Applied GeoSystems, Inc.
A RESNA Company

RESNA
Environmental Solutions
Through Applied Science,
Engineering & Construction

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RECEIVED BY
HAZARDOUS MATERIALS OFFICE
DEC 02 1991
HAYWARD FIRE DEPARTMENT

November 20, 1991

Alameda County Health Agency
Hazardous Materials Program
80 Swan Way, Room 200
Oakland, CA-94621

Attention: Pamela J. Evans

Sub: Work Plan for Soil Remediation
Saklan Avenue Property, Hayward, California.

Dear Ms. Evans:

As determined in the November 15 meeting with you and Mr. Ravi Arulanantham, I have attached the Revised Cancer Risk Assessment for the identified pesticides as per EPA Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A, July 1989. This revised risk assessment with the calculations is attached in appendix G of the final report. The cancer risk value has been calculated with all the appropriate changes as per your request in the letter dated October 29, 1991.

As the cancer risk for DDT is more than one in one million, we had agreed upon in our November 15 meeting to submit a work plan and sampling plan for soil remediation with all the site safety considerations included, to the Alameda County. I have attached a work plan which outlines the type of remediation we intend to conduct to reduce the soil contamination to the calculated soil remediation level, a sampling plan which follows the previous sampling work conducted on the property with the necessary sample location maps, and the site specific health and safety considerations that will be followed during the onsite field work at Saklan Avenue Property.

If you have any questions, please call me or Nalini Frush. We appreciate your help with this project.

Yours Sincerely,
RESNA Industries

Madhulla L

Madhulla Logan
Environmental Analyst

SCOPE OF WORK FOR SOIL REMEDIATION AT SAKLAN AVENUE PROPERTY

1. INTRODUCTION

A preliminary environmental assessment was conducted on the site in September 1989. A review of historical aerial photographs, as part of the assessment indicated a history of greenhouses on the site. Based on that information, the County and the City required that surface soil samples be collected and analyzed for pesticides. Initial soil samples were collected in October 1990, and subsequent soil samples were collected in November 1990. The laboratory analysis of these samples indicated the presence of Aldrin, Lindane, DDT and PCBs. In light of these results, the County requested a health risk assessment to be done on the compound identified. The initial risk assessment by Norman Riley was completed and submitted to the Alameda County in April 1991. The health risk assessment identified the need for further sampling to further define the levels and extent of contamination in the soil.

In May 1991, additional soil and water sampling was conducted which included collecting water samples from the three on site wells. No compounds were identified in the groundwater but the soil sample analysis indicated that significant concentrations of pesticides (DDT, Aldrin and Lindane) were present in the top two and one half feet of the soil and the concentrations of pesticides decreased rapidly beneath the surface. A revised health risk assessment was submitted to the County in May 1991 based on the additional soil sampling results.

The October 1990 sampling identified PCB in one of the samples collected, but additional sampling done through May 1991 did not reveal any PCB concentrations. To further confirm the absence of PCBs, sampling was conducted in August 1991 and no PCBs were detected in any of the samples and there was no indication of soil staining. Consequently, based on all the sampling done it was concluded that no further investigation nor remediation related to PCB was needed on the property.

As a response to the request by Alameda County Health Agency further revisions were made to the revised risk assessment. The revisions included using a 95% UCL value instead of 90% UCL value. The risk assessment with all the calculations was submitted to the County in October 1991. The Alameda County further requested that the calculations to determine the one in one million cancer risk should be redone based on the chemical daily intake using standard default parameters as described in EPA Risk Assessment guidance for Superfund, Human Health Evaluation Manual and the exposure to children should also be calculated based on the same method.

The new cancer risk assessment with all the necessary changes incorporated was submitted to Ms. Pamela Evans and Mr. Ravi Arulanantham in a November 15 meeting at the Alameda County Health Agency. It was identified that since the health risk for DDT residues is greater than one in one million, as deduced from the calculations, it was necessary to mitigate the soil contamination through remediation. This work plan for soil remediation has been proposed in order to comply with the requirements of the Alameda County Health Agency, the City of Hayward and the California Environmental Protection Agency.

2. SOIL REMEDIATION PLAN

It was deduced from the summary of analytical results of soil samples collected from the Saklan Avenue property (see Table 1) that significant concentrations of DDT was confined to the top two and half feet (18 inches) of soil and the concentrations decreased rapidly with increasing depth. Based on this deduction, the soil remediation will be done to a depth of 24 inches using a rotary tiller. The tiller is equipped with blades to break and mince the soil particles and a tine rotor operating at 2000 revolutions per hour to mix the minced soil particles. RESNA field services department has recommended this as a reasonable method to lower the overall concentration of DDT in the soil and to significantly reduce the UCL value of DDT to the calculated soil remediation levels. Remediation will be done as described in the area that has been defined as contaminated by pesticides by previous soil sample analysis. A map of the contaminated section relative to the whole property is attached in Appendix C.

The Soil Remediation Level (SRL) needed to reduce the cancer risk of DDT in adults and children to less than one in one million was calculated using the below mentioned equation.

Soil Remediation Level x Total Risk = Upper Confidence Limit x one in one million risk

Upper confidence limit for DDT in soil is: 3.878 ppm
Total risk calculated for adults is: 2.808×10^{-6}
Soil Remediation Level is: 3.878 ppm x 10^{-6} / $2.808 \times .10^{-6}$ = 1.381 ppm

3. SAMPLING PLAN

The purpose of this sampling plan is to determine the soil remediation level achieved after the completion of the tilling operation.. All soil sampling work will be done in accordance with the RESNA soil sampling protocol attached in Appendix A. The sampling plan will follow the previous soil sampling projects conducted on the Property in October 1990, November 1990, and May 1991. A total of 19 samples will be collected out of which 10 will be surface soil samples, 6 will be collected from 12 to 18 inches below surface and remaining 3 samples will be collected from 24 to 30 inches below surface level. The type of soil samples and the number of samples to be collected in each category is listed in Table 2 of this section.

Community West
Project No. 3-50058-51

TABLE 1

SUMMARY OF ANALYTICAL RESULTS
Sample concentrations in parts per billion

Compound	d1	d2	d3	d4	c1	c2	c3	c4	c5	c6	G-12	G-18	G-27	G-42	G-45	G-70	G-18A	G-27A	G-70A
Aldrin	ND	ND	ND	ND	ND	34	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
a-BHC	31	17	ND	25	ND	ND	ND	ND	ND	ND	ND	5.2	16	ND	ND	ND	ND	ND	ND
d-BHC	590	49	ND	610	14	210	54	ND	ND	ND	ND	ND	18	ND	ND	ND	ND	ND	ND
g-BHC	120	17	ND	24	13	79	33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DDT	2100	1400	5700	3100	550	6500	1400	5600	110	640	ND	ND	160	ND	ND	220	ND	ND	14
DDD	250	240	840	460	57	300	120	590	ND	220	ND	33	52	ND	ND	72	ND	ND	3.3
DDE	1100	1300	1500	1500	230	1900	630	830	120	740	ND	70	59	ND	ND	130	ND	ND	12
PCBs	ND	ND	1900	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

1. d = discrete sample, c = composite sample
2. ND = analytical results below detection limit
3. d1-c6 were surface samples, G-12 - G-70 were at 12 to 18 inches deep, G-18A - G-70A were at 24 to 30 inches deep.

Six out of the 10 surface soil samples will be composite samples and the remaining four will be grab samples The sample locations for the 4 surface grab samples are described in Figure 1, sample location plan in appendix B. The samples will be taken from the surface to about 2 inches depth in an approximately six inches square area. The sample locations for the 6 surface composite samples are described in Figure 2, sample location plan in appendix B. The map identifies 24 locations from where samples will be collected and starting from #1 location three samples from three consecutive sample location numbers will be mixed together to form a composite sample.

The six samples to be collected from 12 to 18 inches deep and three samples to be collected from 24 to 30 inches deep will be grab samples. The sample locations for these samples are described in Figure 3, sample location plan attached in appendix B. There will be one sample location from the center of each hatched grid. Two samples will be taken at locations #18, #27 and #70, one from 12 to 18 inches below the surface and one from 24 to 30 inches below the surface. One sample each will be collected from the remaining three locations.

Table 2

Type of soil sample	Number of samples
Surface grab samples	4 samples
Surface composite samples	6 samples
12 to 18 inches deep soil samples	6 samples
24 to 30 inches deep soil samples	3 samples

All soil samples to be collected will be packed in zero headspace condition into brass tubes, sealed with aluminium foil and plastic caps, labeled, logged and chilled for transport to the laboratory. The soil samples collected will be analyzed for pesticides using EPA method 8080.

4. SITE SAFETY PLAN

Chemical Hazards

The contaminants of concern on the property are mainly pesticides; aldrin, lindane, and DDT. Based upon the October 1990, November 1990 and May 1991 soil analyses, average concentration of aldrin, lindane and DDT in soil were 0.0078 ppm, 0.022 ppm, and 2.557 ppm respectively. The concentration of aldrin, lindane, and DDT in air, calculated using worst case emission factor were $1.6 \times 10^{-7} mg/m^3$, $4.9 \times 10^{-7} mg/m^3$ and 5.2×10^{-5} mg/m^3 respectively. These values are much less than the OSHA or ACGIH Time Weighted Average (TWA) values (whichever is lower) for aldrin, and 5.2 $x10^{-5}$ mg/m^3 respectively. These values are much less than the OSHA or ACGIH Time Weighted Average (TWA) values (whichever is lower) for aldrin, lindane, and DDT. Table 3 below summarizes the concentration of the three pesticides in soil and air with their TWA values.

Table 3

Name of pesticide	OSHA/ACGIH TWA	Concentration in soil	Concentration in air
Aldrin	0.25 mg/m^3	0·.0078 ppm	1.6 x $10^{-7}mg/m^3$
Lindane	0.5 mg/m^3	0.022 ppm	4.9 x $10^{-7}mg/m^3$
DDT	1.0 mg/m^3	2.557 ppm	5.2 x $10^{-7}mg/m^3$

Inhalation , skin absorption, and dermal contact will be the major routes of concern for chemical exposure to the personnel on site. The site safety plan that will be taken to the field will list the pesticides with their respective signs and symptoms on exposure, and the known concentration of the chemical in soil and air. According to RESNAs health and safety policies, for known concentration of chemicals in the work site, the respirator will be selected based on a protection factor calculated as mentioned below:

$$\text{Protection Factor} = \frac{\text{Known concentration of chemical outside (in air)}}{\text{Concentration of chemical inside the respirator}}$$

Based on the above equation the protection factor calculated for the pesticides on site was negligible (less than 10^{-5}) and hence the work will be done in Level D protection with air monitoring,. The personal protective equipment for Level D operations would include, steel toed boots, tyvek coverall, hard hat and safety glasses. Monitoring for aldrin, lindane and DDT will be done using Personal Air Sampling Pumps with glass fiber filters as the collection medium. The site safety officer will be responsible for conducting the ambient air sampling down wind of the site and the samples will be analyzed using NIOSH method 5052 by a laboratory accredited by the American Industrial Hygiene Association. If the laboratory analysis indicates levels of pesticides above action levels (half of TWA values), the Site Safety Officer will evaluate the adequacy of the personal protective equipment.

Physical Hazards

The major physical hazards associated with this work involve using heavy equipments, noise levels that could peak above 85 decibels, and potential heat stress depending on the least 20 feet away from such equipment when it is operating. RESNA will ensure that all equipment used complies to the manufacturer's noise control standards. Hearing protection (foam inserts or ear muffs) will be worn when operating all heavy equipment and whenever required. If temperature exceeds 70 degrees Fahrenheit, workers will be monitored for heat stress after every work period and periodic breaks will be given as often as necessary.

Biological Hazards

The three biological hazards to which workers can be exposed are bee stings, spider bites and poison ivy and/or poison oak. Workers allergic to bee stings will bring their prescribed medication with them to the site to use if they are stung. If any other personnel show signs of an allergic response after being stung by a bee or bitten by a spider, that person will be taken to the nearest hospital (which will be identified with the hospital route map in the site safety plan) . If poison ivy or poison oak are present on the site, additional protective garments and respiratory protection will be used coupled with the mandatory requirement for showers at the end of each day.

Other Site Safety Considerations

The site specific Site Safety Plan to be taken on site will also include apart from chemical and physical hazard evaluation, a more detailed monitoring plan, a description of the different sub tasks, site control and communication method, personnel and equipment decontamination procedures, RESNAs Emergency Response Plan,and the most recent OSHA required training and medical surveillance dates and certificates for personnel involved in remediation work.

APPENDIX A

SOIL SAMPLING PROTOCOL

RESNA

Soil Sampling Protocol

SOIL SAMPLING PROTOCOL

I. SOIL SAMPLING BY DRILLING RIG

1) Review site proposal for boring locations and special instructions. Confirm boring locations in field with client. Have Underground Service Alert (USA) mark utilities in area prior to drilling.

2) Prior to initiating an exploratory boring, all equipment to be used during drilling and sampling operation is steam cleaned. Such equipment includes, but is not limited to, augers, bits, drilling rod, and soil samplers. Additionally, before each sampling event, the sampler and any sample liners are thoroughly cleaned with a dilute trisodium phosphate solution and rinsed with clean tap water or distilled water. Additional decontamination procedures are implemented as needed by specific projects.

3) Each exploratory boring is drilled with a truck-mounted drilling rig using either solid flight or hollow stem augers. The boring is advanced to the desired sampling depth and the sampler is lowered to the bottom of the hole. The sampler is driven a maximum of 18 inches into the undisturbed soils ahead of the auger by a 140-pound, rig-operated hammer falling 30 inches. The number of blows required to drive the sampler the final 12 inches is recorded on the boring log. When necessary, the sampler may be pushed by the drill rig hydraulics. In this case, the pressure exerted (in pounds per square inch) is recorded. After the sampler has penetrated the full depth, it is retrieved to the surface.

4) The samplers commonly used are either a California modified sampler (3 inch or 2.5 inch O.D.) or a standard penetrometer (2 inch O.D.). The standard penetrometer does not contain sample liners and is used to determine soil strength characteristics and visually characterize the subsurface materials. If samples are collected for laboratory analysis the California modified sampler, equipped with brass liners, is used except when the analysis will include copper or zinc. In this instance, the sample should be taken with the standard penetrometer and placed in a labeled plastic bag.

Upon retrieval, the sampler is disassembled into its component parts. One or more of the liners is selected for chemical analysis. The ends of the selected liner(s) are sealed with aluminum foil or teflon tape, capped with plastic caps, labeled, logged on chain-of-custody forms and stored in a chilled ice chest for preservation in the field and during transport to the analytical laboratory. All labels are pre-written to the extent possible with indelible ink to minimize handling time.

5) Samples not sealed for chemical analysis are checked for the presence of contamination in the field by the geologist. Any discoloration or odor is noted on the boring log. Each sample is classified in the field by a geologist using the Unified Soil Classification System and a Munsell soil color chart. In addition, samples may also be field-screened with a photoionization detector (calibrated daily) or threshold limit value sniffer. In either case, the instrument probe is held adjacent to freshly crumbled soil and the stabilized reading value is recorded on the log. Values of volatile vapors measured in the field are reconnaissance only and are not meant to supplant chemical analysis in a certified laboratory. Other visual screening techniques include examination of the sample under hand-lens magnification as-well-as floating sheen inspection resulting from immersion in water.

   Lithology logging will collect geologic data as required, using conventional geologic and hydrogeologic terminology. When rock is logged, a GSA Rock Color Chart and appropriate terminology will be employed to describe rock, fractures, bedding, etc. Soil or rock coring may be specified by the supervising geologist on a project-specific basis.

6) Samples are held in the possession of RESNA personnel until transferred to the analytical laboratory. Transfer to the laboratory is accomplished with either delivery by RESNA personnel, pick-up by laboratory personnel, or transfer by a personal delivery service. Each transfer of responsibility is recorded on a chain-of-custody record that accompanies the samples.

7) Conditions occasionally arise when other drilling equipment are used given site-specific formation conditions. Rotary drilling may be selected if coring or bearing conditions arise. Rotary or casing hammer may be used as deep drilling, flowing sands, or formation-specific conditions require.

8) When drilling though an aquifer known to be contaminated, a staged drilling approach will be used. This would involve using either a temporary or

permanent conductor casing placed adjacent to the contaminated aquifer and pressed or advanced slightly into the underlying aquitard. The cased hole will be cleaned as necessary, following which, a smaller diameter drill bit/auger will be advanced to the next underlying water bearing stratum. An impermeable seal will be placed in the borehole or annular space as appropriate upon completion of exploratory boring/well construction.

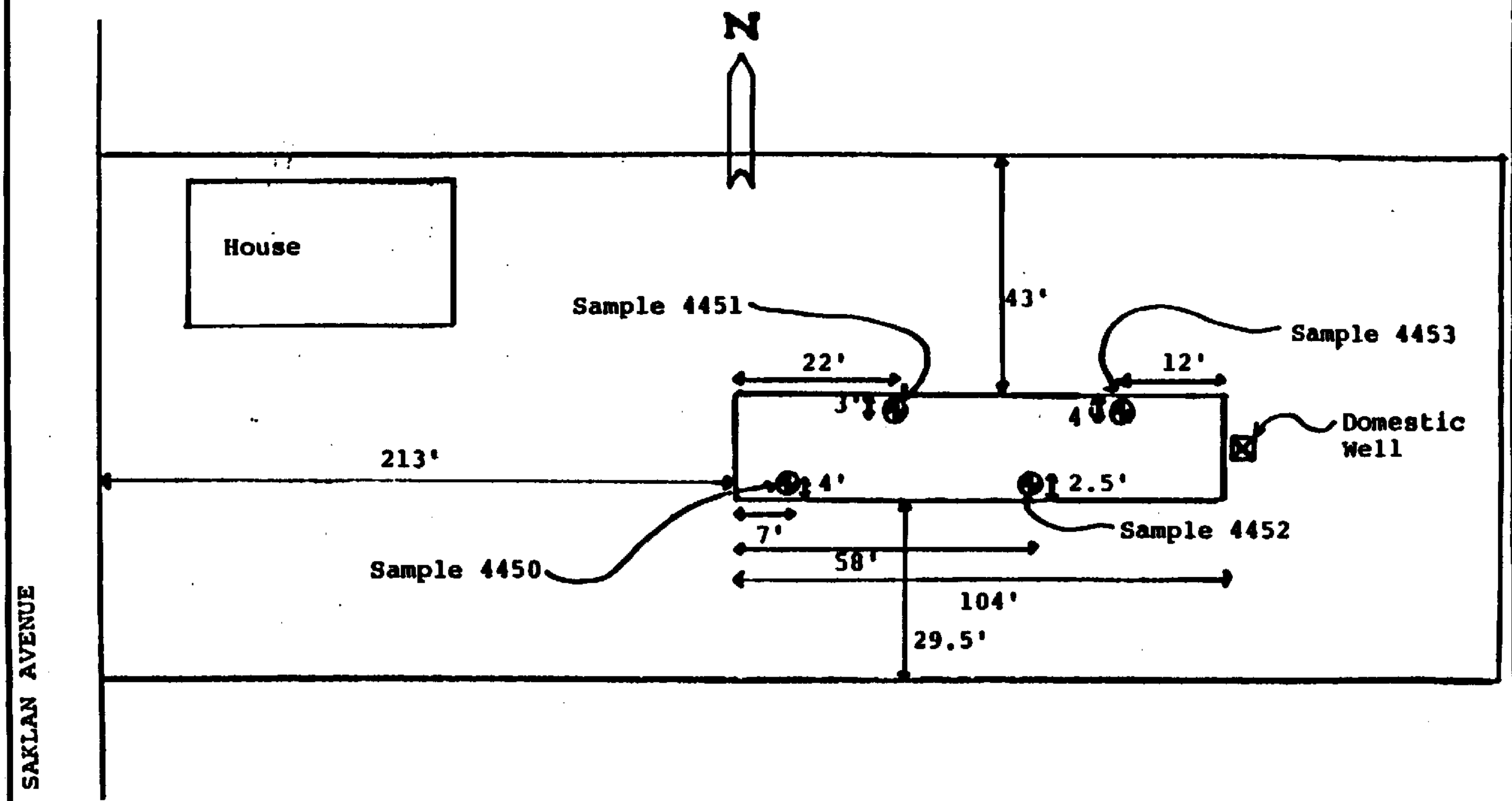
II. SOIL SAMPLING BY HAND

1) Some situations require that samples be collected by hand without the assistance of a drill rig (e.g., soil stock piles, excavation sidewall sampling, etc.). When possible, soil samples will be collected using a steel core sampler equipped with clean brass liners which is advanced into the soil with a slide hammer. In other cases, the outer surface of the soil is removed and a brass liner is driven into the soil by hand or with a hammer. To avoid damaging the liner, a block of wood can be held next to the liner so that the hammer strikes the block rather than the liner. The liner is removed and handled as described above. In deep excavations where safety factors preclude the direct sampling of the bottom or side wall, soil is retrieved by a backhoe bucket and this soil is sampled.

APPENDIX B

SAMPLE LOCATION MAPS

FIGURE 1

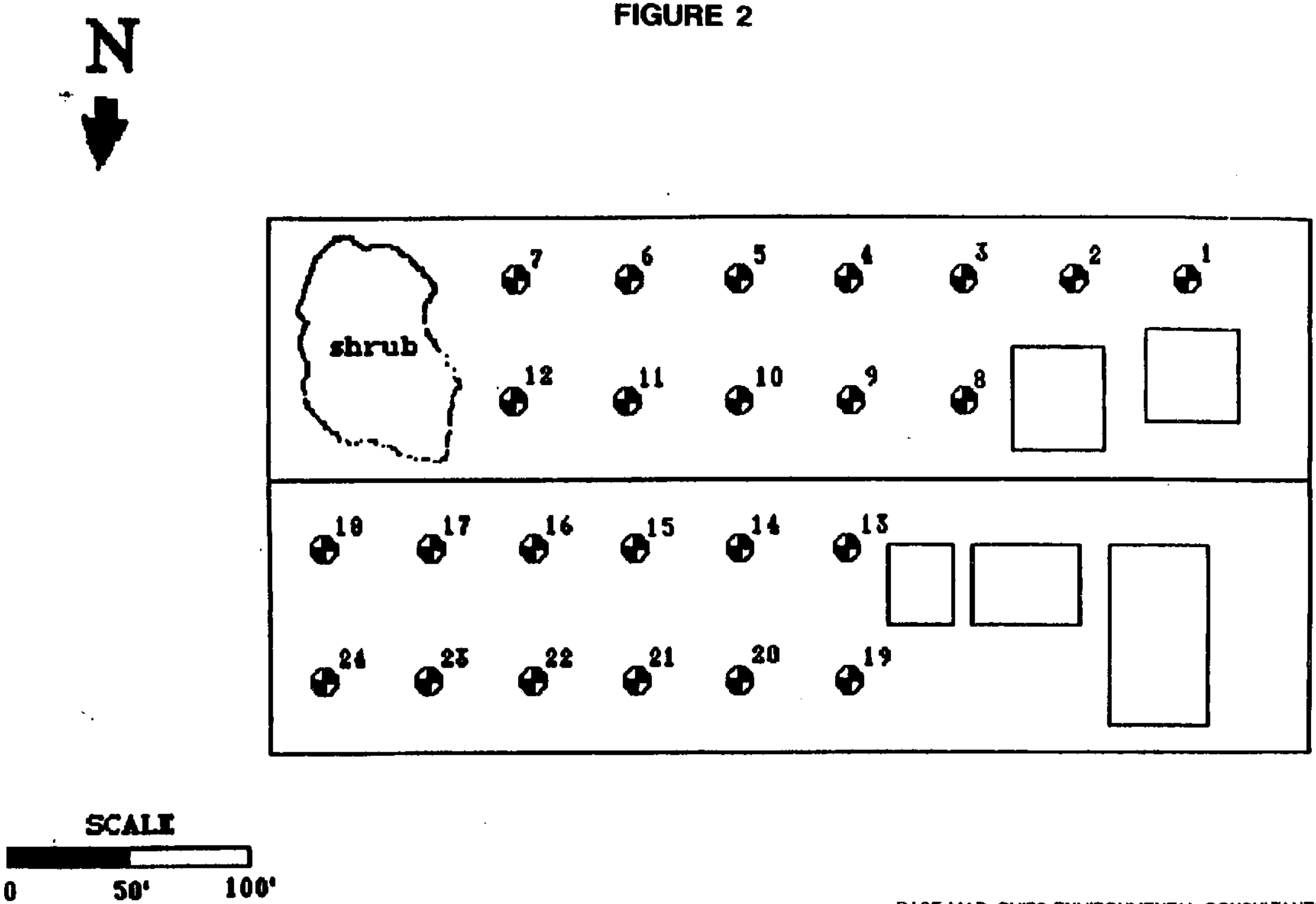


BASE MAP: CHIPS ENVIRONMENTAL CONSULTANTS 10/22/91

NOT TO SCALE

REVIEWED BY:	SAMPLE LOCATION PLAN	RESNA	
	23830-23836 SAKLAN AVENUE PROPERTIES		
APPROVED BY:	HAYWARD, CALIFORNIA	JOB #: 35005651	DRAWN BY: J.D.S.
		DATE: 11/26/91	DRAWING #: FIG. 1

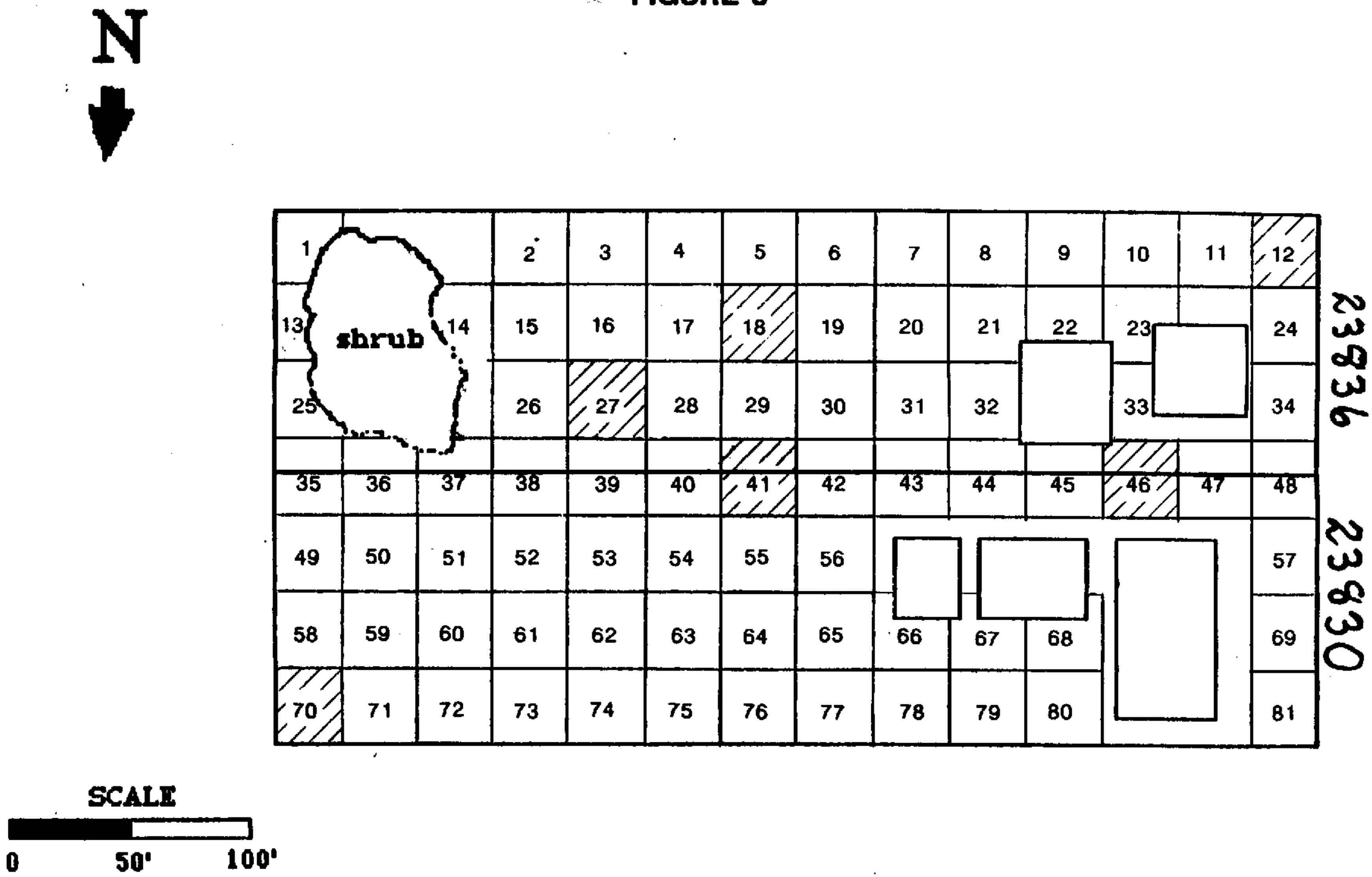
FIGURE 2



BASE MAP: CHIPS ENVIRONMENTAL CONSULTANTS 3/19/91

REVIEWED BY:	SAMPLE LOCATION PLAN	RESNA	
	23830-23836 SAKLAN AVENUE PROPERTIES		
APPROVED BY:	HAYWARD, CALIFORNIA	JOB #: 35005651	DRAWN BY: J.D.S.
		DATE: 11/26/91	DRAWING #: FIG. 2

FIGURE 3

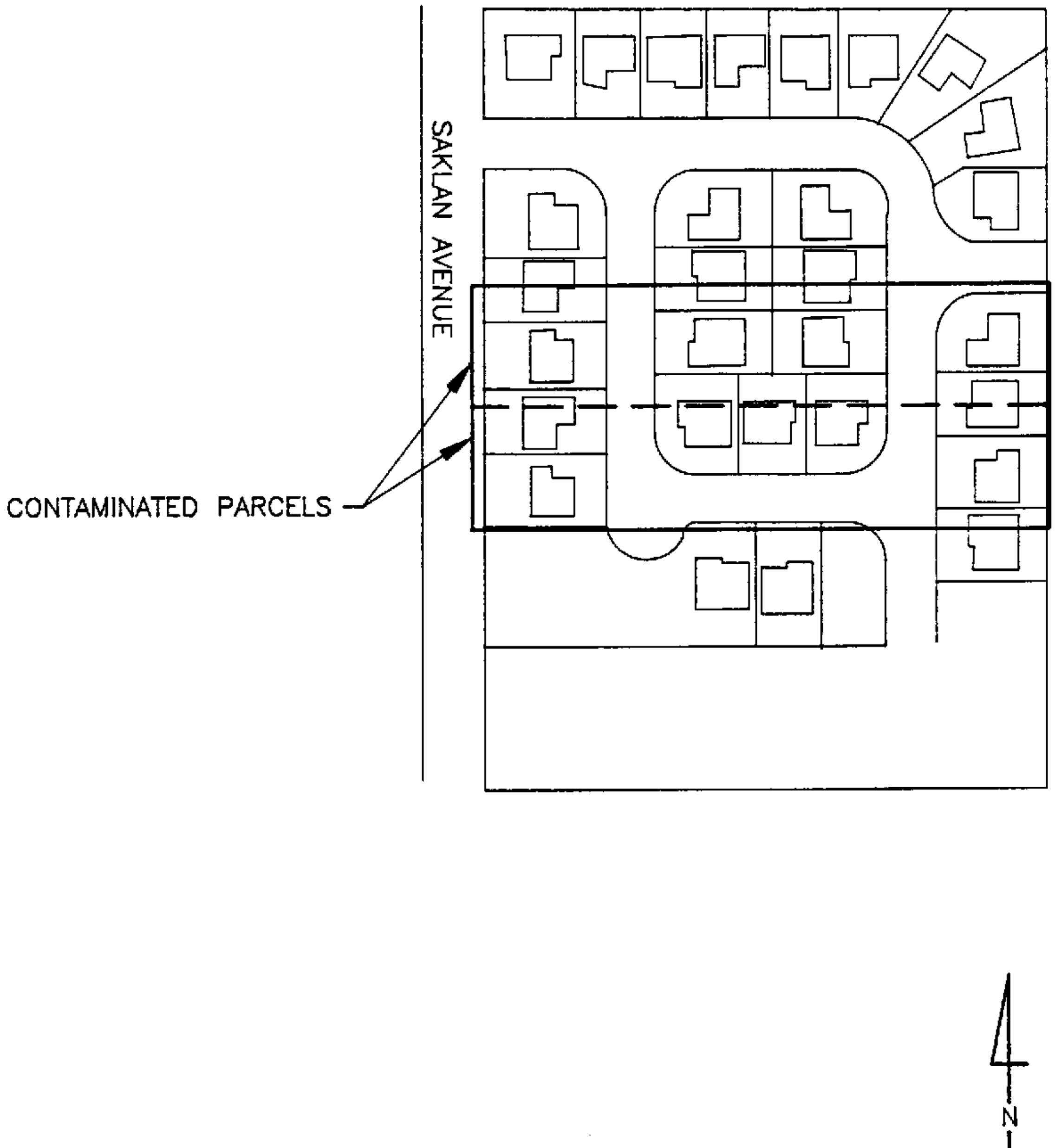


BASE MAP: CHIPS ENVIRONMENTAL CONSULTANTS 3/19/91

REVIEWED BY:	SAMPLE LOCATION PLAN	RESNA	
	23830-23836 SAKLAN AVENUE PROPERTIES		
APPROVED BY:	HAYWARD, CALIFORNIA	JOB #: 35005651	DRAWN BY: J.D.S.
		DATE: 11/26/91	DRAWING #: FIG. 3

APPENDIX C

CONTAMINATED SECTION OF THE PROPERTY



NOT TO SCALE

REVIEWED BY:	**CONTAMINATED PARCELS**	RESNA	
	23830–23836 SAKLAN AVENUE PROPERTIES		
APPROVED BY:	HAYWARD, CALIFORNIA	JOB #: 35005651	DRAWN BY: J.D.S.
		DATE: 11/26/91	DRAWING #:

APPENDIX G

REVISED CANCER RISK ASSESSMENT USING CHRONIC DAILY INTAKE VALUES

NOVEMBER 1991

REVISED RISK ASSESSMENT USING CHRONIC DAILY INTAKE VALUES

The Alameda County Health Agency requested further revisions to be made to the risk assessment in the letter dated October 29, 1991. The Risk Assessment was redone by including the exposure assessment for children and recalculating the chemical exposure and cancer risk value for the compounds identified using the chronic daily intake equation from the EPA Superfund Risk Assessment Manual, Part A, December 1989.

As per the EPA Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part A, December 1989, the equations used to calculate the chemical exposure through inhalation, ingestion and dermal contact are given below:

Inhalation of Airborne Chemicals (mg/Kg-day) :

$$\frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

CA = Contaminant Concentration in Air (mg/m^3)
IR = Inhalation Rate (m^3/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged)

Ingestion of chemicals in soil (mg/kg-day) :

$$\frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT}$$

CS = Chemical concentration in Soil (mg/kg)
IR = Ingestion Rate (mg soil/day)
CF = Conversion Factor (10^{-6} kg/mg)
FI = Fraction ingested from contaminated source (unitless)
EF - Exposure Frequency (days/years)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (period over which exposure is averaged-days)

Dermal Contact with Chemicals :

$$\frac{CS \times CF \times SA \times AF \times ASBS \times EF \times ED}{BW \times AT}$$

CS = Chemical Concentration in Soil (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
SA = Skin Surface Area Available for Contact (cm^2/event)
AF = Soil to Skin Adherence Factor (cm^2/event)
ABS = Absorption Factor (unitless)
EF = Exposure Frequency (events/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Tine (period over which exposure is averaged-days)

The Cancer Risk Value for the 3 pesticides was calculated using the Total Exposure Value which is the sum of the exposures by the three pathways.

Cancer Risk (probability of a person developing cancer) : CDI x SF

CDI : Chronic Daily Intake averaged over 70 years (mg/kg-day)
SF : Slope Factor $(mg/kg\text{-}day)^{-1}$

Table 8 lists the 3 pesticides ; aldrin, lindane, and DDTr with the calculated Chemical Daily Intake values for the three pathways, and the Cancer Risk probability calculated from the Total Exposure for both adults and children.. All calculations based on the above mentioned equations for Chronic Daily Intake and Cancer Risk probability are attached in this section.

Table 8

Summary of Calculated Values for Pesticides

Name of Pesticide	Target Population	Route of Exposure	Chronic Daily Intake (mg/kg-day)	Total Exposure (mg/kg-day)	Cancer Risk
ALDRIN	Adult	Inhalation Ingestion Dermal	1 • 878 x 10^{-8} 5 • 63 x 10^{-9} 2 • 0665 x 10^{-9}	2 • 648 x 10^{-8}	4 • 501 x 10^{-6}
	Children	Inhalation Ingestion Dermal	1 • 753 x 10^{-8} 1 • 315 x 10^{-8} 7 • 238 x 10^{-6}	3 • 140 x 10^{-8}	5 • 339 x 10^{-7}
LINDANE	Adult	Inhalation Ingestion Dermal	5 • 755 x 10^{-8} 1 • 6909 x 10^{-9} 6 • 200 x 10^{-9}	8 • 0638 x 10^{-8}	1 • 048 x 10^{-7}
	Children	Inhalation Ingestion Dermal	5 • 689 x 10^{-8} 3 • 945 x 10^{-8} 2 • 172 x 10^{-6}	8 • 8512 x 10^{-8}	1 • 280 x 10^{-7}
DDTr	Adult	Inhalation Ingestion Dermal	6 • 1056 x 10^{-6} 1 • 821 x 10^{-6} 3 • 339 x 10^{-7}	8 • 2605 x 10^{-6}	2 • 808 x 10^{-6}
	Children	Inhalation Ingestion Dermal	5 • 698 x 10^{-6} 4 • 249 x 10^{-6} 1 • 169 x 10^{-7}	1 • 0063 x 10^{-5}	3 • 421 x 10^{-6}

CANCER RISK CALCULATION FOR ALDRIN

95% Upper confidence Limit for Aldrin: 0.012 mg/kg

Concentration of Contaminant in Air: (to be used to calculate inhalation exposure) is calculated using worst case Emission Factor of 12 gram/hr/m^2 and a number of 500 microseconds/cubic meter which is taken summing the worst case mechanical and erosion emission rates.

Emission Rate $$\frac{.012 \text{ mg/kg} \times 12 \text{ g/hr/m}^2 \times 8093\text{m}^2}{1000 \times 3600 \text{ sec}} = .00003 \text{ mg/sec.}$$

Emission Factor $$\frac{.000032 \text{ mg/sec} \times 500 \text{ Us/m}^3}{1{,}000{,}000 \text{ sec/us (CF)}} = 1.6 \times 10^{-7} \text{ mg/m}^3$$

Chronic Daily Intake for Adults:

Inhalation: $$\frac{1.6 \times 10^{3} \text{ mg/m}^{-6} \times 0.833 \text{ m}^3\text{/hr} \times 24 \text{ hrs} \times 350 \text{ days} \times 30 \text{ yrs}}{70 \text{ kg} \times 70 \times 365} = 5.63 \times 10^{-9} \text{mg/kg-day}$$

Ingestion: $$\frac{.012 \text{ mg/kg} \times 100 \text{ mg/day} \times 10^{-6} \times 350 \text{ days} \times 24 \text{ yrs}}{70 \text{ kg} \times 70 \times 365} = 5.63 \times 10^{-9} \text{ mg/kg-day}$$

Dermal: $$\frac{012 \text{ mg/kg} \times 10^{-6} \times 194\text{cm}^2 \times 145 \text{ mg/cm}^2 \times 10\% \times 30 \text{ yrs}}{70 \text{ kg} \times 70 \times 365} = 2.0665 \times 10^{-9} \text{ mg/kg-day}$$

Total Exposure:	2.648×10^{-8} mg/kg-day
Slope (q*):	17
Cancer Risk in Adults:	$72.648 \times 10^{-8} \times 17 = \underline{4.501 \times 10^{-6}}$

Chronic Daily Intake for Children

Inhalation: $$\frac{1.6 \times 10^{-7} \text{ mg/m}^3 \times 0.833\text{m}^3\text{/hr} \times 24 \text{ hr} \times 350 \text{ days} \times 6 \text{ yrs}}{15 \text{ kg} \times 70 \times 365} = 1.753 \times 10^{-8} \text{ mg/kg-day}$$

Ingestion: $$\frac{.012 \text{ mg/kg} \times 200 \text{ mg/day} \times 10^{-6} \times 350 \text{ days} \times 6 \text{ yrs}}{15 \text{ kg} \times 70 \times 365} = 1.315 \times 10^{-8} \text{ mg/kg-day}$$

Dermal: $$\frac{.012 \text{ mg/kg} \times 10^{-6} \times 2.8 \times 1.45 \text{ mg/cm}^2 \times 10\% \times 6 \text{ yrs}}{15 \text{ kg} \times 70 \times 365} = 7.238 \times 10^{-10} \text{ mg/kg-day}$$

Total Exposure:	3.140×10^{-8} mg/kg-day
Slope (q*):	17
Cancer Risk in Children:	$3.140 \times 10^{-8} \times 17 = \underline{5.339 \times 10^{-7}}$

CANCER RISK CALCULATION FOR LINDANE

95% Upper Confidence Limit for Aldrin: 0.036 mg/kg

Concentration of Contamination in Air:

Emission Rate: $$\frac{0.036 \times 12 g/hr/m^2 \times 8093 m^2}{1000 \times 3600\ sec} = 0.00097\ mg/sec$$

Emission Factor: $$\frac{0.00097\ mg/sec \times 500\ Us/m^3}{1,000,000} = 4.9 \times 10\text{-}7\ mg/m^3$$

Chronic Daily Intake for Lindane in Adults:

Inhalation: $$\frac{4.9 \times 10\text{-}7\ mg/m^3 \times 0.833 m^3/hr \times 24\ hrs \times 350\ days \times 30\ yrs}{70\ kg \times 70 \times 365} = 5.753 \times 10^{-8}\ mg/kg\text{-}day$$

Ingestion: $$\frac{0.036\ mg/kg \times 100\ mg/day \times 10^{-6} \times 350\ days \times 24\ yrs}{70\ kg \times 70 \times 365} = 1.6908 \times 10^{-8}\ mg/kg\text{-}day$$

Dermal: $$\frac{0.036\ mg/kg \times 10^{-6} \times 194\ cm^2 \times 1.45\ mg/cm^2 \times 10\% \times 30\ yrs \times 365\ days}{70\ kg\ 365 \times 70 \times 70} = 6.2 \times 10^{-9}\ mg/kg\text{-}day$$

Total Exposure: 8.0638×10^{-8} mg/kg^{-day}
Slope (q*): 1.3
Cancer risk in Adults: $8.0638 \times 10^{-8} \times 1.3 = \underline{1.048 \times 10^{-7}}$

Chronic Daily Intake for Lindane in Children:

Inhalation: $$\frac{4.9 \times 10^{-7}\ mg/m^3 \times 0.883 m^3/hr \times 24\ hrs \times 350\ days \times 6\ yrs}{15\ kg \times 70 \times 265} = 5.689 \times 10^{-8}\ mg/kg\text{-}day$$

Ingestion: $$\frac{0.036\ mg/kg \times 200\ mg/day \times 10^{-6} \times 350\ days \times 6\ yrs}{15\ kg \times 70 \times 365} = 3.945 \times 10^{-8}\ mg/kg\text{-}day$$

Dermal: $$\frac{0.036\ mg/kg \times 10^{-6} \times 72.8\ cm^2 \times 1.45\ mg/cm^2 \times 6\ yrs \times 10\% \times 365\ day}{15\ kg \times 70 \times 365} = 2.172 \times 10^{-9}\ mg/kg\text{-}day$$

Total Exposure: 9.8512×10^{-8} mg/kg-day
Slope (q*): 1.3
Cancer risk in Children: $9.8512 \times 10^{-8} \times 1.3 = \underline{1.280 \times 10^{-7}}$

CANCER RISK CALCULATION FOR DDTr

95% Upper Confidence Limit for DDTr = 3.878 mg/kg

Concentration of Contaminant in Air:

Emission Rate: $\frac{3.87 \text{ mg/kg} \times 12 \text{ g/hr/m}^2 \times 8093\text{m}^2}{1000 \text{ g} \times 3600 \text{ sec}}$ = 0.1044 mg/sec

Erosion Factor: $\frac{0.1044 \text{ mg/sec} \times 500 \text{ Us/m}^3}{1{,}000{,}000 \text{ Us}}$ = 5.2×10^{-5} mg/m^3

Chronic Daily Intake of DDTr in Adults:

Inhalation: $\frac{5.2 \times 10^{-5} \text{ mg/m}^3 \times 0.833\text{m}^3\text{/hr} \times 24 \text{ hr} \times 350 \text{ days} \times 30 \text{ yrs}}{70 \text{ kg} \times 70 \times 365}$ = 6.1056×10^{-6}mg/kg-day

Ingestion: $\frac{3.878 \text{ mg/kg} \times 100 \text{ mg/day} \times 10^{-6} \times 350 \text{ days} \times 24 \text{ yrs}}{70 \text{ kg} \times 70 \times 365}$ = 1.821×10^{-6} mg/kg-day

Dermal: $\frac{3.878 \text{ mg/kg} \times 10^{-6} \times 194 \text{ cm}^2 \times 1.45 \text{ mg/cm}^2 \times 5\% \times 30 \text{ yrs} \times 365 \text{ days}}{70 \text{ kg} \times 70 \times 365}$ = 3.339×10^{7}mg/kg- day

Total Exposure:	8.2605×10^{-6} mg/kg^{-day}
Slope (q*):	0.34
Cancer Risk in Adults:	$8.2605 \times 10^{-6} \times 0.34$ = $\underline{2.808 \times 10^{-6}}$

Chronic Daily Intake of DDTr in Children:

Inhalation: $\frac{5.2 \times 10^{-5} \text{ mg/m}^3 \times 0.833\text{m}^3\text{/hr} \times 24 \text{ hrs} \times 350 \text{ days} \times 30 \text{ yrs}}{15 \text{ kg} \times 17 \times 365}$ = 5.698×10^{-6} mg/kg-day

Ingestion: $\frac{3.878 \text{ mg/kg} \times 200 \text{ mg/day} \times 10^{-6} \times 350 \text{ days} \times 6 \text{ yrs}}{15 \text{ kg} \times 70 \times 365}$ = 4.249×10^{-6} mg/kg-day

Dermal: $\frac{3.878 \text{ mg/kg} \times 10^{-6} \times 72.8 \text{ cm}^2 \times 1.45 \text{ mg/cm}^2 \times 6 \text{ yrs} \times 365 \text{ days} \times 5\%}{15 \text{ kg} \times 70 \times 365}$ = 1.169×10^{-7} mg/kg-day

Total Exposure:	1.0063×10^{-5} mg/kg-day
Slope (q*):	0.34
Cancer Risk in Children:	1.0063×10^{-5} mg/kg-day x .34 = $\underline{3.421 \times 10^{-6}}$