

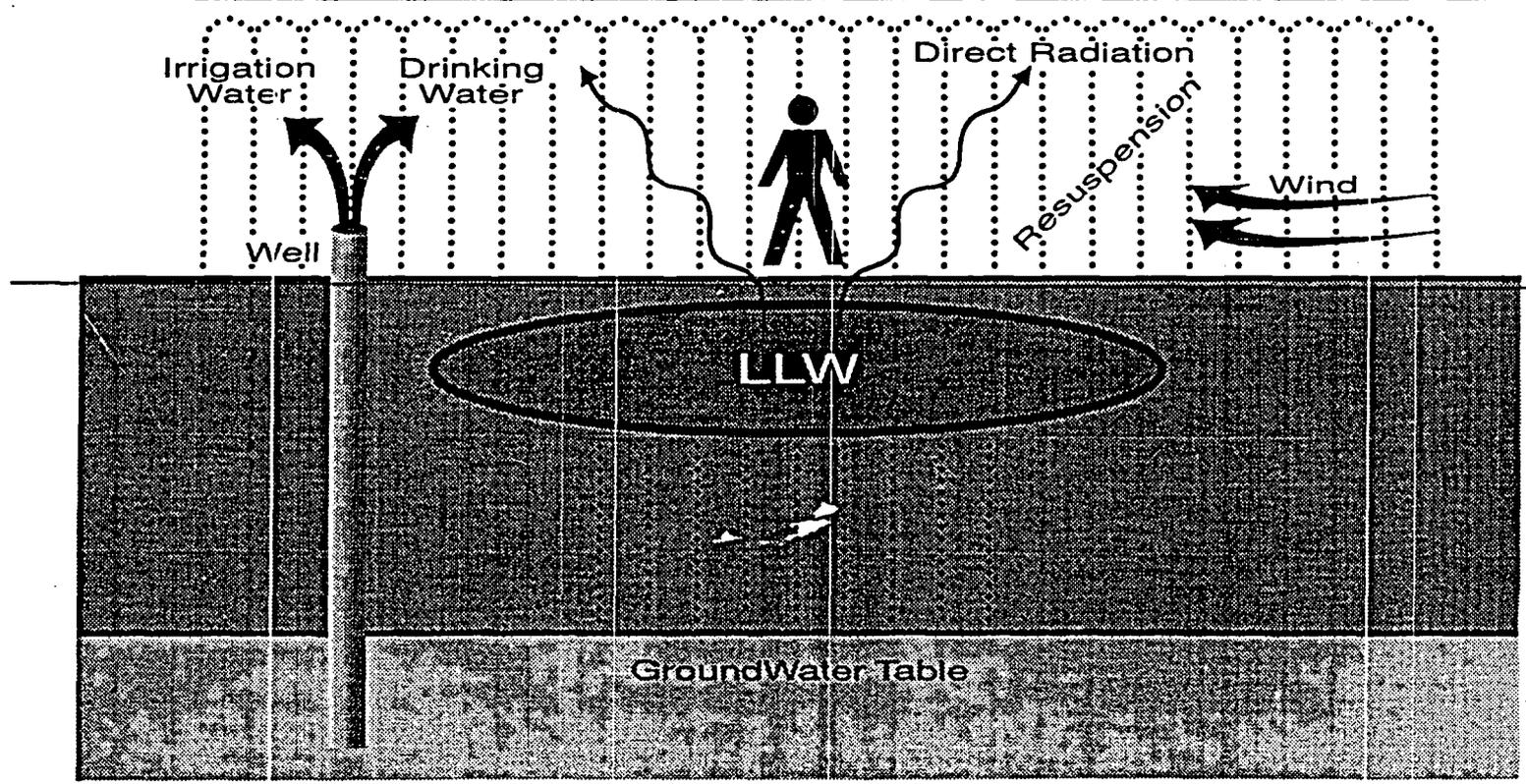


DISPOSAL OF SLIGHTLY CONTAMINATED RADIOACTIVE WASTE FROM NUCLEAR POWER PLANTS

U.S. Nuclear Regulatory Commission
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Exposure Pathways



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DISPOSAL OF SLIGHTLY CONTAMINATED RADIOACTIVE WASTES
FROM NUCLEAR POWER PLANTS

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ABSTRACT

Title 10 of the Code of Federal Regulations at Section 20.2001 provides four general alternatives for radioactive waste disposal: (1) transfer to an authorized recipient as provided in 20.2006, or in regulations Parts 30, 40, 60, 61, 70, or 72, or, (2) by decay in storage, (3) by release in effluent within the limits in 20.1301, or (4) as authorized under 20.2002, 20.2003, 20.2004, or 20.2005. With regard to the disposal of solid wastes, nuclear power plants basically have two options, viz., disposal in a Part 61 licensed low-level waste site, or receive approval pursuant to 20.2002 for disposal in a manner not otherwise authorized by the NRC. On February 24, 1983, the NRC staff published Information Notice No. 83-05, "Obtaining Approval for Disposing of Very-Low Level Radioactive Waste - 10 CFR Section 20.302." Since that time, the staff has reviewed and approved 30 requests for disposal of slightly contaminated radioactive materials pursuant to Section 20.2002 for nuclear power plants located in Non-agreement States. NRC Agreement States have been delegated the authority for reviewing and approving such disposals (whether onsite or offsite) for nuclear power plants within their borders. This paper describes the characteristics of the disposed wastes, the review process, and the staff's guidelines.

INTRODUCTION

NRC regulations, at 10 CFR Part 20.2002, authorize four general alternatives for nuclear power plant licensees to dispose of slightly contaminated radioactive wastes from nuclear power plants: (1) transfer to an authorized recipient as provided in 20.2006, or in regulations Parts 30, 40, 60, 61, 70, or 72, or, ~~(2) by decay in storage, (3) by release in effluent within the~~ limits in 20.1301, or (4) as authorized under 20.2002, 20.2003, 20.2004, or 20.2005. In February 1983, the NRC staff published Information Notice No. 83-05 entitled "Obtaining Approval for Disposing of Very-Low Level Radioactive Waste - 10 CFR Section 20.302." This Information Notice reminded nuclear power plant licensees that they could apply on a case-by-case basis for alternative methods for disposal of slightly contaminated radioactive materials (i.e., methods other than disposal at commercial wastes sites).

CHARACTERISTICS OF DISPOSED WASTES

During the past ten years, the NRC staff has reviewed and approved 30 requests for disposal of slightly contaminated radioactive materials from nuclear power plants (See Figure 1). Experience has shown that the review process can take from 2 weeks to 1 year depending on the completeness of the document. Table 1 contains a list of applications processed by the staff, as well as the general physical characteristics of the wastes. The types of waste disposed include the following slightly contaminated materials: soil, sand, sediment from onsite settling ponds, sewage sludge, wood, spent resins used for cleaning the secondary side of pressurized water reactors (PWRs), roofing materials, and scrap metal from feedwater heaters used in the secondary side of PWRs (See Figure 2). The principal nuclides in the disposed wastes are Co-58, Co-60, Cs-134, and Cs-137, with total activity concentrations in the range of about 1 to 50 pCi/g. Figure 3 shows the total activity (mCi) versus volume of disposed waste.

Disposal methods have included municipal landfills, on-site burial, and processing at a hazardous waste disposal site. Although most of the requests have been for a one-time disposal, the NRC staff has approved requests for disposal of limited quantities contaminated materials on a repetitive basis, e.g., annual disposals of slightly contaminated wood, and disposals of contaminated sewage sludges every 1-2 years. For these repetitive disposals, the licensee must reapply to the NRC when a particular disposal would exceed the boundary conditions imposed by the staff's analysis. (See Figure 4).

REGULATORY REVIEW PROCESS

Applications from reactor licensees located in non-Agreement States should be submitted to the Office of Nuclear Reactor Regulation (NRR). Under 10 CFR 20.2002, licensees may request disposal of specific material on a case-by-case basis or licensees may request permission for routine disposal of specific types of wastes on a repetitive basis using approved procedures and systems. ~~For disposal of radioactive materials in non-Agreement States, the application is reviewed solely by NRC. For disposal of radioactive material on or off the reactor site in an Agreement State, approval is needed from the Agreement State.~~

For offsite disposals, the licensing actions will be noticed in the Federal Register with at least a 30-day comment period. For onsite disposals, the licensing actions do not need to be noticed in the Federal Register unless there is a previously existing requirement for such notices, i.e., a Sholly Notice or 10 CFR 51. Licensing actions under 20.2002 do not remove material from regulatory control unless specifically so stated; these case-specific 20.2002 approvals are not currently subject to BRC policy.

Licensee submittals should identify and describe the waste, disposal site principal pathways of exposure, and the estimated dose to the maximally exposed individual from these pathways. The information regarding the waste for each planned request should include: (1) a brief description of the item to be disposed, including the approximate volume or mass; (2) identification of the principal nuclides expected to be in the waste; (3) estimates of the radionuclide concentrations in the waste; (4) estimates of the total activity of nuclides in the waste; and (5) the basis for the estimated concentrations and total activities (i.e., the number of samples measured, the representativeness of the samples, and the appropriateness of the instruments used to measure the activity in samples). Information regarding the disposal site should include: (1) the method of disposal (e.g., diluted with other sludge, burial in deep trenches, land spread and cover with "clean" soil, etc.); (2) the location of the disposal site (e.g., a legible map of the disposal site with compass direction and scale); (3) local land use (e.g., nearby residences, wells, etc.); (4) and physical or administrative barriers to prevent present and/or future use of the site for other than its intended purpose.*

*Note: For wastes containing mobile radionuclides (e.g., H-3), detailed information on geology and hydrology may be necessary.

The licensee's submittal should briefly discuss the potential pathways of exposure, and estimate doses to individuals from the principal pathways of exposure. Doses should be estimated for both a maximally exposed member of the public, and for a maximally non-occupationally exposed worker. If a particular pathway is not of concern (e.g., inhalation of resuspended radionuclides) then this should be stated and the basis for the statement provided (e.g., the nuclides are in an immobile form, the material is isolated from surface winds by several feet of earth cover, etc.) Pathways that are typically of concern include: 1) external exposure from standing or living above the disposal site; 2) inhalation of resuspended radionuclides if the radioactive material is not covered promptly or effectively; (3) external and internal exposure to an inadvertent intruder; (4) external and internal exposure of an individual from assumed recycling of the disposed material at the time the disposal site is released from regulatory control; (5) internal exposure from the ingestion of ground water; and (6) internal exposure from ingestion of food grown on the disposal site (See Figure 5).

DOSE GUIDELINES

In performing its safety evaluations of these licensee submittals, the staff of the Office of Nuclear Reactor Regulation (NRR) has developed radiation dose guidelines for use by NRR reviewers. Additional review guidelines¹ (Standard Review Plan and NUREG) are under development to ensure that potential radiation doses that may result from the proposed method of disposal are performed in a consistent manner. The waste to which these guidelines are intended to apply includes solid wastes from reactor facilities slightly contaminated with radionuclides with halflives less than 35 years. The staff reviews the licensee's waste stream description, radiological properties, and proposed disposal method, as well as radiological impacts, calculational methods, and assumptions to ensure that the public health and safety is adequately protected. The staff will request additional information from the licensee to further justify the acceptance of the assessment methodology.

The NRR guidelines were developed based on the following principles: first, the annual dose to a member of the public from exposure to the disposed material should be a small fraction of annual exposure to natural background radiation. Second, the annual dose to a member of the public from exposure to the disposed material should be no greater than the annual dose a maximally exposed individual would receive from exposure to radioactive effluents from normal operations at light water reactors. Third, concentrated sources of radioactivity that might pose a health hazard before or after the time of release of the disposal site from all regulatory controls should not be permitted to be disposed under 10 CFR 20.2002.

The NRR guidelines follow:

1. The radioactive material should be disposed in a manner such that it is unlikely that the material would be recycled.
2. Doses to the whole body and any body organ of a maximally exposed individual (~~a member of the general public or a non-occupationally exposed worker~~) from the probable pathways of exposure to the disposed material should be less than 1 mrem/yr.
3. Doses to the whole body and any body organ of an inadvertent intruder from the probable pathways of exposure should be less than 5 mrem/yr.

¹ NUREG-1101, "Onsite Disposal of Radioactive Waste", (Guidelines for Disposal by Subsurface Burial), Vol 1, November 1986.

NUREG-1101, "Onsite Disposal of Radioactive Waste", (Methodology for the Radiological Assessment of Disposal by Subsurface Burial), Vol 2, February 1987.

4. For onsite disposal, the dose to the whole body and any body organ of an individual from assumed recycling of the disposed material at the time the disposal site is released from regulatory control from all likely pathways of exposure should be less than 1 mrem/yr.
5. For disposal in a sanitary landfill, the dose to the whole body and any body organ of an individual from assumed recycling of the disposed material at the time of disposal from all likely pathways of exposure should be less than 5 mrem/yr.

In conclusion, as experience is gained with the use of these guidelines, the NRC staff will consider whether modification or clarifications are needed. The NRC staff believes that the use of 10 CFR 20.2002 for case-specific situations involving slightly contaminated radioactive wastes has been appropriate and any potential radiological impact on public health and safety or the environment has been minimized.

DISPOSAL of SLIGHTLY
CONTAMINATED RADIOACTIVE WASTES FROM NUCLEAR POWER PLANTS
PURSUANT TO 10 CFR 20.302
Table 1

Application Location	Date Rec	Date completed	Lic Tac	Waste Chars. (m ³)	Proposed Disposal	Nuclides Present	Total Act.	Pathways
San Onofre	7/16/81	9/24/81	50206	sand 300	onsite	Cs-137	0.2 mCi	APPROVAL: 1 mrem/yr whole body
Oyster Creek	10/12/82	11/16/82	50219	contaminated. soil 480	onsite	Co-60 Cs-137 Mn-54 Cs-134	5 mCi	APPROVAL; 3 mrem/yr whole body
DC Cook	2/29/88	8/30/88	67788	contaminated concrete, steam generator replacement 653	onsite	Co-60 Cs-134 Cs-137	0.1 mCi	APPROVAL: Insignificant impact because it involves pathways less significant than those considered in the FES.
Vermont Yankee	6/28/89	8/30/89	73766	septic waste 262	onsite	Co-60 Mn-54 Cs-137 Cs-134 Zn-65	0.2 mCi per acre	APPROVAL: 0.2 mrem/yr max. exposed individual/organ; 3.91 mrem/yr inadvertent intruder Licensee evaluation..
Yankee Rowe	4/11/90	5/17/90		sewage 200 once every 1 to 2 years for 30 years.	offsite	Co-60 Mn-54 Cs-134 Cs-137	0.2 mCi	APPROVAL; 0.12 mrem/yr maximally exposed individual/whole body (child), ground irradiation, inhalation, stored vegetable, leafy vegetables, milk ingestion.
Big Rock Point	12/29/89/	8/24/90	75589	dredging spoils 15 yr	onsite	Co-60 Mn-54 Cs-137 Cs-134 Sr-90	0.9 mCi	APPROVAL: 0.03 mrem/yr whole body dose received by maximally exposed individual. (groundshine, inhalati on, groundwater) & 0.857 mrem/10 yrs.
Palisades	11/12/87	3/21/91	67408	soil 170	onsite	Co-60 Cs-137	0.03 mCi	APPROVAL: <1 mrem/yr whole body dose received by maximally exposed individual (groundshine, inhalation, groundwater ingestion)

Application Location	Date Rec	Date completed	Lic Tac	Waste Chars. (m ³)	Proposed Disposal	Nuclides Present	Total Act.	Pathways
Maine Yankee	4/26/90	4/18/91	71250	Hazardous chemical solution 40	offsite	Co-60 Zn-65 Cs-137	0.1 mCi	APPROVAL; 0.1 mrem/yr (lung) inhalation resuspended activity/ingestion of crops grown onsite; 0.0064 mrem/yr (whole body) ingestion drinking water; 0.34 mrem/yr (whole body) direct radiation buried activity; 0.12 (whole body) direct radiation waste transportation; 0.005 (whole body) direct radiation waste handling.
Sequoyah	12/23/85	12/7/87	00179/80	trash 750	offsite		200 mCi	REJECTED: hi-level of specific activity of less than 2 nCi/gm, and total activity proposed per year of 200 mCi, are each orders of magnitude higher than similar parameters of any 20.302 proposal approved for offsite, also non-homogeneity of the trash
Fermi-2	5/26/87	3/14/88	65459	cont soil 850	onsite	Cr-51 Mn-54 Co-58 Co-60	0.3 mCi	APPROVAL: 0.044 mrem/yr whole body public water and fishing ingestion and shoreline sediments, 0.0674 mrem/yr direct exposure to contaminated soil, resuspension of soil into air: 0.3 mrem/yr direct exposure.
Kewaunee	9/12/89	6/17/92	75047	waste sludge 454	onsite	Co-60 Cs-137	0.2 mCi	APPROVAL; 0.034 mrem/yr (whole body) groundshine; 0.008 mrem/yr (whole body) inhalation; 0.007 mrem/yr (whole body) groundwater ingestion.
Brunswick	10/4/91	12/11/91	81827/25	dredging sediments, sand	onsite	Mn-54 Co-60 Cs-137		NON- APPROVAL: Meet NRC acceptance criteria, but the licensee is regulated by state. State approval is needed

Application Location	Date Rec	Date completed	Lic Tac	Waste Chars. (m ³)	Proposed Disposal	Nuclides Present	Total Act.	Pathways
Point Beach 1,2	10/8/87	1/13/88	65821/22	sewage sludge 113	onsite	Co-60 Cs-137	0.003 mCi	APPROVAL: Based on licensee pathway analysis and the licensed materials <3% of the primarily nuclides, already acceptable in the FES, site-specific application to be insignificant radiological impact.
Surry 1,2	11/26/86	4/9/87	64191/92	soil 300	onsite	Co-60 Cs-134 Cs-137 Mn-54	72	APPROVAL: Ground shine, inhalation dose breathing resuspended airborne radioactivity, and ingestion of radioactivity from contaminated water to maximally exposed member of the public <1 mrem/yr; inadvertent intruder <5 mrem/yr.
H.B. Robinson	2/10/83		40447	sediment 6,000	Fossil plant ash pond in licensee's controlled area	Co-68	75	APPROVAL: <5 mrem (teenager, total body of person working 400 hrs/yr above contaminated surface of soil cover zone.
H.B. Robinson	4/28/83		51347	Soil, 50 cu ft 1.5 cu meters	Onsite along the bottom of a drainage ditch	Co-58 Co-60 Co-134(10%) Cs-137(23%) Mn-54 all nuclides	0.014	APPROVAL: <5mrem (direct radiation whole body of person working 400 hrs/yr above contaminated surface of soil cover zone.
Humboldt Bay 3 Eureka, CA	10/27/83		52637	Sludge 1300 cu feet	Offsite RCRA chemical waste disposal landfill (Martinez, Calif.)	Co-60, Cs-134 Cs-137 Th-234	267.8 3.1 155 19.3	APPROVAL: 1.5 mrem (direct radiation to worker standing on uncovered dried sludge)

Application Location	Date Rec	Date completed	Lic Tac	Waste Chars. (m ³)	Proposed Disposal	Nuclides Present	Total Act.	Pathways
Oconee 1,2,3	1/31/85		55509 55510 55511	Sand 1500 cu ft 45 cu m	Onsite Company controlled area (outside security fence)	Cs-134 Cs-137 Co-60 Mn-54 all nuclides	1.2 3 0.1 0.005 <12.3	Approval <1mrem(ground shine to whole body, standing 2000 hrs on soil cover) <0.1 mrem (10 days inhalation of dust from disposal process <2mrem (future ingestion of crops grown on burial site, whole body or any organ.
Big Rock Point		5/8/86		Cont. soil leak in condensate process monitor	Onsite retain soil in place			APPROVAL
Davis Besse	3/11/85	10/15/85	52484	Secondary side resins 5,000 cu ft or 150 cu in every 5 yrs.	Offsite company owned	Co-58(34%) Co-60(3%) Cs-134(27%) Cs-134(34%)	8.5/ every 5 yrs.	APPROVAL: 0.7 mrem (direct rad standing on uncovered basin dredgings) Adult eating veg. grown on disposal site <3mrem (whole body) <4mrem highest dose to any organ <0.1 mrem (drinking ground water. (licensee estimate)
Oconee 1,2,3 Clemson, SC McGuire 1&2 Charlotte, NC Catawaba 1&2 York, SC	2/7/85		55056 55057 55058 55058 55058	Wood 400-700 cu ft 12-21 cu m	Offsite sanitary landfill	Assume Cs-137 100%	0.4 to 0.7 per yr per station	APPROVAL: <1 mrem (resident on decomm. landfill direct rad. whole body or any organ of adult eating veg. grown on soil cover) <0.1 mrem (nuclear station workers, direct rad. or inhalation).

FIGURE 1

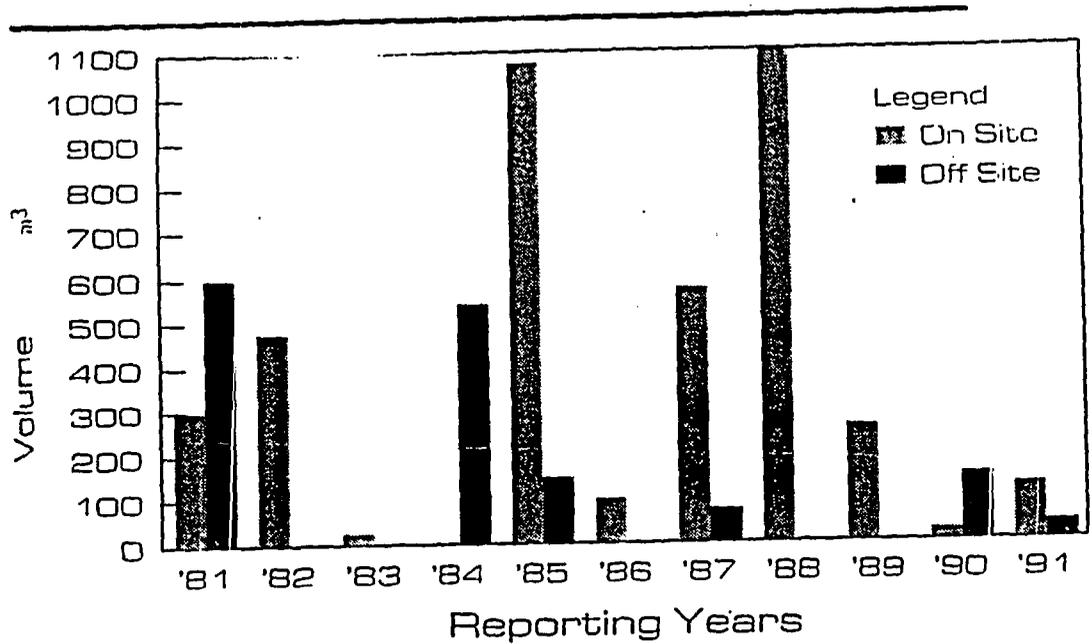


FIGURE 2

Characteristics of Disposed Wastes:

Others (wood, feedwater heater, dredging spoils, chemical soln, roofing material)

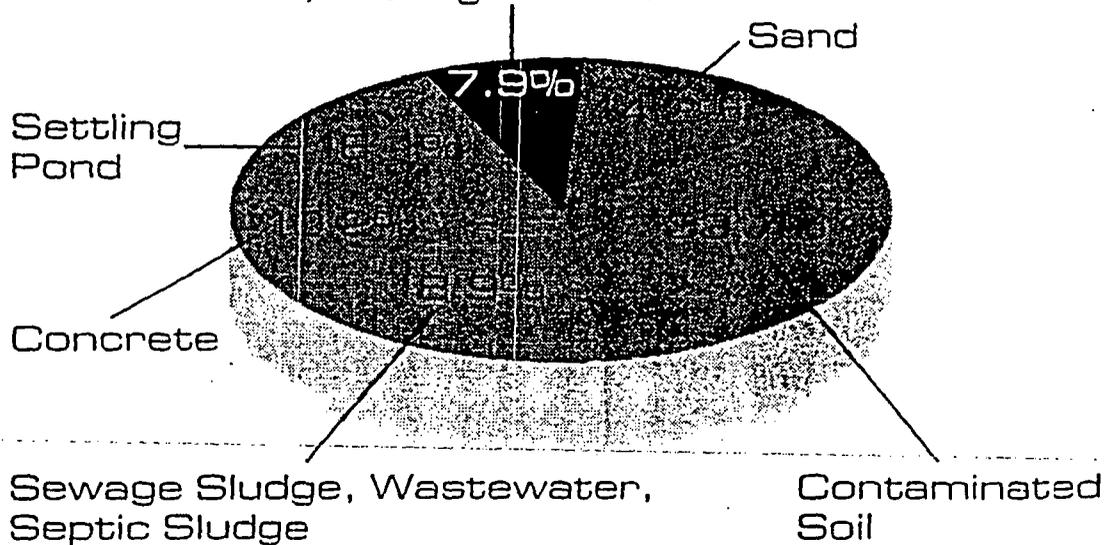


FIGURE 3

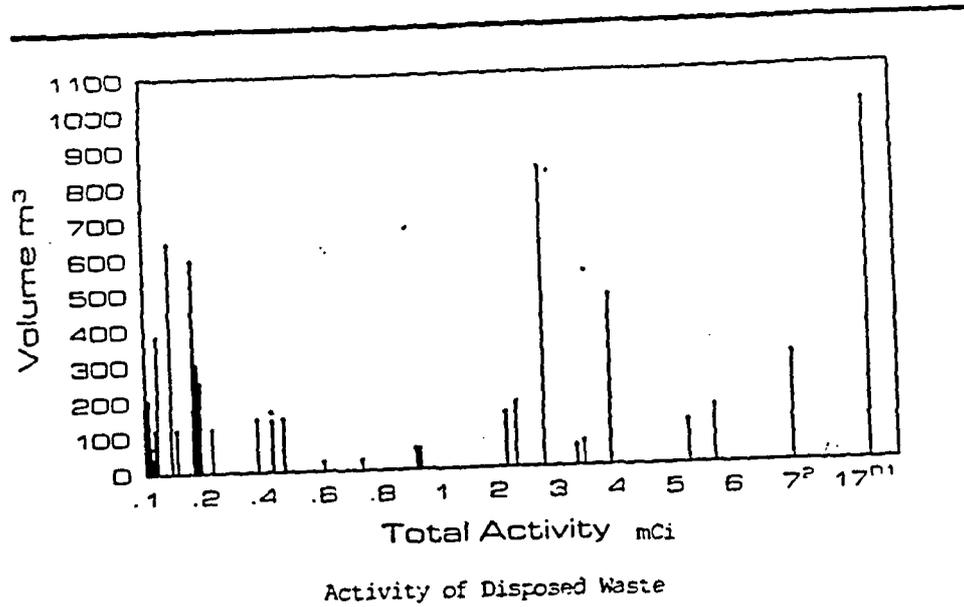


FIGURE 4

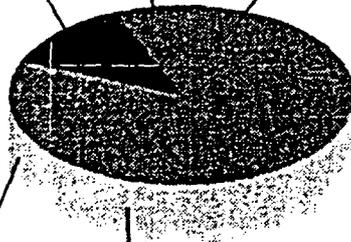
On Site Waste

Off Site Waste

Others (dredging spoils)
12.5%

Spent Resins
6.25%

Contaminated Soil,
Sand 50%

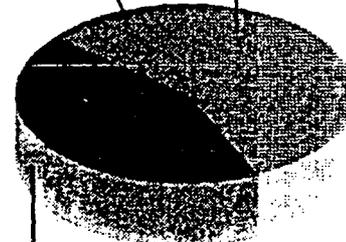


Sediment (settling ponds)
12.5%

Sludge, Concrete,
Feedwater Filters 18.75%

Contaminated Soil
14%

Sewage Sludge
43%

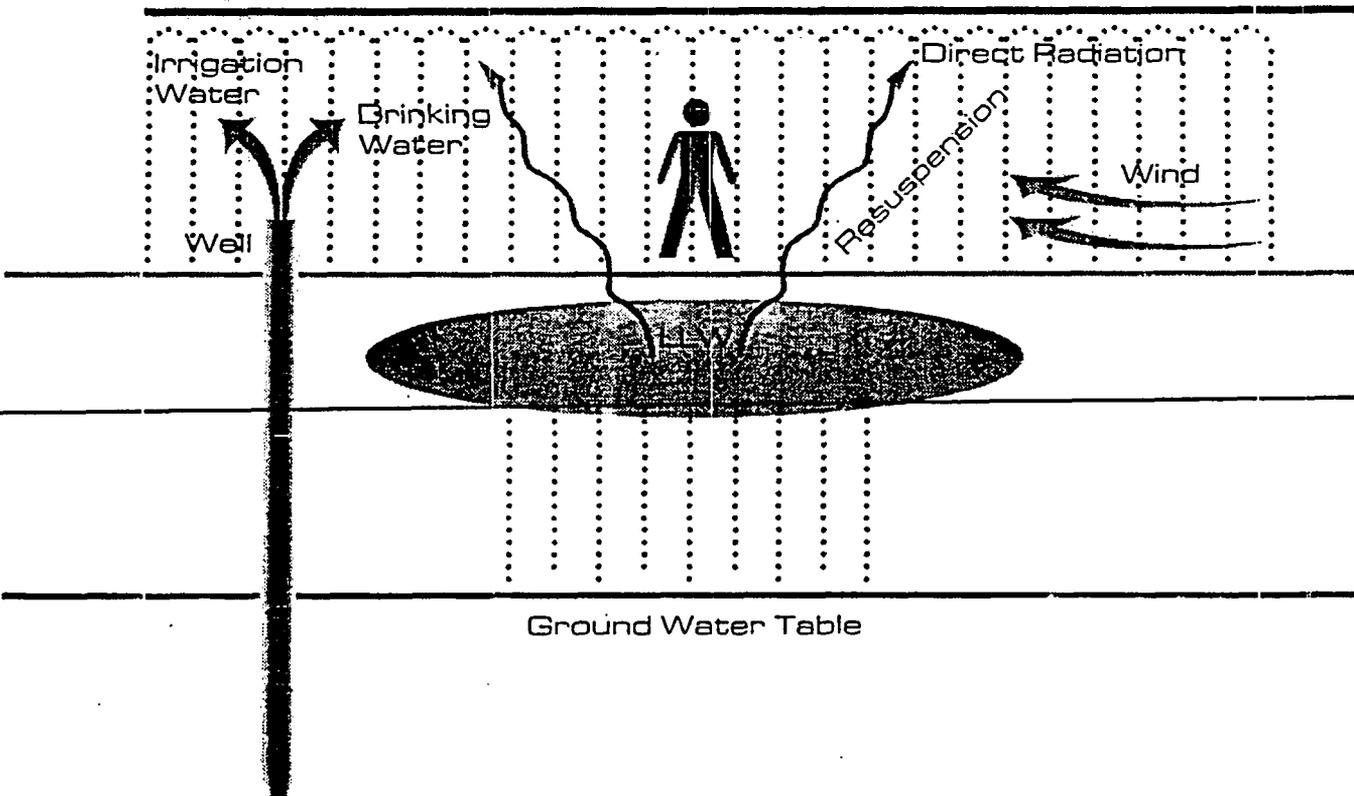


Others (wood, roofing
materials, chemical soln)
43%

The licensee's submittal should briefly discuss the potential pathways of exposure, and estimate doses to individuals from the principal pathways of exposure. Doses should be estimated for both a maximally exposed member of the public, and for a maximally non-occupationally exposed worker. If a particular pathway is not of concern (e.g., inhalation of resuspended radionuclides) then this should be stated and the basis for the statement provided (e.g., the nuclides are in an immobile form, the material is isolated from surface winds by several feet of earth cover, etc.) Pathways that are typically of concern include: (1) external exposure from standing or living above the disposal site (2) inhalation of resuspended radionuclides if the radioactive material is not covered promptly or effectively; (3) external and internal exposure to an inadvertent intruder; (4) external and internal exposure of an individual from assumed recycling of the disposed material at the time the disposal site is released from regulatory control; (5) internal exposure from the ingestion of ground water; and (6) internal exposure from ingestion of food grown on the disposal site (See Figure 5).

FIGURE 5

Exposure Pathways



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