Idaho National Engineering and Environmental Laboratory

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Application for the Risk-Based Storage of PCB Remediation Waste at the INEEL RWMC TSA-RE

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EXECUTIVE SUMMARY

This assessment discusses the PCB hazards present at the Idaho National Engineering and Environmental Laboratory (INEEL) Radioactive Waste Management Complex (RWMC) Transuranic Storage Area Retrieval Enclosure (TSA-RE); the various controls: natural, engineered and administrative that are in place to manage these hazards and minimize any potential risks; and the monitoring and surveillance activities that assure the aforementioned actions are indeed protective of the environment and the public and the worker. This assessment covers only the interim storage of polychlorinated biphenyls (PCBs). It does not address the risks associated with the planned retrieval and treatment. This assessment also includes a quantitative evaluation of potential impacts using very conservative and bounding assumptions. The results confirm that there will be no adverse effects to human health or the environment. Collectively, this qualitative and quantitative evaluation should provide the necessary information to enable the Environmental Protection Agency (EPA) to decide that the present storage configuration with associated controls in place does not and will not pose an unreasonable risk of injury to health or the environment.

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ACRONYMS

CERCLA	Comprehensive Environmental Restoration & Compensation Liability Act
CFR	Code of Federal Regulation
CH-TRU	Contact-handled transuranic
DOE	Department of Energy
DQO	Data Quality Objectives
EDF	Engineering design file
EPA	Environmental Protection Agency
FFA/CO	Federal Facility Agreement and Consent Order
FRP	Fiberglass reinforced plywood
INEEL	Idaho National Engineering and Environmental Laboratory
PCB	polychlorinated biphenyls
RE	Retrieval Enclosure
RWMC	Radioactive Waste Management Complex
RWMIS	Radioactive Waste Management Information System
TRU	Transuranic
TSA	Transuranic Storage Area
TSA-RE	Transuranic Storage Area – Retrieval Enclosure
TSA-RP	Transuranic Storage Area Retrieval Pad

1. INTRODUCTION

The Environmental Protection Agency (EPA) promulgated federal regulations in 40 Code of Federal Regulations (CFR) 761.61(c) effective on August 28, 1998, that allowed for risk-based storage of PCB remediation waste. Those regulations state that any person wishing to store PCB remediation waste in a manner other than prescribed in 40 CFR 761.65, must apply in writing to the EPA Regional Administrator in the region where the site is located. The regulations further state that EPA will issue a written decision on each application for a risk-based storage method for PCB remediation wastes. EPA will approve such an application if it finds that the method will not pose an unreasonable risk of injury to health or the environment. The following information constitutes the risk-based application for the continued storage of PCB remediation waste at the Idaho National Engineering and Environmental Laboratory (INEEL) Radioactive Waste Management Complex (RWMC) Transuranic Storage Area – Retrieval Enclosure (TSA-RE).

2. SITE OVERVIEW

Appendix A provides maps, drawings and photos showing the TSA-RE and its relationship to other facilities. Figure 1 is a map of the INEEL depicting the location of the RWMC. Figure 2 shows the facility location, boundaries and the relationship to other RWMC facilities. Figure 1 shows the location of cells TSA-1, 2, and R within the RE. Figure 2 is an example of TSA container stacking configuration. Drawing 155663 I.N.E.L. Transuranic Storage Area Pad No. 1 shows a composite layout of TSA-1. Drawing 418323 INEL Transuranic Storage Area Pad No. 2 shows a composite layout of TSA-2. Drawing 418322 INEL Transuranic Storage Area Retrieval Pad shows a composite layout of TSA-R. Photo 1 is an aerial view looking east to west before the TSA-RE was constructed. Photo 2 is a close-up of the earthen covered waste before the TSA-RE was constructed. Photo 3 is an aerial view looking east to west of the engineered structure. Photo 4 is a close-up of the TSA-RE looking north to south.

3. HISTORY OF PERTINENT SITE ACTIVITIES

Since 1970, transuranic (TRU) waste, as defined in DOE Order 5820.2A, *Radioactive Waste Management*, has been placed in retrievable storage at the RWMC under the premise that the waste will be retrieved and transported to a permanent repository. The TSA is an area within the RWMC, an operating waste management facility. The RWMC covers approximately 0.6 km^2 (144 acres) located near the southwest corner of the INEEL. Since 1970, contact-handled transuranic (CH-TRU) waste has been stored in containers on ground level asphalt pads within the TSA. This waste was primarily generated by operations conducted for DOE and its predecessors in support of defense programs. CH TRU is defined as containing > 100nCi/g of alpha emitting TRU radionuclides with a half life of > 20 years and having a container surface radiation level of ≤ 200 mR/hr.

The waste is located on three adjacent storage pads. On two of the asphalt pads (TSA-1 and TSA-2), the waste was placed in an assortment of containers that were stacked neatly and covered with a plywood cover, fabric and 0.9 to 1.2 m (3 to 4 feet) of soil. On the third pad (TSA-R) the waste containers were neatly stacked and some were covered with fabric only. The pads are divided into 14 sections referred to as cells.

The TSA-1/TSA-R waste pad storage appears as a mound of soil approximately 6.1 m (20 feet) high, 235 m (770 feet) long, relatively flat across the top for 46 m (150 feet), then sloping down to grade to the west at a 1 to 1 slope and to a shoring wall on the east at a height of 0.9 to 3.0 m (3 to 10 feet). The adjacent TSA-2 pad storage is 6.1m (20 feet) high, 74.4 m (244 feet) long by 45.7 m (150 feet) wide and merges at the top with the east side of the TSA-1 mound. The waste containers on TSA-1 and TSA-2 consist primarily of 208 liter (55-gallon) drums and fiberglass reinforced plywood (FRP) boxes. These containers are stacked approximately 4.9 m (16 feet) high and covered with plywood sheeting, plastic tarp, and 0.9 to 1.2 m (3 to 4 feet) of soil. The waste containers on the TSA-R consist principally of 208 l (55-gallon) drums, metal and FRP boxes, and metal bins. TSA-R Cell #1 is a unique configuration in that it contains 208 cargo containers stacked two high and loaded with 208 l (55-gallon) drums. Metal bins stacked two high form the perimeter of this cell. Also, Cell #1 is the only cell on TSA-R covered with soil; Cells #2 and #3 are covered only with a vinyl –coated geo-fabric tarp. The entire waste storage is divided into 14 cells, which are 45.7 m (150 feet) wide by 12 to 46 m (40 to 150 feet) long. Firebreaks, walls consisting of a meter or two (several feet) of soil, isolate each cell. TSA-1, TSA-2, and TSA-R contain waste placed on the storage pads from time frames 1970-1975, 1975-1980 and 1975 to approximately 1989 respectively.

In 1996, the retrieval enclosure (RE), an engineered metal building, approximately 29,100 m^2 (313,000 $ft^{2)}$ was constructed over the pads. The nominal size of the enclosure that extends over the TSA-R and TSA-1 pad areas is 61 m (200 ft) wide x 358 m (1,175 ft) long, with an average ceiling height of 9.1 to 10.7 m (30 to 35 ft). An adjacent 56 x 130 m (184 x 425 ft) annex extends over the TSA-2 pad. See Photos 3 and 4 in Appendix A.

4. SITE SPECIFIC OBJECTIVES

The purpose of this application is to provide necessary information to the Environmental Protection Agency to gain Agency concurrence for the risk-based storage of PCB remediation wastes as allowed under 40 CFR 761.61c. An analysis is provided herein of the PCB hazards present at the RWMC TSA-RE; the various controls: natural, engineered and administrative that are in place to manage these hazards and minimize any potential risks; and the monitoring and surveillance activities that assure the aforementioned actions are indeed protective of the environment and the public and the worker. This application also provides a quantitative evaluation of the potential risks to demonstrate confidence in the safety of the storage configuration. It is the objective of this application to provide the necessary information to enable the EPA to decide that the present storage configuration with associated controls in place does not and will not pose an unreasonable risk of injury to human health or the environment.

5. NATURE OF CONTAMINATION AND HAZARDS

The nature of contamination and hazards associated with the TSA-RE facility are the radioactive materials and the chemical hazardous materials. The waste types stored within the TSA-RE facility can be grouped into seven general categories:

- Construction material
- Laboratory equipment and material
- Process materials
- Process equipment
- Protective clothing
- Maintenance equipment

- Decontamination materials

These waste types are radioactively contaminated with five major nuclides. The isotopes and their associated decayed activity and mass are shown in the table below:

Table 1. Mass and specific activity for the RE dominant radionuclides.

Isotope	Decayed activity as of 2/93 (Curies)	Specific Activity (Curies per gram)	Mass (grams)
Am-241	71,824	3.43	20,940
Pu-238	48,640	17.11	2,843
Pu-239	32,120	0.062	518,064
Pu-240	7,860	0.227	34,626
Pu-241	128,880	102.96	1,252
	289,324		577,725

These same seven waste categories are also contaminated with non-radioactive hazardous constituents such as carbon tetrachloride, asbestos, lead, and PCBs. The contaminant of interest for this assessment is PCBs. EDF ENV-003 dated 2/5/90 "Hazardous Stored TRU Waste Source Term for the RWMC's TSA" provides additional details on the contaminants and their quantities. This document also specifies a maximum expected quantity of PCBs to be slightly less than 180,000 kg.

6. SITE CONCEPTUAL MODEL

The Radioactive Waste Management Information System (RWMIS) identifies 51,840 m^3 of waste stored in the TSA-RE facility. This can be represented in the site conceptual model by a 230 m (750 foot) long, 5 m (16 foot) high, 45 m (150 foot) wide volume of waste. The waste volume has a 1 m (3 foot) soil cover on all sides, and sits atop an asphalt pad, a 180 m (590 foot) vadose zone and a 76 m (250 foot) thick aquifer. The quantity of PCBs is 180,000 kg and for the purposes of this evaluation is assumed to be uniformly distributed throughout the entire waste volume and soil cover. Based on this assumption, the average PCB concentration is 2.75 mg/cc.

The net water infiltration rate for the INEEL is about 10 cm/yr. The conceptual model will use this same rate for the 26 years (1970 -> 1996) prior to the construction of the TSA-RE facility and will use 0.0 cm/yr for the next 24 years (1996 -> 2020) after the TSA-RE was installed.

7. DATA QUALITY OBJECTIVES

Will the PCBs stored in the TSA-RE pose an unacceptable risk (40 CFR 761.61(c)) to human health and the environment during the next 20 years? More specifically, will the continued storage of the PCBs in the TSA-RE result in soil contamination levels inside the confines of the TSA-RE building >

7.86* mg/g for a worker or 393 mg/g for a visitor in the next 20 years or groundwater contamination levels > 5.0 e-4 mg/l at any time?

$$\text{Soil Concentration (mg/g)} = \frac{TR * BW(kg) * AT(years) * 365 \text{ days/year}}{SF(kg\text{-}day/mg) * IR(g/day) * EF(days/year) * ED(years)}$$

Where:

TR = Target Risk
BW = Body Weight
AT = Averaging Time
SF = Slope Factor
IR = Ingestion Rate
EF = Exposure Frequency
ED = Exposure Duration

In this case, a conservative yet reasonable exposure scenario is a worker who performs a weekly inspection of the TSA-RE waste pad storage. This inspection would take less than 4 hours. He would perform this inspection 50 weeks out of the year (the other two weeks would be inspected by someone else) and would do this for the next twenty years. Based on this scenario the parameter values are as follows:

BW = 71.8 kg
AT = 75 years
SF = 4.0 kg-day/mg
IR = .025 g/day
EF = 50 days/year
ED = 20 years

If the target risk is 1×10^{-4} then the associated soil contamination concentration would be 7.86 mg/g.

In the case of a visitor, a conservative yet reasonable exposure scenario is a person who tours the facility twice a year, two hours at a time for twenty years. An auditor would fill such a scenario. Based on this scenario the parameter values would be as follows:

BW = 71.8 kg
AT = 75 years
SF = 4.0 kg-day/mg
IR = .0125 g/day
EF = 2 days/year
ED = 20 years

If the target risk were 1×10^{-4} then the associated soil contamination concentration would be 393 mg/g.

---

* Note the soil contamination limit was calculated using the same algorithm as the limit for remediation waste in the ASSESSMENT OF RISKS ASSOCIATED WITH THE PCB DISPOSAL AMENDMENTS prepared for the U.S. EPA by Versar, Inc. dated May 11, 1998. The difference is in the values selected for the various parameters.

Even though there is no reasonable scenario for drinking any contaminated water, in the interest of assuring protection of the groundwater resource, the same limit that is in the VERSAR document will be used: 5.0 E-4 mg/L, the Safe Drinking Water Act Maximum Contaminant Level for PCBs.

8. MEDIA OF CONCERN

Based on the two exposure scenarios to the worker and the visitor, the only viable media of concern is the surrounding soil. Due to the importance of the aquifer, the groundwater, although not part of any exposure scenario, is evaluated as a media of concern.

9. POTENTIALLY EXPOSED POPULATIONS

Due to the access control and the period of interest (the next 20 years) the only two potentially exposed populations are workers and visitors.

10. EXPOSURE PATHWAYS/SCENARIOS

Based on the worker/visitor exposure scenario, the only exposure pathways would be incidental soil ingestion and inhalation. Although not part of any exposure scenario, the groundwater pathway will be evaluated against the data quality objectives.

11. EXPOSURE ALGORITHMS AND ASSUMPTIONS

Standard EPA CERCLA algorithms for the incidental soil ingestion and inhalation with modification of select assumptions will be used. For example, only an occupation scenario is considered (children and residents are not evaluated); the exposure duration would be 20 years instead of 30 years (this is the period of interest); and the exposure frequency would be 50 days a year instead of 250 (this is more appropriate for the planned activities over the next 20 years).

Note: The visitor scenario would be similar to the worker but with greatly reduced exposures. For example, one might envision a visitor at the site looking at the TSA-RE a couple of times a year for each of the 20 years. The visitor would spend no more than 2 hours each time.

For the groundwater pathway, both the standard EPA CERCLA algorithms and parameter default values are used.

12. TOXICITY VALUES

The slope factor for ingestion used is 4.0 $(mg/kg\text{-}day)^{-1}$. Note: this value is from the ASSESSMENT OF RISKS ASSOCIATED WITH THE PCB DISPOSAL AMENDMENTS prepared for the U.S. EPA by Versar, Inc. dated May 11, 1998.

There is no slope factor for inhalation.

13. PREVENTIVE AND MITIGATIVE FEATURES

There are numerous preventive and mitigative features that ensure that the PCB hazard is being properly controlled and managed. The first item is that the RWMC receives the vast majority of its waste in a solid waste matrix. For waste forms like sludges, additives were added to sorb any residual moisture.

There are a few isolated cases where small quantities of liquid were placed in the middle of much larger containers. The second item is that the waste containers generally had a plastic or poly liner. The third item is the waste container itself. While there were several types: cargo containers; 30-, 55-, 83-gal drums; plywood boxes; metal M-III bins; FRP boxes; these waste containers, while intact, all provide additional barriers to prevent contact with or migration of the wastes. The next layer of protection is the vinyl coated geo-fabric tarp placed over the waste containers. This helps to prevent moisture from contacting the waste containers. The next barrier is the 3 to 4 feet of soil. The next item is the weather-tight engineered metal building. This prevents any moisture from coming into contact with the waste containers and eliminates any motive force for moving the contaminants. This building also provides protection from heavy snow loading and high winds. Yet another barrier is the underlying asphalt pad. This would help to retard any contaminants that did somehow escape the multiple barriers.

It is also appropriate to discuss the administrative controls that also perform preventive functions. For example access control, security, fire watch, monitoring and surveillance all contribute to the assurance that the wastes are being managed as expected. The administrative controls also minimize the potential for migration of contaminants and limit access (exposure) to the wastes. See Appendices B and C for more details on these programs.

All these collective features help to assure that the PCB waste will stay in place and any contaminant migration would be very limited for the foreseeable future.

14. QUALITATIVE RISK EVALUATION

There are three main components of any traditional determination of risk. The first is that there needs to be a hazard. As was identified above the TSA-RE has both radiological and chemical hazards. The focus of this application is the PCB contaminated waste although this discussion will apply to the other hazardous constituents as well. The second required component is there needs to be a receptor. Someone exposed or potentially exposed. In this case, due to natural barriers (remote site, arid environment, and large distance to the water table), the engineered barriers (the waste containers, the waste liners, the soil cover, the metal building, and the asphalt pad), and the administrative barriers (access control and security), the potential for someone to be exposed by any means to any PCB hazard at the TSA-RE is very small. The last component necessary for a risk to occur is there has to be a pathway/mechanism for the hazard to get to the receptor or for the receptor to get to the hazard. There are only three very unlikely mechanisms available. The first could be inadvertent intrusion. This is not considered plausible due to the access restrictions, security and other institutional controls. The second mechanism is a fire. Here again there are preventive measures depending upon the initiator. For instance, if the initiator is lightning, there is a lightning protection system for the building. In the case of a range fire, there is a defoliated buffer area, a metal building with a fire protection system as well as the waste being under 3 to 4 feet of soil. The last mechanism is a flood. Much work has been done in the last 15 years to improve the flood control measures at the RWMC. Further the worst case scenario of a Mackay Dam failure coupled with a worst case historical Big Lost River flood showed the maximum water level to be below the RE. See EGG-WM-9502 dated December 1990 "Hydrologic Modeling Study of Potential Flooding at the Subsurface Disposal Area from a Hypothetical Breach of Dike 2 at the Idaho National Engineering Laboratory", R. C. Martineau et al. Also the RWMC flood diversion system has been analyzed for rain-on-snow floods with an estimated return of up to 10,000 years. The elevation of the RE is above these flood levels as well. See Dames and Moore, March 29, 1993, "Flood Evaluation Study, Radioactive Waste Management Complex, Idaho National Engineering Laboratory." Appendix C provides additional information on the current flood control measures.

From this qualitative discussion of the key components of any risk assessment, any potential risk is negligible for the near term (twenty years).

15. QUANTITATIVE RISK EVALUATION

In order to provide some additional confidence in the results of the qualitative risk evaluation a conservative simplified quantitative risk evaluation is provided. This exercise is not intended to estimate the actual risk but to provide additional assurance that the data quality objectives (DQO) determined in the previous section will be met and therefore there will be no unacceptable risk posed by this interim storage.

15.1 Soil Ingestion Pathway Analysis

This evaluation is based on the site conceptual model described in the previous section. Two soil ingestion exposure scenarios are considered. The first is that of a worker: an occupational scenario. Standard CERCLA EPA algorithms and values are used with the following modifications. The exposure duration is 20 years, the period of interest, rather than the default value of 30 years. The frequency of exposure is one day a week, for four hours. This is to address the potential exposure during the four-hour weekly inspections. Body weight, soil ingestion rate, and averaging time are set at the EPA standard default values. The soil inhalation pathway, while a possibility, is not evaluated further due to the lack of an inhalation toxicity value.

The second scenario is that of a visitor, where someone might visit the TSA-RE a couple of times a year for each of the twenty years. Each visit would last two hours. All other parameters are set at the standard EPA default values.

For each of these two scenarios, there are defined acceptable soil concentration limits of < 7.86 mg/g for the worker and < 393 mg/g for the visitor. See the DQO section for derivation of these limits.

The first step involves making some very conservative and simplifying assumptions to determine the need to evaluate the situation more robustly. The assumption is that 100 % of the drums have failed completely and that the PCBs have homogeneously mixed throughout the waste volume and surrounding cover.

This is not a realistic possibility but bounds the actual situation.

For this example, we can then calculate an average soil concentration and compare it to the DQOs. If the number is less than the DQO for the worker, then a more rigorous evaluation is not needed. Also it is intuitively obvious that if the waste poses no unacceptable risk to the worker, the visitor will not be subjected to an unacceptable risk either since the soil concentration limit is 50 times higher.

$$\text{Soil Concentration mg/g} = \frac{\text{kg of PCBs} \times 10^6 \text{ mg/kg}}{\text{m}^3 \text{ of waste + cover} \times 10^6 \text{ cm}^3/\text{m}^3 \times \text{soil density g/cm}^3}$$

where:

kg of PCBs	= 180,000 kg
m^3 of waste + cover	= 232 m long x 6 m high x 48 m wide = 66816 m^3
soil density g/cm^3	= 1.5 g/cm^3

therefore:

Soil Concentration mg/g = 1.8 mg/g

Even with the very conservative container failure numbers and subsequent mixing, this soil concentration number is still over 4 times lower than the DQO for the worker. As such, no additional evaluation of the soil pathway is needed.

15.2 Groundwater Pathway Analysis

As stated before, there really isn't a likely groundwater exposure route, but to provide additional assurance, a conservative analysis of the potential impacts to the groundwater is provided. The computational tool chosen for the groundwater pathway is GWSCREEN. GWSCREEN was developed for assessment of the groundwater pathway from leaching of radioactive and non-radioactive substances from surface or buried sources. The code was designed for implementation in the INEEL Federal Facility Agreement and Consent Order (FFA/CO) Track 1 and Track 2 assessment of Comprehensive Environmental Response, Compensation, and Liability Act sites identified as low probability hazard at the Idaho National Engineering and Environmental Laboratory. This is a groundwater risk-screening tool that has been used extensively during the past 8 years at the site.

The conceptual model used is as described in a previous section with the following modification. Since the code is unable to handle two different water infiltration rates, 5.2 cm/yr will be used. This rate is the average of 10 cm/yr for 26 years (the time prior to the TSA-RE, 1970 to 1996) and 0 cm/yr for 24 years (the time after the TSA-RE was constructed, 1996 to 2020). This rate is used for the entire simulation period that will run until the peak dose occurs. This is a conservative assumption since while the building is intact, the infiltration rate is zero.

Conservative and simplifying assumptions are made to determine if there is a need to evaluate this pathway more robustly. In this case, it is assumed that 100% of the drums have failed completely and that the PCBs have homogeneously mixed throughout the waste volume. Another assumption is that the unsaturated zone is 10% of the unsaturated basalt thickness. This is the INEEL FFA/CO Track 2 default value and accounts for the thickness of the interbeds. This also assumes that the travel time in the fractured basalt is instantaneous. The receptor is assumed to be at the downgradient edge of the waste volume. The standard EPA residential default values are used for frequency, duration and quantity of groundwater ingestion: 350 days, 30 years and 2 liters per day. Again, this is not a realistic possibility but will bound the actual situation.

Other key parameters in the model and for the simulation are the sorption coefficients in the source, the unsaturated zone and the aquifer; and the solubility limit. The Track 2 K_d default value for PCBs is 1,500 mL/g and for Aroclor –1254 it is 100 mL/g. At the INEEL, the aquifer K_d is assumed to be 1/25 of the source K_d for the aquifer. For this reason two cases are run: the first with a source and unsaturated K_d of 1,500 mL/g and an aquifer K_d of 60 mL/g. The second case is a source and unsaturated zone K_d of 100 mL/g and an aquifer K_d of 4 mL/g. The solubility limit for PCBs is 3.0E-02 mg/L as provided by "Basics of Pump-and-Treat Groundwater Remediation Technology" (EPA 1990).

Based on these inputs the results are as follows:

Table 2. TSA-RE PCB Groundwater Results.

Case TSA-RE-1	Case TSA-RE-2
Body Weight = 72 kg.	Body Weight = 72 kg.
Water Ingestion = 2 L/d	Water Ingestion = 2 L/d
Exposure Duration = 30 years	Exposure Duration = 30 years
Kd = 1500 ml/g	Kd = 100 ml/g
Kd aquifer = 60 ml/g	Kd aquifer = 4 ml/g
Solubility Limit = 3.1E-02 mg/L	Solubility Limit = 3.1E-02 mg/L
Exposure Frequency = 350 days/year	Exposure Frequency = 350 days/year
Initial Mass = 1.8E11 mg	Initial Mass = 1.8E11 mg
Slope Factor = 4.0 (mg/kg-day)-1	Slope Factor = 4.0 (mg/kg-day)-1
Peak Concentration = 2.487E-7 mg/L	Peak Concentration = 2.487E-7 mg/L
Time of Peak = 1.1E7 years	Time of Peak = 7.1E6 years

Note the peak concentration, 2.5 E-4 mg/L does not change. This is because the solubility limit has been reached.

Also, note that the peak concentration is ½ of the 5.0 E-4 mg/L data quality objective for groundwater. This result is acceptable even assuming very conservative and unrealistic modeling parameters. For this reason, no further evaluation is needed and the interim storage will not pose any groundwater risk.

16. CONCLUSIONS

While it is clear that there is a large quantity of hazardous materials being temporarily stored, it is also clear that there are adequate features both natural and manmade that assure that the storage poses no unreasonable risk of injury to health or the environment. Further, the quantitative evaluation of risk during the next 20 years confirms the adequacy of the storage configuration to protect the environment. Additionally there is also a surveillance and monitoring program that ensures that the system is being managed as planned during this interim period.

These collective actions and features assure that the wastes are being managed safely, that appropriate safeguards and monitoring are in place and that any impact to the worker, public, and the environment is unlikely. This satisfies the requirements presented in 40 CFR 761.61c for risk-based storage of PCB remediation waste.

17. REFERENCES

ASSESSMENT OF RISKS ASSOCIATED WITH THE PCB DISPOSAL AMENDMENTS prepared for the U.S. EPA by Versar, Inc. dated May 11, 1998.

Dames and Moore, March 29, 1993, "Flood Evaluation Study, Radioactive Waste Management Complex, Idaho National Engineering Laboratory",

DOE/ID-10389, Revision 6, January 1994 "Track 2 Sites: Guidance for Assessing Low Probability Hazard Sites at the INEL"

EDF ENV-003 dated 2/5/90 "Hazardous Stored TRU Waste Source Term for the RWMC's TSA"

EDF RWMC-604 dated 6/3/93 "Estimation of Polychlorinated Biphenyl (PCB) Contaminated Waste Stored in the Transuranic Storage Area (TSA)"

EDF RWMC-803, Rev. 3, dated 4/15/98 "Chemical Constituents in Transuranic Storage Area (TSA) Waste"

EGG-WM-9502 dated December 1990 "Hydrologic Modeling Study of Potential Flooding at the Subsurface Disposal Area from a Hypothetical Breach of Dike 2 at the Idaho National Engineering Laboratory", R. C. Martineau et al.

EPA, 1990, "Basics of Pump-and Treat Groundwater Remediation Technology", EPA/600/8-90/003, U. S. Environmental Protection Agency

INEEL/EXT-98-00750, Revision 1, February 1999 "GWSCREEN: A Semi-Analytical Model for Assessment of the Groundwater Pathway from Surface or Buried Contamination Theory and User's Manual Version 2.5" by A. S. Rood

INEL-95/0267 published October 1996 "Transuranic Storage Area Retrieval Enclosure Safety Analysis Report"

APPENDIX A

Maps, Drawings, Photos

Figure 1. Map of the INEEL depicting the location of the RWMC.

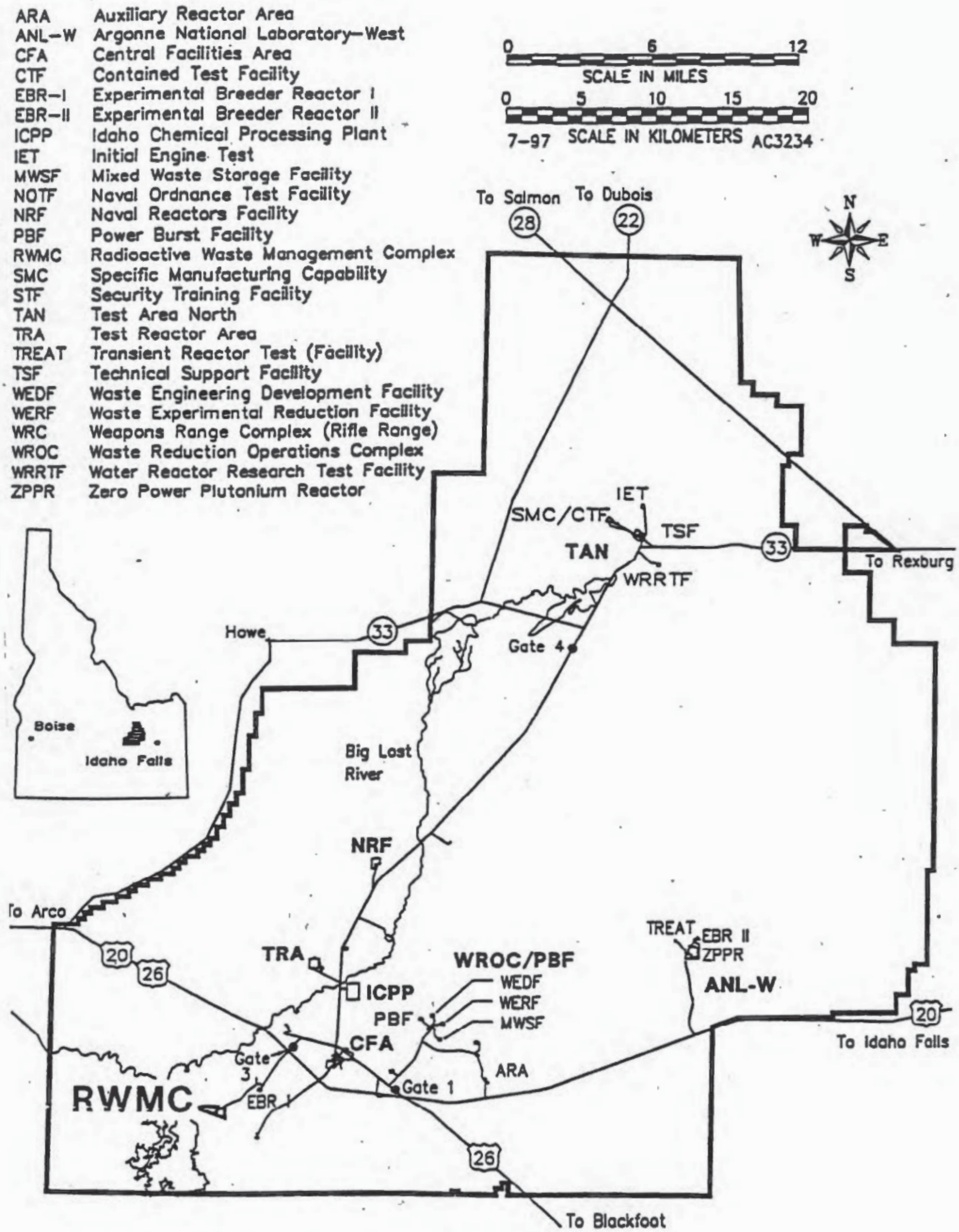


Figure 1. Map of the INEEL depicting the location of the RWMC.

Figure 2. Facility location, boundaries, and relationships to other facilities.

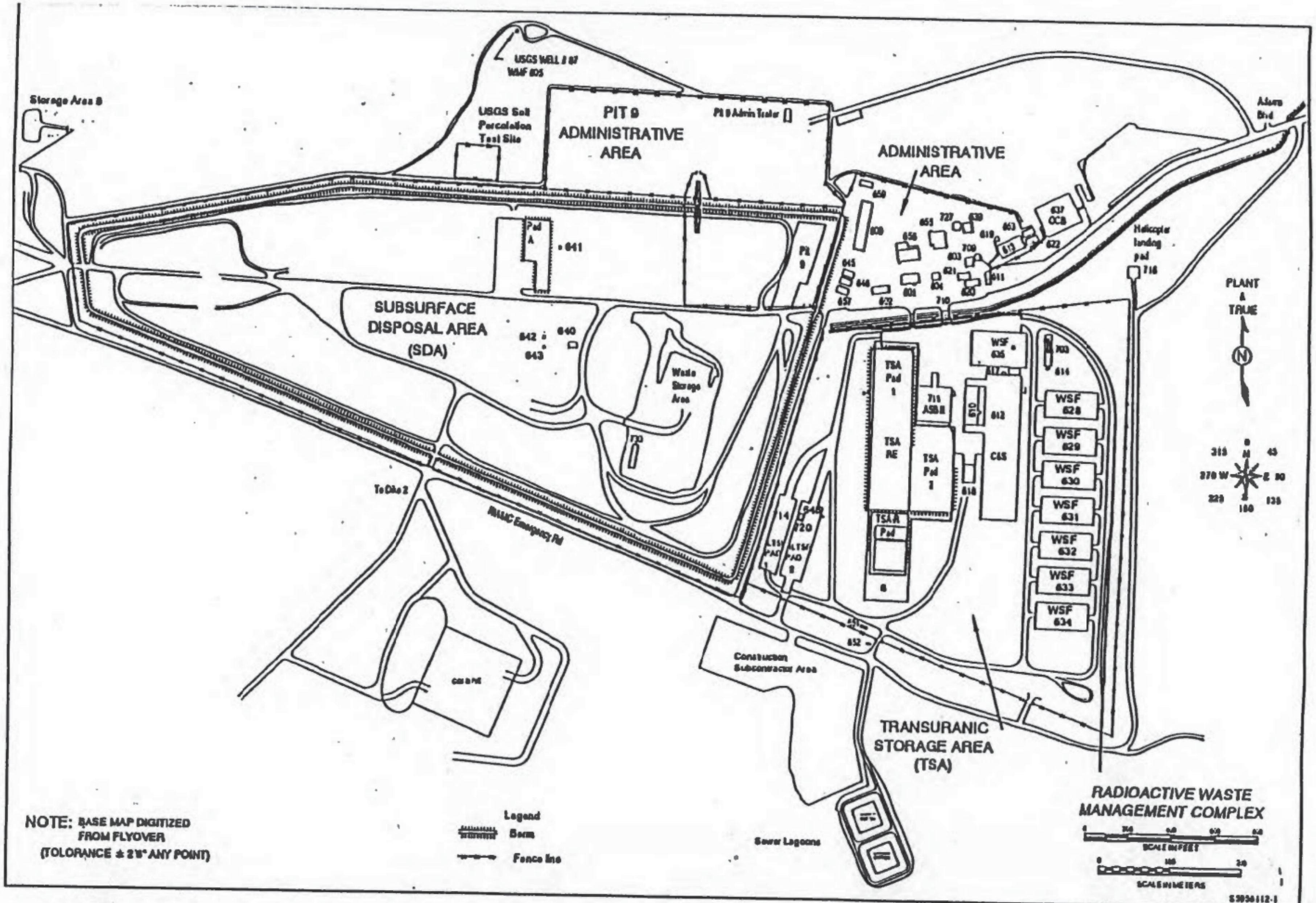


Figure 2. Facility location, boundaries, and relationships to other facilities.

Figure 3. Location of cells at TSA-1, 2, and R.

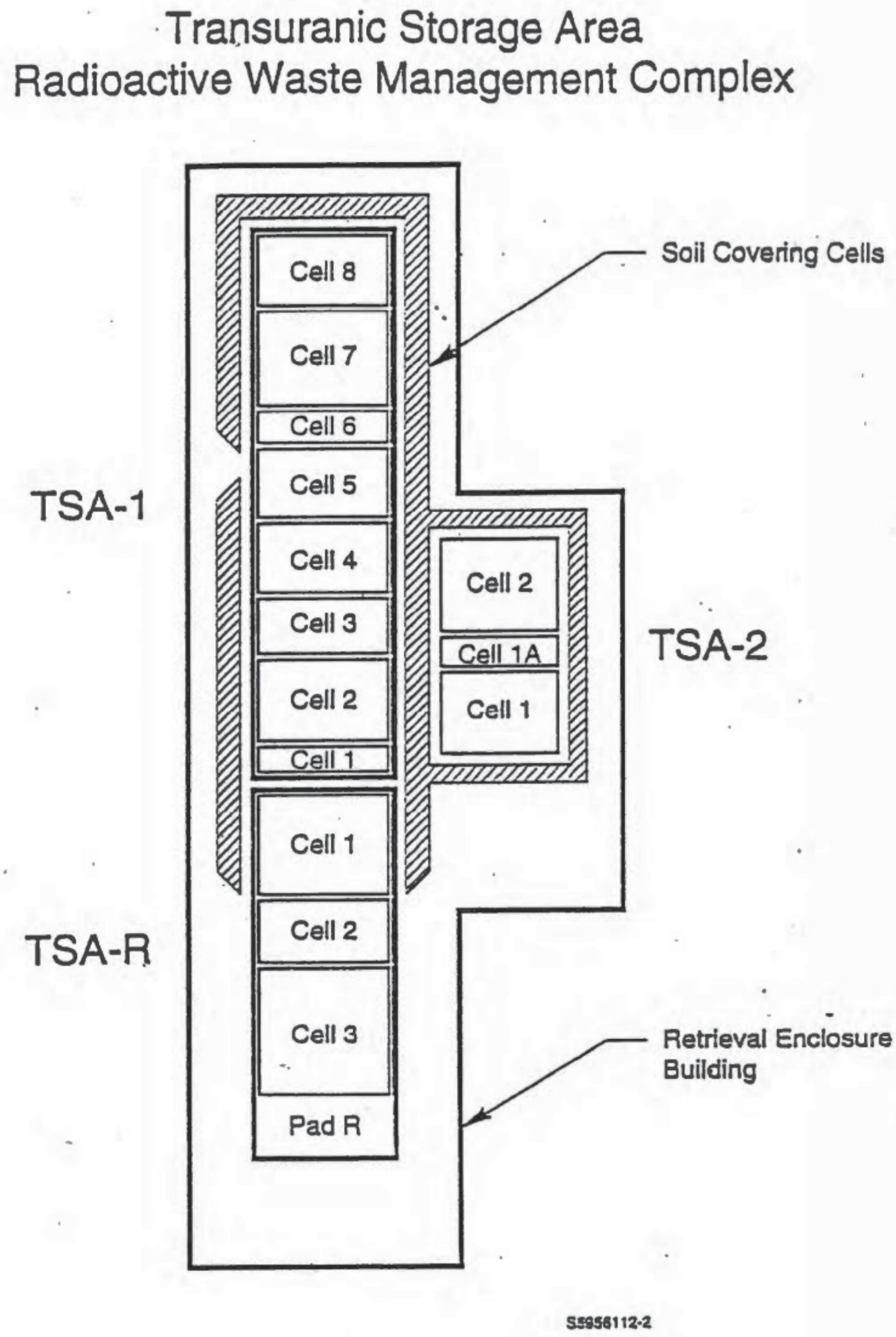


Figure 3. Location of cells at TSA-1, 2. and R.

Figure 4. An example of TSA container stacking configuration

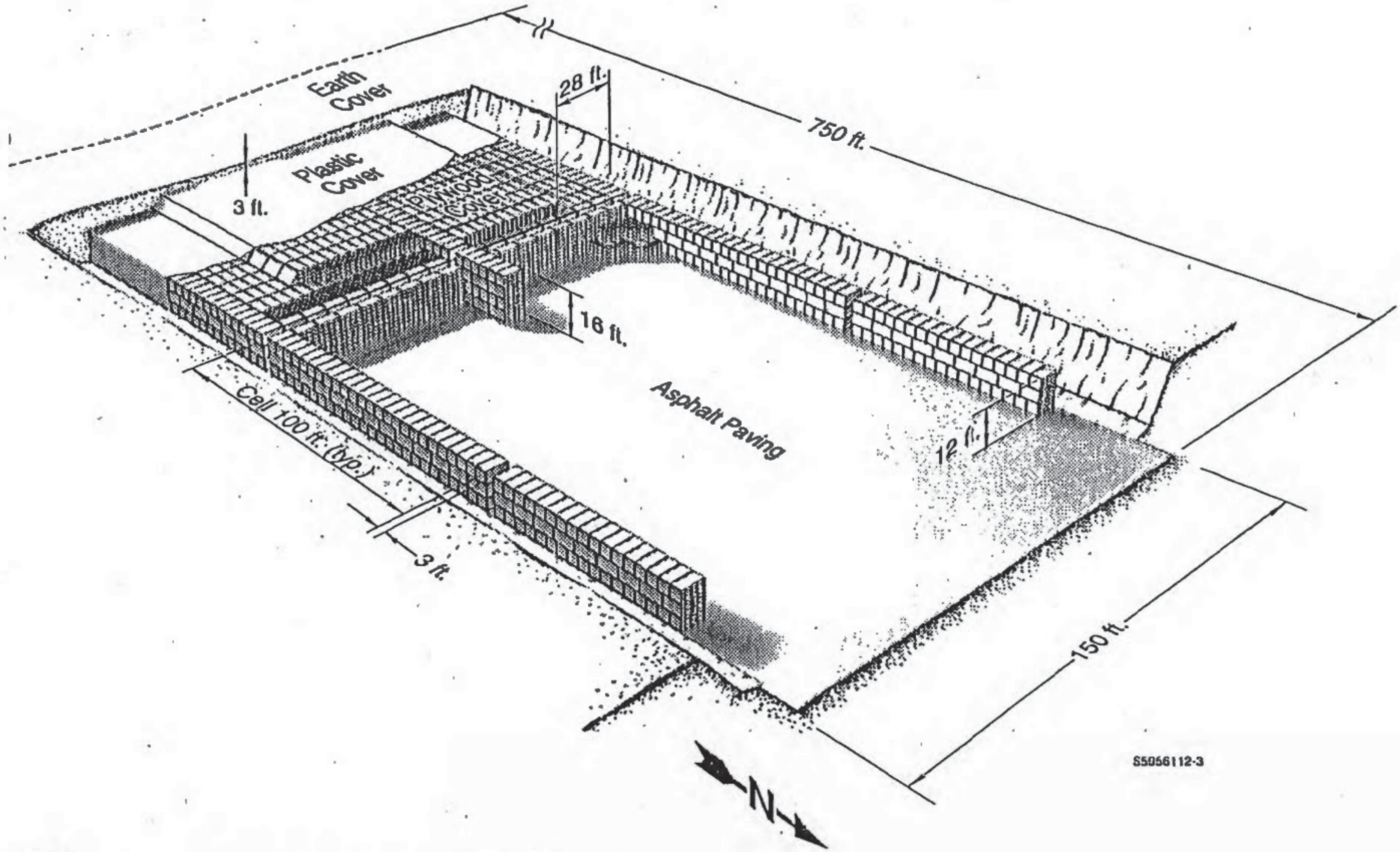
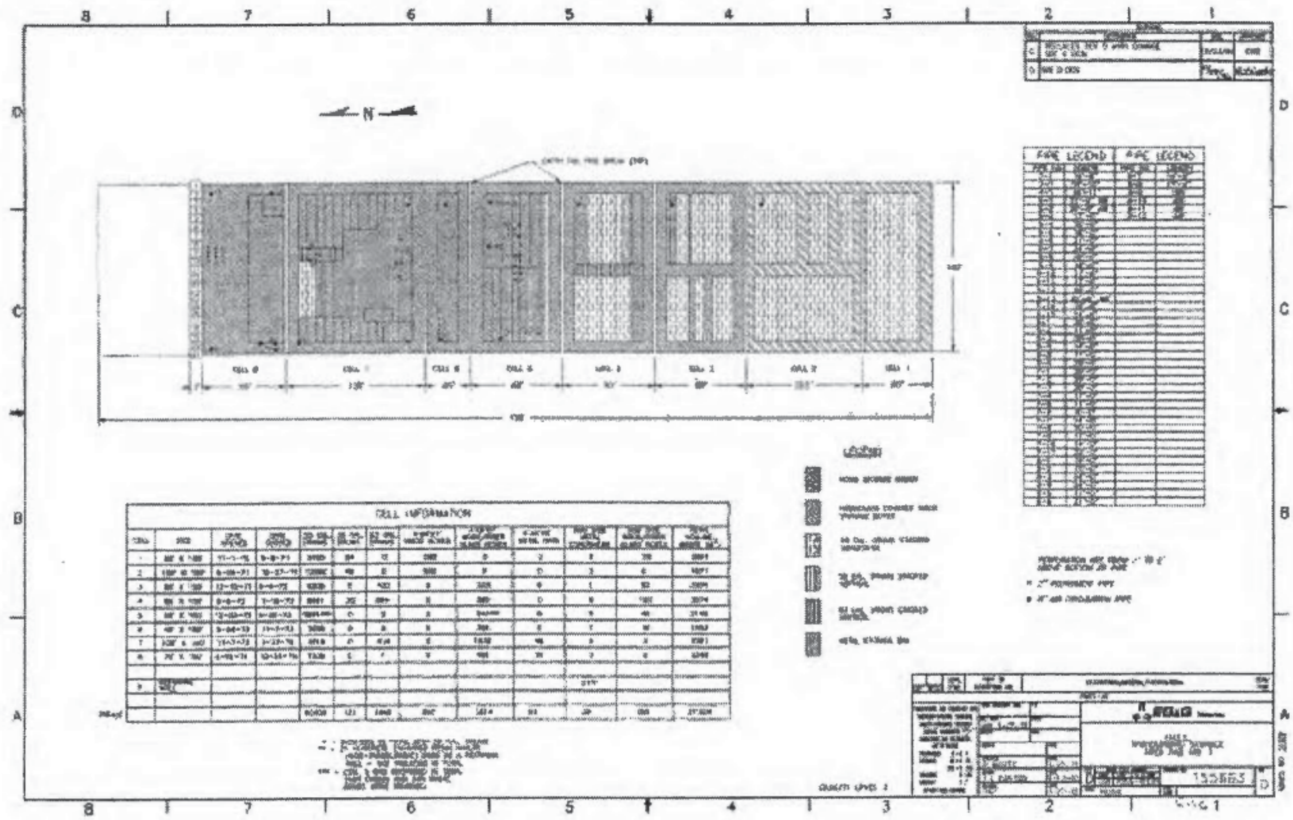
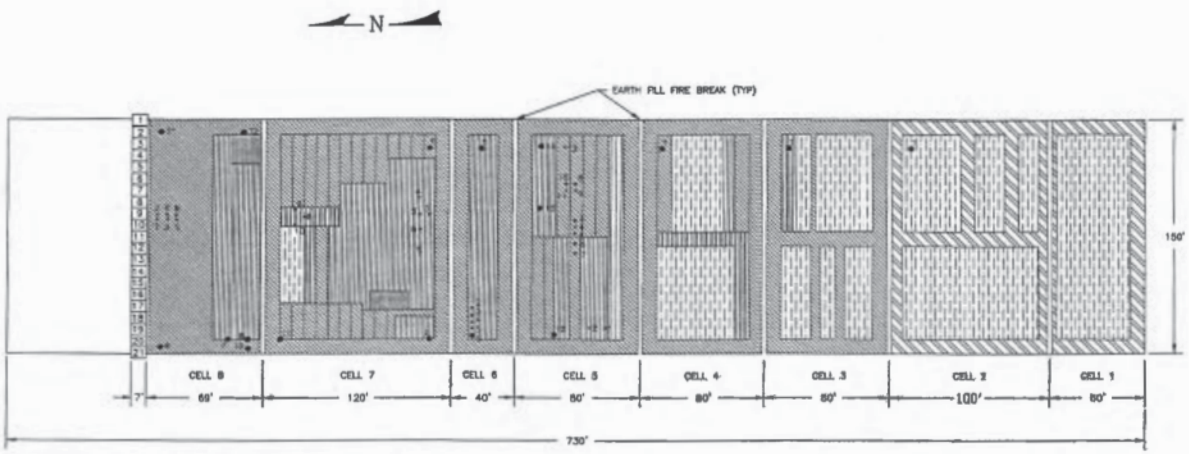


Figure 4. An example of TSA container stacking configuration.



Drawing 1. Composite layout of TSA-1, Drawing Number 155663.

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
C	REPLACES REV B WITH CHANGE SEE C DCN	10/23/90	GRB
D	SEE D DCN	10/29/90	



PIPE LEGEND		PIPE LEGEND	
PIPE NO.	LENGTH	PIPE NO.	LENGTH
2-1	19'-6"	8-7	14'-0"
3-1	19'-10"	8-8	17'-4"
4-1	18'-11"	8-9	AIR
5-1	17'-6" AIR	8-10	AIR
5-2	20'-0" AIR	8-11	AIR
5-3	12'-0"	8-12	AIR
5-4	15'-0"		
5-5	18'-0"		
5-6	21'-0"		
5-7	24'-0"		
5-8	20'-0"		
5-9	14'-0"		
5-10	11'-0"		
5-11	17'-0"		
5-12	20'-0"		
5-13	20'-0" AIR		
5-14	20'-0"		
5-15	24'-0"		
6-1	20'-0"		
6-2	17'-0"		
6-3	20'-0"		
6-4	14'-0"		
6-5	11'-0"		
6-6	20'-0"		
7-1	20'-0"		
7-2	20'-0"		
7-3	20'-0"		
7-4	17'-0"		
7-5	11'-0"		
7-6	8'-0"		
7-7	14'-0"		
7-8	20'-0"		
7-9	17'-0"		
7-10	14'-0"		
7-11	20'-0"		
8-1	18'-0"		
8-2	15'-0"		
8-3	24'-0"		
8-4	24'-0"		
8-5	11'-0"		
8-6	21'-0"		

PERFORATION ARE FROM 1" TO 2" ABOVE BOTTOM OF PIPE

- • 3" INSTRUMENT PIPE
- ● 8" AIR CIRCULATION PIPE

LEGEND

- WOOD STORAGE BOXES
- FIBERGLASS COVERED WOOD STORAGE BOXES
- 55 GAL. DRUMS STACKED HORIZONTAL
- 55 GAL. DRUMS STACKED VERTICAL
- 83 GAL. DRUMS STACKED VERTICAL
- METAL STORAGE BIN

CELL INFORMATION

CELL	SIZE	DATE OPENED	DATE CLOSED	55 GAL. DRUMS	30 GAL. DRUMS	83 GAL. DRUMS	4'X4'X7' WOOD BOXES	4'X4'X7' WOOD/FIBER GLASS BOXES	4'X5'X6' METAL BINS	ODD SIZE METAL CONTAINERS	ODD SIZE WOOD/FIBER GLASS BOXES	TOTAL VOLUME WASTE (M^3)
1	60' X 150'	11-1-70	5-8-71	9093	54	0	295	0	0	0	28	2804
2	100' X 150'	5-19-71	12-27-71	12682	48	0	602	0	0	3	0	4571
3	80' X 150'	12-15-71	6-5-72	9505	0	432	0	539	0	1	52	3994
4	80' X 150'	6-5-72	1-15-73	8841	20	994	0	380	0	6	120	3574
5	80' X 150'	12-22-72	6-20-73	1594***	0	0	0	545***	0	8	45	2148
6	40' X 150'	5-24-73	11-7-73	3658	0	0	0	308	0	7	10	1893
7	120' X 150'	11-7-73	1-23-75	7918	0	414	0	1076	48	0	0	5391
8	70' X 150'	4-24-74	10-25-75	7309	0	*	0	466	35	3	0	3249
X	RETAINING WALL									21**		
TOTALS				60600	122	1840	897	3314	83	28	255	27,624

* – INCLUDED IN TOTAL WITH 55 GAL. DRUMS
** – 21 CONCRETE ENCASSED RESIN VAULTS (NON-TRANSURANIC) USED AS A RETAINING WALL – NOT INCLUDED IN TOTAL.
*** – CELL 5 WAS REOPENED IN 1984, 2465 DRUMS AND 240 WASTE BOXES WERE REMOVED.

QUALITY LEVEL 3

QTY. REQ'D	QUAL. LEVEL	PART OR IDENTIFYING NO.	DESCRIPTION/MATERIAL/SPECIFICATION	ITEM/FIND

PARTS LIST

DIMENSIONING AND SYMBOLOGY ARE PER AMERICAN NATIONAL STANDARD UNLESS OTHERWISE SPECIFIED. SURFACE ROUGHNESS 125. DIMENSIONS AND TOLERANCES ARE IN INCHES. TOLERANCES: X ±.1, DECIMALS .XX ±.03, .XXX ±.005, FRACTIONS ±1/8, ANGULAR ±2°. DO NOT SCALE DRAWING

DES. REV. JAH 1-27-75
CHECKED R. MACFEE 1-27-75
DRAWN A. L. CARLSON 8-13-90
RELEASE PAP 1-27-75

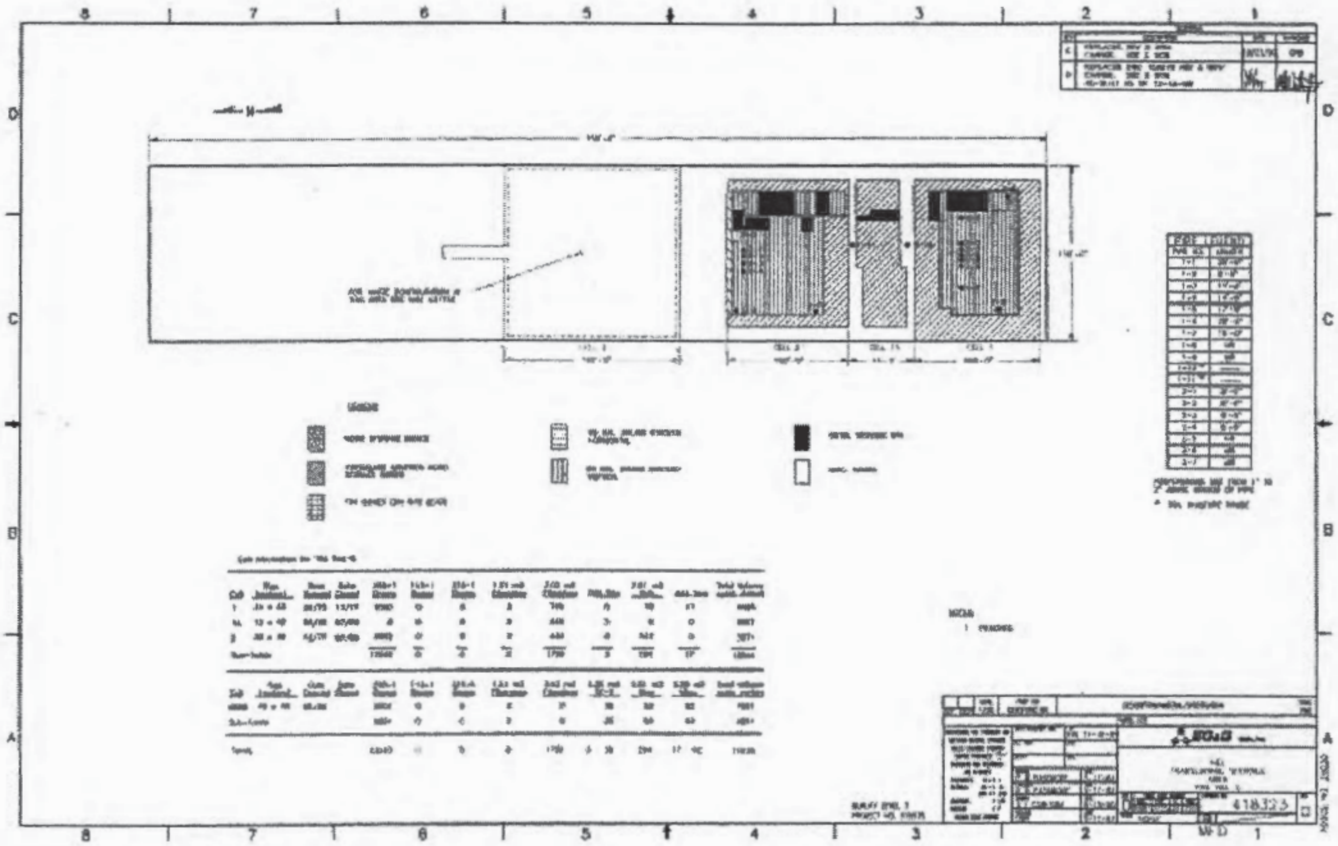
EG&G Idaho, Inc.

I.N.E.L.
TRANSURANIC STORAGE
AREA PAD NO. 1

SIZE D | 0995 | 7005 | -- | 2220 | DRAWING NO. 155663 | REV D
SCALE NONE

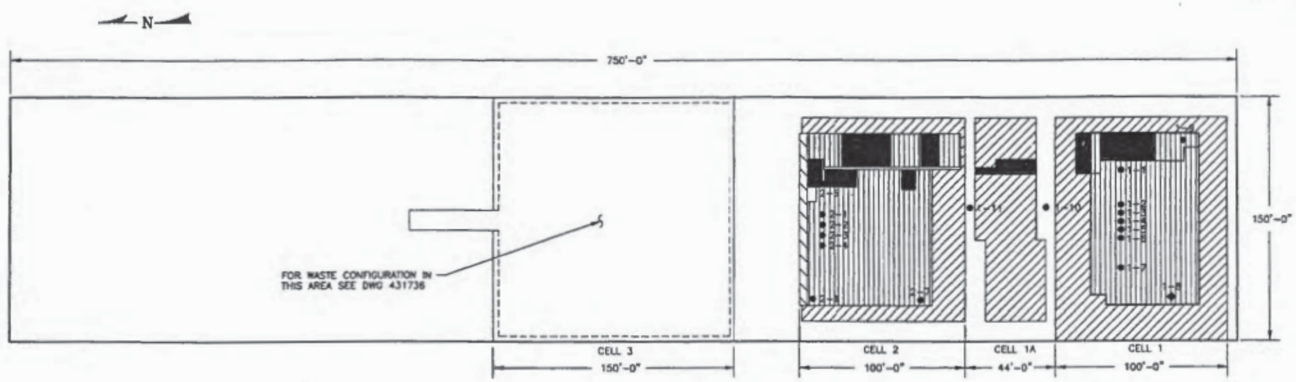
ADOCS NO. 31029

E-161



Drawing 2. Composite layout of TSA-2, Drawing Number 418323

REV	DESCRIPTION	DATE	APPROVED
C	REPLACES REV B WITH CHANGE. SEE C DCN	10/23/90	GRB
D	REPLACES DWG 158273 REV 5 WITH CHANGE. SEE D DCN AS-BUILT AS OF 12-16-96	1/6/97	[illegible]



LEGEND

- WOOD STORAGE BOXES
- FIBERGLASS COVERED WOOD STORAGE BOXES
- TX4 BOXES (ON SITE LEAD)
- 55 GAL. DRUMS STACKED HORIZONTAL
- 55 GAL. DRUMS STACKED VERTICAL
- METAL STORAGE BIN
- MISC. BOXES

PIPE LEGEND	
PIPE NO.	LENGTH
1-1	20'-0"
1-2	8'-6"
1-3	11'-0"
1-4	14'-0"
1-5	17'-0"
1-6	20'-0"
1-7	15'-0"
1-8	AIR
1-9	AIR
1-10 *	—
1-11 *	—
2-1	8'-0"
2-2	8'-0"
2-3	8'-0"
2-4	8'-0"
2-5	AIR
2-6	AIR
2-7	AIR

PERFORATIONS ARE FROM 1" TO 2" ABOVE BOTTOM OF PIPE

* SOIL MOISTURE PROBE

Cell Information for TSA Pad-2

Cell	Size (meters)	Date Opened	Date Closed	208-1 Drums	113-1 Drums	314-1 Drums	1.51 m3 Fiberglass	3.02 m3 Fiberglass	Odd Size	2.81 m3 Bins	Odd Size	Total Volume cubic meters
1	34 x 43	09/75	12/77	8590	0	0	0	740	0	78	17	4406
1A	13 x 40	07/80	07/80	0	0	0	8	636	3	9	0	2067
2	30 x 39	12/77	07/80	8652	0	0	0	404	0	147	0	3571
Sub-Totals				17242	0	0	8	1780	3	234	17	10044

Cell	Size (meters)	Date Opened	Date Closed	208-1 Drums	113-1 Drums	314-1 Drums	1.51 m3 Fiberglass	3.02 m3 Fiberglass	4.25 m3 TX-4	2.81 m3 Bins	3.20 m3 Misc.	Total Volume cubic meters
ASB2	46 x 46	08/80		6001	0	0	0	0	38	50	92	1891
Sub-Totals				6001	0	0	0	0	38	50	92	1891
Totals				23243	0	0	8	1780	3 38	284	17 92	11935

NOTES:

1. REMOVED

QUALITY LEVEL 3
PROJECT NO. 015575

EG&G Idaho, Inc.

INEL
TRANSURANIC STORAGE AREA
PAD NO. 2

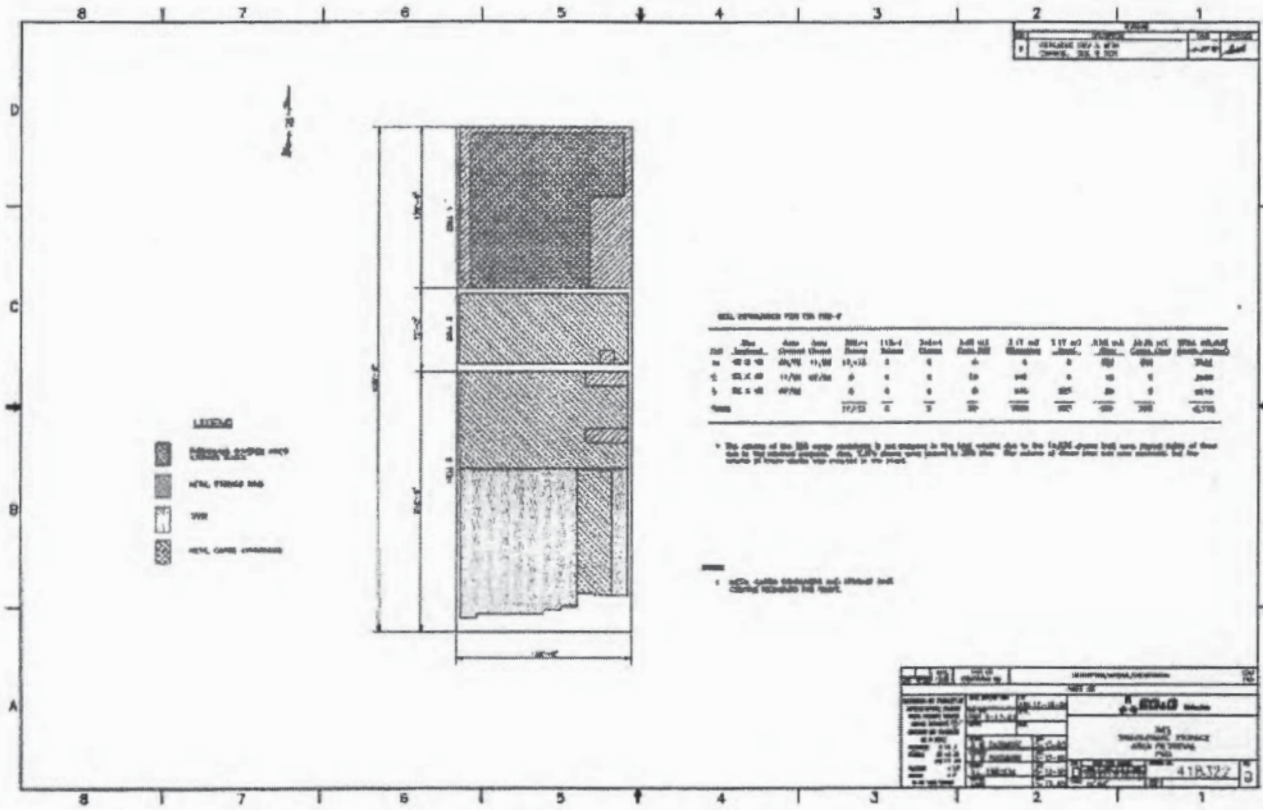
DESIGN R W PASSMORE 5-17-83
CHECKED R W PASSMORE 5-17-83
DRAWN A L CARLSON 8-13-90
DMR 5-17-83
JHN 11-16-84

SCALE NONE

DRAWING NO. 418323 REV D

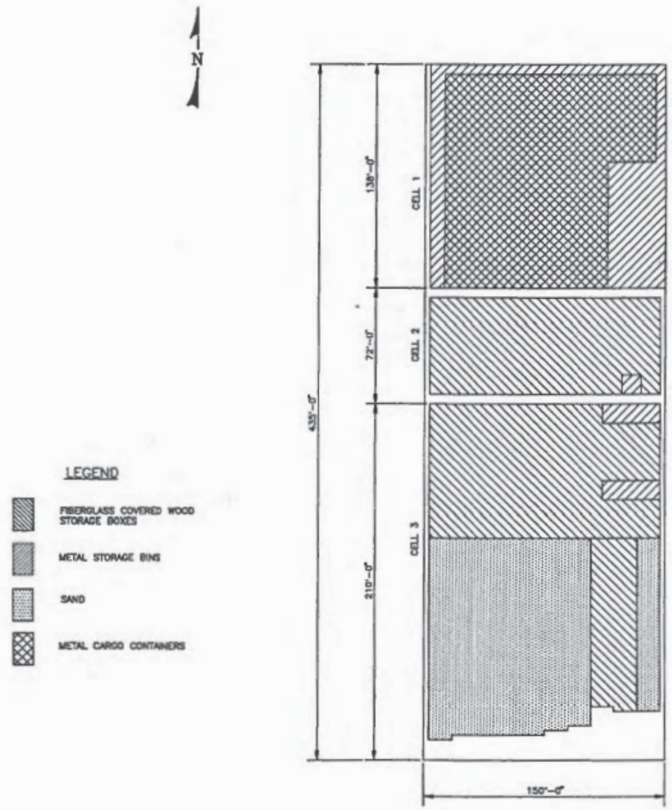
MFD

ADOCS NO. 31030



Drawing 3. Composite layout of TSA-R, Drawing Number 418322

REV	DESCRIPTION	DATE	APPROVED
B	REPLACES REV A WITH CHANGE. SEE B DCN		



CELL INFORMATION FOR TSA PAD-R

Cell	Size (meters)	Date Opened	Date Closed	208-1 Drums	113-1 Drums	314-1 Drums	3.43 m3 Ovez FRP	3.17 m3 Fiberglass	3.17 m3 Sand	3.50 m3 Bins	38.25 m3 Cargo Cont	TOTAL VOLUME (cubic meters)
1*	42 X 46	08/75	11/80	17,113	0	0	0	0	0	352	209	3822
2	22 X 46	11/80	07/82	0	0	0	29	945	0	12	0	3038
3	64 X 46	07/82		0	0	0	0	945	827	86	0	5918
Totals				17,113	0	0	29	1890	827	450	209	12,778

* The volume of the 209 cargo containers is not included in the total volume due to the 14,839 drums that were placed inside of them due to the retrieval projects. Also, 2,274 drums were placed in 280 bins. The volume of these bins was also excluded, but the volume of those drums was included in the count.

NOTES

1. METAL CARGO CONTAINERS AND STORAGE BINS CONTAIN RETRIEVED TRU WASTE.

PARTS LIST

EG&G Idaho, Inc.

INEL
TRANSURANIC STORAGE
AREA RETRIEVAL
PAD

DESIGN R W PASSMORE 5-17-83
CHECKED R W PASSMORE 5-17-83
DRAWN A.L. CARLSON 8-13-90
RELEASE DMR 5-17-83
DES. WAR. RWP 5-17-83
P/M JHN 11-16-84
SIZE D
SCALE NONE
DRAWING NO. 418322 REV B

30765

Photo 1. An aerial view looking east to west before the TSA-RE was constructed.

Photo 2. A close-up of the earthen covered waste before the TSA-RE was constructed.

Photo 3. An aerial view looking east to west of the TSA-RE building.

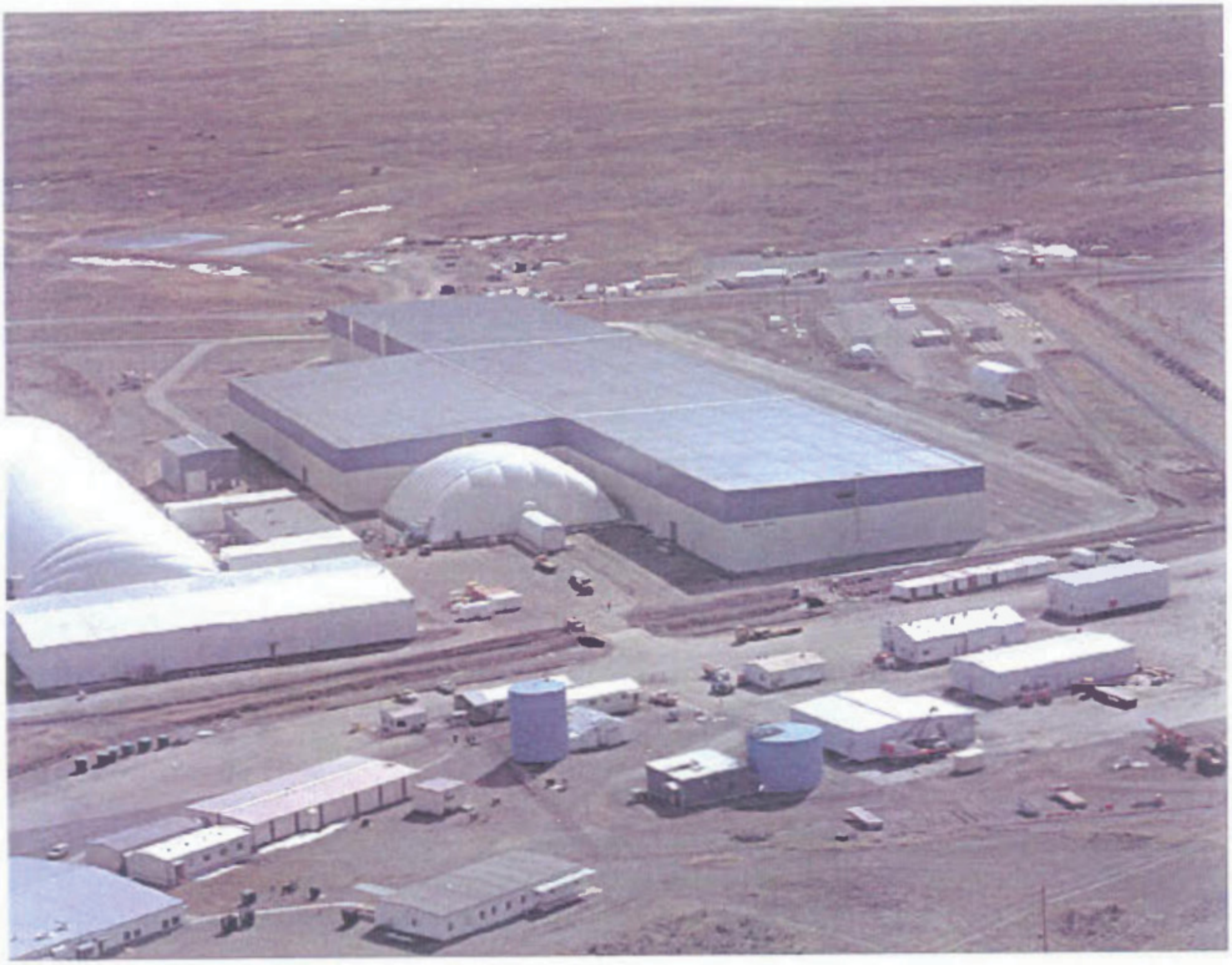


Photo 4. A close-up of the TSA-RE building looking north to south.

APPENDIX B

Institutional Controls

The RWMC is designed and operated to minimize exposure of the general public, operating personnel, and the environment to radioactive and mixed wastes. This appendix describes eight types of institutional controls that are present at the RWMC to ensure that the TSA-RE hazards are being properly managed and controlled. These eight institutional controls are security, communication system, emergency equipment, fire protection, flood control, standby power, personal protection equipment, and inspections. Collectively these controls at the RWMC help prevent and respond to environmental or human health hazards.

SECURITY

Security at the DOE INEEL is maintained 24 hours per day, seven days per week, including all holidays, by a staff of trained security personnel who monitor entry and exit from the facility and provide security at the various complexes throughout the facility. The size of the INEEL [890 mi2 (2,305 km2)], and its location with respect to public highways (Idaho State Highways 22, 28, and 33, and U.S. Routes 20 and 26), have made the construction of a facility boundary security fence impractical. Instead, security at the INEEL and at the waste management units located therein is maintained by a three-level security system consisting of the following: (1) property warning signs and surveillance patrolling, (2) security access control points placed at the entrances to the various complexes within the INEEL and conducting surveillance patrols, and (3) specific security measures taken at the individual areas, such as fencing, warning signs, and building security.

In addition to these three levels of security (signs, security patrols, access control points, and area-specific security), several other features contribute to the safety and security of the INEEL. First, ample lighting is provided throughout the facility areas. Second, security personnel and operations personnel are equipped with hand-held, two-way radios to report upset or trespass conditions immediately. Third, an internal telephone system that encompasses most of the INEEL is provided and is also used for communication outside INEEL premises.

Access to the RWMC is controlled by security personnel who are present at the RWMC during working shifts. Additionally, during off-shifts, INEEL security personnel conduct roving patrols around the perimeter of the RWMC. The security personnel assigned to the RWMC are based at WMF-637, which serves as the main access control point for all persons and vehicles entering or exiting the RWMC area. Security personnel badge authorized visitors and control vehicular entrance and exit from the RWMC.

Physical security at the RWMC includes fencing of the entire area with locked or monitored gates. The perimeter fence is designed as a deterrent to any unauthorized person attempting to enter or remove material from the RWMC, and as a deterrent to wildlife and large animals (e.g., livestock) attempting to enter the RWMC. The perimeter fence is constructed of galvanized steel chain link, topped with barbed wire. The fence, posts, and gates are all grounded. The perimeter fence completely surrounds the RWMC.

All routine employee visitor vehicular and pedestrian traffic to the RWMC is controlled at WMF-637. The security barrier on Adams Boulevard, located adjacent to WMF-637, is controlled by security personnel who must raise the barrier for vehicular entry into or exit from the RWMC. The barricade is closed at all other times. Signs are located at the barrier notifying personnel to stop and process through the building.

Upon entry to the RWMC, all personnel and visitors must pass through access control points. Subject to visitor access approval, visitors are issued temporary passes. All personnel entering the TSA or the SDA are issued dosimetry badges. Visitor access is arranged by the RWMC Manager or designee.

Security personnel log all visitors by listing name, date, time of entry and exit, and the name of authorizing/escort personnel. Access is controlled by card-readers located in WMF-637. The card-reader records the date and time, and allows entry. Once authorized, visitors are passed through the entrance by the security personnel with the escort present. Personnel identification passes and dosimetry must be worn conspicuously by all employees and visitors within the TSA at all times.

Visitors and personnel without appropriate radiation worker, RWMC-specific, and health and safety training are escorted or supervised at all times within the TSA by authorized personnel. Visitors are prohibited from entering the TSA without first obtaining required dosimetry and notifying and receiving approval from the Shift Supervisor. Upon returning from the TSA, visitors must return the dosimetry and undergo radiological scanning to insure no radioactive contamination has been encountered (this may occur prior to leaving the TSA).

COMMUNICATION SYSTEM

The RWMC is equipped throughout by a commercial telephone system for internal, external, and long distance communication. It also has an evacuation and voice paging system that can be manually or automatically initiated. This system includes speaker horns for emergency signal notification. Radios are used for short-range, line-of-sight communication within the RWMC area. Some of the vehicles used within the RWMC are also equipped with two-way radios for intraplant communications. In addition, the fire detection system and CAMs are all equipped with locally visible and audible alarms to alert personnel in the area of emergency or unsafe conditions.

External communication to summon emergency assistance will be made via the INEEL telephone system, vehicle two-way radios, hand-held two-way portable radios, or automatic alarms. The Net D radio system is designated for use during an emergency. In the event of an emergency, the following organizations that may be contacted include: the RWMC IRT, security personnel, RCTs, INEEL Fire Department, DOE-ID Hazardous Materials Response Team, and/or the WCC. The WCC would summon by telephone any outside emergency response organizations, as requested by the RWMC.

In addition to telephones, the INEEL operates a radio-based network for routine and emergency communications. It provides direct two-way voice communication between the RWMC and outside areas. The system is Federal Communications Commission (FCC)-approved. Net control is the WCC located in the DOE-ID building in Idaho Falls and is manned continuously. The radio system operates in repeater mode. All stations on the net transmit to a receiver located at a central point and the signal is automatically retransmitted on a secondary frequency to which all receivers are tuned. The repeaters are provided with standby power. Manual pull fire alarms and automatic fire detection systems automatically send signals to the INEEL Fire Department and to a printer in WMF-637. These systems are continuously monitored. CAM alarms provide signals at the RWMC WMF-637.

EMERGENCY EQUIPMENT

Spill control equipment, personal protection equipment, decontamination equipment, monitoring and survey equipment, and fire control equipment are available at the RWMC to respond to emergencies at the TSA. Emergency equipment is available throughout the RWMC and includes:

- Protective equipment
- First aid equipment
- Radios for communication

- Spill control equipment
- Light and heavy equipment to move drums or to build protective dikes
- Standby power supplies.

The RWMC maintains an emergency response vehicle containing firefighting and first aid equipment. This provides RWMC personnel the capability to respond to emergencies with the proper protective equipment.

Operations/security personnel will notify the appropriate emergency response personnel upon the receipt of an alarm or other emergency notification and issue the appropriate warning to Site personnel.

FIRE PROTECTION

The water supply system at the RWMC consists of two 250,000-gal water storage tanks fed by a deep well. One of the water storage tanks is dedicated for fire fighting water storage and supplies a dedicated fire fighting water distribution system. The second water storage tank supplies the RWMC potable water distribution system. It can be configured to supply the fire water distribution system as needed. The fire water distribution system runs throughout the TSA to provide fire water supplies to (or in the immediate vicinity of) the waste management units. The RWMC is able to provide water through the fire water supply system at adequate volume and pressure to supply automatic sprinkler systems and INEEL Fire Department hose streams to successfully fight fires at the TSA.

The RWMC fire alarm system automatically monitors the status of the RWMC fire pumps. Trouble alarms are transmitted to the INEEL Alarm Room for loss of commercial power, fire pump running, fire pump not in AUTO, low diesel fuel tank level, etc.

FLOOD CONTROL

The RWMC is provided with a variety of flood control and drainage control measures to eliminate run-on to the waste management units at the TSA and facilitate the drainage of water from the TSA. These control measures include:

A diversion system on the Big Lost River to divert flow from the Big Lost River to four spreading areas to the south and southwest of the RWMC.

Dikes (3) along the northeast, east, and south sides of the spreading areas to prevent overflow toward the RWMC.

Drainage control channels and dikes around the RWMC to divert nearby run-off to a run-off channel along Adams Boulevard.

Local grading within the TSA to direct run-off to drainage ditches and culverts leading to the run-off channel along Adams Boulevard.

The diversion system is described in Volume 3 of the INEEL RCRA Part B Permit Application. This system can handle a 100-yr flood. The adequacy of the control systems at the TSA is evaluated in Appendix VI of Revision 3 of Volume 5 of the INEEL RCRA Part B Permit Application. The results of this analysis indicate that the existing control systems can readily handle a 24-hr, 25-yr storm event

STANDBY POWER

The RWMC has standby power sources for continued operation of critical systems during periods of commercial power outage. Three standby power generators (175 kW, 75 kW, and 30 kW) are installed at the RWMC. All three generators come online automatically when commercial power is interrupted, unless manually overridden. All can be started manually and are equipped with time delays of several seconds to prevent nuisance starts.

The standby power system insures continued monitoring and alarm detection of RWMC fire detection systems, CAMs, and other critical monitors and response systems for wastes in storage. An uninterruptible power supply is provided by a battery to supply continuous standby power to the Emergency Command Post. In addition, the fire alarm system has lead acid battery backup, in case of AC power failure.

PERSONNEL PROTECTION EQUIPMENT

Personnel are notified of or protected from chemical and radiological hazards associated with wastes stored at the TSA through radiological monitoring of personnel and containers, use of personal protective equipment (PPE) as may be required for particular tasks. All operations are conducted such that employee radiation exposures to mixed wastes are ALARA, in accordance with DOE policy. All personnel involved in the management of mixed waste are instructed in the use of PPE, as appropriate to their job function and assigned tasks.

Routine protective clothing consists of work coveralls (issued by the RWMC), foot protection, eye protection, and hard hats, as required. Change rooms and lockers are provided at the RWMC. Additional PPE, such as anti-contamination coveralls, respirators, gloves, face protection, or chemical-resistant clothing, will be worn as assigned, for more hazardous tasks. Prior to the start of any operation that may expose employees to the risk of injury or exposure to hazardous substances, RWMC personnel review the operation to insure that the nature of hazards that might be encountered are properly considered; appropriate protective equipment is selected; and appropriate safety procedures and equipment are included. This review will typically involve radiological control, industrial hygiene, and safety personnel, in addition to knowledgeable operations personnel.

If the particular activity to be conducted has not previously been performed or there are unique considerations to be addressed, appropriate work control documentation will specify precautions, protective clothing, monitoring, health physics, industrial safety, and industrial hygiene controls or activities to be performed. The work control documents will also present the sequence of activities to be completed, limiting factors, information to be recorded (such as readings of radiation monitoring equipment), and situations that may require operations to be shut down.

Radiation monitoring is required for all personnel who enter the TSA. The mixed waste consists of commingled hazardous chemicals and radioactive materials. Radioactivity associated with the mixed waste is the most immediate health hazard of concern. Also, because radioactive materials can be detected and measured at concentrations orders of magnitude below chemical concentrations of concern, the continuous monitoring for radioactive contamination serves as a ready mechanism to identify potential releases of mixed waste.

Each worker at the TSA wears an assigned TLD badge. The badge is picked up at the beginning of the shift and returned at the end of the shift. Visitors to the TSA must obtain the TLD badges upon entering the RWMC. A log is maintained of visitor entry into the RWMC (name, date, time). Upon leaving the RWMC, visitors must check back in, to record the time of return and return the TLD badge.

INSPECTIONS

Various inspection programs are in place at the RWMC to insure safe storage of mixed waste at the TSA-RE, proper operation of all supporting equipment and monitoring equipment, and availability of emergency equipment in sufficient number and in operable condition whenever needed. These inspections will prevent malfunctions and detect deterioration, human errors, and discharges that may cause or lead to the release of mixed waste to the environment or pose a threat to human health.

Inspections will be performed in each building, designated area or vault when in use for mixed waste storage. The inspections may occur each workday or on a weekly, biweekly, monthly, quarterly, semiannual, or annual basis depending on the type of inspection. The inspections may be area-wide, waste management unit-specific, for fire or spill response equipment, emergency warning or communications systems, or support equipment. All deficiencies noted in the inspection are documented and remedied at the time of the inspection if possible. Deterioration or malfunctions of equipment or structures identified during the inspection are remedied on a schedule that will insure the problem does not lead to any environmental or human health hazard. Imminent hazards or hazards that have already occurred will be addressed immediately on a case-by-case basis. Corrective action is initiated and tracked to completion

APPENDIX C

GW Screen Output Files

TIME OF RUN: 13:47:08.47 DATE OF RUN: 10/14/99

```
**************************************************
*                                                *
*   This output was produced by the model:       *
*                                                *
*              GWSCREEN                          *
*             Version 2.5                        *
*  A semi-analytical model for the assessment    *
*  of the groundwater pathway from the leaching  *
*  of surficial and buried contamination and     *
* release of contaminants from percolation ponds *
*              01/29/99                          *
*           Arthur S. Rood                       *
* Idaho National Engineering and Environmental   *
* Laboratory, Lockheed Martin Idaho Technologies *
*  Company, Integrated Earth Sciences Unit        *
*             PO Box 1625                        *
*       Idaho Falls, Idaho 83415                 *
**************************************************
```

==
=

ACKNOWLEDGEMENT OF GOVERNMENT SPONSORSHIP AND
LIMITATION OF LIABILITY

==

OUTPUT FILE NAME: 1.out
INPUT FILE NAME: 1.par
Title: TSA-RE PCB RISK ASSESSMENT GWSCREEN Ver 2.5 (Card 1)

Model Run Options

IMODE Contaminant Type and Impacts:	5
ITYPE (1) Vert Avg (2) 3D Point (3) 3d Avg:	1

IDISP (0) Fixed Dispersivity (1-3) Spatially Varying: 0
KFLAG (1) Max Conc (2) Conc vs Time (3) Grid Output: 1
IDIL (1) No dilution factor (2) Include Dilution Factor: 1
IMOIST Source Moisture Content Option: 1
IMOISTU Unsaturated Moisture Content Option: 1
IMODEL (1) Surface/Buried Src (2) Pond (3) Usr Def: 1
ISOLVE (1) Gaussian Quarature (2) Simpsons Rule: (Aquifer) 1
ISOLVEU (1) Gaussian Quarature (2) Simpsons Rule: (Unsat Zone) 1
Health Effects: Carcinogenic incidence risk for non-radiological contaminants
Output mass/activity units: mg
Output concentration units: mg/m**3
Dose/Risk Conversion Units: kg-d/mg
Output health effects units: carcinogenic risk

Exposure Parameters

Body Mass (kg): 72. Averaging Time (days): 27370.
Water Ingestion (L/d): 2.000E+00 Exposure Freq (day/year): 3.500E+02
Exposure Duration (y): 3.000E+01 Limiting Dose: 1.000E-05

Site Parameters

X Coordinate: 0.000E+00 Y Coordinate: 0.000E+00
Source Length (m): 2.300E+02 Source Width (m): 4.500E+01
Percolation Rate (m/y): 5.200E-02
Source Thickness (m): 5.000E+00 Src Bulk Density (g/cc): 1.500E+00
Source Moisture Content: 3.500E-01

Unsaturated Zone Parameters

Unsat Zone Thickness (m): 1.800E+01 Unsat Bulk Density: 1.900E+00
Unsat Dispersivity (m): 0.000E+00 Unsat Moisture Content: 9.000E-02

Aquifer Zone Parameters

Longitudinal Disp (m): 9.000E+00 Transverse Disp (m): 4.000E+00
Aquifer Thickness (m): 7.600E+01 Well Screen Thickness (m): 1.500E+01
Darcy Velocity (m/y): 5.700E+01 Aquifer Porosity: 1.000E-01
Bulk Density (g/cc): 1.900E+00

Calculated Flow Parameters

Percolation Water Flux (m3/y): 5.3820E+02
Unsat Pore Velocity (m/y): 5.7778E-01
Aquifer Pore Velocity (m/y): 5.7000E+02
Longitudinal Disp (m**2/y): 5.1300E+03
Transverse Disp (m**2/y): 2.2800E+03

Contaminant Data

Contaminant Name: PCB

Half Life (y): 1.000E+12
Other Source Loss Rate (1/y): 0.000E+00
Kd Source (ml/g): 1.500E+03
Solubility Limit (mg/L): 3.100E-02
Molecular Weight (mg/L): 2.000E+02
Initial mass/activity: 1.800E+11
Kd Unsat (ml/g): 1.500E+03
Kd Aquifer (ml/g): 6.000E+01
Risk/Dose Conversion Factor: 4.000E+00

Calculated Contaminant Values

Decay Constants (1/y): 6.9315E-13
Leach Rate Constant (1/y): 4.6215E-06
Initial Pore Water Conc (Ci or mg/m**3): 1.5457E+03
Solubility Limited Mass (mg): 3.6101E+09
Solubility Limited Time (y): 1.0572E+07
Unsaturated Retardation Factor: 3.1668E+04
Mean Unsaturated Transit Time (y): 9.8657E+05
Aquifer Retardation Factor: 1.141E+03
Minimum Peak Window Time (y): 9.8657E+05
Maximum Peak Window Time (y): 1.2546E+07

Results for Receptor X = 1.15000E+02 Y = 0.00000E+00

Peak Concentration (mg/m**3): 2.487E-01
Time of Peak (y): 1.1376E+07
Concentrations Averaged Between: 1.1376E+07 and 1.1376E+07 years
Average Concentration (mg/m**3): 2.487E-01
Maximum Dose: 1.063E-05
Maximum Allowable Inventory (mg): 1.693E+11
WARNING: PORE WATER CONCENTRATION OF THE MAXIMUM ALLOWABLE INVENTORY
EXCEEDS THE SOLUBILITY LIMIT OF THE CONTAMINANT
WARNING: THE SOLUBILITY LIMIT OF THE CONTAMINANT WAS EXCEEDED IN THE SOURCE
Execution Time (Seconds): 0

TIME OF RUN: 13:47:19.84 DATE OF RUN: 10/14/99

```
 **************************************************
 *                                                *
 *   This output was produced by the model:       *
 *                                                *
 *                 GWSCREEN                       *
 *                Version 2.5                     *
 *  A semi-analytical model for the assessment    *
 *  of the groundwater pathway from the leaching  *
 *  of surficial and buried contamination and     *
 * release of contaminants from percolation ponds *
 *                  01/29/99                      *
 *               Arthur S. Rood                   *
 * Idaho National Engineering and Environmental   *
 * Laboratory, Lockheed Martin Idaho Technologies *
 *  Company, Integrated Earth Sciences Unit       *
 *                PO Box 1625                     *
 *         Idaho Falls, Idaho 83415               *
 **************************************************
```

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ACKNOWLEDGEMENT OF GOVERNMENT SPONSORSHIP AND
LIMITATION OF LIABILITY

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OUTPUT FILE NAME: 2.out
INPUT FILE NAME: 2.par
Title: TSA-RE PCB RISK ASSESSMENT GWSCREEN Ver 2.5 (Card 1)

Model Run Options

IMODE Contaminant Type and Impacts: 5
ITYPE (1) Vert Avg (2) 3D Point (3) 3d Avg: 1
IDISP (0) Fixed Dispersivity (1-3) Spatially Varying: 0

KFLAG (1) Max Conc (2) Conc vs Time (3) Grid Output: 1
IDIL (1) No dilution factor (2) Include Dilution Factor: 1
IMOIST Source Moisture Content Option: 1
IMOISTU Unsaturated Moisture Content Option: 1
IMODEL (1) Surface/Burried Src (2) Pond (3) Usr Def: 1
ISOLVE (1) Gaussian Quarature (2) Simpsons Rule: (Aquifer) 1
ISOLVEU (1) Gaussian Quarature (2) Simpsons Rule: (Unsat Zone) 1
Health Effects: Carcinogenic incidence risk for non-radiological contaminants
Output mass/activity units: mg
Output concentration units: mg/m**3
Dose/Risk Conversion Units: kg-d/mg
Output health effects units: carcinogenic risk

Exposure Parameters

Body Mass (kg): 72. Averaging Time (days): 27370.
Water Ingestion (L/d): 2.000E+00 Exposure Freq (day/year): 3.500E+02
Exposure Duration (y): 3.000E+01 Limiting Dose: 1.000E-05

Site Parameters

X Coordinate: 0.000E+00 Y Coordinate: 0.000E+00
Source Length (m): 2.300E+02 Source Width (m): 4.500E+01
Percolation Rate (m/y): 5.200E-02
Source Thickness (m): 5.000E+00 Src Bulk Density (g/cc): 1.500E+00
Source Moisture Content: 3.500E-01

Unsaturated Zone Parameters

Unsat Zone Thickness (m): 1.800E+01 Unsat Bulk Density: 1.900E+00
Unsat Dispersivity (m): 0.000E+00 Unsat Moisture Content: 9.000E-02

Aquifer Zone Parameters

Longitudinal Disp (m): 9.000E+00 Transverse Disp (m): 4.000E+00
Aquifer Thickness (m): 7.600E+01 Well Screen Thickness (m): 1.500E+01
Darcy Velocity (m/y): 5.700E+01 Aquifer Porosity: 1.000E-01
Bulk Density (g/cc): 1.900E+00

Calculated Flow Parameters

Percolation Water Flux (m3/y): 5.3820E+02
Unsat Pore Velocity (m/y): 5.7778E-01
Aquifer Pore Velocity (m/y): 5.7000E+02
Longitudinal Disp (m**2/y): 5.1300E+03
Transverse Disp (m**2/y): 2.2800E+03

Contaminant Data

Contaminant Name: PCB
Half Life (y): 1.000E+12

Other Source Loss Rate (1/y): 0.000E+00
Kd Source (ml/g): 1.000E+02
Solubility Limit (mg/L): 3.100E-02
Molecular Weight (mg/L): 2.000E+02
Initial mass/activity: 1.800E+11
Kd Unsat (ml/g): 1.000E+02
Kd Aquifer (ml/g): 4.000E+00
Risk/Dose Conversion Factor: 4.000E+00

Calculated Contaminant Values

Decay Constants (1/y): 6.9315E-13
Leach Rate Constant (1/y): 6.9172E-05
Initial Pore Water Conc (Ci or mg/m**3): 2.3134E+04
Solubility Limited Mass (mg): 2.4120E+08
Solubility Limited Time (y): 1.0774E+07
Unsaturated Retardation Factor: 2.1121E+03
Mean Unsaturated Transit Time (y): 6.5800E+04
Aquifer Retardation Factor: 7.700E+01
Minimum Peak Window Time (y): 6.5800E+04
Maximum Peak Window Time (y): 1.0906E+07

--- Results for Receptor X = 1.15000E+02 Y = 0.00000E+00

Peak Concentration (mg/m**3): 2.487E-01
Time of Peak (y): 7.0778E+06
Concentrations Averaged Between: 7.0777E+06 and 7.0778E+06 years
Average Concentration (mg/m**3): 2.487E-01
Maximum Dose: 1.063E-05
Maximum Allowable Inventory (mg): 1.693E+11
WARNING: PORE WATER CONCENTRATION OF THE MAXIMUM ALLOWABLE INVENTORY EXCEEDS THE SOLUBILITY LIMIT OF THE CONTAMINANT
WARNING: THE SOLUBILITY LIMIT OF THE CONTAMINANT WAS EXCEEDED IN THE SOURCE
Execution Time (Seconds): 0