Glyphosate -
WordPerfect Worksheets for Human Health and Ecological Risk Assessments

Worksheet Version 2.04
Prepared for:

USDA, Forest Service
Forest Health Protection

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GENERAL NOTES

The worksheets included in this document are based on Worksheet Version 2.04. See SERA WSD 01-2.04, Documentation for Worksheets Version 2.04 - Human Health and Ecological Risk Assessments, dated February 25, 2003.

These worksheets are arranged in the following order:

	Table of Contents
Series A	General values and models
Series B	Chemical specific data
Series C	Worker exposures
Series D	General public exposures
Series E	HHRA Summary Tables
Series F	ERA Exposures
Series G	ERA Summary Tables
	List of general references

Most worksheets are designated by a simple alphanumeric code. For example, Worksheet D03 is the third worksheet in Series D. Some closely related worksheets as designated by an additional alphabetic sub-code. For example, Worksheets D01a and D01b are the direct spray scenarios for a child and a woman, respectively.

The worksheets in Series A and B also have short descriptive synonyms, as indicated in the table of contents. For example, Worksheet A03 contains the general assumptions used in exposure assessments for the general public and is designated as ***PUBL***.

The WordPerfect worksheets contain a much more detailed set of Series A and B worksheets than do the EXCEL worksheets. As noted in the documentation, the primary use of the EXCEL worksheets at this stage is to check rather than replace the WordPerfect worksheets. As the worksheets develop further, additional functionality will probably be added to the EXCEL worksheets to make them easier to manipulate and maintain.

It should be noted that all estimates of drift for chronic exposures for the off-site consumption of contaminated vegetation (Worksheets F04b, F11b, and F13b) all based on low-boom ground applications. These will need to be changed for high-boom or air-blast applications. For aerial applications, estimates specific to the program should be based on AGDRIFT.

CHEMICAL SPECIFIC NOTES

Information in these worksheets is based on SERA TR 02-43-09-04a, Glyphosate - Human Health and Ecological Risk Assessment, Final Report, dated March 1, 2003. All section numbers cited in these worksheets refer to this report.

The application rate is fixed at 2 lbs/acre, the "typical" application rate in Forest Service programs. The use of higher or lower rates is discussed in the risk characterization.

The scenarios involving the consumption of contaminated fruit use the residue data from the study by Siltanen and not the defaults. The structure of Worksheet G03, risk characterization for aquatic species, has been modified to accommodate the data on the different formulations of glyphosate (more toxic and less toxic).

REVISION HISTORY

Based on SERA WPWS 01-43-07-03a, November 23, 2001, the SERA WordPerfect worksheets prepared under Task 7. Modified to Version 2.04. See documentation cited above.

No comments have been received on these new worksheets and no revisions have been made to these worksheets.

WORKSHEETS FOR
Glyphosate
WS Version 2.04

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GENERAL ASSUMPTIONS, VALUES, and MODELS

Worksheet A01 [CONST]**:** Constants and conversion factors used in calculations

Conversion	ID	Value
mg/lb	mg_lb	453,600
mL/gallon	ml_gal	3,785
lb/gallon to mg/mL	lbg_mgml	119.8
lb/acre to $\mu g/cm^2$	lbac_ugcm	11.21
lb/acre to mg/cm^2	lbac_mgcm	0.01121
gallons to liters	gal_lit	3.785

Worksheet A02 [STD]**:** General Assumptions Used in Worker Exposure Assessments

Parameter	ID	Value	Units	Reference
Body Weight (General)	BW	70	kg	ICRP (1975), p. 13
Surface area of both hands	Hands	840	cm^2	U.S. EPA/ORD 1992, p. 8-11
Surface area of lower legs	LLegs	2070	cm^2	U.S. EPA/ORD 1992, p. 8-11
Weight of liquid adhering to surface of skin after a spill	Liq	0.008	mL/cm^2	Mason and Johnson 1987

Worksheet A03 [PUBL]**:** General Assumptions Used in Exposure Assessments for the General Public

Verbal Description: This table contains various values used in the exposure assessments for the general public. Three general groups of individuals are considered: adult male, adult female, and a 2 year old child. Values are specified for body weight, surface areas for various parts of the body, water intake, fish consumption, and the consumption of fruits or vegetables. Not all types of value are specified for each group. The only values specified are those used in the risk assessment.

Description	ID	Value	Units	Reference
		Body Weights		
Male, Adult	BWM	70	kg	ICRP (1975), p. 13.
Female, Adult	BWF	64	kg	See Note 1 below.
Child, 2-3 years old	BWC	13.3	kg	U.S. EPA/ORD 1996, p. 7-1, Table 7-2
		Body Surface Areas		
Female, feet and lower legs	SAF1	2915	cm^2	U.S. EPA/ORD 1992, p. 8-11, Table 8-3, total for feet and lower legs
Female, exposed skin when wearing shorts and a T-shirt	SAF2	5300	cm^2	U.S. EPA/ORD 1992, p. 8-11, Table 8-3, total for arms, hands, lower legs, and feet.
Child, male, 2-3 years old, total body surface area	SAC	6030	cm^2	U.S. EPA/ORD 1996, p. 6-15, Table 6-6, 50th percentile.
		Water Intake		
Adult				
typical	WCAT	2	L/day	U.S. EPA/ORD 1996, p. 3-28, Table 3-30, midpoint of mean (1.4 L/day) and 90th percentile (2.4 L/day) rounded to one significant place.
lower range for exposure assessment	WCAL	1.4	L/day	U.S. EPA/ORD 1996, p. 3-28, Table 3-30, mean
upper range	WCAH	2.4	L/day	U.S. EPA/ORD 1996, p. 3-28, Table 3-30, 90th percentile
Child, < 3 years old				
typical	WCT	1	L/day	U.S. EPA/ORD 1996, p. 3-28, Table 3-30, midpoint of mean (0.61L/day) and 90th percentile (1.5 L/day) rounded to one significant place.
lower range for exposure assessment	WCL	0.61	L/day	U.S. EPA/ORD 1996, p. 3-28, Table 3-30, mean
upper range	WCH	1.50	L/day	U.S. EPA/ORD 1996, p. 3-28, Table 3-30, 90th percentile

[1]This is the average value (63.79 kg), rounded to the nearest kg for 3 different groups of women between 15-49 years old: control (62.07 kg), pregnant (65.90 kg), and lactating (63.48 kg). See Burnmaster 1998, Table III, p.218. This is identical to the body weight for females, 45-55 years old, 50th percentile from U.S. EPA, 1985, page 5, Table 2-2, rounded to nearest kilogram.

Worksheet A03 [PUBL]***(continued)*:** General Assumptions Used in Exposure Assessments for the General Public

Description	ID	Value	Units	Reference
		Fish Consumption		
Freshwater anglers, typical intake per day over a prolonged period	FAT	0.010	kg/day	U.S. EPA/ORD 1996, p. 10-51, average of means from four studies rounded to one significant place.
Freshwater anglers, maximum consumption for a single day	FAU	0.158	kg/day	Ruffle et al. 1994
Native American subsistence populations, typical intake per day	FNT	0.081	kg/day	U.S. EPA/ORD 1996, p. 10-51, median value of 94 individuals
Native American subsistence populations, maximum for a single day	FNU	0.770	kg/day	U.S. EPA/ORD 1996, p. 10-51, highest value of 94 individuals
		Consumption of Fruits and Vegetables		
Consumption of fruit, total				
Central	FrTC	0.00168	kg fruit/kg bw/day	U.S. EPA/ORD 1996, Table 9-3, p. 9-11, Central and upper estimates are mean and 95th percentile, respectively. The 5th percentile is given as zero. For these worksheets, the central estimate is used for the lower bound.
Lower	FrTL	0.00168		
Upper	FrTU	0.01244		
Consumption of vegetables, total				
Central	VgTC	0.0036	kg veg/kg bw/day	U.S. EPA/ORD 1996, Table 9-12, p. 9-12, mean, 5th percentile and 95th percentile.
Lower	VgTL	0.00075		
Upper	VgTU	0.01		
Consumption of vegetables, homegrown				
Central	VgHC	0.000761	kg veg/kg bw/day	U.S. EPA/ORD 1996, Table 12-15, p. 9-14, mean, 5th percentile and 95th percentile for individuals between 20 and 39 years old..
Lower	VgHL	0.0000777		
Upper	VgHU	0.00492		
Worst-case scenario for consumption in a single day, acute exposure scenario only.	VAcute	0.454	kg food	1 lb. The approximate mid range of the above typical and upper limits based on the 64 kg body weight.
		Miscellaneous		
Estimate of dislodgeable residue as a proportion of application rate shortly after application.	DisL	0.1	none	Harris and Solomon 1992, data on 2,4-D

Worksheet A04 [HK]**:** Estimated pesticide residues on various types of vegetation shortly after an application of 1 lb/acre.

Type of Vegetation	Concentration (mg chemical/kg vegetation)			
	Typical		Upper Limit	
	ID	Value	ID	Value
The following values are from Hoerger and Kenaga (1972).				
Range grass	RGT	125	RGU	240
Grass	GST	92	GSU	110
Leaves and leafy crops	LVT	35	LVU	125
Forage crops	FCT	33	FCU	58
Pods containing seeds	PDT	3	PDU	12
Grain	GNT	3	GNU	10
Fruit	FRT	1.5	FRU	7
The following values are from Fletcher et al. (1994)				
Short grass	SGT	85	SGU	240
Tall grass	TGT	36	TGU	110
Broadleaf/forage plants and small insects	BLT	45	BLU	135
Fruits, pods, seeds, and large insects	FRT2	7	FRU2	15

Worksheet A05 [FRUIT]**:** Concentration of a chemical on spheres of various sizes at an application rate of 1 lb/acre.

Diameter (cm)	Planar Surface Area (cm^2)[a]	Amount deposited (mg)[b]	Weight of sphere (kg)[c]	Concentration (mg/kg)[d]
1	0.78540	0.00880	0.00052	16.8
5	19.63495	0.21991	0.06545	3.36
10	78.53982	0.87965	0.52360	1.68
	Application rate	1 lb/acre =	0.0112	mg/cm^2

a Planar surface area of a sphere = πr^2 where r is the radius in cm.

b Amount deposited is calculated as the application rate in mg/cm^2 multiplied by the planar surface area.

c Assumes a density of 1 g/cm^3 for the fruit. The volume of a sphere is $(1 \div 6) \times \pi \times d^3$ where d is the diameter in cm. Assuming a density of 1 g/cm^3, the weight of the sphere in kg is equal to:

$$kg = (1 \div 6) \times \pi \times d^3 \div 1000$$

d Amount of chemical in mg divided by the weight of the sphere in kg.

Worksheet A06 [OFFSITE**]:** Central estimates of off-site drift (expressed as fraction of application rate) associated with ground applications of pesticides [1] (from AgDRIFT Version 1.16, Teske et al. 2001)

Distance Down Wind (feet)	Low Boom	High Boom	Orchard Airblast (Normal)
25	0.0187	0.1034	0.0057
50	0.0101	0.0515	0.0029
100	0.0058	0.0262	0.0007
300	0.0024	0.0078	0.0001
500	0.0015	0.0038	0.0000403
900	0.0008	0.0015	0.000013
990	0.0007	0.0013	< 0.0000108

[1] Estimates based on very fine to fine spray. This will over-estimate drift for applications involving larger droplets.

Worksheet A07a [KAMODEL]: Estimate of first-order absorption rate (k_a in $hour^{-1}$) and 95% confidence intervals (from SERA 1997).

Model parameters	ID	Value	
Coefficient for $k_{o/w}$	C_KOW	0.233255	
Coefficient for MW	C_MW	0.005657	
Model Constant	C	1.49615	
Number of data points	DP	29	
Degrees of Freedom (d.f.)	DF	26	
Critical value of $t_{0.025}$ with 26 d.f.[1]	CRIT	2.056	
Standard error of the estimate	SEE	16.1125	
Mean square error or model variance	MDLV	0.619712	
Standard deviation of model (s)	MSD	0.787218	$MDLV^{0.5}$
X′X, cross products matrix	0.307537	-0.00103089	0.00822769
	-0.00103089	0.000004377	-0.0000944359
	0.0082	-0.0000944359	0.0085286

[1] Mendenhall and Scheaffer 1973, Appendix 3, 4, p. A31.

Central (maximum likelihood) estimate:

$$\log_{10} k_a = 0.233255 \log_{10}(\boldsymbol{k_{o/w}}) - 0.005657\ \boldsymbol{MW} - 1.49615$$

95% Confidence intervals for $\log_{10} k_a$

$$\log_{10} k_a \pm \boldsymbol{t}_{0.025} \times \boldsymbol{s} \times (\boldsymbol{a'X'X\,a})^{0.5}$$

where $\boldsymbol{a}$ is a column vector of {1, MW, $\log_{10}(\boldsymbol{k_{o/w}})$}.

NB: Although the equation for the central estimate is presented with $k_{o/w}$ appearing before MW to be consistent with the way a similar equation is presented by EPA, MW must appear first in column vector $\boldsymbol{a}$ because of the way the statistical analysis was conducted to derive X′X .

See following page for details of calculating $\boldsymbol{a'X'X\,a}$ without using matrix arithmetic.

Worksheet Worksheet A07a (continued)
Details of calculating $a' X' X a$

The term $\mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a}$ requires matrix multiplication. While this is most easily accomplished using a program that does matrix arithmetic, the calculation can be done with a standard calculator.

Letting

$$\mathbf{a} = \{a\_1, a\_2, a\_3\}$$

and

$$(\mathbf{X}'\mathbf{X})^{-1} = \{ \{b\_1, b\_2, b\_3\}, \{c\_1, c\_2, c\_3\}, \{d\_1, d\_2, d\_3\} \},$$

$\mathbf{a}' \cdot (\mathbf{X}'\mathbf{X})^{-1} \cdot \mathbf{a}$ is equal to

Term 1: $\{a\_1 \times ([a\_1 \times b\_1] + [a\_2 \times c\_1] + [a\_3 \times d\_1])\} +$
Term 2: $\{a\_2 \times ([a\_1 \times b\_2] + [a\_2 \times c\_2] + [a\_3 \times d\_2])\} +$
Term 3: $\{a\_3 \times ([a\_1 \times b\_3] + [a\_2 \times c\_3] + [a\_3 \times d\_3])\}.$

Worksheet A07b [KPMODEL]: Estimate of dermal permeability (K_p in cm/hr) and 95% confidence intervals (data from U.S. EPA/ORD 1992).

Model parameters	ID	Value	
Coefficient for $k_{o/w}$	C_KOW	0.706648	
Coefficient for MW	C_MW	0.006151	
Model Constant	C	2.72576	
Number of data points	DP	90	
Degrees of Freedom (d.f.)	DF	87	
Critical value of $t_{0.025}$ with 87 d.f.[1]	CRIT	1.96	
Standard error of the estimate	SEE	45.9983	
Mean square error or model variance	MDLV	0.528716	
Standard deviation of model (s)	MSD	0.727129	$MDLV^{0.5}$
X′X, cross products matrix	0.0550931	-0.0000941546	-0.0103443
	-0.0000941546	0.0000005978	-0.0000222508
	-0.0103443	-0.0000222508	0.00740677

[1] Mendenhall and Scheaffer, 1973, Appendix 3, Table 4, p. A31.

NOTE: The data for this analysis is taken from U.S. EPA/ORD (1992), Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, Table 5-4, pp. 5-15 through 5-19. The EPA report, however, does not provide sufficient information for the calculation of confidence intervals. The synopsis of the above analysis was conducted in STATGRAPHICS Plus for Windows, Version 3.1 (Manugistics, 1995) as well as Mathematica, Version 3.0.1.1 (Wolfram Research, 1997). Although not explicitly stated in the EPA report, 3 of the 93 data points are censored from the analysis because they are statistical outliers: [Hydrocortisone-21-yl]-hemipimelate, n-nonanol, and n-propanol. The model parameters reported above are consistent with those reported by U.S. EPA but are carried out to greater number of decimal places to reduce rounding errors when calculating the confidence intervals. See notes to Worksheet A07a for details of calculating maximum likelihood estimates and confidence intervals.

CHEMICAL SPECIFIC VALUES

Worksheet B01 [APPL]**:** Anticipated Application and Dilution Rates

Item		Code	Value	Units	Source
Application rate (***R***)					
	Central	Typ	2	lbs/acre	Section 2.4
	Lower	Low	2		Section 2.4
	Upper	Hi	2		Section 2.4
Dilution (***Dil***)					
	Central	CDil	10	gal./acre	Section 2.4
	Lower	LDil	5		
	Upper	HDil	25		
Concentration in field solutions[1]: $\mathbf{R_{(lb/acre)} \div Dil_{(gal/acre)} \times 119.8\ mg/mL \div lb/gal}$					
	Central	TypDr	24	mg/mL	
	Lower	LowDr	9.6		
	Upper	HI_Dr	48		

The typical concentration in applied solution is calculated as the typical application rate (lbs/acre) divided by the typical dilution (gal/acre), yielding units of lbs/gallon. This is converted to mg/mL using the relationship of lb/gal = 119.8 mg/mL from Worksheet A01. The lowest estimated concentration is calculated as the lowest application rate divided by the highest dilution. The highest estimated concentration is calculated as highest application rate divided by the lowest dilution.

NOTE ON UNITS FOR APPLICATION RATE: In all cases, lb/acre refers to lb a.i./acre.

Worksheet B02 [CHEM]**:** Summary of chemical specific values used in exposure assessment worksheets.

Parameter	ID	Value	Units	Source/Reference
Molecular weight	MW	169.07	grams/mole	Table 2-1
Water Solubility, pH 7 and 20°C	WS	12000	mg/L	Table 2-1
$K_{o/w}$, pH 7	Kow	1.26e-03	unitless	Table 2-1, Chamberlain et al. 1996, pH 6.86, log $K_{o/w}$ = -2.90
Foliar half-time ($t_{½}$)	FT12	46	days	From Siltanen et al. (1981). See Section 3.2.3.6.
central	FrT12C	46	days	
lower	FrT12L	46	days	
upper	FrT12U	46	days	
Dissipation coefficients on vegetation				
central	VgKC	0.0151	day^{-1}	ln(2)/half-time. The upper limit on half-time is used to calculate the lower limit on dissipation coefficient.
lower	VgKL	0.0151	day^{-1}	
upper	VgKU	0.0151	day^{-1}	
Bioconcentration factor, edible portion, acute exposure	BCFT	0.38	L/kg fish	Section
Bioconcentration factor, edible portion, chronic exposure	BCFCh	0.38	L/kg fish	
Bioconcentration factor, whole fish, acute	BCFWA	0.52	L/kg fish	
Bioconcentration factor, whole fish, chronic	BCFWC	0.52	L/kg fish	
Acute RfD[a]	RfDA	2	mg/kg bw/day	Section 3.3.4.
Chronic RfD	RfDC	2	mg/kg bw/day	

Worksheet B03 [KA_CHEM]**:** Calculation of first-order dermal absorption rate (k_a)[1].

Parameters	Value	Units	Reference
Molecular weight	169.07	g/mole	
$K_{o/w}$ at pH 7	0.00126	unitless	
$\log_{10} K_{o/w}$	-2.9		

Column vector ***a*** for calculating confidence intervals

a_1	1
a_2	169.07
a_3	-2.9

Calculation of $\mathbf{a'} \cdot (\mathbf{X'X})^{-1} \cdot \mathbf{a}$

Term 1	0.1094644277
Term 2	-0.002875289
Term 3	0.0941674301
$\mathbf{a'} \cdot (\mathbf{X'X})^{-1} \cdot \mathbf{a}$	0.2008

$\log_{10} k_a = 0.233255 \log_{10}(\boldsymbol{k_{o/w}}) - 0.005657\ \boldsymbol{MW} - 1.49615$

$\log_{10}$ of first order absorption rate (k_a)

Central estimate	-3.1289320585	±	$\boldsymbol{t}_{0.025}$	×	$\boldsymbol{s}$	×	$\mathbf{(a'\cdot(X'X)^{-1}\cdot a)}^{0.5}$
Lower limit	-3.85420250383	-	2.0560	×	0.787218	×	0.44810713005
Upper limit	-2.40366161317	+	2.0560	×	0.787218	×	0.44810713005

First order absorption rates (i.e., antilog or 10^x of above values).

Central estimate	7.43e-04	$hour^{-1}$
Lower limit	1.40e-04	$hour^{-1}$
Upper limit	3.95e-03	$hour^{-1}$

[1] See Worksheet A07a for details of method.

Worksheet B04 [KP_CHEM]**:** Calculation of dermal permeability rate (K_p) in cm/hour [1].

Parameters	Value	Units	Reference
Molecular weight	169.07	g/mole	
$K_{o/w}$	0.00126	unitless	
$\log_{10} K_{o/w}$	-2.89962945488		

Column vector ***a*** for calculating confidence intervals

a_1	1
a_2	169.07
a_3	-2.89962945488

Calculation of $\mathbf{a'} \cdot (\mathbf{X'X})^{-1} \cdot \mathbf{a}$

Term 1	0.0691690187
Term 2	0.0120774345
Term 3	0.10317789536
$\mathbf{a'} \cdot (\mathbf{X'X})^{-1} \cdot \mathbf{a}$	0.1844

$\log_{10} K_p = 0.706648 \log_{10}(\boldsymbol{k_{o/w}}) - 0.006151 \boldsymbol{MW} - 2.72576$

$\log_{10}$ of dermal permeability

Central estimate	-5.81472692503	±	$\boldsymbol{t}_{0.025}$	×	$\boldsymbol{s}$	×	$\mathbf{a'} \cdot (\mathbf{X'X})^{-1} \cdot \mathbf{a}^{0.5}$
Lower limit	-6.42672209645	-	1.9600	×	0.727129	×	0.42941821107
Upper limit	-5.20273175361	+	1.9600	×	0.727129	×	0.42941821107

Dermal permeability

Central estimate	1.53e-06	cm/hour
Lower limit	3.74e-07	cm/hour
Upper limit	6.27e-06	cm/hour

[1] See Worksheet A07a for details of method.

Worksheet B05 [DERM]**:** Summary of chemical specific dermal absorption values.

Description	Code	Value	Units	Reference/Source
Zero-order absorption (K_p)				
Central estimate	KpC	**1.5e-06**	cm/hour	Worksheet KPMODEL, values rounded to two significant figures
Lower limit	KpL	**3.7e-07**	cm/hour	
Upper limit	KpU	**6.3e-06**	cm/hour	
First-order absorption rates (k_a)				
Central estimate	AbsC	**0.00041**	$hour^{-1}$	Calculated from *in vitro* absorption in human skin preparations from Wester et al. (1991). See Section 3.1.3.
Lower limit	AbsL	**0.00013**	$hour^{-1}$	
Upper limit	AbsU	**0.001**	$hour^{-1}$	

Worksheet B06 [AMBWAT]**:** Estimates of the concentrations in ambient water per pound applied per acre are used in the chronic contaminated water exposure assessments.

Scenario	NOTE: GLEAMS modeling was not done in this risk assessment.	ID	***WCR*** (mg/L) ÷ (lb/acre)
	Short-term Peak Concentrations in Streams (See Section 3.2.3.4)		
Central	Based on GLEAMS modeling of stream and supported by monitoring data.	AWPT	0.02
Lower		AWPL	0.001
Upper		AWPU	0.4
	Longer-term Concentrations in Lakes (See Section 3.2.3.4 for details)		
Central	Based on GLEAMS modeling of pond	AWT	0.001
Lower		AWL	0.0001
Upper		AWU	0.008

Worksheet C01a: Worker exposure estimates for directed foliar (backpack) applications [WkBkExp01]

Verbal Description: The absorbed dose for the worker is calculated from the amount handled per day and the generic absorbed dose rate from several field studies on worker applications of a number of herbicides. The amount handled per day is calculated from the application rates as well as estimates of the hours worked per day and acres treated per hour.

Parameter/Assumption		Value	Units	Source/Designation
Application rates (***R***)				
	Central	2	lb/acre	APPL.TYP
	Lower	2		APPL.LOW
	Upper	2		APPL.HI
Hours of application per day (***Hrs***)				
	Central	7	hours	USDA 1989a,b,c
	Lower	6		USDA 1989a,b,c
	Upper	8		USDA 1989a,b,c
Acres treated per hour (***Acres***)				
	Central	0.625	acres/hour	USDA 1989a,b,c
	Lower	0.25		USDA 1989a,b,c
	Upper	1		USDA 1989a,b,c
Acres treated per day (**ATD**): **Hrs × Acres**				
	Central	4.375	acres/day	
	Lower	1.5		
	Upper	8		
Amount handled per day (***AHD***): **R × ATD**				
	Central	8.75	lb/day	
	Lower	3		
	Upper	16		
Absorbed dose rate (***ADR***):				
	Central	0.003	(mg agent/kg bw) ÷ (lbs agent handled per day)	SERA 2001.
	Lower	0.0003		
	Upper	0.01		
Absorbed dose [D_{Abs}]: **AHD × ADR**				
	Central	2.63e-02	mg/kg bw/day	
	Lower	9.00e-04		
	Upper	1.60e-01		

Worksheet C01b: Worker exposure estimates for boom spray (hydraulic ground spray) applications [WkHyExp01]

Verbal Description: The absorbed dose for the worker is calculated from the amount handled per day and the generic absorbed dose rate from several field studies on worker applications of a number of herbicides. The amount handled per day is calculated from the application rates as well as estimates of the hours worked per day and acres treated per hour.

Parameter/Assumption		Value	Units	Source/Designation
Application rates (***R***)				
	Central	2	lb/acre	APPL.TYP
	Lower	2		APPL.LOW
	Upper	2		APPL.HI
Hours of application per day (***Hrs***)				
	Central	7	hours	USDA 1989a,b,c
	Lower	6		
	Upper	8		
Acres treated per hour (***Acres***)				
	Central	16	acres/hour	USDA 1989a,b,c.
	Lower	11		
	Upper	21		
Acres treated per day (***ATD***): **Hrs × Acres**				
	Central	112	acres/day	
	Lower	66		
	Upper	168		
Amount handled per day (***AHD***): **R × ATD**				
	Central	224	lb/day	
	Lower	132		
	Upper	336		
Absorbed dose rate (***ADR***)				
	Central	0.0002	(mg agent/kg bw) ÷ (lbs agent handled per day)	SERA 2001
	Lower	0.00001		
	Upper	0.0009		
Absorbed dose [D_{Abs}]: **AHD × ADR**				
	Central	4.48e-02	mg/kg bw/day	
	Lower	1.32e-03		
	Upper	3.02e-01		

Worksheet C01c: Worker exposure estimates for aerial applications [WKAREXP01]

Verbal Description: The absorbed dose for the worker is calculated from the amount handled per day and the generic absorbed dose rate from several field studies on worker applications of a number of herbicides (SERA 2001). The amount handled per day is calculated from the application rates as well as estimates of the hours worked per day and acres treated per hour.

Parameter/Assumption		Value	Units	Source/Designation
Application rates (***R***)				
	Central	2	lb/acre	Appl.Typ
	Lower	2		Appl.Low
	Upper	2		Appl.Hi
Hours of application per day (***Hrs***)				
	Central	7	hours	USDA 1989a,b,c
	Lower	6		
	Upper	8		
Acres treated per hour (***Acres***)				
	Central	70	acres/hour	USDA 1989a,b,c
	Lower	40		
	Upper	100		
Acres treated per day (***ATD***): **Hrs × Acres**				
	Central	490	acres/day	
	Lower	240		
	Upper	800		
Amount handled per day (***AHD***): **R × ATD**				
	Central	980	lb/day	
	Lower	480		
	Upper	1600		
Absorbed dose rate (***ADR***)				
	Central	0.00003	(mg agent/kg bw) ÷ (lbs agent handled per day)	SERA 2001
	Lower	0.000001		
	Upper	0.0001		
Absorbed dose [D_{Abs}]: **AHD × ADR**				
	Central	2.94e-02	mg/kg bw	
	Lower	4.80e-04		
	Upper	1.60e-01		

Worksheet C02a: Workers: Accidental Dermal Exposure Assessments Using Zero-Order Absorption Wearing Contaminated Gloves for One Minute [WrkDrmZr01]

Verbal Description: Dermal absorption is calculated using the zero-order model from U.S. EPA/ORD (1992):

$$\text{Dose (mg/kg)} = Kp \times C \times \text{Time} \times S \div W$$

Each of the above terms are described below.

Parameter	Value	Units	Source
Body weight (***W***)	70	kg	STD.BW
Surface Area of hands (***S***)	840	cm^2	STD.Hands
Dermal permeability (K_p)			
Central	1.50e-06	cm/hour	DERM.KpC
Lower	3.70e-07	cm/hour	DERM.KpL
Upper	6.30e-06	cm/hour	DERM.KpU
Concentration in solution (***C***) [1]			
Central	24	mg/mL	APPL.TypDr
Lower	9.6	mg/mL	APPL.LowDr
Upper	48	mg/mL	APPL.HI_Dr
Duration of Exposure (***T***)	0.0167	hours	1÷60
Absorbed Dose (D_{Abs}): **Kp × C × T × S ÷ W**			
Central	7.20e-06	mg/kg	
Lower	7.10e-07	mg/kg	
Upper	6.05e-05	mg/kg	

[1] Note that 1 mL is equal to 1 cm^3 and thus mg/mL = mg/cm^3.

Worksheet C02b: Workers: Accidental Dermal Exposure Assessments Using Zero-Order Absorption Wearing Contaminated Gloves for One Hour [WrkDrmZr60]

Verbal Description: Dermal absorption is calculated using the zero-order model from U.S. EPA/ORD (1992):

$$\text{Dose (mg/kg)} = Kp \times C \times \text{Time} \times S \div W$$

Each of the above terms are described below.

Parameter		Value	Units	Source
Body weight (***W***)		70	kg	STD.BW
Surface Area of hands (***S***)		840	cm^2	STD.Hands
Dermal permeability (K_p)				
	Central	1.50e-06	cm/hour	DERM.KpC
	Lower	3.70e-07		DERM.KpL
	Upper	6.30e-06		DERM.KpU
Concentration in solution (***C***)[1]				
	Central	24	mg/mL	APPL.TypDr
	Lower	9.6		APPL.LowDr
	Upper	48		APPL.HI_Dr
Duration of Exposure (***T***)		1	hours	
Absorbed Dose (D_{Abs}): **Kp × C × T × S ÷ W**				
	Central	4.32e-04	mg/kg bw	
	Lower	4.26e-05		
	Upper	3.63e-03		

[1] Note that 1 mL is equal to 1 cm^3 and thus mg/mL = mg/cm^3.

Worksheet C03a: Accidental Spill onto the Hands for 1 Hour Based on the Assumption of First-Order Absorption [WrkDrmFrHnd]

Verbal Description: A worker spills a solution of the compound at a specified concentration (***C***) on a defined area of the skin (***A***). Based on the amount of liquid adhering to the skin (***L***), the amount of chemical absorbed (***Dose***) over a given period is calculated from the first order dermal absorption coefficient (k_a), the amount of time that the chemical remains on the surface of the skin before it is effectively removed by washing (***T***) and the body weight (***W***) (Durkin et al. 1995).

Parameter	Value	Units	Source
Liquid adhering to skin after a spill (***L***)	0.008	mL/cm^2	STD.Liq
Body weight (***W***)	70	kg	STD.BW
Surface Areas (**A**)			
Hands	840	cm^2	STD.Hands
Duration of Exposure (***T***)	1	hours	
First-order dermal absorption rates (k_a)			
Central	0.00041	$hour^{-1}$	DERM.ABSC
Lower	0.000130		DERM.ABSL
Upper	0.00100		DERM.ABSU
Concentration in solution (***C***)			
Central	24	mg/mL	APPL.TypDr
Lower	9.6		APPL.LowDr
Upper	48		APPL.HI_Dr
Amount Deposited on Skin (***Amnt***): L × A × C			
Central	161.28	mg	
Lower	64.512		
Upper	322.56		
Proportion absorbed over period ***T*** (***Prop***): $1-e^{-k\,T}$			
Central	0.0004099	unitless	
Lower	0.0001300		
Upper	0.0009995		
Absorbed Dose (D_{Abs}): **Amnt × Prop ÷ W**			
Central	9.44e-04	mg/kg bw	
Lower	1.20e-04		
Upper	4.61e-03		

Worksheet C03b: Accidental Spill onto the Lower Legs for 1 Hour Based on the Assumption of First-Order Absorption [WrkDrmFrLeg]

Verbal Description: A worker spills a solution of the compound at a specified concentration (***C***) on a defined area of the skin (***A***). Based on the amount of liquid adhering to the skin (***L***), the amount of chemical absorbed (***Dose***) over a given period is calculated from the first order dermal absorption coefficient (k_a), the amount of time that the chemical remains on the surface of the skin before it is effectively removed by washing (***T***) and the body weight (***W***) (Durkin et al. 1995).

Parameter	Value	Units	Source
Liquid adhering to skin after a spill (***L***)	0.008	mL/cm^2	STD.Liq
Body weight (***W***)	70	kg	STD.BW
Surface Areas (**A**)			
Legs	2070	cm^2	STD.LLegs
Duration of Exposure (***T***)	1	hours	
First-order dermal absorption rates (k_a)			
Central	0.00041	$hour^{-1}$	DERM.ABSC
Lower	0.000130		DERM.ABSL
Upper	0.00100		DERM.ABSU
Concentration in solution (***C***)			
Central	24	mg/mL	APPL.TypDr
Lower	9.6		APPL.LowDr
Upper	48		APPL.HI_Dr
Amount Deposited on Skin (***Amnt***): L × A × C			
Central	397.44	mg	
Lower	158.976		
Upper	794.88		
Proportion absorbed over period ***T*** (***Prop***): $1-e^{-k T}$			
Central	0.0004099	unitless	
Lower	0.0001300		
Upper	0.0009995		
Absorbed Dose (D_{Abs}): **Amnt × Prop ÷ W**			
Central	2.33e-03	mg/kg bw	
Lower	2.95e-04		
Upper	1.14e-02		

Worksheet D01a: Direct Spray of a Child, Assumption of First-Order Absorption [SpillFOACh01]

Verbal Description: A naked child is accidentally sprayed over the entire body surface (***A***) with a field dilution of a specified concentration (***C***). The child is effectively washed - i.e., all of the compound is removed - after a specified period of time (***T***). The absorbed dose (***D***) is calculated from the amount of liquid adhering to the skin (***L***), the first-order dermal absorption rate (k_a) and the body weight (***W***).

Parameter	Value	Units	Source
Liquid adhering to skin after a spill (***L***)	0.008	mL/cm^2	STD.Liq
Body weight (***W***)	13.3	kg	PUBL.BWC
Exposed surface area (***A***)			
Whole Body	6030	cm^2	PUBL.SAC
Duration of Exposure (***T***)	1	hours	
First-order dermal absorption rates (k_a)			
Central	0.00041	$hour^{-1}$	DERM.ABSC
Lower	0.00013		DERM.ABSL
Upper	0.001		DERM.ABSU
Concentration in solution (***C***)			
Central	24	mg/mL	APPL.TypDr
Lower	9.6		APPL.LowDr
Upper	48		APPL.HI_Dr
Amount Deposited on Skin (***Amnt***): L × A × C			
Central	1157.76	mg	
Lower	463.104		
Upper	2315.52		
Proportion absorbed over period ***T*** (***Prop***): $1-e^{-k\,T}$			
Central	0.0004099	unitless	
Lower	0.0001300		
Upper	0.0009995		
Absorbed Dose (D_{Abs}): **Amnt × Prop ÷ W**			
Central	3.57e-02	mg/kg bw	
Lower	4.53e-03		
Upper	1.74e-01		

Worksheet D01b: Direct Spray of a Woman, Assumption of First-Order Absorption [SpillFOAWm01]

Verbal Description: A woman is sprayed over the feet and lower legs (***A***) with a field dilution of a specified concentration (***C***). The woman effectively washes - i.e., all of the compound is removed - after a specified period of time (***T***). The absorbed dose (***D***) is calculated from the amount of liquid adhering to the skin (***L***), the first-order dermal absorption rate (k_a) and the body weight (***W***).

Parameter	Value	Units	Source
Liquid adhering to skin after a spill (***L***)	0.008	mL/cm^2	STD.Liq
Body weight (***W***)	64	kg	PUBL.BWF
Exposed surface area (***A***)			
Feet and lower legs	2915	cm^2	PUBL.SAF1
Duration of Exposure (***T***)	1	hours	
First-order dermal absorption rates (k_a)			
Central	0.00041	$hour^{-1}$	DERM.ABSC
Lower	0.000130		DERM.ABSL
Upper	0.00100		DERM.ABSU
Concentration in solution (***C***)			
Central	24	mg/mL	APPL.TypDr
Lower	9.6		APPL.LowDr
Upper	48		APPL.HI_Dr
Amount Deposited on Skin (***Amnt***): L × A × C			
Central	559.68	mg	
Lower	223.872		
Upper	1119.36		
Proportion absorbed over period ***T*** (***Prop***): $1-e^{-k T}$			
Central	0.0004099	unitless	
Lower	0.0001300		
Upper	0.0009995		
Absorbed Dose (D_{Abs}): **Amnt × Prop ÷ W**			
Central	3.58e-03	mg/kg	
Lower	4.55e-04		
Upper	1.75e-02		

Worksheet D02: Dermal contact with contaminated vegetation by a young woman [VegC_FOA01].

***Verbal Description**: A woman wearing shorts and a short sleeved shirt is in contact with contaminated vegetation for 1 hour shortly after application of the compound - i.e. no dissipation or degradation is considered. The chemical is effectively removed from the surface of the skin - i.e., washing - after 24 hours.*

Parameter/Assumption		Value	Units	Source/Reference
Contact time (***Tc***)		1	hour	N/A
Exposure time (***Te***)		24	hours	N/A
Body weight (***W***)		64	kg	PUBL.BWF
Exposed surface area (***A***)		5300	cm^2	PUBL.SAF2
Application Rates in lb/acre (***Rlb***)				
	Central	2	lb/acre	APPL.TYP
	Lower	2		APPL.LOW
	Upper	2		APPL.HI
First-order dermal absorption rate (***k***)				
	Central	0.00041	$hour^{-1}$	DERM.AbsC
	Lower	0.000130		DERM.AbsL
	Upper	0.00100		DERM.AbsU
Application Rates in µg/cm^2 (***Rµg***): Rlb × Const.lbac_ugcm				
	Central	22.42	µg/cm^2	
	Lower	22.42		
	Upper	22.42		
Proportion dislodgeable (***PropDr***)		0.1	none	PUBL.DisL
Dislodgeable residue (***Dr***): ***Rµg*** × ***PropDr***				
	Central	2.242	µg/cm^2	
	Lower	2.242		
	Upper	2.242		
Transfer Rate (***Tr***): $Tr = 10^{(1.09 \times \log10(Dr) + 0.05)} \div 1000$ µg/mg				
	Central	2.71e-03	mg/(cm^2 hr)	The method of Durkin et al. (1995, p. 68, equation 4) is used to calculate the transfer rate (***Tr***) in units of µg/(cm^2·hr)) based on the dislodgeable residue ***(Dr***) in units of µg/cm^2. This is converted to units of mg/(cm^2·hr)) by dividing by 1000 µg/mg.
	Lower	2.71e-03		
	Upper	2.71e-03		
Amount Transferred to Skin Surface (***Amnt***): ***Tr*** × ***Tc*** × ***A***				
	Central	14.33734	mg	
	Lower	14.33734		
	Upper	14.33734		
Proportion Absorbed (***PropAbs***): $1 - e^{-ka \times Te}$				
	Central	9.79e-03	unitless	
	Lower	3.12e-03		
	Upper	2.37e-02		
Absorbed dose (D_{Abs}): **Amnt** × **PropAbs** ÷ **W**				
	Central	2.19e-03	mg/kg bw	
	Lower	6.98e-04		
	Upper	5.31e-03		

Worksheet D03: Consumption of contaminated fruit, acute exposure scenario [VegAcHHRA01].

Verbal Description: Edible fruit is contaminated by drift (***Dr***). A drift of 1 (unity) indicates direct spray. The individual consumes contaminated fruit shortly after application of the chemical - i.e. no dissipation or degradation is considered. The concentration of the chemical in fruit (***C***) is estimated from empirical relationships relating residues on plants to application rate.

Parameters/Assumptions		Value	Units	Source/Reference
Amount of fruit consumed per Unit Body Weight (***A***):				
	Central	0.00168	kg fruit/kg bw/day	PUBL.FrTC
	Lower	0.00168		PUBL.FrTL
	Upper	0.01244		PUBL.FrTU
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***)				
	Central	2.4	mg/kg per lb/acre	Based on Siltanen et al. (1981) as discussed in Section 3.2.3.6.
	Lower	2.4		
	Upper	5.9		
Drift (***Drift***)				
	Central	1	unitless	Direct spray
	Lower	1		
	Upper	1		
Proportion Removed by Washing (***Wash***)				
	Central	0	unitless	No washing is assumed for this scenario.
	Lower	0		
	Upper	0		
Concentration on fruit (***C***): ***R*** × ***rr*** × ***Drift*** × (1-**Wash**)				
	Central	4.8	mg/kg fruit	
	Lower	4.8		
	Upper	11.8		
Dose estimates (***D***): ***C*** × ***A***				
	Central	8.06e-03	mg/kg bw	
	Lower	8.06e-03		
	Upper	1.47e-01		

Worksheet D04: Consumption of contaminated fruit, chronic exposure scenario [VegChHHRA01].

Verbal Description: An individual consumes contaminated fruit for a period of time (**t**) *starting shortly after application of the chemical.* The concentration of the chemical in fruit at time zero (***C_0***) is estimated from the application rate (***A***), the proportion of drift (***Drift***), and empirical residues rates (***rr***) summarized in HK. The foliar halftime (***t_{50}***) is used to estimate the foliar decay coefficient (***k***): $\mathbf{k = ln(2) \div t_{50}}$. The concentration on the vegetation after time ***t*** (C_t) is calculated as $C_t = C_0 e^{-kt}$. The time-weighted average of the concentration on vegetation ($\mathbf{C_{TWA}}$) is calculated as the integral of the concentration after time ***t*** (C_t) divided by the duration (***t***).

Parameters/Assumptions		Value	Units	Source/Reference
Halftime on vegetation (***t_{50}***)	Central	46	days	CHEM.FrT12C
	Lower	46		CHEM.FrT12L
	Upper	46		CHEM.FrT12U
Duration of exposure (***T***)		90	days	N/A
Amount of fruit consumed per unit body weight(***A***): Central is also used for lower.				
	Central	0.00168	kg fruit/kg bw/day	PUBL.FrTC
	Lower	0.00168		PUBL.FrTL
	Upper	0.01244		PUBL.FrTU
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***):				
	Central	2.4	mg/kg fruit per lb/acre applied	Based on Siltanen et al. (1981) as discussed in Section 3.2.3.6.
	Lower	2.4		
	Upper	5.9		
Drift (***Drift***)				
	Central	1	unitless	Assume direct spray
	Lower	1		
	Upper	1		
Decay coefficient (***k***): ln(2)/***t_{50}***				
	Central	0.015068	day^{-1}	Upper estimate of ***t_{50}*** used to calculate lower limit of ***k*** and lower estimate of ***t_{50}*** used to calculate upper limit of ***k***.
	Lower	0.015068		
	Upper	0.015068		

Worksheet D04 *(continued)*: Consumption of contaminated fruit, chronic exposure scenario [VegChHHRA01].

Initial Concentration on Vegetation ($\mathbf{C_0}$): : $\mathbf{C_0 = A \times Drift \times rr}$

Central	4.8	mg/kg veg.	
Lower	4.8		
Upper	11.8		

Concentration on Vegetation at time $\boldsymbol{T}$ ($\boldsymbol{C_T}$): $\mathbf{C_T = C_0\ e^{-kT}}$

Central	1.24e+00	mg/kg veg.	
Lower	1.24e+00		
Upper	3.04e+00		

Time-weighted Average Concentration on Raw Vegetation ($\boldsymbol{C_{TWA}}$): $\boldsymbol{C_0\ (1 - e^{-k\,T}) \div (k\ T)}$

Central	2.6274863	mg/kg veg.	
Lower	2.6274863		
Upper	6.4592372		

Proportion Removed by Washing ($\boldsymbol{P_{wash}}$):

Central	0	unitless	Assume that washing is ineffective.
Lower	0		
Upper	0		

TWA Concentration on Consumed Vegetation ($\mathbf{C_{Con}}$): $\boldsymbol{C_{TWA} \times 1\text{-}P_{Wash}}$

Central	2.63e+00	mg/kg veg.	
Lower	2.63e+00		
Upper	6.46e+00		

Dose estimates ($\boldsymbol{D}$): $\boldsymbol{C_{Con} \times A}$

Central	4.41e-03	mg/kg bw/day	
Lower	4.41e-03		
Upper	8.04e-02		

Worksheet D05: Consumption of contaminated water following an accidental spill, acute exposure scenario [DWAcHHRA01].

***Verbal Description**:* A young child (2-3 years old) consumes contaminated water shortly after an accidental spill of 200 gallons of a field solution into a pond that has an average depth of 1 m and a surface area of 1000 m^2 or about one-quarter acre . No dissipation or degradation is considered.

Parameters/Assumptions		Value	Units	Source/Reference
Surface area of pond (SA)		1000	m^2	N/A
Average depth (DPTH)		1	m	N/A
Volume of pond in cubic meters (VM)		1000	m^3	N/A
Volume of pond in Liters (VL)		1000000	L	1 m^3 = 1,000 L
Volume of spill (VS)		200	gallons	N/A
		757	liters	1 gallon = 3.785 Liters
Concentrations in field solution (C_{Fld} (mg/L))				
	Central	24000	mg/L	APPL.TypDR × 1000
	Lower	9600		APPL.LowDR × 1000
	Upper	48000		APPL.Hi_DR × 1000
Concentrations in ambient water (C_{Wrt}): $C_{Fld} \times VS_{(Liters)} \div VL$)				
	Central	18.168	mg/L	
	Lower	7.2672		
	Upper	36.336		
Body weight (W)		13.3	kg	PUBL.BWC
Amount of water consumed (A)				
	Central	1	L/day	PUBL.WCT
	Lower	0.61		PUBL.WCL
	Upper	1.5		PUBL.WCH
Dose estimates (D): $C_{wrt} \times A \div W$				
	Central	1.37e+00	mg/kg bw	
	Lower	3.33e-01		
	Upper	4.10e+00		

Worksheet D06: Consumption of from a stream contaminated by runoff and/or percolation, acute exposure scenario [DWAcStrmHHRA01].

Verbal Description: A young child (2-3 years old) consumes contaminated ambient water from a stream that has been contaminated from run-off and/or percolation The levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate (***R***) by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

Parameters/Assumptions		Value	Units	Source/Reference
Application Rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Water Contamination Rate (***WCR***):				
	Central	0.02	mg/L per lb/acre applied	AMBWAT.AWPT
	Lower	0.001		AMBWAT.AWPL
	Upper	0.4		AMBWAT.AWPU
Body weight (***W***)		13.3	kg	PUBL.BWC
Amount of water consumed (***A***)				
	Central	1	L/day	PUBL.WCT
	Lower	0.61		PUBL.WCL
	Upper	1.5		PUBL.WCH
Concentration in Water (***C***): **R × WCR**				
	Central	0.04	mg/L	
	Lower	0.002		
	Upper	0.8		
Dose estimates (***D***): **C × A ÷ W**				
	Central	3.01e-03	mg/kg bw/day	
	Lower	9.17e-05		
	Upper	9.02e-02		

Worksheet D07: Consumption of contaminated water, chronic exposure scenario [DWChHHRA01].

Verbal Description: An adult (70 kg male) consumes contaminated ambient water for a lifetime. The levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

Parameters/Assumptions		Value	Units	Source/Reference
Application Rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Water Contamination Rate (***WCR***):				
	Central	0.001	mg/L per lb/acre applied	AMBWAT.AWT
	Lower	0.0001		AMBWAT.AWL
	Upper	0.008		AMBWAT.AWU
Body weight (***W***)		70	kg	PUBL.BWM
Amount of water consumed (***A***)				
	Central	2	L/day	PUBL.WCAT
	Lower	1.4		PUBL.WCAL
	Upper	2.4		PUBL.WCAH
Concentration in Water (***C***): **R × WCR**				
	Central	0.002	mg/L	
	Lower	0.0002		
	Upper	0.016		
Dose estimates (***D***): **C × A ÷ W**				
	Central	5.71e-05	mg/kg bw/day	
	Lower	4.00e-06		
	Upper	5.49e-04		

Worksheet D08a: Consumption of contaminated fish, acute exposure scenarios for recreational fisherman following an accidental spill [FishAcHHRA01].

***Verbal Description**:* An adult angler consumes fish taken from contaminated water shortly after an accidental spill of a fixed amount of a field solution into a pond of a specified depth and surface area. No dissipation or degradation is considered. As in the acute drinking water scenario, the concentration in the pond estimated from the concentration in the spilled solution, the volume spilled and the volume of the pond, assuming instantaneous mixing. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

Parameters/Assumptions		Value	Units	Source/Reference
Surface area of pond [SA]		1000	m^2	N/A
Average depth [DPTH]		1	m	N/A
Volume of pond in cubic meters [VM]		1000	m^3	N/A
Volume of pond in Liters [VL]		1000000	L	1 m^3 = 1,000 L
Volume of spill [VS]		200	gallons	N/A
		757	liters	1 gallon = 3.785 Liters
Concentrations in spilled solution ($C_{Fld\ (mg/L)}$)				
	Central	24000	mg/L	APPL.TYPDR×1000
	Lower	9600		APPL.LOWDR×1000
	Upper	48000		APPL.HI_DR×1000
Concentrations in ambient water (C_{Wat}): $C_{Fld} \times VS_{(Liters)} \div VL$				
	Central	18.168	mg/L	
	Lower	7.2672		
	Upper	36.336		
Bioconcentration factor ($BCF_{(L/kg\ fish)}$)		0.38	L/kg fish	CHEM.BCFT
Concentration in fish (C_{Fish}): C_{Wat} × BCF				
	Central	6.90384	mg/kg fish	
	Lower	2.761536		
	Upper	13.80768		
Body weight (W)		70	kg	PUBL.BWM
Amount of fish consumed (A)				
	Central	0.158	kg/day	PUBL.FAU
	Lower	0.158		PUBL.FAU
	Upper	0.158		PUBL.FAU
Dose estimates (D): $C_{Fish} \times A \div W$				
	Central	1.56e-02	mg/kg bw	
	Lower	6.23e-03		
	Upper	3.12e-02		

Worksheet D08b: Consumption of contaminated fish, acute exposure scenarios for subsistence populations following an accidental spill [FishAcHHRA02].

***Verbal Description**:* An individual who relies on caught fish as a major source of protein consumes fish taken from contaminated water shortly after an accidental spill of a fixed amount of a field solution into a pond of a specified depth and surface area. As in the acute drinking water scenario, the concentration in the pond estimated from the concentration in the spilled solution, the volume spilled and the volume of the pond, assuming instantaneous mixing. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

Parameters/Assumptions		Value	Units	Source/Reference
Surface area of pond [SA]		1000	m^2	N/A
Average depth [DPTH]		1	m	N/A
Volume of pond in cubic meters [VM]		1000	m^3	N/A
Volume of pond in Liters [VL]		1000000	L	1 m^3 = 1,000 L
Volume of spill [VS]		200	gallons	N/A
		757	liters	1 gallon = 3.785 Liters
Concentrations in spilled solution ($C_{Fld\ (mg/L)}$)				
	Central	24000	mg/L	APPL.TYPDR×1000
	Lower	9600		APPL.LOWDR×1000
	Upper	48000		APPL.HI_DR×1000
Concentrations in ambient water (C_{Wat}): $C_{Fld} \times VS_{(Liters)} \div VL$				
	Central	18.168	mg/L	
	Lower	7.2672		
	Upper	36.336		
Bioconcentration factor ($BCF_{(L/kg\ fish)}$)		0.38	L/kg fish	CHEM.BCFT
Concentration in fish (C_{Fish}): C_{Wat} × BCF				
	Central	6.90384	mg/kg fish	
	Lower	2.761536		
	Upper	13.80768		
Body weight (W)		70	kg	PUBL.BWM
Amount of fish consumed (A)				
	Central	0.77	kg/day	PUBL.FNU
	Lower	0.77		PUBL.FNU
	Upper	0.77		PUBL.FNU
Dose estimates (D): $C_{Fish} \times A \div W$				
	Central	7.59e-02	mg/kg bw	
	Lower	3.04e-02		
	Upper	1.52e-01		

Worksheet D09a: Consumption of contaminated fish, chronic exposure scenario for recreational fisherman [FishChHHRA01].

***Verbal Description**:* An adult (70 kg male) consumes fish taken from contaminated ambient water for a lifetime. The levels in water are estimated from monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. As in the chronic drinking water scenario, the concentration in water is calculated as the application rate multiplied by the water contamination rate. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

Parameters/Assumptions		Value	Units	Source/Reference
Application Rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Water Contamination Rate (***WCR***)				
	Central	0.001	mg/L per lb/acre applied	AMBWAT.AWT
	Lower	0.0001		AMBWAT.AWL
	Upper	0.008		AMBWAT.AWU
Concentration in Water (C_{Wat}): $R \times WCR$				
	Central	0.002	mg/L	
	Lower	0.0002		
	Upper	0.016		
Bioconcentration factor (***BCF***)		0.38	L/kg fish	CHEM.BCFCh
Concentration in fish (C_{Fish}): $C_{Wat} \times$ BCF)				
	Central	0.00076	mg/kg fish	
	Lower	0.000076		
	Upper	0.00608		
Body weight (***W***)		70	kg	PUBL.BWM
Amount of fish consumed (***A***)				
	Central	0.01	kg/day	PUBL.FAT
	Lower	0.01		PUBL.FAT
	Upper	0.01		PUBL.FAT
Dose estimates (***D***): $\mathbf{C_{Fish}} \times \mathbf{A} \div \mathbf{W}$				
	Central	1.09e-07	mg/kg bw/day	
	Lower	1.09e-08		
	Upper	8.69e-07		

Worksheet D09b: Consumption of contaminated fish, chronic exposure scenario for subsistence populations [FishChHHRA02].

Verbal Description: An individual who relies on caught fish as a major source of protein consumes fish taken from contaminated ambient water for a lifetime. The levels in water are estimated from monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. As in the chronic drinking water scenario, the concentration in water is calculated as the application rate multiplied by the water contamination rate. The concentration in fish is estimated as the product of the concentration in water and the chronic BCF. The dose is calculated as the product of the concentration in the fish and the amount of fish consumed divided by the body weight.

Parameters/Assumptions		Value	Units	Source/Reference
Application Rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Water Contamination Rate (***WCR***) : **C** ÷ ***R***				
	Central	0.001	mg/L per lb/acre applied	AMBWAT.AWT
	Lower	0.0001		AMBWAT.AWL
	Upper	0.008		AMBWAT.AWU
Concentration in Water (***C***): **R** × **WCR**				
	Central	0.002	mg/L	
	Lower	0.0002		
	Upper	0.016		
Bioconcentration factor (***BCF***)		0.38	L/kg fish	CHEM.BCFCh
Concentration in fish (C_{Fish}): C_{Wat} × **BCF**				
	Central	0.00076	mg/kg fish	
	Lower	0.000076		
	Upper	0.00608		
Body weight (***W***)		70	kg	PUBL.BWM
Amount of fish consumed (***A***)				
	Central	0.081	kg/day	PUBL.FNT
	Lower	0.081		PUBL.FNT
	Upper	0.081		PUBL.FNT
Dose estimates (***D***): C_{Fish} × ***A*** ÷ ***W***				
	Central	8.79e-07	mg/kg bw/day	
	Lower	8.79e-08		
	Upper	7.04e-06		

SUMMARY TABLES FOR HUMAN HEALTH RISK ASSESSMENT

Worksheet E01: Summary of Worker Exposure Scenarios

Scenario	Dose (mg/kg/day or event)			Exposure Assessment Worksheet
	Central	Lower	Upper	
General Exposures (dose in mg/kg/day)				
Directed ground spray (Backpack)	2.63e-02	9.00e-04	1.60e-01	C01a
Broadcast ground spray (Boom spray)	4.48e-02	1.32e-03	3.02e-01	C01b
Aerial applications	2.94e-02	4.80e-04	1.60e-01	C01c
Accidental/Incidental Exposures (dose in mg/kg/event)				
Immersion of Hands, 1 minute	7.20e-06	7.10e-07	6.05e-05	C02a
Contaminated Gloves, 1 hour	4.32e-04	4.26e-05	3.63e-03	C02b
Spill on hands, 1 hour	9.44e-04	1.20e-04	4.61e-03	C03a
Spill on lower legs, 1 hour	2.33e-03	2.95e-04	1.14e-02	C03b

Worksheet E02: Summary of risk characterization (HQ's[1]) for workers.

Acute RfD	2	mg/kg/day	Sect. 3.3.3.	
Chronic RfD	2	mg/kg/day	Sect. 3.3.3.	

Scenario	Hazard Quotient Based on Chronic RfD			Exposure Assessment Worksheet
	Central	Lower	Upper	
General Exposures [using Chronic RfD]				
Directed ground spray (Backpack)	1e-02	5e-04	8e-02	C01a
Broadcast ground spray (Boom spray)	2e-02	7e-04	2e-01	C01b
Aerial applications	1e-02	2e-04	8e-02	C01c
Accidental/Incidental Exposures [using Acute RfD]				
Scenario	Hazard Quotient Based on Acute RfD			Exposure Assessment Worksheet
	Central	Lower	Upper	
Immersion of Hands, 1 minute	4e-06	4e-07	3e-05	C02a
Contaminated Gloves, 1 hour	2e-04	2e-05	2e-03	C02b
Spill on hands, 1 hour	5e-04	6e-05	2e-03	C03a
Spill on lower legs, 1 hour	1e-03	1e-04	6e-03	C03b

[1] The hazard quotients are the level of exposure divided by the RfD then rounded to one or two significant decimal places or digits. Hazard quotients >1 and ≤2 are shown to two significant digits. All others are rounded to one significant decimal place or integer. All hazard quotients that are below the level of concern – i.e., a hazard quotient below unity – are expressed in scientific notation. All hazard quotients greater than unity are expressed in fixed point decimal notation and highlighted with a shaded background.

Worksheet E03: Summary of Exposure Scenarios for the General Public

Scenario	Target	Dose (mg/kg/day)			Worksheet
		Central	Lower	Upper	
Acute/Accidental Exposures					
Direct spray, entire body	Child	3.57e-02	4.53e-03	1.74e-01	D01a
Direct spray, lower legs	Woman	3.58e-03	4.55e-04	1.75e-02	D01b
Dermal, contaminated vegetation	Woman	2.19e-03	6.98e-04	5.31e-03	D02
Contaminated fruit	Woman	8.06e-03	8.06e-03	1.47e-01	D03
Contaminated water, spill	Child	1.37e+00	3.33e-01	4.10e+00	D05
Contaminated water, stream	Child	3.01e-03	9.17e-05	9.02e-02	D06
Consumption of fish, general public	Man	1.56e-02	6.23e-03	3.12e-02	D08a
Consumption of fish, subsistence populations	Man	7.59e-02	3.04e-02	1.52e-01	D08b
Chronic/Longer Term Exposures					
Contaminated fruit	Woman	4.41e-03	4.41e-03	8.04e-02	D04
Consumption of water	Man	5.71e-05	4.00e-06	5.49e-04	D07
Consumption of fish, general public	Man	1.09e-07	1.09e-08	8.69e-07	D09a
Consumption of fish, subsistence populations	Man	8.79e-07	8.79e-08	7.04e-06	D09b

Worksheet E04: Summary of risk characterization (HQ's[1]) for the general public [1] .

Chronic RfD		2	mg/kg/day	Sect. 3.3.3.	
Acute RfD		2	mg/kg/day	Sect. 3.3.3.	

Scenario	Target	Hazard Quotient			Worksheet
		Central	Lower	Upper	
Acute/Accidental Exposures					
Direct spray, entire body	Child	2e-02	2e-03	9e-02	D01a
Direct spray, lower legs	Woman	2e-03	2e-04	9e-03	D01b
Dermal, contaminated vegetation	Woman	1e-03	3e-04	3e-03	D02
Contaminated fruit	Woman	4e-03	4e-03	7e-02	D03
Contaminated water, spill	Child	7e-01	2e-01	**2**	D05
Contaminated water, stream	Child	2e-03	5e-05	5e-02	D06
Consumption of fish, general public	Man	8e-03	3e-03	2e-02	D08a
Consumption of fish, subsistence populations	Man	4e-02	2e-02	8e-02	D08b
Chronic/Longer Term Exposures					
Contaminated fruit	Woman	2e-03	2e-03	4e-02	D04
Consumption of water	Man	3e-05	2e-06	3e-04	D07
Consumption of fish, general public	Man	5e-08	5e-09	4e-07	D09a
Consumption of fish, subsistence populations	Man	4e-07	4e-08	4e-06	D09b

[1] The hazard quotients are the level of exposure divided by the RfD then rounded to one or two significant decimal places or digits. Hazard quotients >1 and ≤2 are shown to two significant digits. All others are rounded to one significant decimal place or integer. All hazard quotients that are below the level of concern – i.e., a hazard quotient below unity – are expressed in scientific notation. All hazard quotients greater than unity are expressed in fixed point decimal notation and highlighted with a shaded background.

Worksheet F01: Direct spray of small mammal assuming first order absorption kinetics [DDFOAEco01].

Verbal Description: A mammal of a specified body weight is directly sprayed over one half of the body surface as the chemical is being applied. An empirical relationship between body weight and surface area is used to estimate the surface area of the animal. The absorbed dose over the first day – i.e., a 24 hour period – is estimated using the assumption of first-order dermal absorption.

Parameter/Assumption		Value	Units	Source/Reference
Period of exposure (***T***)		24	hour	N/A
Body weight (***W***)		0.020	kg	Section 4.2.1.
Exposed surface area (***A***)		$m^2=0.11 \times BW(kg)^{0.65}$		U.S. EPA/ORD 1993, eq. 3-22, p. 3-14
		0.0086509	m^2	
		86.51	cm^2	10,000 cm^2 /m^2
Application rate in lbs/acre (***R***$_{lbs}$)				
	Central	2	lb/acre	APPL.TYP
	Lower	2		APPL.LOW
	Upper	2		APPL.HI
Conversion Factor (***CF***) for lb/acre to mg/cm^2		0.01121		Const.LBAC_MGCM
Application rate in mg/cm^2 (***R***$_{mg}$): ***R***$_{lbs}$ × ***CF***				
	Central	0.02242	lb/acre	
	Lower	0.02242		
	Upper	0.02242		
First-order dermal absorption rate (***k***)				
	Central	0.00041	$hour^{-1}$	DERM.AbsC
	Lower	0.000130		DERM.AbsL
	Upper	0.00100		DERM.AbsU
Amount deposited on animal (***Amnt***): ***0.5*** × ***A*** × ***R***$_{mg}$				
	Central	0.96977	mg	
	Lower	0.969768		
	Upper	0.96977		
Proportion absorbed over period ***T*** (***Prop***): $1-e^{-k\,T}$				
	Central	0.00979	unitless	
	Lower	0.003115		
	Upper	0.02371		
Estimated Absorbed Doses (***D***): **Amnt × Prop ÷ W**				
	Central	4.75e-01	mg/kg	
	Lower	1.51e-01		
	Upper	1.15e+00		

Worksheet F02a: Direct spray of small mammal assuming 100% absorption over the first 24 hour period [DDEco01].

Verbal Description*: A 20 g mammal is directly sprayed over one half of the body surface as the chemical is being applied. The deposited dose is assumed to be completely absorbed during the first day. An empirical relationship between body weight and surface area is used to estimate the surface area of the animal.*

Parameter/Assumption		Value	Units	Source/Reference
Period of exposure (***T***)		24	hour	N/A
Body weight (***W***)		0.020	kg	Section 4.2.1.
Exposed surface area		$m^2=0.011 \times BW(g)^{0.65}$		U.S. EPA/ORD 1993, eq. 3-22, p. 3-14
		0.0086509	m^2	
	(***SA***)	86.51	cm^2	m^2 = 10,000 cm^2
Application rate in lbs/acre ($\boldsymbol{R_{lbs}}$)				
	Central	2	lb/acre	APPL.TYP
	Lower	2		APPL.LOW
	Upper	2		APPL.HI
Conversion Factor (***CF***) for lb/acre to mg/cm^2		0.01121		Const.LBAC_MGCM
Application rate in mg/cm^2 ($\boldsymbol{R_{mg}}$): $\boldsymbol{R_{lbs} \times CF}$				
	Central	0.02242	mg/cm^2	
	Lower	0.02242		
	Upper	0.02242		
Amount deposited on animal (***Amnt***): $\boldsymbol{0.5 \times SA \times R_{mg}}$				
	Central	0.96977	mg	
	Lower	0.969768		
	Upper	0.96977		
Estimated Absorbed Doses ($\boldsymbol{D_{Abs}}$): **Amnt ÷ W**				
	Central	4.85e+01	mg/kg	
	Lower	4.85e+01		
	Upper	4.85e+01		

Worksheet F02b: Direct spray of bee assuming 100% absorption over the first 24 hour period [DDEco02].

Verbal Description*: A honeybee is directly sprayed over one half of the body surface as the chemical is being applied. The deposited dose is assumed to be completely absorbed during the first day. An empirical relationship between body weight and surface area is used to estimate the surface area of the animal.*

Parameter/Assumption		Value	Units	Source/Reference
Period of exposure (***T***)		24	hour	N/A
Body weight (***W***)		0.000093	kg	Section 4.2.1.
Exposed surface area (***SA***)		$cm^2=1110\times BW(kg)^{0.65}$		Boxenbaum and D'Souza 1990
		2.6597260	cm^2	
Application rate ($\boldsymbol{R_{lbs}}$)				
	Central	2	lb/acre	APPL.TYP
	Lower	2		APPL.LOW
	Upper	2		APPL.HI
Conversion Factor (***CF***) for lb/acre to mg/cm^2		0.01121		Const.LBAC_MGCM
Application rate in mg/cm^2 ($\boldsymbol{R_{mg}}$): $\boldsymbol{R_{lbs} \times CF}$				
	Central	0.02242	mg/cm^2	
	Lower	0.02242		
	Upper	0.02242		
Amount deposited on animal (***Amnt***): $\boldsymbol{0.5 \times SA \times R_{mg}}$				
	Central	0.02982	mg	
	Lower	0.029816		
	Upper	0.02982		
Estimated Absorbed Doses ($\boldsymbol{D}_{Abs}$): ***Amnt ÷ W***				
	Central	3.21e+02	mg/kg	
	Lower	3.21e+02		
	Upper	3.21e+02		

Worksheet F03: Consumption of contaminated fruit by a small mammal, acute exposure scenario [VegAcERA01].

Verbal Description*: A 20 g mammal consumes fruit shortly after application of the chemical - i.e. no dissipation or degradation is considered. The contaminated vegetation accounts for 100% of the diet. Residue estimates based on relationships for fruit from Hoerger and Kenaga (1972) summarized in Worksheet A05a.*

Parameters/Assumptions		Value	Units	Source/Reference
Body weight (***W***)		0.020	kg	Section 4.2.1
Allometric coefficients for food consumption in g based on body weight in g				
	a	0.621		Rodents U.S. EPA/ORD 1993, p. 3-6
	b	0.584		
Food consumed per day (***A***): **a×(W×1000)^{b}÷1000**				
		0.003572	kg	
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***)				
	Central	2.4	mg/kg fruit per lb/acre applied	Based on Siltanen et al. (1981) as discussed in Section 3.2.3.6.
	Lower	2.4		
	Upper	5.9		
Concentration in food(***C***): **R × rr**				
	Central	4.8	mg/kg food	
	Lower	4.8		
	Upper	11.8		
Dose estimates (***D***): **A × C ÷ W**				
	Central	8.57e-01	mg/kg bw	
	Lower	8.57e-01		
	Upper	2.11e+00		

Worksheet F04a: Consumption of contaminated fruit by a small mammal, chronic exposure scenario at application site [VegChSmMam01].

Verbal Description**:* A 20 g mammal consumes contaminated fruit for a 90 day period starting shortly after application of the chemical. Food consumption is estimated from allometric relationships. The concentration of the chemical in fruit at time zero (C_0) is estimated from the application rate (A***), the proportion of drift (***Drift***), and empirical residues rates (***rr***) summarized in HK. Because the animal is assumed to inhabit the application site, drift is taken as unity - i.e., direct spray. The foliar halftime (t_{50}) is used to estimate the foliar decay coefficient (***k***): $\mathbf{k = \ln(2) \div t_{50}}$. The concentration on the vegetation after time ***t*** (C_t) is calculated as $C_t = C_0 e^{-kt}$. The time-weighted average of the concentration on vegetation ($\mathbf{C_{TWA}}$) is calculated as the integral of the concentration after time ***t*** (C_t) divided by the duration (***t***). The daily dose is calculated as the product of food consumption and the proportion of the diet that is contaminated divided by the body weight.

Parameters/Assumptions		Value	Units	Source/Reference
Duration of exposure (***T***)		90	days	N/A
Body weight (***W***)		0.02	kg	N/A
Allometric coefficients for food consumption in g based on body weight in g				
	a	0.621		U.S. EPA/ORD 1993, p. 3-6
	b	0.584		
Food consumed per day (***A***): $\mathbf{a \times (W \times 1000)^{b} \div 1000}$				
		0.0035718	kg	
Foliar halftimes ($t_{½}$)	Central	46	days	CHEM.FrT12C
	Lower	46		CHEM.FrT12L
	Upper	46		CHEM.FrT12U
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***):				
	Central	2.4	mg/kg fruit per lb/acre applied	Based on Siltanen et al. (1981) as discussed in Section 3.2.3.6.
	Lower	2.4		
	Upper	5.9		
Drift (***Drift***):				
	Central	1	unitless	Assume direct spray
	Lower	1		
	Upper	1		
Decay coefficient (***k***): $\ln(2)/t_{50}$				
	Central	0.0150684	day^{-1}	Upper estimate of t_{50} used to calculate lower limit of ***k*** and lower estimate of t_{50} used to calculate upper limit of ***k***.
	Lower	0.0150684		
	Upper	0.0150684		

Worksheet F04a *(continued)*: Consumption of contaminated vegetation by a small mammal, chronic exposure scenario .

Initial Concentration on Vegetation ($\mathbf{C_0}$): : $\mathbf{C_0 = R \times rr \times Drift}$

Central	4.8	mg/kg veg.	
Lower	4.8		
Upper	11.8		

Concentration on Vegetation at time $\boldsymbol{T}$ ($\boldsymbol{C_T}$): $\mathbf{C_T = C_0\ e^{-kT}}$

Central	1.24e+00	mg/kg veg.	These values are not used directly in calculating the dose.
Lower	1.24e+00		
Upper	3.04e+00		

Time-weighted Average Concentration on Vegetation ($\boldsymbol{C_{TWA}}$): $\boldsymbol{C_0\ (1 - e^{-k\,T}) \div (k\ T)}$

Central	2.63e+00	mg/kg veg.	
Lower	2.63e+00		
Upper	6.46e+00		

Proportion of Diet Contaminated (***Prop***)[1]:

Central	0.1	unitless	See footnote.
Lower	0.05		
Upper	0.2		

Dose estimates ($\boldsymbol{D_{Abs}}$): $\mathbf{C_{TWA} \times A \times Prop \div W}$

Central	4.69e-02	mg/kg/day
Lower	2.35e-02	
Upper	2.31e-01	

[1] Based on data on the shrew (U.S. EPA/ORD 1996, p. 2-214,), the vegetation accounts for about 5% of the diet. This is used as the lower limit. The typical and upper values are judgementally set to account for incidental contamination of other contaminated food items such as insects as well as different feeding preferences among other small mammals.

Worksheet F04b: Consumption of contaminated fruit by a small mammal, chronic exposure scenario off-site [VegChSmMam02].

Verbal Description: A 20 g mammal consumes contaminated fruit for a 90 day period starting shortly after application of the chemical. Food consumption is estimated from allometric relationships. The concentration of the chemical in fruit at time zero (***C_0***) is estimated from the application rate (***A***), the proportion of drift (***Drift***), and empirical residues rates (***rr***) summarized in HK. Drift is estimated for distances of 25 to 100 feet from the application site. The foliar halftime (***t_{50}***) is used to estimate the foliar decay coefficient (***k***): $\mathbf{k = ln(2) \div t_{50}}$. The concentration on the vegetation after time ***t*** (C_t) is calculated as $C_t = C_0 e^{-kt}$. The time-weighted average of the concentration on vegetation ($\mathbf{C_{TWA}}$) is calculated as the integral of the concentration after time ***t*** (C_t) divided by the duration (***t***). The daily dose is calculated as the product of food consumption and the proportion of the diet that is contaminated divided by the body weight.

Parameters/Assumptions		Value	Units	Source/Reference
Duration of exposure (***T***)		90	days	N/A
Body weight (***W***)		0.02	kg	Section 4.2.1
Allometric coefficients for food consumption in g based on body weight in g				
	a	0.621		U.S. EPA/ORD 1993, p. 3-6
	b	0.584		
Food consumed per day (***A***): $\mathbf{a \times (W \times 1000)^b \div 1000}$				
		0.0035718	kg	
Foliar halftimes (***$t_{½}$***)	Central	46	days	CHEM.FrT12C
	Lower	46		CHEM.FrT12L
	Upper	46		CHEM.FrT12U
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***):				
	Central	2.4	mg/kg fruit per lb/acre applied	Based on Siltanen et al. (1981) as discussed in Section 3.2.3.6.
	Lower	2.4		
	Upper	5.9		
Drift (***Drift***):				
	50 feet	0.0101	unitless	Estimated from AgDRIFT for low-boom applications. See Worksheet A06.
	100 feet	0.0058		
	25 feet	0.0187		
Decay coefficient (***k***): ln(2)/***t_{50}***				
	Central	0.0150684	day^{-1}	Upper estimate of ***t_{50}*** used to calculate lower limit of ***k*** and lower estimate of ***t_{50}*** used to calculate upper limit of ***k***.
	Lower	0.0150684		
	Upper	0.0150684		

Worksheet F04b *(continued)*: Consumption of contaminated vegetation by a small mammal, chronic off-site exposure scenario .

Initial Concentration on Vegetation ($\mathbf{C_0}$): $\mathbf{C_0 = R \times rr \times Drift}$

Central	0.04848	mg/kg veg.
Lower	0.02784	
Upper	0.22066	

Concentration on Vegetation at time T (C_T): $\mathbf{C_T = C_0\ e^{-kT}}$

Central	1.25e-02	mg/kg veg.
Lower	7.17e-03	
Upper	5.69e-02	

Time-weighted Average Concentration on Vegetation (C_{TWA}): $\mathbf{C_0\ (1 - e^{-k\,T}) \div (k\ T)}$

Central	2.65e-02	mg/kg veg.
Lower	1.52e-02	
Upper	1.21e-01	

Proportion of Diet Contaminated (***Prop***)[1]:

Central	0.1	unitless	See footnote.
Lower	0.05		
Upper	0.2		

Dose estimates (D): $\mathbf{C_{TWA} \times A \times Prop \div W}$

Central	4.74e-04	mg/kg bw/day
Lower	1.36e-04	
Upper	4.31e-03	

[1] Based on data on the shrew (U.S. EPA/ORD 1996, p. 2-214,), the vegetation accounts for about 5% of the diet. This is used as the lower limit. The typical and upper values are judgementally set to account for incidental contamination of other food items such as insects as well as different feeding preferences among other small mammals.

Worksheet F05: Consumption of contaminated water by a small mammal, acute exposure scenario for an accidental spill. [DWAcERA01].

Verbal Description*: An animal of a specified weight consumes contaminated water shortly after an accidental spill into a small pond. No dissipation or degradation is considered.* The amount of water consumed is estimated from allometric relationships

Parameters/Assumptions		Value	Units	Source/Reference
Surface area of pond [SA]		1000	m^2	N/A
Average depth [DPTH]		1	m	N/A
Volume of pond in cubic meters [VM]		1000	m^3	N/A
Volume of pond in Liters [VL]		1000000	L	1 m^3 = 1,000 L
Volume of spill [VS]		200	gallons	N/A
		757	liters	1 gallon = 3.785 Liters
Concentrations in field solution (C_{Fld} (mg/L))				
	Central	24000	mg/L	APPL.TypDR × 1000
	Lower	9600		APPL.LowDR × 1000
	Upper	48000		APPL.Hi_DR × 1000
Concentrations in ambient water (C_{Wrt}): $C_{Fld} \times VS_{(Liters)} \div VL$)				
	Central	18.168	mg/L	
	Lower	7.2672		
	Upper	36.336		
Body weight (W)		0.02	kg	Section 4.2.1
Allometric coefficients for water consumption in L based on body weight in kg				
	a	0.099		All mammals. U.S. EPA/ORD 1993, Eq. 3-17, p. 3-10.
	b	0.9		
Water consumed per day (A): $\mathbf{a \times W^b}$				
		0.002928	L	
Dose estimates (D): $C_{wrt} \times A \div W$				
	Central	2.66e+00	mg/kg bw	
	Lower	1.06e+00		
	Upper	5.32e+00		

Worksheet F06: Consumption of contaminated water by a small mammal, acute exposure scenario for runoff or percolation into a stream. [DWAcStrmERA01].

Verbal Description: An small mammal consumes stream water contaminated by runoff and/or percolation. The peak levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

Parameters/Assumptions		Value	Units	Source/Reference
Application Rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Peak Water Contamination Rate (***rr***):				
	Central	0.02	mg/L per lb/acre applied	AMBWAT.AWPT
	Lower	0.001		AMBWAT.AWPL
	Upper	0.4		AMBWAT.AWPU
Body weight (***W***)		0.02	kg	
Allometric coefficients for water consumption in L based on body weight in kg				
	a	0.099		All mammals. U.S. EPA/ORD 1993, Eq. 3-17, p. 3-10.
	b	0.9		
Water consumed per day (***A***): $\mathbf{a \times W^{b}}$				
		0.002928	L	
Concentration in Water (***C***): **R** × **rr**				
	Central	0.04	mg/L	These values are used in Worksheet G03 for characterizing acute risks to aquatic species.
	Lower	0.002		
	Upper	0.8		
Dose estimates (***D***): **C** × **A** ÷ **W**				
	Central	0.00586	mg/kg bw/day	
	Lower	0.00029		
	Upper	0.11712		

Worksheet F07: Consumption of contaminated water by a small mammal, chronic exposure scenario [DWChERA01].

Verbal Description: A small mammal consumes contaminated ambient water for an extended period of time. The levels in water are estimated from modeling or monitoring data and thus dissipation, degradation and other environmental processes are implicitly considered. The calculations involve multiplying the application rate by the water contamination rate to get the concentration in ambient water. This product is in turn multiplied by the amount of water consumed per day and then divided by the body weight to get the estimate of the absorbed dose.

Parameters/Assumptions		Value	Units	Source/Reference
Application Rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Water Contamination Rate (***rr***):				
	Central	0.001	mg/L per lb/acre applied	AMBWAT.AWT
	Lower	0.0001		AMBWAT.AWL
	Upper	0.008		AMBWAT.AWU
Body weight (***W***)		0.02	kg	
Allometric coefficients for water consumption in L based on body weight in kg				
	a	0.099		All mammals. U.S. EPA/ORD 1993, Eq. 3-17, p. 3-10.
	b	0.9		
Water consumed per day (***A***): $\mathbf{a \times W^b}$				
		0.002928	L	
Concentration in Water (***C***): **R** × **rr**				
	Central	0.002	mg/L	
	Lower	2.00e-04		
	Upper	0.016		
Dose estimates (***D***): **C** × **A** ÷ **W**				
	Central	0.000293	mg/kg/day	
	Lower	0.0000293		
	Upper	0.002342		

Worksheet F08: Consumption of contaminated fish by predatory bird, acute exposure scenario after accidental spill. *[FishBirdAcute]*

Verbal Description: A predatory bird consumes fish taken from contaminated water after an accidental spill of 200 gallons of a field solution into a pond that has an average depth of 1 m and a surface area of 1000 m^2 or about one-quarter acre . No dissipation or degradation is considered. The assumption is made that bioconcentration will reach equilibrium. This probably will overestimate exposure and subsequent risk.

Parameters/Assumptions		Value	Units	Source/Reference
Surface area of pond (SA)		1000	m^2	N/A
Average depth (DPTH)		1	m	N/A
Volume of pond in cubic meters (VM)		1000	m^3	N/A
Volume of pond in Liters (VL)		1000000	L	1 m^3 = 1,000 L
Volume of spill (VS)		200	gallons	N/A
	VS_L	757	liters	1 gallon = 3.785 liters
Concentrations in field solution (***FC***)				
	Central	24000	mg/L	APPL.TypDR×1000
	Lower	9600		APPL.LowDR×1000
	Upper	48000		APPL.Hi_DR×1000
Concentrations in ambient water (***WC***): **FC × VS_L /VL**				
	Central	18.168	mg/L	
	Lower	7.2672		
	Upper	36.336		
Bioconcentration factor (***BCF***)		0.52	L/kg fish	CHEM.BCFWA
Concentrations in fish (***C_{Fish}***): **WC × BCF**				
	Central	9.44736	mg/kg fish	
	Lower	3.778944		
	Upper	18.89472		
Fish consumed as a proportion of body weight (**P_F**)				
	Central	0.1	g fish/g bw	Various species based on values from U.S. EPA/ORD (1993).
	Lower	0.05		
	Upper	0.15		
Dose estimates (D) (**C_{Fish} × P_F**)				
	Central	9.45e-01	mg/kg bw/day	
	Lower	1.89e-01		
	Upper	2.83e+00		

Worksheet F09: Consumption of contaminated fish by predatory bird, chronic exposure scenario. *[FishBirdChronic]*

***Verbal Description**: An predatory bird consumes fish taken from contaminated ambient water for a lifetime. The levels in water are estimated from monitoring and modeling data and dissipation, degradation and other environmental processes are considered.*

Parameters/Assumptions		Value	Units	Source/Reference
Application Rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Water Contamination Rate (***WCR***)				
	Central	0.001	mg/L per lb/acre applied	AMBWAT.AWT
	Lower	0.0001		AMBWAT.AWL
	Upper	0.008		AMBWAT.AWU
Concentration in Water (***C***): **WCR × R**				
	Central	0.002	mg/L	These values are used in G03 for chronic assessment of aquatic species.
	Lower	0.0002		
	Upper	0.016		
Bioconcentration factor (***BCF***)		0.52	L/kg fish	CHEM.BCFWhl
Concentrations in fish (***FC***): **C × BCF**				
	Central	0.00104	mg/kg fish	
	Lower	0.000104		
	Upper	0.00832		
Fish consumed as a proportion of body weight ($\boldsymbol{P_F}$)				
	Central	0.1	g fish/g bw	Various species based on values from U.S. EPA/ORD (1993).
	Lower	0.05		
	Upper	0.15		
Dose estimates (***D***): $\mathbf{FC \times P_F}$				
	Central	1.04e-04	mg/kg bw/day	
	Lower	5.20e-06		
	Upper	1.25e-03		

Worksheet F10: Consumption of contaminated vegetation by a large mammal, acute exposure scenario on-site. *[VGCLMA]*

***Verbal Description**:* A 70 kg herbivore, such as a deer, consumes short grass shortly after application of the chemical - i.e. no dissipation or degradation is considered. Caloric requirements are used to estimate food consumption.

Parameters/Assumptions		Value	Units	Source/Reference
Body weight (***W***)		70	kg	N/A
Caloric requirement (***KR***)		5226.288	kcal/day	U.S. EPA/ORD (1993, p. 3-6)
above based on following equation: $kcal/day = 1.518 \times W(g)^{0.73}$				
Caloric content of vegetation (dry weight, ***KCD***)		2.46	kcal/g	U.S. EPA (1993, p. 3-5)
Water content of vegetation (proportion, ***PW***)		0.85	unitless	U.S. EPA/ORD (1993, p. 4-14)
Caloric content of vegetation (wet weight, ***KCW***)		0.37	kcal/g	***KCD*** × (1-***PW***)
Food consumed per day (wet weight, ***A***)		14.16338	kg	(***KR*** ÷ ***KCW***)/1000 g/kg
Duration of exposure (***T***)		1	day	N/A
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***)				
	Central	85	mg/kg veg. per lb/acre applied	HK.SGT
	Lower	85		HK.SGT
	Upper	240		HK.SGU
Conc. in Vegetation (***C***): ***R*** × ***rr***				
	Central	170	mg/kg	Note: lower value based on typical ***rr*** and lower ***R***.
	Lower	170		
	Upper	480		
Drift (***Drift***)				
	Central	1	unitless	Direct spray on-site
	Lower	1		
	Upper	1		
Proportion of Diet Contaminated (***Prop***)				
	Central	1	unitless	Assume grazing exclusively on-site.
	Lower	1		
	Upper	1		
Dose estimates (***D***): **Drift × Prop × C × A ÷W**				
	Central	3.44e+01	mg/kg bw	
	Lower	3.44e+01		
	Upper	9.71e+01		

Worksheet F11a: Consumption of contaminated vegetation by a large mammal, chronic exposure scenario on-site [VegChLrgMam01].

Verbal Description: A 70 kg herbivore, such as a deer, consumes short grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 10 to 100% of the diet assuming that the animal would spend 10 to 100% of the grazing time at the application site. Because the animal is assumed to be on-site, drift is set to unity - i.e., direct spray. Residue estimates based on relationships for range grass. Caloric requirements are used to estimate food consumption. Dissipation is considered using the foliar halftime and taking time-weighted average concentration over the exposure period.

Parameters/Assumptions		Value	Units	Source/Reference
Duration of exposure (***T***)		90	days	N/A
Body Weight (***W***)		70	kg	
Caloric requirement (***KR***)		5226.28803	kcal/day	U.S. EPA/ORD (1993, p. 3-6)
above based on following equation: $kcal/day = 1.518 \times W(g)^{0.73}$				
Caloric content of vegetation (dry weight, ***KCD***)		2.46	kcal/g	U.S. EPA/ORD (1993, p. 3-5)
Water content of vegetation (proportion, ***PW***)		0.85	unitless	U.S. EPA/ORD (1993, p. 4-14)
Caloric content of vegetation (wet weight, ***KCW***)		0.369	kcal/g	***KCD*** × (1-***PW***)
Food consumed per day (wet weight, ***A***)		14.1633822	kg	(***KR*** ÷ ***KCW***)/1000 g/kg
Foliar halftimes ($t_{½}$)	Central	46	days	Worksheet B03
	Lower	46		
	Upper	46		
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***):				
	Central	85	mg/kg veg per lb/acre	HK.SGT
	Lower	85		HK.SGU
	Upper	240		HK.SGU
Drift (***Drift***)				
	Central	1	unitless	On-site scenario assumes a function drift of 1 - i.e., direct spray
	Lower	1		
	Upper	1		
Decay coefficient (***k***): $\ln(2)/t_{50}$				
	Central	0.0150684	day^{-1}	Upper estimate of t_{50} used to calculate lower limit of ***k*** and lower estimate of t_{50} used to calculate upper limit of ***k***.
	Lower	0.0150684		
	Upper	0.0150684		

Worksheet F11a *(continued)*: Consumption of contaminated vegetation by a large mammal, chronic exposure scenario on-site.

Initial Concentration on Vegetation ($\mathbf{C_0}$): **R × rr × Drift**

Central	170	mg/kg veg.
Lower	170	
Upper	480	

Concentration on Vegetation at time ***T*** ($\boldsymbol{C_T}$): $\mathbf{C_0\ e^{-kT}}$

Central	4.38e+01	mg/kg veg.
Lower	4.38e+01	
Upper	1.24e+02	

Time-weighted Average Concentration on Vegetation ($\boldsymbol{C_{TWA}}$): $\boldsymbol{C_0\ (1 - e^{-k\,T}) \div (k\ T)}$

Central	93.0568071	mg/kg veg.
Lower	93.0568071	
Upper	262.748632	

Proportion of Diet Contaminated (***Prop***)

Central	0.3	unitless
Lower	0.1	
Upper	1.0	

Dose estimates (***D***): $\boldsymbol{C_{TWA}} \times \boldsymbol{A} \times$ **Prop** $\div \boldsymbol{W}$

Central	5.65e+00	mg/kg bw/day
Lower	1.88e+00	
Upper	5.32e+01	

Worksheet F11b: Consumption of contaminated vegetation by a large mammal, chronic exposure scenario off-site [VegChLrgMam02].

Verbal Description: A 70 kg herbivore, such as a deer, consumes range grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 100% of the diet assuming that the animal would spends all of the grazing time near the application site. Drift is estimated at distances of 25 to 100 feet from the application site. Residue estimates based on relationships for range grass. Caloric requirements are used to estimate food consumption. Dissipation is considered using the foliar halftime and taking time-weighted average concentration over the exposure period.

Parameters/Assumptions		Value	Units	Source/Reference
Duration of exposure (***D***)		90	days	N/A
Body Weight (***W***)		70	kg	
Caloric requirement (***KR***)		5226.28803	kcal/day	U.S. EPA/ORD (1993, p. 3-6)
above based on following equation: $kcal/day = 1.518 \times W(g)^{0.73}$				
Caloric content of vegetation (dry weight, ***KCD***)		2.46	kcal/g	U.S. EPA/ORD (1993, p. 3-5)
Water content of vegetation (proportion, ***PW***)		0.85	unitless	U.S. EPA/ORD (1993, p. 4-14)
Caloric content of vegetation (wet weight, ***KCW***)		0.37	kcal/g	***KCD*** × (1-***PW***)
Food consumed per day (wet weight, ***A***)		14.16	kg	(***KR*** ÷ ***KCW***)/1000 g/kg
Foliar halftimes ($t_{½}$)	Central	46	days	Worksheet B03
	Lower	46		
	Upper	46		
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***):				
	Central	85	mg/kg veg per lb/acre	HK.SGT
	Lower	85		HK.SGU
	Upper	240		HK.SGU
Drift (***Drift***)				
	50 feet	0.0101	unitless	Estimated from AgDRIFT for low-boom applications. See Worksheet A06.
	100 feet	0.0058		
	25 feet	0.0187		
Decay coefficient (***k***): ln(2)/t_{50}				
	Central	0.0150684	day^{-1}	Upper estimate of t_{50} used to calculate lower limit of ***k*** and lower estimate of t_{50} used to calculate upper limit of ***k***.
	Lower	0.0150684		
	Upper	0.0150684		

Worksheet F11b *(continued)*: Consumption of contaminated vegetation by a large mammal, chronic exposure scenario off-site.

Initial Concentration on Vegetation ($\mathbf{C_0}$): **R × rr × Drift**

Central	1.717	mg/kg veg.
Lower	0.986	
Upper	8.976	

Concentration on Vegetation at time ***T*** ($\boldsymbol{C_T}$): $\mathbf{C_0\ e^{-kT}}$

Central	4.42e-01	mg/kg veg.
Lower	2.54e-01	
Upper	2.31e+00	

Time-weighted Average Concentration on Vegetation ($\boldsymbol{C_{TWA}}$): $\boldsymbol{C_0\ (1 - e^{-k\,T}) \div (k\ T)}$

Central	0.93987375	mg/kg veg.
Lower	0.53972948	
Upper	4.91339941	

Proportion of Diet Contaminated (***Prop***)

Central	1	unitless
Lower	1	
Upper	1	

Dose estimates (***D***): $\boldsymbol{C_{TWA}}$ × ***A*** × **Prop** ÷ ***W***

Central	1.90e-01	mg/kg bw/day
Lower	1.09e-01	
Upper	9.94e-01	

Worksheet F12: Consumption of contaminated vegetation by a large bird, acute exposure scenario. *[VGCLBA]*

Verbal Description: A 4 kg herbivorous bird, such as a Canada Goose, consumes grass shortly after application of the chemical - i.e. no dissipation or degradation is considered. The contaminated vegetation accounts for 100% of the diet. Residue estimates based on relationships for short grass summarized in Worksheet A05.

Parameters/Assumptions		Value	Units	Source/Reference
Body weight (***W***)		4	kg	N/A
Caloric requirement (***KR***)		467.5185	kcal/day	U.S. EPA/ORD (1993, Eq. 3-35, p. 3-22)
above based on following equation: $kcal/day = 3.12 \times W(g)^{0.604}$				
Caloric content of vegetation (dry weight, ***KCD***)		2.46	kcal/g	U.S. EPA/ORD (1993, p. 3-5)
Water content of vegetation (proportion, ***PW***)		0.85	unitless	U.S. EPA/ORD (1993, p. 4-14)
Caloric content of vegetation (wet weight, ***KCW***)		0.369	kcal/g	***KCD*** × (1-***PW***)
Food consumed per day (wet weight, ***A***)		1.266988	kg	(***KR*** ÷ ***KCW***)/1000 g/kg
Duration of exposure (***T***)		1	day	N/A
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***)				
	Central	85	mg/kg vegetation per lb/acre applied	HK.SGT
	Lower	85		HK.SGT
	Upper	240		HK.SGU
Conc. in Vegetation (***C***): [**R×rr**]				
	Central	170	mg/kg	Note: lower value based on typical ***rr*** and lower ***R***.
	Lower	170		
	Upper	480		
Drift (***Drift***)				
	Central	1	unitless	Direct spray on-site
	Lower	1		
	Upper	1		
Proportion of Diet Contaminated (***Prop***)				
	Central	1	unitless	Assume feeding exclusively on-site.
	Lower	1		
	Upper	1		
Dose estimates (***D***): **Drift × Prop × C × A ÷ W**				
	Central	5.38e+01	mg/kg bw	
	Lower	5.38e+01		
	Upper	1.52e+02		

Worksheet F13a: Consumption of contaminated vegetation by a large bird, chronic on-site exposure scenario. *[VegChLBrd01]*

Verbal Description: A 4 kg herbivorous bird, such as a Canada Goose, consumes grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 10 to 100% of the diet assuming that the animal spends 10% to 100% of the time feeding at the site. Because the location is the application site, drift is set to unity - i.e., direct spray. Residue estimates based on short grass. Caloric requirements are used to estimate food consumption from U.S. EPA/ORD (1993). Dissipation is considered using the foliar halftime and taking the geometric mean of the initial and day-90 residues as the measure of dose.

Parameters/Assumptions		Value	Units	Source/Reference
Body weight (***W***)		4	kg	N/A
Caloric requirement (***KR***)		467.5185	kcal/day	U.S. EPA/ORD (1993, p. 3-6)
above based on following equation: $kcal/day = 3.12 \times W(g)^{0.604}$				
Caloric content of vegetation (dry weight, ***KCD***)		2.46	kcal/g	U.S. EPA/ORD (1993, p. 3-5)
Water content of vegetation (proportion, ***PW***)		0.85	unitless	U.S. EPA/ORD (1993, p. 4-14)
Caloric content of vegetation (wet weight, ***KCW***)		0.369	kcal/g	***KCD*** × (1-***PW***)
Food consumed per day (wet weight, ***A***)		1.266988	kg	(***KR*** ÷ ***KCW***)/1000 g/kg
Duration of exposure (***T***)		90	days	N/A
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***)				
	Central	85	mg/kg veg per lb/acre	HG.SGT
	Lower	85		HG.SGT
	Upper	240		HG.SGU
Drift (***Drift***):				
	Central	1	unitless	Set to unity for on-site assessment.
	Lower	1		
	Upper	1		
Day 0 Conc. in Vegetation (C_0): **R** × **rr** × **Drift**				
	Central	170	mg/kg	
	Lower	170		
	Upper	480		
Foliar dissipation coefficient (***k***)				
	Central	0.01507	day^{-1}	Worksheet B02
	Lower	0.01507		
	Upper	0.01507		
Conc. in Vegetation at time T (C_T) [$C_0 \times e^{-k \times T}$]				
	Central	4.38e+01	mg/kg	
	Lower	4.38e+01		
	Upper	1.24e+02		

Worksheet F13a *(continued)*: Consumption of contaminated vegetation by a large bird, chronic on-site exposure scenario.

Time-weighted Average Concentration on Vegetation (C_{TWA}): $C_0 (1 - e^{-k T}) \div (k T)$

Central	93.05681	mg/kg	
Lower	93.05681		
Upper	262.7486		

Proportion of diet contaminated (P_D)

Central	0.3	unitless	See section 4.2.2.3.
Lower	0.1		
Upper	1.0		

Dose estimates (D): $P_D \times C_{TWA} \times A \div W$

Central	8.84e+00	mg/kg bw
Lower	2.95e+00	
Upper	8.32e+01	

Worksheet F13b: Consumption of contaminated vegetation by a large bird, chronic off-site exposure scenario. *[VegChLBrd02]*

Verbal Description: A 4 kg herbivorous bird, such as a Canada Goose, consumes grass for a 90 day period after application of the chemical. The contaminated vegetation accounts for 100% of the diet assuming that the animal spends all of the feeding time near the site. Drift is estimated at 25 to 100 feet from the application site. Residue estimates are based on short grass. Caloric requirements are used to estimate food consumption. Dissipation is considered using the foliar halftime and taking the geometric mean of the initial and day-90 residues as the measure of dose.

Parameters/Assumptions		Value	Units	Source/Reference
Body weight (***W***)		4	kg	N/A
Caloric requirement (***KR***)		467.5185	kcal/day	U.S. EPA/ORD (1993, p. 3-6)
above based on following equation: $kcal/day = 3.12 \times W(g)^{0.604}$				
Caloric content of vegetation (dry weight, ***KCD***)		2.46	kcal/g	U.S. EPA/ORD (1993, p. 3-5)
Water content of vegetation (proportion, ***PW***)		0.85	unitless	U.S. EPA/ORD (1993, p. 4-14)
Caloric content of vegetation (wet weight, ***KCW***)		0.369	kcal/g	***KCD*** × (1-***PW***)
Food consumed per day (wet weight, ***A***)		1.266988	kg	(***KR*** ÷ ***KCW***)/1000 g/kg
Duration of exposure (***T***)		90	days	N/A
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***)				
	Central	85	mg/kg veg per lb/acre	HG.SGT
	Lower	85		HG.SGT
	Upper	240		HG.SGU
Drift (***Drift***):				
	50 feet	0.0101	unitless	Estimated from AgDRIFT for low-boom applications. See Worksheet A06.
	100 feet	0.0058		
	25 feet	0.0187		
Day 0 Conc. in Vegetation (C_0): **R** × **rr** × **Drift**				
	Central	1.717	mg/kg	Note: lower value based on typical ***rr*** and lower ***R***.
	Lower	0.986		
	Upper	8.976		
Foliar dissipation coefficient (***k***)				
	Central	0.01507	day^{-1}	Worksheet B02
	Lower	0.01507		
	Upper	0.01507		
Conc. in Vegetation at time T (C_T): $C_0 \times e^{-k \times T}$]				
	Central	4.42e-01	mg/kg	
	Lower	2.54e-01		
	Upper	2.31e+00		

Worksheet F13b *(continued)*: Consumption of contaminated vegetation by a large bird, chronic off-site exposure scenario.

Time-weighted Average Concentration on Vegetation (C_{TWA}): $C_0 (1 - e^{-k T}) \div (k T)$

Central	0.939874	mg/kg	
Lower	0.539729		
Upper	4.913399		

Proportion of diet contaminated (P_D)

Central	1.0	unitless	100% of time spent feeding near site
Lower	1.0		
Upper	1.0		

Dose estimates (D): $P_D \times C_{TWA} \times A \div W$

Central	2.98e-01	mg/kg bw
Lower	1.71e-01	
Upper	1.56e+00	

Worksheet F14: Consumption of contaminated insects by a small bird, acute exposure scenario. *[InsCSBA]*

***Verbal Description**: A small insectivorous bird (10g) consumes insects shortly after application of the chemical - i.e. no dissipation or degradation is considered. The contaminated food accounts for 100% of the diet. Residue estimates in insects are based on relationships for seed containing pods and forage crops from Hoerger and Kenaga (1972) summarized in Worksheet A05a.*

Parameters/Assumptions		Value	Units	Source/Reference
Body weight (***W***)		0.01	kg	N/A
Caloric requirement (***KR***)		12.53587	kcal/day	U.S. EPA/ORD 1993, Eq. 3-35, p. 3-22
above based on following equation: $kcal/day = 3.12 \times W(g)^{0.604}$				
Caloric content of insects (dry weight, ***KCD***)		4.3	kcal/g	U.S. EPA/ORD 1993, p. 3-5
Water content of insects (proportion, ***PW***) [1]		0.65	unitless	U.S. EPA/ORD 1993, p. 4-13
Caloric content of insects (wet weight, ***KCW***)		1.505	kcal/g	***KCD*** × (1-***PW***)
Food consumed per day (wet weight, ***A***)		0.0083	kg	(***KR*** ÷ ***KCW***)/1000 g/kg
Duration of exposure (***T***)		1	day	N/A
Application rates (***R***)				
	Central	2	lb/acre	APPL.Typ
	Lower	2		APPL.Low
	Upper	2		APPL.Hi
Residue rates (***rr***)				
	Central	45	mg/kg per lb/acre applied	HK.BLT
	Lower	45		HK.BLT
	Upper	135		HK.BLU
Conc. in Vegetation (***C***): **R × rr**				
	Central	90	mg/kg	
	Lower	90		
	Upper	270		
Drift (***Drift***)				
	Central	1	unitless	Direct spray on-site
	Lower	1		
	Upper	1		
Proportion of Diet Contaminated (***Prop***)				
	Central	1	unitless	Assume feeding exclusively on-site.
	Lower	1		
	Upper	1		
Dose estimates (***D***): **Drift × Prop × C × A ÷ W**				
	Central	7.50e+01	mg/kg bw	
	Lower	7.50e+01		
	Upper	2.25e+02		

[1] Average of beetles (61%) and grasshoppers (69%) from U.S. EPA/ORD 1993, Table 4-1, p. 4-13.

Worksheet G01: Summary of Exposure Scenarios for Terrestrial Animals.

Scenario	Dose (mg/kg/day)			Worksheet
	Central	Lower	Upper	
Acute/Accidental Exposures				
Direct spray				
small mammal, first-order absorption	4.75e-01	1.51e-01	1.15e+00	F01
small animal, 100% absorption	4.85e+01	4.85e+01	4.85e+01	F02a
bee, 100% absorption	3.21e+02	3.21e+02	3.21e+02	F02b
Contaminated vegetation				
small mammal	8.57e-01	8.57e-01	2.11e+00	F03
large mammal	3.44e+01	3.44e+01	9.71e+01	F10
large bird	5.38e+01	5.38e+01	1.52e+02	F12
Contaminated water				
small mammal, spill	2.66e+00	1.06e+00	5.32e+00	F05
stream	5.86e-03	2.93e-04	1.17e-01	F06
Contaminated insects				
small bird	7.50e+01	7.50e+01	2.25e+02	F14
Contaminated fish				
predatory bird, spill	9.45e-01	1.89e-01	2.83e+00	F08
Longer-term Exposures				
Contaminated vegetation				
small mammal, on site	4.69e-02	2.35e-02	2.31e-01	F04a
off-site	4.74e-04	1.36e-04	4.31e-03	F04b
large mammal, on site	5.65e+00	1.88e+00	5.32e+01	F11a
off-site	1.90e-01	1.09e-01	9.94e-01	F11b
large bird, on site	8.84e+00	2.95e+00	8.32e+01	F13a
off-site	2.98e-01	1.71e-01	1.56e+00	F13b
Contaminated water				
small mammal	2.93e-04	2.93e-05	2.34e-03	F07
Contaminated fish				
predatory bird	1.04e-04	5.20e-06	1.25e-03	F09

Worksheet G02: Summary of quantitative risk characterization for terrestrial animals [1]

Scenario	Hazard Quotient[2] Central	Lower	Upper
Acute/Accidental Exposures			
Direct spray			
small mammal, first-order absorption	3e-03	9e-04	7e-03
small animal, 100% absorption	3e-01	3e-01	3e-01
bee, 100% absorption	6e-01	6e-01	6e-01
Contaminated vegetation			
small mammal	5e-03	5e-03	1e-02
large mammal	2e-01	2e-01	6e-01
large bird	1e-01	1e-01	3e-01
Contaminated water			
small mammal, spill	2e-02	6e-03	3e-02
small mammal, stream	3e-05	2e-06	7e-04
Contaminated insects			
small bird	1e-01	1e-01	4e-01
Contaminated fish			
predatory bird, spill	2e-03	3e-04	5e-03
Longer-term Exposures			
Contaminated vegetation			
small mammal, on site	3e-04	1e-04	1e-03
off-site	3e-06	8e-07	2e-05
large mammal, on site	3e-02	1e-02	3e-01
off-site	1e-03	6e-04	6e-03
large bird, on site	9e-02	3e-02	8e-01
off-site	3e-03	2e-03	2e-02
Contaminated water			
small mammal	2e-06	2e-07	1e-05
Contaminated fish			
predatory bird	1e-06	5e-08	1e-05

Toxicity Indices [3]

Acute toxicity value for mammal - NOAEL	175	mg/kg
Chronic toxicity value for mammal - NOAEL	175	mg/kg/day
Acute toxicity value for bird - NOAEL	562	mg/kg
Chronic toxicity value for birds - NOAEL	100	mg/kg/day
Acute toxicity for honey bee - NOEC	540	mg/kg

[1] See Worksheet G01 (Table 4-1 in text) for summary of exposure assessment.
[2] Estimated dose ÷ toxicity index
[3] See Section 4.3 for a discussion of the toxicity indices.

Worksheet G03: Quantitative Risk Characterization for Aquatic Species.

Hazard Quotients [1]	**Central**	**Lower**	**Upper**	**Toxicity Value (mg/L)**	**End-point**
Fish, Acute Exposures					
Typical species, less toxic formulation	4e-04	2e-05	8e-03	97	LC_{50}
Sensitive species, less toxic formulation	4e-03	2e-04	8e-02	10	LC_{50}
Typical species, more toxic formulation	2e-02	9e-04	3e-01	2.3	LC_{50}
Sensitive species, more toxic formulation	3e-02	2e-03	6e-01	1.3	LC_{50}
Fish, Chronic Exposures					
Typical species, less toxic formulation	8e-05	8e-06	6e-04	25.7	NOEC
Sensitive species, less toxic formulation	8e-04	8e-05	6e-03	2.57	NOEC
Typical species, more toxic formulation	3e-03	3e-04	3e-02	0.64	NOEC
Sensitive species, more toxic formulation	6e-03	6e-04	4e-02	0.36	NOEC
Aquatic Invertebrates, Acute Exposures					
Less toxic formulation	5e-05	3e-06	1e-03	780	LC_{50}
Most toxic formulation	4e-03	2e-04	7e-02	11	LC_{50}
Aquatic Invertebrates, Chronic Exposures					
Less toxic formulation	4e-05	4e-06	3e-04	50	NOEC
Most toxic formulation	3e-03	3e-04	2e-02	0.7	NOEC
Aquatic Plants					
Acute	1e-02	7e-04	3e-01	3	NOEC
Chronic	7e-04	7e-05	5e-03	3	NOEC

Exposures (mg/L)	Central	Lower	Upper	Worksheets	
Acute	0.04	0.002	0.8	F06	Stream
Longer-term	0.002	0.0002	0.016	F09	Pond

See Sections 4.3.3.2, 4.3.3.3, and 4.3.3.4 for a discussion and derivation of the toxicity values for fish, invertebrates, and aquatic plants, respectively. See Worksheets F06 and F09 for the derivation of the concentrations in streams and ponds, respectively. See text of Section 4.4 for a discussion of stimulation of growth in aquatic plants.

[1]The hazard quotients are the level of exposure divided by the toxicity value then rounded to one or two significant decimal places or digits. Hazard quotients >1 and ≤2 are shown to two significant digits. All others are rounded to one significant decimal place or integer. All hazard quotients that are below the level of concern – i.e., a hazard quotient below unity – are expressed in scientific notation. All hazard quotients greater than unity are expressed in fixed point decimal notation and highlighted with a shaded background.

Worksheet G04: Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Runoff [TerrPlntRU].

Application rate	**2**	lb/acre	Typical FS rate, Section 2.4.
NOEC Species	4.5	lb/acre	Section 4.3.2.4.
Tolerant Species	4.5	lb/acre	Section 4.3.2.4.

Annual Rainfall	Clay	Loam	Sand
	Proportion lost in Runoff		
5	0.000000	0.000000	0.000000
10	0.000000	0.000000	0.000000
15	0.005506	0.013191	0.013660
20	0.025762	0.071700	0.075165
25	0.040532	0.099593	0.087748
50	0.105288	0.200950	0.131956
100	0.198008	0.318784	0.196351
150	0.260653	0.384306	0.245778
200	0.306579	0.424599	0.286189
250	0.341392	0.452699	0.320101
	Functional Off-site Application Rate[1]		
5	0.00e+00	0.00e+00	0.00e+00
10	0.00e+00	0.00e+00	0.00e+00
15	1.10e-02	2.64e-02	2.73e-02
20	5.15e-02	1.43e-01	1.50e-01
25	8.11e-02	1.99e-01	1.76e-01
50	2.11e-01	4.02e-01	2.64e-01
100	3.96e-01	6.38e-01	3.93e-01
150	5.21e-01	7.69e-01	4.92e-01
200	6.13e-01	8.49e-01	5.72e-01
250	6.83e-01	9.05e-01	6.40e-01
	Hazard Quotient[2]		
5	0e+00	0e+00	0e+00
10	0e+00	0e+00	0e+00
15	2e-03	6e-03	6e-03
20	1e-02	3e-02	3e-02
25	2e-02	4e-02	4e-02
50	5e-02	9e-02	2e+01
100	9e-02	1e-01	9e-02
150	1e-01	2e-01	1e-01
200	1e-01	2e-01	1e-01
250	2e-01	2e-01	1e-01

[1] The functional off-site application rate is calculated as the nominal application rate (specified above after the worksheet title) multiplied by the proportion lost in runoff.

[2] The hazard quotient is calculated as the functional off-site application rate divided by the NOEC value. The NOEC's are specified above on the lines following the application rate. The hazard quotients are rounded to one or two significant decimal places or digits. Hazard quotients >1 and ≤2 are shown to two significant digits. All others are rounded to one significant decimal place or integer. All hazard quotients that are below the level of concern – i.e., a hazard quotient below unity – are expressed in scientific notation. All hazard quotients greater than unity are expressed in fixed point decimal notation and highlighted with a shaded background.

Worksheet G05: Summary of Exposure Assessment and Risk Characterization for Terrestrial Plants from Drift and Wind Erosion [TerrPlntWind].

	Most Sensitive Plant	Least Sensitive Plant	
Post-emergence NOEC, lb/acre	0.035	0.56	Section 4.3.2.5.
Application Rate, lb/acre	2	Typical FS use.	Section 2.4

Estimates of the proportion of offsite drift

Distance (feet)	Drift[1]	
25	0.0187	Terrestrial Drift based on AGDRIFT using a low boom ground sprayer. See section 4.2.3.2 for discussion.
50	0.0101	
100	0.0058	
300	0.0024	
500	0.0015	
900	0.0008	

Estimates of functional offsite application rate

Distance (feet)	Rate (lb/acre)	
25	0.0374	Calculated as the product of the application rate and the estimated proportion of offsite drift.
50	0.0202	
100	0.0116	
300	0.0048	
500	0.003	
900	0.0016	

Hazard Quotient - Sensitive Species [1]

25	1.1	Calculated as the offsite application rate divided by the NOEC for the most sensitive species.
50	6e-01	
100	3e-01	
300	1e-01	
500	9e-02	
900	5e-02	

Hazard Quotient - Tolerant Species [1]

25	7e-02	Calculated as the offsite application rate divided by the NOEC for the least sensitive species.
50	4e-02	
100	2e-02	
300	9e-03	
500	5e-03	
900	1e-02	

[1] The hazard quotients are the level of exposure divided by the toxicity value then rounded to one or two significant decimal places or digits. Hazard quotients >1 and ≤2 are shown to two significant digits. All others are rounded to one significant decimal place or integer. All hazard quotients that are below the level of concern – i.e., a hazard quotient below unity – are expressed in scientific notation. All hazard quotients greater than unity are expressed in fixed point decimal notation and highlighted with a shaded background.

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