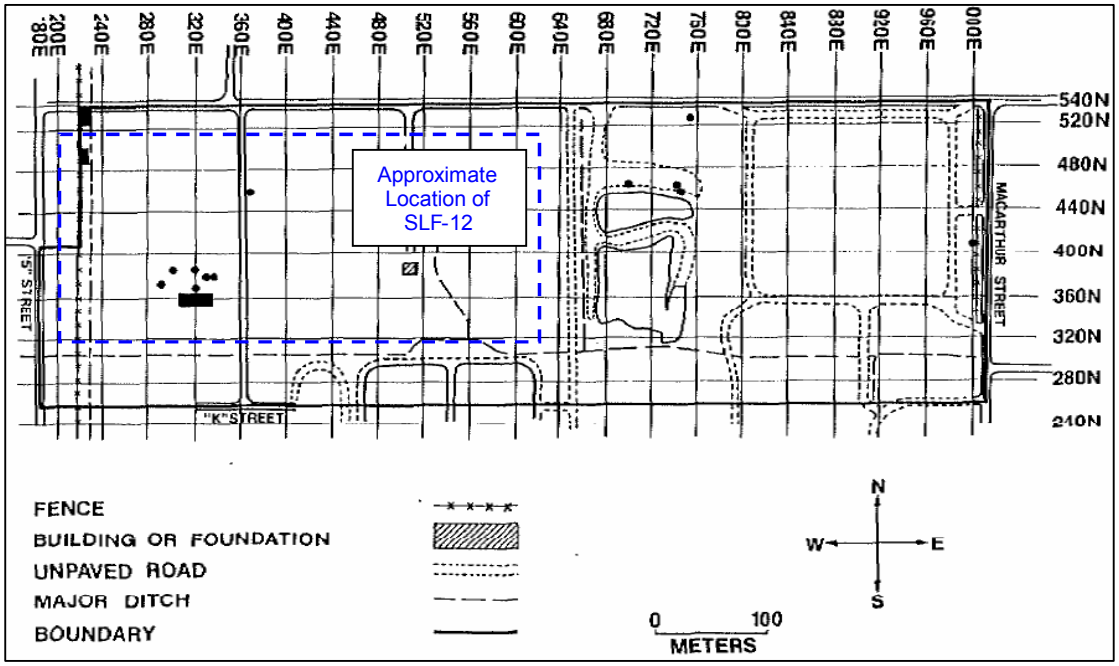


Figure 3. LOOW Vicinity Property D areas of elevated direct radiation (dark areas indicate regions of generally elevated radiation levels, dots indicate isolated hot spots).[51]

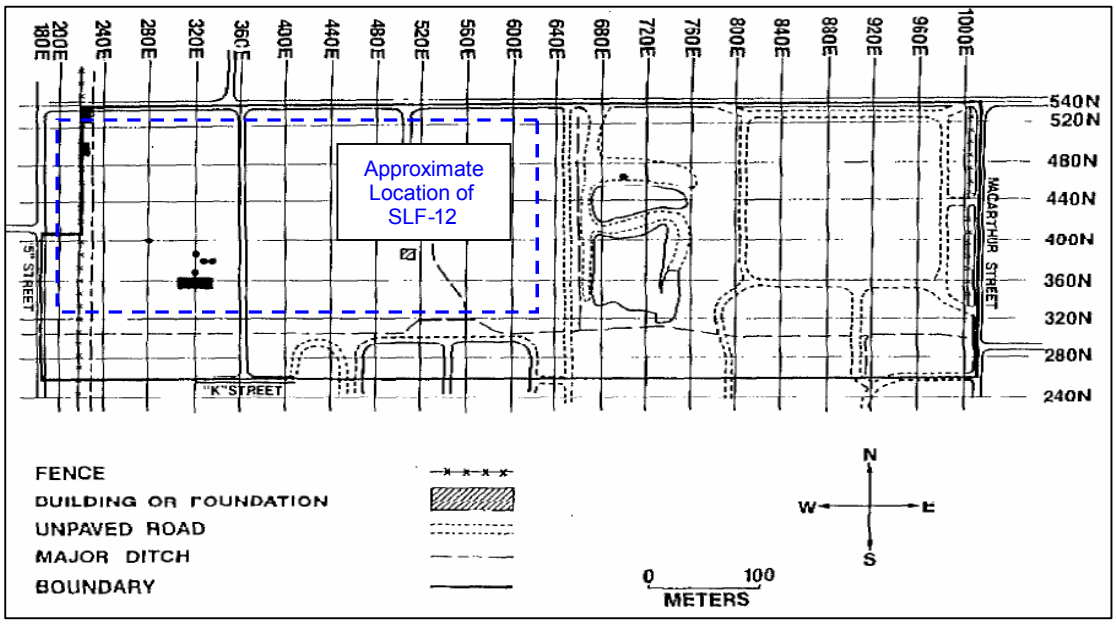


Figure 4. LOOW Vicinity Property D areas with elevated radionuclide concentrations in soil that exceed DOE criteria (dark areas indicate regions of generally elevated radionuclide concentrations in soil, dots indicate isolated hot spots).[52]

[51] ORAU, 1984a.
[52] *Ibid.*

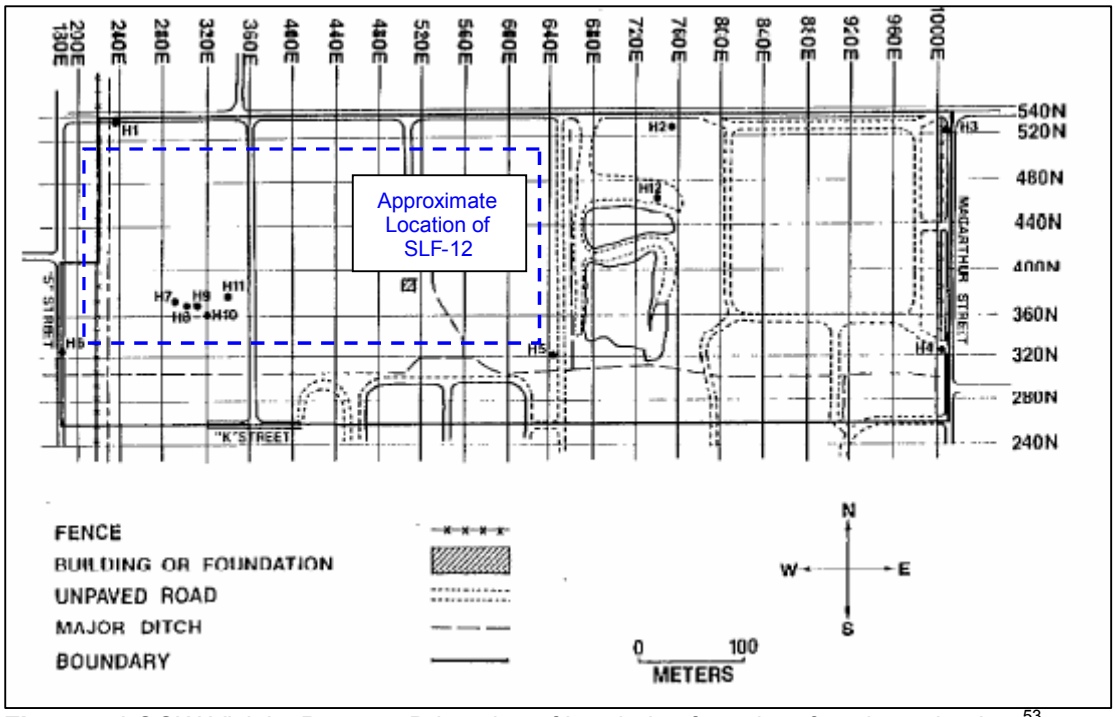


Figure 5. LOOW Vicinity Property D location of boreholes for subsurface investigation.[53]

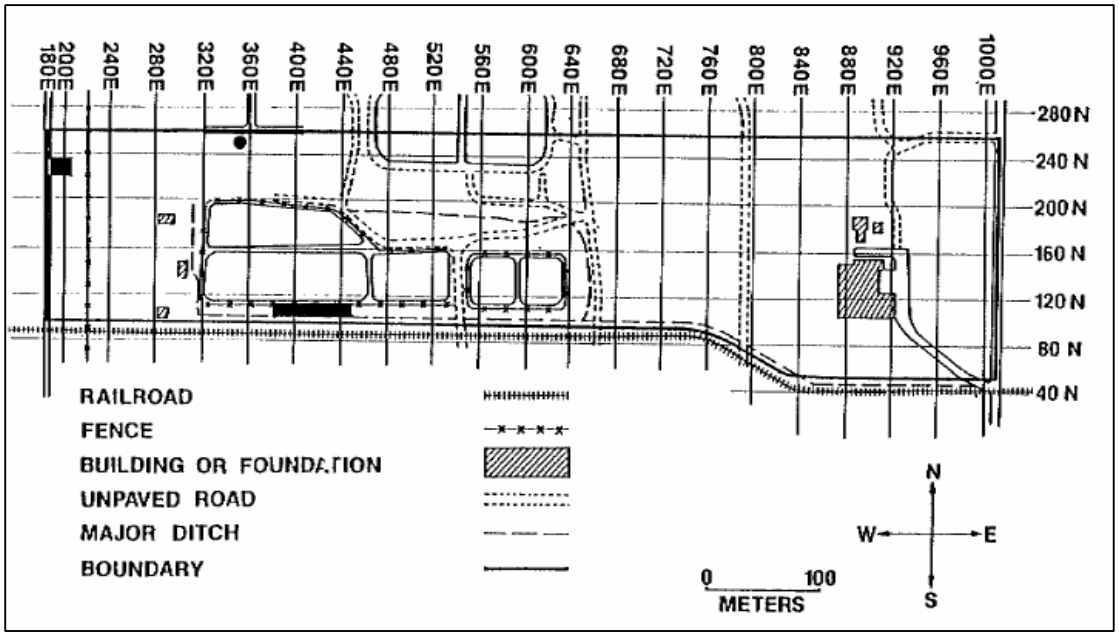


Figure 6. LOOW Vicinity Property E areas indicating elevated radionuclide concentrations in soil that exceed DOE criteria (dark areas indicate regions of generally elevated radionuclide concentrations in soil, dots indicate isolated hot spots).[54]

[53] *Ibid.*
[54] ORAU, 1984b.

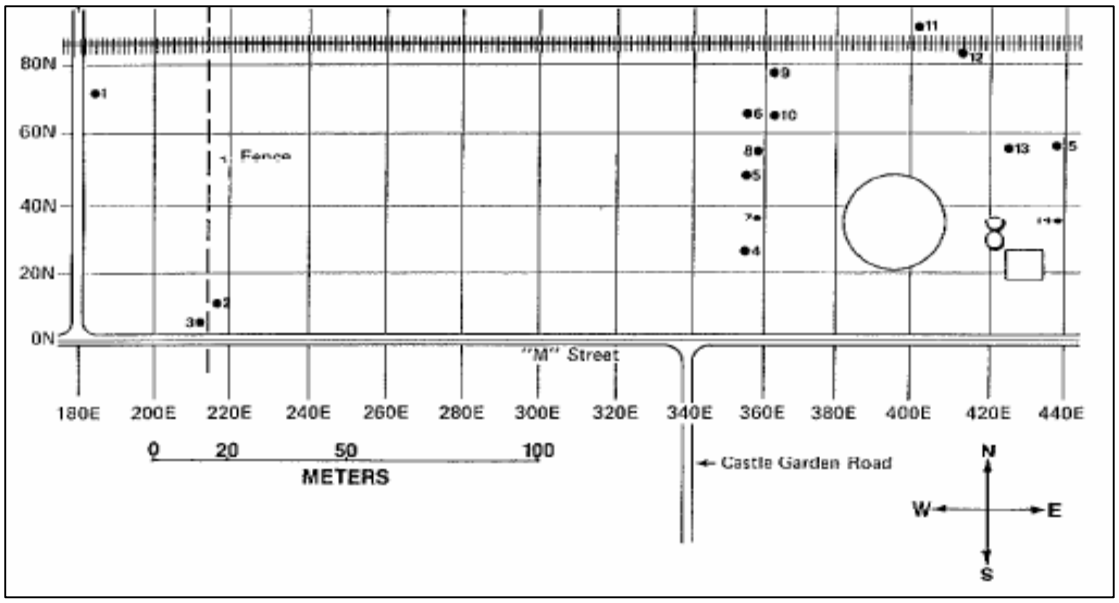


Figure 7. Western portion of LOOW Vicinity Property E' indicating areas of elevated surface radiation levels.[55]

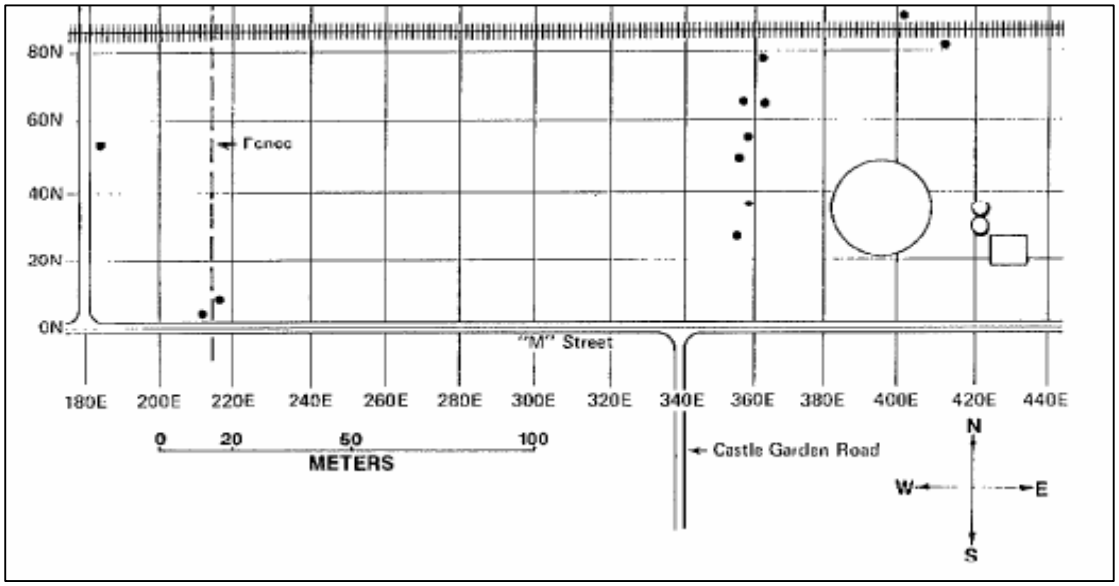


Figure 8. Western Portion of LOOW Vicinity Property E' indicating areas of elevated radionuclide concentrations in soil that exceeded DOE criteria.[56]

[55] ORAU, 1983a.
[56] *Ibid.*

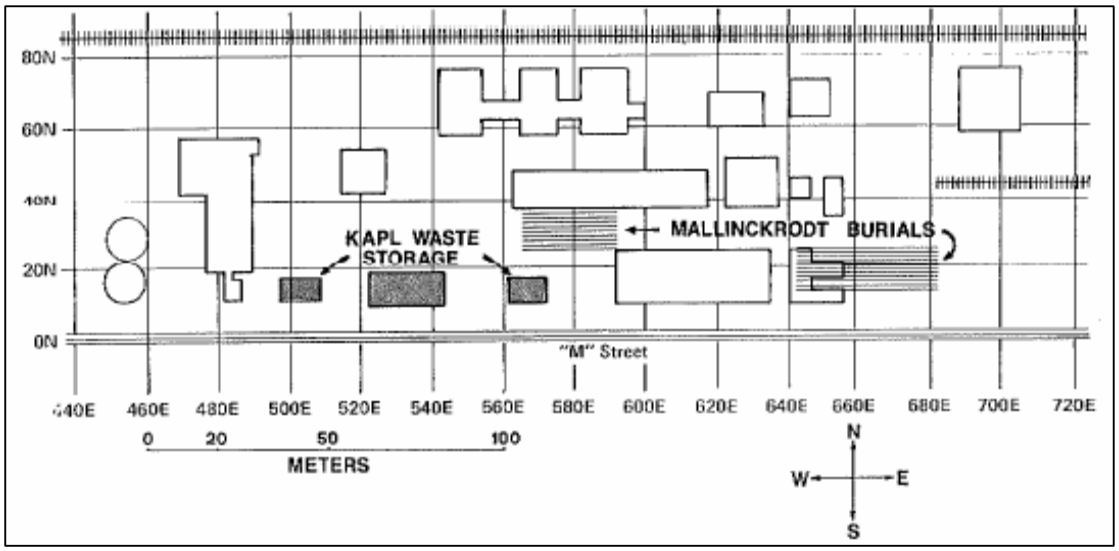


Figure 9. Central Portion of LOOW Vicinity Property E' indicating areas previously used for the burial or storage of radioactive wastes.[57].

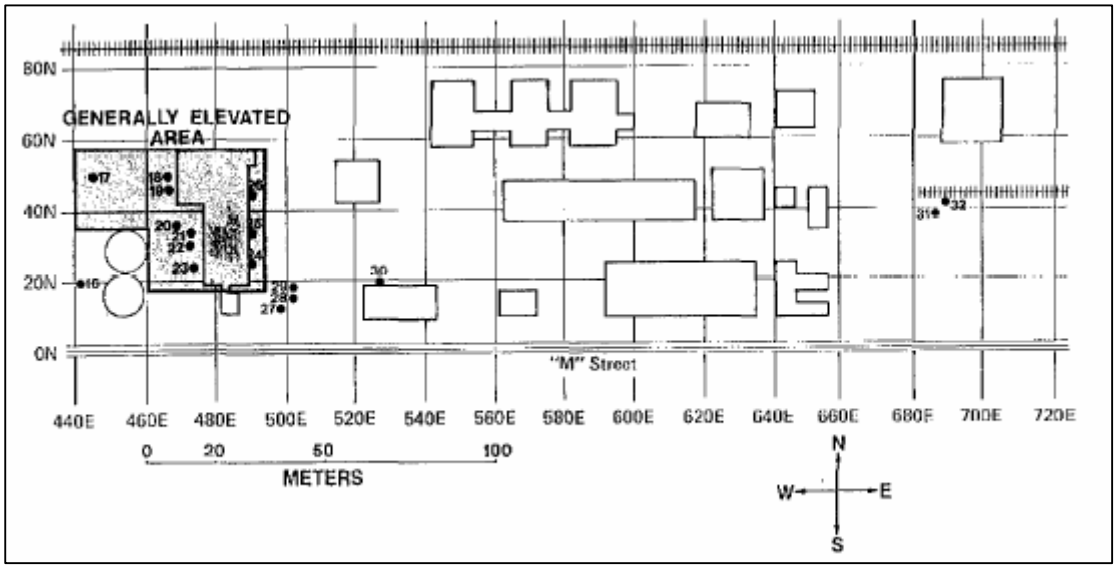


Figure 10. Central portion of LOOW Vicinity Property E' indicating areas of elevated surface radiation levels.[58]

[57] *Ibid.*
[58] *Ibid.*

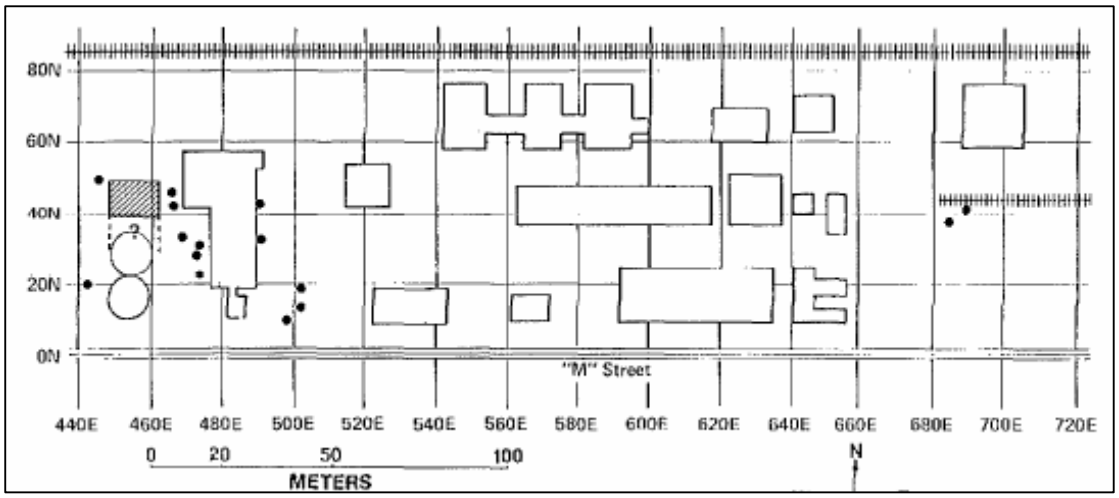


Figure 11. Central portion of LOOW Vicinity Property E' indicating areas where radionuclide concentrations in soil exceeded DOE criteria (dark areas indicate regions of generally elevated radionuclide concentrations in soil, dots indicate isolated hot spots).[59]

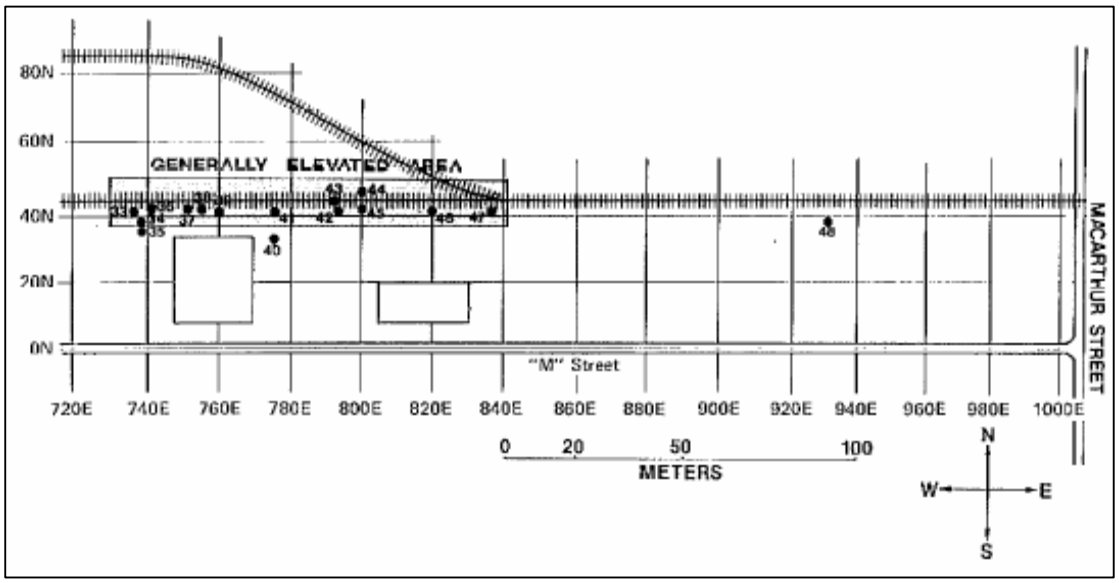


Figure 12. Eastern portion of LOOW Vicinity Property E' indicating areas of elevated surface radiation levels.[60]

[59] *Ibid.*
[60] *Ibid.*

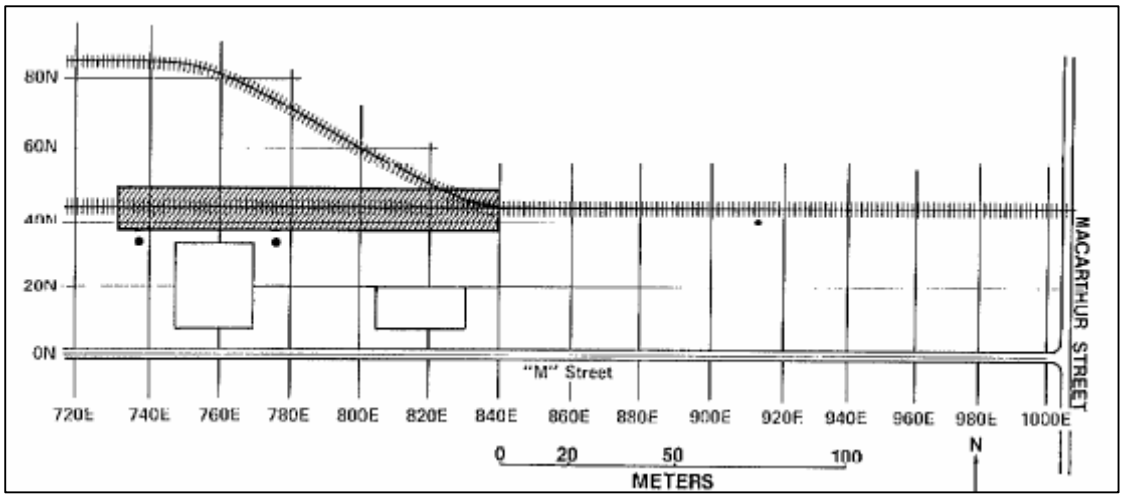


Figure 13. Eastern portion of LOOW Vicinity Property E' indicating areas of elevated radionuclide concentrations in soil (Dark areas indicate regions of generally elevated radionuclide concentrations in soil, dots indicate isolated hot spots).[61]

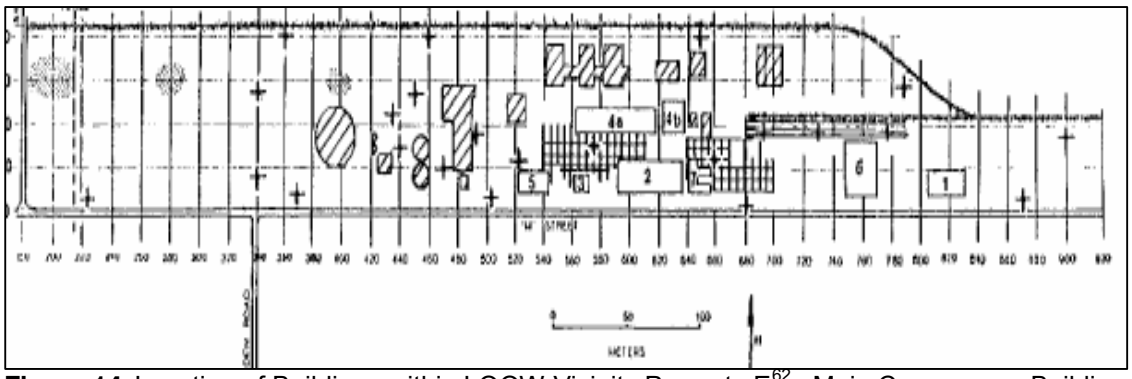


Figure 14. Location of Buildings within LOOW Vicinity Property E[62]. Main Compressor Building assumed to be building "4a".

[61] *Ibid.*
[62] Detection Science Group, 1982.

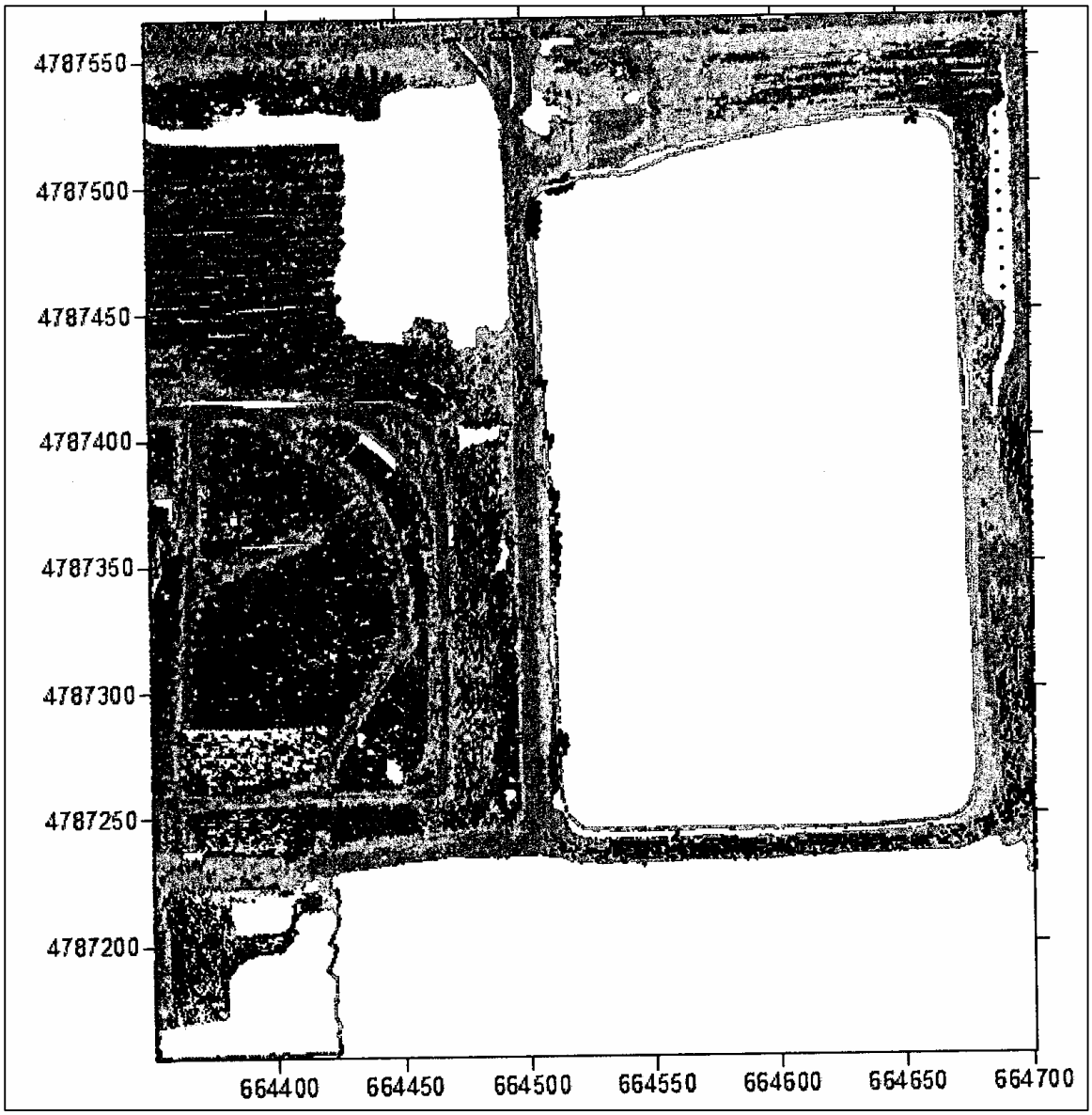


Figure 15. CWM Investigation Area 14 (eastern portion of LOOW Vicinity Property F). White areas indicate locations not scanned by CWM in 2008 survey.[63]

[63] CWM, 2008. Appendix A, p. A-42.

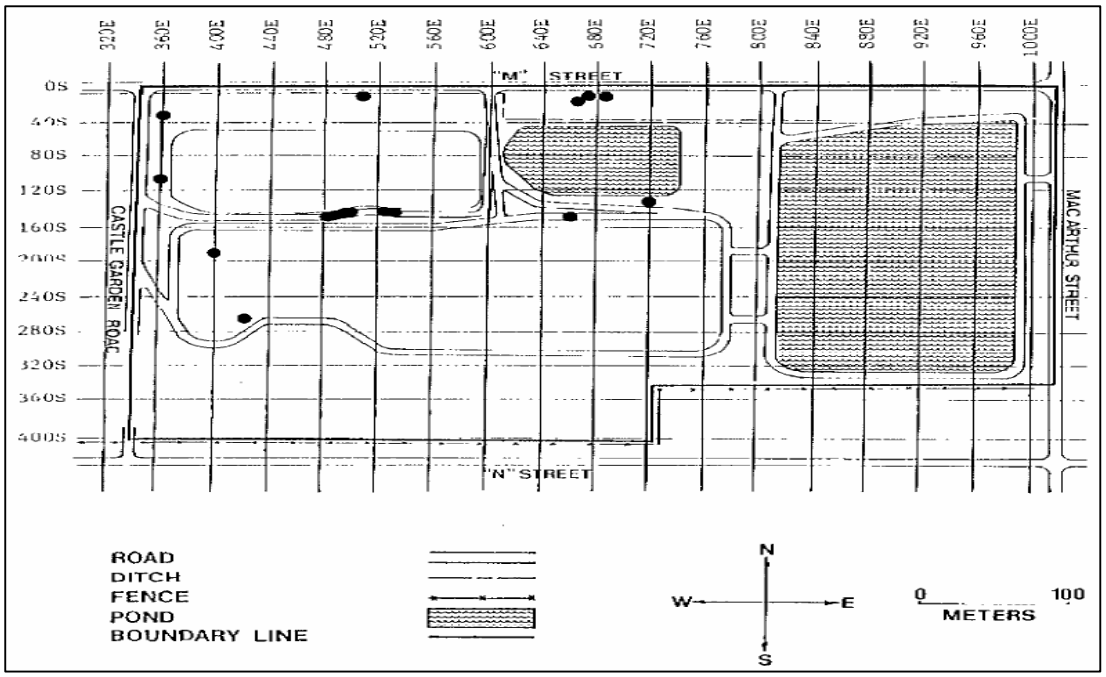


Figure 16. LOOW Vicinity Property F with areas indicating elevated surface radiation levels.[64]

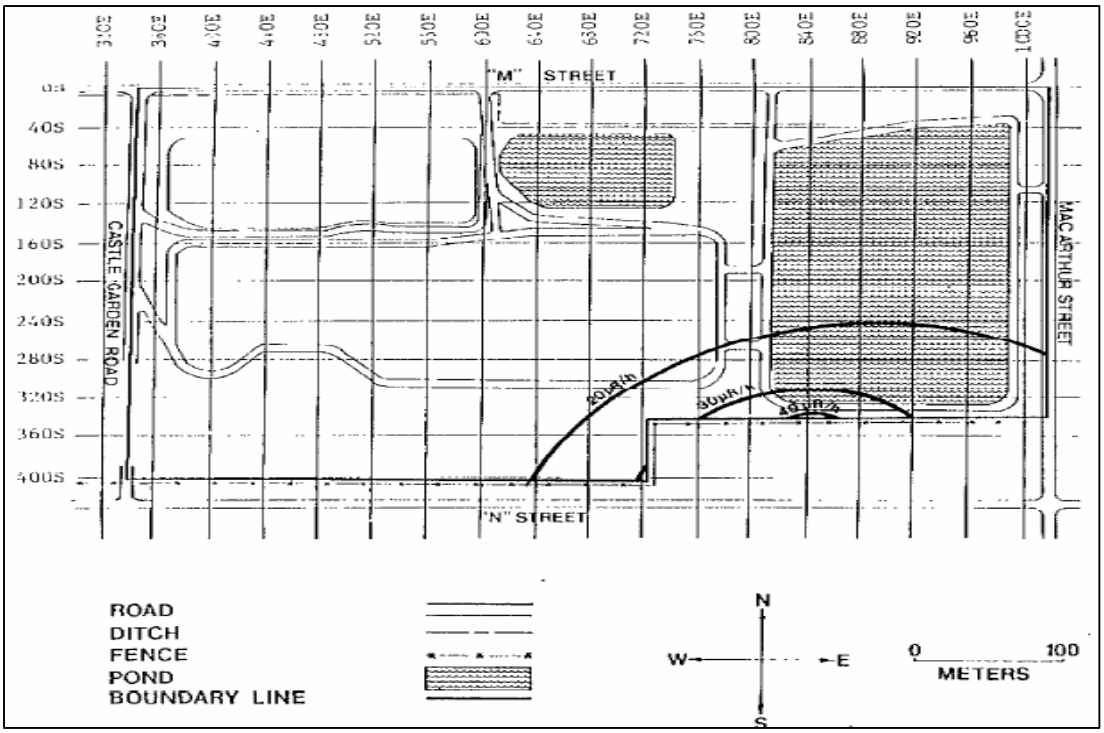


Figure 17. LOOW Vicinity Property F with exposure rates (uR/h) measured at 1meter about the surface.[65]

[64] ORAU, 1984c.
[65] *Ibid.*

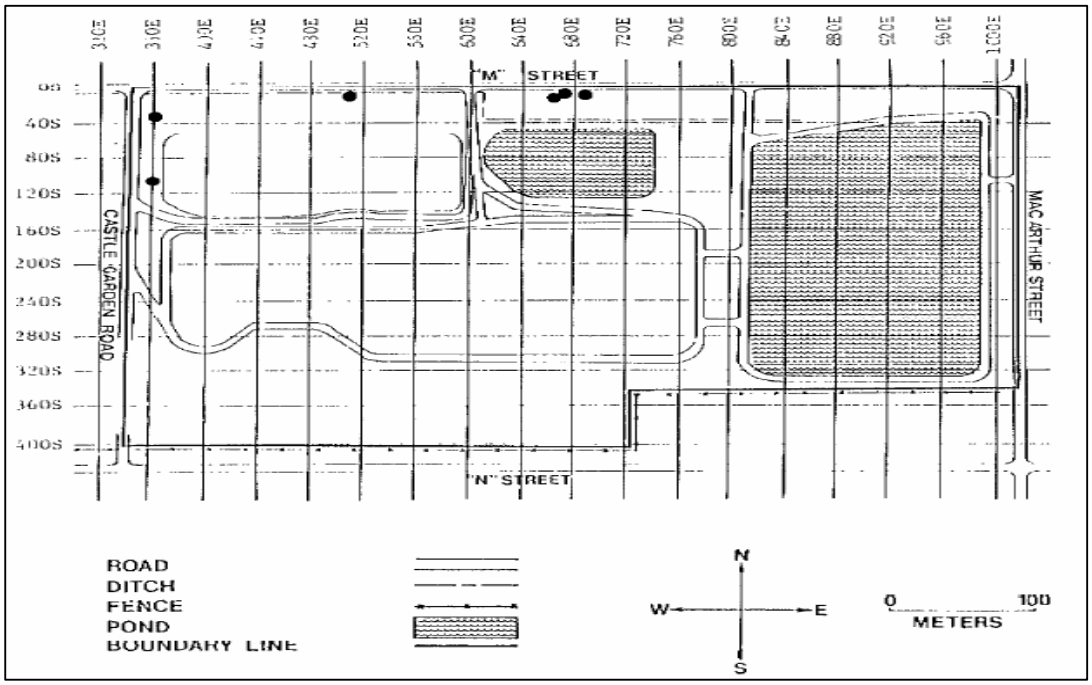


Figure 18. LOOW Vicinity Property F locations were radionuclide concentrations in soil exceeded the criteria for Formerly Utilized Sites.[66]

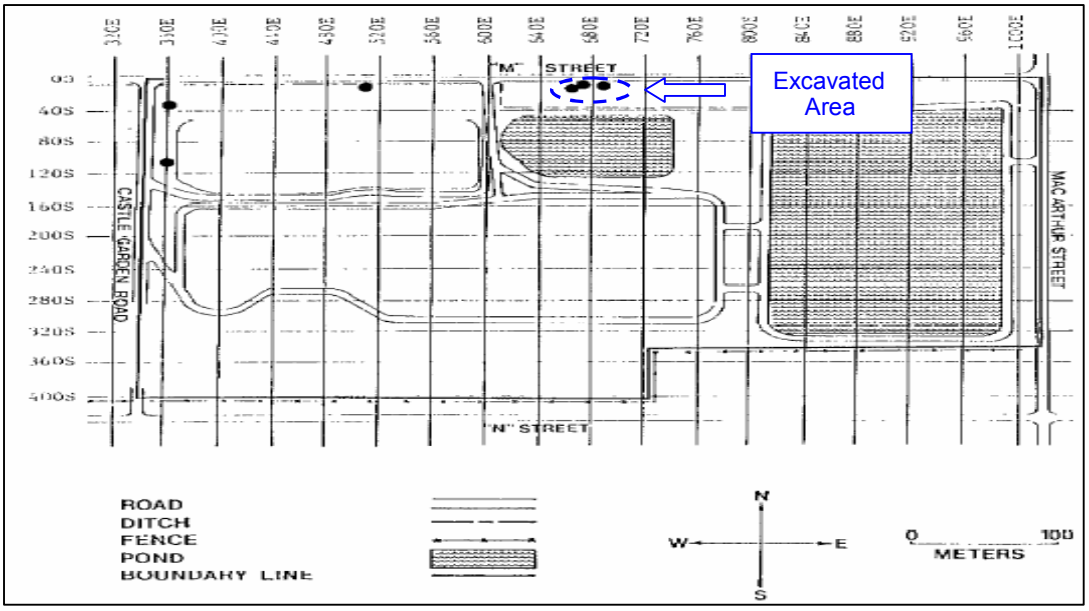


Figure 19. LOOW Vicinity Property F indicating excavated area.[67]

[66] *Ibid.*
[67] *Ibid.*

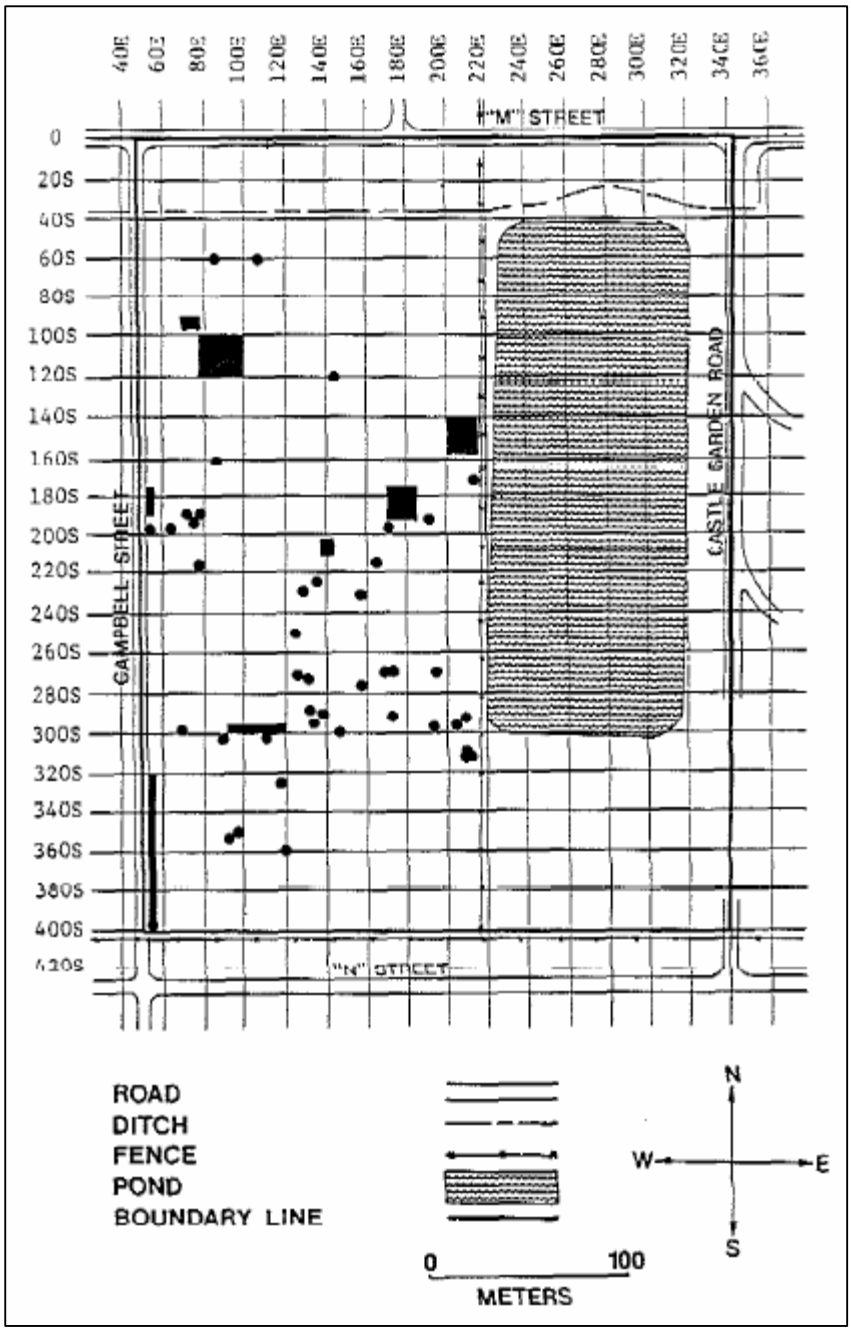


Figure 20. LOOW Vicinity Property G with locations of areas of elevated direct radiation (dark areas indicate regions that are generally contaminated, dots indicate isolated hot spots).[68]

[68] ORAU, 1984d.

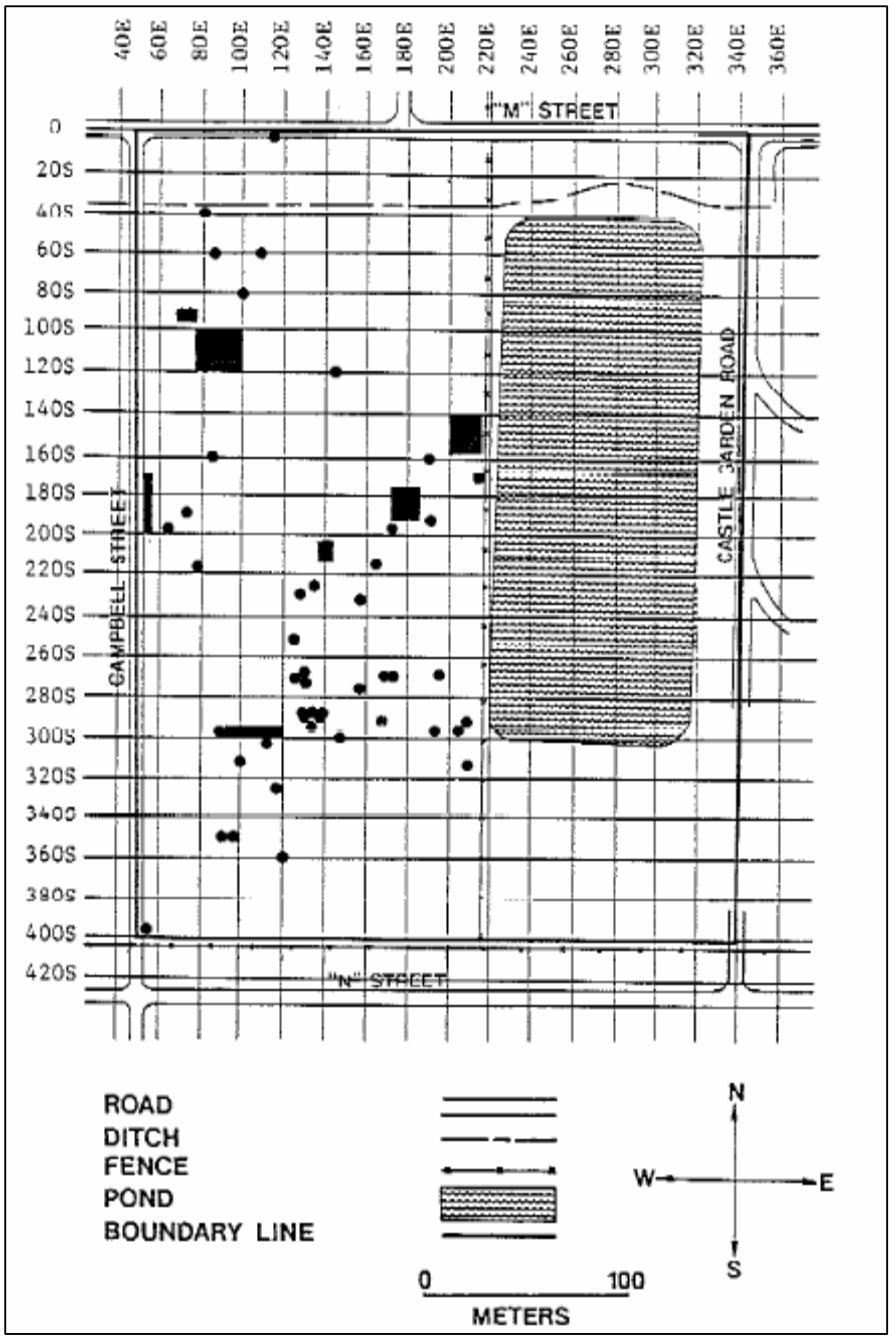


Figure 21. LOOW Vicinity Property G with locations of areas where radionuclide concentrations exceeded criteria levels (dark areas indicate regions that are generally contaminated, dots indicate isolated hot spots).[69]

[69] *Ibid.*

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