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US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
EDGEWOOD CHEMICAL BIOLOGICAL CENTER
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Division of Nuclear Materials Safety
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, PA 19406-1415

Dear Sir or Madam:

03004552

References:

- Nuclear Regulatory Commission (NRC) License No. 19-10306-01, Docket No. 030-04552.

- Final Release Survey Report for the Westwood Radioactive Material Disposal Facility (WRMDF), Foster Wheeler Environmental Corp., 28 April 1998.

- NRC Telephone Conversation Record, 19 July 2005, 0930 hours.

The Westwood Radioactive Material Disposal Facility (WRMDF) at Aberdeen Proving Ground was formerly used to manage radioactive waste. Remediation of this site occurred during 1997 and 1998 as part of a U.S. Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), resulting in release of the WRMDF from NRC License 19-10306-01. Following the remediation/removal effort, sampling and analysis actions determined that Cesium-137 (Cs-137) levels in one small area exceeded the removal action cleanup criteria. The risk assessment under CERCLA determined that the residual Cs-137 does not pose an unacceptable risk to future military/industrial workers and that the potential dose is below the regulatory criteria of 25 milliRem/year. In a follow up phone conversation between NRC and the licensee (see reference), NRC requested a detailed report from the licensee outlining the follow up sampling and analysis of the area exhibiting residual Cs-137 levels.

The attached report entitled Assessment of Residual Cs-137 in Sediment, Westwood Radiological Material Disposal Facility, March 2006, describes the sampling/analysis effort in detail. The report concludes that further remediation is not warranted since the expected dose is below 25 milliRem/year, the site is under water and the site will not be available for future unrestricted residential use.

Request NRC approval of the attached report and its conclusion that no further Cs-137 remediation is warranted.

138798

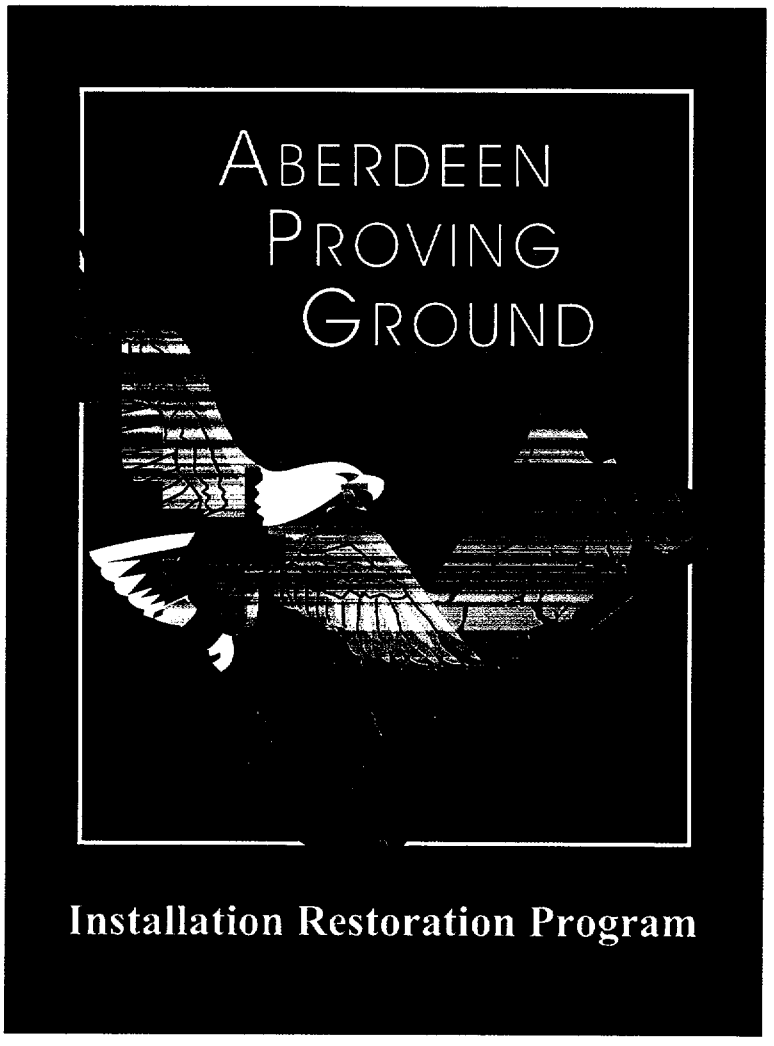
NMSS/RGN1 MATERIALS-002

Questions regarding this request should be addressed to Mr. Eric Kujala, ECBC Radiation Safety Officer, by telephone (410) 436-1381 or email eric.kujala@us.army.mil.

Sincerely,

for J. H. Zarzycki
Technical Director

Enclosure



WESTWOOD STUDY AREA

Assessment Of Residual Cs-137 In Sediment
Westwood Radiological Material Disposal Facility

March 2006

U.S. Army Garrison
Aberdeen Proving Ground, Maryland

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14. ABSTRACT

The WRMDF was used from sometime after World War II until the early 1960s as a facility for processing radioactive waste. A CERCLA removal action was accomplished in 1997 and 1998 to address residual contamination by Cs-137, primarily associated with underground wastewater lines and structures, and including a small area in the marsh adjacent to a wastewater line headwall. That 1997/1998 work was jointly regulated by the NRC, with the site being removed from the NRC License. Subsequent CERCLA investigation found that a small volume of sediment in the marsh is still contaminated with Cs-137. This document is an assessment of the residual Cs-137 in sediment, the potential risk to human health the environment, as well as an assessment of the need for further remediation. This assessment indicates that the dose to industrial workers is less than 25 mrem/year (10 CFR 20 Subpart E), that residual radioactivity is as low as reasonably achievable, and that further remediation is not necessary.

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Westwood Radiological Material Disposal Facility
Westwood Study Area
Aberdeen Proving Ground, Maryland

Prepared for

Directorate of Safety, Health and Environment
U.S. Army Garrison
Aberdeen Proving Ground, Maryland

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1 PURPOSE

The purpose of this document is to respond to a request by the U.S. Nuclear Regulatory Commission (NRC) concerning a site at Aberdeen Proving Ground (APG) formerly used to manage radioactive waste. The site is the former Westwood Radioactive Material Disposal Facility (WRMDF). Remediation was accomplished under the U.S. Environmental Protection Agency (EPA) Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) from August 1997 through September 1998. There was joint oversight of that removal action by EPA and NRC, resulting in release of the WRMDF from the NRC license (19-10306-01), with unrestricted use of the site allowed. Following the removal action (i.e., an interim action under CERCLA), soil, sediment, surface water and groundwater throughout the Westwood Study Area, including the WRMDF site, were sampled and analyzed for radionuclides, with a radiological risk assessment performed. That sampling and analysis found Cs-137 remaining at the site at activity levels higher than the removal action cleanup criteria in a small area less than 30 feet in diameter within the marsh adjacent to the WRMDF where radioactive wastewater had been discharged. The radiological risk assessment under CERCLA determined that the residual CS-137 does not pose an unacceptable risk to future military/industrial workers and that because the dose would be less than the regulatory criteria of 25 mrem/yr, that there was no reason to reexamine release of the site from the NRC license.

While EPA approved the radiological risk assessment, they did not forward the radiological risk assessment to NRC, and preferring to defer to the NRC on radiological issues, in telephone communication with NRC personnel, asked the NRC to reevaluate the site (i.e., reexamine release of the site from the NRC license). In a telephone conversation between the NRC, EPA, the Maryland Department of the Environment (MDE), and the Army on 19 July 2005, NRC established the following requirements for the licensee, the U.S. Army Research, Development & Engineering Command (RDECOM)[1]:

> 1) RDECOM, the licensee, is responsible for submitting a document to the NRC that describes what areas have been found to have unexpected levels of radioactivity, the extent of the radioactivity, what actions they intend to take relative to dealing with the elevated levels, and what is the basis for the proposed actions. Consistent with the original request for unrestricted release for this area, the basis for any requested proposed actions should be in accordance with 10 CFR 20 Subpart E (i.e. < 25 mrem/year). Following submittal of this and other information as required, the NRC will approve actions that will eventually allow this area to be re-released for unrestricted use.
>
> 2) RDECOM is responsible for controlling activities associated within the impacted area under their existing license until such time that a decision is rendered relative to disposition of the area.

[1] The actual Army organization holding the NRC license is the U.S. Army Edgewood Chemical Biological Center (ECBC), which is an element of RDECOM. The ECBC is an organizational grandchild of the original Edgewood Arsenal.

2 BACKGROUND

2.1 Site Description

The former WRMDF occupied a 2.0-acre area adjacent to the Installation boundary, south and east of Westwood Road (Figure 1). The portion of the site that was occupied by the historical demilitarization and radioactive waste management activities is now an open field that slopes gently to Reardon Inlet.

2.2 Historical Activities

The site was used during the late 1940s and/or early 1950s for a demilitarization operation. Most or all of the demilitarization consisted of defusing munitions, most of which were incendiary munitions. Historical information and environmental sampling and analysis have not identified significant residual contamination of soil or other environmental media from the demilitarization activities (i.e., no unacceptable risk to military/industrial workers or ecological receptors identified).

The radioactive waste management activities at the site began sometime after the demilitarization activities ceased, either the late 1940s or during the 1950s. It is known that the WRMDF was operating at least as early as 1957. There was no actual disposal of radioactive waste at the site, but only receipt, temporary storage, processing and packaging of the waste. During the early 1960s, the initial portion of a research and development project was also conducted at the WRMDF, involving use of a wiped-film evaporator to concentrate liquid radioactive waste. The WRMDF was operated until circa 1964 when the activities were moved to a larger site in the Bush River Area.[2]

The WRMDF was located within a fenced area approximately 120 feet by 200 feet in size. Structures included Building E5960 and adjacent concrete slabs where the waste handling work was accomplished, a small equipment shed (Building E5962) and a wastewater holding and drain system that included tanks in a concrete tank pit (Building S5961) (Figure 2). Discharge of wastewater from the tanks was to Reardon Inlet, which is located immediately south of the site. Operations and waste management practices at this unit were very similar to those at the Bush River Area RMDF. The unit SOP specified testing of the wastewater prior to discharge to Reardon Inlet.

Building E5960 existed prior to its usage as a radioactive waste handling facility. As originally constructed, wastewater from E5960, and also Building 3014 (another former building that had been demolished prior to WRMDF activities) was discharged to the Reardon Inlet marsh. This discharge line ran south-southeast from near the western end of Building E5960. This system was separate from the wastewater system that handled low level liquid radioactive wastewater and which included the storage tanks in the tank pit (Figure 2). The sanitary wastewater system for E5690 was upgraded during the 1967 to 1969 period, with the addition of a 625-gallon septic tank, a chlorine contact chamber, and a sand filter bed approximately 10 feet wide and 23 feet in

[2] The activities were moved to the former Toxic Gas Yard and that site in the Bush River Area was thereafter also referred to as the "RMDF", or more commonly as the "Rad Yard".

length. This upgrade suggests that there were plans for reuse of the site.[3] However, the buildings at the site were demolished during the 1970 to 1972 period.

The main channel for flow within Reardon Inlet comes onpost northeast of the WRMDF, runs under Westwood Road and flows along the southern edge of the marsh until it is south-southwest of the WRMDF, and then flows northward to a point immediately southwest of the WRMDF, from where flow is westward within the Reardon Inlet marsh. The discharge line for the radioactive wastewater system originally terminated at the headwall at the edge of the Reardon Inlet marsh, a location not in the primary flow pathway within the drainage system. Because of this, drainage of the discharged wastewater away from the headwall area was not good. At some point in time during operation of the WRMDF, an extension of nearly 150 feet was added to the discharge line such that discharge was into the flowing channel south-southeast of the WRMDF.

There was a partial decontamination of the WRMDF facilities in the mid-1960s when the operations were moved to the Bush River area. A more thorough decommissioning and decontamination was accomplished during the early 1970s, and the recent remediation was accomplished in 1997 and 1998.

2.3 Environmental Setting

The portion of the WRMDF site in which activities occurred has been an open grass field since the structures were demolished. There are trees along south edge of the site, in the area adjacent to Reardon Inlet. There are also trees to the west of the WRMDF site, between Westwood Road and Reardon Inlet. The portion of the site where WRMDF activities occurred drains south to Reardon Inlet. The westernmost portion of the open field area drains west to a drainage swale that carries precipitation runoff from the offpost area to the north of the WRMDF to Reardon Inlet.

A substantial portion of the Reardon Inlet marsh in the area immediately south of the WRMDF site has standing water. In the area near the former WRMDF wastewater line headwall the standing water is approximately two feet in depth. The Reardon Inlet marsh in the vicinity of the former WRMDF has not always had as much standing water. Circa 1999 beavers built dams both upstream and downstream of the WRMDF, creating the ponding. Without the damming of water by beaver, ponding of water in the wetland in this area was primarily following precipitation events.

2.4 Site Assessment, Remediation and Regulatory Background

2.4.1 Historical Decontamination Efforts

There was partial decontamination of the WRMDF facilities circa 1964 after operations were moved to the Bush River area. The first substantial decommissioning and decontamination effort at the WRMDF site was in the early 1970s. In addition to the demolition of the buildings, the concrete tank pit was also demolished, as well as the concrete pads used as work surfaces. Debris from the buildings and other structures was contaminated with radionuclides, and was disposed offpost as radioactive waste. At least some soil from around and beneath the tank pit

[3] Most of the septic system upgrades at APG occurred during the 1970s to meet requirements of the National Pollution Discharge Elimination System (NPDES) which was created in Section 402 of the Clean Water Act in 1972. The upgrade of the septic system at Building E5960 predates the NPDES requirements.

was also excavated and disposed offpost. Other than the concrete tank pit, underground wastewater lines for both the radioactive wastewater and sanitary systems were left in place.

2.4.2 CERCLA Removal Action and Final Status Survey

The removal action was accomplished and associated documentation prepared and staffed from August 1997 through September 1998. The final release survey report was completed in April 1998 (Foster Wheeler, 1998).

The removal action was accomplished to remove the wastewater lines that were left in place, as well as any radionuclide contaminated soil that was associated with the wastewater systems. The planned excavation was based on the information concerning the wastewater systems plus data from soil sampling. The actual extent of excavation was determined by instrument readings in the field and sampling and analysis data collected during the remediation, and was larger than the original plan. The vertical extent of excavation was also determined by field and laboratory data during the remediation. The actual excavation footprint is shown in Figure 3. Approximately 25,000 ft^3 of waste was packaged and disposed at the Envirocare, Inc., facility in Clive, Utah (Foster Wheeler, 1998; NRC, 1998).

Cs-137 is the only radionuclide that was present at the WRMDF site in a significant quantity with an activity higher than natural or anthropogenic background. The release criteria for the site was established at 15 pCi/g Cs-137. Compliance with this limit was to be demonstrated by showing that the average Cs-137 activity level in each of the survey areas is less than 15 pCi/g, and that the maximum activity level in any sample is no higher than three times the average (i.e., not higher than 45 pCi/g). The data from verification sampling and analysis did demonstrate compliance with the release criteria.

The following excerpt from the Final Release Survey Report (Foster Wheeler, 1998) concerning remedial activities in the area of the headwall provides insight into the 1998 understanding of residual contamination and rationale for decommissioning:

> *The area surrounding the headwall is the area where the highest concentrations were found, first by the EA study, and later in the preliminary site evaluation by Foster Wheeler. Apparently, material was discharged at the headwall before the steel line was installed extending the discharge point to a location across the marsh. It was found that the extent of the dispersion of contamination during that early period was greater in the SSE and ESE directions, generally upstream. This suggests that during rainy weather contamination was caught in the backwaters of the Reardon Inlet and never completely washed out to the bay. This left a mixture of contaminated residue, leaves and other debris which subsequently was covered with silt.*
>
> *During excavation the analysis of in-process samples showed a decreasing trend in the concentration of cesium-137 in the sediments with depth and distance from the headwall, with occasional high samples. These higher concentrations were believed to have resulted from subsidence of the SE side of the excavation which added soil from these former backwater deposits to the excavation.*

Excavation was continued until concentrations in the materials removed (from underwater) were reduced to values well below the release criteria. This is reflected in samples E-47, E-48 and D-49 taken from the bucket at the conclusion of the excavation of the headwall area.

Samples E-43, E-44, E-45 and E-46 were taken to assess the amount of contamination that remained in the backwater area. Contamination was found, i.e., 26.4 pCi/g cesium-137 in sample E-46, but at a depth of more than two feet, and representing only a limited area.

The headwall area is still regarded as meeting the release criteria because this one high sample is not more than three times the limit of 15 pCi/g, and the contaminated material is covered with at least two feet of soil. Furthermore, a computer code for analyzing the dose via various environmental pathways, RESRAD, was used to evaluate this condition. The analysis showed that the total effective dose equivalent (TEDE) from cesium-137 (using default values) is 27 times lower when the cesium-137 has a two foot thick clean cover. For comparison, a cesium-137 concentration of 405 pCi/g in subsurface soil below a depth of two feet would be required to give the same TEDE as the TEDE from soil uniformly contaminated with 15 pCi/g cesium-137 all the way to the surface.

2.4.3 Residual Cs-137 Contamination

The extent of residual contamination in soil and sediment at the former WRMDF site is defined by data from analysis of 130 samples plus readings from field instruments at the time of remediation. The soil and sediment samples were collected as part of verification for the removal action (1997/1998), and as part of the CERCLA RI (2003) and FS (2004). The sampling locations are shown in Figure 4, while the Cs-137 data are listed in Table 1. Figure 5 is an enlargement of former wastewater line headwall area.

Samples at only three locations have residual Cs-137 activity higher than 7 pCi/g. Those three samples are C06-SS-18, C06-SD-13 and C06-SD-15, all located in the immediate vicinity of the former headwall. Four depth intervals were sampled at each of these three locations; 0-½ feet, ½-2 feet, 2-4 feet and 4-6 feet. The area of contaminated sediment is tightly bounded on the west, south and east by sampling at 7 locations (5 of these locations sampled at 4 depths), with a spacing between bounding sample locations of between 15 and 20 feet (Figure 5).

Cs-137 activity is high in surface and near surface sediment (0-2 feet) at only one of the locations, C06-SS-18. The deepest (i.e., 4-6 foot depth) intervals at locations C06-SS-18 and C06-SD-13 have low Cs-137 activity levels. At C06-SD-15, the Cs-137 is high (66 pCi/G) in the 4-6 foot depth interval, and the Cs-137 may extend to a depth of greater than 6 feet. The estimated size of the area with high Cs-137 activity in surface sediment is 100 feet^2 (Figure 5). The larger area of subsurface sediment having elevated Cs-137 is estimated to be 375 feet^2. The volume of contaminated sediment is estimated to be 2, 14, 28 and 28 yards^3 in the four depth intervals sampled, 0-½, ½-2, 2-4 and 4-6 feet, respectively, with a total contaminated volume of 72 yards^3. The calculated average activities in the four depth intervals, from surface to deepest, are 131, 28, 47 and 23 pCi/g, with the mass/volume weighted average Cs-137 activity in the entire 72 yard^3 calculated to be 36.6 pCi/g. It is estimated that 0.00255 Ci of Cs-137 is present in

this contaminated volume of sediment, with approximately 10% present in the 0-½ foot depth interval, and 15%, 50% and 25% of the Cs-137 in the increasingly deeper intervals.

The headwall area is not located within the primary flow path for surface water in Reardon Inlet. Because of this, there is little potential for erosion and transport of Cs-137 contaminated sediment from the headwall area to downstream areas within the Reardon Inlet marsh. Given the width of the Reardon Inlet marsh at the former WRMDF and the topographic elevation profile of the drainage system, any erosion that would occur would remove only the surface sediments in the headwall area. If erosion of the sediment in the former headwall area were to occur, deposition of the transported sediment would be primarily within the downstream area immediately southwest of the WRMDF which is a low energy area where standing water is normally found and fine-grained sediments (i.e., silts) could settle.[4] This area is approximately 100,000 feet^2 in size. Assuming erosion and transport of the top six inches of sediment from the headwall area and deposition in this downstream area, the increase in the Cs-137 activity level in the top six inches of sediment in the deposition area would average approximately 0.1 pCi/g, and would likely not be detectable by sampling and analysis.

2.4.4 CERCLA Risk Assessment

The CERCLA radiological risk assessment for the WSA (General Physics Corporation, 2005) was drafted prior to the 2004 supplemental sampling of headwall area sediments at multiple depth intervals. The headwall surface sediment sample with a Cs-137 activity level of 72 pCi/g had been collected in 2003, and was included in the risk assessment data set. The supplemental sampling of headwall sediments was accomplished while the draft document underwent it's first regulatory review. When the draft document was revised and finalized, it was updated to evaluate the supplemental sediment data.

The risk assessment concluded that the supplemental sediment data are consistent with the removal action verification data:

> *The main difference between removal action and FS observations and data are higher activity levels found in FS samples. The removal action samples at the headwall/backwater remedial excavation were collected using a backhoe bucket at the conclusion of the excavation. This sampling approach was used because it was the safest method of collecting soil/sediment material from a deep water and mud-filled excavation. In using the backhoe, the sample would have been a composite from the small area within which the sample material was obtained. Data from discrete point and depth sampling during the FS with a hand auger provides a range of activity levels that are both higher and lower, but consistent with the removal action verification results.*

[4] This is based on a conservative assumption that a surface runoff event that is capable of eroding sediment from the former WRMDF headwall area would not have sufficient energy to also transfer sediment farther downstream than the 100,000 feet^2 area described. This assumption is likely not valid (i.e., overly conservative), and any runoff event large enough to erode sediment from the headwall area would likely also result in transport of eroded sediment farther downstream, with deposition in a larger area, with no detectable increase in Cs-137 activity levels. Also note that it is quite possible that there is no runoff event that could erode sediment from the headwall area, because of it's location outside of the main flow channel in Reardon Inlet.

The CERCLA risk assessment included the headwall area. The risk assessment evaluated two scenarios, one using all of the WRMDF data outside of the headwall area plus an activity level of 72 pCi/g for Cs-137 in the headwall area. Spatial distribution of Cs-137 was not considered in this scenario, which could be interpreted as being representative of either a future industrial worker in the WRMDF being occasionally present in the headwall area or of a situation where the headwall area was disturbed with Cs-137 contaminated sediment spread across the WRMDF site. Neither of these situations is a likely or reasonable possibility (see discussion in following Section 3.2), but the estimated risk and dose to future outdoor workers associated with this scenario are 2.95×10^{-5} and 2.05 mrem/yr and do not exceed regulatory limits. To provide a point of reference, the CERCLA risk assessment also evaluated an unreasonable scenario and found that the dose and risk from Cs-137 to an outdoor worker would not be unacceptable even if the worker were to stand in the Cs-137 hot spot at the headwall 8 hours a day, 225 days a year for the next 25 years.

Concerning risk to ecological receptors, the CERCLA risk assessment found that "*The radiation exposure to terrestrial and aquatic organisms from Cs-137 is less than BCGs, indicating that is unlikely that residual contamination is adversely affecting receptor populations.*"

The conclusions of the CERCLA risk assessment concerning the WRMDF site were:

> *Current data from the headwall/backwater area, if they had been available at the time the removal action was completed, would not indicate that release criteria were being met, and further excavation would have been required. However, the radiation dose to future industrial workers and to hypothetical future residents is less than the regulatory criteria of 25 mrem/yr (3.1 mrem/yr), and there is no reason to reexamine release of the site from the NRC license.*

3 LAND USAGE AND EXPOSURE SCENARIOS

3.1 Current and Future Land Usage

A gate on Westwood Road east of the WRMDF site and immediately south of the bridge over Reardon Inlet controls access to that portion of the Westwood area that is west and north of Reardon Inlet. During the period of time when mission activities related to testing and training were no longer being conducted in the area, and the only activity was operation of the debris landfill, that gate was left open most of the time. Since the closure of the Westwood Debris Landfill circa 2003, there are no active operations in the area west and north of Reardon Inlet. In recent years, with closure of the landfill and increasing concern for unexploded ordnance hazards, the gate has been kept locked. Access to the area has been infrequent and mostly by security patrols and environmental workers.

There has been no usage of the WRMDF site since the 1960s. There are no site features or characteristics that make the site attractive for recreational activities such as hunting or fishing.

The area in which the former WRMDF site is located is designated in the APG Master Plan as an "Open Space" under both existing and planned future land uses. A record of decision (ROD) under CERCLA establishes a land use restriction on all of the Westwood area that prevents future military family housing, elementary and secondary schools, child care facilities, playgrounds, and nonmilitary residential housing.

It is possible that the upland portion of the WRMDF site will be used in the future for military/industrial activities. The cleanup level used for Cs-137 in soil for the 1997/1998 remediation was 15 pCi/g, an activity level protective of workers and military personnel, and actual levels following remediation are substantially lower than 15 pCi/g. The subsequent CERCLA remedial investigation and risk assessment verified that the dose/risk to workers/military personnel associated with the low levels of residual Cs-137 in surface and subsurface soil in the upland portion of the site are not unacceptable (i.e., not exceeding 25 mrem/yr or a cancer risk of approximately 10^{-4}.

3.2 Hypothetical Exposure Scenarios

A variety of scenarios have been considered for possible exposure to radiation from residual Cs-137 in sediment near the former wastewater line headwall. The scenarios considered and evaluations of the potential for exposure are:

Construction on Hot Spot Area. *This scenario would involve construction on the hot spot area, with workers in the constructed facility exposed to radiation from the residual Cs-137 in sediment.* Exposure associated with this scenario is very unlikely for several reasons. The hot spot is located in a wetland, and existing environmental regulations protect wetlands. While construction in wetlands is not prohibited, there will be a preference to construct only in upland areas of the site, or to move a project to another location where wetlands will not be impacted. Even if there were construction in the marsh at the hot spot area, there would be no exposure to the workers using the constructed facility. The marsh sediment does not provide a suitable foundation for construction, and the sediments would either be excavated and removed from the site with the marsh area backfilled to increase the elevation, or the site would be backfilled with the Cs-137 contaminated sediment left in place beneath the backfill. In either case there would be no exposure of future site workers because the residual Cs-137 would either be gone from the site or covered with four or more feet of soil. There would be no significant exposure of construction workers, because activities to either excavate or cover the Cs-137 contaminated sediment would be accomplished in just a few hours using heavy construction equipment.[5] Because there is little or no potential for exposure with this scenario, a quantitative dose estimate was not prepared.

Work in Hot Spot Area Without Construction. *This scenario would have workers present in the hot spot area to perform tasks associated with their jobs.* This scenario is not a realistic possibility. Even if the beaver dams were removed, the hot spot site would still be underwater at times and wet much of the remaining time. There is no reason to expect that workers or military personnel would ever be required to frequently or even occasionally be present in the marsh at the location of the Cs-137 hot spot. Because this scenario is not a realistic possibility, a quantitative dose estimate was not prepared.

[5] Excavated sediment would require management to ensure either appropriate disposal or proper management such that there would be no future unacceptable exposure to the Cs-137.

Excavation of Sediment from Hot Spot for Use at Another Location. *This scenario would involve excavation of Cs-137 contaminated sediment from the marsh hot spot use at a construction site (either the former WRMDF site or another site) where it would be placed as surface soil and exposure would subsequently occur.* This scenario is also not a realistic possibility. The marsh sediment is a mixture of silt, sand and organic matter and would not be a suitable material for use at a construction site, either as topsoil or as fill material. Furthermore, existing environmental regulations protect wetlands, and would inhibit, or prohibit, the use of the marsh as a borrow site. Because this scenario is not a realistic possibility, a quantitative dose estimate was not prepared.

Recreational Activity in the Hot Spot Area. *Recreational scenarios are those where the persons occupy the hot spot area while engaged in recreational activities, either because the hot spot area is within a designated recreational area, or because they are briefly present in the hot spot while hiking, hunting or fishing.* The same factors that make the hot spot area an unlikely location for workers to be exposed, also make designation of the hot spot area for recreation not a realistic possibility. It is possible that a hiker will in the future walk through, or maybe even briefly pause in, the hot spot area. These exposure events are expected to be very infrequent and of very short duration, with very little exposure.

Erosion and Surface Water Transport of Sediment from Hot Spot. *This scenario assumes that there is erosion of the uppermost sediment from the hot spot area and transport of Cs-137 contaminated sediment to downstream areas of the Reardon Inlet marsh, with potential exposure to human and ecological receptors.* Exposure to Cs-137 activity in sediment if it were to be eroded and transported downstream is even less likely than exposure in the headwall area, because the downstream area where sediment deposition would most likely occur normally contains standing water, even without construction by beavers. Because there is no potential for significant exposure under this erosion and sediment transport scenario, a quantitative dose estimate was not prepared. The fraction of a pCi/g that would be added to existing activity in downstream sediment would not pose an unacceptable risk/dose to either humans or ecological receptors even if exposure were to occur.

3.3 Estimated Dose and Risk from Cs-137 in Headwall Sediment

A recreational activity scenario was evaluated using RESRAD. The exposure parameters used are standard RESRAD industrial worker factors with the occupancy factor revised to once a week for 36 weeks, 2 minutes exposure time for each exposure event. The contaminated zone was assumed to be circular and 100 feet^2 in size with a contaminated zone thickness of 2.0 feet and a Cs-137 activity level of 131 pCi/g. This activity level is the average of the two laboratory measurements in surface sediment (0 – 0.5 foot depth) in the hotspot. The actual activity level in the 0.5 – 2 foot portion of the interval is substantially lower (28 pCi/g), but because most of the dose would be from the unshielded sediment at the surface, it is appropriate to use the higher activity level for the surface material. The dose for this exposure scenario was calculated to be 0.0275 mrem/yr (at time t = 0). The RESRAD Summary Report for this scenario is presented in Appendix A.

While there are no realistic scenarios involving substantial exposure to the Cs-137 hot spot because of its location in a marsh, to provide a point of reference, exposure calculations were also performed for a fictional scenario where the hot spot is located in an upland location, not in a marsh. Because there are no outdoor worker scenarios that would have a worker occupying a very small area routinely for a substantial portion of each work day, a scenario involving construction over such a hot spot was assumed. A worker was assumed to occupy an office space over the hot spot for 6 hours each day, 225 days per year. RESRAD default factors for indoor dust filtration (0.4) and external gamma shielding (0.7) were used.[6] The contaminated zone discussed above for the recreational activity scenario was used in the model. The estimated dose for this fictional indoor worker scenario with an upland hot spot instead of a marsh hot spot is 20.7 mrem/yr. The RESRAD Summary Report for this scenario is presented in Appendix B.

3.4 Exposure of Ecological Receptors

The CERCLA risk assessment evaluated potential for risk to ecological receptors in the Westwood Study Area, including the former WRMDF site, and concluded that there is no potential for significant adverse effects to ecological populations. This evaluation was performed using the approach developed by the Department of Energy (DOE) in the technical standard, "*A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (DOE-STD-1153-2002)*" (DOE, 2002). The Biota Concentration Guide (BCG) (e.g., screening level) for Cs-137 in sediment for ecological receptors is 3120 pCi/g, while the soil BCG is 20.8 pCi/g. The Cs-137 levels in sediment and soil at the former WRMDF are substantially lower than these screening levels.

4 REMEDIAL CONSIDERATIONS

If the Cs-137 hot spot was located in the upland portion of former WRMDF site it is likely that the combination of dose for a conservative worker scenario, small volume of contaminated soil and easy access would lead to a decision to perform further remediation to remove the Cs-137 hot spot. The actual situation with the hot spot in the marsh is different, with there being no potential for significant exposure and with further remediation being difficult and costly.

The Cs-137 hot spot does not pose unacceptable risk to industrial/military workers, site visitors or ecological receptors, and any future erosion and transport of the contaminated sediment to downstream locations would also not pose risk. If further remediation were to be performed with no risk driver, then it is also possible that the remedy would have to be implemented in a manner that prevents sediment transport during remediation to downstream areas, even though such transport would not pose risk to human health or the environment. A sediment retention wall could be constructed around the hot spot excavation area, and it is possible that destruction of the beaver dams to reduce ponding would be necessary.

In upland areas, excavation above the water table can be accomplished with relatively steep sidewalls and field instruments can be used to aid in identifying soil to be excavated. In saturated loose marsh sediments with overlying surface water, precise excavation will not be

[6] Heating, ventilation and air conditioning systems filter/remove a portion of the dust that is present in outdoor air, and the building structure also shields occupants from a portion of the external gamma radiation. RESRAD considers these factors in calculation of dose for that portion of time a worker is indoors. The dust filtration and external gamma factors used are the default values for RESRAD.

possible. The excavation will be underwater and use of field instruments to assess remaining in situ soil will not be possible. The result of these factors will be that the amount of sediment actually excavated will be substantially larger than the in situ contaminated volume. It is likely that the actual excavated sediment volume will be at least 5 to 10 times as high as the actual in situ volume.

Like most range areas at APG, unexploded ordnance (UXO) may be present at the site. When excavating an upland site, excavation can be performed in 2-foot depth increments, with use of magnetometers and metal detection equipment to examine in situ soil to identify metallic items that are potentially UXO. Metallic items can be either hand dug before mechanical excavation, or during the mechanical excavation with trained personnel operating equipment and visually observing at the point of excavation. This approach will not be possible when excavating underwater in a marsh. The mechanically excavated sediment will have to be processed/screened to remove UXO prior to shipment for disposal.

The material excavated would be a mixture of sediment and water. The Cs-137 in the contaminated sediment will be primarily adsorbed to fine-grained clay and silt. The surface water in the excavation area and any water removed from the excavation could be contaminated with Cs-137 because of suspended solids. Dewatering of the excavated material would be necessary to facilitate screening for UXO. It is possible that treatment or disposal of water separated from the excavated material, and possibly water in the excavation, would be necessary.

The excavation and disposal costs for further remediation of the marsh hot spot would likely be $150,000, not including isolation of the excavation area to prevent sediment transport downstream, dewatering of excavated sediment, screening excavated sediment for UXO, and water treatment/disposal. These requirements could increase costs to the $300,000 to $500,000 range.

5 PLANNED ACTION

Because there is no potential for significant exposure and because further remediation would be difficult and costly, no action is planned to further remediate Cs-137 contaminated sediment in the former headwall area of the WRMDF site at APG. A CERCLA action at APG will prevent future unrestricted residential use of the site.

6 REFERENCES

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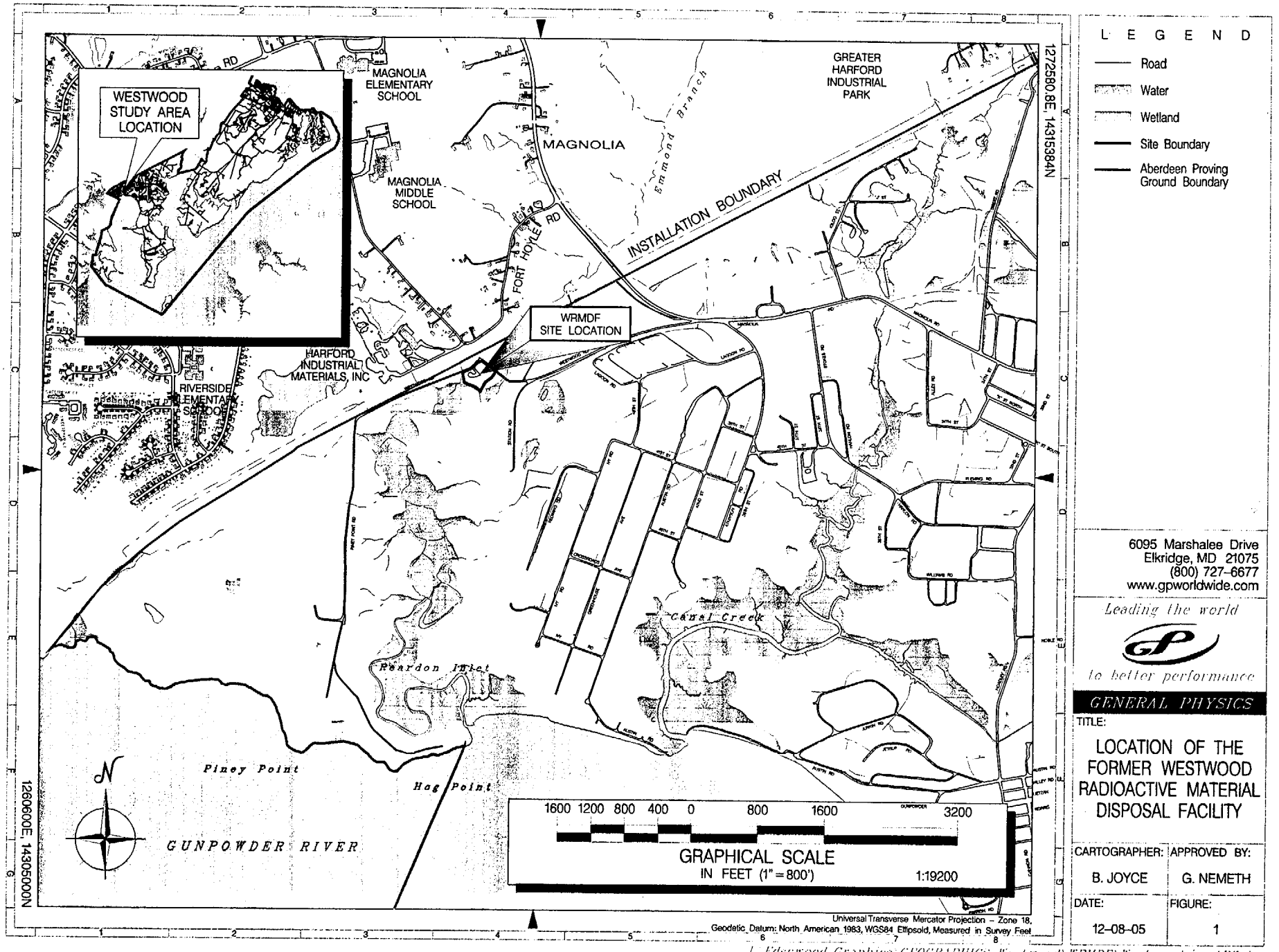
FIGURES



L E G E N D

- Road
- Water
- Wetland
- Site Boundary
- Aberdeen Proving Ground Boundary

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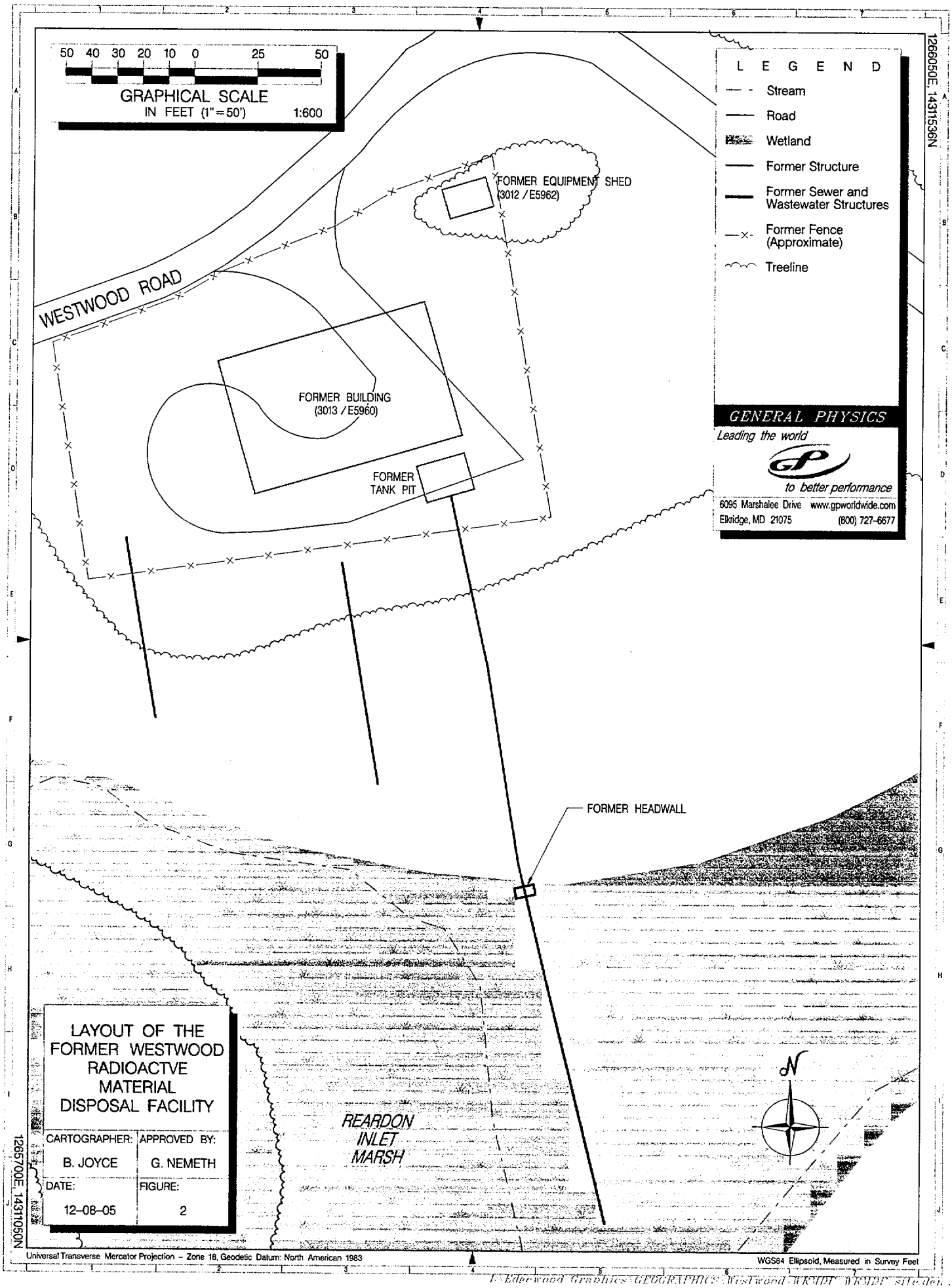
GENERAL PHYSICS

TITLE:

LOCATION OF THE FORMER WESTWOOD RADIOACTIVE MATERIAL DISPOSAL FACILITY

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	G. NEMETH
DATE:	FIGURE:
12-08-05	1

I Edgewood Graphics GEOGRAPHICS Westwood\WRMDF\Westwood in APG.dgn


50 40 30 20 10 0 25 50
GRAPHICAL SCALE
IN FEET (1"=50')
1:600
LEGEND
Stream
Road
Wetland
Former Structure
Former Sewer and Wastewater Structures
Former Fence (Approximate)
Treeline
WESTWOOD ROAD
FORMER EQUIPMENT SHED (3012 / E5962)
FORMER BUILDING (3013 / E5960)
FORMER TANK PIT
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LAYOUT OF THE FORMER WESTWOOD RADIOACTVE MATERIAL DISPOSAL FACILITY
CARTOGRAPHER: B. JOYCE
APPROVED BY: G. NEMETH
DATE: 12-08-05
FIGURE: 2
Universal Transverse Mercator Projection – Zone 18, Geodetic Datum: North American 1983
WGS84 Ellipsoid, Measured in Survey Feet
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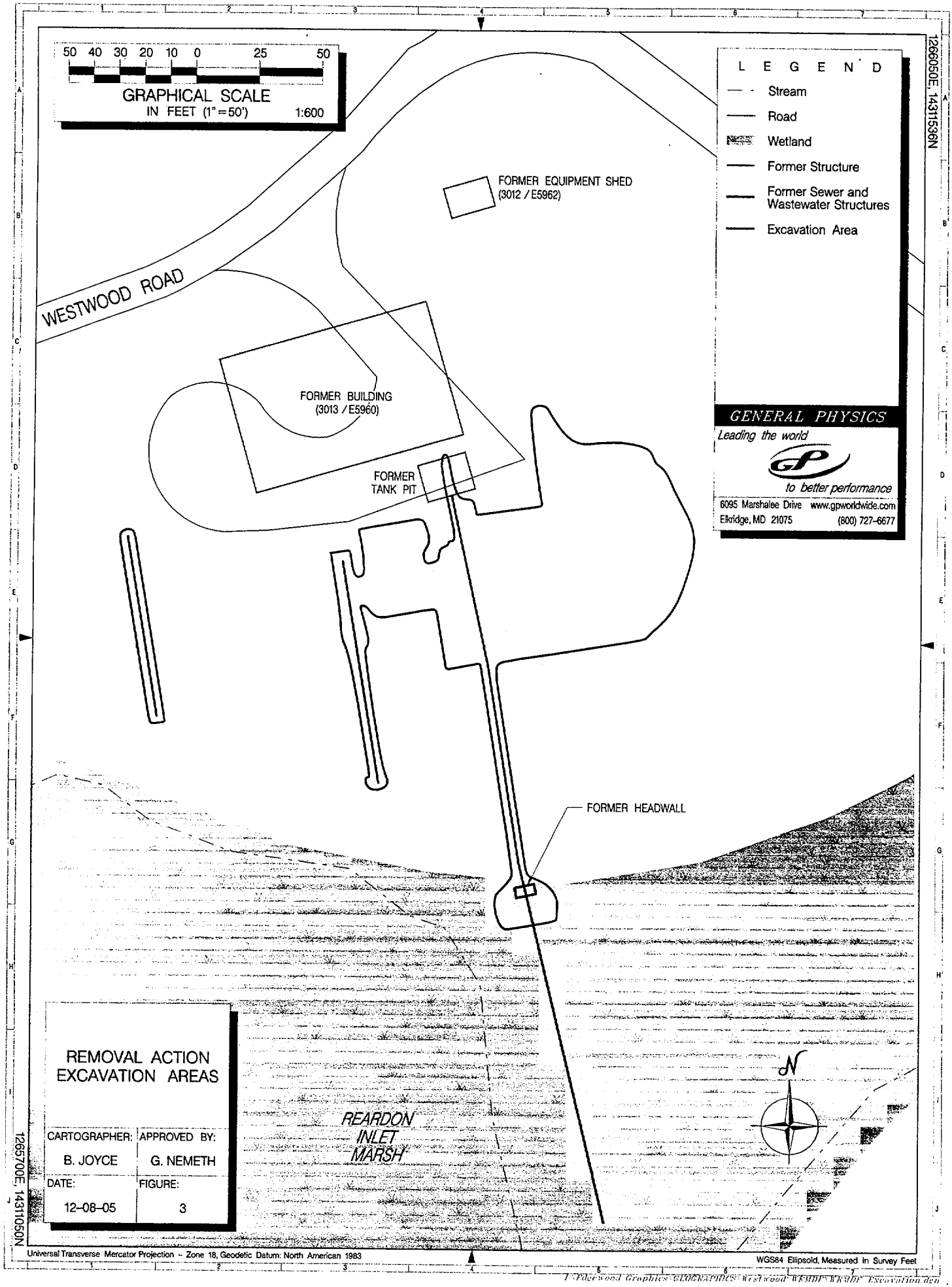

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REMOVAL ACTION EXCAVATION AREAS

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	G. NEMETH
DATE:	FIGURE:
12-08-05	3

Universal Transverse Mercator Projection – Zone 18, Geodetic Datum: North American 1983

WGS84 Ellipsoid, Measured In Survey Feet

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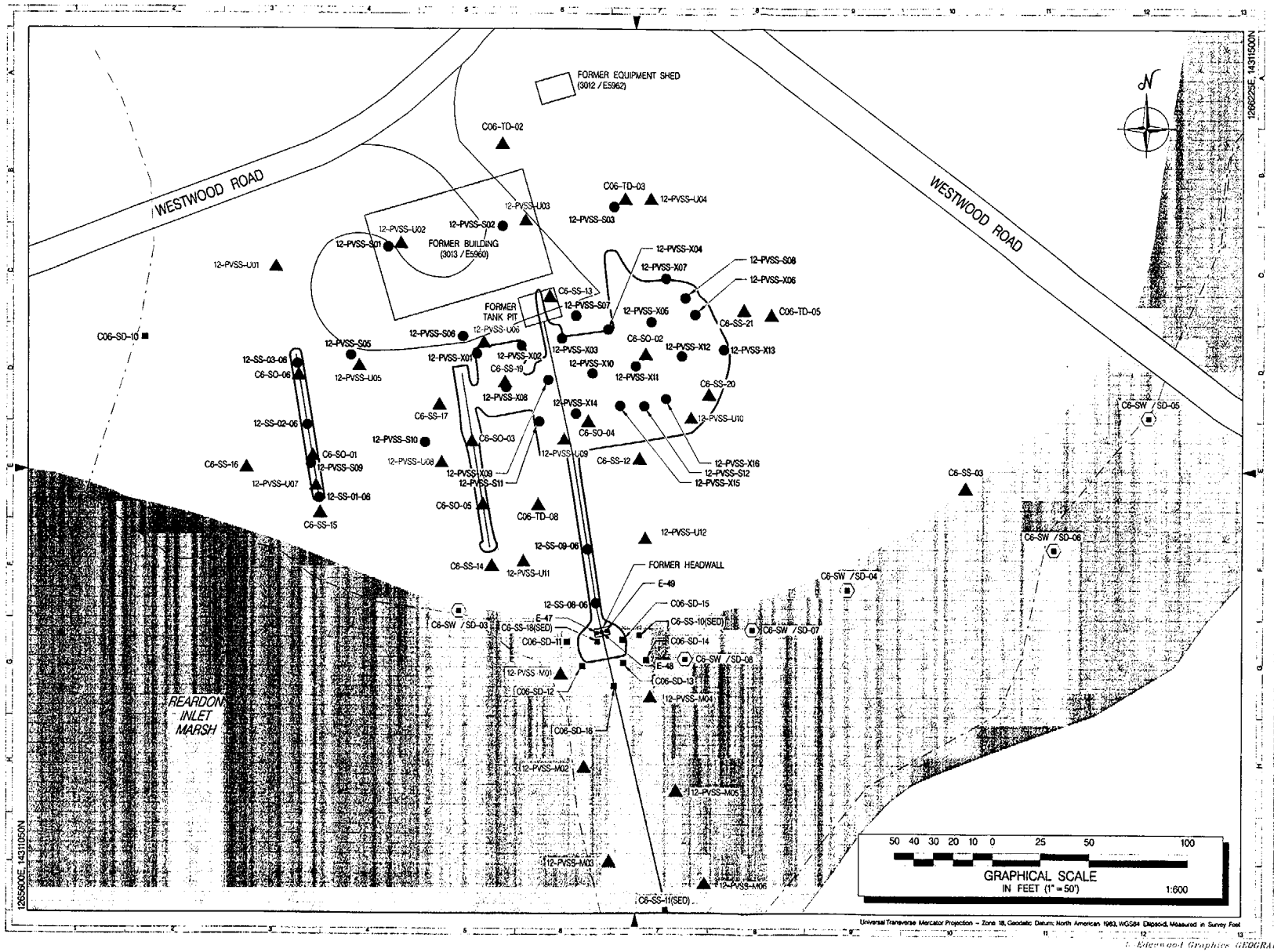

L E G E N D

- Stream
- Remediated Area
- Road
- Wetland
- Former Structure
- Former Sewer and Wastewater Structures
- Removal Action Verification Surface Soil Sample Locations
- RI Soil Sample Locations
- Removal Action Verification Subsurface Soil Sample Location
- RI Surface Water / Sediment Sample Location
- RI Sediment Sample Location
- FS Test Dig Subsurface Soil Sample Location
- FS Sediment Sample Location

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TITLE:

WESTWOOD STUDY AREA

WESTWOOD RADIOACTIVE MATERIAL DISPOSAL FACILITY SEDIMENT AND SOIL SAMPLING LOCATIONS

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	G. NEMETH
DATE:	FIGURE:
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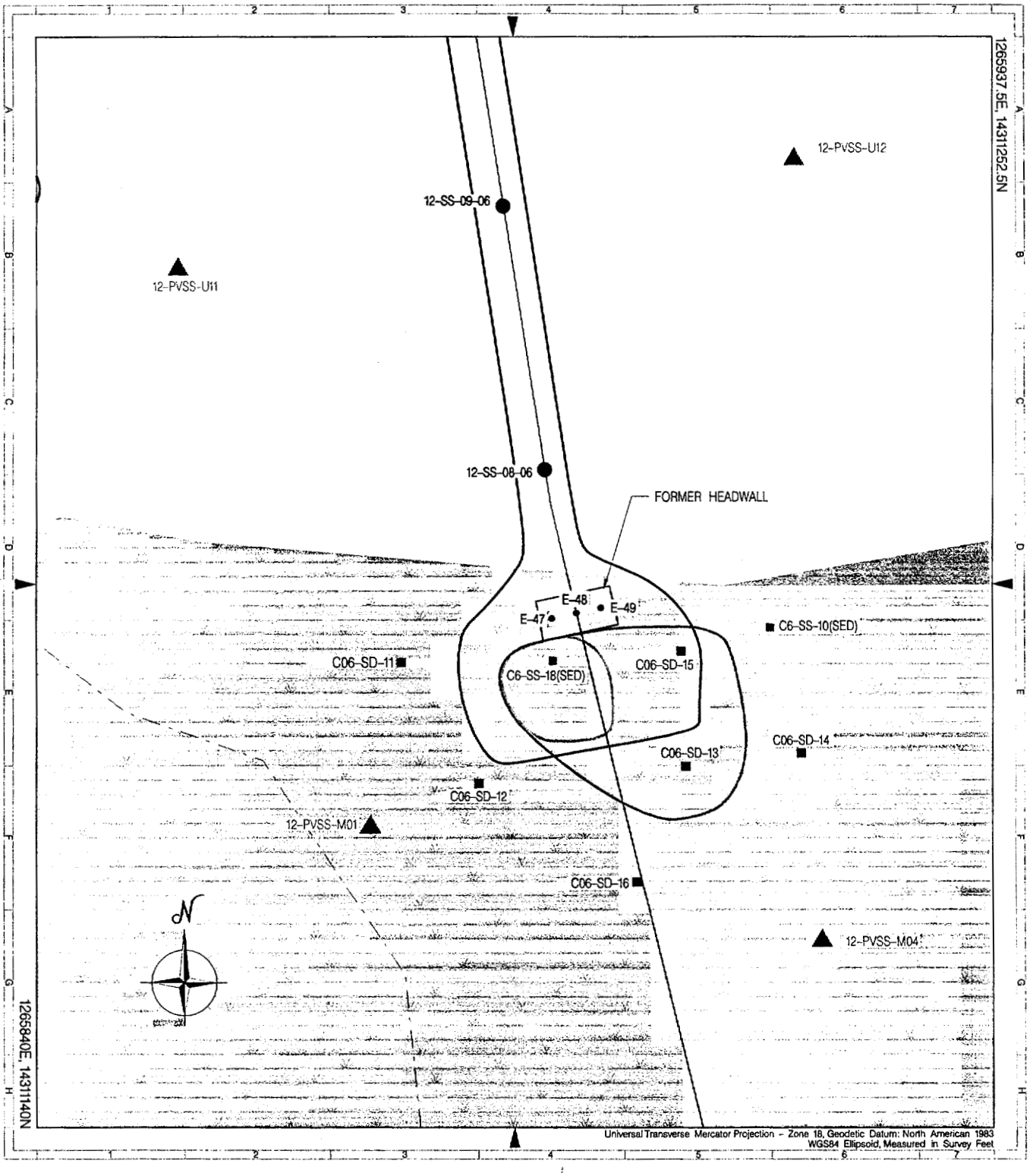

15 10 5 0 15 30

NOT TO SCALE

APPROXIMATELY 1" = 15' 1:180

- Stream
- Former Sewer and Wastewater Structures
- FS Sediment Sample Location
- Remediated Area
- Removal Action Verification Surface Soil Sample Locations
- Area of Subsurface Contamination
- Road
- Removal Action Verification Subsurface Soil Sample Location
- Area of Surface Contamination
- Wetland
- RI Sediment Sample Location

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TITLE:

RESIDUAL CS-137 IN HEADWALL AREA SEDIMENT

CARTOGRAPHER:	APPROVED BY:	DATE:	FIGURE:
B. JOYCE	G. NEMETH	12-08-05	5

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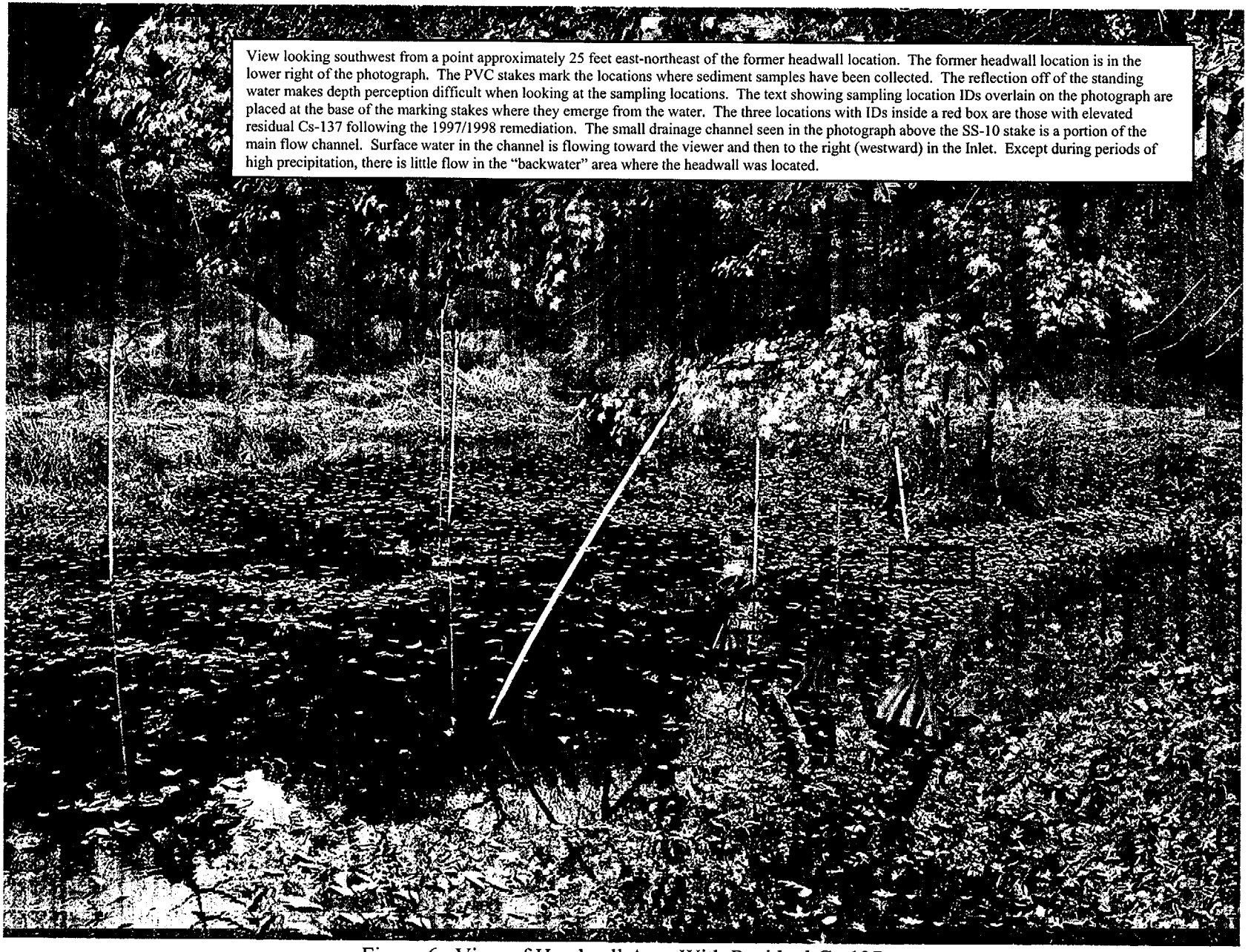

Figure 6. View of Headwall Area With Residual Cs-137

TABLES

Table 1. Westwood Radioactive Material Disposal Facility Post-Removal Action Cs-137 Activity Levels

Removal Action Verification Surface Soil 1998	
Sample Number	Activity (pCi/g)
12-PVSS-M01	<0.2
12-PVSS-M02	<0.2
12-PVSS-M03	0.2
12-PVSS-M04	<0.2
12-PVSS-M05	<0.1
12-PVSS-M06	<0.1
12-PVSS-U01	<0.2
12-PVSS-U02	0.13
12-PVSS-U03	1.1
12-PVSS-U04	1.2
12-PVSS-U05	<0.1
12-PVSS-U06	1.1
12-PVSS-U07	0.4
12-PVSS-U08	1
12-PVSS-U09	1.2
12-PVSS-U10	1.7
12-PVSS-U11	0.9
12-PVSS-U12	0.3
N	18
Maximum	1.7
Minimum	0.13

Removal Action Verification Subsurface Soil 1998	
Sample Number	Activity (pCi/g)**
12-PVSS-S01	<0.1
12-PVSS-S02	<0.1
12-PVSS-S03	<0.1
12-PVSS-S04	<0.1
12-PVSS-S05	<0.1
12-PVSS-S06	0.2
12-PVSS-S07	5.8
12-PVSS-S08	<0.1
12-PVSS-S09	<0.1
12-PVSS-S10	<0.1
12-PVSS-S11	<0.1
12-PVSS-S12	<0.1
12-PVSS-X01	1.3
12-PVSS-X02	4.6
12-PVSS-X03	7
12-PVSS-X04	6.4
12-PVSS-X05	1.8
12-PVSS-X06	4
12-PVSS-X07	6.2
12-PVSS-X08	4.8
12-PVSS-X09	6.7
12-PVSS-X10	4.4
12-PVSS-X11	3
12-PVSS-X12	4.2
12-PVSS-X13	1.3
12-PVSS-X14	0.3
12-PVSS-X15	2.4
12-PVSS-X16	3.6
12-SS-01-06	5.89
12-SS-02-06	0.105
12-SS-03-06	0.254
12-SS-04-06 (1')	1.08
12-SS-05-06 (1')	0.255
12-SS-06-06 (1')	0.28
E-47 (7')	1.21
E-48 (7')	0.87
E-49 (7')	3.29
E-52	1.5
E-53	6.59
N	39
Maximum	7
Minimum	0.105

Remedial Investigation Risk Assess Surface Soil & Sed January 2003	
Sample Number	Activity (pCi/g)
C06-SD-01	0.19
C06-SD-02	0.21
C06-SD-03	0.22
C06-SD-04	0.31
C06-SD-05	0.08
C06-SD-06	0.16
C06-SD-07	0.72
C06-SD-08	0.27
C06-SD-10**	ND
C06-SS-03	0.49
C06-SS-10 (0-6")	0.43
C06-SS-11 (0-6")	ND
C06-SS-12 (0-6")	0.5
C06-SS-13 (0-6")	0.11
C06-SS-14 (0-6")	4.09
C06-SS-15 (0-6")	0.44
C06-SS-16 (0-6")	0.59
C06-SS-17 (0-6")	0.65
C06-SS-18	**72.16**
C06-SS-19	0.25
C06-SS-20	4.87
C06-SS-21	0.6
C06-TD-05 (0-6")**	0.06
N	23
Maximum	72.16
Minimum	0.06

Remedial Investigation Risk Assess Subsurface Soil January 2003	
Sample Number	Activity (pCi/g)
C06-SO-01 (4')	0.06
C06-SO-02 (10')	ND
C06-SO-03 (7')	0.06
C06-SO-04 (4-6')	0.07
C06-SO-05 (6"-2')	1.47
C06-SO-06 (6"-2')	ND
C06-SS-10 (6"-2')	0.4
C06-SS-11 (6"-2')	0.18
C06-SS-12 (6"-2')	ND
C06-SS-13 (6"-2')	0.92
C06-SS-14 (6"-2')	1.59
C06-SS-15 (6"-2')	0.2
C06-SS-16 (6"-2')	0.12
C06-SS-17 (6"-2')	0.13
C06-TD-02 (1')**	0.07
C06-TD-03 (1')**	1.04
C06-TD-08 (2')**	ND
C06-TD-08 (2')**	ND
N	18
Maximum	1.59
Minimum	0.06

Feasibility Study Headwall Soil/Sediment November 2004	
Sample Number	Activity (pCi/g)**
C06-SD-11-1 (0-6")	0.74
C06-SD-11-2 (6"-2')	0.49
C06-SD-11-3 (2-4')	0.43
C06-SD-11-4 (4-6')	0.09
C06-SD-12-1 (0-6")	0.06
C06-SD-12-2 (6"-2')	ND
C06-SD-12-3 (2-4')	ND
C06-SD-12-4 (4-6')	ND
C06-SD-13-1 (0-6")	0.37
C06-SD-13-2 (6"-2')	0.35
C06-SD-13-3 (2-4')	**29.4**
C06-SD-13-4 (4-6')	3.21
C06-SD-14-1 (0-6")	0.26
C06-SD-14-2 (6"-2')	0.28
C06-SD-14-3 (2-4')	0.66
C06-SD-14-4 (4-6')	ND
C06-SD-15-1 (0-6")	0.91
C06-SD-15-2 (6"-2')	9.33
C06-SD-15-3 (2-4')	**95.5**
C06-SD-15-4 (4-6')	**66.3**
C06-SD-16-1 (0-6")	0.21
C06-SD-16-2 (6"-2')	0.29
C06-SD-16-3 (2-4')	0.15
C06-SD-16-4 (4-6')	0.27
C06-SS-10-1 (0-6")	0.38
C06-SS-10-2 (6"-2')	0.64
C06-SS-10-3 (2-4')	1.14
C06-SS-10-4 (4-6')	1.02
C06-SS-18-1 (0-6")	**189.4**
C06-SS-18-2 (6"-2')	**47.0**
C06-SS-18-3 (2-4')	**17.0**
C06-SS-18-4 (4-6')	1.87
N	32
Maximum	189.4
Minimum	0.06

** Not validated
ND = Non Detect
(7') = Depth below ground surface

APPENDIX A – RESRAD SUMMARY REPORT – Recreational Activity

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Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 MORBIDITY

Menu	Parameter	Current Value	Base Case*	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/l)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E-02	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E-02	1.000E+02	BIOFAC(1,2)

*Base Case means Default.lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	9.000E+00	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	6.100E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	1.310E+02	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (if different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	4.600E-03	4.600E+03	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	4.600E+03	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	4.600E+03	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.188E-04	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	1.140E+04	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	2.500E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.400E-04	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E-01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LF15
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LF16
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19E	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19E	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19E	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19E	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19E	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19E	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)
R19E	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19E	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19E	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19E	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19E	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19E	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19E	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19E	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19E	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19E	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	0.000E+00	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

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	suppressed
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	9.30 square meters	Cs-137	1.310E+02
Thickness:	0.61 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 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+03
TDOSE(t):	2.753E-02	2.690E-02	2.568E-02	2.182E-02	1.371E-02	2.698E-03	2.447E-05	0.000E+00
M(t):	1.101E-03	1.076E-03	1.027E-03	8.729E-04	5.486E-04	1.079E-04	9.788E-07	0.000E+00

Maximum TDOSE(t): 2.753E-02 mrem/yr at t = 0.000E+00 years

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.753E-02	1.0000	5.334E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.077E-07	0.0000
Total	2.753E-02	1.0000	5.334E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.077E-07	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.753E-02	1.0000
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	0.000E+00	0.0000	2.753E-02	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
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		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.690E-02	1.0000	5.212E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.006E-07	0.0000
Total	2.690E-02	1.0000	5.212E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.006E-07	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.690E-02	1.0000
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	0.000E+00	0.0000	2.690E-02	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.568E-02	1.0000	4.979E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.870E-07	0.0000
Total	2.568E-02	1.0000	4.979E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.870E-07	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.568E-02	1.0000
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	0.000E+00	0.0000	2.568E-02	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.182E-02	1.0000	4.229E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.439E-07	0.0000
Total	2.182E-02	1.0000	4.229E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.439E-07	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.182E-02	1.0000
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	0.000E+00	0.0000	2.182E-02	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.371E-02	1.0000	2.658E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.533E-07	0.0000
Total	1.371E-02	1.0000	2.658E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.533E-07	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	1.371E-02	1.0000
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	0.000E+00	0.0000	1.371E-02	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.698E-03	1.0000	5.280E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.017E-08	0.0000
Total	2.698E-03	1.0000	5.280E-09	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.017E-08	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.698E-03	1.0000
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	0.000E+00	0.0000	2.698E-03	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.447E-05	1.0000	5.027E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.900E-10	0.0000
Total	2.447E-05	1.0000	5.027E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.900E-10	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	0.000E+00	1.0000	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	2.447E-05	1.0000
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	0.000E+00	0.0000	2.447E-05	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	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	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	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	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

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	2.101E-04	2.053E-04	1.960E-04	1.666E-04	1.047E-04	2.059E-05	1.868E-07	0.000E+00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E-00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Cs-137	1.190E+05	1.218E-05	1.278E-05	1.501E-05	2.388E-05	1.214E+08	1.338E+08	*8.704E+13

*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

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Cs-137	1.310E+02	0.000E+00	2.101E-04	1.190E+05	2.101E-04	1.190E+05

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

Nuclide (j)	Parent (i)	THF(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	1.000E+03
Cs-137	Cs-137	1.000E+00	2.753E-02	2.690E-02	2.568E-02	2.182E-02	1.371E-02	2.698E-03	2.447E-05	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(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	1.000E+03
Cs-137	Cs-137	1.000E+00	1.310E+02	1.280E+02	1.222E-02	1.039E+02	6.527E+01	1.284E+01	1.165E-01	1.675E-08

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 0.61 seconds

APPENDIX B – RESRAD SUMMARY REPORT – Indoor Worker

(Fictional Scenario for a Cs-137 Hot Spot located in an upland area instead of a marsh.)

Summary : RESRAD Default Parameters Industrial Worker Scenario
File : IND_WORK default.RAD

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Summary : RESRAD Default Parameters Industrial Worker Scenario
File : IND_MORF default.RAD

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 12 MORBIDITY

Menu	Parameter	Current Value	Base Case*	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(1)
D-34	Food transfer factors:			
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(1,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(1,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(1,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(1,2)

*Base Case means Default.Lib w/o Associate Nuclide contributions.

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	9.300E+03	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	6.100E-01	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Cs-137	1.310E+02	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	not used	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	not used	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	not used	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	not used	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	not used	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	not used	2.000E-02	---	HGWT
R014	Saturated zone b parameter	not used	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	not used	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	not used	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	not used	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	not used	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
RC15	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
RC15	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
RC15	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
RC15	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
RC15	Unsat. zone 1, field capacity	not used	2.000E-01	---	FCUZ(1)
RC15	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
RC15	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
RC16	Distribution coefficients for Cs-137				
RC16	Contaminated zone (cm**3/g)	4.600E+03	4.600E+03	---	DCNUCC(1)
RC16	Unsaturated zone 1 (cm**3/g)	not used	4.600E+03	---	DCNUCU(1,1)
RC16	Saturated zone (cm**3/g)	not used	4.600E+03	---	DCNUCS(1)
RC16	Leach rate (/yr)	0.000E+00	0.000E+00	1.188E-04	ALEACH(1)
RC16	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
RC17	Inhalation rate (m**3/yr)	1.140E+04	8.400E+03	---	INHALR
RC17	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
RC17	Exposure duration	2.500E+01	3.000E+01	---	ED
RC17	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
RC17	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
RC17	Fraction of time spent indoors	1.500E-01	5.000E-01	---	FIND
RC17	Fraction of time spent outdoors (on site)	0.000E+00	2.500E-01	---	FOTD
RC17	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
RC17	Radii of shape factor array (used if FS = -1):				
RC17	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
RC17	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
RC17	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
RC17	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
RC17	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
RC17	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
RC17	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
RC17	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
RC17	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
RC17	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
RC17	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
RC17	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LF15
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LF16
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LW15
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LW16
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	not used	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
R19E	Wet weight crop yield for Non-Leafy (kg/m**2)	not used	7.000E-01	---	YV(1)
R19E	Wet weight crop yield for Leafy (kg/m**2)	not used	1.500E+00	---	YV(2)
R19E	Wet weight crop yield for Fodder (kg/m**2)	not used	1.100E+00	---	YV(3)
R19E	Growing Season for Non-Leafy (years)	not used	1.700E-01	---	TE(1)
R19E	Growing Season for Leafy (years)	not used	2.500E-01	---	TE(2)
R19E	Growing Season for Fodder (years)	not used	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19E	Translocation Factor for Non-Leafy	not used	1.000E-01	---	TIV(1)
R19E	Translocation Factor for Leafy	not used	1.000E+00	---	TIV(2)
R19E	Translocation Factor for Fodder	not used	1.000E+00	---	TIV(3)
R19E	Dry Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RDRY(1)
R19E	Dry Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RDRY(2)
R19E	Dry Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RDRY(3)
R19E	Wet Foliar Interception Fraction for Non-Leafy	not used	2.500E-01	---	RWET(1)
R19E	Wet Foliar Interception Fraction for Leafy	not used	2.500E-01	---	RWET(2)
R19E	Wet Foliar Interception Fraction for Fodder	not used	2.500E-01	---	RWET(3)
R19E	Weathering Removal Constant for Vegetation	not used	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	LCF correction factor for gaseous forms of C14	not used	0.000E+00	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

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	suppressed
Find peak pathway doses	active

Summary : RESRAD Default Parameters Industrial Worker Scenario
File : IND_WORK default.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	9.30 square meters	Cs-137	1.310E+02
Thickness:	0.61 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 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+03
TDOSE(t):	2.065E-01	2.017E-01	1.926E-01	1.637E-01	1.029E-01	2.023E-00	1.835E-02	0.000E+00
M(t):	8.259E-01	8.069E-01	7.703E-01	6.547E-01	4.114E-01	8.093E-02	7.341E-04	0.000E+00

Maximum TDOSE(t): 2.065E-01 mrem/yr at t = 0.000E+00 years

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.065E-01	1.0000	2.298E-05	0.0000	0.000E+00	0.0000	0.000E-00	0.0000	0.000E+00	0.0000	0.000E-00	0.0000	3.297E-04	0.0000
Total	2.065E+01	1.0000	2.298E-05	0.0000	0.000E+00	0.0000	0.000E-00	0.0000	0.000E+00	0.0000	0.000E-00	0.0000	3.297E-04	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.065E-01	1.0000
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	0.000E+00	0.0000	2.065E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
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		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.017E+01	1.0000	2.234E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.221E-04	0.0000
Total	2.017E+01	1.0000	2.234E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.221E-04	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.017E+01	1.0000
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	0.000E+00	0.0000	2.017E+01	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.926E+01	1.0000	2.152E-05	0.0000	0.000E-00	0.0000	0.000E-00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.075E-04	0.0000
Total	1.926E+01	1.0000	2.152E-05	0.0000	0.000E+00	0.0000	0.000E-00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.075E-04	0.0000

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

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	1.926E+01	1.0000
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	0.000E+00	0.0000	1.926E+01	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.637E+01	1.0000	1.812E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.615E-04	0.0000
Total	1.637E+01	1.0000	1.812E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.615E-04	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	1.637E+01	1.0000
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	0.000E+00	0.0000	1.637E+01	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.029E+01	1.0000	1.139E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.642E-04	0.0000
Total	1.029E+01	1.0000	1.139E-05	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.642E-04	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	1.029E+01	1.0000
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	0.000E+00	0.0000	1.029E+01	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	2.023E+00	1.0000	2.241E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.232E-05	0.0000
Total	2.023E+00	1.0000	2.241E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.232E-05	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	2.023E+00	1.0000
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	0.000E+00	0.0000	2.023E+00	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	1.835E-02	1.0000	2.154E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.107E-07	0.0000
Total	1.835E-02	1.0000	2.154E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.107E-07	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	0.000E+00	0.0000	1.835E-02	1.0000
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	0.000E+00	0.0000	1.835E-02	1.0000

*Sum of all water independent and dependent pathways.

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

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	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	0.000E+00	0.0000	0.000E+00	0.0000

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

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Cs-137	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	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	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

Parent (i)	Product (j)	Thread Fraction	DSR(j,t) At Time in Years (mrem/yr)/(pCi/g) 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Cs-137+D	Cs-137+D	1.000E+00	1.576E-01	1.540E-01	1.470E-01	1.249E-01	7.852E-02	1.544E-02	1.401E-04	0.000E-00

The DSR includes contributions from associated (half-life ≤ 180 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Cs-137	1.586E+02	1.624E+02	1.701E+02	2.001E+02	3.184E+02	1.619E+03	1.784E+05	*8.704E+13

*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

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Cs-137	1.310E+02	0.000E-00	1.576E-01	1.586E-02	1.576E-01	1.586E+02

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

Nuclide (j)	Parent (i)	THF(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	1.000E+03
Cs-137	Cs-137	1.000E+00	2.065E-01	2.017E-01	1.926E-01	1.637E-01	1.029E-01	2.023E-02	1.835E-02	0.000E+00

THF(i) is the thread fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	THF(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	1.000E+03
Cs-137	Cs-137	1.000E+00	1.310E+02	1.280E+02	1.222E-02	1.039E+02	6.527E+01	1.284E+01	1.295E-01	1.075E-08

THF(i) is the thread fraction of the parent nuclide.

RESCALC.EXE execution time = 0.64 seconds

This is to acknowledge the receipt of your letter/application dated

4/27/2006, and to inform you that the initial processing which includes an administrative review has been performed.

☑ ENVIRON. ASSESSMENT 19-10306-01
There were no administrative omissions. Your application was assigned to a technical reviewer. Please note that the technical review may identify additional omissions or require additional information.

☐ Please provide to this office within 30 days of your receipt of this card

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A copy of your action has been forwarded to our License Fee & Accounts Receivable Branch, who will contact you separately if there is a fee issue involved.

Your action has been assigned **Mail Control Number** 138798.
When calling to inquire about this action, please refer to this control number.
You may call us on (610) 337-5398, or 337-5260.

NRC FORM 532 (RI)
(6-96)

Sincerely,
Licensing Assistance Team Leader