

Letter Health Consultation

Boeing Commercial Airplane Fabrication Division, Auburn Plant
Exposures to Surface Water Seasonal Sampling 2013
Algona, King County, Washington

August 15, 2014

Prepared by

**The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry**



Foreword

The Washington State Department of Health (DOH) prepared this health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services. ATSDR is responsible for health issues related to hazardous substances.

The purpose of a health consultation is to assess the health threat posed by hazardous substances in the environment. If needed, a health consultation will also recommend steps or actions to protect public health. Health consultations are initiated in response to health concerns raised by residents or agencies about exposure to hazardous substances.

This health consultation was prepared in accordance with ATSDR methodologies and guidelines. However, the report has not been reviewed and cleared by ATSDR. The findings in this report are relevant to conditions at the site during the time the report was written. It should not be relied upon if site conditions or land use changes in the future.

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STATE OF WASHINGTON

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August 15, 2014

Mayor David Hill
City of Algona
City Hall
402 Warde Street
Algona, Washington 98001

Re: Boeing Commercial Airplane Fabrication Division, Auburn Plant
2013 Seasonal Surface Water Sampling Results Assessment
Algona, King County, Washington

Dear Mayor Hill:

The Washington State Department of Health (DOH) evaluated seasonal surface water test results for the Chicago Avenue and residential area ditches in the City of Algona. This assessment is a follow up to a recommendation in our March 2013 assessment. It is based on a previous request from the City of Algona to evaluate whether chemicals found in ditches pose a health concern to children or city personnel. This sampling was conducted as part of the ongoing groundwater remedial investigation by The Boeing Company (Boeing). The Washington State Department of Ecology (Ecology) directed Boeing to develop a seasonal approach for sampling to determine if there is a change in the concentration of volatile organic compounds (VOCs) during dry (June – September) and wet (October – March) seasons. DOH completed the review of data using surface water screening levels developed in the March 2013 letter health consultation that evaluated surface water in Chicago Avenue Ditch and Government Canal [1].

Based on the evaluation of wet season sampling data, exposure to ditch water is not expected to result in harmful health effects to children or workers. DOH recommends continued monitoring of ditches. Parents should be aware that ditches are not safe places to play and may contain contaminants unrelated to the Boeing site, including fecal matter from animals and sewer overflow. In addition, workers should wear protective clothing when performing duties in ditches. DOH will review work plans and additional data as they become available. Additionally, DOH will continue to work with the City of Algona, Ecology, and Boeing to educate residents about the contamination. Limitations of this report include lack of VOCs concentration from the breathing zone and ambient air. A summary of the findings is included in this letter. DOH conducts health consultations in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

Past releases of chlorinated solvents (VOCs) at the Boeing Auburn plant resulted in two plumes of contaminated groundwater. The plumes lie in the shallow, intermediate, and deep zones of the aquifer^a underlying the Boeing Auburn plant and beyond. The contamination consists mainly of trichloroethylene (TCE, also called trichloroethene) and its breakdown products^b at relatively low levels.^c Tetrachloroethylene, also called perchloroethylene (PCE), is also present at lower levels in some areas. Boeing is confirming the extent or edges of the plumes. A shallow zone of one of the plumes has migrated below the northeast end of the City of Algona.

Exposure Pathways

In order to harm health, people must first come into contact with the chemical. An exposure pathway describes how a chemical moves from a source and comes into contact with people. A completed exposure pathway consists of a source, a release, an exposure point, an exposure route, and a potentially exposed population. In the dry season, the residential ditches did not have water; therefore, no completed exposure pathway was identified for these ditches during that time. However, Chicago Avenue ditch contained water and a completed exposure pathway has been identified for this ditch. In the wet season, the residential ditches did have water; therefore, a completed exposure pathway has been identified for these ditches during that season. Contaminated groundwater is assumed to be discharging into the Chicago Avenue and residential ditches. There are two completed pathways of exposure to PCE, TCE, cis-1,2-DCE, or vinyl chloride in water for children and workers.

Children- It was assumed that children up to two years old do not enter the ditch. Children this young would be supervised and the ditch represents a potential drowning hazard. Children 3 years old up to 16 years old might enter the ditch. These children playing in the ditch at 9th Avenue and north could be exposed to TCE, cis-1,2-DCE, or vinyl chloride. Children could be exposed by touching or accidentally ingesting water and breathing vapors escaping from water. Children most likely wade or walk through the ditch (with or without shoes). They probably do not remain immersed in the ditch. Minimal exposure is expected to occur by feet, legs, and hands. During the school year, children may play in the ditch during weekends or daylight hours after school. The possible health implications for exposed children are discussed in the following section. Contaminants have not been detected in the water in the ditch south of 7th Avenue and no exposures are expected in this area. To evaluate exposures DOH assumed two exposure scenarios, children 1) entering the ditch briefly and getting wet for 15 minutes once a day 3 days a week (150 days per year) or 2) playing the ditch for an average of 30 minutes on any given day during the summer or on a weekend (50 days a year).

^a For remedial purposes, Boeing has defined the aquifer by dividing it into three zones. Monitoring wells represent the depth at which the groundwater is tested. The shallow zone includes the water table to 30 feet below ground surface (bgs). The intermediate zone is from 30–60 feet bgs. The deep zone is from 60–100 feet bgs.

^b Breakdown products of TCE in the environment include 1,1-dichloroethylene (1,1-DCE), 1,1-dichloroethane (1,1-DCA), cis-1,2-dichloroethylene (cis-1,2,-DCE), trans 1,2-dichloroethylene (trans-1,2-DCE), 1,2-dichloroethane (1,2-DCA), vinyl chloride and chloroethane. Only some of these contaminants have been found in groundwater or surface water samples.

^c Landau Associates. 2012. Letter from Eric Weber of Landau Associates to Robin Harrover of the Department of Ecology dated October 15, 2012. Re: status report number 40, July through September 2012 Activity Period, Boeing Auburn Facility, RCRA WAD 041337130, corrective Action Agreed Order No. 01HWTRNR-3345

Workers- Algona Public Works personnel also have a completed exposure pathway for TCE, cis-1,2-DCE, or vinyl chloride when working in the ditches. The Public Works Department maintains the ditch by mowing/raking and removing flood debris, trash, and culvert blockages. During these tasks workers may enter the water of the ditch. Workers wear gloves, boots, long sleeve shirts, and heavy work pants when working in the ditches. Contact with water is expected to occur intermittently on hands, legs, and feet. Rain gear is used during heavy rain. Personnel estimate that on average they enter the ditches two days a week and get wet four times a day while working in the ditch. Workers may also breathe vapors escaping from water. To evaluate exposures DOH assumed that workers entered the ditch either 1) three days a week four times a day for 15 minutes or 2) once a week for four hours (four 1-hour intervals during one day).

Results and Discussion

Due to a lack of water in the 2013 dry season, no surface water samples were collected in the residential ditches. However, Chicago Avenue ditch has water year round; because of this samples can be collected over all four quarters. Samples for the first quarter were taken during the 2013 wet season. DOH completed the review of data using surface water screening levels developed in the March 2013 letter health consultation that evaluated surface water in Chicago Avenue ditch and Government Canal [1].

The Environmental Protection Agency (EPA) developed surface water screening levels using risk assessment guidance from the EPA Superfund program. This regional screening level calculator can be found at: http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search. The calculator determines exposures from accidental ingestion and skin contact of chemicals in the water. DOH used site-specific, chronic, recreational, surface water exposure scenarios to calculate screening levels for children and workers. These screening levels are based on an insignificant increase in cancer risk and no risk for non-cancer effects. Cancer risk estimates measures the chance (probability) of developing cancer. An insignificant risk is equivalent to the development of 1 cancer case in 1,000,000 people exposed for a lifetime (1×10^{-6}). EPA considers a cancer risk up to 1 additional case of cancer in 10,000 people (1×10^{-4}) to be within their risk range. Attachment 1 lists site-specific exposure parameters entered into the calculator and the screening results. Site specific exposure parameters were described in the previous letter health consultation for Chicago Avenue Ditch and Government Canal [1].

In addition to the site-specific exposure parameters that were entered, a correction was made to the calculator due to an error that was discovered in the background calculations for vinyl chloride (VC). The correction was made under the “Select Individual Chemicals” menu by selecting “Test Chemical (blank/default)” this allows for input of a user-provided chemical entry from the “Select Chemical Info Type” menu. The VC parameters for children and adults that were entered for this evaluation are shown in Attachment 1.

Table 1 summarizes the results of PCE, TCE, and breakdown chemicals tested during wet season sampling in 2013 along the Chicago Avenue ditch [2]. TCE and breakdown products cis-1,2-dichloroethylene (DCE) and VC were detected. None of the samples exceeded the screening levels, therefore no further evaluation is needed (See Attachments) [1, 3].

Table 1. Comparison of Chicago Avenue ditch surface water concentrations (ppb) with health-based screening levels, Boeing Commercial Airplane Fabrication Division, Auburn Plant, King County, Washington.

Chemical	Surface Water Concentrations (ppb) from December 2013			Surface Water Screening Levels (ppb)*		Is Exposure a Concern?
	Ditch along Chicago Avenue			Child	Worker	
	9 th Ave N	10 th Ave N	11 th Ave N			
Vinyl chloride	0.4 / 0.39	0.4 / 0.44	0.4 / 0.37	5.05	4.4	No
Trichloroethylene (TCE)	ND/ 0.026	ND / 0.073	0.7 / 0.72	74	32	No
Dichloroethylene, cis-1,2-	ND / –	0.7 / –	0.9 / –	5820**	1400**	No
Tetrachloroethylene (PCE)	ND/ ND	ND / ND	ND / ND	1380	197	No
Chloroethane	–/ ND	ND/ND	– / ND	–	–	No
Dichloroethane, 1,1 -	–/ ND	ND/ND	– / ND	–	–	No
Dichloroethane, 1,2 -	–/ ND	ND/ND	– / ND	–	–	No
Dichloroethylene, 1,1 -	–/ ND	ND/ND	– / ND	–	–	No
Dichloroethylene, trans-1,2-	–/ ND	ND/ND	– / ND	–	–	No

Notes: **Bold** values indicate detected compounds; * per EPA regional screening calculator for recreational surface water exposures (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) see letter attachments 1 and 2 for input parameters; ** non-carcinogenic risk only

Analyzed by EPA method for volatile organic chemicals SW8260/SW8260 SIM (0.4/0.39)

Abbreviations:

- EPA – U.S. Environmental Protection Agency
- ND – not detected at 0.2 µg/L (0.02 µg/l for tetrachloroethylene)
- PCE – tetrachloroethylene, same as perchloroethylene
- ppb – parts per billion or micrograms per liter
- TCE – trichloroethylene

In November 2013, 19 of the 22 residential ditches in Algona identified in the work plan were sampled [4]. Ditches 10, 19, and 20 were dry and could not be sampled. Table 2 summarizes the results of PCE, TCE, and breakdown chemicals detected during wet season residential ditch sampling [5]. Tetrachloroethylene (PCE), TCE, DCE, and VC were detected. None of the samples exceeded the screening levels, therefore no further evaluation is needed (See Attachments) [1, 3].

Table 2. Comparison of residential ditch surface water concentrations (ppb) with health-based screening levels, Boeing Commercial Airplane Fabrication Division, Auburn Plant, King County, Washington.

Chemical	Wet Season Surface Water Concentrations (ppb) from November 2013										Surface Water Screening Levels (ppb)*		Is Exposure a Concern?
	Residential Ditches										Child	Worker	
	1	2	3	4	5	6	7	8	9	11			
Vinyl chloride	0.3/0.18	ND/ 0.085	ND/ND	ND/ 0.13	0.2/0.26	ND/ 0.07	ND/ND	ND/ND	ND/ND	0.3/0.2	5.05	4.4	No
Trichloroethylene (TCE)	0.8/0.79	ND/ 0.19	ND/ND	ND/ 0.045	1.4/1.5	ND/ 0.022	ND/ND	ND/ND	ND/ND	ND/ND	74	32	No
Dichloroethylene, cis-1,2-	0.6	0.4	ND	0.2	1.4	ND	ND	ND	ND	ND	5820**	1400**	No
Tetrachloroethylene (PCE)	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	1380	197	No
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	–	–	No
Dichloroethane, 1,1 -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	–	–	No
Dichloroethane, 1,2 -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	–	–	No
Dichloroethylene, 1,1 -	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	–	–	No
Dichloroethylene, trans-1,2-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	–	–	No

Table 2. Continued

Chemical	Wet Season Surface Water Concentrations (ppb) from November 2013									Surface Water Screening Levels (ppb)*		Is Exposure a Concern?
	Residential Ditches									Child	Worker	
	12	13	14	15	16	17	18	21	22			
Vinyl chloride	0.2/0.19	ND/0.14	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	5.05	4.4	No
Trichloroethylene (TCE)	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	74	32	No
Dichloroethylene, cis-1,2-	0.3	ND	ND	ND	ND	ND	ND	ND	ND	5820**	1400**	No
Tetrachloroethylene (PCE)	0.2/0.15	ND/0.12	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/ND	ND/0.042	1380	197	No
Chloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	No
Dichloroethane, 1,1 -	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	No
Dichloroethane, 1,2 -	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	No
Dichloroethylene, 1,1 -	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	No
Dichloroethylene, trans-1,2-	ND	ND	ND	ND	ND	ND	ND	ND	ND	-	-	No

Notes: **Bold** values indicate detected compounds; * per EPA regional screening calculator for recreational surface water exposures (http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search) see letter attachments 1 and 2 for input parameters; ** non-carcinogenic risk only
 Analyzed by EPA method for volatile organic chemicals SW8260/SW8260 SIM (0.2/0.19)

Abbreviations:

EPA – U.S. Environmental Protection Agency

ND – not detected at 0.2 µg/L (0.02 µg/l for tetrachloroethylene, trichloroethylene, and vinyl chloride)

PCE – tetrachloroethylene, same as perchloroethylene

ppb – parts per billion or micrograms per liter

TCE – trichloroethylene

Conclusion

DOH concludes that exposure to PCE; TCE; cis-1,2-DCE; and vinyl chloride levels found during the wet season ditch sampling in 2013 is not expected to result in harmful effects to children or workers. This is consistent with our previous March 2013 assessment findings, which concluded that harmful effects to children or workers was not expected from exposure to water in the Chicago Avenue ditch [1].

Recommendations

DOH recommends the following:

- Contaminant levels in the ditches could change over time, therefore to avoid exposures to contaminants related and unrelated to the Boeing site:
 - Parents should prevent children's access to the ditches.
 - Workers should wear protective clothing when performing duties in the ditches. This should include waterproof gloves, jackets, and waders.
- Continued monitoring of the Chicago Avenue and residential ditches are necessary to confirm that harmful exposures do not occur. Boeing should work with Ecology to determine ongoing monitoring requirements.

DOH will work with the City of Algona, Ecology, and Boeing to educate residents about the contamination in the ditches and how to prevent exposures. Boeing is already executing or developing work plans to address the contamination. DOH intends to review work plans and additional data as they becomes available. We can amend these conclusions and recommendations as necessary.

DOH appreciates this opportunity to assist you with these technical issues. Please contact me at 360-236-3376 if you have any questions.

Sincerely,

Lenford O'Garro, MS., RS
Toxicologist, Health Assessor
Site Assessments and Toxicology Section

Enclosures (2)

cc: Joanne Snarski, Department of Health
Rhonda Kaetzel, Public Health – Seattle King County
Robin Harrover, Department of Ecology
James Bet, The Boeing Company
Chris Anderson, Environmental Manager, Auburn

References

1. Kaetzel, R. Washington State Department of Health. Letter Health Consultation – Boeing Commercial Airplane Fabrication Division, Auburn Plant Exposures to Surface Water in Chicago Avenue Ditch and Government Canal Algona, King County, Washington. 2013.
2. January 15, 2014. Report prepared by Landau Associates submitted to Robin Harrover, Washington State Department of Ecology. Re: *Status Report: No. 45, October through December 2013 Activity Period, Boeing Commercial Airplane Group, Auburn Plant, WAD 041337130, RCRA Corrective Action Agreed Order No. 01HWTRNR-3345.*
3. U.S. Environmental Protection Agency. Regional Screening Levels for Chemicals Contaminants at Superfund Sites: Regional Screening Calculator; surface water screening levels. Available at internet: http://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search
4. Landau Associates. 2013. Work plan: City of Algona Yard and Ditch Surface Water Sampling Work Plan, Boeing Auburn Facility, Auburn, Washington. Prepared for The Boeing Company. June 6.
5. Landau Associates. 2014. Technical Memorandum: Re: *Algona Neighborhood Ditch Sampling Investigation, Boeing Auburn Facility, Auburn, Washington.* From Jennifer Wynkoop and Sarah Fees, to James Bet, The Boeing Company. January 27, 2014.

Attachment 1

Site-specific equation inputs for ditch water screening levels, Boeing Auburn Plant, Algona, Washington

Variable	Scenario inputs			
	Child 150 day	Child 50 day	Worker 150 day	Worker 50 day
TR (target cancer risk) unitless	0.000001	0.000001	0.000001	0.000001
THQ (target hazard quotient) unitless	1	1	1	1
EF _{recwc} (child exposure frequency) day/year	150	50	0	0
EF _{recwa} (adult exposure frequency) day/year	150	50	150	50
EF ₀₋₂ (mutagenic exposure frequency) day/year	0	0	0	0
EF ₂₋₆ (mutagenic exposure frequency) day/year*	150	50	0.00001	0.00001
EF ₆₋₁₆ (mutagenic exposure frequency) day/year	150	50	0	0
EF ₁₆₋₃₀ (mutagenic exposure frequency) day/year	0	0	150	50
ED _{recwc} (exposure duration - child) year	4	4	0	0
ED _{recwa} (exposure duration - adult) year	10	10	25	25
ED ₀₋₂ (mutagenic exposure duration) year	0	0	0	0
ED ₂₋₆ (mutagenic exposure duration) year*	4	4	0.00001	0.00001
ED ₆₋₁₆ (mutagenic exposure duration) year	10	10	0	0
ED ₁₆₋₃₀ (mutagenic exposure duration) year	0	0	25	25
LT (lifetime - recreator) year	70	70	70	70
EV _{recwa} (adult) events/day	1	1	4	4
EV _{recwc} (child) events/day	1	1	0	0
EV ₀₋₂ (mutagenic) events/day	0	0	0	0
EV ₂₋₆ (mutagenic) events/day*	1	1	0.00001	0.00001
EV ₆₋₁₆ (mutagenic) events/day	1	1	0	0
EV ₁₆₋₃₀ (mutagenic) events/day	0	0	4	4
ET _{recwa} (adult exposure time) hour/event	0.25	0.5	0.25	1
ET _{recwc} (child exposure time) hour/event	0.25	0.5	0	0
ET _{recw0-2} (mutagenic exposure time) hour/event	0	0	0	0
ET _{recw2-6} (mutagenic exposure time) hour/event*	0.25	0.5	0.00001	0.00001
ET _{recw6-16} (mutagenic exposure time) hour/event	0.25	0.5	0	0
ET _{recw16-30} (mutagenic exposure time) hour/event	0	0	0.25	1
ET _{recw-adj} (age-adjusted exposure time) hour/event	0.25	0.5	0.25	1
ET _{recw-madj} (mutagenic age-adjusted exposure time) hour/event	0.25	0.5	0.25	1
BW _{recwa} (body weight - adult) kg	41	41	70	70
BW _{recwc} (body weight - child) kg	15	15	15	15
BW ₀₋₂ (mutagenic body weight) kg	0	0	0	0
BW ₂₋₆ (mutagenic body weight) kg	15	15	15	15
BW ₆₋₁₆ (mutagenic body weight) kg	41	41	0	0
BW ₁₆₋₃₀ (mutagenic body weight) kg	0	0	70	70
IRW _{recwa} (water intake rate - adult) L/hr	0	0	0	0
IRW _{recwc} (water intake rate - child) L/hr	0.004	0.004	0	0
IRW ₀₋₂ (mutagenic water intake rate) L/hr	0	0	0	0
IRW ₂₋₆ (mutagenic water intake rate) L/hr**/*	0.0037	0.0037	0.00001	0.00001
IRW ₆₋₁₆ (mutagenic water intake rate) L/hr**	0.0037	0.0037	0	0
IRW ₁₆₋₃₀ (mutagenic water intake rate) L/hr***	0	0	0.0037	0.0037
SA _{recwa} (skin surface area - adult) cm ²	3721	3721	6600	6600
SA _{recwc} (skin surface area - child) cm ²	1642	1642	0	0
SA ₀₋₂ (mutagenic skin surface area) cm ²	0	0	0	0
SA ₂₋₆ (mutagenic skin surface area) cm ^{2**/}	1642	1642	0.00001	0.00001
SA ₆₋₁₆ (mutagenic skin surface area) cm ^{2**}	3721	3721	0	0
SA ₁₆₋₃₀ (mutagenic skin surface area) cm ^{2**}	0	0	6600	6600
l _{sc} (apparent thickness of stratum corneum) cm	0.001	0.001	0.001	0.001
IFW _{rec-adj} (age-adjusted water intake rate) L/kg	0.04	0.027	0	0
IFWM _{rec-adj} (mutagenic age-adjusted water intake rate) L/kg	0.213	0.142	0.198	0.264
DFW _{rec-adj} (age-adjusted dermal factor) cm ² -event/kg	201814.146	67271.382	1414285.714	471428.571
DFWM _{rec-adj} (mutagenic age-adjusted dermal factor) cm ² -event/kg	605442.439	201814.146	1414285.714	471428.571

Notes: per EPA regional screening calculator for recreational surface water exposures

Highlighted cells are site-specific input values (using recreational surface water scenario)

* An estimate of 0 (0.00001) was used to retain carcinogenic calculation estimates for adults

** Average ingestion rate for wading and splashing in swimming pool (EFH Table 3-93)

*** Surface area consists of feet, lower legs, and hands; child surface area was calculated using total surface for 3-6 and 11-16 year olds (EFH Table 7-7) multiplied by portion of extremity (EFH Table 7-9); For equivalent adult surface area see (EFH Table 7-16)

EFH - Exposure Factors Handbook (U.S. EPA 2011)

EPA - U.S. Environmental Protection Agency

Attachment 2

Output from EPA's Site-specific Recreator Screening Levels for Surface Water, Boeing Auburn Plant, Algona, Washington

ca=Cancer, nc=Noncancer, ca* (Where nc SL < 100 x ca SL),

ca** (Where nc SL < 10 x ca SL),

max=SL exceeds ceiling limit (see User's Guide), sat=SL exceeds csat

Scenario	Chemical	CAS Number	Mutagen?	VOC?	Chemical Type	Ingestion SF (mg/kg-day) ⁻¹	SFO Ref	Chronic RfD (mg/kg-day)	RfD Ref	RAGSe GIABS (unitless)	kp	mw	pi	logds
Child 150 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	1.40E+00	U	3.00E-03	U	1	0.00838	62.5	3.1415927	-3.15
Child 50 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	1.40E+00	U	3.00E-03	U	1	0.00838	62.5	3.1415927	-3.15
Worker 150 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	7.20E-01	I	3.00E-03	I	1	0.00838	62.5	3.1415927	-3.15
Worker 50 days	Vinyl Chloride	75-01-4	Yes	Yes	Organics	7.20E-01	I	3.00E-03	I	1	0.00838	62.5	3.1415927	-3.15
Child 150 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Child 50 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Worker 150 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Worker 50 days	Dichloroethane, 1,1-	75-34-3	No	Yes	Organics	5.70E-03	U	2.00E-01	U	1	0.00675	98.96	3.1415927	-3.354176
Child 150 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Child 50 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Worker 150 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Worker 50 days	Dichloroethane, 1,2-	107-06-2	No	Yes	Organics	9.10E-02	U	6.00E-03	U	1	0.0042	98.96	3.1415927	-3.354176
Child 150 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-	-	5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-	-	5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-	-	5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,1-	75-35-4	No	Yes	Organics	-	-	5.00E-02	U	1	0.0117	96.94	3.1415927	-3.342864
Child 150 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-	-	9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-	-	9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-	-	9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	No	Yes	Organics	-	-	9.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 150 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-	-	2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-	-	2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-	-	2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,2-cis-	156-59-2	No	Yes	Organics	-	-	2.00E-03	U	1	0.011	96.94	3.1415927	-3.342864
Child 150 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-	-	2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Child 50 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-	-	2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Worker 150 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-	-	2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Worker 50 days	Dichloroethylene, 1,2-trans-	156-60-5	No	Yes	Organics	-	-	2.00E-02	U	1	0.011	96.94	3.1415927	-3.342864
Child 150 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Child 50 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Worker 150 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Worker 50 days	Tetrachloroethylene	127-18-4	No	Yes	Organics	2.10E-03	U	6.00E-03	U	1	0.0334	165.83	3.1415927	-3.728648
Child 150 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784
Child 50 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784
Worker 150 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784
Worker 50 days	Trichloroethylene	79-01-6	Yes	Yes	Organics	4.60E-02	U	5.00E-04	U	1	0.0116	131.39	3.1415927	-3.535784

Attachment 2

Scenario	dslc	dsc	c	littleb	B	tstar	tau_event	F	In EPD?	Carcinogenic DAevent	Noncarcinogenic Daevent	DAeventna	Ingestion SL TR=1.0E-6 (µg/L)	Dermal SL TR=1.0E-6 (µg/L)	Carcinogenic SL TR=1.0E-6 (µg/L)
Child 150 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	6.086E-6	0.066687	0.0804354	1.05E+01	1.08E+00	9.82E-01
Child 50 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	6.3719E-6	0.2000609	0.2413061	5.32E+00	8.02E-01	6.97E-01
Worker 150 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	0.0000251	-	0.0193561	-	4.47E+00	4.47E+00
Worker 50 days	0.0007079	7.0795E-7	0.3505315	0.3189446	0.0254807	0.565015	0.2354229	1	Yes	0.0000753	-	0.0580682	-	6.16E+00	6.16E+00
Child 150 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0222108	4.4457978	5.3623578	1.12E+05	3.88E+03	3.75E+03
Child 50 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0666324	13.337393	16.087073	1.66E+05	8.23E+03	7.84E+03
Worker 150 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0031694	-	1.290404	-	5.54E+02	5.54E+02
Worker 50 days	0.0004424	4.4241E-7	0.3507675	0.3191598	0.0258262	0.9041406	0.3767253	1	Yes	0.0095082	-	3.8712121	-	8.06E+02	8.06E+02
Child 150 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0013912	0.1333739	0.1608707	7.02E+03	3.91E+02	3.70E+02
Child 50 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0041737	0.4001218	0.4826122	1.04E+04	8.28E+02	7.67E+02
Worker 150 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0001985	-	0.0387121	-	5.57E+01	5.57E+01
Worker 50 days	0.0004424	4.4241E-7	0.3441311	0.3131135	0.0160696	0.9041406	0.3767253	1	Yes	0.0005956	-	0.1161364	-	8.10E+01	8.10E+01
Child 150 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	1.1114495	1.3405894	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	3.3343484	4.0217683	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	-	0.322601	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3634974	0.3307845	0.0443062	0.8808947	0.3670395	1	Yes	-	-	0.967803	-	-	-
Child 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.2000609	0.2413061	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.6001827	0.7239183	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.0580682	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.1742045	-	-	-
Child 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.044458	0.0536236	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.1333739	0.1608707	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.012904	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.0387121	-	-	-
Child 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	0.4445798	0.5362358	-	-	-
Child 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	1.3337393	1.6087073	-	-	-
Worker 150 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.1290404	-	-	-
Worker 50 days	0.0004541	4.5408E-7	0.3616588	0.3291028	0.0416554	0.8808947	0.3670395	1	Yes	-	-	0.3871212	-	-	-
Child 150 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.0602865	0.1333739	0.1608707	3.04E+05	1.38E+03	1.38E+03
Child 50 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.1808595	0.4001218	0.4826122	4.51E+05	2.93E+03	2.91E+03
Worker 150 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.0086027	-	0.0387121	-	1.97E+02	1.97E+02
Worker 50 days	0.0001868	1.8679E-7	0.4514447	0.4132241	0.1654263	2.1414503	0.8922709	1	Yes	0.0258081	-	0.1161364	-	2.96E+02	2.96E+02
Child 150 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0009174	0.0111145	0.0134059	2.61E+03	7.56E+01	7.35E+01
Child 50 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0027522	0.0333435	0.0402177	3.91E+03	1.60E+02	1.54E+02
Worker 150 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0003927	-	0.003226	2.81E+03	3.24E+01	3.20E+01
Worker 50 days	0.0002912	2.9122E-7	0.3682564	0.3351426	0.0511406	1.3735485	0.5723119	1	Yes	0.0011782	-	0.009678	2.10E+03	4.86E+01	4.75E+01

Attachment 2

Scenario	Ingestion SL (Child) HQ=1 (µg/L)	Dermal SL (Child) HQ=1 (µg/L)	Noncarcinogenic SL (Child) HQ=1 (µg/L)	Ingestion SL (Adult) HQ=1 (µg/L)	Dermal SL (Adult) HQ=1 (µg/L)	Noncarcinogenic SL (Adult) HQ=1 (µg/L)	Screening Level (µg/L)
Child 150 days	1.10E+05	1.19E+04	1.07E+04	-	1.43E+04	1.43E+04	5.05E+00 ca**
Child 50 days	1.64E+05	2.52E+04	2.18E+04	-	3.04E+04	3.04E+04	1.05E+01 ca**
Worker 150 days	-	-	-	-	3.44E+03	3.44E+03	4.36E+00 ca**
Worker 50 days	-	-	-	-	4.75E+03	4.75E+03	6.16E+00 ca**
Child 150 days	7.30E+06	7.76E+05	7.02E+05	-	9.37E+05	9.37E+05	3.75E+03 ca**
Child 50 days	1.10E+07	1.65E+06	1.43E+06	-	1.99E+06	1.99E+06	7.84E+03 ca**
Worker 150 days	-	-	-	-	2.25E+05	2.25E+05	5.54E+02 ca**
Worker 50 days	-	-	-	-	3.28E+05	3.28E+05	8.06E+02 ca**
Child 150 days	2.19E+05	3.74E+04	3.20E+04	-	4.52E+04	4.52E+04	3.70E+02 ca**
Child 50 days	3.29E+05	7.94E+04	6.40E+04	-	9.58E+04	9.58E+04	7.67E+02 ca**
Worker 150 days	-	-	-	-	1.09E+04	1.09E+04	5.57E+01 ca**
Worker 50 days	-	-	-	-	1.58E+04	1.58E+04	8.10E+01 ca**
Child 150 days	1.83E+06	1.13E+05	1.07E+05	-	1.37E+05	1.37E+05	
Child 50 days	2.74E+06	2.41E+05	2.21E+05	-	2.90E+05	2.90E+05	
Worker 150 days	-	-	-	-	3.29E+04	3.29E+04	
Worker 50 days	-	-	-	-	4.80E+04	4.80E+04	
Child 150 days	3.29E+05	2.17E+04	2.04E+04	-	2.62E+04	2.62E+04	
Child 50 days	4.93E+05	4.61E+04	4.21E+04	-	5.56E+04	5.56E+04	
Worker 150 days	-	-	-	-	6.31E+03	6.31E+03	
Worker 50 days	-	-	-	-	9.18E+03	9.18E+03	
Child 150 days	7.30E+04	4.83E+03	4.53E+03	-	5.82E+03	5.82E+03	
Child 50 days	1.10E+05	1.02E+04	9.36E+03	-	1.24E+04	1.24E+04	
Worker 150 days	-	-	-	-	1.40E+03	1.40E+03	
Worker 50 days	-	-	-	-	2.04E+03	2.04E+03	
Child 150 days	7.30E+05	4.83E+04	4.53E+04	-	5.82E+04	5.82E+04	
Child 50 days	1.10E+06	1.02E+05	9.36E+04	-	1.24E+05	1.24E+05	
Worker 150 days	-	-	-	-	1.40E+04	1.40E+04	
Worker 50 days	-	-	-	-	2.04E+04	2.04E+04	
Child 150 days	2.19E+05	3.06E+03	3.02E+03	-	3.69E+03	3.69E+03	1.38E+03 ca**
Child 50 days	3.29E+05	6.49E+03	6.36E+03	-	7.83E+03	7.83E+03	2.91E+03 ca**
Worker 150 days	-	-	-	-	8.88E+02	8.88E+02	1.97E+02 ca**
Worker 50 days	-	-	-	-	1.33E+03	1.33E+03	2.96E+02 ca**
Child 150 days	1.83E+04	9.16E+02	8.73E+02	-	1.11E+03	1.11E+03	7.35E+01 ca**
Child 50 days	2.74E+04	1.94E+03	1.82E+03	-	2.34E+03	2.34E+03	1.54E+02 ca**
Worker 150 days	-	-	-	-	2.66E+02	2.66E+02	3.20E+01 ca**
Worker 50 days	-	-	-	-	3.99E+02	3.99E+02	4.75E+01 ca**

Notes: Chemical-specific model inputs are defined in Attachment 1

Abbreviations not defined in Attachment 1

- b - Correlation coefficient fitted to Flynn data set
- B - Ratio of permeability through stratum corneum: viable epidermis
- c - correlation coefficient fitter to Flynn's data
- CAS - Registry number assigned by Chemical Abstracts Service
- DA event - Dose absorbed per event
- Ds - Effective diffusivity of the absorbing chemical through the epidermis
- Dsc - Effective diffusion coefficient chemical transfer though stratum corneum
- Lsc - Apparent thickness of stratum corneum
- EPD - Effective predictive domain
- FA - Fraction absorbed water
- GIABS - Fraction of contaminant absorbed in intestinal tract
- HQ - Hazard quotient
- kp - Dermal permeability coefficient
- MW - Molecular weight
- RAGSe - Risk Assessment Guidance for Superfund, Vol. 1 Part E (2004)
- RfD - EPA reference dose
- SF/SFO - Oral cancer slope factor
- SL - Screening level
- t* - Time to reach steady-state
- tau - Lag time per event
- TR - Target risk
- ug/L - Micrograms per liter
- VOC - Volatile organic compound