RADIATION SURVEY REPORT
NO. CESWT-SO-R2-05-98
MONAZITE AOC
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
18-22 MAY 1998

PREPARED FOR:
U.S. ARMY CORPS OF ENGINEERS, LOUISVILLE DISTRICT

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EXECUTIVE SUMMARY
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1. PURPOSE. This survey was conducted to determine the presence and extent of potential radiological contamination in the Monazite Area of Concern (AOC) at Ravenna Army Ammunition Plant (RVAAP) and to aid determination of remedial alternatives.

2. CONCLUSIONS.

2.1 A review of the survey results indicate that there is Thorium-natural contamination above acceptable average and hot spot levels in the Monazite AOC.

2.2 Given the elevated sample results some level of remediation or control is warranted.

2.3 The external pathway contributes almost all of the dose from the contamination in the AOC. Remedial activities should focus on controlling the external pathway or eliminating the source.

3. RECOMMENDATION. Establish specific Derived Concentration Guideline Levels for the Monazite AOC and excavate soils exceeding the levels using an insitu-gamma spectrometry system to guide the excavation. Evaluate excavated soils for acceptance by a RCRA subtitle C facility.

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1. **REFERENCES.** See Appendix A for a list of references.

2. **PURPOSE.** This survey was conducted to determine the presence and extent of potential radiological contamination in the Monazite Area of Concern (AOC) at Ravenna Army Ammunition Plant (RVAAP) and to aid determination of remedial alternatives.

2.1 Specific objectives.

2.1.1 Define the quantities and spacial distribution of the residual radioactivity in the AOC.

2.1.2 Define the boundaries of residual radioactivity in the AOC.

3. **GENERAL.**

3.1 Project management for the survey was conducted by the U.S. Army Corps of Engineers, Tulsa District (USACESWT).

3.2 The survey was managed by Mr. David Hays, Health Physicist, USACESWT. A team of consisting of Mr. Hays and Mr. Barry Tudor, USACESWT, Industrial Hygienist performed the field surveys.

3.3 The USACE personnel mentioned above have varied expertise in radiological health issues and are qualified to perform the survey. Each individual was provided occupational health and safety training by USACESWT to administer a safe working environment.

3.4 Laboratory analyses were performed by the U.S. Army Center for Health Promotion and Preventive Medicine Radiologic, Classical, and Clinical Chemistry Division (RCCCD).

3.5 RCCCD utilized its Internal Quality Assurance (QA) Plan for the sample analysis and data validation.

3.6 The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) provided Mr. Mark Moscato as a

Quality Assurance Officer. Mr. Moscato reviewed the work plan and provided recommendations to insure a comprehensive survey. He also observed surveys in progress to insure the plan was followed.

3.7 A list of abbreviations used in this report can be found in Appendix A.

4. Site and Project Background.

4.1 Site Background.

4.1.1 DOD activities at Ravenna Army Ammunition Plant(RVAAP) date back to 1940 and include the storage, handling, and packing of military ammunition and explosives. The site is located in northeastern Ohio in Portage and Trumbell Counties, see Appendix B. The installation includes 21,419 acres in a tract approximately 3.5 miles wide by 11 miles long. RVAAP is a government owned contractor operated facility under the control of the US Army Industrial Operations Command.

4.1.2 A site assessment was conducted and documented in: Preliminary Assessment for Ravenna Army Ammunition Plant, February 1996, by Science Applications International Corporation (SAIC). This site assessment did not adequately address the radiological concerns at RVAAP.

4.1.3 A historical assessment of radiological use at RVAAP was conducted in July of 1990, by Olin Ordnance. The report generated from that assessment identified the Monazite Sand Storage and Projectile Radiography operations. These operations were licensed by the Atomic Energy Commission [now the US Nuclear Regulatory Commission (NRC)]. Both licenses were terminated.

4.1.4 Radioactive materials (RAM) were known to be used or stored at four locations on RVAAP.

- Monazite Sand Storage Area
- Projectile Radiography on Load Line 3
- Building 2F4
- Building 130

4.1.4.1 Areas other than the Monazite sand location are addressed in RADIATION SURVEY REPORT NO. CESWT-SO-**R1**-05-98, RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO, 18-22 MAY 1998.

4.1.4.2 Monazite AOC. The Monazite AOC consists of approximately 4,400 square meter area between and along two former rail lines in the tank farm area of RVAAP. The General Services Administration (GSA) owned Monazite ore and leased two tanks from RVAAP to store the ore from the late 1950's to 1974. The two storage tanks (tanks 1305, and 1303) were used to store approximately 3,023,553 pounds of monazite ore. The monazite ore contained less than 10 percent natural Thorium. Data on the license application indicates 170,000 pounds of Thorium. This is approximately 6% of the total weight.

The ore was removed and shipped to Holland under an AEC licensed action under export license STE-8179. The historical documentation of this export consist of the AEC license application and a few letters from GSA. It is unclear if the license number STE-8179 is an AEC number. GSA's policy of destroying records seven years after transaction has limited the available records.

Monazite ore was only stored at RVAAP. Monazite is a very insoluble and stable crystal structure and does not degrade in typical environmental conditions. Thorium is not very mobile in the environment and is normally distributed by physical means.

GSA contracted with Health Physics Associates Ltd to decontaminate the tanks and surrounding area in May 1975. The tanks were decontaminated and declared excess by GSA in January 1976. The tanks were demolished sometime later. During the survey of the decontaminated tanks contamination of the soil was found east of tank 1303. The top few inches of soil were to be scrapped and drummed for disposal. A letter from GSA to the commander of RVAAP, dated 7 January 1976, states that this was done. All waste from the decontamination in 1975 was drummed and shipped to a burial site in Kentucky. See Appendix G for copy of this historical documentation.

The Ohio Department of Health requested that, as part of the radiological survey of other areas of RVAAP, USACE scan the former monazite storage area. This was done as part of a scoping survey in April 1998. During this survey it was determined that exposure levels in excess of 40 times background were present in several areas and the exposure rate across the area was greater than background for RVAAP. The surface scan conducted by Health Physics Associates in 1975 identified elevated exposure readings in some of the same areas as found in this survey. Results of the 1975 surface scan are included in Appendix G.

4.2 Chronology.

4.2.1 The USACESWT began preparations for the survey in April of 1998.

4.2.2 On 11 April 1998 the USACESWT conducted a scoping survey and walkover of the AOC.

4.2.3 After addressing all interested parties' comments the USACESWT finalized the survey work plan on 15 May 1998; Radiation Survey Plan No. CESWT-SO-P1-05-98, Ravenna Army Ammunition Plant, Ravenna, OH, 18-21 May 1998.

4.2.4 On 18 May 1998 the USACESWT began it's survey of RVAAP AOC. The workplan and health and safety plan, were adhered to in all phases of the work.

4.2.5 The USACESWT received final laboratory results for the survey on 28 August 1998.

4.3 Site Conditions at time of Survey.

4.3.1 The AOC was dry and covered by vegetation with the exception of the rail beds. The east rail bed consists of rock and the west rail bed had recently been dug up to remove the rail ties. A shallow (2 ft) ditch runs along the east side of the east rail bed.

4.3.2 Two crushed and badly corroded drums were on the site. The drums were contaminated with radioactive material and contained plastic sheeting, some soil, and rubber gasket material. The drums are located just east of the west rail bed and between tanks 1306 and 1310 (see Appendix E photographs).

4.3.3 A 48 m^2 concrete pad exists in the contaminated area across (east) from tank 1306. The pad is visible in the historical photo provided in Appendix E, and it is drawn on the site drawing (see figure 5-2).

4.3.4 Onsite support was available to the USACE team during the survey; excellent support was provided by Mr. Mark Patterson and the RVAAP security personnel.

4.3.5 Building 1055 was used as the base of operations for the survey team. The USACE and USACHPPM field personnel utilized this building throughout the survey.

4.3.6 A scoping survey conducted in April of 1998 identified radiological contamination from operations in the AOC.

4.4 Potential Contaminants. The potential contaminant at the Monazite AOC is Thorium natural (Th-232 and associated radioactive daughters). Uranium is discussed due to concerns in other AOCs. Guideline values for these isotopes are reported in Table 4.4.

Table 4.4 Derived Concentration Guidelines (DCGL)

Contaminant	DCGL Soil pCi/g	DCGL Structures dpm/100 cm^2
Th-232 + Daughters	*9	1,000 total, 200 removable
U-238	35	5,000 total

* The use of the computer model (RESRAD) and 9 pCi/g resulted in a site specific industrial use exposure of 25 mrem/yr, however, the 40 CFR 192.41 limits of 5 pCi/g surface and 15 pCi/g subsurface may be acceptable as guidance to aid in determination of alternatives. Legally the 40 CFR 192 standard is not applicable to the AOC. The residential guideline limit corresponding to 25 mrem/yr was calculated using RESRAD and is 3 pCi/g. See Appendix F for the input parameters and the RESRAD Report.

5. RADIATION SURVEYS and RESULTS.

5.1 Instruments/Equipment.

5.1.1 A list of instruments is provided in table 5-1.

Table 5-1. Instrumentation used during the RVAAP Survey.

	Alpha/Beta	PIC	Gamma NaI 1"x1"	Gamma Spectrometer
Readout Make	LUDLUM	Reuter Stokes	LUDLUM	CANBERRA
Readout Model	2360	**RSS-112**	2350-1	Inspector
Serial Number	141324	97100087	129436	Not Listed
Cal. DUE Date	30 Jul 98	11 Nov 98	25 Sep 98	FIELD E. CAL
Calibrated Sensitivity	23% Tc-99 24% Th-230	< 1 uR/hr	< 1 uR/hr	1024 CHANNELS
Probe Make	LUDLUM	Reuter Stokes	LUDLUM	CANBERRA
Probe Model	43-1-1	RSS-112	44-2	NaI

5.1.2 All instruments met QA requirements of the Sampling Plan. Quality Control Charts for the Ludlum instruments are included in Appendix C. PIC QA was done in accordance with the sampling plan Section 3 paragraph 3.4. The MCA lap top computer battery limited its use so 3 daily repetitive measurements were not done, however, the same location was measured each day.

5.1.3 The gamma probe used was a 1 inch x 1 inch sodium iodide crystal.

5.1.4 The sensitivity of the gamma survey meter is less than 1 uR/hr and correlates well with NUREG 1575, Table 6.7. The estimated scanning minimal detectable concentration of Thorium 232 and daughters is 2.5 pCi/g.

5.1.5 Operational instrument checks were performed with a NIST traceable Cesium-137 source. Checks were made at approximately 1 mm from the source. The same procedures were used for each check to assure reproducibility.

5.1.6 The alpha/beta instrument was only used to check equipment for contamination. A second instrument (Ludlum 2350, with GM probe) was used to scan personnel out of the exclusion zone. This instrument response to a check source was checked daily prior to use. This response check was not recorded.

5.2 <u>INSTRUMENTATION SURVEYS</u>. A suitable reference area (3,600 m^2) for the environmental survey was located and instrument readings were collected using the same methods used in the AOC. See Appendix B and D for location of Reference area.

5.2.1 A quick gamma walkover scan was performed in the AOC to delineate the approximate boundary of contamination. An exclusion zone was established using caution tape enclosing this area. The AOC was then sectioned into 100 square meter grids. This resulted in 42 grids. The corners of each grid were marked with surveyor's flags. The grid pattern was started at the southern end of tank #1310 and extended north along the dirt road to the rail bed intersection and east to the east rail bed (See figure 5-2). This area was larger than that expected from the scoping survey. USACE was intending to use the survey results as final status results (depending on the data results) however, the increase in area meant that it was not feasible to do so.

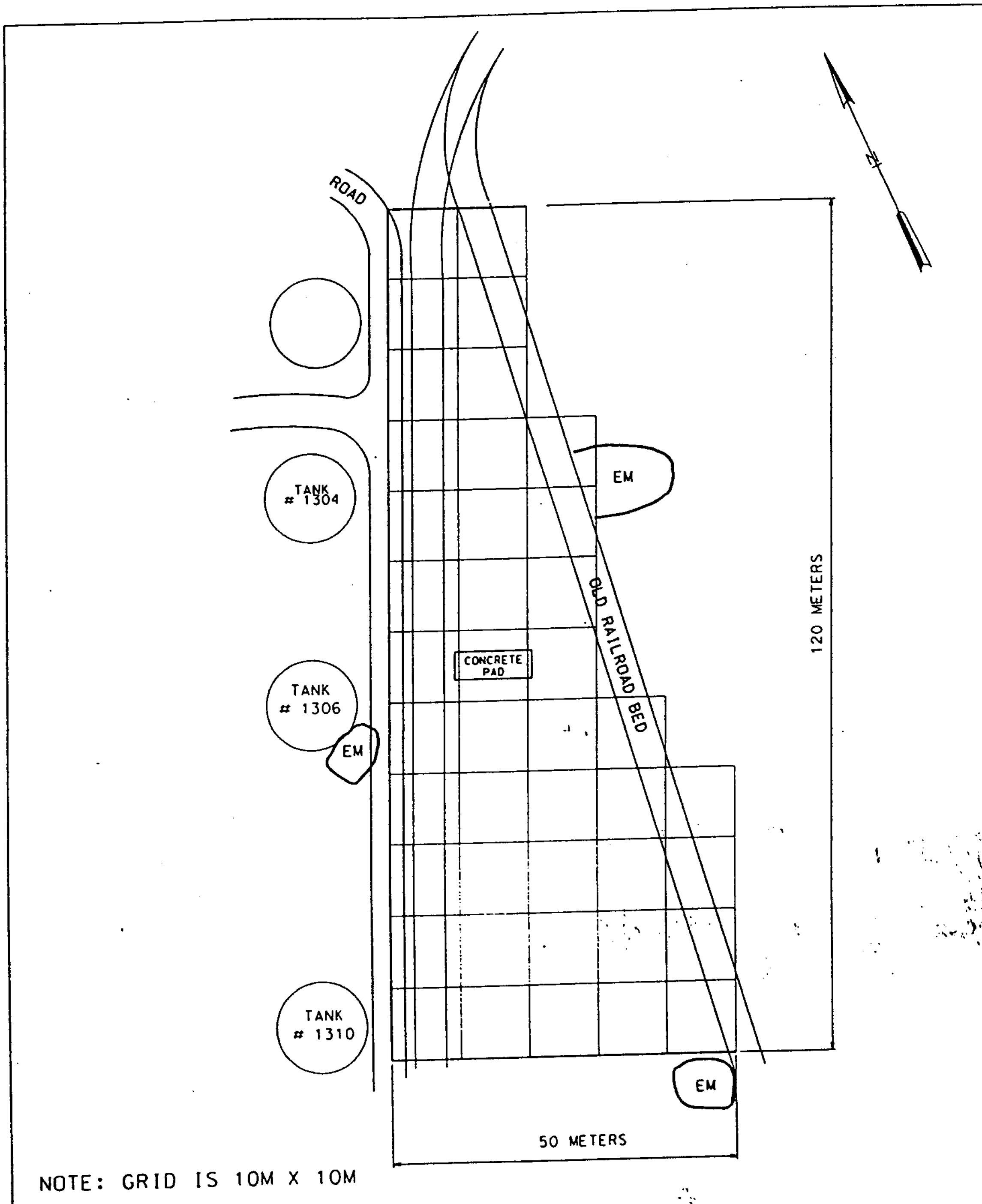
5.2.2 Each grid was then scanned with the gamma instrumentation. Various elevated measurement locations were marked with flags for consideration as sample points.

5.2.3 The gamma scan was then extended to include the west existing row of tanks, the pile of excavated rail ties, the area to the east of the east rail bed, and the northern and southern ends of the area. Three areas of elevated measurements were located outside of the survey grids. These locations are marked on figure 5-2 as EM.

5.2.4 An exposure rate survey was conducted using the gamma instrument (micro Roentgen ratemeter mode) at 1 meter above each sampling location and a walkover scan of 100% of the area with the probe held within a meter of the surface.

5.2.5 One minute integrated counts were also done at each sample location and randomly in each grid square. The 1-minute count was conducted in contact with the ground utilizing the gamma instrument and recorded in counts per minute (cpm). Gamma scanning was also done utilizing the instrument ratemeter mode (kcpm) with the probe held a couple inches off the surface.

Figure 5-2
Area of Concern



TITLE: MONAZITE SAND STORAGE TANK FARM AREA	RVAAP USACE DRAWN BY: ROY LONG	SCALE NONE	SHEET 8 OF 10

5.2.6 The bore hole of samples taken at depth were scanned utilizing the gamma instrument in an attempt to determine vertical extent of contamination. Borings were done in the reference area to establish instrument background data for this purpose.

5.2.7 A multi-channel analyzer was used to collect representative spectrums in the AOC. A few of these spectrums are presented in Appendix E.

5.2.8 In addition to the exposure rate readings, pressurized ionization chamber (PIC) readings were also taken. A PIC is considered a primary standard. This measurement consists of the average of 220 data points collected over a period of eighteen minutes. Occasionally one of the 220 readings was recorded outside of typical values. These anomalies occurred in the reference area and survey areas, additionally, all occurred in the afternoons in direct sun. This has been experienced during other surveys with different PICs and is not considered a reflection of site operations but is possibly due to changes in cosmic radiation.

5.3 SAMPLING. Samples were collected in accordance with the sampling plan with the exception of the depth samples. All samples met the laboratory and sampling plan quality assurance criteria.

5.3.1 Twenty one soil samples were collected from the AOC (12 surface samples; 2 QC; and 7 at depth). Twenty soil samples were collected from the reference area.

5.3.2 All 41, 0.5 kilogram, soil samples were analyzed for U-238, Th-232 (natural), and any other identifiable isotopes present. The laboratory reported Cs-137 (from weapons test fallout) and Potasium-40, another naturally occurring isotope.

5.3.3 The sampling plan stated a sample was to be collected in the depth interval with the highest reading and the remaining intervals composited. The surface soil had the highest readings and given the soil strata (see Figure 5-4), the decision was made to collect the surface sample and a sample composite from approximately 0.2 to 0.4 meters. While scanning the hole to a depth of 0.5 meters.

5.4 Survey Results.

5.4.1 Instrument Background Results. Background measurements from the reference area were taken for each monitoring instrument and method. The average background values were established at a 95% confidence level. These data are reported in Appendix D and below.

5.4.2 Soil samples were collected from the reference area. These data are reported in Appendix D and below.

5.4.3 Instrumentation survey results.

5.4.3.1 Gamma Instrumentation Results.

Each sample area was surveyed at approximately 1 meter from the surface and the location with the highest exposure reading was recorded. The sample area exposure rates ranged from 15 uR/hr to 1,300 uR/hr, compared to the reference area range of a low of 11.5 uR/hr to a high of 15.5 uR/hr and 13.9 uR/hr mean.

The surface integrated 1 minute count measurements ranged from a low of 2342 cpm to a high of 220255 cpm. The average of the 1 minute count measurements is 32,075 cpm (this average is skewed due to approximately 14% of the readings being extremely elevated >50,000 cpm) in the AOC and is compared to the 2413 cpm mean of the reference area. Removing the extremely elevated counts results in an average of 10,967 cpm.

Scanning of the bore holes indicates that the contamination is primarily in the top 6 inches of soil, with significantly less contamination to a depth of 1 foot. This is supported by and supports the sample results. This also follows the observed soil layer types/composition. The top 4-8 inches is top soil, the next 6-8 inches is a sand layer below which is a clay like layer of undetermined depth. This pattern was fairly consistent throughout the AOC but depths to each varied and in a couple of surface sample locations sand was not found (See figure 5-4). The soil depth pattern may be a result of the construction of the rail lines and tanks, or possibly the stated remedial activities of 1975.

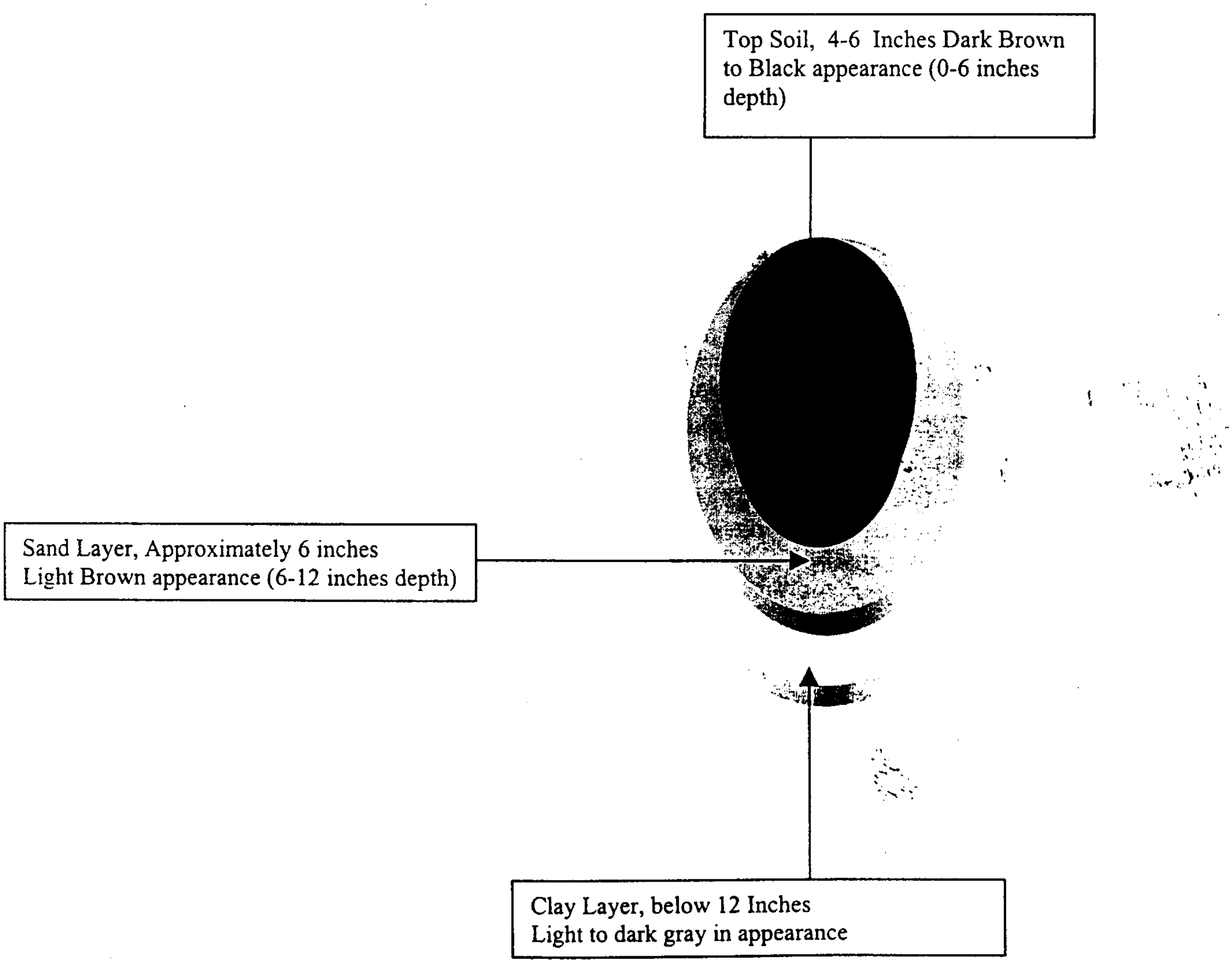
5.4.3.2 Pressurized Ionization Chamber (PIC) Results. The exposure rate ranged from 9.8 uR/hr to 277 uR/hr with a mean of 35 uR/hr at 1 meter height. This compares to the reference area range of 8.9 uR/hr to 11.5 uR/hr and mean of 10.6 uR/hr.

5.4.3.3 Multi-channel Analyzer (MCA) Results. A MCA was used to collect representative spectrums from the AOC and the reference area. Spectrums from the AOC were distinguishable from the spectrums collected in the reference area and were indicative of Th-232 contamination. All spectrums collected in the AOC were identical (independent of amplitude). Representative spectrums are reported in Appendix E.

5.4.3.4 Photo Ionization Detector (PID) Results. A PID was used as a health and safety instrument while sampling. The PID readings varied from a low of 0 to a high of 1 ppm. The individual results are not reported.

Figure 5-4
Monazite Sand Area Of Concern Soil Type and Depth.

Soil strata was determined by visual observation of material in hand auger and hole. <u>Depths and thickness of materials varied over the area.</u> (Note: Types and colors not determined by geologist.)



5.4.4 Laboratory Analysis. Soil samples were collected for gamma spectral analysis, specifically U-238 and Th-232. The laboratory utilized the gamma emissions from daughter products Th-234 and Ac-228 to determine the activities of U-238 and Th-232 respectively. Any other peaks found such as Cs-137 are also reported. Duplicate and replicate samples were taken as discussed in the work/sampling plan.

5.4.4.1 The Th-232 activity concentration ranged from a low of 7 pCi/g to a high of 1,650 pCi/g. This compares to the reference area range of a low of 0.3 pCi/g to a high of 3 pCi/g. The LLD at the 95% confidence level ranged from 0.3 to 4 pCi/g. All results and locations where samples were taken are included in Appendix E.

5.4.4.2 The elevated Thorium levels in the sample interfered with the U-238 analysis. The U-238 activity concentration ranged from a low of -33 pCi/g to a high of 67 pCi/g. The LLD at 95% confidence level was determined to be less than 90 pCi/g and varied depending on the Thorium and daughter interference. All results and locations where samples were taken are included in the AOC Appendices. Analysis shows that the U-238 levels in the AOC are less than the LLD. Given the AOC history, U-238 contamination was not expected.

5.4.4.3 Cesium-137 was found in almost all of the samples. The values reported are typical for the region due to fallout from atmospheric atomic weapons tests and are not indicative of site operations. The results are reported in Appendix E.

5.4.4.4 Potassium-40 is a naturally occurring radioisotope. The K-40 results are typical for the region and are used to determine adequacy of the reference area. The samples with high levels of Thorium caused interference with the K-40 analysis, however samples with lower Thorium levels did not have interference. The data demonstrates that the reference and AOC K-40 levels are indistinguishable. The results are reported in Appendix E.

5.5 <u>Survey Data Review</u>. Contaminant distribution and attenuation by vegetation and soil moisture add significant error to the field measurement conversion to soil concentrations. Values presented are best-fit estimates as determined by the actual sample result correlation to the field data.

5.5.1 The estimated average site concentration of Th-natural is 21 pCi/g. This average does not include areas of extremely elevated readings (Hot Spots) since these areas will likely exceed the allowable concentration based on an area factor, and therefore will need to be remediated. The estimated site average including sampled hot spots is 70 pCi/g. Most extremely elevated areas were less than 10 m^2. Assuming 95% of the contamination lies in the top 15 cm of soil results in 828 cubic yards (yd^3) of contaminated soil. This number doubles if we assume contamination in the top foot of soil. If only hot spot removal is done it will result in an estimated 200 yd^3 of contaminated soil.

5.5.2 All grids had some area of contamination at various levels. Contamination was not uniform across the AOC. In general, the southern 5 grids were the least contaminated while grids in the area around and north of the concrete pad were the most contaminated. The west rail bed was contaminated along its entire length through the gridded area.

5.5.3 The three elevated measurement (EM) areas outside of the grids (see Figure 5-2) consist of the following:

- EM 1. Approximately 54 m^2 with surface contamination up to 920 pCi/g (sample RVAAP-M-02S location).
- EM 2. Approximately 10 m^2 with an estimated surface contamination of 50 pCi/g.
- EM 3. Approximately 100 m^2 with an estimated surface contamination of 8 pCi/g.

5.5.4 Contaminant distribution and attenuation by vegetation and soil moisture add significant error to the field measurement conversion to soil concentrations. Composite samples from grids for laboratory analysis would greatly increase the accuracy of the average concentration estimate. (Example: Twenty grids sampled by collecting four samples per grid and compositing into a 1 grid representative sample.) **However, if excavation is selected, a remedial action survey such as insitu-gamma spectrometry to guide the excavation would provide the accuracy to insure a cost effective and protective remediation and eliminate the potential need for additional sampling.**

5.5.5 Given the elevated sample results 1650, 920 pCi/g, etc, some level of remediation is warranted.

6. Discussions.

6.1 RESRAD Report and Assumptions.

6.1.1 The following exposure scenarios were analyzed for the Monazite AOC:

6.1.1.1 Scenario A: Industrial Use of the Site. A hypothetical person is assumed to work in the area of the site. Under this scenario a hypothetical individual is assumed to work in the area of concern for 8 hours per day (2 indoors), 5 days per week, and fifty weeks per year. It is assumed that the worker does not ingest ground water, plants, fish, or meat/milk (from livestock) from the site. See Appendix F for parameters.

6.1.1.2 Scenario B: Residential Use of the Site and Municipal Water Supply. A hypothetical resident is assumed to live in the decontaminated area and to use an uncontaminated municipal water supply for drinking, household purposes, and irrigation. The resident is assumed to ingest plant foods grown on-site; however, no livestock is raised for the production of meat and milk, and no pond is present on-site to provide fish and other aquatic food. Parameters are the same as for Scenario A with the exception of adding the plant ingestion pathway and changing the occupancy factors to residential.

6.1.1.3 Placement of a cover over the AOC was also evaluated using Scenario A and a one foot cover thickness.

6.1.2 The RESRAD default values have been used if no site-specific, data were available. These default values are based on national average or reasonable maximum values.

6.1.3 RESULTS. **Note: DCGLs should be established with regulator approval prior to beginning remedial actions.**

6.1.3.1 The industrial use site specific DCGL for Th-nat corresponding to 25 mrem/yr is 9 pCi/g. The AOC area has little affect on the dose and the depth of contamination has a minimal affect to the dose since the external pathway contributes most of the dose. See graphs provided in Appendix F. The dose using 21 pCi/g and Scenario A is 57 mrem/yr (hot spots removed).

6.1.3.2 The residential use site specific DCGL for Th-nat corresponding to 25 mrem/yr is 3 pCi/g. The AOC area has little affect on the dose and the depth of contamination has a minimal affect to the dose since the external pathway contributes most of the dose. See graphs provided in Appendix F. The dose using 21 pCi/g and Scenario B is 166 mrem/yr (hot spots removed).

6.1.3.4 A cover would reduce the industrial exposure to acceptable levels (2 mrem/yr), but its thickness would have to be maintained and land use restrictions may be required. See graphs provided in Appendix F.

6.1.4 The derived guidelines listed in paragraph 6.1.3 are for a large homogeneously contaminated area. For a small, isolated area of contamination the allowable concentration that can remain on-site may be higher than the homogeneous guideline, depending on the size of the contaminated area and in accordance with the ranges given in Table 6.1.4.

Table 6.1.4 Ranges for areas of elevated measurements(Yu,1997).

Area Range in square meters	Area factor (multiple of guideline)
<1	10
1-<3	6
3-<10	3
10-25	2

6.2 Alternatives. Alternatives are presented for discussion purposes and are not meant to take the place of alternative presentations such as in an Engineering Evaluation Cost Analysis.

6.2.1 Alternative 1. No Action. The no action alternative is viable given the following; the area is to remain in control of the government, the site is covered with vegetation which keeps the contamination from spreading by dust, the primary exposure pathway is external, and the contamination is in the surface soil. However, the US Army dose limit for release of sites for unrestricted use is 25 mrem/yr and 100 mrem/yr for restricted use. To demonstrate compliance with the dose limits the survey requirements of NUREG 1575, MARSSIMS, would be used, which requires an elevated measurement comparison. The hot spots found in the AOC would likely require remediation to meet the criteria. If the land is to be available for future use some remedial effort will be required.

6.2.2 Alternative 2. Fence. Erecting an 8 ft chain link fence around the contaminated area would cost approximately $18,000 plus administrative and maintenance costs. This option has the same problem of land use as the no action alternative.

6.2.3 Alternative 3. Cover. A one foot cover placed over the AOC would reduce the external exposure to less than 2 mrem/yr. The cost of the cover would be approximately $27,564, not including administrative costs but which includes; clearing, covering with 6″ fill and 6″ top soil, and seeding. Although a cover would virtually eliminate the exposure path, the protectiveness of it is a function of the erosion rate. Example: at the average erosion rate of 0.001 meters/yr (Yu, 1993) a cover would have to be 1 meter thick to protect for 1000 years. A cover thickness greater than 1 foot does not provide much more protection as shown in the graphs provided in Appendix F. Design/maintenance costs to control erosion and restrictions on land use should be considered also.

6.2.4 Alternative 4. Remediation & Disposal. Excavation and disposal of the contaminated soil would reduce the source to acceptable levels of radiation exposure permanently and would make the land available for use. The draw back is the costs. Given the estimated concentration it is very likely that the soil could be disposed of in a RCRA subtitle C facility ($80/yd^3) which would reduce the cost of disposal. The other disposal option would be to utilize the USACE Kansas City District contract with Envirocare of Utah for disposal ($130/yd^3). Estimated costs of clearing, excavation (+ concrete), transportation, disposal, and reclamation are presented in Table 6-2.

Table 6-2. Alternative 4 Costs.

Excavation	RCRA C*	Envirocare*
6 inches	$122,602	$184,702
1 foot	$238,649	$362,924
Hot spots	$37,000	$48,000

*High end estimate and does not include administrative or final status survey costs.

Utilizing insitu-gamma spectrometry to guide excavation could reduce volume of soil significantly and thus reduce costs.

6.2.5 Insitu-Treatment. An insitu chemical treatment to decrease the solubility of Thorium utilizing a product called MAECTITE was reviewed and data provided shows it to be somewhat effective. Given the fact that the Monazite and Thorium-232 are typically not very mobile and that the treatment would not alter the external dose pathway, it is not considered as an effective option.

7. CONCLUSIONS.

7.1 A review of the survey results indicate that there is Thorium-natural contamination above acceptable average and hot spot levels in the Monazite AOC.

7.2 Given the elevated sample results some level of remediation or control is warranted.

7.3 The external pathway contributes almost all of the dose from the contamination in the AOC. Remedial activities should focus on controlling the external pathway or eliminating the source.

8. RECOMMENDATION. Establish specific Derived Concentration Guideline Levels for the Monazite AOC and excavate soils exceeding the level using an insitu-gamma spectrometry system to guide the excavation. Evaluate excavated soils for acceptance by a RCRA subtitle C facility.

DAVID C. HAYS Jr.
Health Physicist
Tulsa District Corps of Engineers

Appendix A

REFERENCES and ABBREVIATIONS

1. REFERENCES.

1.1 AR 40-5, 15 October 1990, Preventive Medicine.

1.2 AR 40-14, 30 June 1995, Occupational Ionizing Radiation Personnel Dosimetry.

1.3 DA Pam 40-18, 30 June 1995, Personnel Dosimetry Guidance and Dose Recording Procedures for Personnel Occupationally Exposed to Ionizing Radiation.

1.4 AR 385-11, 1 May 1980, Ionizing Radiation protection (Licensing, Control, Transportation, Disposal, and Radiation Safety).

1.5 ER and EM 385-1-80, 30 May 1997, Ionizing Radiation Protection, and Radiation Protection, USACE.

1.6 EM-385-1-1, 3 Sep 1996, Safety and Health Requirements Manual, USACE.

1.7 DoD Instruction No. 6055.8, 3 January 1983, Occupational Radiation Protection Program.

1.8 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), December 1997.

1.9 TG 155, February 1993, Environmental Sampling Guide, US Army Environmental Hygiene Agency (USACHPPM).

1.10 Title 10, CFR, 1996 rev, Chapter I, Nuclear Regulatory Commission (USNRC).

1.11 Title 29, CFR, 1995 rev, Chapter I, Department of Labor.

1.12 Title 49, CFR, 1989 rev, Parts 100-177, Transportation.

1.13 NUREG/CR-5849, ORAU-92/C57, 1 June 1992, Manual for Conducting Radiological Surveys in Support of License

Termination (DRAFT), USNRC.

1.14 DG-4006, February 17, 1998, Demonstrating Compliance With The Radiological Criteria For License Termination, (DRAFT),USNRC.

1.15 USACESWT, Radiation Survey Plan No. CESWT-SO-P1-05-98, Ravenna Army Ammunition Plant, Ravenna, OH, 18-21 May 1998, 10 April 1998.

1.16 Preliminary Assessment for Ravenna Army Ammunition Plant, February 1996, by Science Applications International Corporation (SAIC).

1.17 Letter dated July 25, 1990, from Olin Ordnance, RVAAP, to USEPA, Subject: Request for information pursuant to section 104 (e) of CERCLA as amended for industrial landfill INC.

1.18 Radiation Protection Survey No. 43-071-69, Ionizing Radiation Sources Ravenna Army Ammunition Plant, Ravenna, Ohio 19-20 May 1969, US Army Environmental Hygiene Agency, Edgewood Arsenal, MD, 21010, (NOTE: now USACHPPM)

1.19 Yu, C., et al.,1993, Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil, ANL/EAIS-8, prepared by Argonne National Laboratory, Argonne. Ill., for U.S. Department of Energy, Office of Environmental Restoration, Sept.

1.20 Yu C. et al., 1997, RERAD Computer Code version 5.782, October 1997.

1.21 Yu, C., et al.,1993, Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0, ANL/EAD/LD-2, prepared by Argonne National Laboratory, Argonne. Ill., for U.S. Department of Energy, Office of Environmental Restoration, Sept.

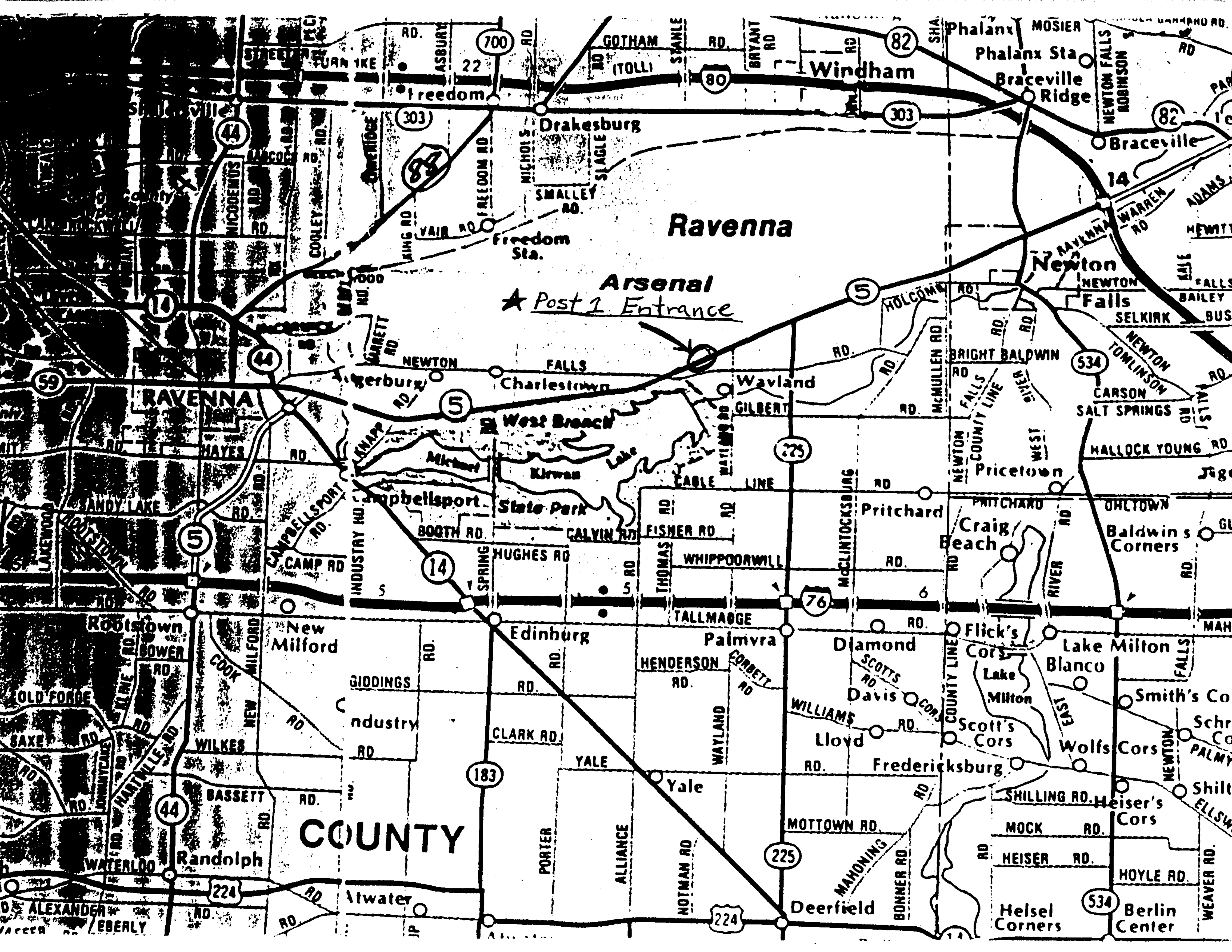
1.22 United States Department of Agriculture Soil Conservation Service, 19**, Soil Survey of Portage County, Ohio, 19**.

2. ABBREVIATIONS.

AOC	Areas of concern
bkg	background
BEC	Base Realignment and Closure Environmental Coordinator
BRAC	Base Realignment and Closure
cal	calibration
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
Cs-137	Cesium-137
Co-60	Cobalt-60
DAC	Department of the Army Civilian
dpm	disintegrations per minute
$dpm/100cm^2$	disintegrations per minute per 100 square centimeters
eff	efficiency
g	gram
H-3	hydrogen-3 (tritium)
inst	instrument
IAW	In Accordance with
LLD	Lower Level of Detection
MACOM	major Army command
MDA	Minimum Detectable Activity
mCi	millicurie
mm	millimeter
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Guide
pCi	picocurie
ppm	parts per million
RVAAP	Ravenna Army Ammunition Plant
RCCCD	Radiologic, Classic and Clinical Chemistry Division
RPO	Radiation Protection Officer
SN	serial number
SOP	standing operating procedure
Th-nat	Thorium-232 and daughters
U-238	Uranium-238
USACE	United States Army Corps of Engineers
USAEHA	United States Army Environmental Hygiene Agency
USACHPPM	USA Center for Health Promotion & Preventive Medcine
uR/hr	microroentgen per hour
uCi	microcurie

Appendix B

Maps



Ravenna
Arsenal
★ Post 1 Entrance
Windham
Phalanx
Phalanx Sta
Braceville Ridge
Braceville
Freedom
Drakesburg
Freedom Sta.
Newton Falls
Charlestown
Wayland
West Branch
Michael Kirwan Lake State Park
Campbellsport
RAVENNA
Pricetown
Pritchard
Craig Beach
Baldwins Corners
Rootstown
New Milford
Edinburg
Palmyra
Diamond
Flick's Cors
Lake Milton
Blanco
Davis Cors
Scott's Cors
Lloyd
Fredericksburg
Wolfs Cors
Smith's Co
Yale
Industry
Heiser's Cors
Randolph
Atwater
Deerfield
Helsel Corners
Berlin Center
COUNTY
TURNPIKE
(TOLL)
GOTHAM RD.
SMALLEY RD.
VAIR RD
NEWTON FALLS
HOLCOMB RD
BRIGHT BALDWIN RD
GILBERT RD.
SALT SPRINGS
HALLOCK YOUNG RD
CABLE LINE RD
BOOTH RD.
CALVIN RD
FISHER RD
HUGHES RD
WHIPPOORWILL RD.
TALLMADGE RD.
HENDERSON RD.
GIDDINGS RD.
CLARK RD.
YALE
WILLIAMS RD
SHILLING RD.
MOTTOWN RD.
MOCK RD.
HEISER RD.
HOYLE RD.
BASSETT RD.
WILKES RD
CAMP RD
HAYES RD
SANDY LAKE
OLD FORGE
WATERLOO
ALEXANDER RD
EBERLY
INDUSTRY RD.
SPRING
THOMAS
McCLINTOCKSBURG
WAYLAND
PORTER
ALLIANCE
NOTMAN RD
MAHONING
BONNER RD
COUNTY LINE
WEAVER RD
MAHONING
RIVER RD
McMULLEN RD
CARSON
SELKIRK
BAILEY
RAVENNA WARREN RD
303
700
80
82
84
44
14
5
59
534
225
76
183
224

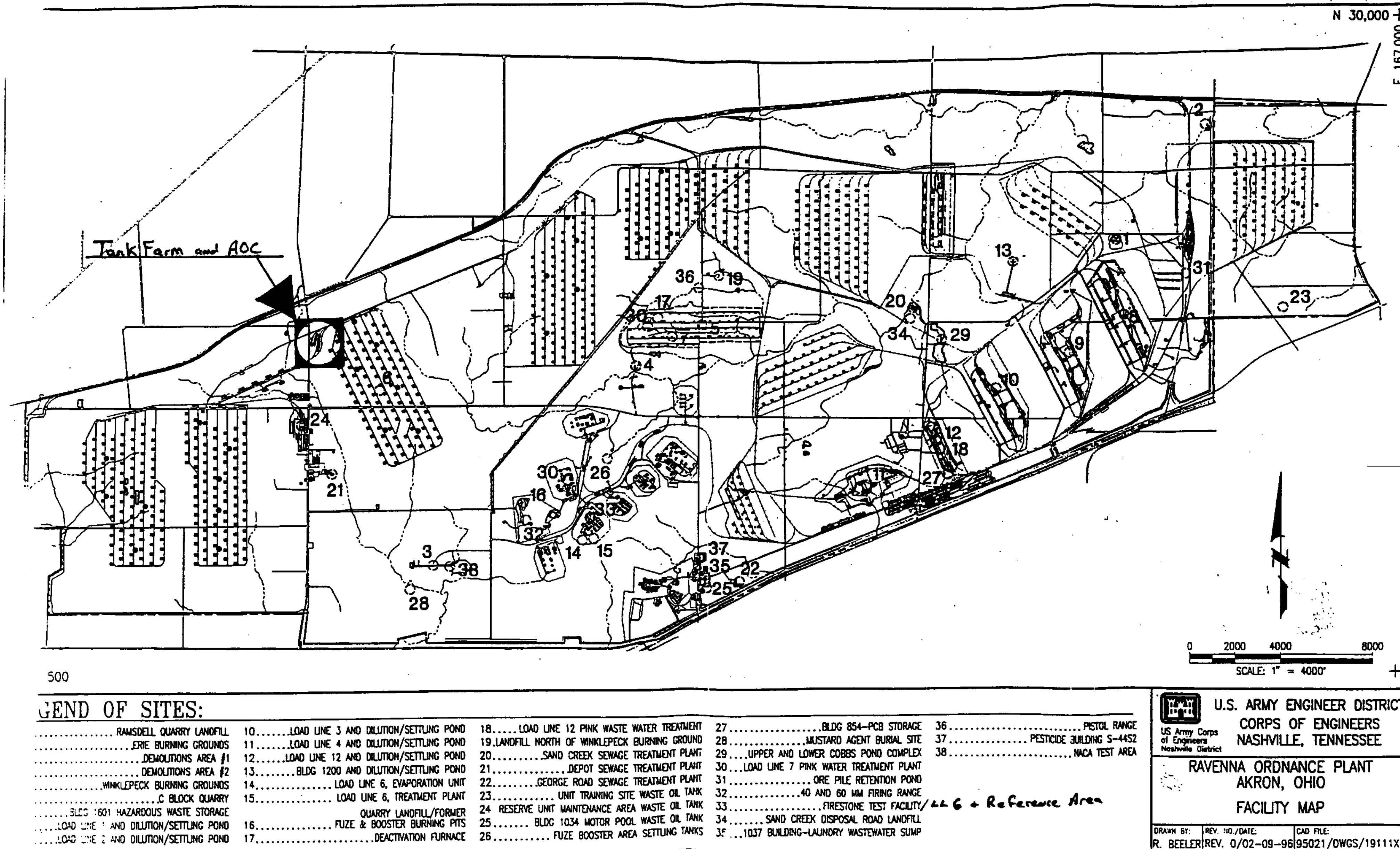
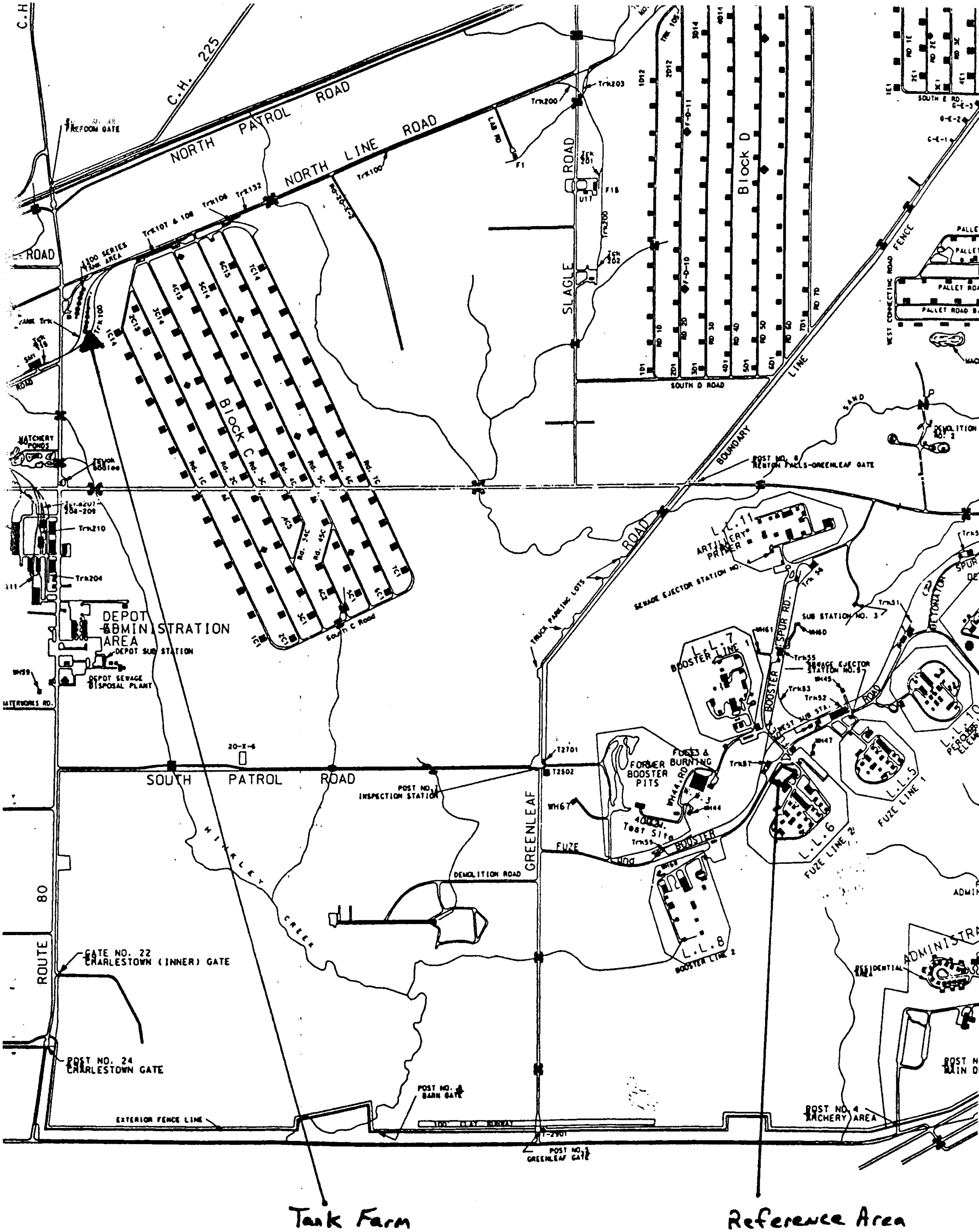
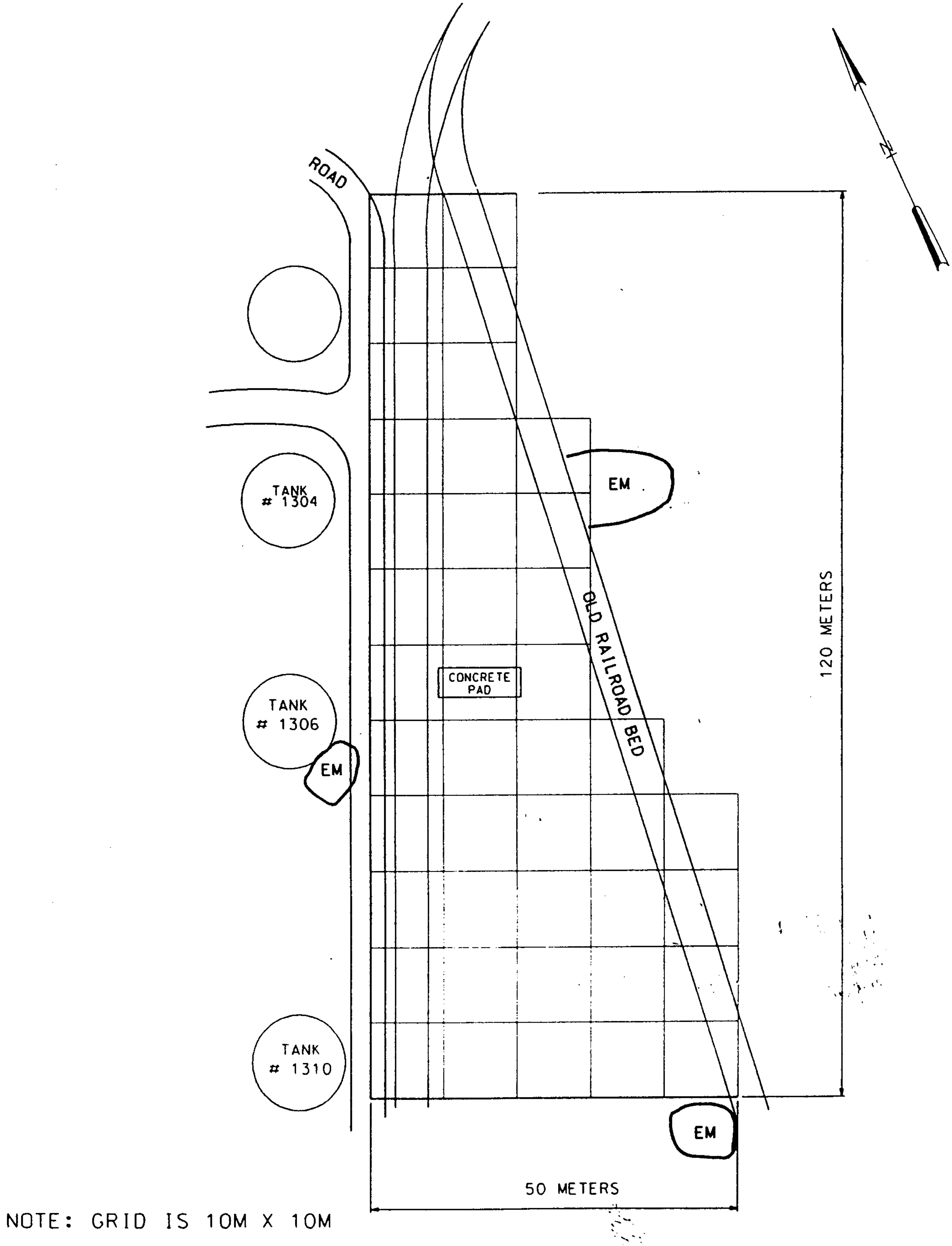


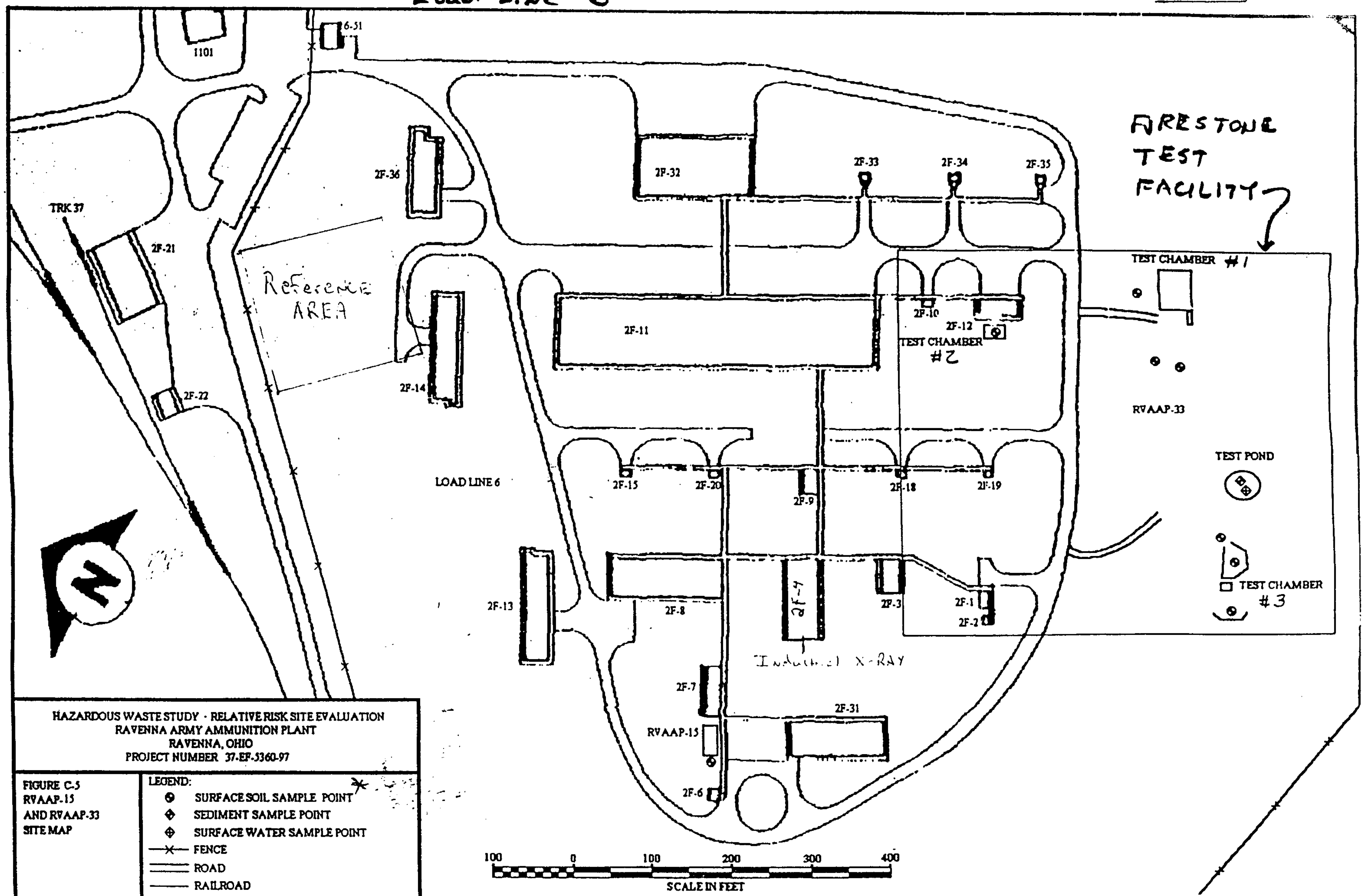
Figure 4-1. Facility Map


C.H. 225
NORTH PATROL ROAD
NORTH LINE ROAD
SLAGLE ROAD
Block D
Block C
SOUTH D ROAD
South C Road
BOUNDARY LINE ROAD
DEPOT ADMINISTRATION AREA
DEPOT SUB STATION
DEPOT SEWAGE DISPOSAL PLANT
SOUTH PATROL ROAD
GREENLEAF
ROUTE 80
HINKLEY CREEK
DEMOLITION ROAD
GATE NO. 22 CHARLESTOWN (INNER) GATE
POST NO. 24 CHARLESTOWN GATE
EXTERIOR FENCE LINE
POST NO. 3 GREENLEAF GATE
POST NO. 4 ARCHERY AREA
POST NO. 1 INSPECTION STATION
L.L.11 ARTILLERY PRIMER
L.L.7 BOOSTER LINE 1
L.L.6 FUZE LINE 2
L.L.5 FUZE LINE 1
L.L.8 BOOSTER LINE 2
FORMER BOOSTER PITS
FUSE & BURNING
TRUCK PARKING LOTS
SEWAGE EJECTOR STATION NO.
SUB STATION NO. 3
POST NO. 6 RENTON FALLS-GREENLEAF GATE
WEST CONNECTING ROAD FENCE
PALLET ROAD
RESIDENTIAL AREA
Tank Farm
Reference Area



TITLE: MONAZITE SAND STORAGE TANK FARM AREA	RVAAP USACE DRAWN BY: ROY LONG	SCALE NONE	SHEET 8 OF 10

Load Line 6



* Samples Shown are from Previous Survey

Appendix C

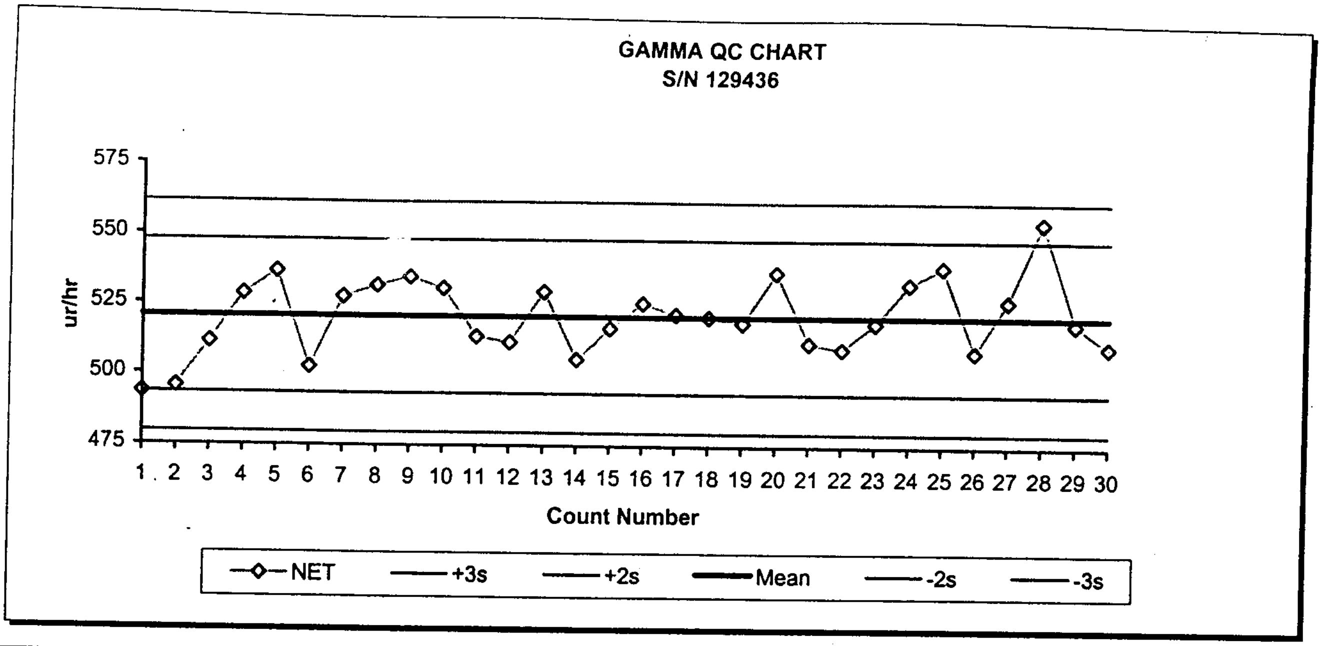
INSTRUMENTS & QUALITY ASSURANCE

INSTRUMENTATION

Table C-1. Instrumentation used during RVAAP Survey.

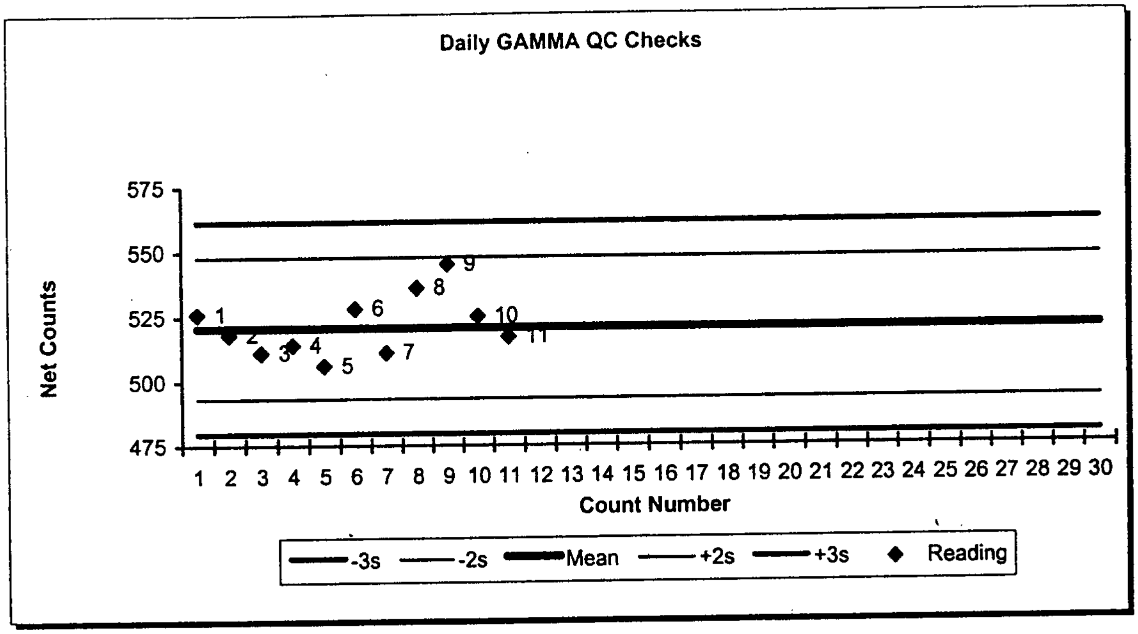
	Alpha/Beta	PIC	Gamma NaI 1"x1"	Gamma Spectrometer
Readout Make	LUDLUM	Reuter Stokes	LUDLUM	CANBERRA
Readout Model	2360	RSS-112	2350-1	Inspector
Serial Number	141324	97100087	129436	Not Listed
Cal. DUE Date	30 Jul 98	11 Nov 98	25 Sep 98	FIELD E. CAL
Calibrated Sensitivity	23% Tc-99 24% Th-230	< 1 uR/hr	< 1 uR/hr	1024 CHANNELS
Probe Make	LUDLUM	Reuter Stokes	LUDLUM	CANBERRA
Probe Model	43-1-1	RSS-112	44-2	NaI

All instruments met QA requirements.

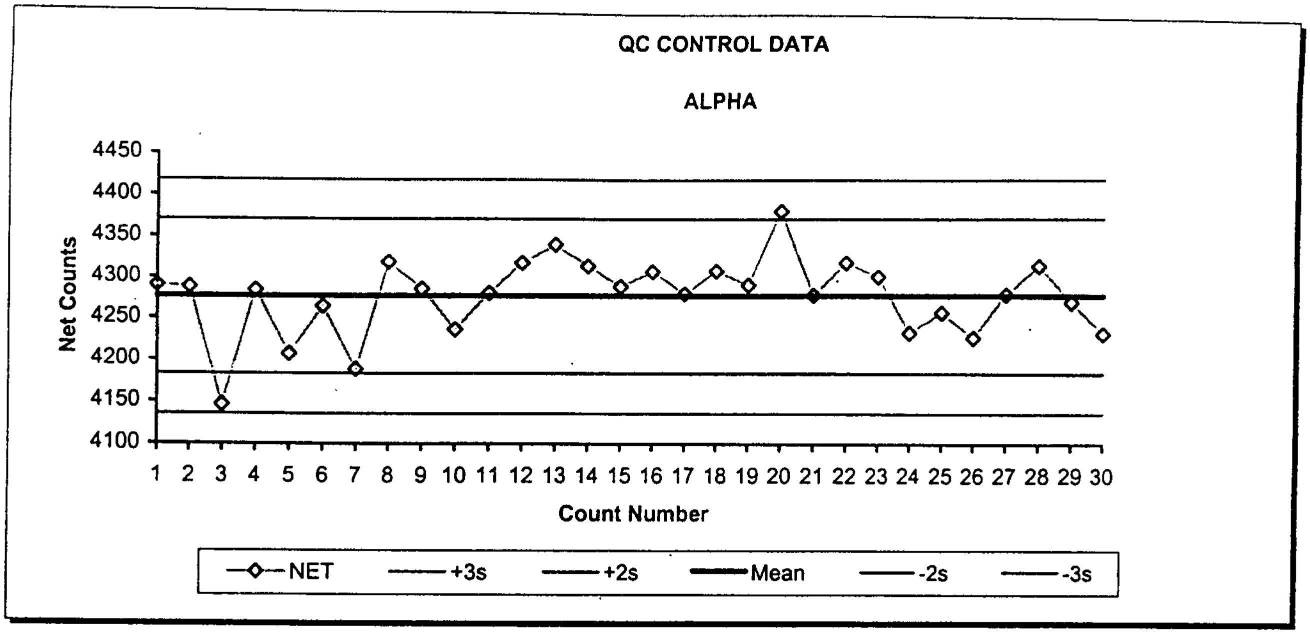


Model:	2350-1	SN#	129436	PROBE	44-2	SN#	129486	Cal Due:	25Sep98
Source:	Cs-137	SN#	2007-95	Activity:	1	uCi		Cal Date:	8Feb95
Mean	+2s	SN#	-2s		+3s:		-3s	Date:	13May97
521	548	to	493	to	561	to	480	Efficiency:	NA

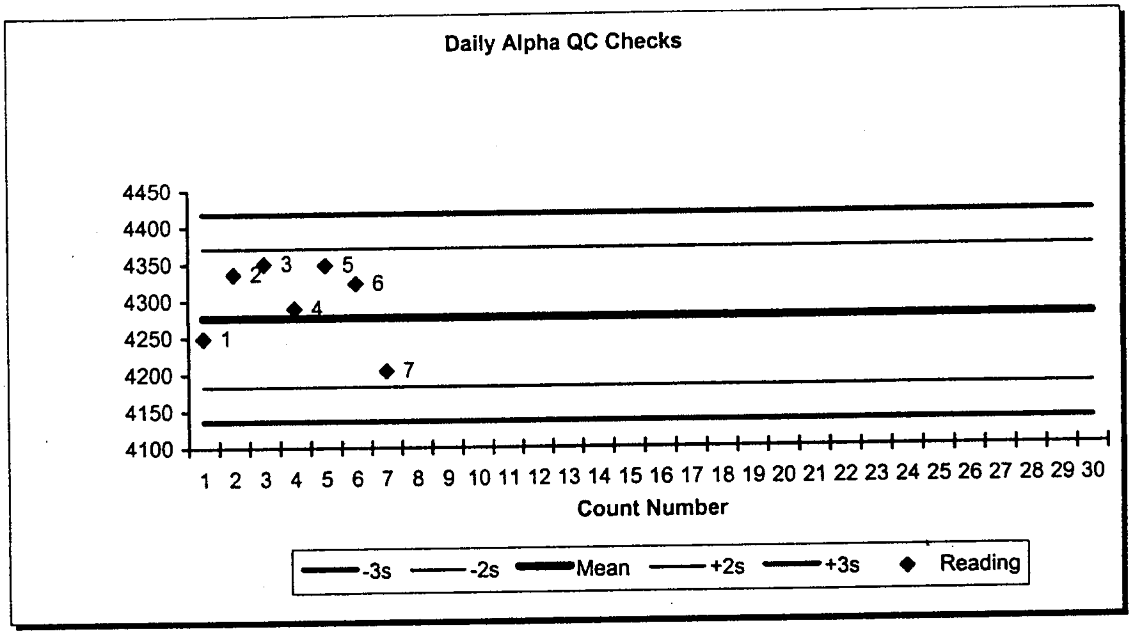
Chk.#	Gross	Net	Chk.#	Gross	Net	Chk.#	Gross	Net	COMMENTS
1	501	493	11	521	513	21	519	511	
2	503	495	12	519	511	22	517	509	
3	519	511	13	537	529	23	526	518	
4	536	528	14	513	505	24	540	532	
5	544	536	15	524	516	25	546	538	
6	510	502	16	533	525	26	516	508	
7	535	527	17	529	521	27	534	526	
8	539	531	18	528	520	28	562	554	
9	542	534	19	526	518	29	526	518	
10	538	530	20	544	536	30	518	510	
Bkgd:	8	uci	Mean:	521	uci	2sigma:	27 cnts	3sigma:	41



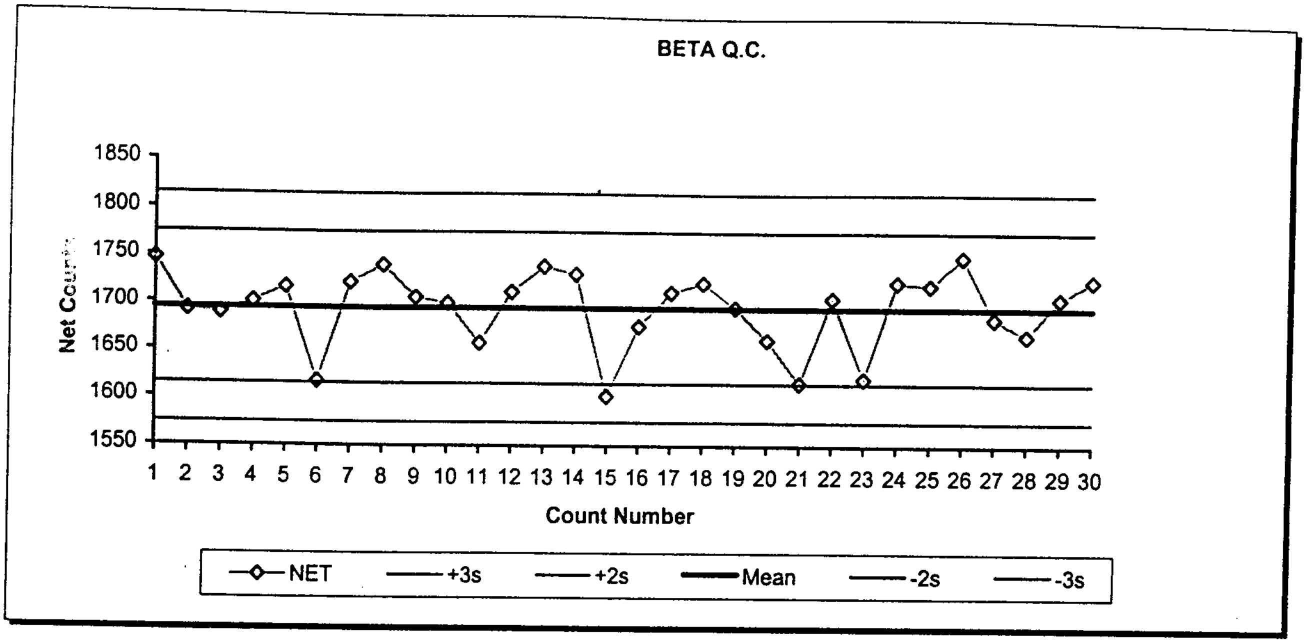
Daily BETA Checks in counts										
	Date	Gross	BKG	NET	GROSS	BKG	NET	GROSS	BKG	NET
1	18May97			0			0			0
2	19May97	534	8	526	532	14	518	520	9	511
3	20May97	529	15	514	519	13	506	537	9	528
4	21May97	519	8	511	545	9	536	554	9	545
5	22May97	544	19	525	531	14	517			0
6				0			0			0
7				0			0			0
8				0			0			0
9				0			0			0
10				0			0			0



Model:	2360	SN#	141324	PROBE	43-1-1	SN#	143708	Cal Due:	30Jul98
Source:	Th-230	SN#	2001-95	Activity:	17,600	dpm		Cal Date:	1Feb95
Mean	+2s		-2s		+3s:		-3s	Date:	18May98
4277	4371	to	4183	to	4418	to	4136	Efficiency:	0.243
Chk.#	Gross	Net	Chk.#	Gross	Net	Chk.#	Gross	Net	COMMENTS
1	4291	4290	11	4281	4280	21	4278	4277	
2	4289	4288	12	4318	4317	22	4318	4317	
3	4147	4146	13	4340	4339	23	4301	4300	
4	4285	4284	14	4314	4313	24	4233	4232	
5	4208	4207	15	4289	4288	25	4257	4256	
6	4265	4264	16	4307	4306	26	4227	4226	
7	4189	4188	17	4280	4279	27	4279	4278	
8	4319	4318	18	4308	4307	28	4314	4313	
9	4286	4285	19	4291	4290	29	4270	4269	
10	4237	4236	20	4381	4380	30	4232	4231	
Bkgd:	1	cpm	Mean:	4277	cpm	2sigma:	93 cpm	3sigma:	140 cpm



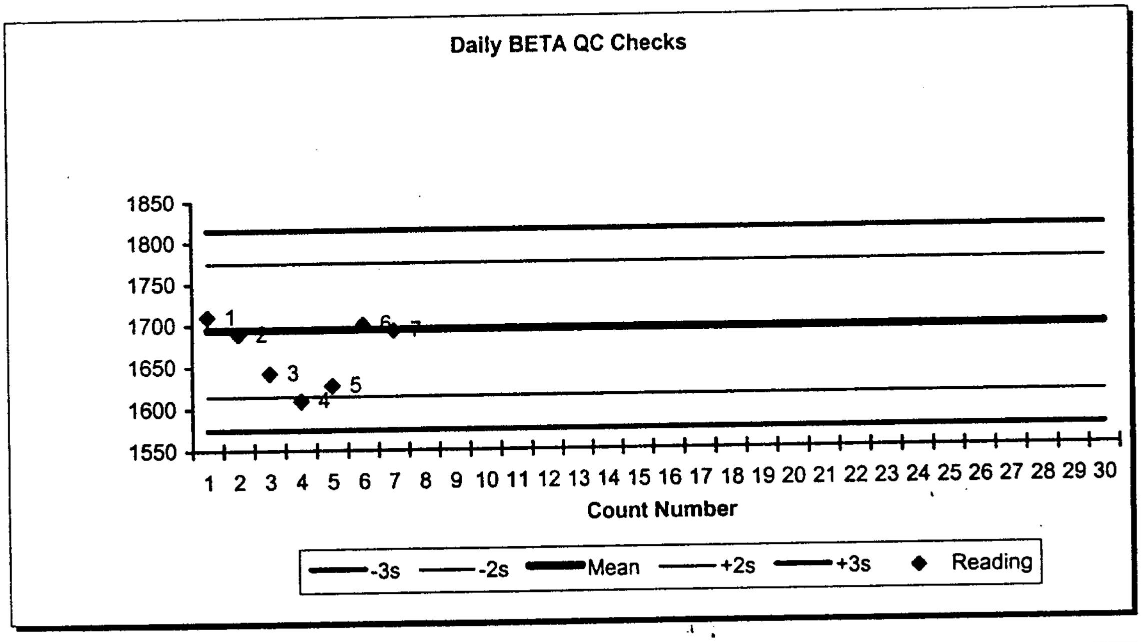
Daily Alpha Checks in cpm										
	Date	Gross	BKG	NET	GROSS	BKG	NET	GROSS	BKG	NET
1	18May98			0			0			0
2	19May98	4250	1	4249		0	0	4337	1	4336
3	20May98	4350	0	4350	4289	0	4289	4349	1	4348
4	21May98	4324	1	4323	4204	0	4204	NOT USED		
5	22May98		0	0			0			0
6	23May98			0			0			0
7				0			0			0
8				0			0			0
9				0			0			0
10				0			0			0



Model:	2360	SN#	141324	PROBE	43-1-1	SN#	143708	Cal Due:	30Jul98
Source:	Tc-99	SN#	2004-95	Activity:	7,400	dpm		Cal Date:	8Feb95
Mean	+2s		-2s		+3s:		-3s	Date:	18May98
1694	1774	to	1614	to	1814	to	1574	Efficiency:	0.228977

Chk.#	Gross	Net	Chk.#	Gross	Net	Chk.#	Gross	Net	COMMENTS
1	1922	1746	11	1833	1657	21	1791	1615	
2	1868	1692	12	1887	1711	22	1881	1705	
3	1865	1689	13	1914	1738	23	1796	1620	
4	1877	1701	14	1906	1730	24	1898	1722	
5	1892	1716	15	1777	1601	25	1895	1719	
6	1792	1616	16	1851	1675	26	1925	1749	
7	1897	1721	17	1887	1711	27	1860	1684	
8	1915	1739	18	1897	1721	28	1842	1666	
9	1881	1705	19	1871	1695	29	1881	1705	
10	1875	1699	20	1837	1661	30	1900	1724	

Bkgd:	176	cpm	Mean:	1694	cpm	2sigma:	80 cpm	3sigma:	120 cpm



Daily BETA Checks in cpm										
	Date	Gross	BKG	NET	GROSS	BKG	NET	GROSS	BKG	NET
1	19May98	1947	237	1710	NU	NU	NU	1876	187	1689
2	20May98	1900	258	1642	1792	183	1609	1806	179	1627
3	21May98	1889	189	1700	1863	170	1693			0
4				0			0			0
5				0			0			0

POINT 4 FALLS OUTSIDE OF WARNING LIMITS, BUT IS WITHIN THE CONTROL LIMITS, INSTRUMENT IS ADEQUATE FOR USE

CHAIN-OF-CUSTODY RECORD

The proponent of this form is the Directorate of Laboratory Sciences.

INSTALLATION Ravenna AAP PROJECT NUMBER 29-23-8440

PROJECT OFFICER Hays / Moscato

PACKED BY David Hays

NOTE: For use of this form, see AEHA TG 155 ; or DLS SOP No. 3.0.

DATE SAMPLED	FIELD IDENTIFICATION NUMBER	LAB NUMBER	SAMPLE TYPE	COMP.	GRAB	TOTAL NUMBER OF CONTAINERS	Gamma Spec, U-238, Th-nat	Gross alpha Beta	Drinking water
20 MAY 98	RUAAP-F3-01S	—	—	—	—	—	—		
—	thru	—	—	—	—	—	—		
—	RUAAP-F3-17S		Soil		X	17	X		
20 May 98	RUAAP-F4-01S		Soil		X	1	X		
20 May 98	RUAAP-F1-01S		Soil		X	1	X		
21 May 98	RUAAP-F2-01S	—	—	—	—	—	—		
—	thru	—	—	—	—	—	—		
—	RUAAP-F2-03S		Soil		X	3	X		
20 MAY 98	RUAAP-F3-01X		Sediment		X	1	X		
	RUAAP-F3-02X		Sediment		X	1	X		
20 MAY 98	RUAAP-F3-01A thru 18A		wipes		X	18		X	
20 MAY 98	RUAAP-F4-01A thru 17A		wipes		X	17		X	
21 May 98	RUAAP-F1-01A thru 17A		wipes		X	17		X	
21 May 98	RUAAP-F2-01A thru 17A		wipes		X	17		X	
21 May 98	RUAAP-M-01S thru 21S		Soil		X	21	X		
22 May 98	RUAAP-B-03W thru 05W		water		X	3			X
			TOTAL			117			

SAMPLE PARAMETER

DATE SHIPPED 22 MAY 98 CARRIER USED Fed Ex SEAL INTACT ☐ YES ☐ NO

LAB NUMBER	RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME	COMMENTS
All above	[signature]	22 MAY 98/1500			

REMARKS

(*) See previous COC, Contact Gary Wright / Waters 03W & 04W need filtering. collected ~~[illegible]~~ 22 MAY 98

AEHA Form 235-R, 1 JUN 93

CHAIN OF CUSTODY RECORD

The proponent of this form is the Directorate of Laboratory Sciences

INSTALLATION Ravenna AAP PROJECT NO. 71-23-8440

PROJECT OFFICER David Heys / Moscato*

PACKED BY David Heys

NOTE: For use of this form, see AEHA TG 155, or DLS SOP No. 5

SAMPLE PARAMETER

DATE SAMPLED	FIELD IDENTIFICATION NUMBER	LAB NUMBER	SAMPLE TYPE	COMP	GRAB	TOTAL NUMBER OF CONTAINERS	Gamma Spec, U[238], Th[232]	Gross α, β - see remarks
19 MAY 98	RVAAP - BF-01S thru							
	BF-20S		Soil		X	20	X	
19 MAY 98	RVAAP - F1-01W		water		X	1	X	X
"	RVAAP - F1-02W		water		X	1	X	X
"	RVAAP - F3-01W		water		X	1	X	X
19 MAY 98	RVAAP - F3-02W		water		X	1	X	X
20 MAY 98	RVAAP - B-01W - 02W		water		X	2	X	

(Data follows)

TOTAL

DATE SHIPPED 19 MAY 98 CARRIER USED Fed Ex SEAL INTACT YES ☐ NO ☐

LAB NUMBER	RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME	COMMENTS
RVAAP - BF-01S thru - BF-20S	David Heys	20 MAY 98 / 1400			

REMARKS *This Chain Of Custody is an addendum to the Chain of Custody originally submitted on * Consult Gary Wright

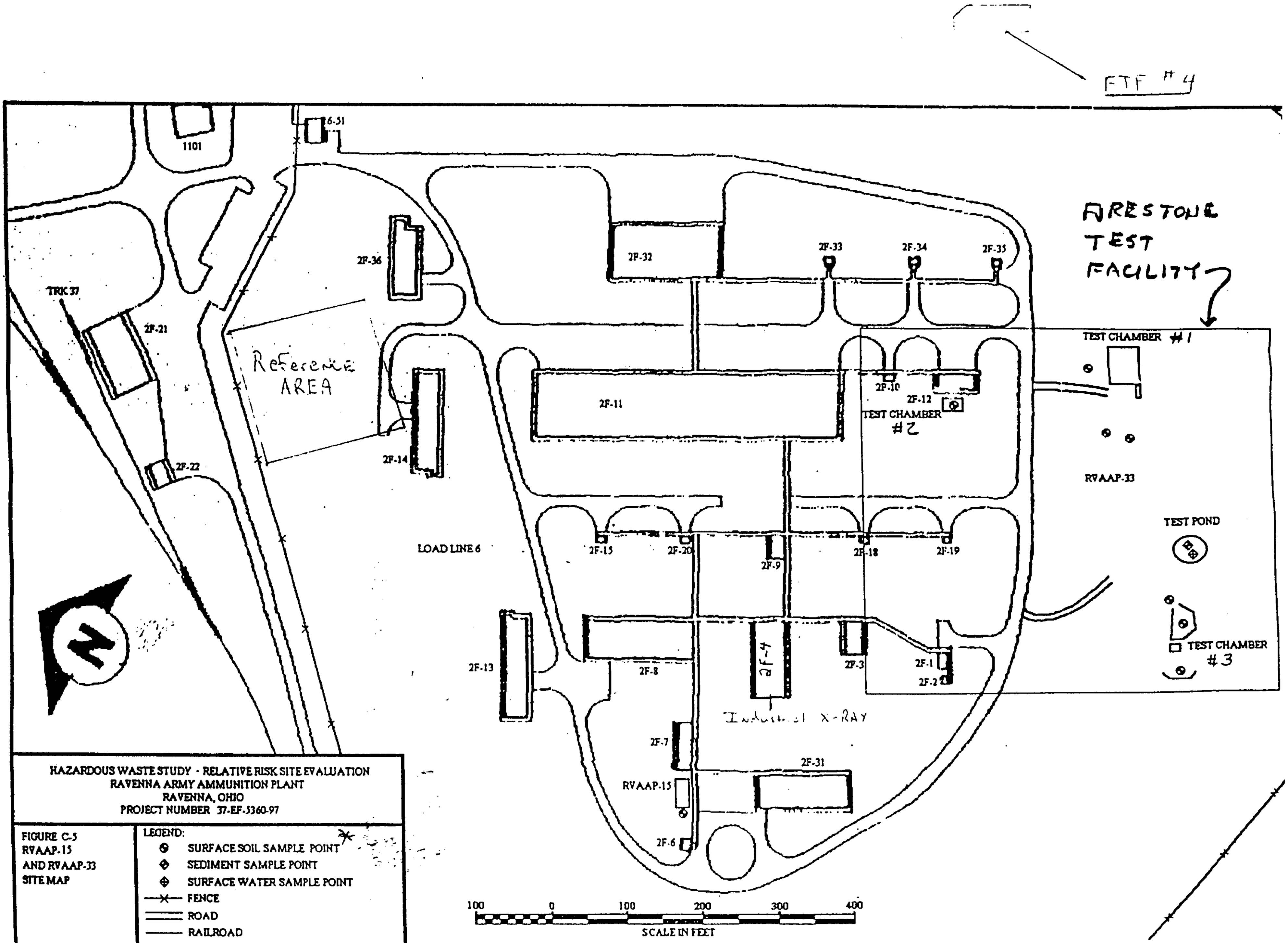
(1) Waters need filtered + preserved by End of Day (X) Friday (X)

CHPPM FORM 235-R-E, 1 Jun 96 (MCHB-DC-LLI) Replaces AEHA Form 235-R, 1 JUN 93, which is obsolete.

(2) Water analysis

Appendix D

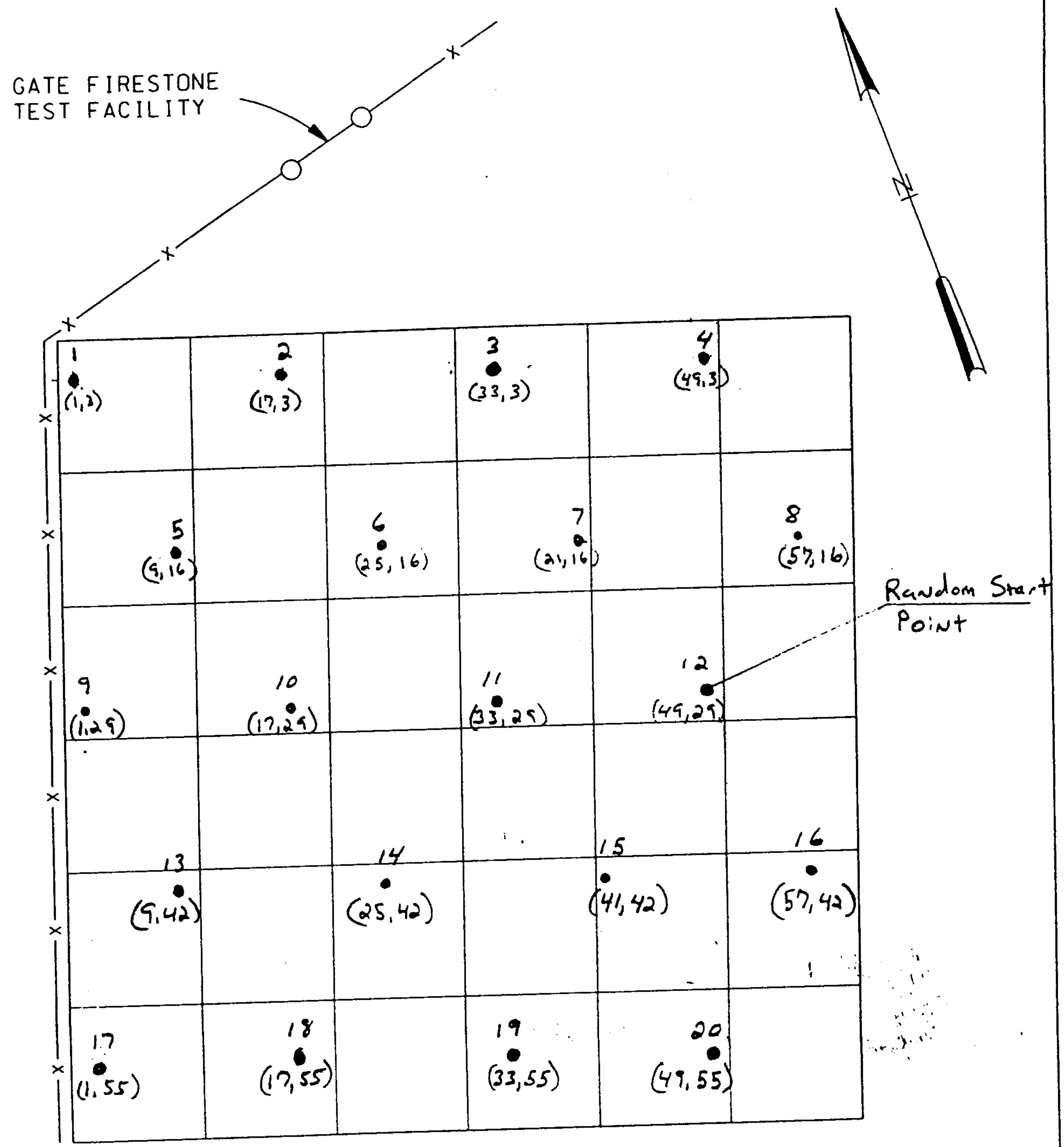
REFERENCE AREA SURVEY



HAZARDOUS WASTE STUDY - RELATIVE RISK SITE EVALUATION
RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
PROJECT NUMBER 37-EF-5360-97

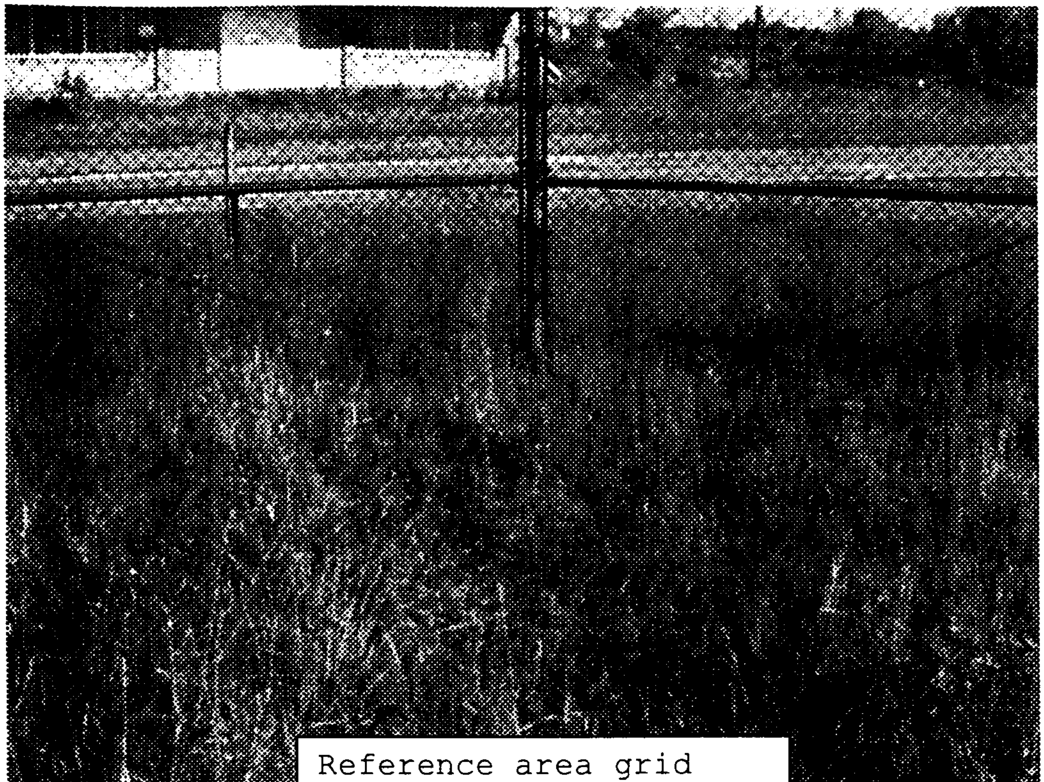
FIGURE C-5
RVAAP-15
AND RVAAP-33
SITE MAP

* Samples Shown are from Previous Survey

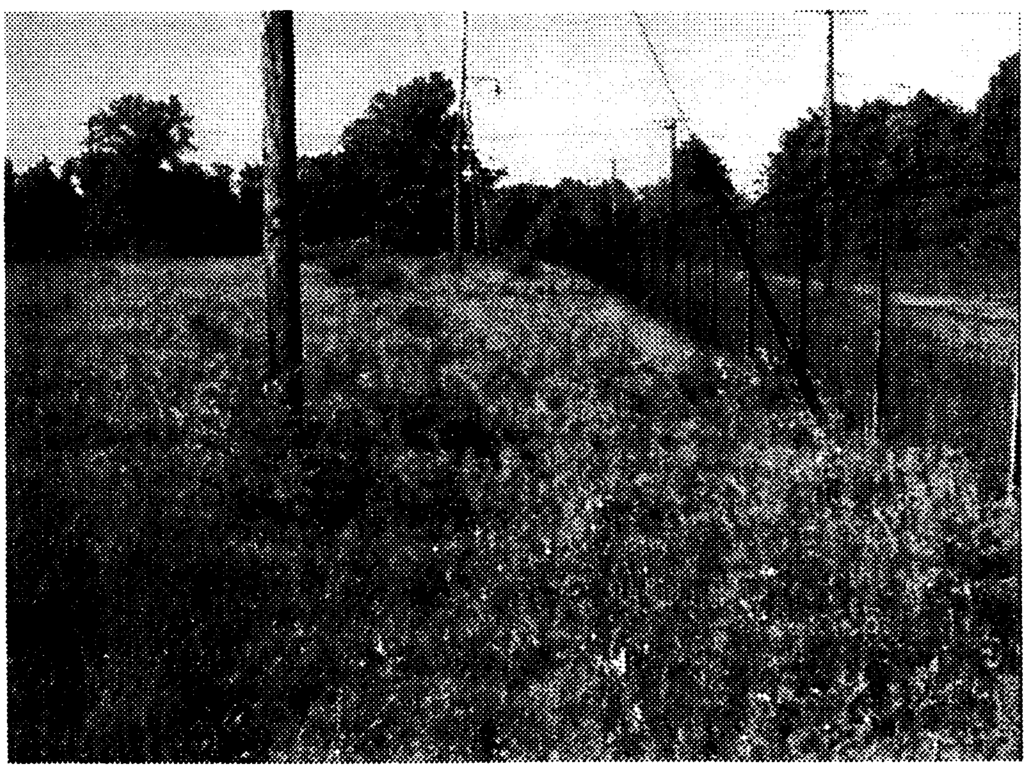


NOTE: GRID IS 10 X 10M

TITLE:		SCALE	SHEET
FTF REFERENCE AREA	RVAAP USACE DRAWN BY: ROY LONG	NONE	9 OF 10

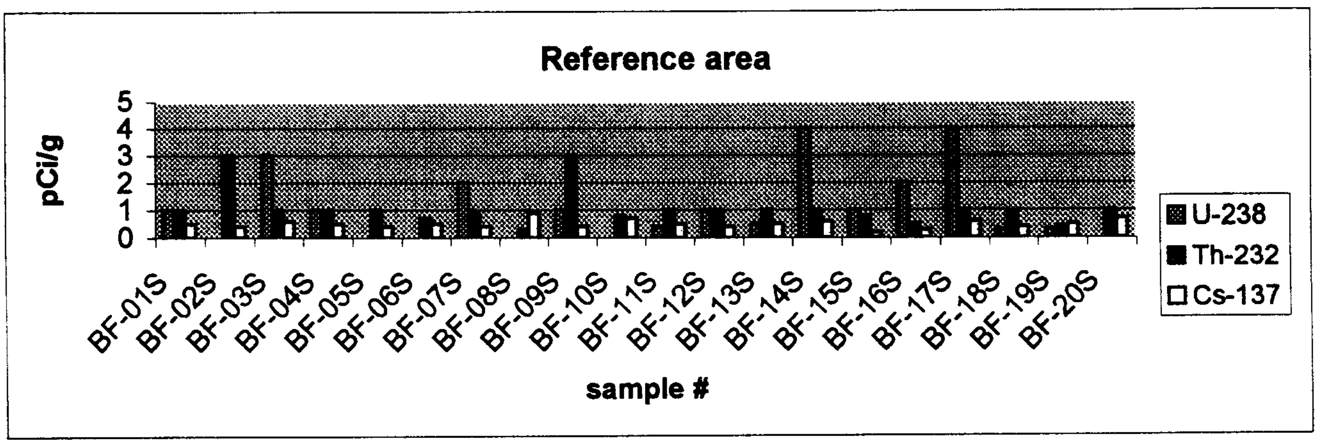


Reference area grid starting point



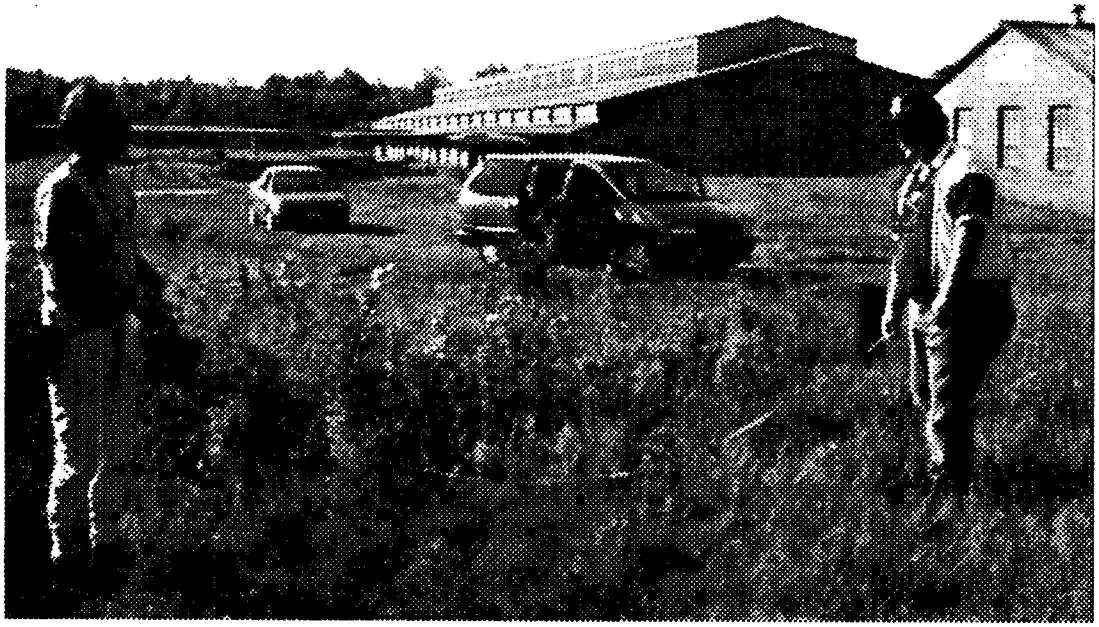
Reference area grid

Ravenna Army Ammunition Plant Reference Area Study													
					LAB RESULTS pCi/gm								
SAMPLE# RVAAP-	44-2 uR/hr	PIC uR/hr	cpm surface	cpm depth .5m	U-238	+/-	2s	Th-232	+/-	2s	Cs-137	+/-	2s
					LLD =4			LLD = 0.6			LLD = 0.1		
BF-01S	13.2	9.8	2393		1	+/-	3	1	+/-	0.3	0.5	+/-	0.1
BF-02S	14	9.7	2403		-0.5	+/-	3	3	+/-	0.3	0.4	+/-	0.1
BF-03S	14.2	9.7	2328		3	+/-	3	1	+/-	0.2	0.6	+/-	0.1
BF-04S	14.7	9.5	2356		1	+/-	3	1	+/-	0.3	0.5	+/-	0.1
BF-05S	13.8	10	2551		-3	+/-	3	1	+/-	0.3	0.4	+/-	0.1
BF-06S	13.3	9.4	2274		-0.01	+/-	3	0.7	+/-	0.2	0.5	+/-	0.1
BF-07S	13.1	9.4	2193	3884	2	+/-	3	0.9	+/-	0.3	0.4	+/-	0.1
BF-08S	13.2	9.1	1699	1839	-2	+/-	3	0.3	+/-	0.2	0.9	+/-	0.1
BF-09S	13.3	9.8	2524		1	+/-	3	3	+/-	0.3	0.4	+/-	0.1
BF-10S	15.5	10.4	2606		-1	+/-	3	0.8	+/-	0.3	0.7	+/-	0.1
BF-11S	15.1	10.3	2588		0.4	+/-	3	1	+/-	0.3	0.5	+/-	0.1
BF-12S	14.1	10.5	2399		1	+/-	3	1	+/-	0.3	0.4	+/-	0.1
BF-13S	14.7	10.3	2653	3420	0.5	+/-	3	1	+/-	0.3	0.5	+/-	0.1
BF-14S	13.9	10.5	2629		4	+/-	3	1	+/-	0.3	0.6	+/-	0.1
BF-15S	14.9	10.1	2483		1	+/-	3	0.8	+/-	0.2	0.2	+/-	0.1
BF-16S	11.5	8.9	1839		2	+/-	3	0.5	+/-	0.3	0.3	+/-	0.1
BF-17S	13.7	10.7	2565		4	+/-	3	1	+/-	0.3	0.6	+/-	0.1
BF-18S	14.1	10.5	2412	3924	0.3	+/-	3	0.9	+/-	0.3	0.4	+/-	0.1
BF-19S	14.2	10.4	2587		0.3	+/-	3	0.4	+/-	0.2	0.5	+/-	0.1
BF-20S	14.8	11.5	2786	3708	-0.7	+/-	3	1	+/-	0.3	0.7	+/-	0.1
BF-10SD	NA	10.6			3	+/-	3	0.9	+/-	0.3	0.6	+/-	0.1
STATISTICS													
mean	13.97	10.05	2413.4	3355	0.823333			1.057143			0.504762		
std	0.901	0.615	263.485	870.44	1.790177			0.67939			0.153219		

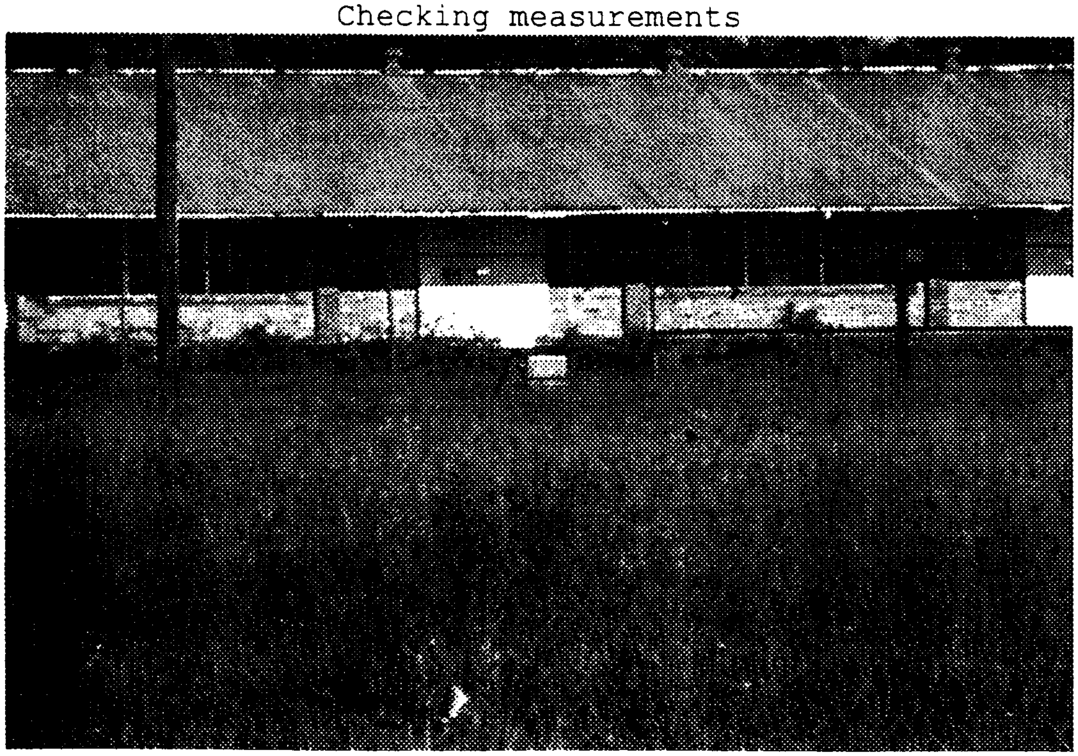


BACKGROUND WATER pCi/L				
	GROSS ALPHA		GROSS BETA	
Sample#	LLD	3	LLD	3
RVAAAP-B-01W	-0.2	+/- 1	2	+/- 1
RVAAP-B-O2W	0	+/- 1	3	+/- 1
RVAAP-B-O3W	2	+/- 2	2	+/- 1
RVAAP-B-04W	0.5	+/- 2	2	+/- 1
RVAAP-B-05W	-0.9	+/- 1	1	+/- 1

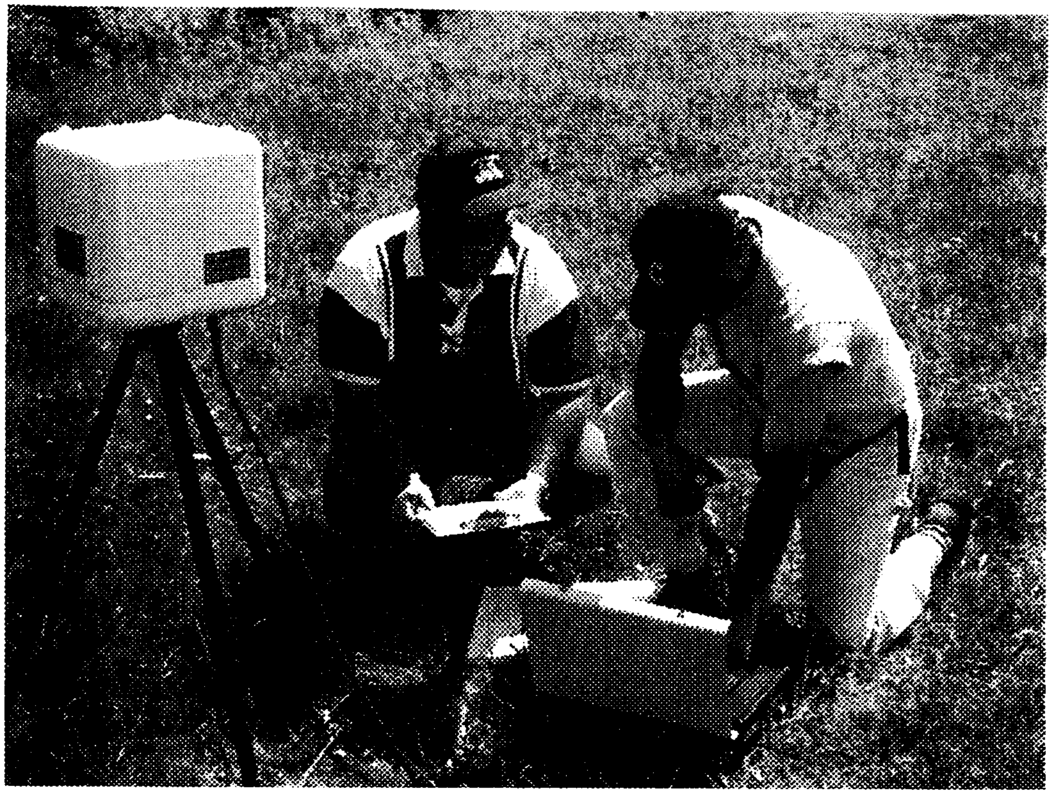
Soil collected in a triangular grid pattern with a randum start point to aid in future surveys such as the tank farm area.



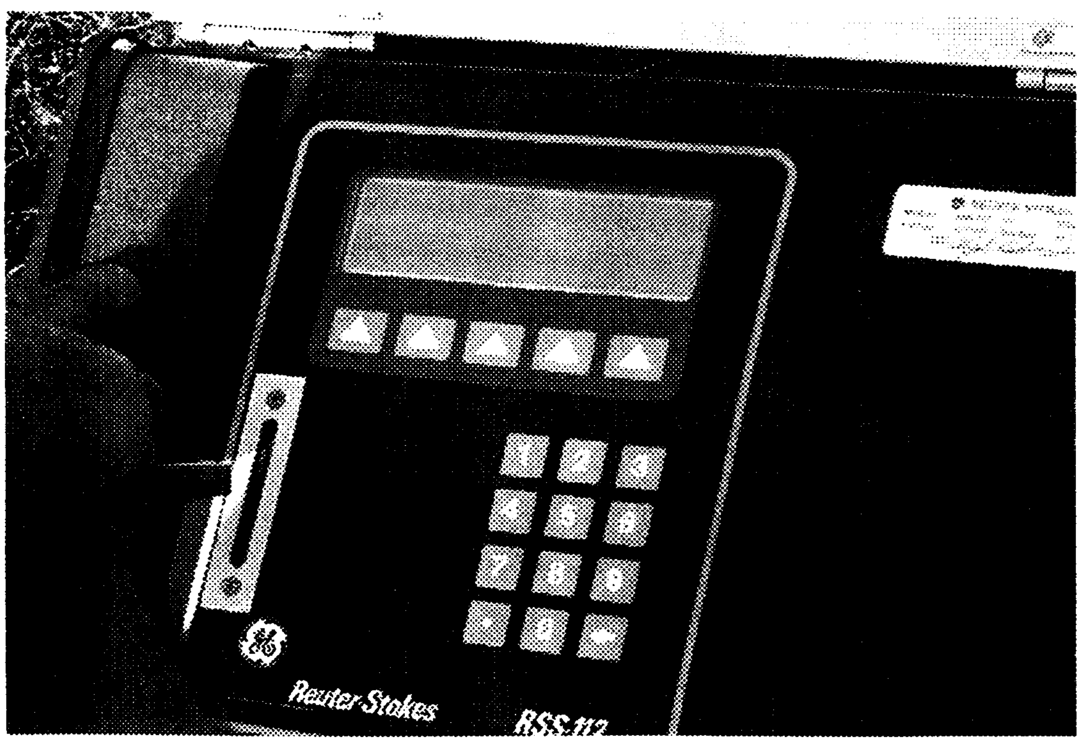
Reference area grid
Checking measurements



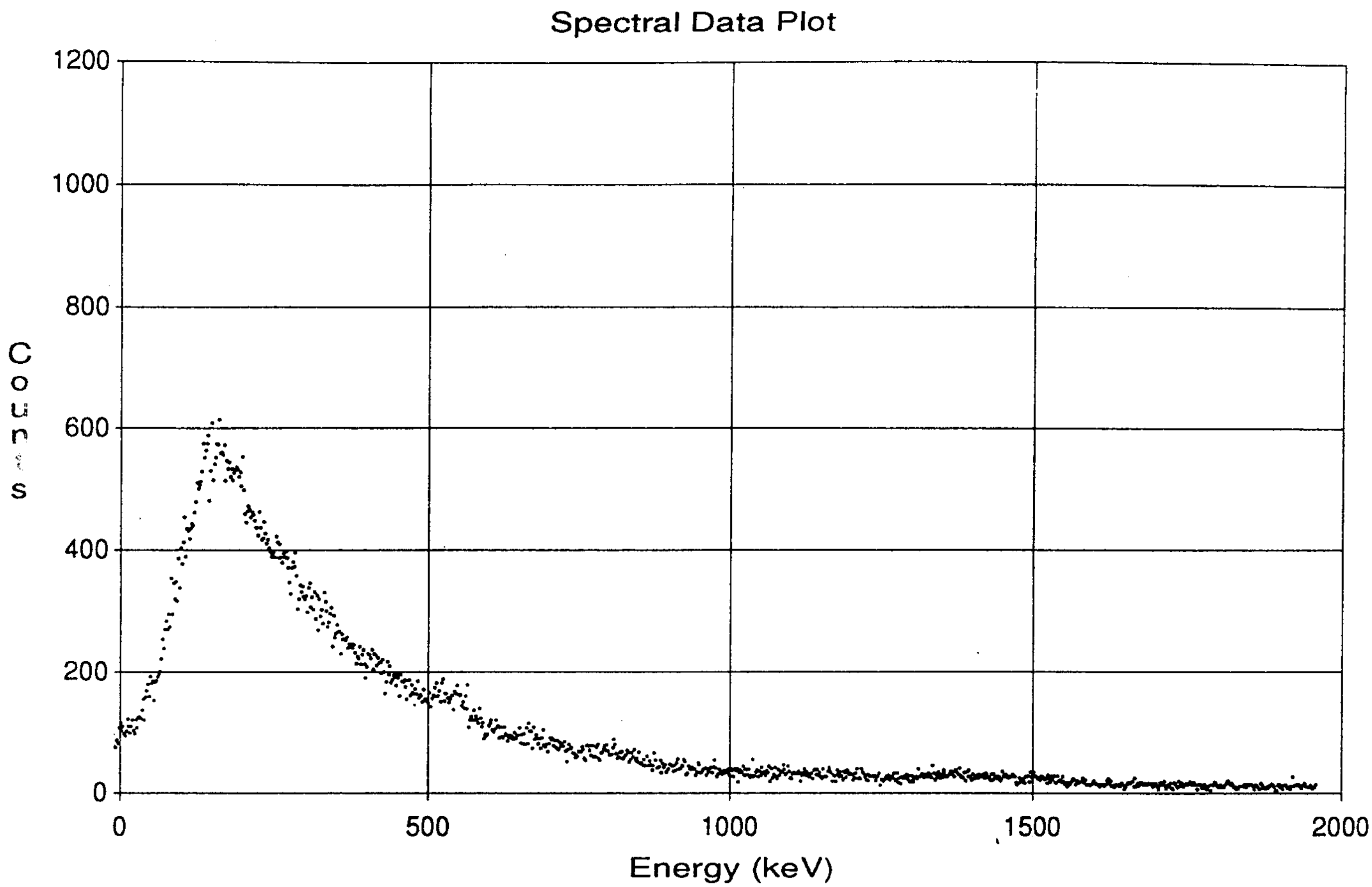
Reference area grid



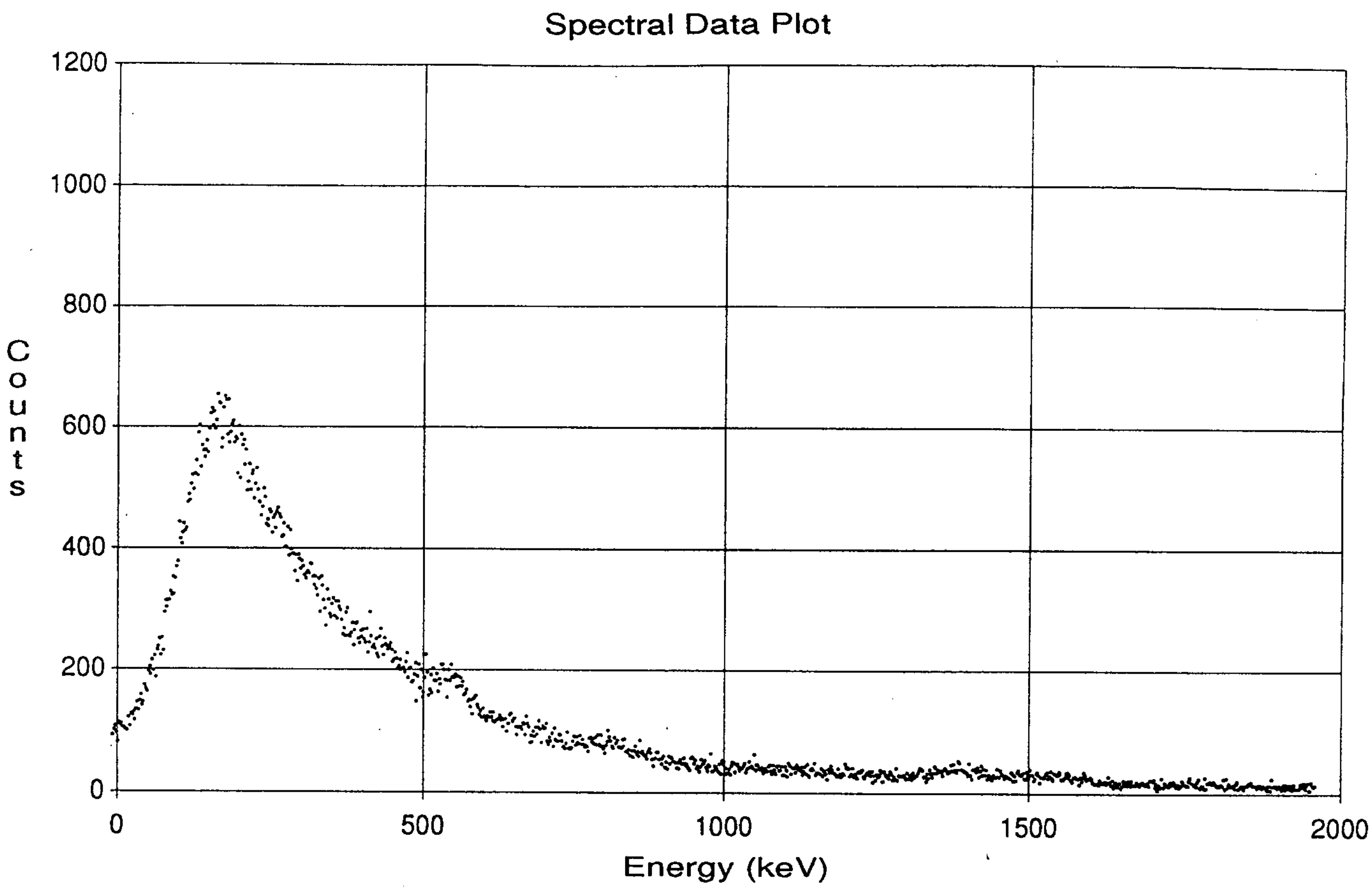
Pressurized Ionization Chamber (PIC)
Operation & quality assurance



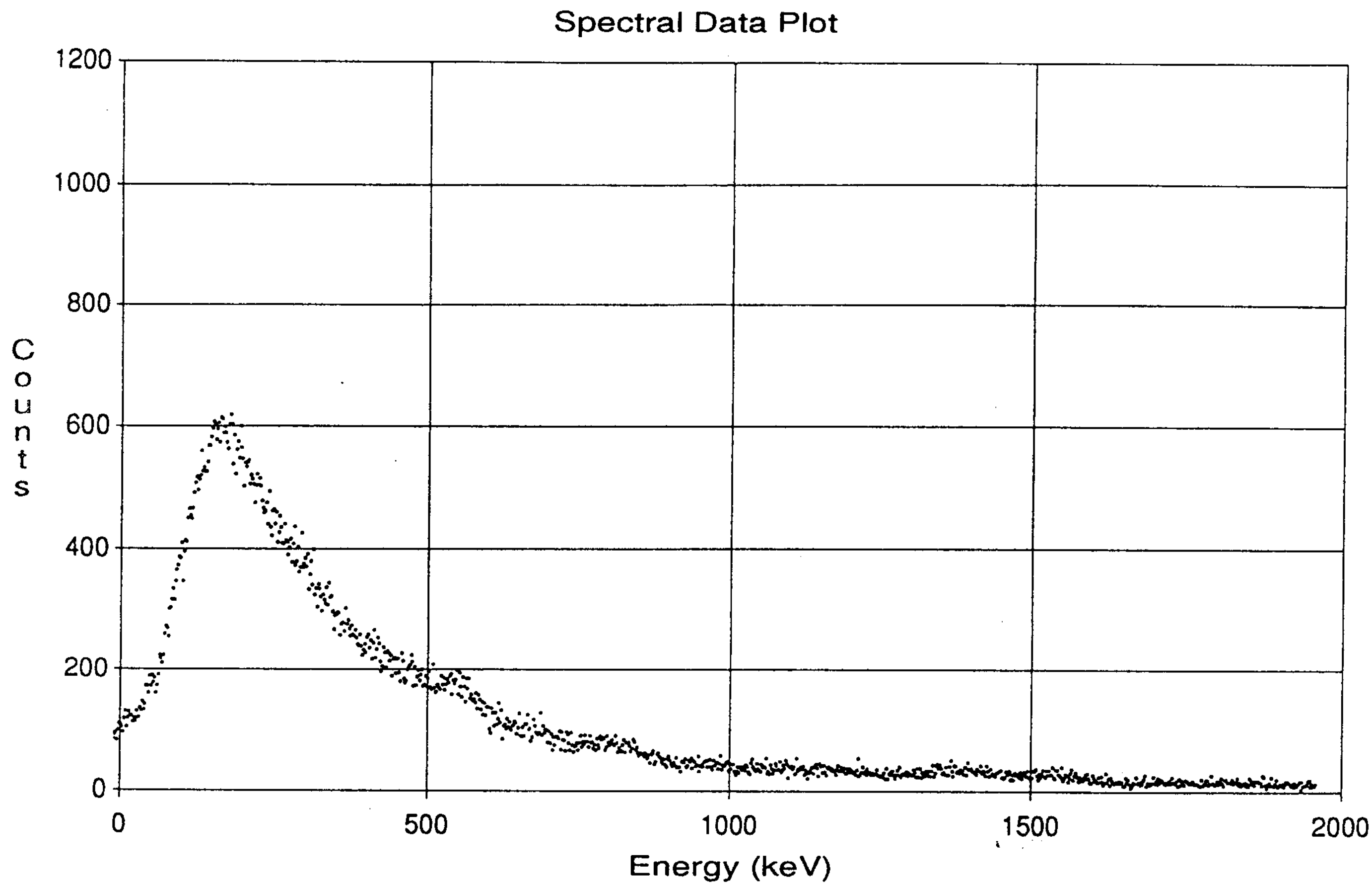
PIC operation & QA



Datasource: RVR04.CNF
Live Time: 300 sec
Real Time: 302 sec
Acq. Start: 5-19-98 10:12:14 AM
Start: 1 : -47.95 (keV)
Stop: 1024 : 1957.87 (keV)



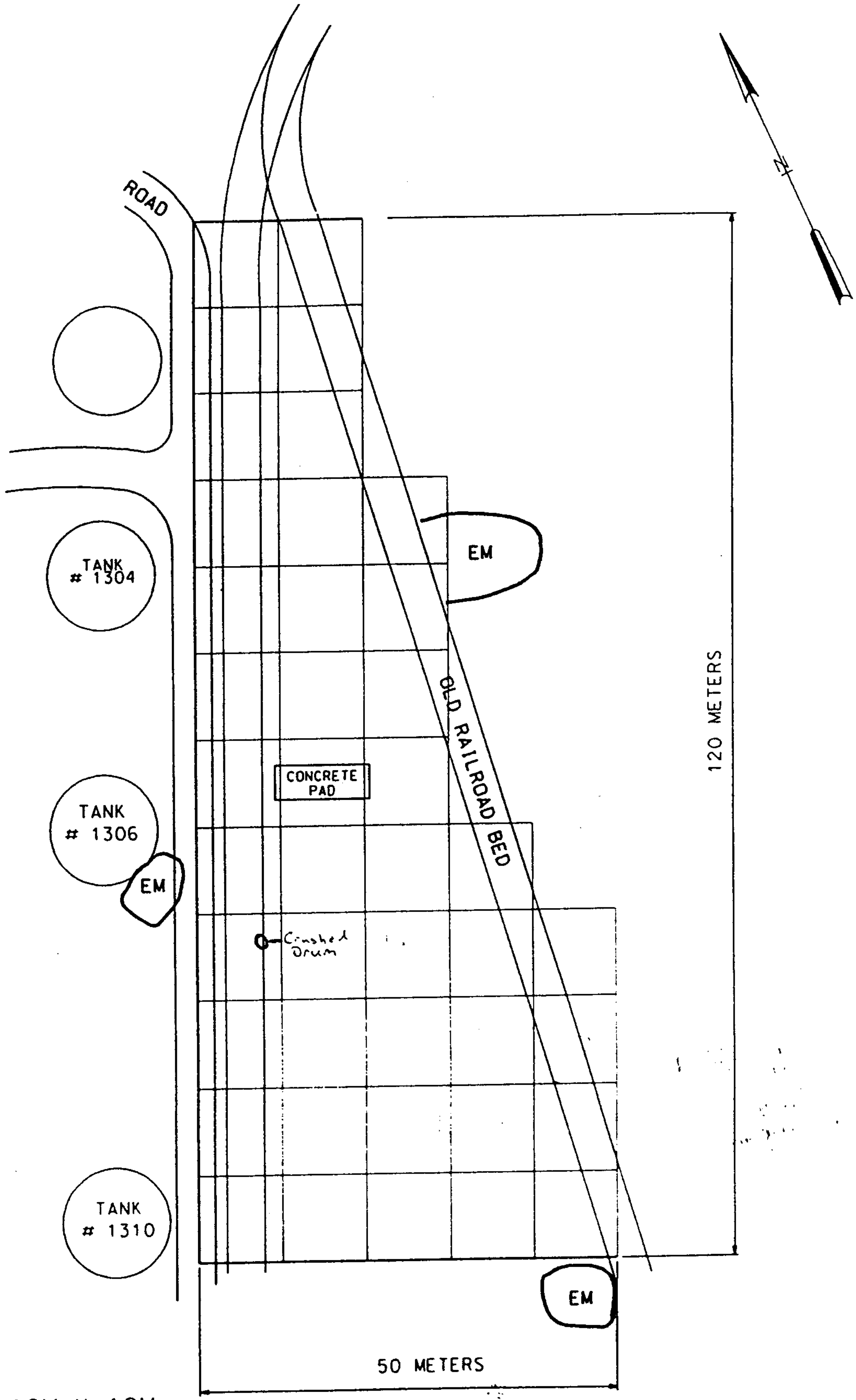
Datasource: RVR9
Live Time: 300 sec
Real Time: 302 sec
Acq. Start: 5-19-98 9:27:26 AM
Start: 1 : -47.95 (keV)
Stop: 1024 : 1957.87 (keV)



Datasource:	RVR17.CNF			
Live Time:	300 sec			
Real Time:	302 sec			
Acq. Start:	5-19-98	9:15:40 AM		
Start:	1	:	-47.95 (keV)	
Stop:	1024	:	1957.87 (keV)	

Appendix E

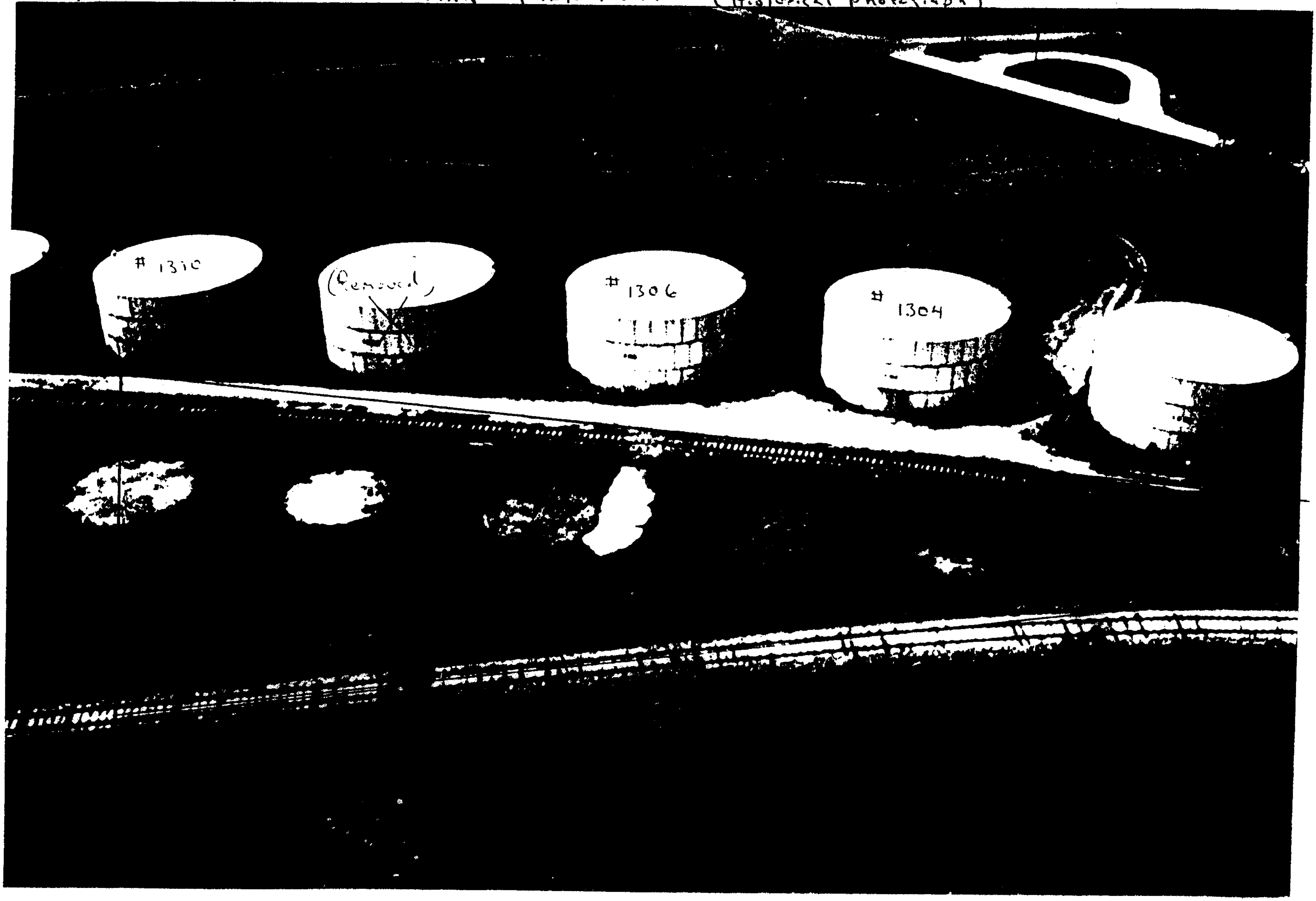
AOC SURVEY DATA

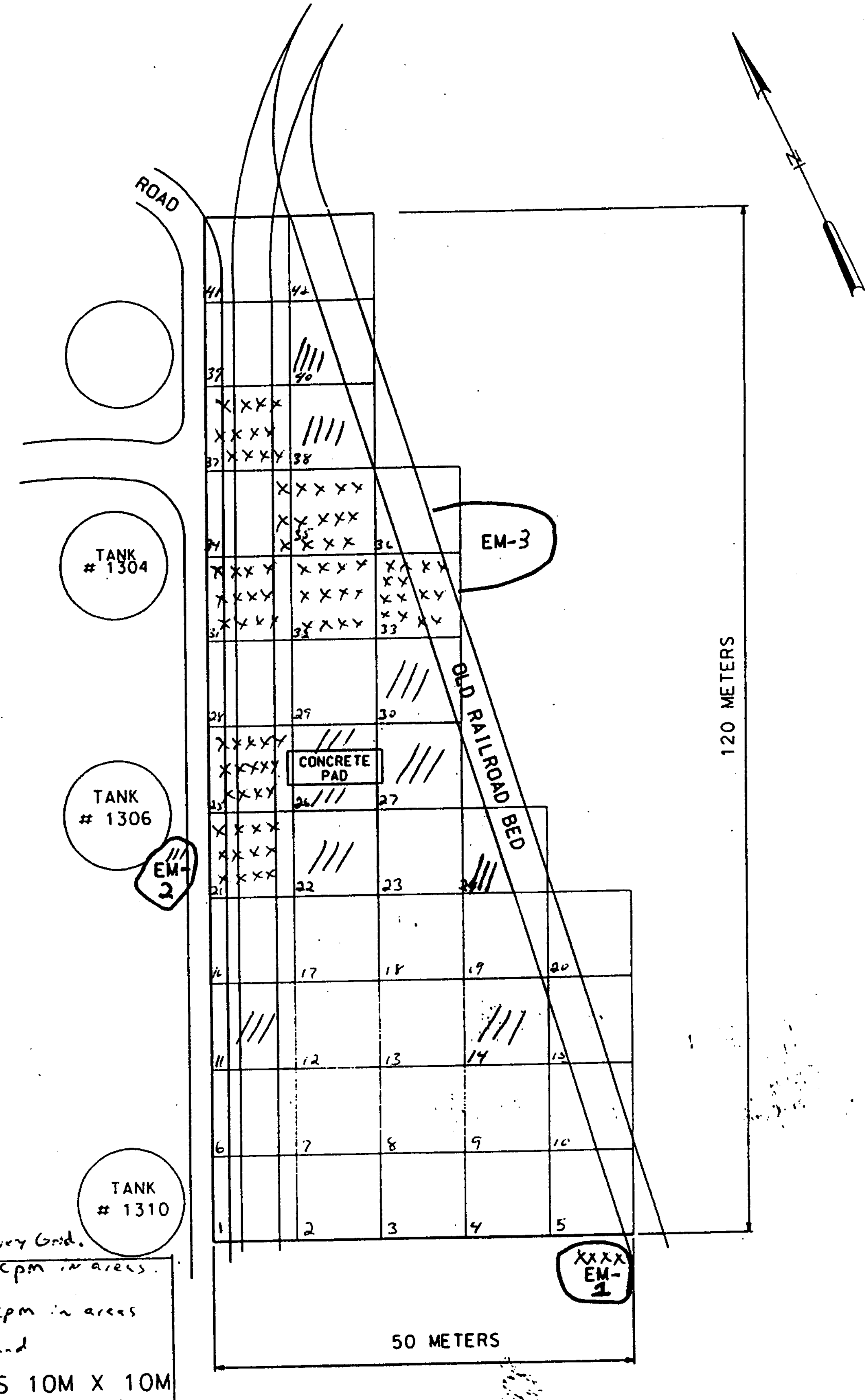


NOTE: GRID IS 10M X 10M

TITLE: MONAZITE SAND STORAGE TANK FARM AREA	RVAAP USACE DRAWN BY: ROY LONG	SCALE NONE	SHEET 8 OF 10

Monazite AOC at RVAAP Tank Farm (Historical Photograph)





1 Minute Counts in every Grid.
xxxx > 50,000 cpm in areas.
/////// > 10,000 cpm in areas
Grid > Background
NOTE: GRID IS 10M X 10M

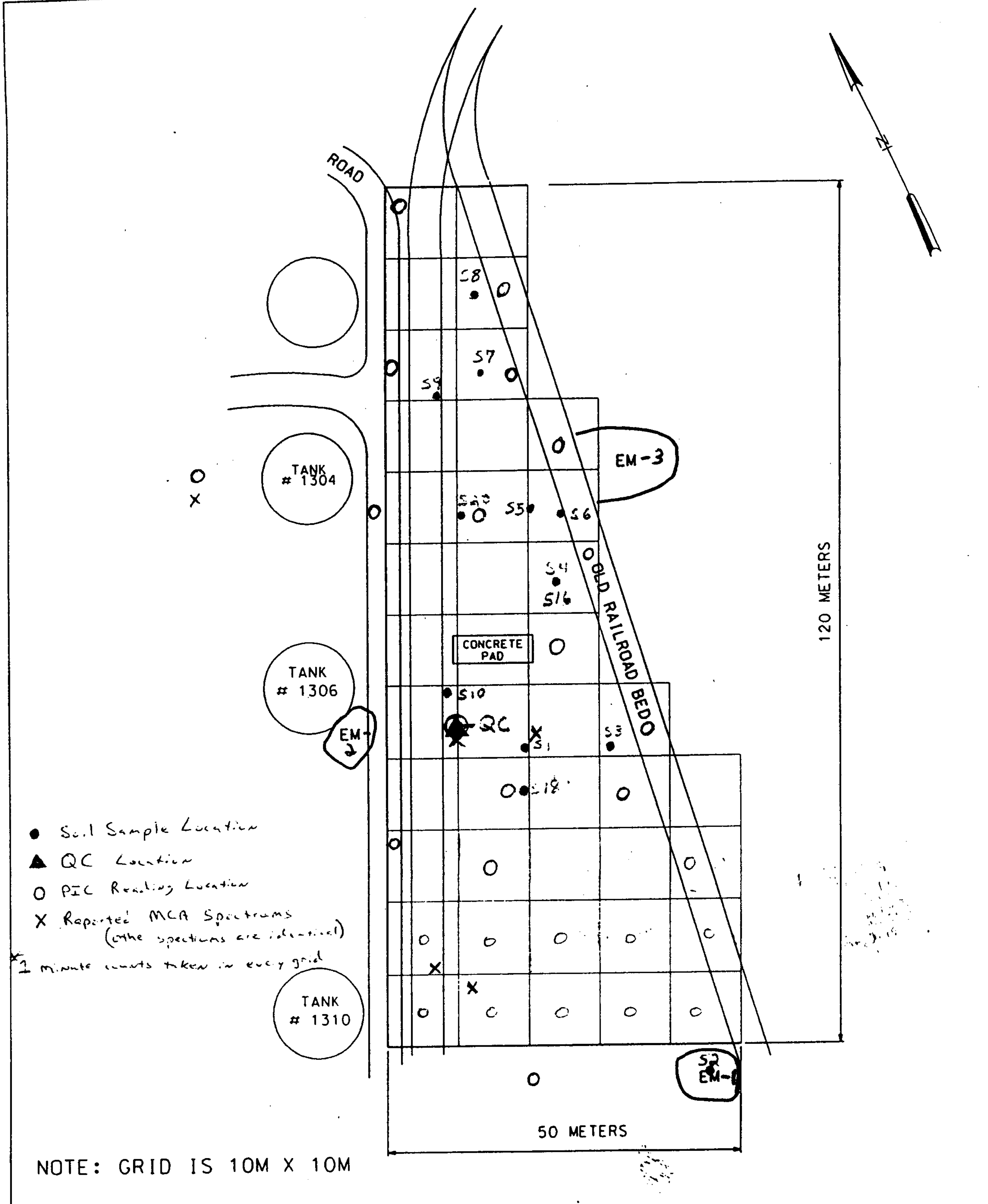
TITLE: MONAZITE SAND STORAGE TANK FARM AREA	RVAAP USACE DRAWN BY: ROY LONG	SCALE NONE	SHEET 8 OF 10

Ravenna Army Ammunition Plant Monazite Area of Concern													
		LAB RESULTS pCi/gm											
Sample #		U-238*	+/-	2s	Th-232	+/-	2s	Cs-137	+/-	2s	K-40*	+/-	2s
	cpm	LLD =90			LLD = 4			LLD = 0.1			LLD =5		
RVAAP-M-01S	42306	15	+/-	16	87	+/-	2	1	+/-	0.4	12	+/-	4
RVAAP-M-02S	209384	0.1	+/-	43	920	+/-	10	0.4	+/-	0.8	76	+/-	10
RVAAP-M-03S	29482	-17	+/-	14	69	+/-	2	0.6	+/-	0.3	10	+/-	4
RVAAP-M-04S	39375	-0.1	+/-	11	39	+/-	2	0.7	+/-	0.3	9	+/-	2
RVAAP-M-05S	85895	18	+/-	27	300	+/-	4	0.4	+/-	0.5	27	+/-	7
RVAAP-M-06S	139636	67	+/-	45	880	+/-	10	0.1	+/-	0.8	73	+/-	10
RVAAP-M-07S	31154	7	+/-	22	170	+/-	3	0.5	+/-	0.4	18	+/-	6
RVAAP-M-08S	36951	5	+/-	13	54	+/-	2	1	+/-	0.3	10	+/-	4
RVAAP-M-9S	220255	-33	+/-	54	1650	+/-	10	2	+/-	1	140	+/-	20
RVAAP-M-10S	106994	25	+/-	39	670	+/-	10	0.05	+/-	0.7	59	+/-	10
RVAAP-M-9SR	9S replicate	5	+/-	48	1230	+/-	10	2	+/-	1	96	+/-	10
RVAAP-M-12S	10S at depth	2	+/-	7	16	+/-	0.9	0.1	+/-	0.1	0.3	+/-	1
RVAAP-M-12SR	12S replicate	3	+/-	7	15	+/-	0.9	0.02	+/-	0.1	4	+/-	1
RVAAP-M-14S	3S at depth	2	+/-	4	5	+/-	0.5	0.07	+/-	0.08	6	+/-	0.9
RVAAP-M-14SR	14S replicate	-0.6	+/-	6	11	+/-	0.9	0.3	+/-	0.1	6	+/-	3
RVAAP-M-4SD	4S duplicate	2	+/-	9	27	+/-	1	0.5	+/-	0.2	6	+/-	3
RVAAP-M-17S	4S at depth	3	+/-	5	7	+/-	0.6	0.09	+/-	0.09	6	+/-	3
RVAAP-M-18S	8481	2	+/-	6	7	+/-	0.7	0.5	+/-	0.2	4	+/-	1
RVAAP-M-19S	18S at depth	-1	+/-	3	0.5	+/-	0.2	0.04	+/-	0.05	24	+/-	1
RVAAP-M-20S	77199	16	+/-	17	110	+/-	3	0.6	+/-	0.3	4	+/-	0.9
RVAAP-M-21S	20S at depth	-2	+/-	6	12	+/-	0.9	-0.03	+/-	0.1	14	+/-	5
STATISTICS											62	+/-	1
mean	85593	6		*	299			1			31		*
std	70930	18			478			1			38		

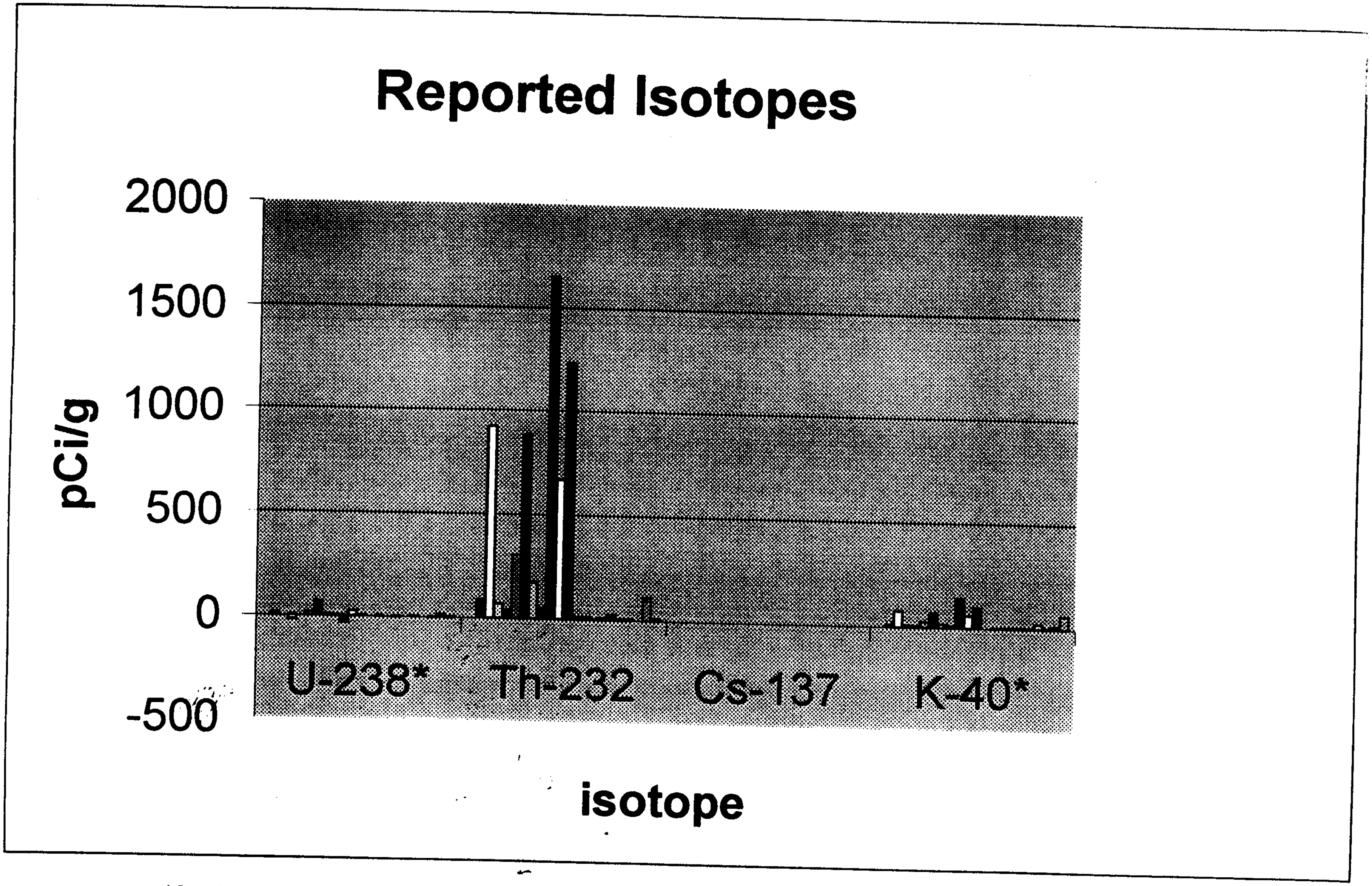
* Interference from Th-232 and Daughters

Depth or QC

Sample	depth	Th-232
RVAAP-M-10S	0-.15	670
RVAAP-M-12S	.2-.4	16
RVAAP-M-03S	0-.15	69
RVAAP-M-14S	.2-.4	5
RVAAP-M-04S	0-.15	39
RVAAP-M-17S	.2-.4	7
RVAAP-M-18S	0-.15	7
RVAAP-M-19S	.2-.4	0.5
RVAAP-M-20S	0-.15	110
RVAAP-M-21S	.2-.4	12



TITLE: MONAZITE SAND STORAGE TANK FARM AREA *Soil Sample Locations*	RVAAP USACE DRAWN BY: ROY LONG	SCALE NONE	SHEET 8 OF 10



*Graph Demonstrates Th-232 interference with K-40 and U-238

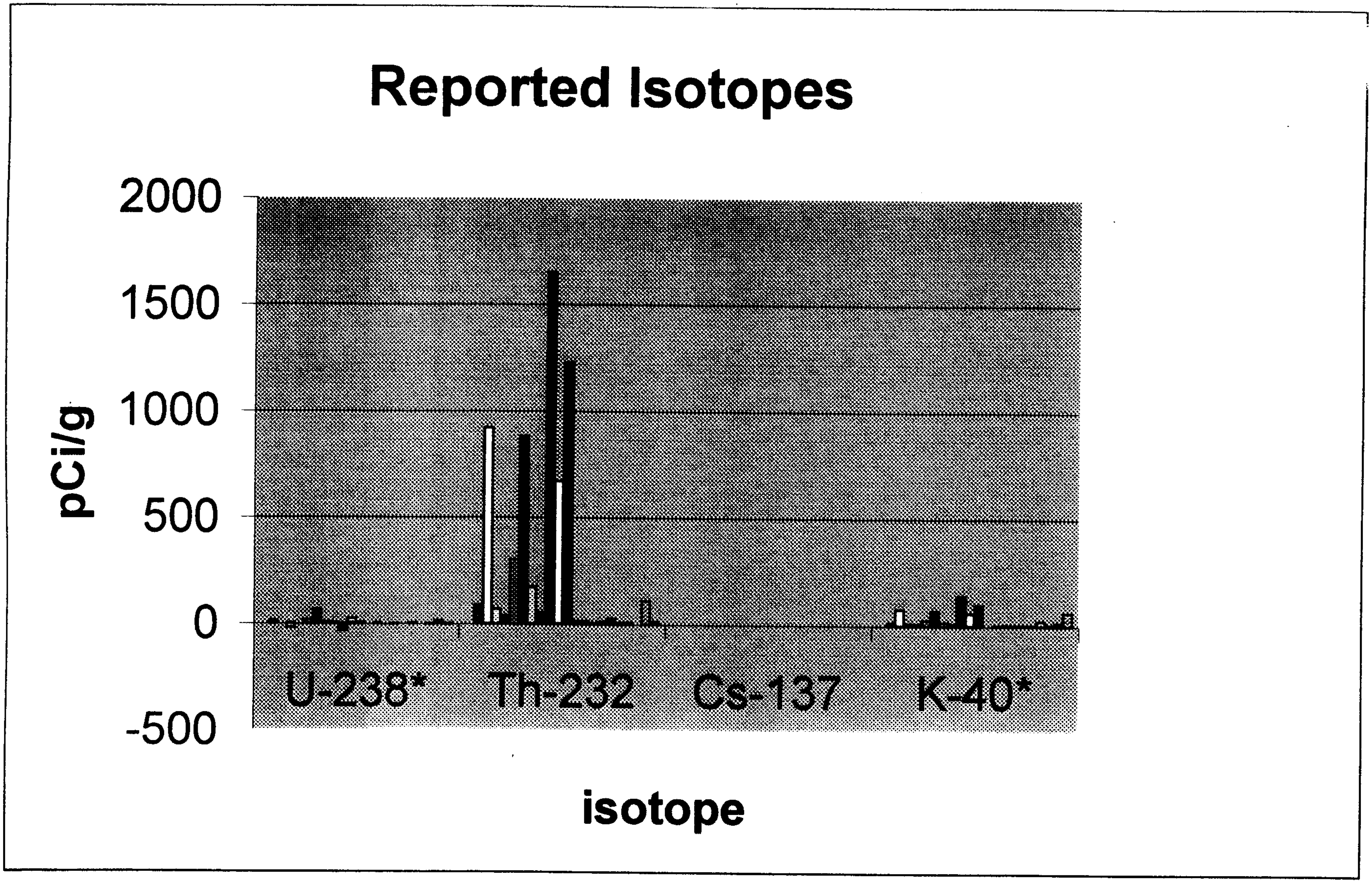
Ravenna Army Ammunition Plant
Monazite Area of Concern

Field Data Conversions

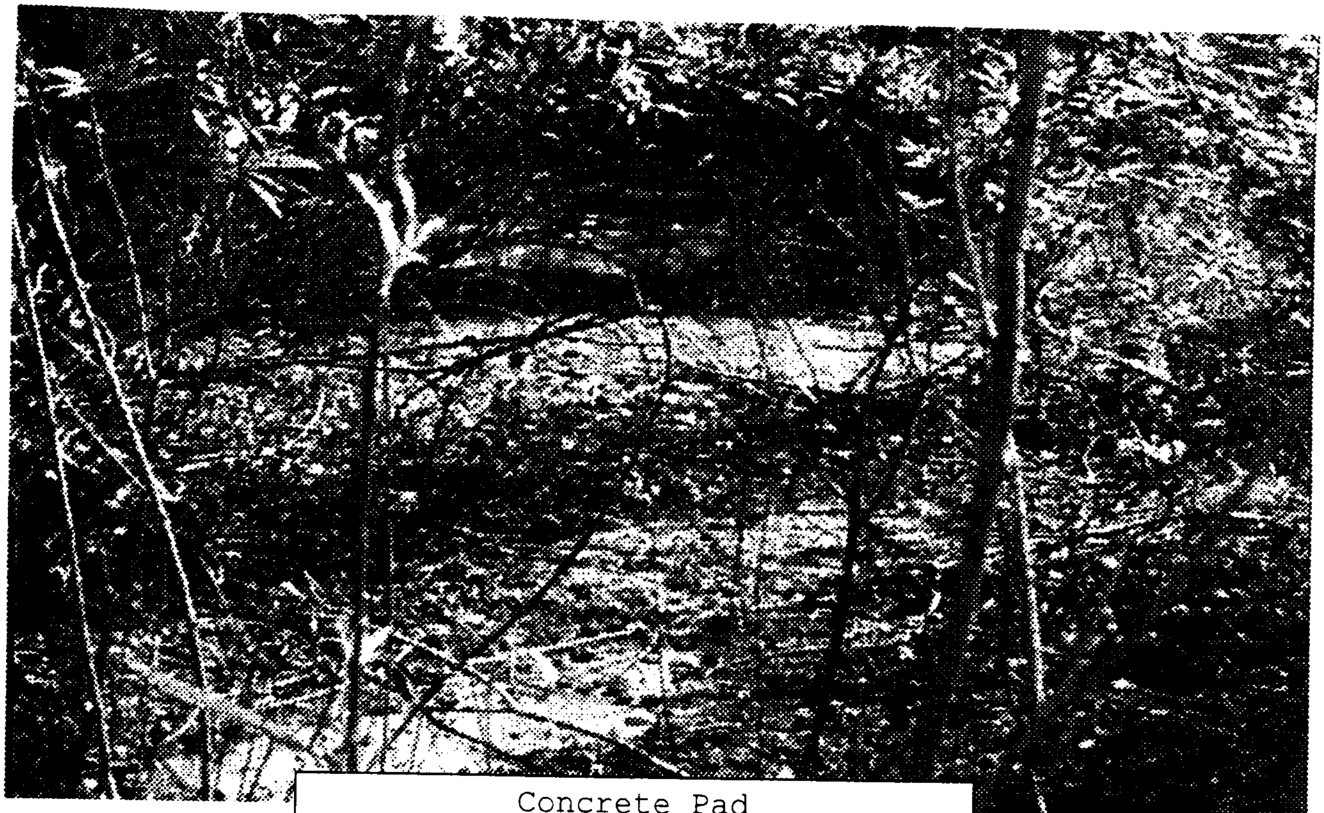
Grid/Sample #	cpm	PIC	uR/hr	pCi/g-Th-232
1	14343	25.6	50.1	29.0
2	4316	12.6	20.1	5.9
3	4012	12.2	19.2	5.2
4	9819	19.8	36.6	18.6
5	7814	17.2	30.5	14.0
6	4835	13.3	21.6	7.1
7	7573	16.8	29.8	13.4
8	5742	14.5	24.3	9.2
9	6712	15.7	27.2	11.4
10	114801	156.2	351.0	615.1
11	15159	26.7	52.6	30.9
12	15486	27.1	53.5	31.6
13	3772	11.9	18.4	4.7
14	54945	78.4	171.7	202.1
15	11400	21.8	41.3	22.2
16	8975	18.7	34.0	16.6
17	6368	15.3	26.2	10.6
18	13923	25.1	48.8	28.0
19	6667	15.7	27.1	11.3
20	61311	86.7	190.8	246.0
21	97542	133.8	299.3	496.0
22	58972	83.7	183.8	229.9
23	26861	41.9	87.6	57.8
24	8930	18.6	33.9	16.5
25	59723	84.6	186.0	235.1
26	7756	17.1	30.4	13.8
27	9852	19.8	36.7	18.7
28	7565	16.8	29.8	13.4
29	2342	10.0	14.2	1.4
30	5262	13.8	22.9	8.1
31	4365	12.7	20.2	6.0
32	2752	10.6	15.4	2.3
33	3324	11.3	17.1	3.6
34	3163	11.1	16.6	3.3
35	2622	10.4	15.0	2.0
36	4090	12.3	19.4	5.4
37	2661	10.5	15.1	2.1
38	19360	32.2	65.1	40.5
39	3455	11.5	17.5	3.9
40	3073	11.0	16.3	3.1
41	6013	14.8	25.2	9.8
42	2508	10.3	14.7	1.8
Samples	220255	293.3	666.9	1342.8
	8481	18.0	32.5	15.5
	77199	107.4	238.4	355.7
	42306	62.0	133.9	93.3
	209384	279.2	634.3	1267.7
	29482	45.3	95.5	63.8
	39375	58.2	125.1	86.6
	85895	118.7	264.4	415.7
	139636	188.5	425.4	786.5
	31154	47.5	100.5	67.7
	36951	55.0	117.8	81.0
	91796	126.3	282.1	456.4
average	32075.5185	48.7	103.2	**139.6**
calculated pCi/g	32075.5185			**70**

Data Analysis

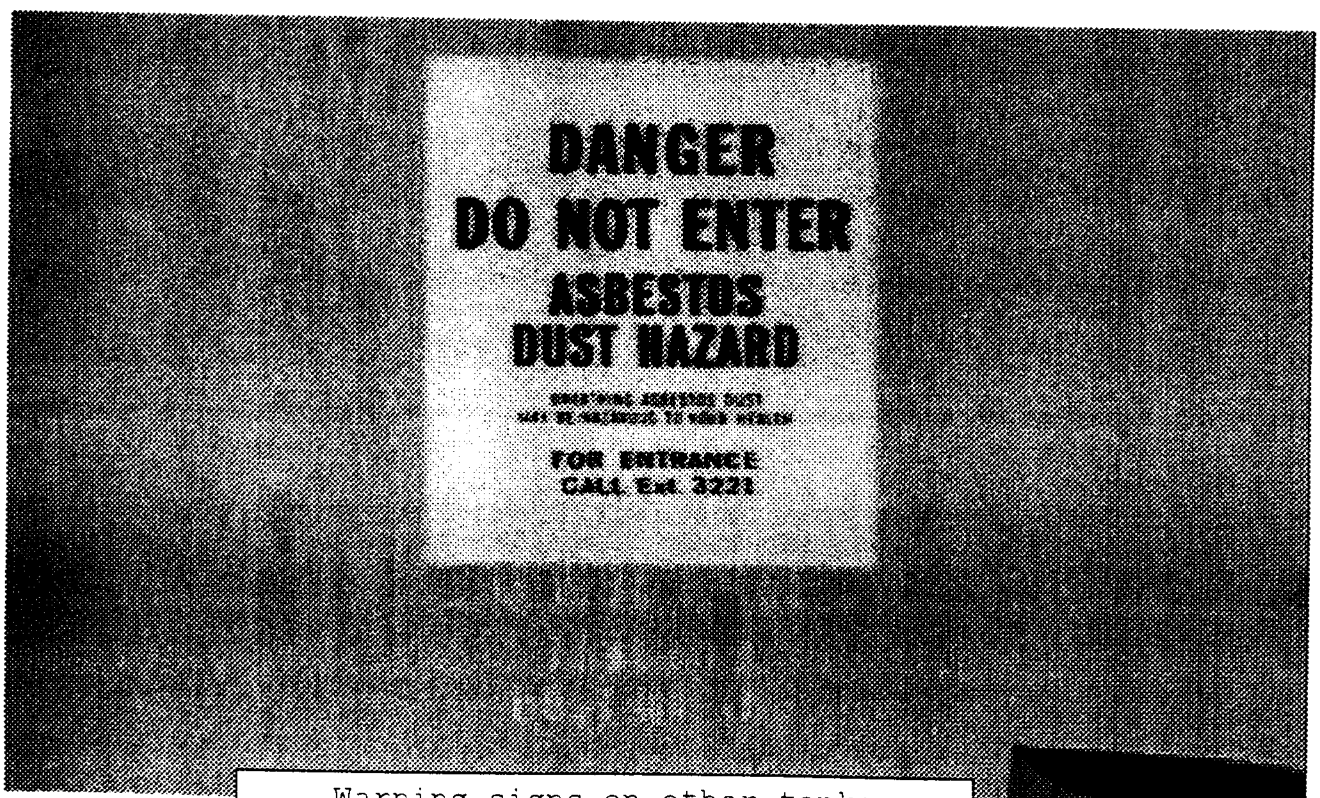
Sample # Th-232	pCi/g actual	cpm	pCi/g calculated
RVAAP-M-01S	87	42306	93.3
RVAAP-M-02S	920	209384	1267.7
RVAAP-M-03S	69	29482	63.8
RVAAP-M-04S	39	39375	86.6
RVAAP-M-05S	300	85895	415.7
RVAAP-M-06S	880	139636	786.5
RVAAP-M-07S	170	31154	67.7
RVAAP-M-08S	54	36951	81.0
RVAAP-M-9S	1650	220255	456.4
RVAAP-M-10S	670	91796	1342.8
RVAAP-M-18S	7	8481	15.5
RVAAP-M-20S	110	77199	355.7
average	413.0	84326.2	419.4
test*		**1.015**	
*** mean of caculated data/mean of actual data**			
calculated pCi/g without hot spots			**21**



*Graph Demonstrates Th-232 interference with K-40 and U-238



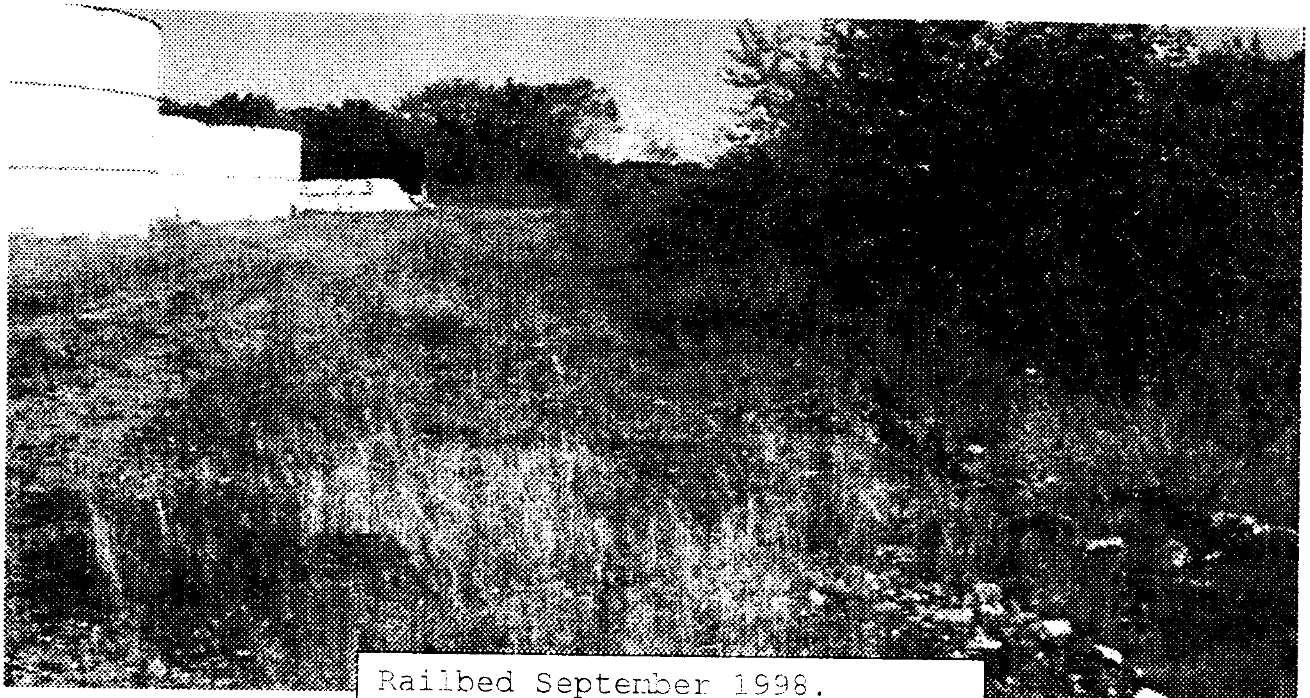
Concrete Pad



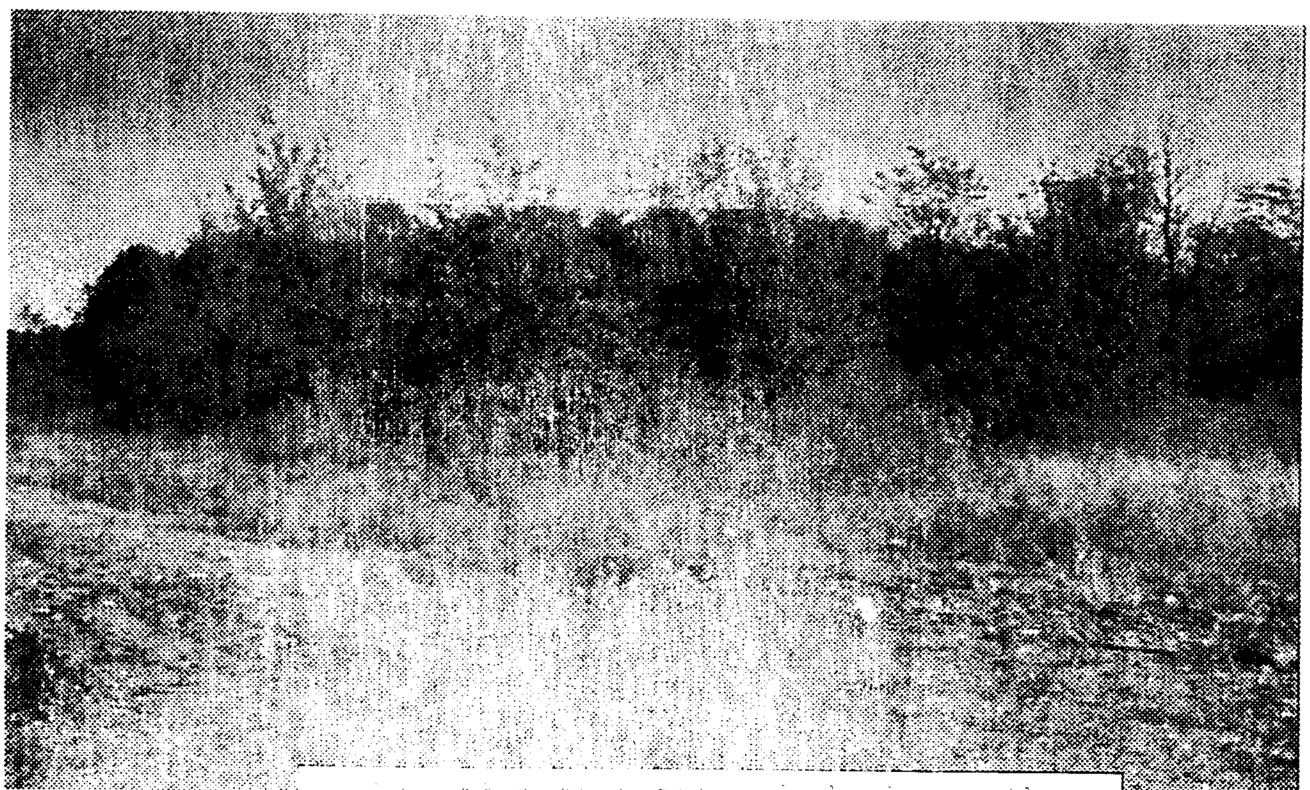
Warning signs on other tanks

Remaining 55 gallon drum. Contains plastic sheeting and soil.

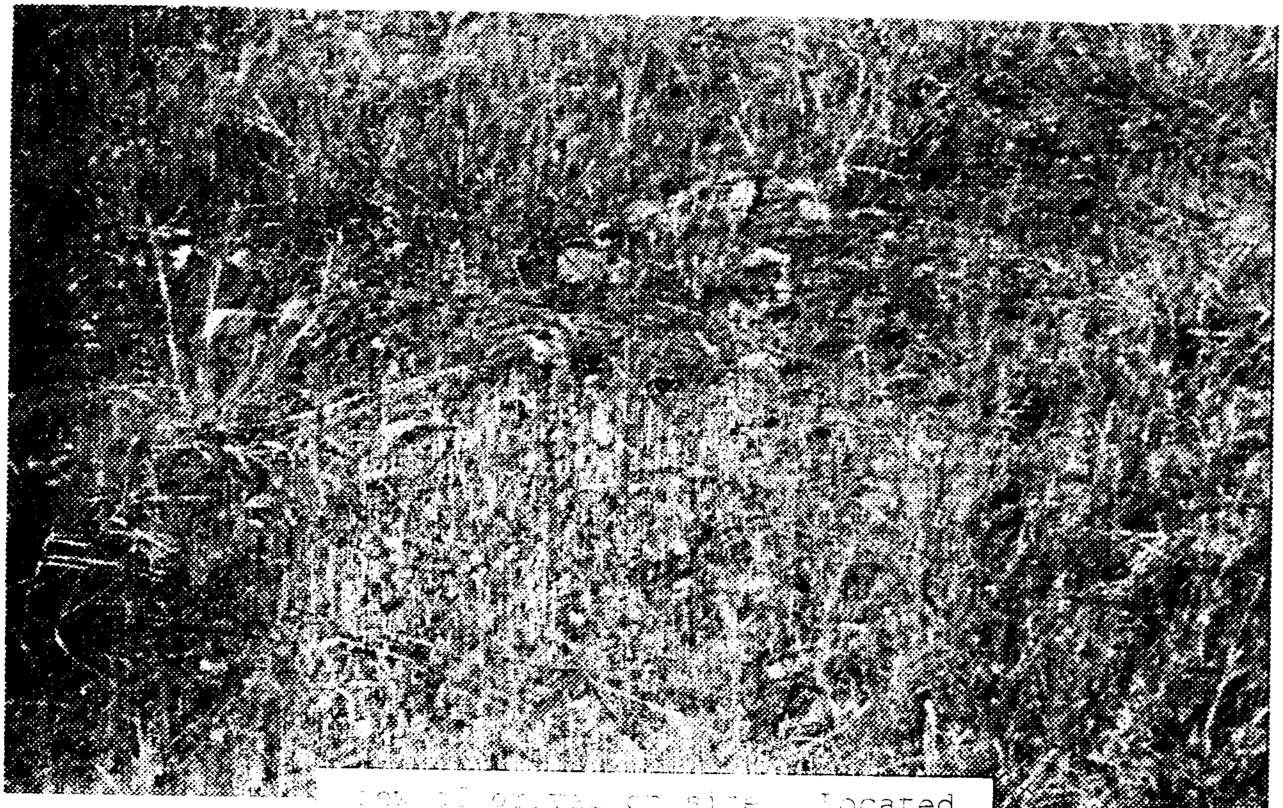
Remnants of second drum.. Appears to be rubber seals.



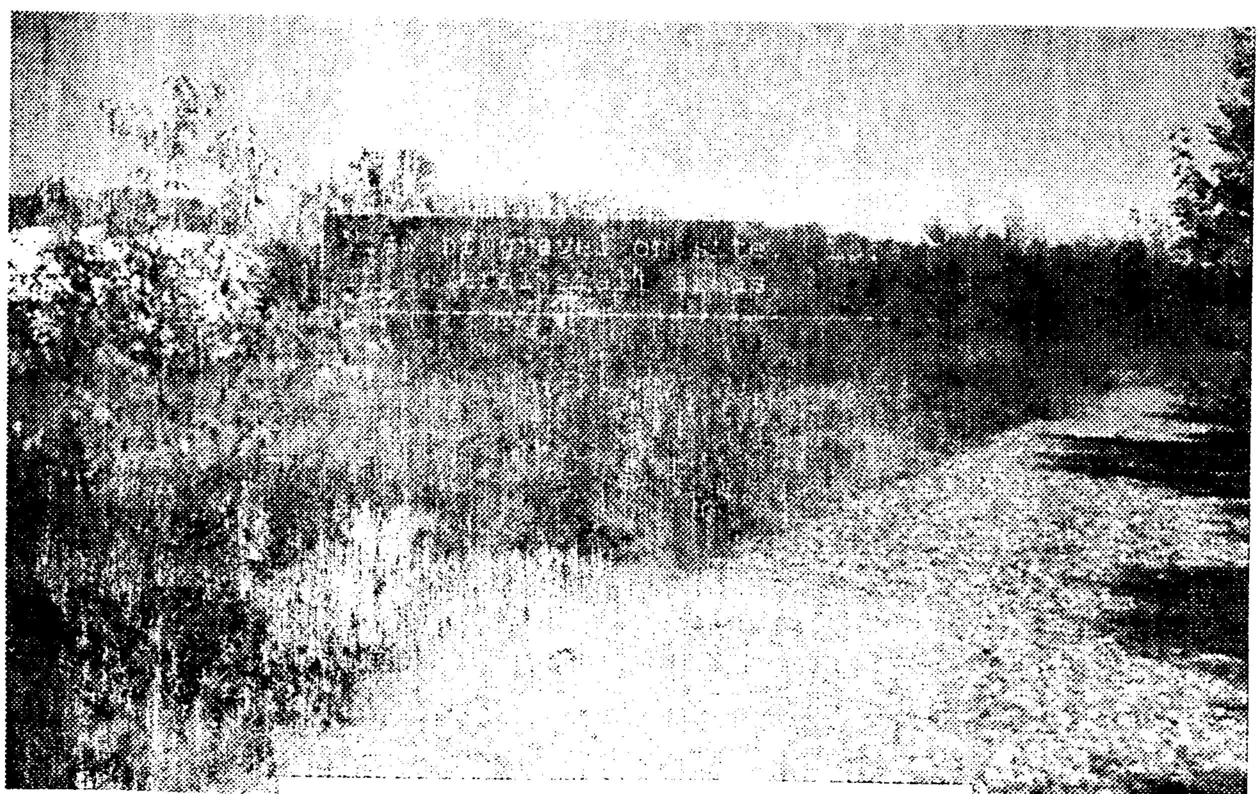
Railbed September 1998.
Note: vegetation growth.



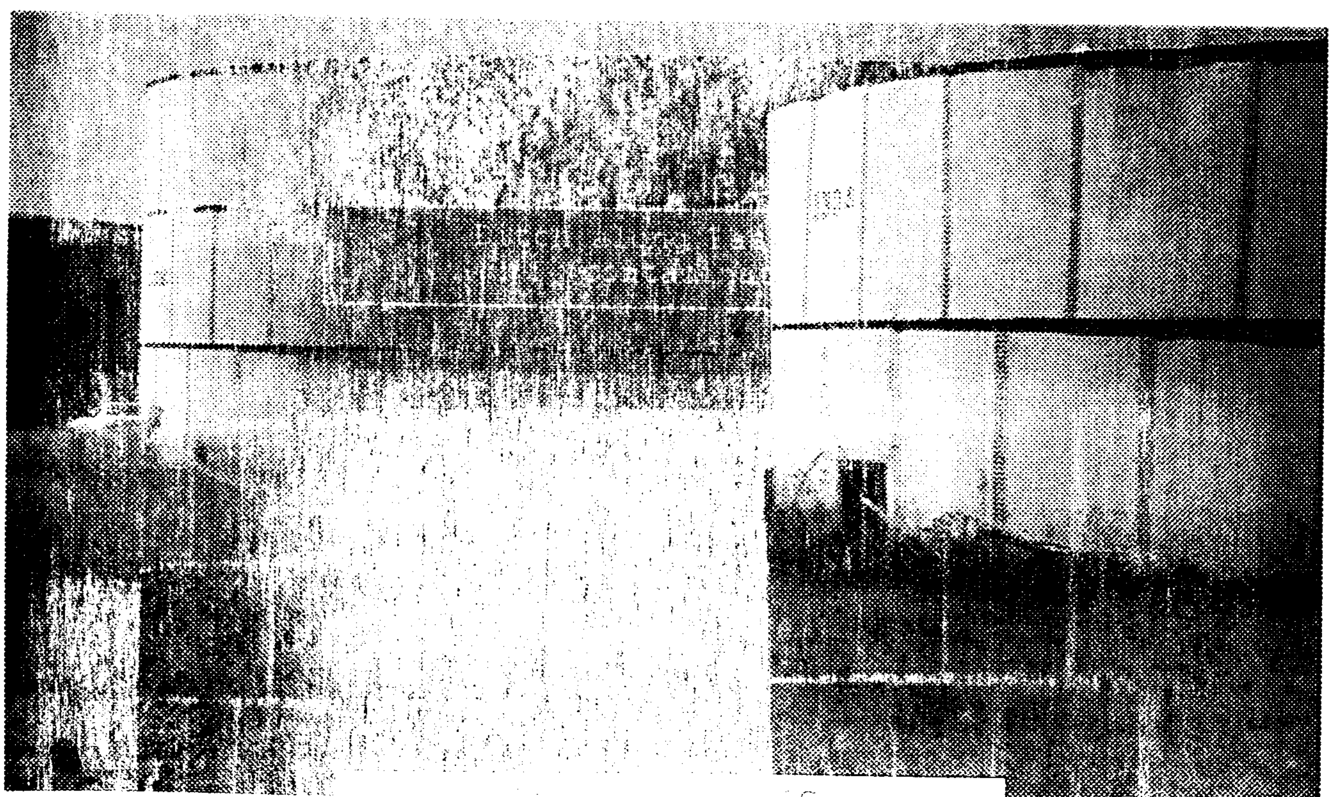
[illegible] of [illegible] trees and shrub growth.



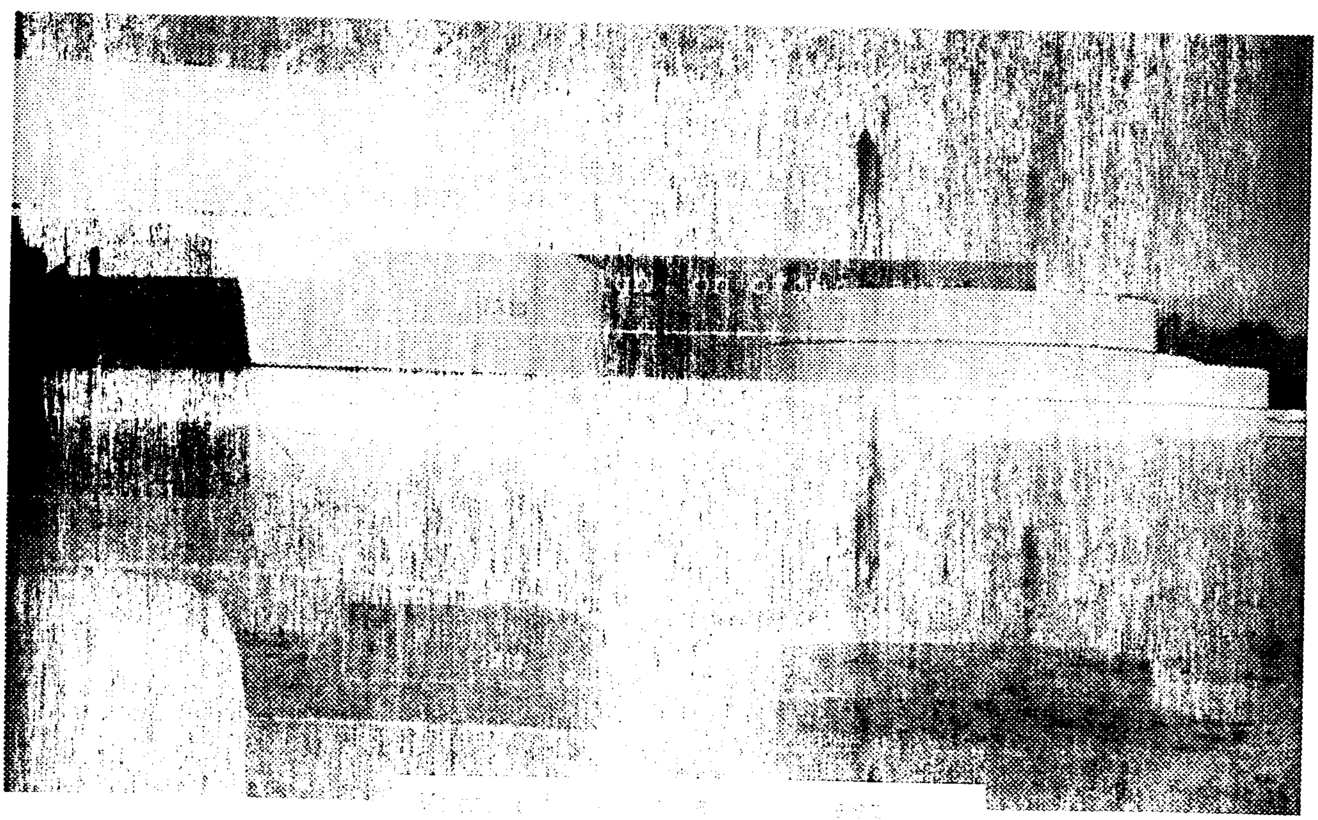
[illegible] of gravel on site. Located [illegible] several small areas.

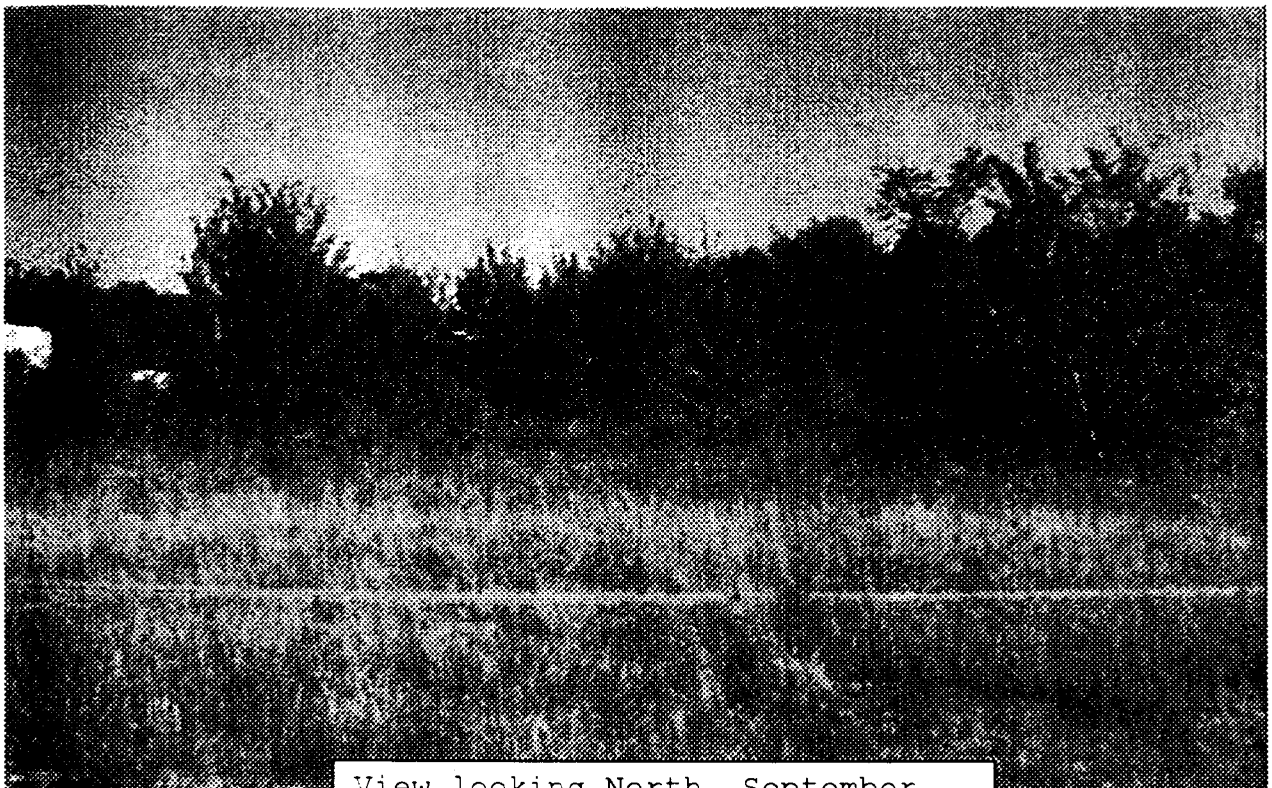


Remaining [illegible] side of [illegible]




1312

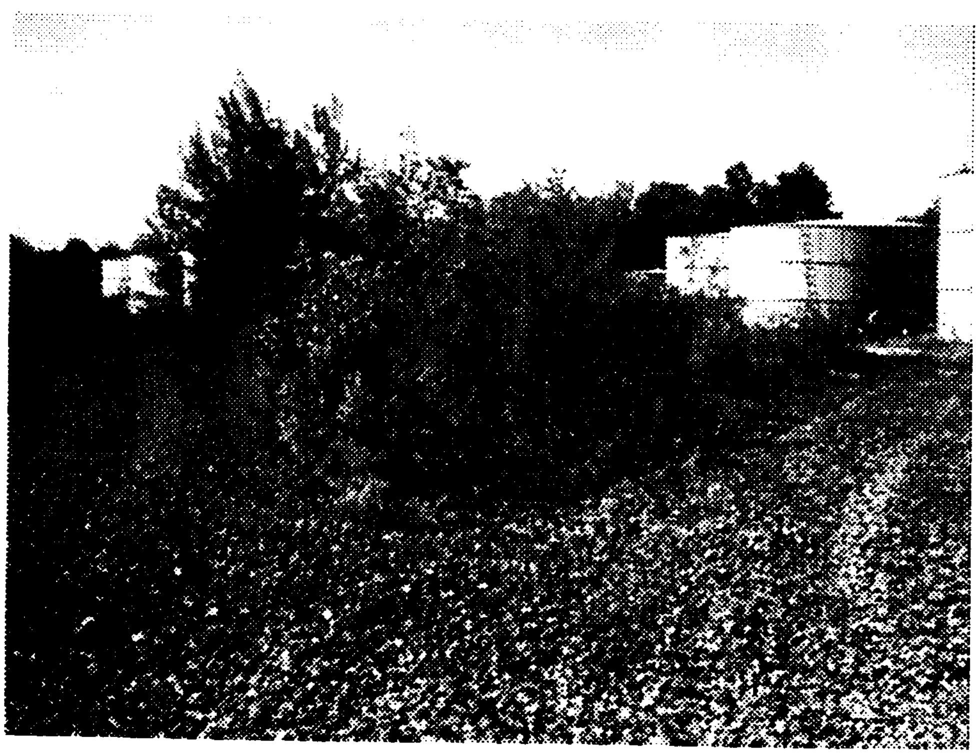




View looking North, September.

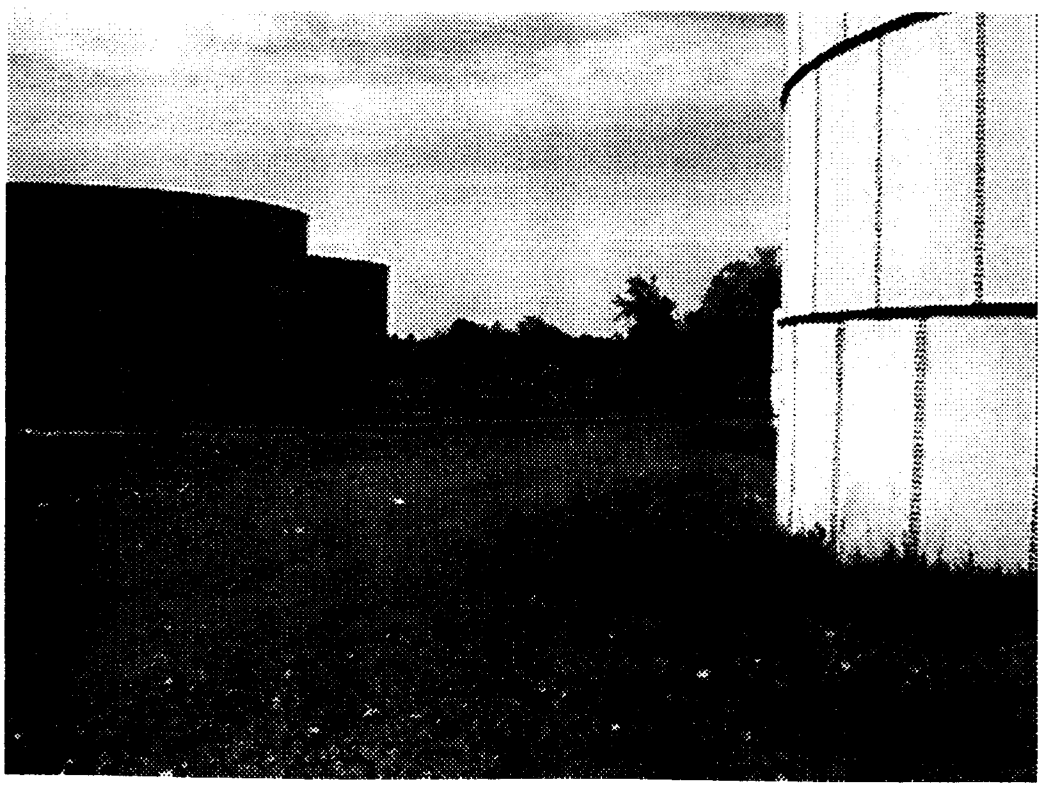
Gravel and brick pieces in various locations.

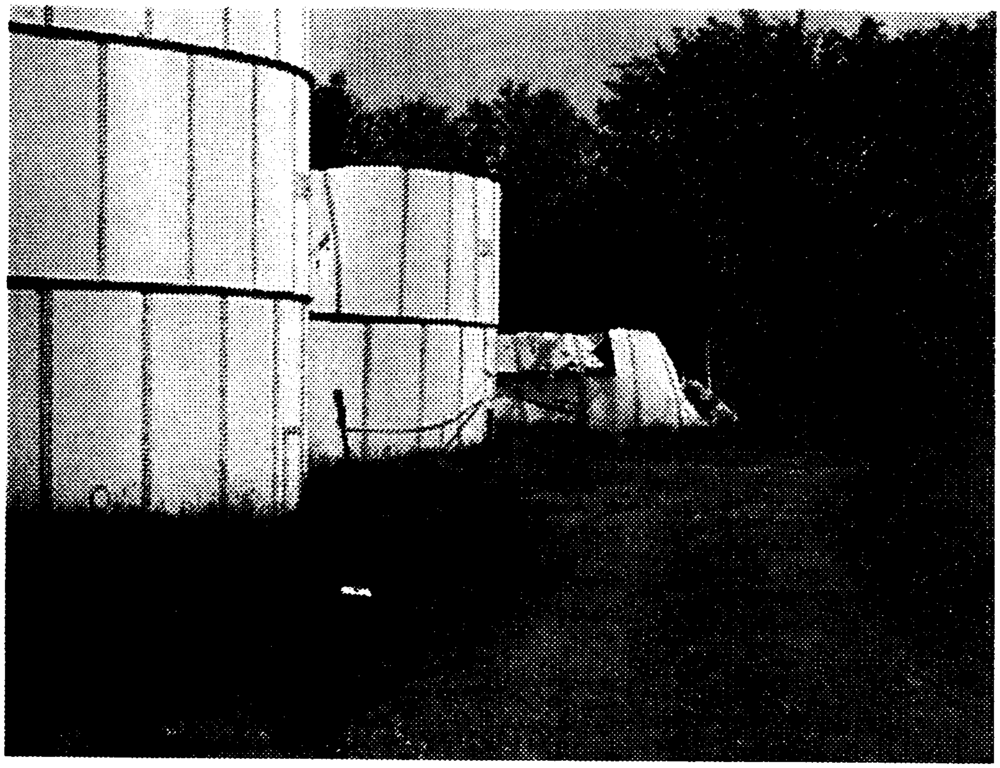
Tank Farm
View of south/east end of contaminated area



Tank Farm
View looking from rail bed junction

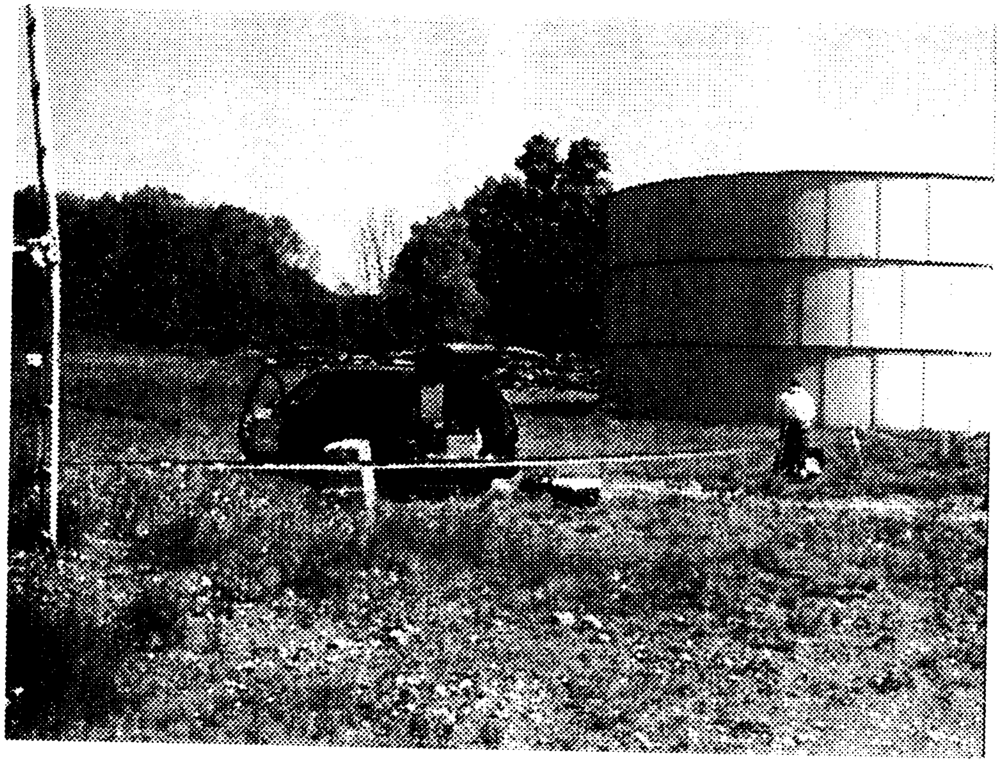
Tank Farm
2 Views of south end of contaminated area



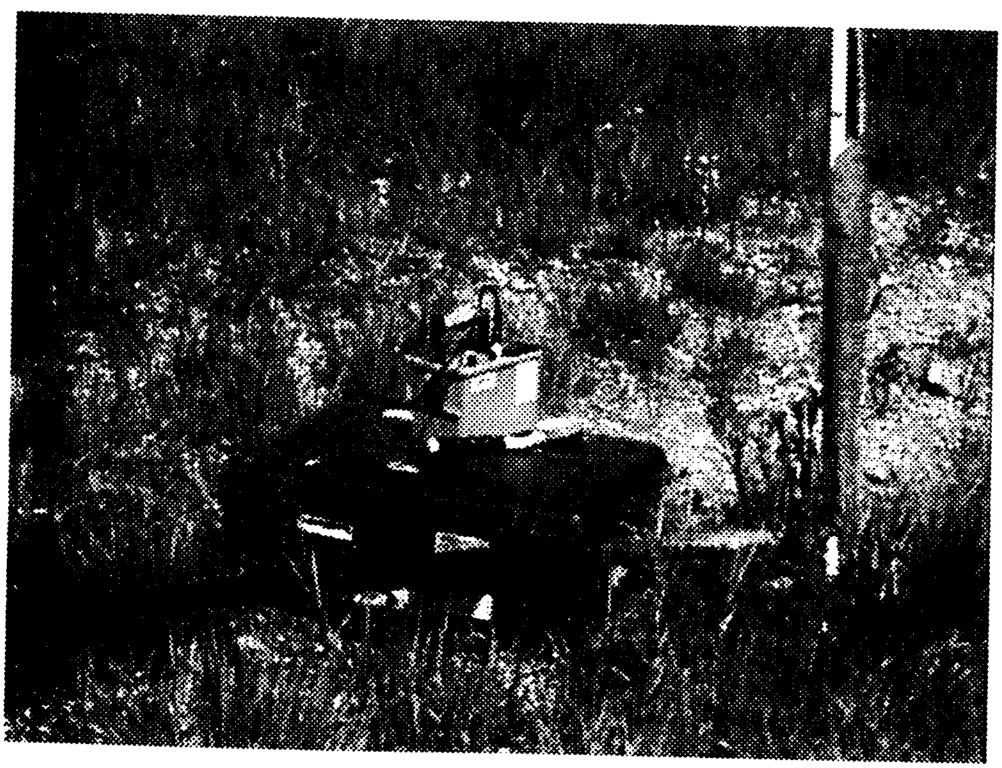


Tank Farm
View of North West end

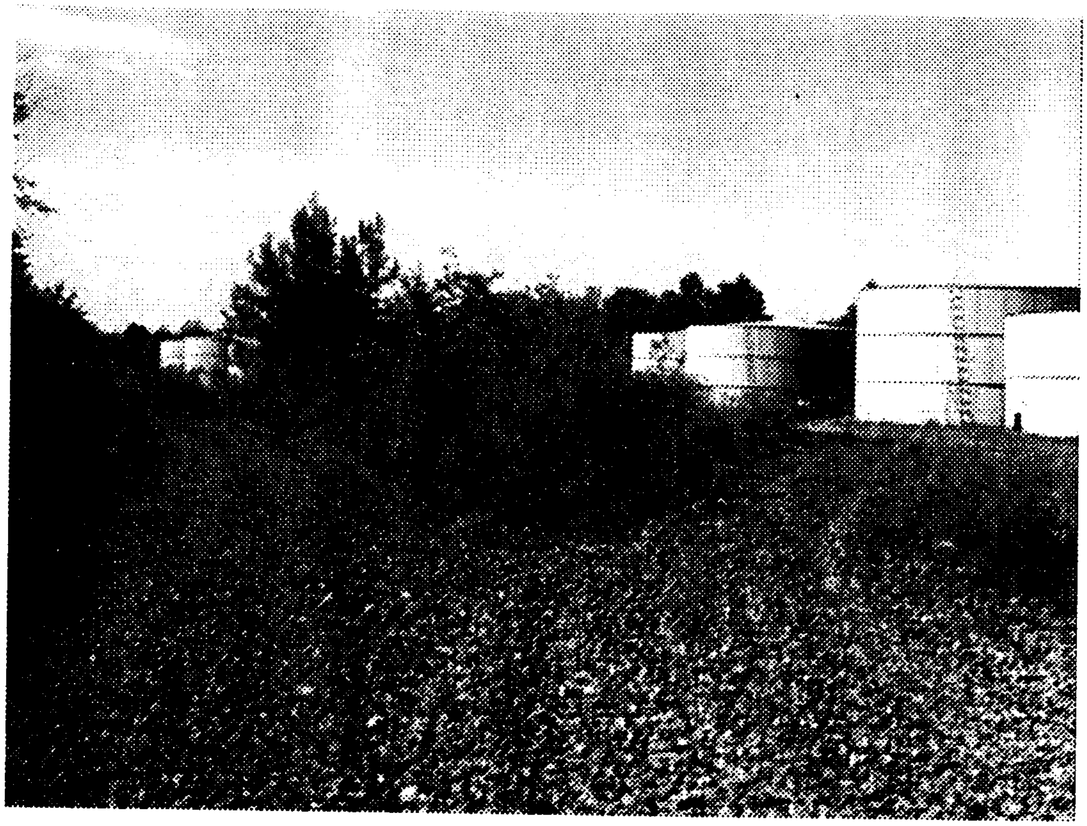
Tank Farm
West rail bed (contaminated)



Tank Farm
Exclusion Zone

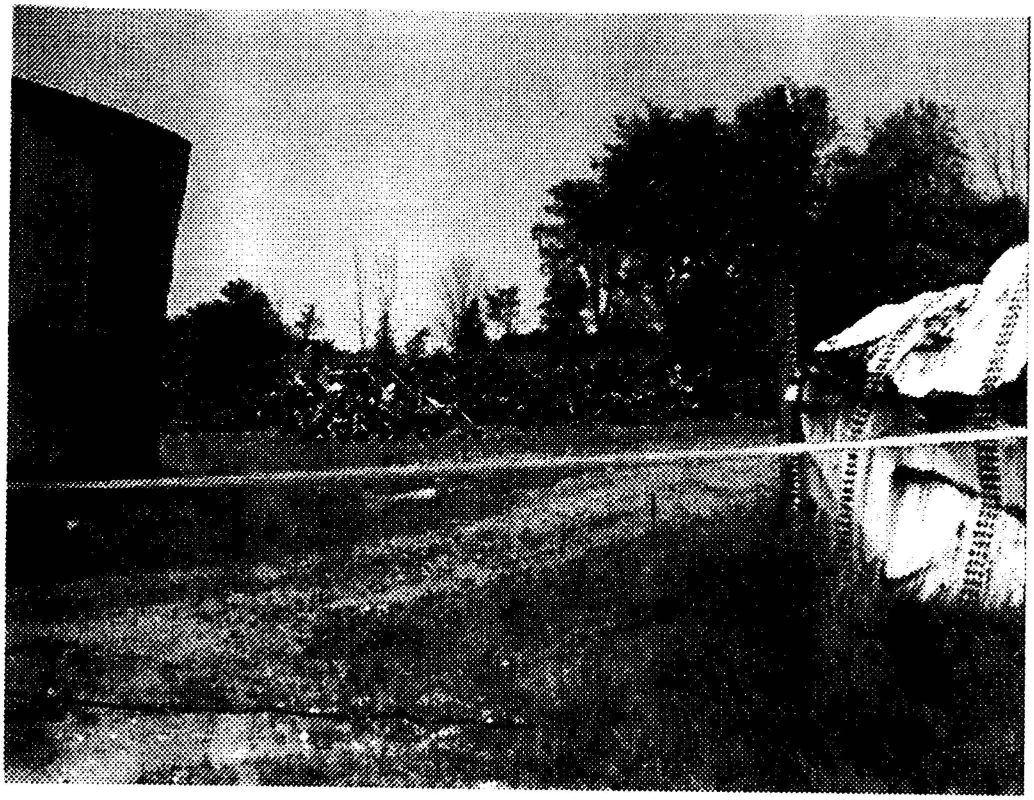


Ttank Farm
Exclusion Zone Entrance
And Frisking Instrument



Tank Farm
View from junction of rail bed towards exclusion zone

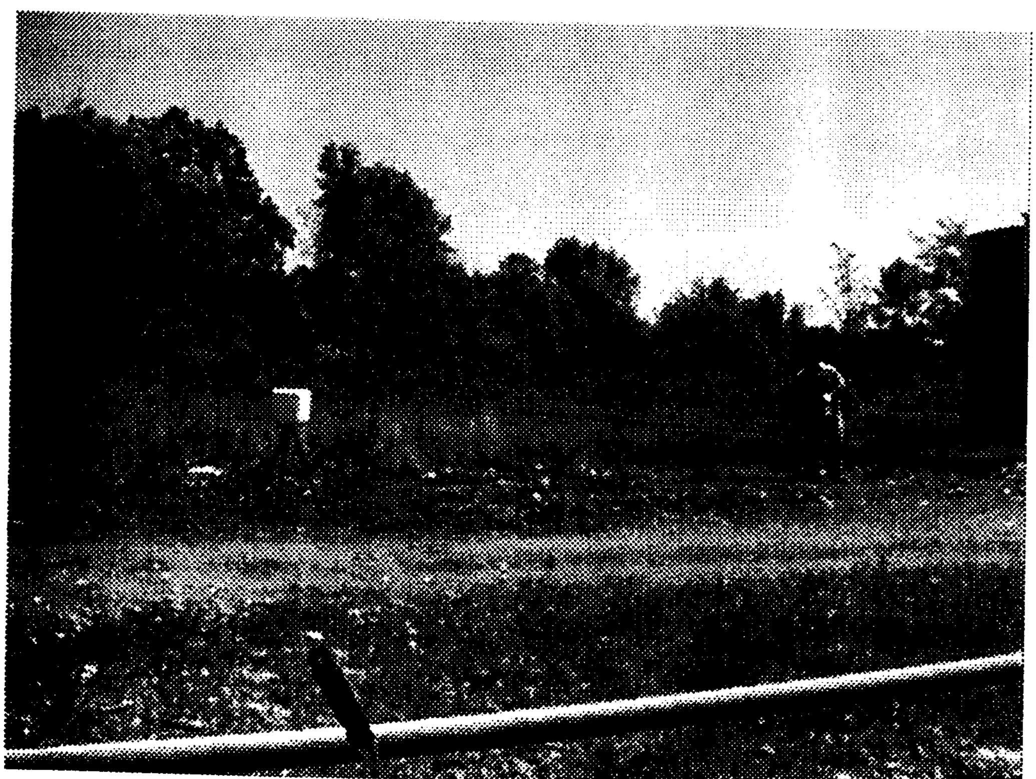
Tank Farm
View of crushed 55 gallon drum



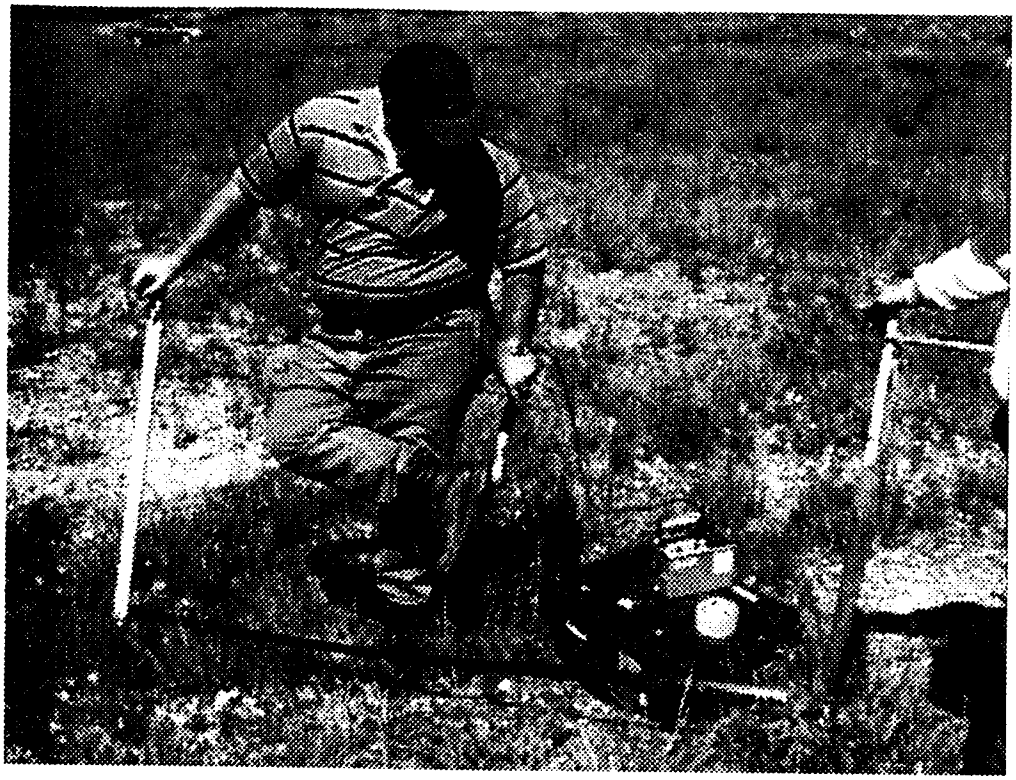
Tank Farm
Rail tie pile

Tank farm
View looking east at rail bed
(hot-spot flags)

Tank Farm
Field readings

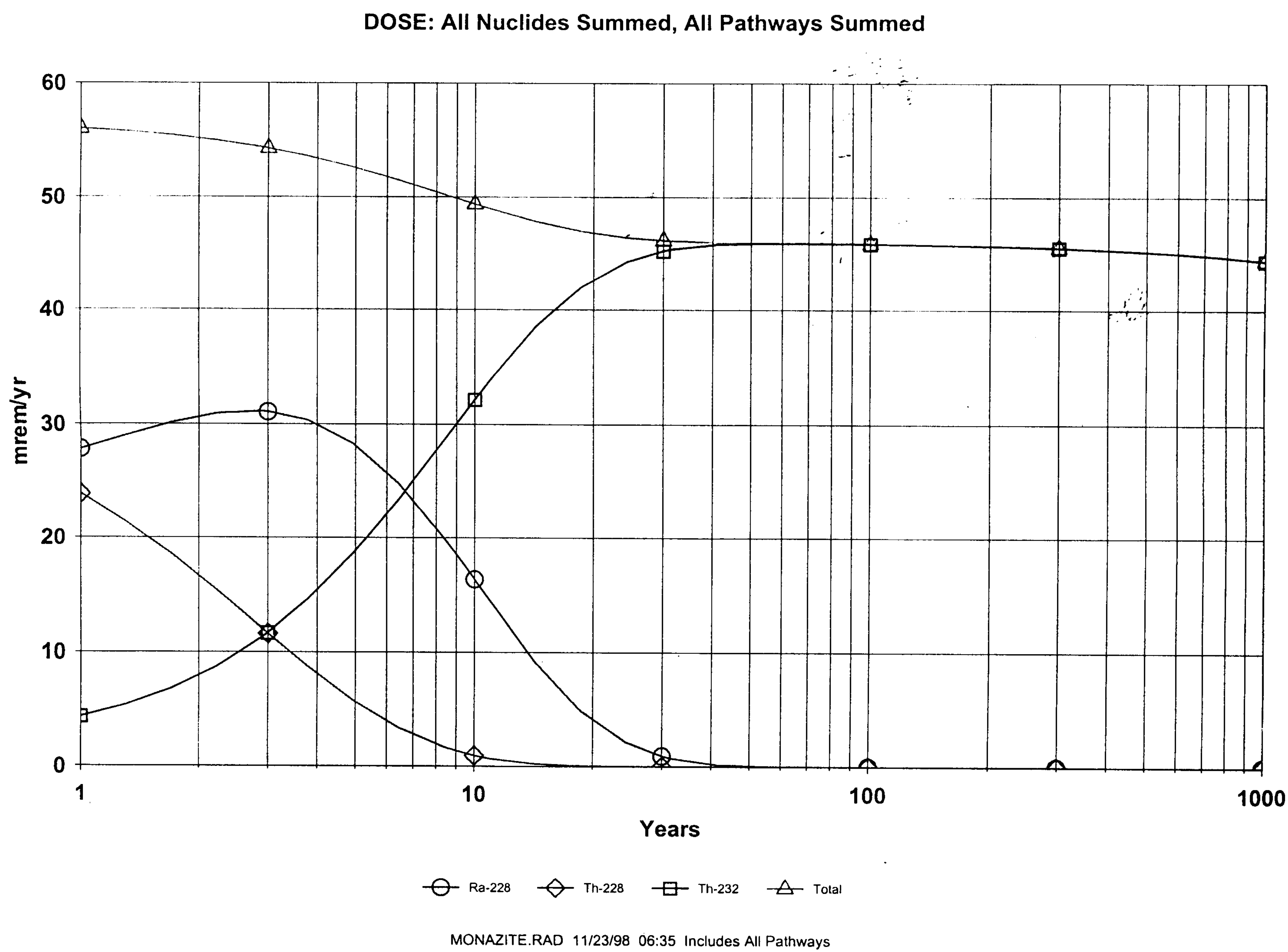


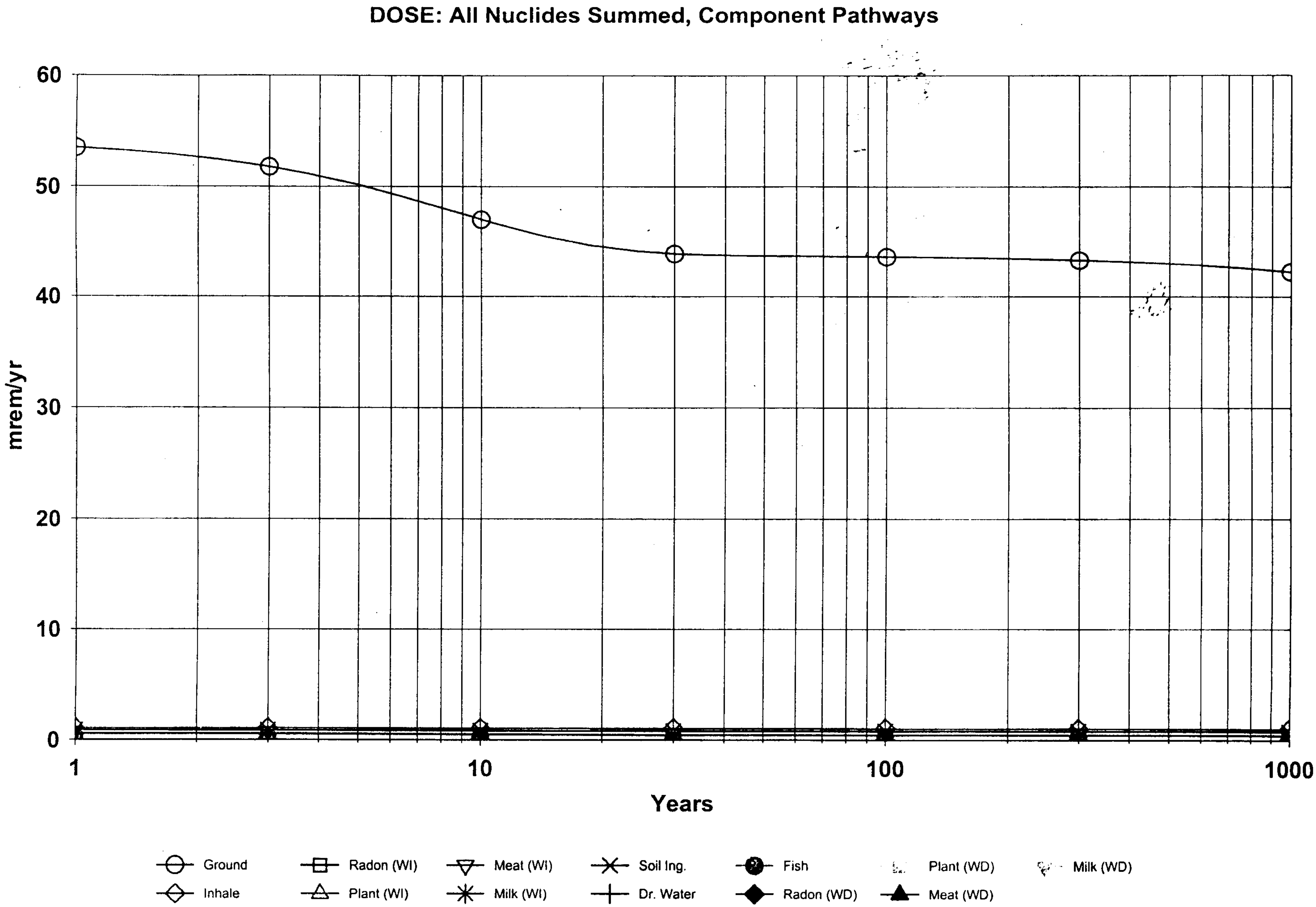
Tank Farm
PIC reading and instrumental scanning



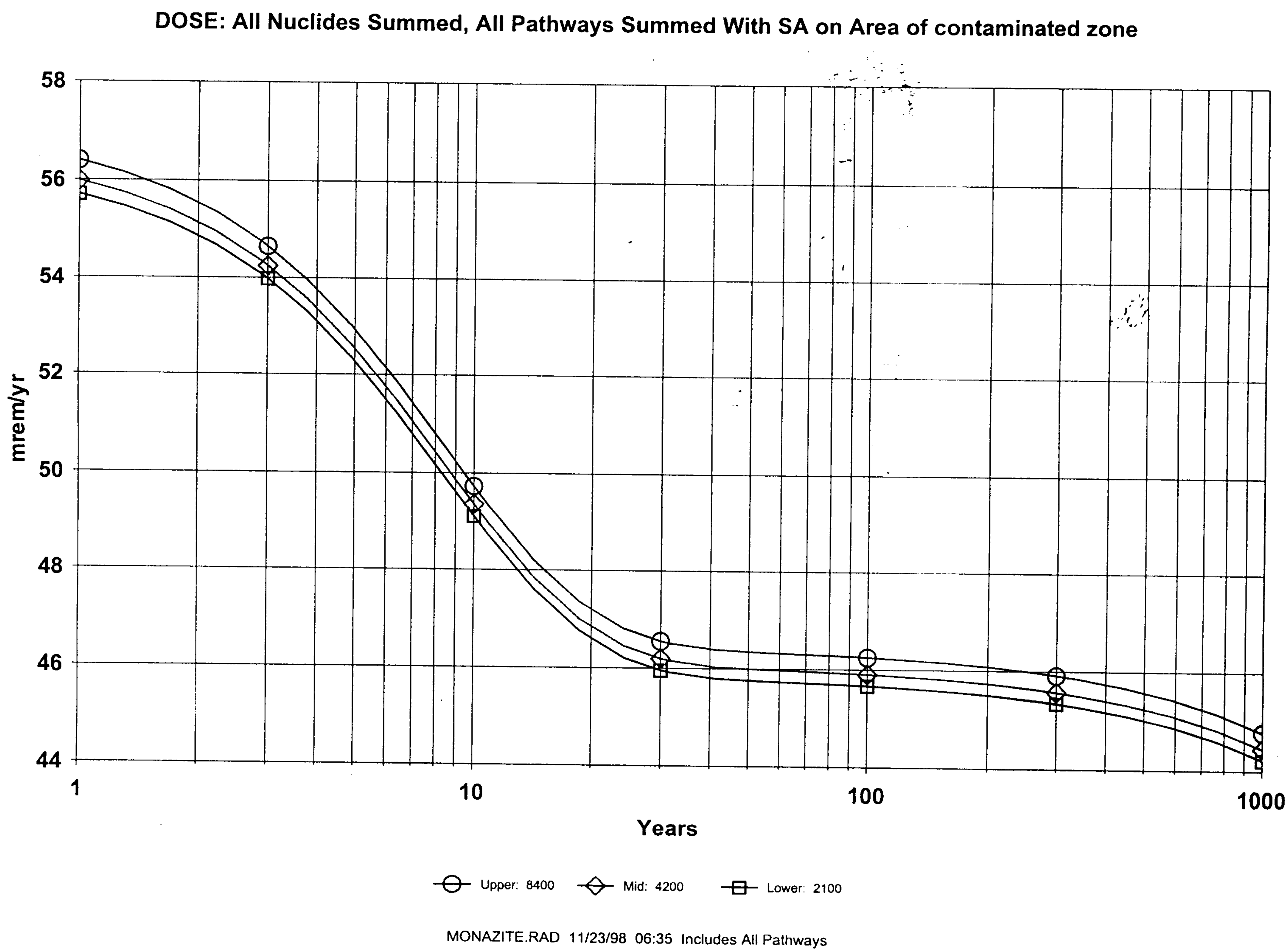
Tank Farm
Frisking out of the exclusion zone

Exclusion Zone
View looking East

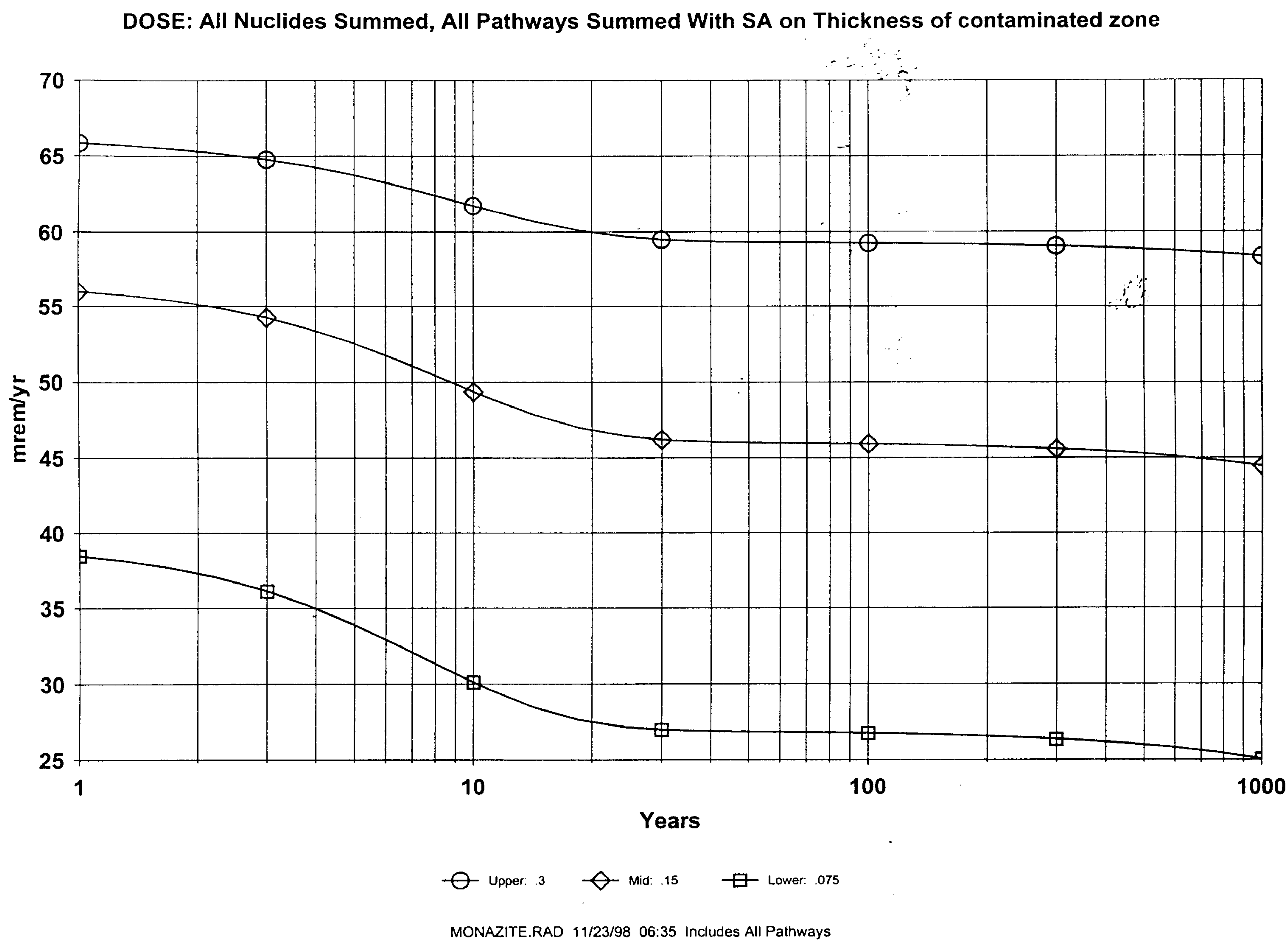

DOSE: All Nuclides Summed, All Pathways Summed
60
50
40
30
20
10
0
mrem/yr
1
10
100
1000
Years
Ra-228
Th-228
Th-232
Total
MONAZITE.RAD 11/23/98 06:35 Includes All Pathways



MONAZITE.RAD 11/23/98 06:35 Includes All Pathways



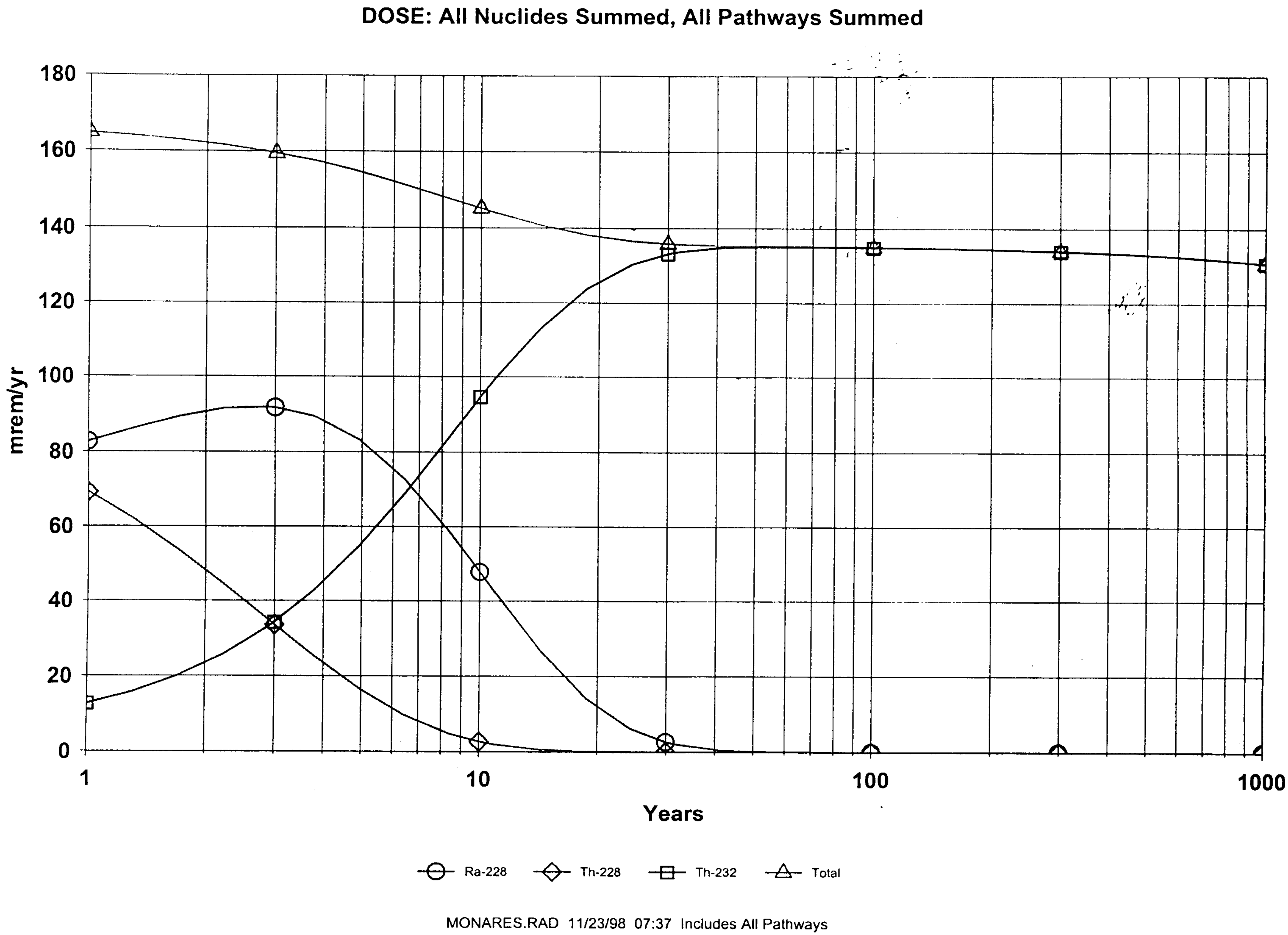
DOSE: All Nuclides Summed, All Pathways Summed With SA on Area of contaminated zone
58
56
54
52
50
48
46
44
mrem/yr
1
10
100
1000
Years
Upper: 8400
Mid: 4200
Lower: 2100
MONAZITE.RAD 11/23/98 06:35 Includes All Pathways


DOSE: All Nuclides Summed, All Pathways Summed With SA on Thickness of contaminated zone
mrem/yr
70
65
60
55
50
45
40
35
30
25
1
10
100
1000
Years
Upper: .3
Mid: .15
Lower: .075
MONAZITE.RAD 11/23/98 06:35 Includes All Pathways

Scenario B
Graphs of Dose and Components over Time

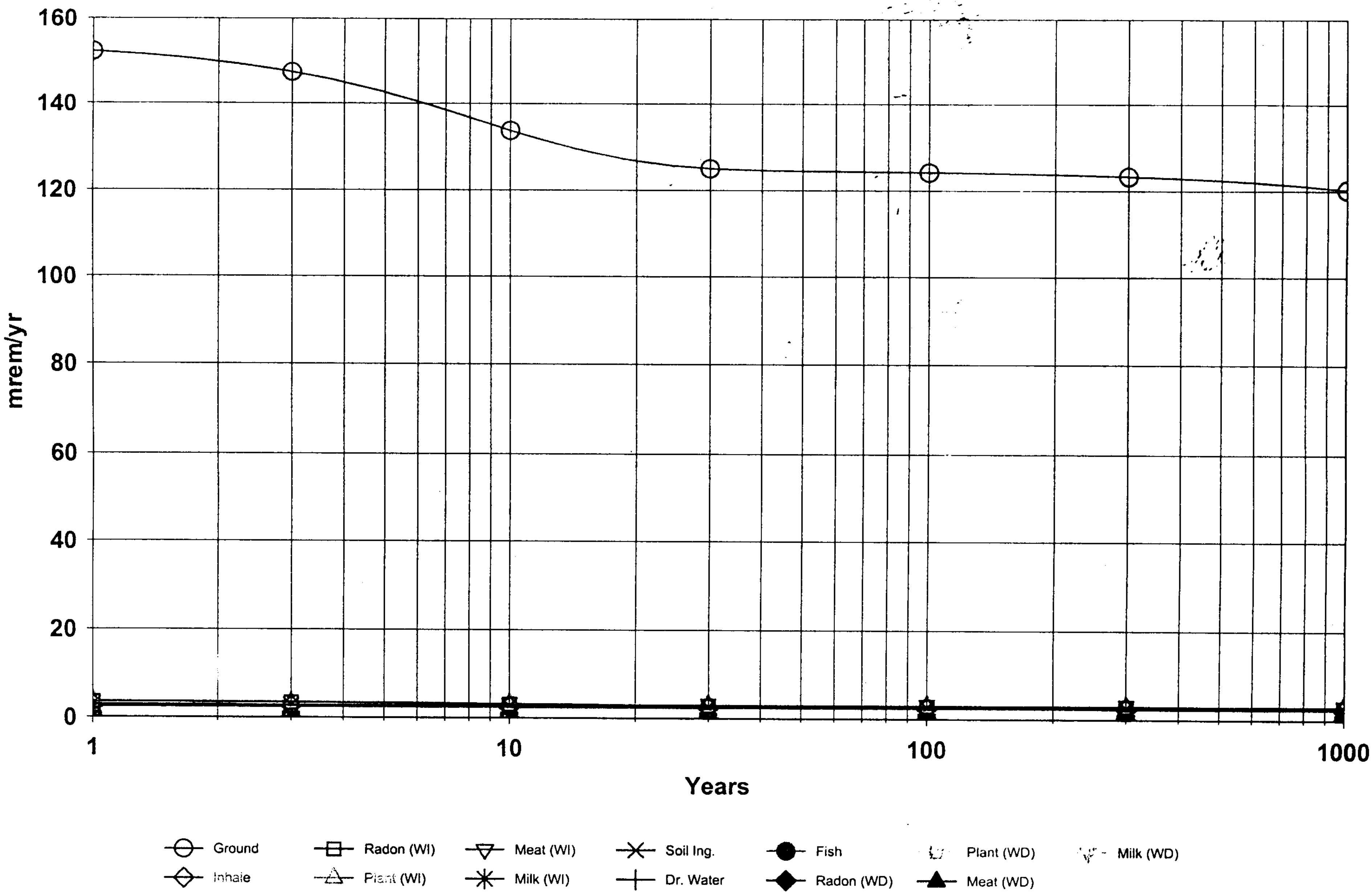
<u>Graphs</u>

Dose vs Time
Components of Dose vs Time
Effect of Contaminated Area on Dose vs Time
Effect of Depth of Contamination on Dose vs Time
Effect of Erosion on Dose vs Time

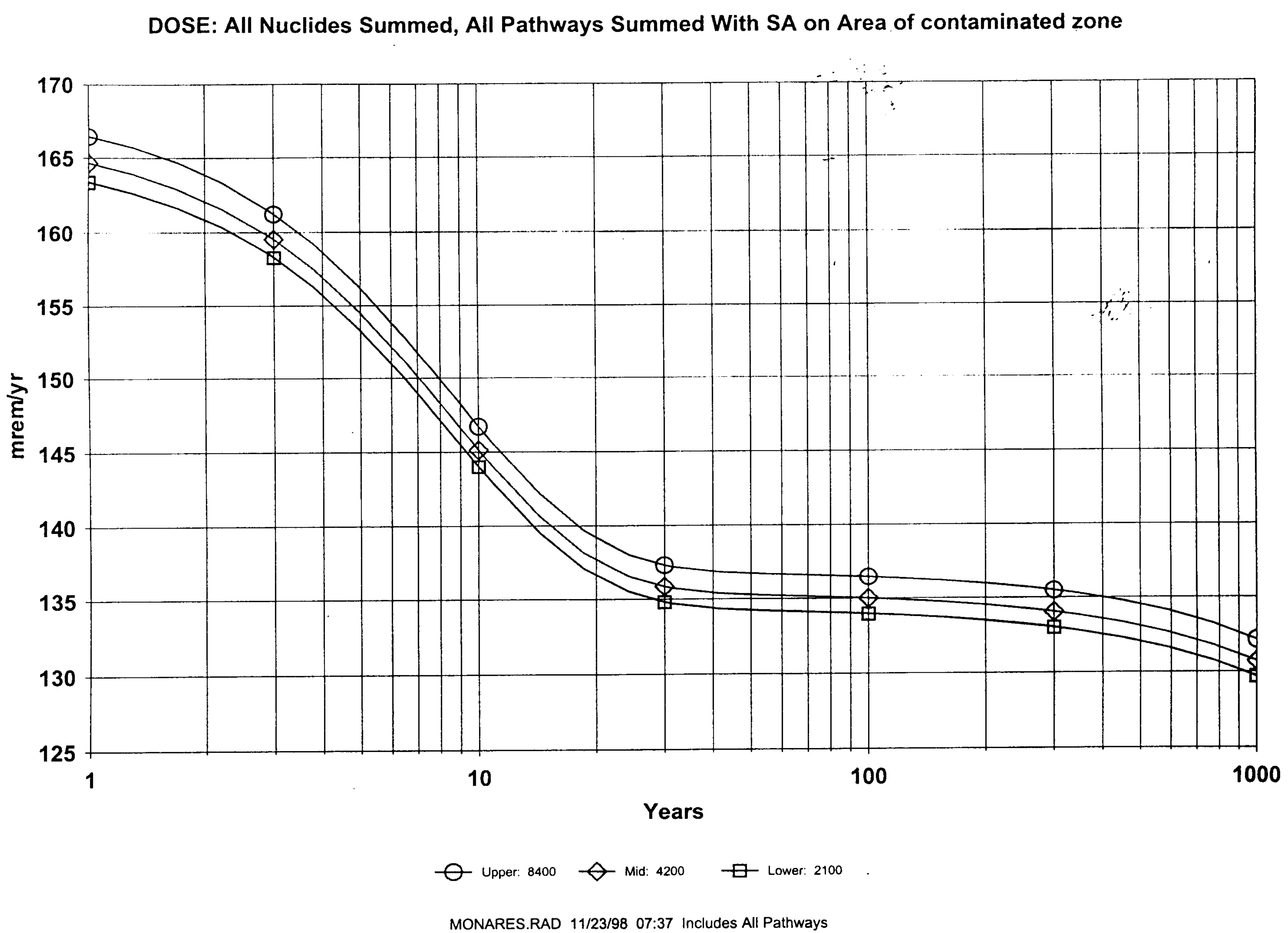


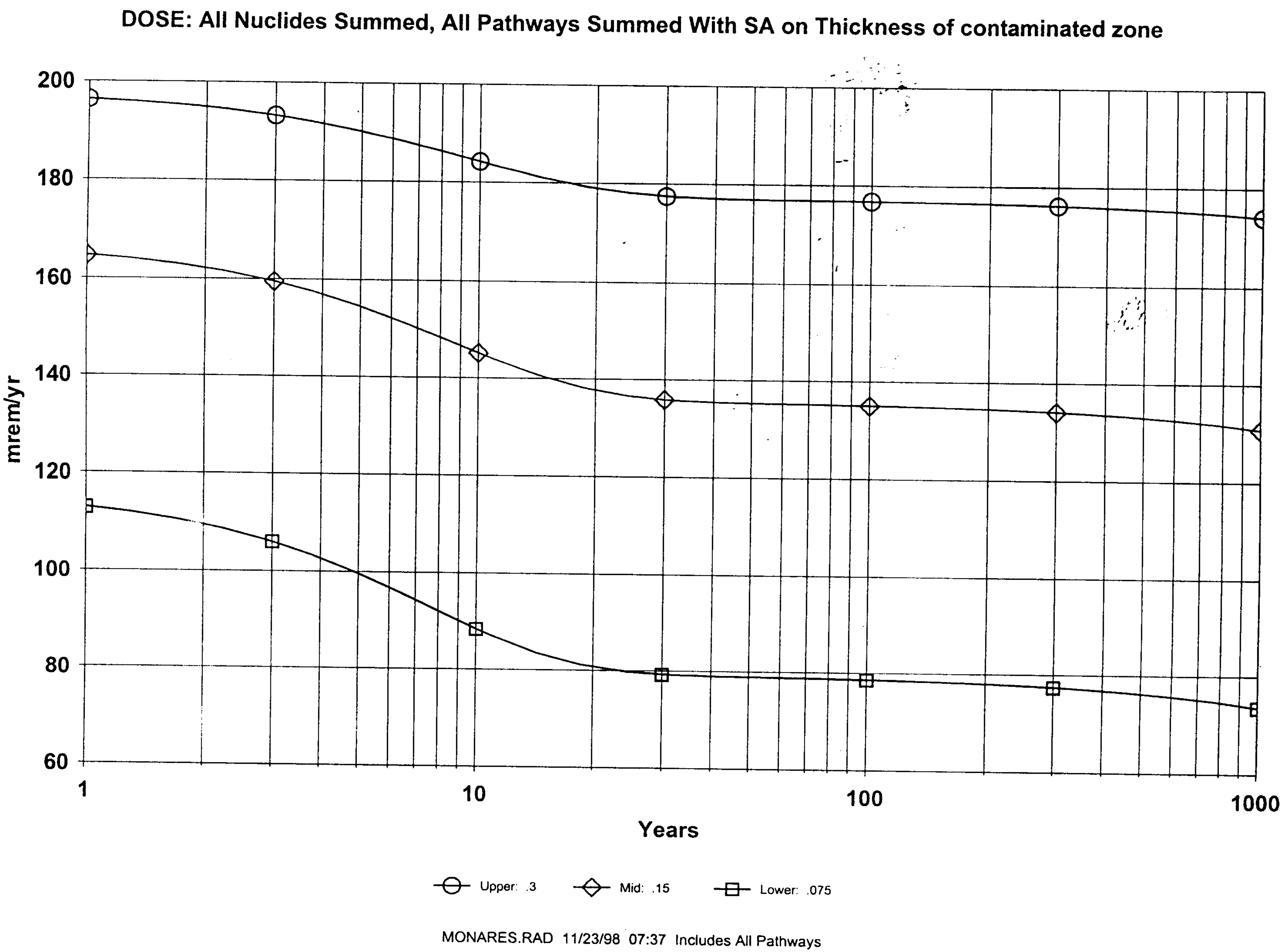
DOSE: All Nuclides Summed, All Pathways Summed
180
160
140
120
100
80
60
40
20
0
mrem/yr
1
10
100
1000
Years
Ra-228
Th-228
Th-232
Total
MONARES.RAD 11/23/98 07:37 Includes All Pathways

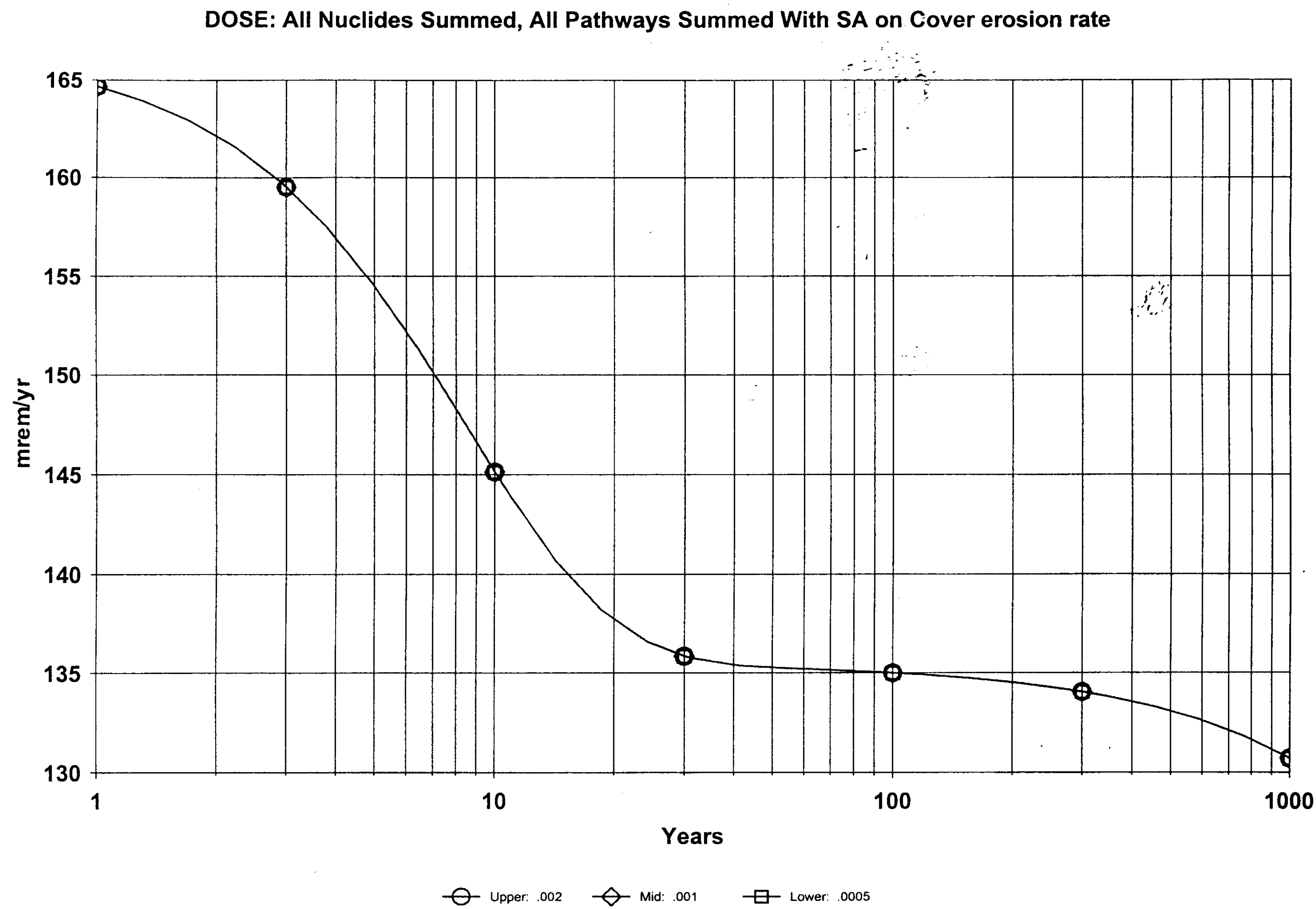
DOSE: All Nuclides Summed, Component Pathways



MONARES.RAD 11/23/98 07:37 Includes All Pathways


DOSE: All Nuclides Summed, All Pathways Summed With SA on Area of contaminated zone
170
165
160
155
150
145
140
135
130
125
mrem/yr
1
10
100
1000
Years
Upper: 8400
Mid: 4200
Lower: 2100
MONARES.RAD 11/23/98 07:37 Includes All Pathways


DOSE: All Nuclides Summed, All Pathways Summed With SA on Thickness of contaminated zone
200
180
160
140
120
100
80
60
mrem/yr
1
10
100
1000
Years
Upper: .3
Mid: .15
Lower: .075
MONARES.RAD 11/23/98 07:37 Includes All Pathways



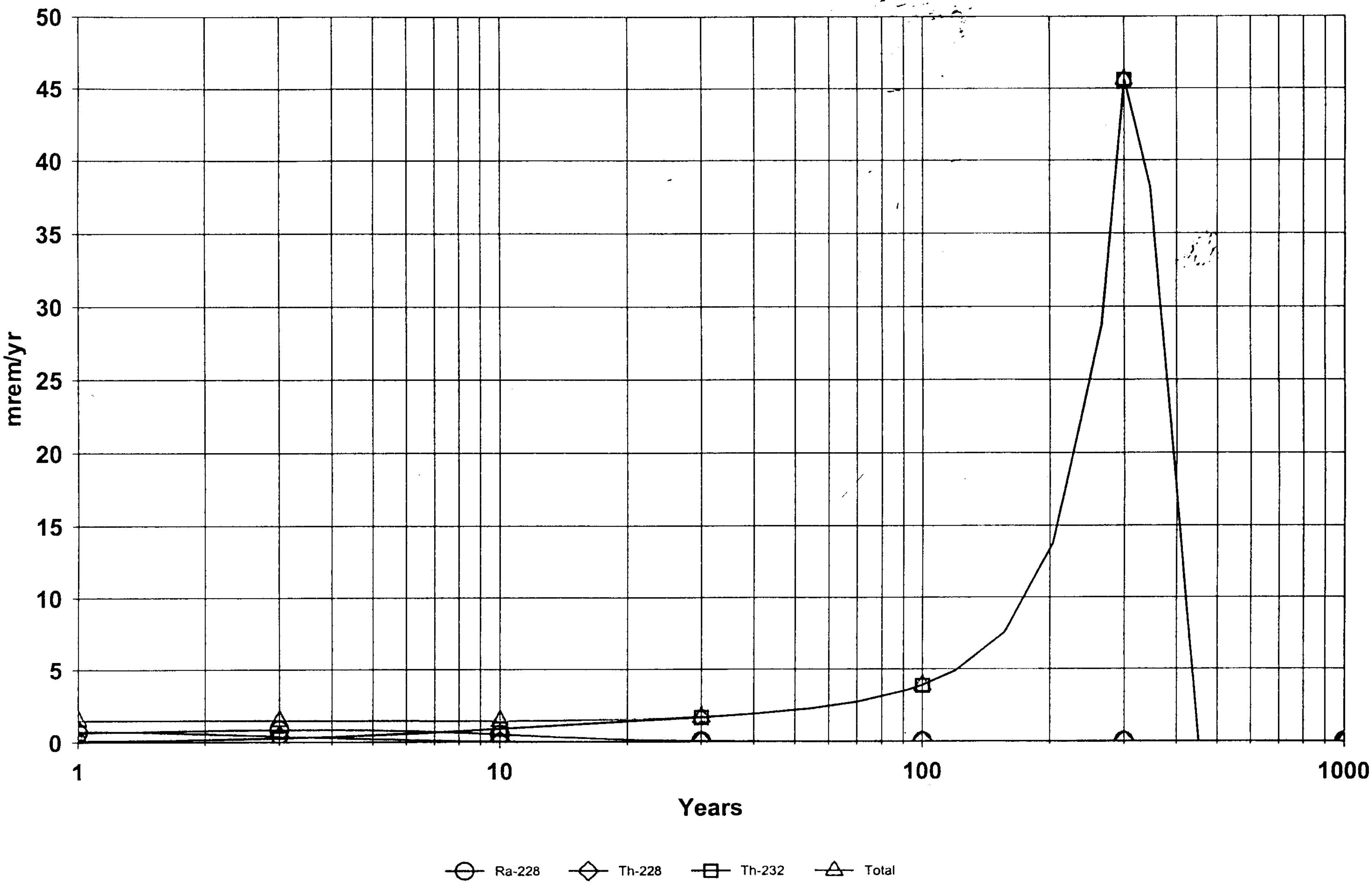
MONARES.RAD 11/23/98 07:37 Includes All Pathways

Scenario A
aphs of Dose and Components over Time With Cover

Graphs

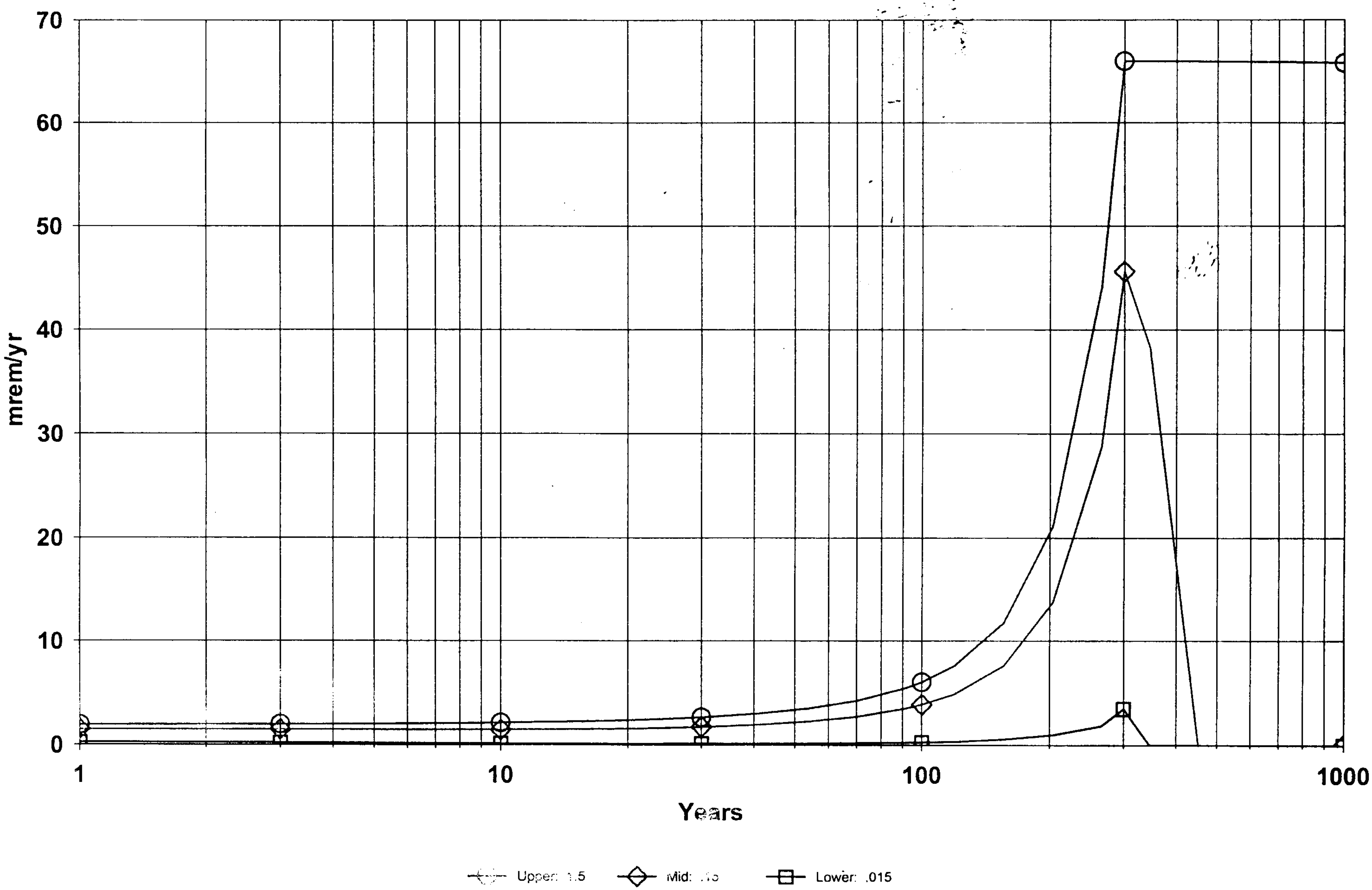
Dose vs Time
Effect of Depth of Contamination on Dose vs Time
Effect of Cover Thickness on Dose vs Time
Effect of Cover Erosion Rate on Dose vs Time

DOSE: All Nuclides Summed, All Pathways Summed



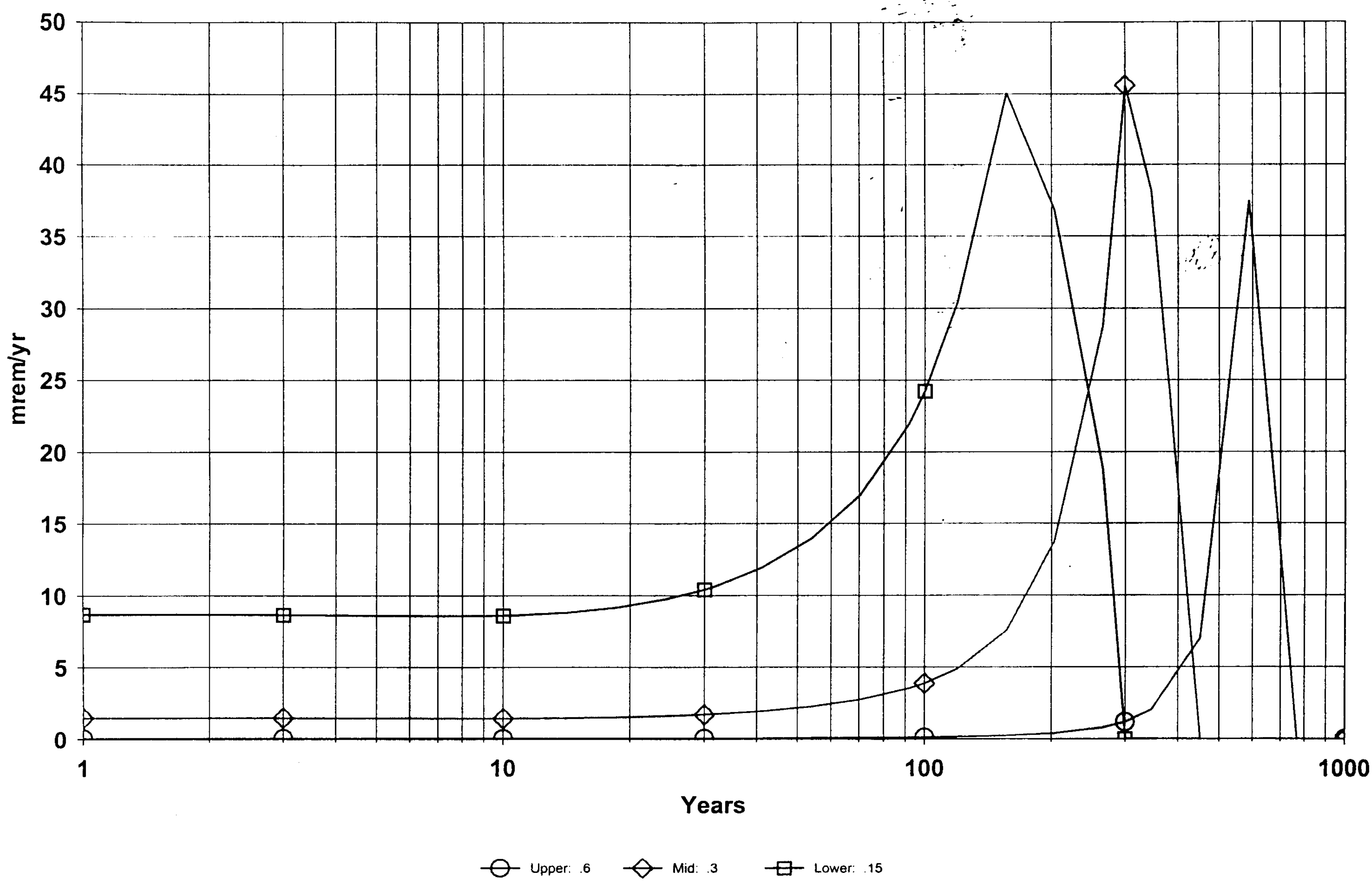
MONACOV.RAD 11/23/98 07:56 Includes All Pathways

DOSE: All Nuclides Summed, All Pathways Summed With SA on Thickness of contaminated zone



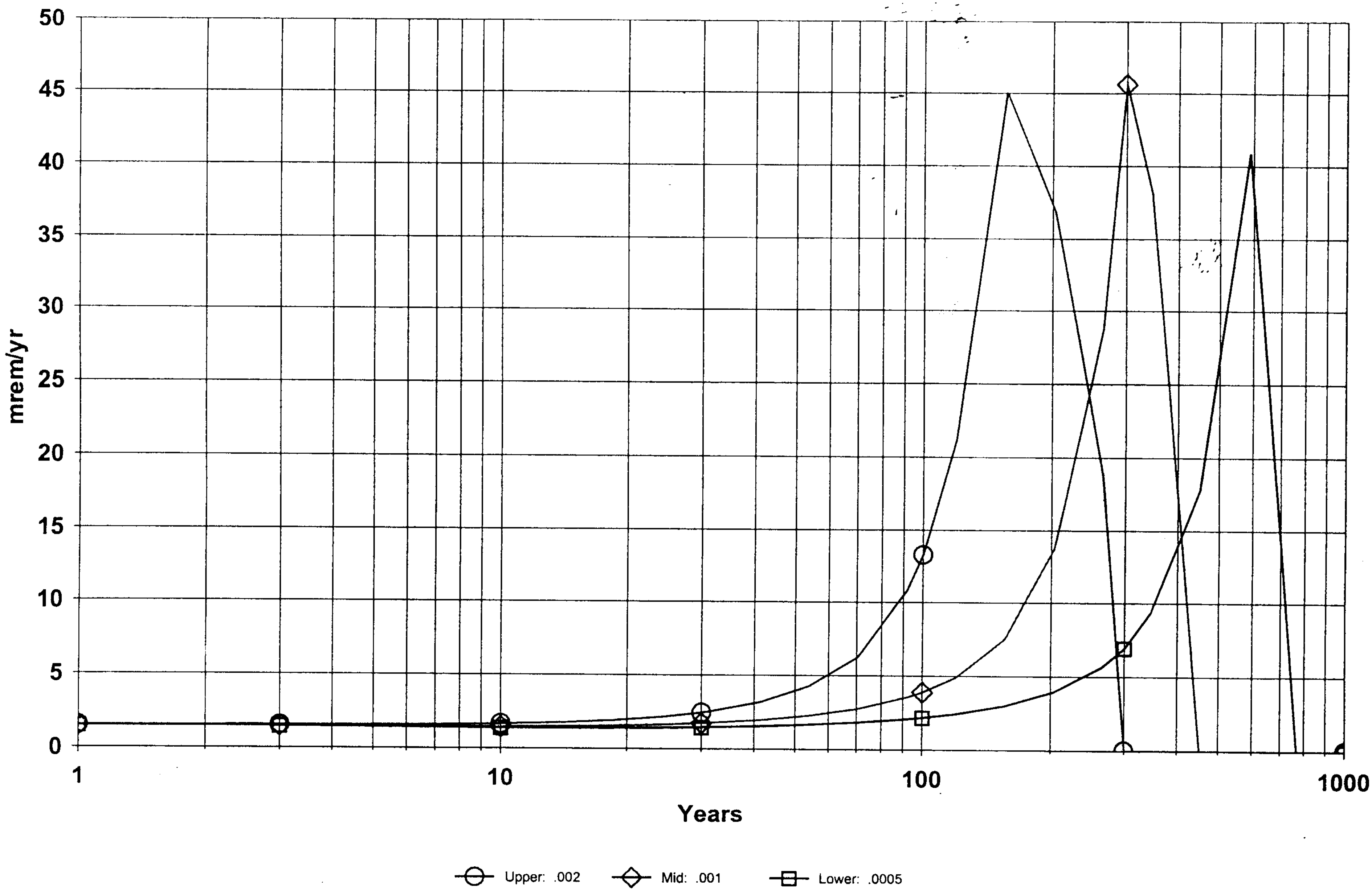
MONACOV.RAD 11/23/98 07:56 Includes All Pathways

DOSE: All Nuclides Summed, All Pathways Summed With SA on Cover depth



MONACOV.RAD 11/23/98 07:56 Includes All Pathways

DOSE: All Nuclides Summed, All Pathways Summed With SA on Cover erosion rate



MONACOV.RAD 11/23/98 07:56 Includes All Pathways

RESRAD SUMMARY REPORT

SCENARIO A

(SCENARIO B not provided, only changes are reflected in Body of report)

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

enu	Parameter	Current Value	Default	Para Na
-1	Dose conversion factors for inhalation, mrem/pCi:			
-1	Ra-228+D	5.080E-03	5.080E-03	DCF2
-1	Th-228+D	3.450E-01	3.450E-01	DCF2
-1	Th-232	1.640E+00	1.640E+00	DCF2
-1	Dose conversion factors for ingestion, mrem/pCi:			
-1	Ra-228+D	1.440E-03	1.440E-03	DCF3
-1	Th-228+D	8.080E-04	8.080E-04	DCF3
-1	Th-232	2.730E-03	2.730E-03	DCF3
-34	Food transfer factors:			
-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(
-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(
-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(
-34				
-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(
-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(
-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(
-34				
-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(
-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(
-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(
-5	Bioaccumulation factors, fresh water, L/kg:			
-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFA
-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFA
-5				
-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFA
-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFA
-5				
-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFA
-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFA

Site-Specific Parameter Summary

nu	Parameter	User Input	Default	Used by (If different fr
011	Area of contaminated zone (m**2)	4.200E+03	1.000E+04	---
011	Thickness of contaminated zone (m)	1.500E-01	2.000E+00	---
011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---
011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---
011	Time since placement of material (yr)	0.000E+00	0.000E+00	---
011	Times for calculations (yr)	1.000E+00	1.000E+00	---
011	Times for calculations (yr)	3.000E+00	3.000E+00	---
011	Times for calculations (yr)	1.000E+01	1.000E+01	---
011	Times for calculations (yr)	3.000E+01	3.000E+01	---
011	Times for calculations (yr)	1.000E+02	1.000E+02	---
011	Times for calculations (yr)	3.000E+02	3.000E+02	---
011	Times for calculations (yr)	1.000E+03	1.000E+03	---
011	Times for calculations (yr)	not used	0.000E+00	---
011	Times for calculations (yr)	not used	0.000E+00	---
012	Initial principal radionuclide (pCi/g): Ra-228	2.100E+01	0.000E+00	---
012	Initial principal radionuclide (pCi/g): Th-228	2.100E+01	0.000E+00	---
012	Initial principal radionuclide (pCi/g): Th-232	2.100E+01	0.000E+00	---
012	Concentration in groundwater (pCi/L): Ra-228	not used	0.000E+00	---
012	Concentration in groundwater (pCi/L): Th-228	not used	0.000E+00	---
012	Concentration in groundwater (pCi/L): Th-232	not used	0.000E+00	---
013	Cover depth (m)	0.000E+00	0.000E+00	---
013	Density of cover material (g/cm**3)	not used	1.500E+00	---
013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---
013	Density of contaminated zone (g/cm**3)	1.280E+00	1.500E+00	---
013	Contaminated zone erosion rate (m/yr)	8.000E-07	1.000E-03	---
013	Contaminated zone total porosity	4.000E-01	4.000E-01	---
013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---
013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---
013	Contaminated zone b parameter	7.750E+00	5.300E+00	---
013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---
013	Humidity in air (g/m**3)	not used	8.000E+00	---
013	Evapotranspiration coefficient	5.700E-01	5.000E-01	---
013	Precipitation (m/yr)	1.000E+00	1.000E+00	---
013	Irrigation (m/yr)	2.000E-01	2.000E-01	---
013	Irrigation mode	overhead	overhead	---
013	Runoff coefficient	3.000E-01	2.000E-01	---
013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---
013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---
014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---
014	Saturated zone total porosity	4.000E-01	4.000E-01	---
014	Saturated zone effective porosity	2.000E-01	2.000E-01	---
014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---
014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---
014	Saturated zone b parameter	5.300E+00	5.300E+00	---
014	Water table drop rate (m/yr)	0.000E+00	1.000E-03	---
014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---
014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---
014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---

Site-Specific Parameter Summary (continued)

enu	Parameter	User Input	Default	Used by (If different fr
015	Number of unsaturated zone strata	not used	1	---
015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---
015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---
015	Unsat. zone 1, total porosity	not used	4.000E-01	---
015	Unsat. zone 1, effective porosity	not used	2.000E-01	---
015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---
015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---
016	Distribution coefficients for Ra-228			
016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---
016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---
16	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---
016	Leach rate (/yr)	0.000E+00	0.000E+00	2.869E
016	Solubility constant	0.000E+00	0.000E+00	not us
016	Distribution coefficients for Th-228			
016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---
016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---
016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---
016	Leach rate (/yr)	0.000E+00	0.000E+00	3.359E
016	Solubility constant	0.000E+00	0.000E+00	not us
016	Distribution coefficients for Th-232			
016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---
016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---
016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---
016	Leach rate (/yr)	0.000E+00	0.000E+00	3.359E
016	Solubility constant	0.000E+00	0.000E+00	not us
017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---
017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---
017	Exposure duration	3.000E+01	3.000E+01	---
017	Shielding factor, inhalation	4.000E-01	4.000E-01	---
017	Shielding factor, external gamma	7.000E-01	7.000E-01	---
017	Fraction of time spent indoors	5.700E-02	5.000E-01	---
017	Fraction of time spent outdoors (on site)	1.710E-01	2.500E-01	---
017	Shape factor flag, external gamma	-1.000E+00	1.000E+00	-1 shows non-ci
017	Radii of shape factor array (used if FS = -1):			
17	Outer annular radius (m), ring 1:	6.250E+00	5.000E+01	---
17	Outer annular radius (m), ring 2:	1.250E+01	7.071E+01	---
17	Outer annular radius (m), ring 3:	1.875E+01	0.000E+00	---
17	Outer annular radius (m), ring 4:	2.500E+01	0.000E+00	---
17	Outer annular radius (m), ring 5:	3.125E+01	0.000E+00	---
17	Outer annular radius (m), ring 6:	3.750E+01	0.000E+00	---
17	Outer annular radius (m), ring 7:	4.375E+01	0.000E+00	---
17	Outer annular radius (m), ring 8:	5.000E+01	0.000E+00	---
17	Outer annular radius (m), ring 9:	5.625E+01	0.000E+00	---
17	Outer annular radius (m), ring 10:	6.250E+01	0.000E+00	---
17	Outer annular radius (m), ring 11:	6.875E+01	0.000E+00	---
17	Outer annular radius (m), ring 12:	7.500E+01	0.000E+00	---

Site-Specific Parameter Summary (continued)

enu	Parameter	User Input	Default	Used by (If different fr
017	Fractions of annular areas within AREA:			
017	Ring 1	1.000E+00	1.000E+00	---
017	Ring 2	1.000E+00	2.732E-01	---
017	Ring 3	1.000E+00	0.000E+00	---
017	Ring 4	6.000E-01	0.000E+00	---
017	Ring 5	2.600E-01	0.000E+00	---
017	Ring 6	1.400E-01	0.000E+00	---
017	Ring 7	7.300E-02	0.000E+00	---
017	Ring 8	4.600E-02	0.000E+00	---
017	Ring 9	3.100E-02	0.000E+00	---
017	Ring 10	1.900E-02	0.000E+00	---
017	Ring 11	1.000E-02	0.000E+00	---
017	Ring 12	2.500E-03	0.000E+00	---
018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---
018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---
018	Milk consumption (L/yr)	not used	9.200E+01	---
018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---
018	Fish consumption (kg/yr)	not used	5.400E+00	---
018	Other seafood consumption (kg/yr)	not used	9.000E-01	---
018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---
018	Drinking water intake (L/yr)	not used	5.100E+02	---
018	Contamination fraction of drinking water	not used	1.000E+00	---
018	Contamination fraction of household water	0.000E+00	1.000E+00	---
018	Contamination fraction of livestock water	not used	1.000E+00	---
018	Contamination fraction of irrigation water	not used	1.000E+00	---
018	Contamination fraction of aquatic food	not used	5.000E-01	---
018	Contamination fraction of plant food	not used	-1	---
018	Contamination fraction of meat	not used	-1	---
018	Contamination fraction of milk	not used	-1	---
019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---
019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---
019	Livestock water intake for meat (L/day)	not used	5.000E+01	---
019	Livestock water intake for milk (L/day)	not used	1.600E+02	---
019	Livestock soil intake (kg/day)	not used	5.000E-01	---
019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---
019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---
019	Depth of roots (m)	not used	9.000E-01	---
019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---
019	Household water fraction from ground water	not used	1.000E+00	---
019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---
019	Irrigation fraction from ground water	not used	1.000E+00	---
19B	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---
19B	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---
19B	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---
19B	Growing Season for Non-Leafy (years)	not used	1.700E-01	---
19B	Growing Season for Leafy (years)	not used	2.500E-01	---
19B	Growing Season for Fodder (years)	not used	8.000E-02	---
19B	Translocation Factor for Non-Leafy	not used	1.000E-01	---

Site-Specific Parameter Summary (continued)

enu	Parameter	User Input	Default	Used by (If different f
19B	Translocation Factor for Leafy	not used	1.000E+00	---
19B	Translocation Factor for Fodder	not used	1.000E+00	---
19B	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---
19B	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---
19B	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---
19B	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---
19B	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---
19B	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---
19B	Weathering Removal Constant for Vegetation	not used	2.000E+01	---
14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---
14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---
14	Fraction of vegetation carbon from soil	not used	2.000E-02	---
14	Fraction of vegetation carbon from air	not used	9.800E-01	---
14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---
14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---
14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---
14	Fraction of grain in beef cattle feed	not used	8.000E-01	---
14	Fraction of grain in milk cow feed	not used	2.000E-01	---
'OR	Storage times of contaminated foodstuffs (days):			
'OR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---
'OR	Leafy vegetables	1.000E+00	1.000E+00	---
'OR	Milk	1.000E+00	1.000E+00	---
'OR	Meat and poultry	2.000E+01	2.000E+01	---
'OR	Fish	7.000E+00	7.000E+00	---
'OR	Crustacea and mollusks	7.000E+00	7.000E+00	---
'OR	Well water	1.000E+00	1.000E+00	---
'OR	Surface water	1.000E+00	1.000E+00	---
'OR	Livestock fodder	4.500E+01	4.500E+01	---
)21	Thickness of building foundation (m)	1.500E-01	1.500E-01	---
)21	Bulk density of building foundation (g/cm**3)	2.400E+00	2.400E+00	---
)21	Total porosity of the cover material	not used	4.000E-01	---
)21	Total porosity of the building foundation	1.000E-01	1.000E-01	---
)21	Volumetric water content of the cover material	not used	5.000E-02	---
)21	Volumetric water content of the foundation	3.000E-02	3.000E-02	---
)21	Diffusion coefficient for radon gas (m/sec):			
)21	in cover material	not used	2.000E-06	---
)21	in foundation material	3.000E-07	3.000E-07	---
)21	in contaminated zone soil	2.000E-06	2.000E-06	---
)21	Radon vertical dimension of mixing (m)	2.000E+00	2.000E+00	---
)21	Average building air exchange rate (1/hr)	5.000E-01	5.000E-01	---
)21	Height of the building (room) (m)	2.500E+00	2.500E+00	---
)21	Building interior area factor	0.000E+00	0.000E+00	code computed (t
)21	Building depth below ground surface (m)	-1.000E+00	-1.000E+00	code computed (t
)21	Emanating power of Rn-222 gas	not used	2.500E-01	---
)21	Emanating power of Rn-220 gas	1.500E-01	1.500E-01	---

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	active
Find peak pathway doses	suppressed

Co	Zone Dimensions	Initial Soil Concentrations, pCi/g	
Area:	4200.00 square meters	Ra-228	2.100E+01
Thickness:	0.15 meters	Th-228	2.100E+01
Cover Depth:	0.00 meters	Th-232	2.100E+01

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 25 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years)	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E
TDOSE(t)	.670E+01	5.598E+01	5.425E+01	4.935E+01	4.619E+01	4.590E+01	4.557E+01	4.444E
M(t)	.268E+00	2.239E+00	2.170E+00	1.974E+00	1.848E+00	1.836E+00	1.823E+00	1.778E

laximum TDOSE(t): 5.670E+01 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

dic-clide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
-228	2.082E+01	0.3673	2.689E-03	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-228	3.338E+01	0.5888	1.826E-01	0.0032	5.632E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000
-232	2.126E-03	0.0000	8.681E-01	0.0153	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
tal	5.421E+01	0.9561	1.053E+00	0.0186	5.632E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

dio-clide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
tal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

um of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	2.732E+01	0.4880	5.365E-02	0.0010	1.583E-01	0.0028	0.000E+00	0.0000	0.000E+00	0.0000
h-228	2.324E+01	0.4151	1.271E-01	0.0023	3.920E-01	0.0070	0.000E+00	0.0000	0.000E+00	0.0000
h-232	2.951E+00	0.0527	8.717E-01	0.0156	1.040E-02	0.0002	0.000E+00	0.0000	0.000E+00	0.0000
otal	5.351E+01	0.9558	1.052E+00	0.0188	5.607E-01	0.0100	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
otal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

adio-	Ground		Inhalation		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	3.044E+01	0.5612	9.544E-02	0.0018	2.891E-01	0.0053	0.000E+00	0.0000	0.000E+00	0.0000
h-228	1.126E+01	0.2075	6.158E-02	0.0011	1.899E-01	0.0035	0.000E+00	0.0000	0.000E+00	0.0000
h-232	1.010E+01	0.1863	8.908E-01	0.0164	6.801E-02	0.0013	0.000E+00	0.0000	0.000E+00	0.0000
otal	5.180E+01	0.9550	1.048E+00	0.0193	5.470E-01	0.0101	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

adio-	Water		Fish		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
otal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

adio-	Ground		Inhalation		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	1.593E+01	0.3227	6.212E-02	0.0013	1.897E-01	0.0038	0.000E+00	0.0000	0.000E+00	0.0000
h-228	8.910E-01	0.0181	4.874E-03	0.0001	1.503E-02	0.0003	0.000E+00	0.0000	0.000E+00	0.0000
h-232	3.019E+01	0.6118	9.633E-01	0.0195	2.894E-01	0.0059	0.000E+00	0.0000	0.000E+00	0.0000
otal	4.701E+01	0.9526	1.030E+00	0.0209	4.942E-01	0.0100	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

adio-	Water		Fish		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
otal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

dio-	Ground		Inhalation		Radon		Plant		Meat	
clide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
-228	8.807E-01	0.0191	3.553E-03	0.0001	1.087E-02	0.0002	0.000E+00	0.0000	0.000E+00	0.0000
-228	6.346E-04	0.0000	3.471E-06	0.0000	1.071E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-232	4.304E+01	0.9318	1.014E+00	0.0219	4.458E-01	0.0097	0.000E+00	0.0000	0.000E+00	0.0000
tal	4.392E+01	0.9509	1.017E+00	0.0220	4.567E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

dio-	Water		Fish		Radon		Plant		Meat	
clide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
tal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

um of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

adio-	Ground		Inhalation		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	561E-05	0.0000	1.034E-07	0.0000	3.162E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-228	6.120E-15	0.0000	3.347E-17	0.0000	1.033E-16	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-232	4.364E+01	0.9508	1.014E+00	0.0221	4.535E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000
otal	4.364E+01	0.9508	1.014E+00	0.0221	4.535E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

adio-	Water		Fish		Radon		Plant		Meat	
uclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
a-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
h-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
otal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

dic- clide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
-228	2.792E-18	0.0000	1.126E-20	0.0000	3.448E-20	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-232	4.333E+01	0.9508	1.006E+00	0.0221	4.505E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000
tal	4.333E+01	0.9508	1.006E+00	0.0221	4.505E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

dic- clide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
tal	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

um of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	4.226E+01	0.9509	9.790E-01	0.0220	4.400E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000
Total	4.226E+01	0.9509	9.790E-01	0.0220	4.400E-01	0.0099	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.
Ra-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-228	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Th-232	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

arent (i)	Product (j)	Branch Fraction*	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02
			DSR(j,t) (mrem/yr)/(pCi/g)						
a-228	Ra-228	1.000E+00	1.004E+00	8.646E-01	6.415E-01	2.257E-01	1.141E-02	3.314E-07	3.613E-20
a-228	Th-228	1.000E+00	0.000E+00	4.587E-01	8.375E-01	5.498E-01	3.148E-02	9.160E-07	9.985E-20
a-228	∑DSR(j)		1.004E+00	1.323E+00	1.479E+00	7.754E-01	4.289E-02	1.247E-06	1.360E-19
h-228	Th-228	1.000E+00	1.632E+00	1.136E+00	5.503E-01	4.355E-02	3.102E-05	2.992E-16	0.000E+00
h-232	Th-232	1.000E+00	6.416E-02	6.416E-02	6.415E-02	6.413E-02	6.408E-02	6.391E-02	6.341E-02
h-232	Ra-228	1.000E+00	0.000E+00	1.124E-01	2.926E-01	6.284E-01	8.009E-01	8.081E-01	8.024E-01
h-232	Th-228	1.000E+00	0.000E+00	3.013E-02	1.971E-01	8.387E-01	1.292E+00	1.314E+00	1.304E+00
h-232	∑DSR(j)		6.416E-02	2.067E-01	5.538E-01	1.531E+00	2.157E+00	2.186E+00	2.170E+00

Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j)
he DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 25 mrem/yr

uclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.
a-228	2.491E+01	1.889E+01	1.690E+01	3.224E+01	5.829E+02	2.004E+07	*2.726E+14	*2.
h-228	1.532E+01	2.201E+01	4.543E+01	5.740E+02	8.059E+05	*8.192E+14	*8.192E+14	*8.
h-232	3.897E+02	1.210E+02	4.514E+01	1.633E+01	1.159E+01	1.144E+01	1.152E+01	1.

At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

uclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
a-228	2.100E+01	2.713 ± 0.005	1.482E+00	1.687E+01	1.004E+00	2.491E+01
h-228	2.100E+01	0.000E+00	1.632E+00	1.532E+01	1.632E+00	1.532E+01
h-232	2.100E+01	58.1 ± 0.1	2.189E+00	1.142E+01	6.416E-02	3.897E+02

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

.clide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02
-228	Ra-228	1.000E+00	2.108E+01	1.816E+01	1.347E+01	4.739E+00	2.396E-01	6.960E-06	7.587E-19
-228	Th-232	1.000E+00	0.000E+00	2.360E+00	6.145E+00	1.320E+01	1.682E+01	1.697E+01	1.685E+01
-228	∑DOSE(j):		2.108E+01	2.052E+01	1.962E+01	1.794E+01	1.706E+01	1.697E+01	1.685E+01
-228	Ra-228	1.000E+00	0.000E+00	9.632E+00	1.759E+01	1.154E+01	6.611E-01	1.924E-05	2.097E-18
-228	Th-228	1.000E+00	3.427E+01	2.385E+01	1.156E+01	9.146E-01	6.515E-04	6.283E-15	0.000E+00
-228	Th-232	1.000E+00	0.000E+00	6.328E-01	4.138E+00	1.761E+01	2.712E+01	2.759E+01	2.739E+01
-228	∑DOSE(j):		3.427E+01	3.412E+01	3.328E+01	3.007E+01	2.779E+01	2.759E+01	2.739E+01
-232	Th-232	1.000E+00	1.347E+00	1.347E+00	1.347E+00	1.347E+00	1.346E+00	1.342E+00	1.332E+00

.F(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

.clide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02
-228	Ra-228	1.000E+00	2.100E+01	1.809E+01	1.342E+01	4.722E+00	2.387E-01	6.935E-06	7.563E-19
-228	Th-232	1.000E+00	0.000E+00	2.352E+00	6.122E+00	1.315E+01	1.676E+01	1.691E+01	1.680E+01
-228	∑S(j):		2.100E+01	2.044E+01	1.954E+01	1.787E+01	1.700E+01	1.691E+01	1.680E+01
-228	Ra-228	1.000E+00	0.000E+00	5.903E+00	1.078E+01	7.075E+00	4.051E-01	1.179E-05	1.286E-18
-228	Th-228	1.000E+00	2.100E+01	1.462E+01	7.081E+00	5.605E-01	3.992E-04	3.851E-15	0.000E+00
-228	Th-232	1.000E+00	0.000E+00	3.878E-01	2.536E+00	1.079E+01	1.662E+01	1.691E+01	1.680E+01
-228	∑S(j):		2.100E+01	2.091E+01	2.040E+01	1.843E+01	1.703E+01	1.691E+01	1.680E+01
-232	Th-232	1.000E+00	2.100E+01	2.100E+01	2.100E+01	2.099E+01	2.098E+01	2.093E+01	2.079E+01

F(i) is the branch fraction of the parent nuclide.

Appendix F

RESRAD REPORT

Scenario A
Graphs of Dose and Components over Time

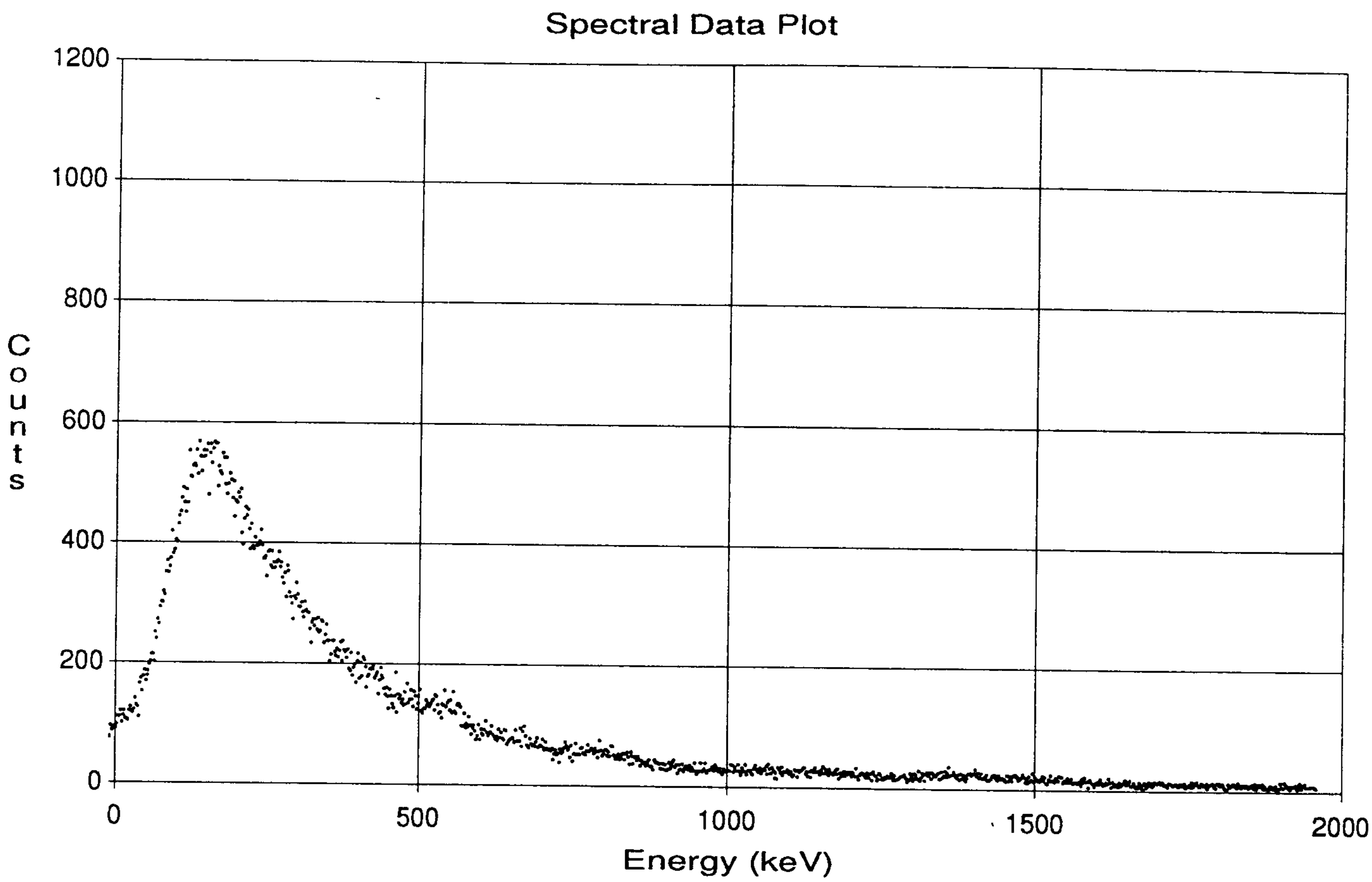
<u>Graphs</u>

Dose vs Time

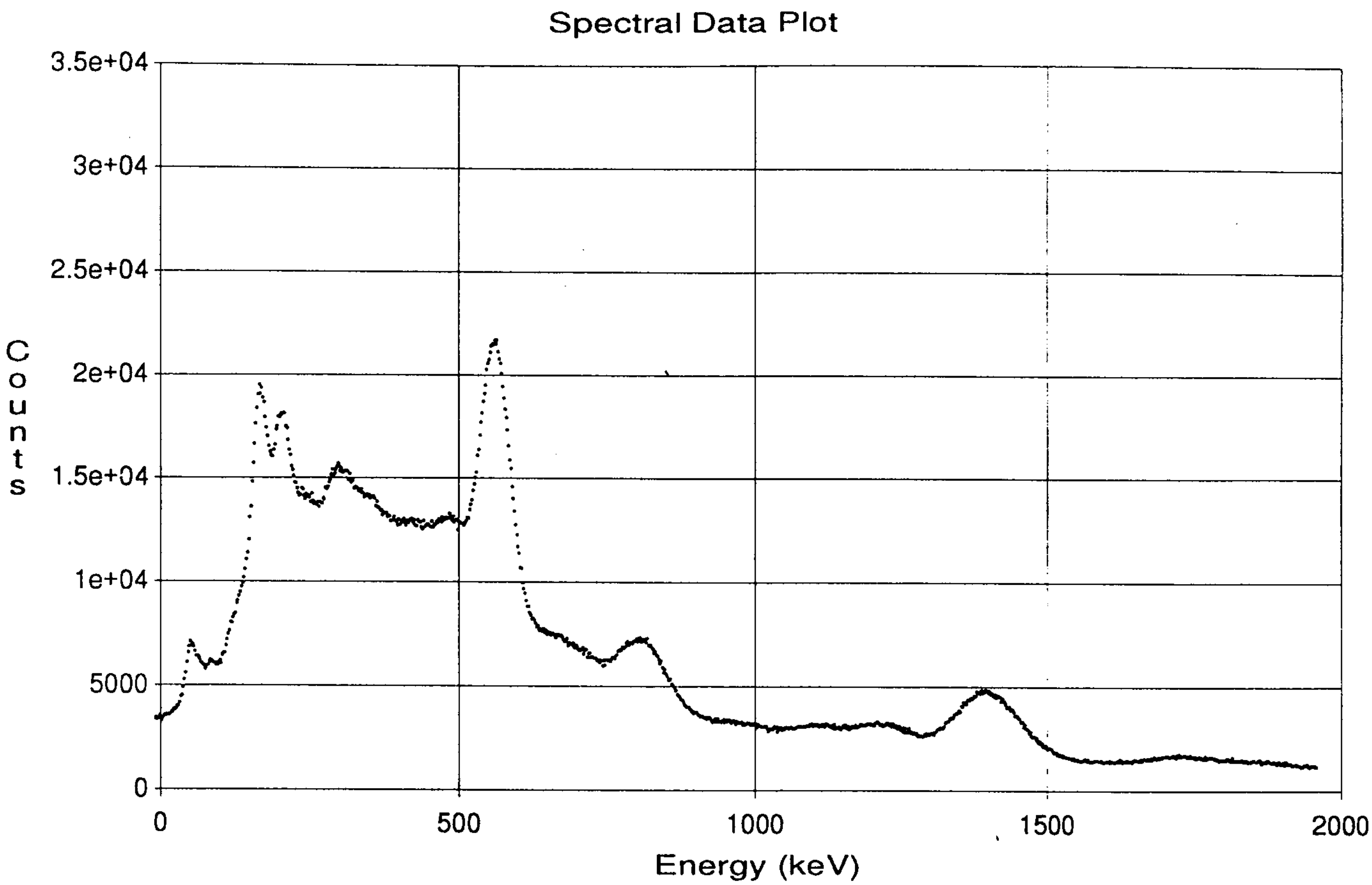
Components of Dose vs Time

Effect of Contaminated Area on Dose vs Time

Effect of Depth of Contamination on Dose vs Time

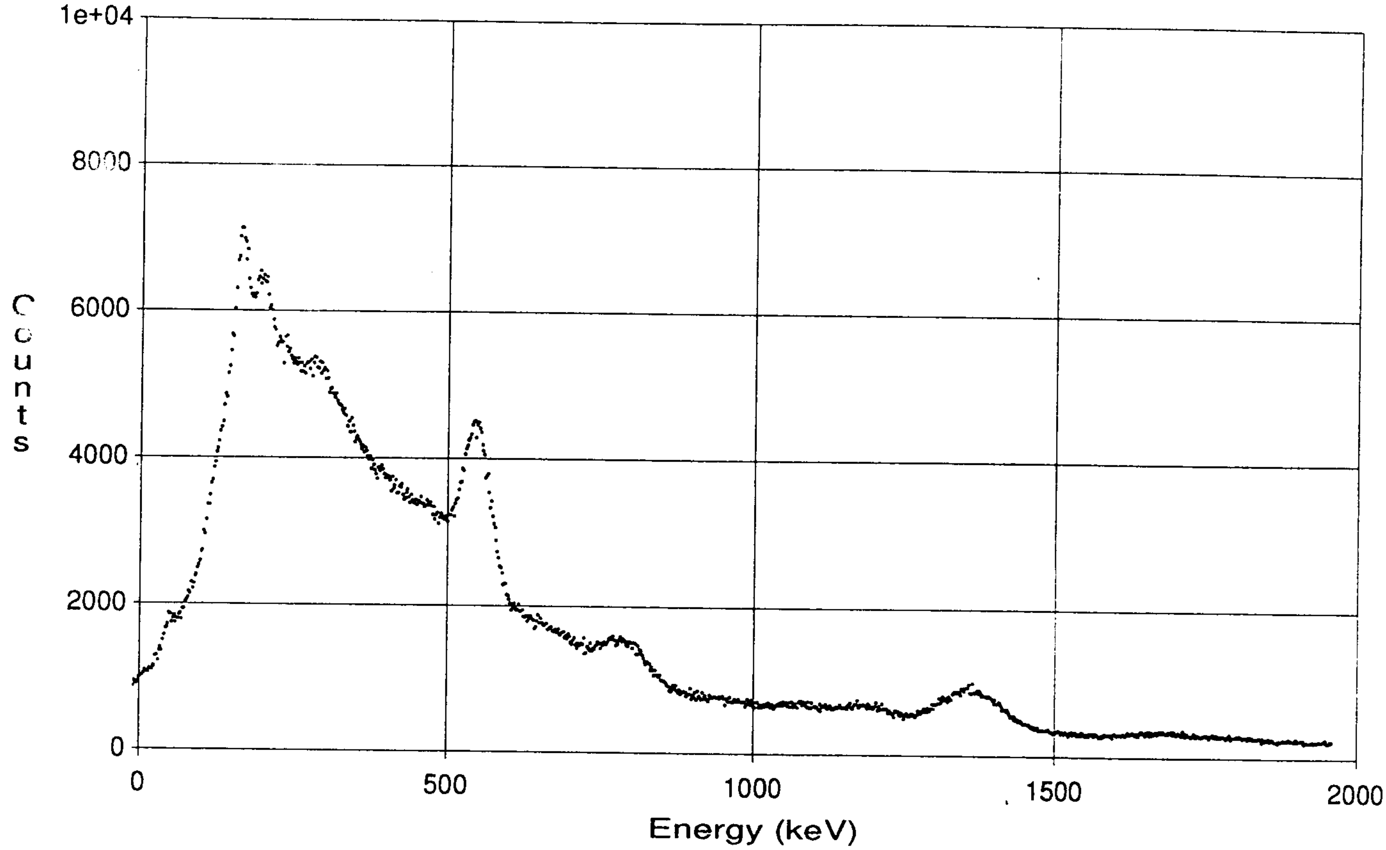


Datasource: MONABACK.CNF *Background behind tank 1304.*
Live Time: 300 sec
Real Time: 302 sec
Acq. Start: 5-22-98 9:40:02 AM
Start: 1 : -47.95 (keV)
Stop: 1024 : 1957.87 (keV)

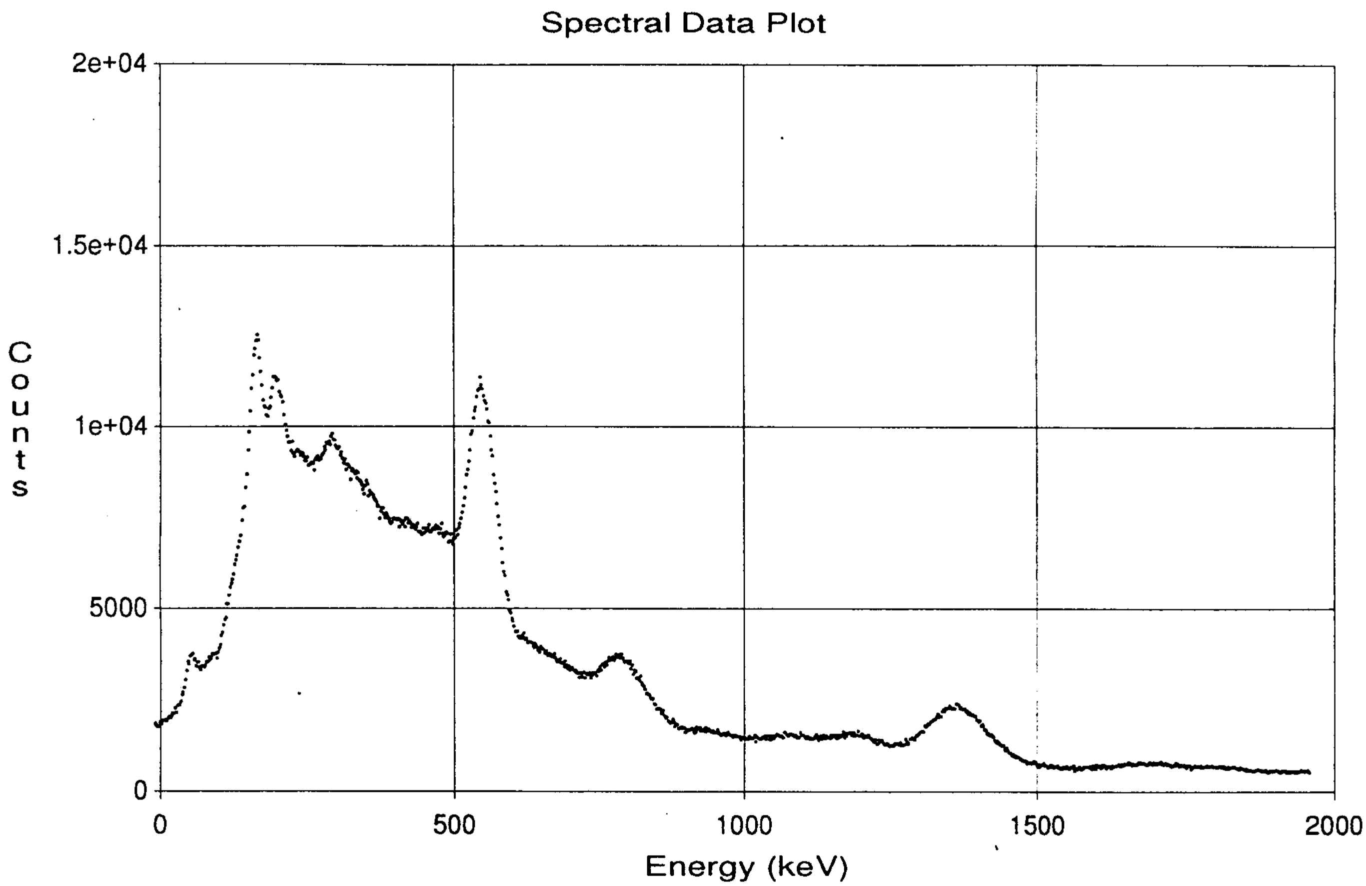


Datasource:	MONQC.CNF		
Live Time:	300 sec		
Real Time:	429 sec		
Acq. Start:	5-21-98 3:40:25 PM		
Start:	1	:	-47.95 (keV)
Stop:	1024	:	1957.87 (keV)

Spectral Data Plot



Datasource:	M41X21.CNF
Live Time:	300 sec
Real Time:	330 sec
Acq. Start:	5-21-98 4:30:06 PM
Start:	1 : -47.95 (keV)
Stop:	1024 : 1957.87 (keV)



Datasource:	MONA9X12.CNF		
Live Time:	300 sec		
Real Time:	362 sec		
Acq. Start:	5-21-98 4:04:46 PM		
Start:	1	:	-47.95 (keV)
Stop:	1024	:	1957.87 (keV)

Appendix G

HISTORICAL DOCUMENT EXCERPTS

HEALTH PHYSICS ASSOCIATES LTD. CONSULTANTS IN RADIATION SAF

in industry and the profe

A-15-75

July 14, 1975

Mr. David Emerson
Commander's Representative
Ravenna Army Ammunition Plant
Ravenna, Ohio 44266

Re: Monazite Storage
Tanks #1303 and 1305

Gentlemen:

This is to certify that Health Physics Associates Ltd., under contract with General Services Administration, have completed decontamination activities of storage tanks 1303 and 1305 located at the Ravenna Army Ammunition Plant in Ravenna, Ohio on May 23, 1975.

A complete report is being prepared. A summary of the results is attached.

Very truly yours,

HEALTH PHYSICS ASSOCIATES LTD.

William B. Rivkin
Vice President

WBR:pw

cc: John Trunda

Enclosure 1

UNITED STATES OF AMERICA

GENERAL SERVICES ADMINISTRATION

Region 5
230 S. Dearborn Street
Chicago, IL 60604

January 7, 1976

Commander's Representative
Ravenna Army Ammunition Plant
Ravenna, OH 44266

Dear Sir:

Attached is a report submitted by Health Physics Associates Ltd. finalizing radioactive decontamination of GSA storage tanks No. 1303 and No. 1305, formerly used to store Monazite, Rare Earth Material.

General Services Administration has declared these tanks excess, since all of the Monazite has been shipped. The fixed radiation level has been determined to be at an acceptable level, therefore, these tanks can now be scrapped for release to restrictive public use.

The ground area east of tank No. 1303, referenced in the second paragraph of page 3, has since been cleaned out to an acceptable level and leveled with a fill of slag. All drums of accumulated radioactive sand and sod have also been satisfactorily transported to a designated burial ground.

Please extend our sincere appreciation to Messrs. O. D. Riesterer and J. DiMauro, and other members of your staff who were very cooperative and helpful during the outloading of the Monazite and decontamination of the tanks and surface ground areas.

Sincerely,

CHARLES D. BEELER
Director, Property Management Division
Federal Supply Service

Enclosure

RECEIVED JAN 12 1976 GENERAL MANAGER

TO OFFICE
GM
CO-COR
COMPT.
SAFETY
ENGR.
IND.REL.
ST&I
PROD.
RETURN

HEALTH PHYSICS ASSOCIATES LTD.

REPORT OF
RADIATION DECONTAMINATION PROGRAM

Conclusion:

All decontaminated facilities surveyed at termination of the program, except for item noted below, indicated levels of less than "diminimous levels"* (see attached), as stipulated by the Nuclear Regulatory Commission for release to restrictive public use. Restrictive may be defined as for other than storage and/or preparation of food, drugs, cosmetics or similar products.

Ground area east of tank #1303 at Ravenna (see Figure I) indicated levels of Thorium-232 concentrations in excess of those recommended for public thoroughfares. These areas will have to have the top soil layer removed and resurveyed.

Respectfully submitted,

Don Sreniawski
Health Physicist

Approved,

William B. Rivkin
Vice President
Health Physics Associates Ltd.

TABLE XIII

SOIL SAMPLE ANALYSIS

POST DECONTAMINATION

Location of Sample	Level of Contamination pCi/gm
1. South of tank 3222J at Great Lakes	0.03±0.01
2. North of tank 3222I at Great Lakes	0.21±0.04
3. West of tank #1303 at Ravenna	2.15±0.12
4. West of tank #1305 at Ravenna	1.83±0.07

0.4

TANK 1303

Entrance cut into tank wall

WALLS OF TANK

← Position

	11 (fence post)	10	9	8	6	7	5	4	3	2	1
G	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.5	0.3	0.3
F	0.3	0.4	0.3	0.5	0.4	0.5	0.3	0.5	0.5	0.5	0.4
E	1.0	0.3	0.4	0.6	0.6	0.7	0.4	0.3	0.5	1.0	1.0
D	1.3	0.3	0.5	0.5	0.5	0.45	0.5	0.4	0.6	0.6	0.6
C	0.6	0.25	0.25	0.3	0.3	0.5	0.6	0.6	0.9	0.5	0.5
B	0.3	0.3	0.4	0.9	1.5	1.6	3.5	2.0	2.0	1.5	0.6
A	0.15	0.2	0.2	0.6	2.0	2.0	4.0	3.0	1.4	0.8	0.7

nce post

RAILROAD ⟵ NORTH

SURVEY READINGS /MR/HI

3.6-1

Olin
ORDNANCE

RAVENNA ARSENAL, I
8451 STATE ROUTE 5, RAVENNA, OHIO 44266-9
TELEPHONE (216) 358-7111 • FAX: (216) 297-3

July 25, 1990

THRU: Contracting Officer's Representative
Ravenna Army Ammunition Plant
8451 State Route 5
Ravenna, Ohio 44266-9297

TO: U. S. Environmental Protection Agency
Region 5
ATTN: 5HS - 11 (Mr. David Meyer)
230 S. Dearborn Street
Chicago, IL 60604

Subject: Request For Information Pursuant to Section 104 (e) of CERCLA As Amended For Industrial Landfill, Inc. (Ref. USEPA's 21 June 1990 Letter to Ravenna Army Ammunition Plant, Same Subject as Above)

Dear Mr. Meyer,

As requested by the reference USEPA letter, the Ravenna Army Ammunition Plant (RVAAP) has researched its historical use of radiological materials. There's record of two periods in which radiological materials have been stored and/or used at RVAAP.

The utilized material were two (ea.) units of 1,000 Curies, Cobalt 60, solid radiographic source and one (ea.) unit of 500 Curies, Cobalt 60, solid radiographic source. These three radiographic sources were used from 1969 to 1972 for quality assurance processes to determine uniformity of solidified explosive following melt pour into military projectiles. These cobalt sources were returned to the licensed lender/owner following their discontinued use at RVAAP. All actions that transpired regarding this lend-use agreement were oversighted by the then known Atomic Energy Commission (AEC). Attachment #1 delineates return of these active sources to the licensed owner.

The other radiological material that existed at RVAAP was monazite ore. The ore was a low-specific-activity material that generated a radiological characteristic by naturally contained thorium. The thorium constituent was identified as being less that 10% of the monazite ore compound. The ore was under ownership by Federal Supply Service, Property Management Division of the General Services Administration (GSA) that had leased above ground tank (fully enclosed) space at RVAAP. The exact time of the ore's

ENCLOSURE 3

emplacement within the RVAAP confines is uncertain due to installation records being destroyed; it can only be approximated that the ore had arrived at RVAAP sometime in the late 1950's or early 1960's. In June 1974 the monazite ore was removed from RVAAP and exported to Rotterdam, Holland under an AEC licensed transaction. Following the ore's removal, processes were undertaken to decontaminate the storage tanks and affected ground surface area probably contaminated with the ore's fines during the loading operation. All collected contaminants were identified as being transported to an AEC approved burial location in Kentucky. RVAAP made a diligent effort to make personal contact with respective personnel of GSA and the service organization involved with the decontamination process; with the objective to confirm the subject activity and pinpoint the exact location of the disposal site. No personal contacts were able to be completed due to disbandment of the specified agency within GSA; GSA records were lost due to the agency's policy to destroy documents of completed transactions that are seven years or older; and the vendor performing the decontamination has since gone out of business without any traceability to the whereabouts of employees and company records. RVAAP terminated any further efforts in obtaining additional information on the subject. Attachment #2 provides all available historical records associated to the monazite ore.

RVAAP's point of contact for further discussion or request regarding any of the above subject matter will be Mr. Thomas M. Chanda, Environmental Engineer, at phone 216-297-3221.

Sincerely,

RAVENNA ARSENAL, INC.

H. R. Cooper

H. R. Cooper
Plant Engineer

TMC/wt/tc90056

Attachment

cf: AMCCOM
ATTN: AMSMC-ISE-M (Capt. Michael Leggieri)

cc: N. Wulff
G. Wolfgang
T. Chanda
File

c-2
4)

FORM APPROVED
BUREAU OF BUDGET NO.

UNITED STATES ATOMIC ENERGY COMMISSION

APPLICATION FOR SOURCE MATERIAL LICENSE

Pursuant to the regulations in Title 10, Code of Federal Regulations, Chapter 1, Part 40, application is h made for a license to receive, possess, use, transfer, deliver or import into the United States, source ma for the activity or activities described.

1. (Check one)
- ☒ (a) New license
- ☐ (b) Amendment to License No. ______
- ☐ (c) Renewal of License No. ______
- ☐ (d) Previous License No. ______

2. NAME OF APPLICANT
Samincorp, Inc.

3. PRINCIPAL BUSINESS ADDRESS
445 Park Avenue, New York, New York, 10022

4. STATE THE ADDRESS(ES) AT WHICH SOURCE MATERIAL WILL BE POSSESSED OR USED
Exported to Rhone Progil, chez Fertiladour, Usine de Saint Bernard, Quai Saint Bernard, 64340 Le Boucan, Rotterdam, Holland, under export licence STE-8179

5. BUSINESS OR OCCUPATION
Ore trading

6. (a) IF APPLICANT IS AN INDIVIDUAL, STATE CITIZENSHIP
N/A

(b) AGE
N/A

7. DESCRIBE PURPOSE FOR WHICH SOURCE MATERIAL WILL BE USED
Source material is a minor component of monazite ore, which will be processed to extract the nonradioactive rare-earth elements (lanthanides and actinides). The source material containing residue is stored or disposed of by the Processor as prescribed under French law.

8. STATE THE TYPE OR TYPES, CHEMICAL FORM OR FORMS, AND QUANTITIES OF SOURCE MATERIAL YOU PROPOSE TO REC POSSESS, USE, OR TRANSFER UNDER THE LICENSE

(a) TYPE	(b) CHEMICAL FORM	(c) PHYSICAL FORM (Including % U or Th.)	(d) MAXIMUM AMOUNT ANY ONE TIME (in pour
NATURAL URANIUM			
URANIUM DEPLETED IN THE U-235 ISOTOPE			
THORIUM (ISOTOPE)	Natural thorium contained in monazite ore		170,000 lbs natura thorium

(e) MAXIMUM TOTAL QUANTITY OF SOURCE MATERIAL YOU WILL HAVE ON HAND AT ANY TIME (in pounds) Total mater to be packed and shipped for export, 3,023,553 lbs monazite containing 170,000 lbs

9. DESCRIBE THE CHEMICAL, PHYSICAL, METALLURGICAL, OR NUCLEAR PROCESS OR PROCESSES IN WHICH THE SOURCE MATERIAL BE USED INDICATING THE MAXIMUM AMOUNT OF SOURCE MATERIAL INVOLVED IN EACH PROCESS AT ANY ONE TIME, AND PROVI A THOROUGH EVALUATION OF THE POTENTIAL RADIATION HAZARDS ASSOCIATED WITH EACH STEP OF THOSE PROCESSES.
Under this licence the ore will not be processed in any way. The monazite ore (by definition low-specific-activity material) is at present in tanks at GSA storage depots and will be packed into steel drums by the applicant and their contractor. The monazite packed in strong steel drums will then be transported in sole-use vehicles to ports for export shipments to west Europe.

10. DESCRIBE THE MINIMUM TECHNICAL QUALIFICATIONS INCLUDING TRAINING AND EXPERIENCE THAT WILL BE REQUIRED OF PLICANT'S SUPERVISORY PERSONNEL INCLUDING PERSON RESPONSIBLE FOR RADIATION SAFETY PROGRAM (OR OF APPLICAN PPLICANT IS AN INDIVIDUAL).
Person responsible for radiation safety holds an M.S. in Health Physics and is currently employed as a Radiologic Safety Officer.

11. DESCRIBE THE EQUIPMENT AND FACILITIES WHICH WILL BE USED TO PROTECT HEALTH AND MINIMIZE DANGER TO LIFE OR PROP AND RELATE THE USE OF THE EQUIPMENT AND FACILITIES TO THE OPERATIONS LISTED IN ITEM 9. INCLUDE (a) RADIATION DETE AND RELATED INSTRUMENTS (including film badges, dosimeters, counters, air sampling, and other survey equipment as appropriate. The descrip radiation detection instruments should include the instrument characteristics such as type of radiation detected, window thickness, and the range(s) of e strument).
As set out in appended Operating Procedure.

(b) METHOD, FREQUENCY, AND STANDARDS USED IN CALIBRATING INSTRUMENTS LISTED IN (a) ABOVE, INCLUDING AIR SAM EQUIPMENT (for film badges, specify method of calibrating and processing, or name supplier).
As set out in appended Operating Procedure.

...HOWING TYPE AND LOCATION OF HOOD AND FILTERS, MINIMUM VELOCITIES MAINTAINED AT HOOD OPENINGS AND PR... FOR TESTING SUCH EQUIPMENT.

Minimal dust generated.
Not required for low-specific-activity ores.

... DESCRIBE PROPOSED PROCEDURES TO PROTECT HEALTH AND MINIMIZE DANGER TO LIFE AND PROPERTY AND RELATE THESE PROCEDURES TO THE OPERATIONS LISTED IN ITEM 9; INCLUDE (a) SAFETY FEATURES AND PROCEDURES TO AVOID NONNUCLEAR ACCIDENTS, SUCH AS FIRE, EXPLOSION, ETC., IN SOURCE MATERIAL STORAGE AND PROCESSING AREAS

As set out in appended Operating Procedure.

(b) EMERGENCY PROCEDURES IN THE EVENT OF ACCIDENTS WHICH MIGHT INVOLVE SOURCE MATERIAL.

Accident procedures are set out in appended Operating Procedure. However, since the material concerned is low-specific-activity material, spillages will not create any emergency. Any such spillages will be avoided; if they occur accidentally, appropriate means will be taken to recover the spillage material.

(c) DETAILED DESCRIPTION OF RADIATION SURVEY PROGRAM AND PROCEDURES. Dosimetry.

The four to five workers responsible for the loading/packing will be required to be recorded on a daily basis. GSA Depot personnel will survey the work area before and after outloading, to establish that the area has not been contaminated.

13. WASTE PRODUCTS: *If none will be generated, state "None" opposite (a), below. If waste products will be generated, check here* ☐ *and explain on a supplemental sheet:*

(*a*) Quantity and type of radioactive waste that will be generated. None.

(*b*) Detailed procedures for waste disposal.

14. IF PRODUCTS FOR DISTRIBUTION TO THE GENERAL PUBLIC UNDER AN EXEMPTION CONTAINED IN 10 CFR 40 ARE TO BE MANUFACTURED, USE A SUPPLEMENTAL SHEET TO FURNISH A DETAILED DESCRIPTION OF THE PRODUCT, INCLUDING: Not applicable.

(*a*) PERCENT SOURCE MATERIAL IN THE PRODUCT AND ITS LOCATION IN THE PRODUCT.

(*b*) PHYSICAL DESCRIPTION OF THE PRODUCT INCLUDING CHARACTERISTICS, IF ANY, THAT WILL PREVENT INHALATION OR INGESTION OF SOURCE MATERIAL THAT MIGHT BE SEPARATED FROM THE PRODUCT.

(*c*) BETA AND BETA PLUS GAMMA RADIATION LEVELS (*Specify instrument used, date of calibration and calibration technique used*) AT THE SURFACE OF THE PRODUCT AND AT 12 INCHES.

(*d*) METHOD OF ASSURING THAT SOURCE MATERIAL CANNOT BE DISASSOCIATED FROM THE MANUFACTURED PRODUCT.

CERTIFICATE

(This item must be completed by applicant)

15. *The applicant, and any official executing this certificate on behalf of the applicant named in Item ... certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 40, and that all information contained herein, including any supplements attached hereto, ... true and correct to the best of our knowledge and belief.*

Hans von Michaelis
(Applicant named in Item 2)

Dated June 4, 1974

BY: Dr. Hans von Michaelis
(Print or type name under signature)

Assistant to the Chairman
(Title of certifying official authorized to act on behalf of the applicant)

WARNING: 18 U.S.C. Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

General Services Administration · Federal Supply Service · Washington, DC 20406

Date: APR 25 1978

Reply to Attn of: FJO

Subject: Destruction of GSA Records

To: Contracting Officer's Representative
Ravenna Army Ammunition Plant
Ravenna, OH 44266

This is authority for the Stores and Transportation Division to proceed with the destruction of strategic and critical material records listed in the enclosed letter dated April 14, 1978.

A. A. Mustone

A. A. MUSTONE
Director
Stockpile Storage Division

Enclosure

General Manager
Ravenna Arsenal, Inc.
FWD FOR
X Information
Compliance as applicable
☐ Reply NLT 4-28-78

RECEIVED
APR 28 1978
GENERAL MANAGER

5-1-78

Enclosure 4

RAVENNA ARSENAL, INC.
RAVENNA, OHIO 44266

April 14, 1978

Contracting Officer's Representative
Ravenna Army Ammunition Plant
Ravenna, Ohio 44266

Subject: Destruction of General Services Administration (GSA) Records.

Reference: Storage Manual for General Services Administration Strategic and Critical Material.

Dear Sir:

Storage Manual for General Services Administration Strategic and Critical Material states:

(Records maintained at storage installations documenting receipts, storage and shipment of strategic and critical materials such as: GSA Form 46, GSA Form 131, GSA Form 132 and GSA Form 1052; may be destroyed two years after all stored material of like kind or grade has been shipped out, and an additional ninety days after notice has been furnished to GSA that the records are to be destroyed.)

Request to destroy the records of the following material:

Commodity	Last Shipping Date	Balance
Copper	5-9-74	0
Monazite	11-19-74	0
Nickel Oxide	1-30-70	0
Silicon Carbide	7-7-77	0

5-1-78

[illegible]
[illegible]
[illegible]
AUDIT
[illegible]
ENGR
IR&D
S & T
P & MC
RETURN

Please forward copy of this request to:

General Services Administration (FSS)
Director, Stock Storage Division (FJO)
ATTN: Mr. ~~A. Mustone~~ J. Sanders
Washington, D. C. 20406

RECEIVED
APR 28 1978
GENERAL MANAGER

Very truly yours,

RAVENNA ARSENAL, INC.

J. N. DiMauro

J. N. DiMauro, Manager
Stores & Transportation Div.

JND:fd