

Appendix G: Hydraulic gradient calculations

Upper Pakiri Formation

Groundwater flow to the Valley 1 and 2 stream confluence:

Height of rear of landfill - 120 mRL

Height at stream confluence - 70 mRL

Distance - 1,700 m

Hydraulic gradient (i) = $120-70/1700 = 0.03$

Regional groundwater in Pakiri Formation

Groundwater flow to the Hoteo River:

Height of regional groundwater in TB01 - 35 mRL

Approximate height of Hoteo River - 25 mRL

Distance from TB01 to Hoteo River - 1,700 m

Hydraulic gradient (i) = $35-25/1700 = 0.006$

Groundwater flow to the Waiteraire Stream:

Height of regional groundwater in TB01 - 35 mRL

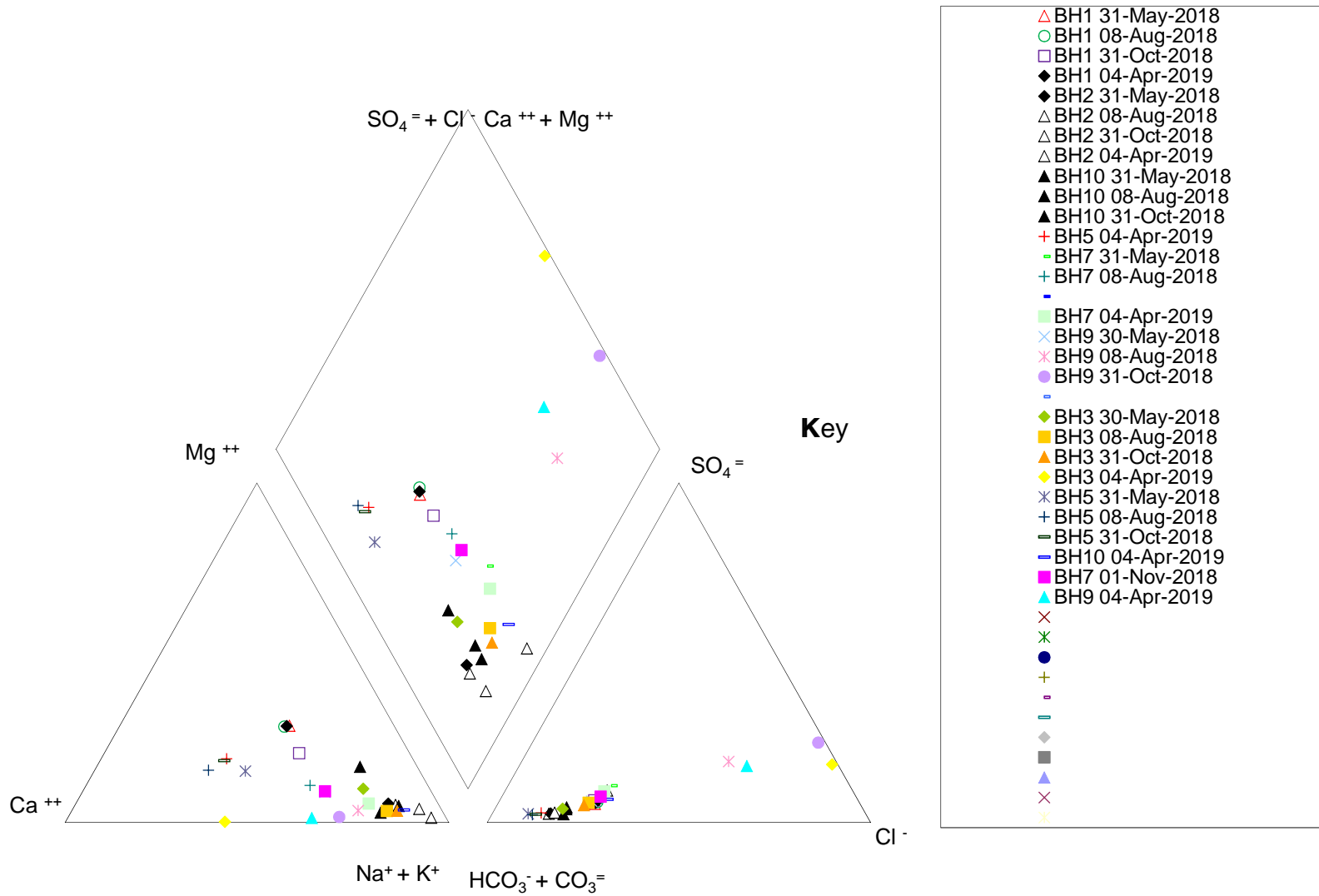
Approximate height of Waiteraire Stream - 30 mRL

Distance from TB01 to Waiteraire Stream - 1000 mRL

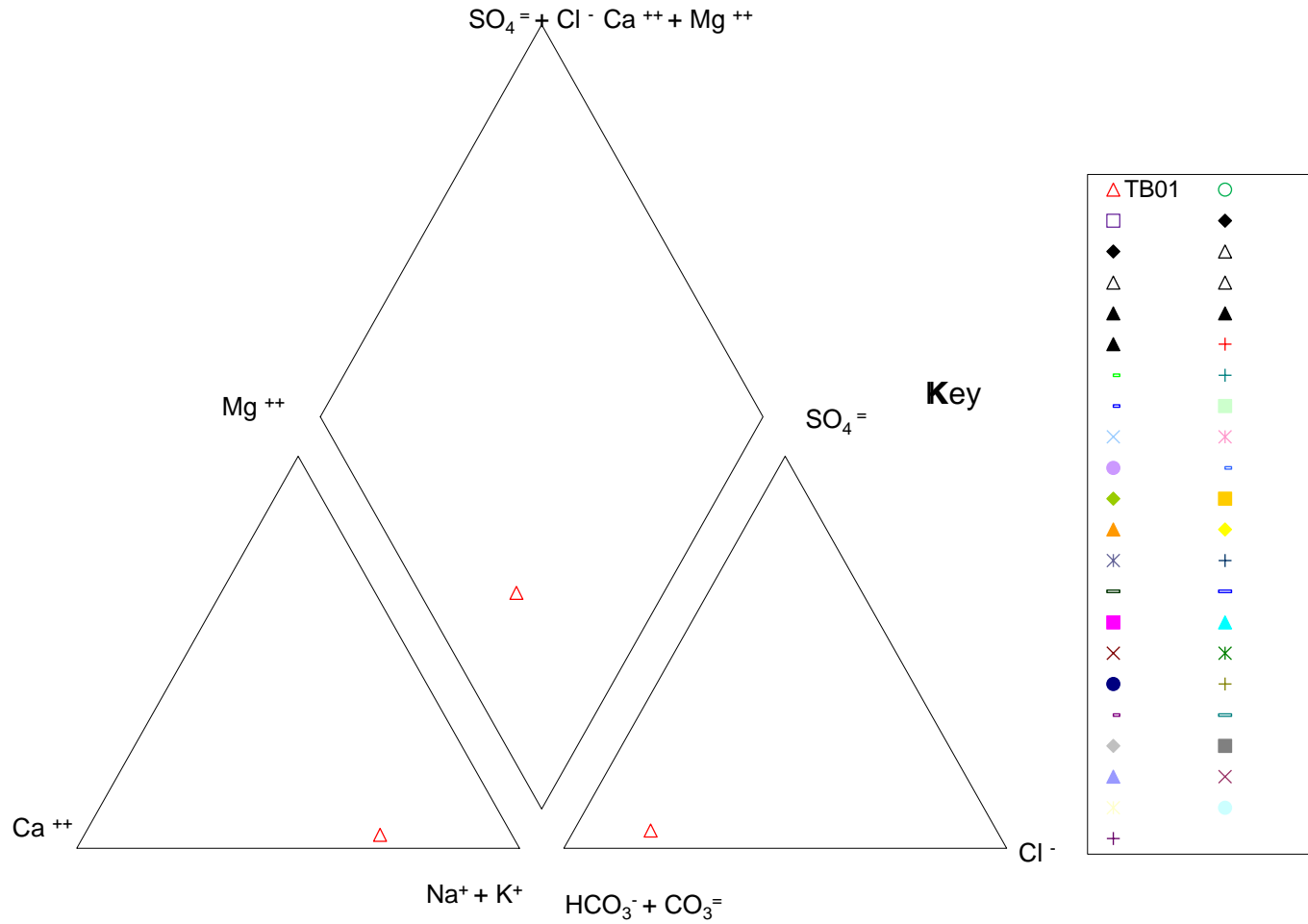
Hydraulic gradient (i) = $35-30/1000 = 0.005$

Appendix H: Groundwater chemistry Piper Plots

Combined Piper Plot - Upper Pakiri Formation

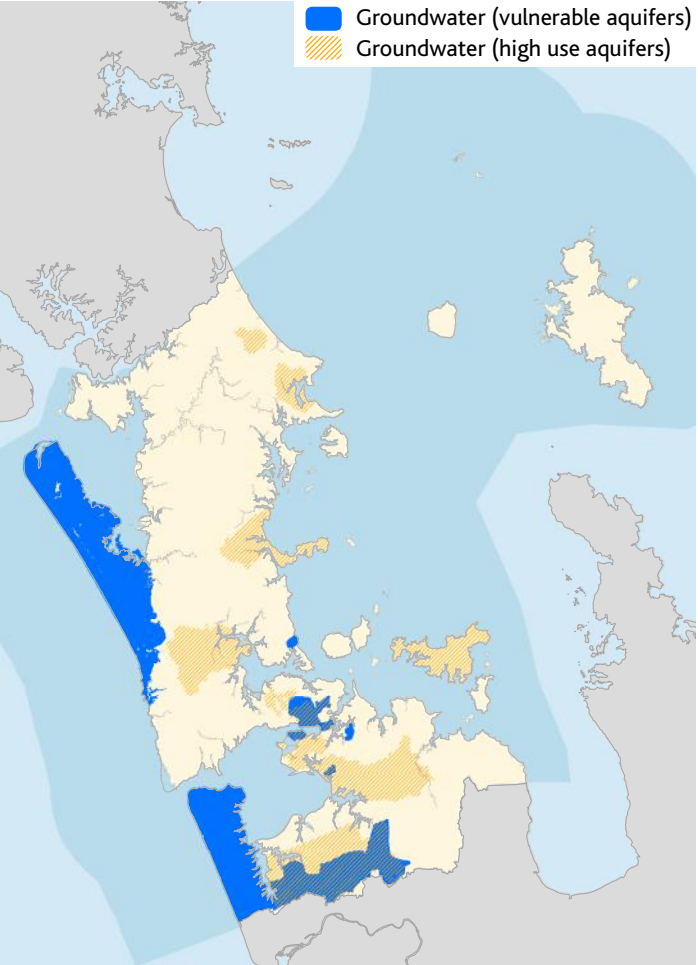


Piper Plot TB01



**Appendix I: Auckland Council Groundwater
Management Areas**

- Groundwater (vulnerable aquifers)
- Groundwater (high use aquifers)



GROUNDWATER MANAGEMENT AREAS



Appendix J: Auckland Council Bore and Consent Search

Table G1: Bores within 5 km of Valley 1

CONSENT_NUMBER	CONSENT_HOLDER	BORE_ID	GRANTED_DATE	EXPIRY_DATE	CONSENT_STATUS	PURPOSE	WORKS_DESCRIPTION	EASTING	NORTHING	ACTIVITY_STATUS	BORE_USE	ACTIVITY_DESCRIPTION	MAIN_AQUIFER	DATE_DRILLED	TOTAL_DEPTH	DIAMETER	CASING_FROM	CASING_TO	PROPERTY_ADDRESS
0		1963						1741300	5981400	Drilled		Drilled pre-1987 for MARTIN by *** DRILLER UNKNOWN ***.	Waitemata	2000101	45		0		
28620	Homeward Bound Group NZ Ltd	22011	20031203	20041204	Expired	To authorise the construction of a bore for household and stock supply.	Construction of a 100mm diameter bore to a depth of approximately 230m. Installation of PVC casing to a depth of approximately 80m.	1741060	5982340	Drilled	Domestic/Stock	To authorise the construction of a bore for household and stock supply.	Waitemata	20031212	170	100	0	64	26 Homeward Bound Drive Wellsford Rodney District
30241	NZ Transport Agency Attention: Tammy Muharemi	22248	20041206	20051207	Expired	To authorise the construction of 12 bores for groundwater monitoring purposes.	Construction of twelve 25mm diameter bores to an approximate depth of 40m. Installation of PVC casing, with a proposed grouting length of 4m. Depth to top of screen material to 20m and bottom to 40m, with a gravel screen material.	1744800	5974500	Proposed	Observation / Piezo	To authorise the construction of 12 bores for groundwater monitoring purposes.							496 State Highway 1 Dome Valley Rodney
0		20894						1737910	5980200	Drilled	Irrigation	Pre permit bore. Location supplied by owner. Wellsford Golf club. AG 660968. Bore close to 12th green near water tanks.					0		
52451		23657	20100712		Assessment Completed	To authorise the construction of one bore for geological	The construction of a 100mm diameter bore to an approximate depth of 300m. Installation of phd flush walled casing material to an approximate depth of 50m.	1740888	5980888	Drilled	Water Supply	13/02/13 To authorise the construction of one bore for municipal water supply purposes.To authorise the construction of one bore for geological investigation.	Waitemata	20130429	250.56	150	0	86	Wilson Road Dairy Flat Rodney
10342	B HOCHENHALL	170	19880216	19890218	Expired	Authorize the construction of a bore for the extraction of groundwater for stock and domestic supply.	Construction of a 100mm dia. bore to approx. 90m depth and installation of P.V.C. casing to approx. 30m.	1738600	5978500	Drilled		Construction of a 100mm dia. bore to approx. 90m depth and installation of P.V.C. casing to approx. 30m.	Waitemata		90	100	0		WAYBY STATION ROAD WELLSFORD Rodney District
10945	MR PJ HARTLEY BJ HARTLEY	773	19911111	19921111	Expired	Authorize the construction of a bore for the extraction of groundwater for irrigation, stock and domestic supply	Construction of a 100mm dia. bore to approx. 100m depth and installation of P.V.C. casing to approx. 60m.	1737520	5977730	Drilled	Irrigation	Irrigation, stock & domestic supply.	Waitemata		100	100	0		177 Wayby Station Road Wayby Rodney
41454	Watercare Services Limited	23657	20130320	20140318	Expired	13/02/13 To authorise the construction of one bore for municipal water supply purposes.To authorise the construction of one bore for geological investigation.	The construction of a 250mm diameter bore to an approximate depth of 250m. Installation of ASTM A106/Schedule 40 carbon steel casing to an approximate depth of 86m. Proposed grouting to full length.	1740888	5980888	Drilled	Water Supply	13/02/13 To authorise the construction of one bore for municipal water supply purposes.To authorise the construction of one bore for geological investigation.	Waitemata	20130429	250.56	150	0	86	Wilson Road Dairy Flat Rodney
41692	Watercare Services Limited	28894	20130524	20140527	Expired	The construction of one bore for use as water supply for wastewater treatment plant equipment.	The construction of a 104mm diameter bore to an approximate depth of 150m. Installation of Grade C PVC casing material to an approximate depth of 50-70m. Proposed grouting to 90m.	1738148	5980606	Proposed	Water Supply	The construction of one bore for use as water supply for wastewater treatment plant equipment.							0 State Highway 1 Wayby Valley Rodney
37862	GD & PA Nelson Family Trusts P'ship (Gordon D Nelson, Richard J Crighton & Barry Maguire, Patricia A Nelson)	23589	20100420	20110422	Expired	To authorise the construction of one bore for stock supply.	The construction of a 104mm diameter bore to an approximate depth of between 200-250m. Installation of Grade C PVC casing material to an approximate depth of 80m. Proposed grouting to 30m.	1740670	5982120	Drilled	Stock	To authorise the construction of one bore for stock supply.	Waitemata	20100811	36	100	0	18	222 Whangaripo Valley Road Wayby Valley Rodney
42100	Watercare Services Limited	29067	20130910	20140910	Expired	To authorise the construction of one bore for municipal supply.	The construction of a 100mm diameter bore to an approximate depth of 300m. Installation of steel socketed and screwed casing material to an approximate depth of 85m. Proposed grouting to full length.	1739565	5979805	Proposed	Other	To authorise the construction of one bore for municipal supply.							Spindler Road Wellsford Rodney
42102	Watercare Services Limited	29068	20130910	20140913	Expired	To authorise the construction of one bore for municipal supply.	The construction of a 100mm diameter bore to an approximate depth of 300m. Installation of steel socketed and screwed casing material to an approximate depth of 85m. Proposed grouting to full length.	1739895	5981420	Proposed	Other	To authorise the construction of one bore for municipal supply.							Wilson Road Wayby Valley Rodney
36824	Rodney District Council	23339	20090320	20100323	Expired	To authorise the construction of one bore for groundwater investigation.	The construction of a 100mm diameter bore to an approximate depth of 300m. Installation of steel HWT flush jointed casing material to an approximate depth of 91m.	1740715	5981115	Proposed	Aquifer Test	To authorise the construction of one bore for groundwater investigation.	Waitemata						0 Wilson Road Warkworth Rodney
35930	Rodney District Council	23178	20080620	20090619	Expired	to authorise the construction of a bore for domestic and stock watering.	The construction of a 100mm diameter bore to an approximate depth of 250m. Installation of steel casing material to an approximate depth of 50m.	1740093	5981667	Drilled	Domestic/Stock	to authorise the construction of a bore for domestic and stock watering.	Waitemata	20080714	119.7				0 Wayby Valley Road Wayby Valley Rodney
12923	Barry Blennerhassett & Lorraine Margaret Blennerhassett	1401	19940714	19950714	Expired	Authorize sealing of an abandoned bore.	Backfilling of an abandoned bore with cement grout from the bottom of the bore to ground level	1740600	5982700	Decommissioned/Backfilled		Backfilling of an abandoned bore with cement grout from the bottom of the bore to ground level	Waitemata	19940714	30	100	0		
12924	Barry Blennerhassett & Lorraine Margaret Blennerhassett	1402	19940714	19950714	Expired	Authorize sealing of an abandoned bore.	Backfilling of an abandoned bore with cement grout from the bottom of the bore to ground level	1740600	5982700	Decommissioned/Backfilled		Backfilling of an abandoned bore with cement grout from the bottom of the bore to ground level	Waitemata		20	100	0		
12726	Barry Blennerhassett & Lorraine Margaret Blennerhassett	1346	19940616	19950616	Expired	Authorize the construction of a bore for the extraction of groundwater for stock and domestic supply	Construction of a 100mm dia. bore to approx. 200m depth and installation of PVC casing to approx. 60m.	1740795	5982395	Drilled	Domestic/Stock		Waitemata	19940621	225	100	0	78	487 Wayby Valley Road Wayby Valley Rodney

Table G2: Water takes within 5 km of Valley 1

CONSENT_NUMBER	FILE_REFERENCE	CONSENT HOLDER	CONSENT_STATUS	GRANTED_DATE	EXPIRY_DATE	REVIEW_DATE	PROCESSING_OFFICER	PURPOSE	EASTING	NORTHING	ANNUAL_ALLOCATION	DAILY_ALLOCATION	TAKE_ID	ACTIVITY_STATUS	PURPOSE_CLASS	ACTIVITY_DESCRIPTION	SITE_NAME	SITE_DESCRIPTION	AQUIFER	MANAGEMENT_AREA	SOURCE	USE_TYPE	BORE_ID	PROPERTY_ADDRESS
13332	AR945872	Rodney District Council	Superseded	20030506	20140531	20081231	Roger Bannister	To authorise the taking of surface water from the Hoteo River for municipal supply in accordance with Section 14 of the Resource Management Act 1991.	1740220	5981590	230000	1300	1156	Occurring	Other	A replacement application to take up to 1500 cubic metres per day at a maximum rate of 20 litres per second of surface water from the Hoteo River for Wellsford municipal supply.	Wellsford Water Supply	362 Wayby Valley Rd, Wellsford, Rodney		Hoteo	River/lake	Municipal Supply		362 Wayby Valley Road Wayby Valley Rodney
36246	5872	Watercare Services Limited	Expired (Replacement Lodged)	20090203	20140531	20091231	Katrina Browne	To authorise the taking of water from the Hoteo River for municipal supply in accordance with Section 14 of the Resource Management Act 1991.	1740220	5981590	270000	1300	1156	Occurring	Other	A replacement application to take up to 1500 cubic metres per day at a maximum rate of 20 litres per second of surface water from the Hoteo River for Wellsford municipal supply.	Wellsford Water Supply	362 Wayby Valley Rd, Wellsford, Rodney		Hoteo	River/lake	Municipal Supply		362 Wayby Valley Road Wayby Valley Rodney
25214	660967	Wellsford Golf & Squash Club Inc.	Expired	20010514	20140531	20041231	Roger Bannister	To authorise the taking of surface water from an off stream dam for irrigation of golf course tees and greens in accordance with Section 14 of the Resource Management Act 1991.	1738025	5980495	4500	25	174	Occurring	Other	Watering of greens & general use with fertilisers & insecticides and weedicides.	Wellsford Golf Club	1496 State Highway 1		Hoteo	Dam	Golf Course		1496 State Highway 1 Wellsford Rodney
322	AG660325	DJ FIRTH	Cancelled	19690625				To take water from aBorefor -Industrial Use	1744200	5982300		0	1191			To take water from aBorefor - Industrial Use			Hoteo Groundwater	Bore	Industrial Use		WELLSFORD LEIGH RD Rodney District	
941	AK660967	Wellsford Golf & Squash Club Inc.	Replaced	19690321	20011001			To take surface water from an unnamed tributary of the Hoteo River for watering of green and fairways on golf course, general use in club rooms and domestic use.	1738025	5980495	9100	25	174	Occurring	Other	Watering of greens & general use with fertilisers & insecticides and weedicides.	Wellsford Golf Club	1496 State Highway 1		Hoteo	Dam	Golf Course		1496 State Highway 1 Wellsford Rodney
942	AG660968	Wellsford Golf & Squash Club Inc.	Cancelled	19690321				Watering golf course and fairways, use in clubhouse	1737910	5980200		47	175			Watering golf course and fairways, use in clubhouse			Hoteo Groundwater	Bore	Pastoral	20894	SH 1 WELLSFORD Rodney District	
983	AR661009	DW WORSNOP	Cancelled	19690324				To take from a River/lake up to 26.09 cmpd for - Pastoral	1739400	5980900		26	1151			To take from a River/lake up to 26.09 cmpd for - Pastoral			Hoteo	River/lake	Pastoral		No Address	
151	AR660151	FL COOP	Cancelled	19691015				STOCK & DOMESTIC USE COWSHED WASHING MILK COOLING~~~~	1738600	5981100		3	180						Hoteo	River/lake			RUSTY BROOK RD RD 4, WELLSFORD, Rodney District	
2324	AR781632	Rodney District Council	Replaced	19780119	19880119			To take surface water from the Hoteo River for municipal supply	1740220	5981590		760	1160	Occurring		To take surface water from the Hoteo River for municipal supply			Hoteo	River/lake	Municipal Supply		362 WAYBY-TOMARATA RD WELLSFORD Rodney District	
183	AR660183	F DIBBLE	Cancelled	19700331				To take up to 3.74 cmpd from a River/lake	1737600	5978500		4	170			To take up to 3.74 cmpd from a River/lake			Hoteo	River/lake			HOTE0 NORTH RD Rodney District	
8022	AG917999	MR PJ HARTLEY BJ HARTLEY	Cancelled	19911211	20061231		_Maira Wright	TO TAKE GROUNDWATER FOR IRRIGATION OF A 1 HECTARE MIXED ORCHARD, INTERPLANTED WITH MARKET GARDEN AND UP TO 0.2 HA PLASTICHOUSE CROPS	1737520	5977730		55	3928					Waitemata	Hoteo Groundwater	Bore	Pastoral	773	177 Wayby Station Road Wayby Rodney	
7609	AR907515	WH CORNELL AND JJ CORNELL	Expired	19910412	19941231			TO TAKE SURFACE WATER FROM THE HOTE0 RIVER TO STORAGE~IN AN OX-BOW LAKE~~~~	1740100	5981100		500	1155						Hoteo	River/lake	Pastoral		WILSON ROAD WAYBY VALLEY Rodney District	
7676	AL907619	WH CORNELL AND JJ CORNELL	Expired	19910412	19941231			TO TAKE WATER FROM AN OX-BOW LAKE FOR IRRIGATION OF UP~TO 30HA OF FORESTRY~~~~	1740200	5981100		500	1159				WILSON ROAD, WAYBY VALLEY		Hoteo	River/lake	Other		WILSON RD WAYBY VALLEY Rodney District	
6060	AR875872	Rodney District Council	Replaced	19880324	19941231			To take surface water from the Hoteo River for municipal supply	1740220	5981590		1300	1156	Occurring	Other	A replacement application to take up to 1500 cubic metres per day at a maximum rate of 20 litres per second of surface water from the Hoteo River for Wellsford municipal supply.	Wellsford Water Supply	362 Wayby Valley Rd, Wellsford, Rodney		Hoteo	River/lake	Municipal Supply		362 Wayby Valley Road Wayby Valley Rodney
41455	23688	Watercare Services Limited	Expired	20130424	20140430		Andy Samaratunga	To take a maximum 2,760 m3/day and 55,775 m3/year of groundwater from a Waitemata sandstone 250 mm bore for a pumping test	1740888	5980888		2760	21006	Proposed		To take groundwater for a pump test.	Watercare Services	Wilson Rd, Wellsford	Waitemata	Hoteo Groundwater	Bore	Other	23657	Wilson Road Dairy Flat Rodney

Appendix K: AquiferTest Pro



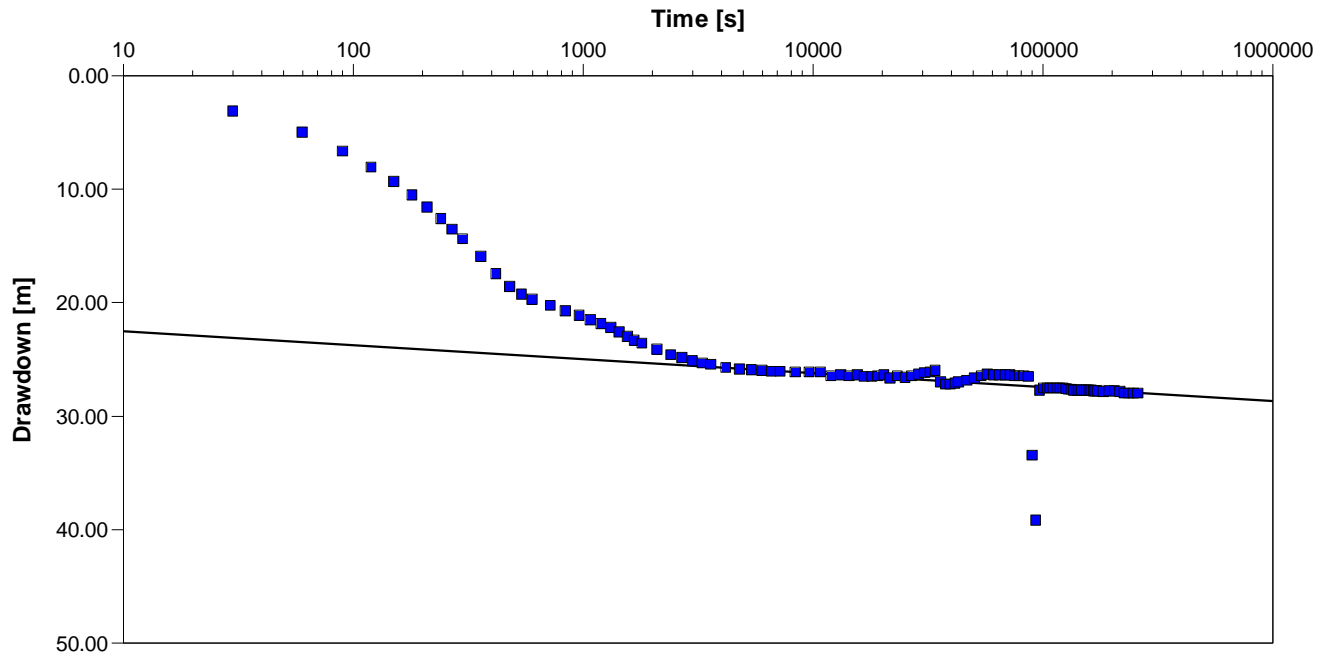
Pumping Test Analysis Report

Project: Polaris

Number: 1005069

Client: Waste Management Ltd

Location: Dome Valley	Pumping Test: Pumping Test 1	Pumping Well: Well 1
Test Conducted by: McMillan Drilling		Test Date: 20/11/2018
Analysis Performed by: KELE	Cooper Jacob	Analysis Date: 27/11/2018
Aquifer Thickness: 50.00 m	Discharge Rate: 0.55 [l/s]	



Calculation using COOPER & JACOB

Observation Well	Transmissivity [m ² /d]	Hydraulic Conductivity [m/d]			
Well 1	7.15 × 10 ⁰	1.44 E-01			

Appendix L: Redvale leachate data

Parameter	Unit	Max			Min			Average			Median		
		LC1	LC2	LC3	LC1	LC2	LC3	LC1	LC2	LC3	LC1	LC2	LC3
Arsenic total	g/m3	0.3400	0.3300	0.2920	0.0080	0.0050	0.0400	0.0708	0.1057	0.1653	0.0500	0.0800	0.1385
Barium	g/m3	5.7000	5.6000	6.4000	0.8370	3.2000	4.5000	3.5796	4.4333	5.5250	3.7500	4.5000	5.6000
Cadmium total	g/m3	0.0100	0.0117	0.0005	0.0001	0.0001	0.0005	0.0022	0.0024	0.0005	0.0012	0.0007	0.0005
Chromium total	g/m3	0.7340	1.3800	0.6300	0.0189	0.0250	0.1290	0.2136	0.2910	0.4520	0.1860	0.1670	0.5200
Lead total	g/m3	0.1700	0.1750	0.0200	0.0010	0.0030	0.0020	0.0243	0.0248	0.0088	0.0080	0.0144	0.0068
Mercury total	g/m3	0.0065	0.0014	-	0.0001	0.0001	-	0.0006	0.0005	-	0.0002	0.0004	-
Selenium total	g/m3	0.0380	-	-	0.0380	-	-	0.0380	-	-	0.0380	-	-
Silver total	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Cyanide	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	g/m3	0.0200	0.0240	0.0134	0.0009	0.0052	0.0080	0.0076	0.0117	0.0104	0.0074	0.0105	0.0102
m+p-cresol	g/m3	4.9000	2.5000	0.9400	0.0070	0.0390	0.9400	1.3712	1.2463	0.9400	0.2400	1.2000	0.9400
3- + 4-methylphenol (m+p-cresol)	g/m3	5.9000	13.0000	0.9400	0.0046	0.0100	0.0950	0.5423	1.8688	0.3783	0.0495	0.1622	0.1000
o-cresol (2-methylphenol)	g/m3	0.2100	-	-	0.0020	-	-	0.0304	-	-	0.0096	-	-
3-Methylphenol (m-cresol)	g/m3	0.0230	-	0.0265	0.0230	-	0.0265	0.0230	-	0.0265	0.0230	-	0.0265
2-Methylphenol (o-cresol)	g/m3	0.1300	0.2780	0.0350	0.0035	0.0004	0.0080	0.0183	0.0543	0.0163	0.0112	0.0220	0.0115
4-Methylphenol (p-cresol)	g/m3	4.2000	1.5200	-	0.0002	0.0030	-	0.7105	0.5140	-	0.1435	0.1610	-
Chlordane	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Endrin	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Heptachlor	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Methoxychlor	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Pentachlorophenol	g/m3	0.0050	0.0014	-	0.0002	0.0014	-	0.0025	0.0014	-	0.0024	0.0014	-
Toxaphene	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
2,4 - D	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
2,4,5 - TP	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Nitrobenzene	g/m3	0.0090	-	-	0.0090	-	-	0.0090	-	-	0.0090	-	-
methyl ethyl ketone (2-butanone)	g/m3	17.6000	58.4000	0.2200	0.0180	0.1000	0.2200	1.9648	16.6730	0.2200	0.3300	10.1500	0.2200
2-butanone (refer Methyl Ethyl Ketone)	g/m3	17.6000	58.4000	8.9000	0.0180	0.1000	0.2200	1.6453	11.7823	2.3240	0.2685	1.3100	0.4200
Methyl ethyl ketone (MEK, 2-Butanone)	g/m3	28.3000	58.4000	-	0.0180	0.1000	-	3.8295	22.0743	-	0.5200	19.7000	-
Pyridine	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
carbon tetrachloride	g/m3	0.0200	-	-	0.0200	-	-	0.0200	-	-	0.0200	-	-
chloroform	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethylene (tetrachloroethene)	g/m3	0.0020	-	-	0.0010	-	-	0.0015	-	-	0.0015	-	-
trichloroethylene (trichloroethene)	g/m3	0.0050	0.0150	-	0.0032	0.0008	-	0.0044	0.0088	-	0.0050	0.0096	-
trichloroethene	g/m3	0.0050	0.0150	-	0.0050	0.0008	-	0.0050	0.0088	-	0.0050	0.0096	-
1,1-dichloroethene	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
1,2-dichloroethane	g/m3	0.0011	0.0018	0.0014	0.0005	0.0018	0.0008	0.0009	0.0018	0.0012	0.0011	0.0018	0.0013
Vinyl chloride	g/m3	0.0840	0.0081	0.0050	0.0018	0.0033	0.0041	0.0154	0.0057	0.0045	0.0060	0.0057	0.0044
chlorobenzene	g/m3	0.0060	0.0050	0.0027	0.0006	0.0012	0.0018	0.0034	0.0022	0.0024	0.0037	0.0016	0.0026
1,4-Dichlorobenzene	g/m3	0.0143	0.0076	0.0052	0.0020	0.0028	0.0042	0.0072	0.0052	0.0047	0.0070	0.0055	0.0047
Hexachlorobutadiene	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
Hexachlorobenzene	g/m3	0.0068	-	-	0.0068	-	-	0.0068	-	-	0.0068	-	-
Hexachloroethane	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
PCB (polychlorinated biphenyls)	g/m3	0.0030	-	-	0.0010	-	-	0.0020	-	-	0.0020	-	-
2,4,5-Trichlorophenol	g/m3	-	-	-	-	-	-	-	-	-	-	-	-
2,4,6-Trichlorophenol	g/m3	0.0029	-	-	0.0029	-	-	0.0029	-	-	0.0029	-	-

Appendix M: Equilibrium Partitioning

Table M1: Equilibrium partitioning to estimate source concentration

Contaminant	Maximum Redvale Leachate (mg/L)	RBCA Log Kd (L/kg)	RBCA Kd (L/kg)	RBCA Log Koc (L/kg)	RBCA Koc (L/kg)	RBCA Kd from Koc (L/kg)	H	Total concentration from Cw (equilibrium partitioning)
Arsenic	0.34	1.46	29.07	Kd		29.1	0	10
Barium	6.40	1.63	42.38	Kd		42.4	0	272
Cadmium	0.01	2.08	121.53	Kd		121.5	0	1.5
Chromium (III) (total chromium)	1.40	6.38	2401043.34	Kd		2401043.3	0	3361461
Lead (inorganic)	0.18	1	10	Kd		10.0	0	1.8
Mercury	0.01	1.87	74.01	Kd		74.0	0.47	0.48
Selenium	0.04	0.64	4.36	Kd		4.4	0	0.17
Silver	0.0011	1.10	12.72	Kd		12.7	0	0.014
Cyanide	0.098	1.00	9.9	Kd		9.9	0	0.99
Benzene	0.02				1.82	66	0.23	0.021
Cresol, m-	0.03				1.94	87	0.00004	0.029
Cresol, o-	0.28				1.99	98	1.0	0.0007
Cresol, p-	4.20				1.91	81	0.8	0.0004
Chlordane, gamma	0.03				5.6	393432	3934.3	0.004
Chlordane, cis- (alpha chlordane)	0.03				6.85	7079458	70794.6	0.004
Endrin	0.025				3.97	9333	93.3	0.00005
Heptachlor	0.025				4.07	11749	117.5	0.02
Methoxychlor	10.00				4.89	77625	776.2	0.0007
Pentachlorophenol	0.01				2.6	410	4.1	0.00012
Toxaphene	0.50				5.0	95816	958.2	0.00014
Dichlorophenoxyacetic acid, 2,4-	10.00				2.95	891.25	8.9	0.00000001
Trichlorophenoxyacetic acid, 2,4,5-	1.00				1.7	53	0.5	0.0000004
Dinitrotoluene, 2,4-	0.025				1.71	51.29	0.5	0.00004
Nitrobenzene	0.01				2.12	131.83	1.3	0.0009
Methyl ethyl ketone	58.40				0.3	1.9	0.02	0.002
Pyridine	5.00				0.6	4.4	0.04	0.29
Carbon tetrachloride	0.02				2.27	186.21	1.9	1.20
Chloroform	0.025				1.67	46.77	0.5	0.15
Tetrachloroethylene	0.002				2.2	155	1.6	0.76
Trichloroethylene	0.015				1.97	93.33	0.9	0.43
Dichloroethane, 1,2-	0.0018				1.24	17.38	0.2	0.05
Dichloroethylene, 1,1-	0.025				1.81	64.57	0.6	1.06
Vinyl chloride	0.084				1.04	10.96	0.1	3.49
Chlorobenzene	0.006				2.33	213.80	2.1	0.18
Dichlorobenzene, 1,4-	0.0143				2.81	645.65	6.5	0.12
Hexachlorobutadiene	0.025				3.84	6918	69.2	0.99
Hexachlorobenzene	0.0068				4.45	28183.83	281.8	0.02
Hexachloroethane	0.025				3.26	1819.70	18.2	0.16
Polychlorinated biphenyls (liquid)	0.003				5.7	530000	5300	0.017
Trichlorophenol, 2,4,5-	0.005				2.5	298	3.0	0.0002
Trichlorophenol, 2,4,6-	0.0029				2.1	131	1.3	0.0003

Notes:

Redvale data laboratory detection limit halved

Maximum value from MWI RUST

Waste acceptance criteria TCLP

Appendix N: Groundwater risk assessment results

N1 RBCA site conceptual model and input parameters

N1.1 Source concentrations

As indicated in Section 8.3.1, the software model adopted for assessing the environmental effects uses equilibrium partitioning to determine leachate concentrations from total concentrations at the source. To simulate the Redvale Landfill leachate concentrations in RBCA has required back-calculating a total concentration using equilibrium partitioning. The maximum leachate concentrations recorded in Redvale Landfill and the back-calculated total concentrations are summarised on Appendix N Table 1.

Appendix N Table 1: Source concentrations based on maximum Redvale Landfill leachate concentrations

	Contaminant	Redvale Landfill leachate data (mg/L)	Back calculated total concentration (mg/kg) ¹
Metals	Arsenic	0.34	10
	Barium	6.40	272
	Cadmium	0.01	1.5
	Chromium	1.40	3361461
	Lead	0.18	1.8
	Mercury	0.01	0.48
	Selenium	0.04	0.17
	Silver	0.0011	0.014
Other inorganics	Cyanides	0.098	0.99
Aromatic hydrocarbons	Benzene	0.02	0.021
	m-cresol	0.03	0.029
	o-cresol	0.28	0.33
	p-cresol	4.20	4.2
Pesticides and herbicides	Chlordane, gamma	0.03	118
	Chlordane, cis- (alpha chlordane)	0.03	2124
	Endrin	0.025	2.3
	Heptachlor	0.025	2.9
	Methoxychlor	10.00	7764
	Pentachlorophenol	0.01	0.021
	Toxaphene	0.50	479
	2,4-dichlorophenoxyacetic acid	10.00	91
	2,4,5-trichlorophenoxypropionic acid	1.00	0.72
Other organics	2,4-dinitrotoluene	0.025	0.018
	Nitrobenzene	0.01	0.014
	Methyl ethyl ketone	58.40	12
	Pyridine	5.00	1.3
	Carbon tetrachloride	0.02	0.042

	Contaminant	Redvale Landfill leachate data (mg/L)	Back calculated total concentration (mg/kg) ¹
Chlorinated organics	Chloroform	0.025	0.017
	Tetrachlorethene	0.002	0.0036
	Trichloroethene	0.015	0.017
	1,2-dichloroethane	0.0018	0.00067
	1,1-dichloroethene	0.025	0.022
	Vinyl chloride	0.084	0.039
	Chlorobenzene	0.006	0.014
	1,4-dichlorobenzene	0.0143	0.095
	Hexachloro-1,3-butadiene	0.025	1.7
	Hexachlorobenzene	0.0068	1.9
	Hexachloroethane	0.025	0.46
	Polychlorinated biphenyls	0.003	16
	2,4,5-trichlorophenol	0.005	0.016
	2,4,6-trichlorophenol	0.0029	0.0044

Notes:

1. Back-calculated from the Redvale leachate data using equilibrium partitioning.

The information provided in this appendix relates to the assessment of potential effects on surface water and groundwater users. The following tables (Appendix N Table 2 to Appendix N Table 4) summarise the input parameters adopted for assessing fate and transport characteristics in relation to the identified points of exposure (POEs).

Appendix N Table 2 lists the soil input parameters and the values adopted for the modelling carried out to represent the body of the landfill.

Appendix N Table 2: Fate and transport model – soil input parameters (representing landfill material)

Parameter	Value Selected for Model Input	Source
Contaminant concentrations in soil	Redvale leachate data	Based on the relationship of the Redvale leachate data and Kd values (refer Section 8.3.1 and Appendix M).
Contaminated soil source dimensions: - top of contaminated soil - bottom of contaminated soil	1 m 95 m	Based on details presented on Fig No. ENG-18 of the Engineering Report. This assumes that waste will be located beneath a 1 m thick cap.
Length of source zone parallel to groundwater flow	1,400 m	Length of landfill based on details presented on Fig No. ENG-18 of the Engineering Report.
Soil type	Sand	Conservative assumption given the geology is fractured rock and adopts generic values in the RBCA database.
Fraction of organic carbon (foc)	0.01	Assumed value in the absence of site-specific data.

Parameter	Value Selected for Model Input	Source
Adsorption coefficient (Kd/Koc)	Contaminant-specific	Texas Risk Reduction Programme RG-366 TRRP-19 Toxicity Factors and Chemical Physical Parameters, June 2001, as collated in the Chemical Database within USEPA's <i>RBCA tool kit</i> .
pH	7.5	Based on the assessment of typical leachate composition from landfills in NZ, pH ranges between 7 and 8.5. See Engineering Report Table 5, Section 6.4.2.
Infiltration	0.0005 cm/yr	Based on HELP (Hydrologic Evaluation of Landfill Performance, version 3.07) which predicts the maximum seepage over 50 years of simulation to be 3.01 m ³ /year or 8.2L/day. Over 60 hectares, that translates to an infiltration rate of 0.0005cm/yr. See Engineering Report, Section 4.4.2.

The following Appendix N Table 3 lists the shallow groundwater parameters and the values adopted for the modelling carried out to assess the potential effects on the Valley 1 and 2 stream, i.e. POE#1 (Appendix N Table 3).

Appendix N Table 3: Fate and transport model - groundwater input parameters for the Valley 1 and 2 stream (POE#1)

Parameter	Value selected for model input	Source
Depth to groundwater	95 m (same as source depth so no separation, i.e.no vadose zone)	Based on readings collected from BH7 near the base of Valley 1 and considering the thickness of the landfill (Fig No. ENG-18, Engineering Report).
Saturated hydraulic conductivity	3.0×10^{-6} m/s	Adopted value based on the higher range of the rock mass hydraulic conductivity, refer Section 3.8.
Effective porosity	0.001	Inferred, based on low permeability soils and rock present.
Groundwater gradient	0.03	Estimated based on topography and a range of measured gradients between 0.022 and 0.044.
Fraction of organic carbon (foc)	0.001	Reference value for soil type present ²⁴
Dispersion for groundwater receptor	$\alpha_x = 36$ $\alpha_y = 11.88$ $\alpha_z = 1.8$	Calculated from distance to receptor based on ASTM model.
pH	8.5	Median value based on site-specific data (refer Section 4.8 (groundwater quality) of this report). Laboratory analysis of groundwater collected from BH7 indicated pH values between 8.1 and 8.5.

²⁴ MfE, 1999, *Guidelines for Assessing and Managing Petroleum Hydrocarbon Contaminated Sites in New Zealand*

Parameter	Value selected for model input	Source
Plume mixing depth at source	1 m	Mixing depth based on anticipated seasonal groundwater fluctuations.
Biological decay	Contaminant specific	RBCA default half-life values adopted for organic contaminants.
Surface water flow	0.001 m ³ /s (Valley 1 and 2 stream)	Calculated conservatively based on a low flow rate of 1 L/s/km ² and 1 km ² catchment.
Distance to receptor	360 m	Based on the distance from the toe of the proposed landfill to the stream confluence.

Appendix N Table 4 lists the regional groundwater parameters and the values adopted for the modelling carried out to assess the potential effects on both the freshwater ecology and recreational use of the Hōteō River, Waiteraire Stream and the farm bore, i.e. POE#2 to POE#6.

Appendix N Table 4: Fate and transport model - groundwater input parameters for the Hōteō River, Waiteraire Stream and farm bore (POE#2 to POE#6)

Parameter	Value selected for model input	Source
Depth to groundwater	130 m	Based on readings collected from site near the base of Valley 1 and considering the thickness of the landfill.
Saturated hydraulic conductivity	1.7 x 10 ⁻⁶ m/s	Adopted value based on the hydraulic conductivity estimated during the pumping test, refer Section 3.8
Effective porosity	0.001	Inferred, based on soils and rock present.
Groundwater gradient	0.006 (Hōteō River, Farm bore) 0.005 (Waiteraire Stream)	Estimated based on the regional groundwater level in the test bore and the approximate relative level of the Hōteō River and Waiteraire Stream.
Fraction of organic carbon (foc)	0.001	Reference value for soil type present.
Dispersion for groundwater receptor	Hōteō River $\alpha_x = 210$ $\alpha_y = 69.3$ $\alpha_z = 10.5$ Farm bore $\alpha_x = 190$ $\alpha_y = 63$ $\alpha_z = 9.5$ Waiteraire Stream $\alpha_x = 100$ $\alpha_y = 33$ $\alpha_z = 5$	Calculated from distance to receptor based on ASTM model.
pH	8.5	Median value based on site-specific data (refer Section 4.8 (groundwater quality) of this report).

Parameter	Value selected for model input	Source
Biological decay	Contaminant specific	RBCA default half-life values adopted for organic contaminants.
Plume mixing depth at source	1 m	Mixing depth based on anticipated seasonal groundwater fluctuations.
Surface water flow	0.54 m ³ /s (Hōteo River)	The Hōteo River MALF is 0.54 m ³ /s (Land Air Water Aotearoa, Mean Annual Low Flow). This flow has also been adopted for the Waiteraire Stream.
Distance to receptor	2,100 m	Based on the distance from the western edge of the proposed landfill to the Hōteo River.
	1,900 m	Based on the distance from the western edge of the landfill to the farm bore.
	1,000 m	Based on the distance from the southern edge of the landfill to the Waiteraire Stream.

N2 Point of exposure concentration limits

The adopted POE exposure limits are provided in Appendix N Table 5.

Appendix N Table 5: Point-of-exposure concentration limits

Contaminant	ANZECC trigger levels for protection of 95% of species in freshwater (mg/L)	ANZECC recreational guideline values (mg/L)	ANZECC livestock drinking water (mg/L)	Drinking-water standards 2005 (revised 2018) (mg/L)
Arsenic	0.024	0.05	0.5	0.01
Barium	-	1	-	0.7
Cadmium	0.0002	0.005	0.01	0.004
Chromium (III) (total chromium)	0.0033	0.05	1	0.05
Lead (inorganic)	0.0034	0.05	0.1	0.01
Mercury	0.0006	0.001	0.002	0.007
Selenium	0.011	0.01	0.02	0.01
Silver	0.00005	0.05	-	-
Cyanide	0.007	0.1	-	0.6
Benzene	0.95	0.01	-	0.01
Cresol, m-	0.1	-	-	-
Cresol, o-	0.1	-	-	-
Cresol, p-	0.1	-	-	-
Chlordane, gamma	0.00008	0.006	0.0002	0.0002
Chlordane, cis-(alpha chlordane)	0.00008	0.006	0.0002	0.0002
Endrin	0.00002	0.001	0.001	0.001

Contaminant	ANZECC trigger levels for protection of 95% of species in freshwater (mg/L)	ANZECC recreational guideline values (mg/L)	ANZECC livestock drinking water (mg/L)	Drinking-water standards 2005 (revised 2018) (mg/L)
Heptachlor	0.00009	0.003	-	-
Methoxychlor	0.000005	-	0.02	0.02
Pentachlorophenol	0.01	0.01	0.009	0.009
Toxaphene	0.0002	-	-	-
Dichlorophenoxyacetic acid, 2,4-	0.28	-	-	0.04
Trichlorophenoxyacetic acid, 2,4,5-	0.036	-	-	0.01
Dinitrotoluene, 2,4-	0.065	-	-	-
Nitrobenzene	0.55	-	-	-
Methyl ethyl ketone	1.0	-	-	-
Pyridine	1.0	-	-	-
Carbon tetrachloride	0.24	0.003	0.005	0.005
Chloroform	0.37	-	0.4	0.4
Tetrachloroethylene	1.0	0.01	0.05	0.05
Trichloroethylene	1.0	0.03	0.02	0.02
Dichloroethane, 1,2-	1.9	0.01	0.03	0.03
Dichloroethylene, 1,1-	0.7	0.0003	-	-
Vinyl chloride	1.0	-	0.0003	0.0003
Chlorobenzene	1.0	-	-	-
Dichlorobenzene, 1,4-	0.06	-	0.4	0.0003
Hexachlorobutadiene	1.0	-	0.0007	0.0007
Hexachlorobenzene	0.00005	-	-	-
Hexachloroethane	0.36	-	-	-
Polychlorinated biphenyls (liquid)	1.0	-	-	-
Trichlorophenol, 2,4,5-	0.0005	0.001	-	-
Trichlorophenol, 2,4,6-	0.02	0.01	0.2	0.2

N3 RBCA fate and transport model results

The following tables present the results of the POE concentrations predicted by the RBCA model, as described in Section 8.8.

Appendix N Table 6 details the predicted POE#1 concentrations in the shallow groundwater at the Valley 1 and 2 stream confluence.

Appendix N Table 6: POE concentrations predicted at the Valley 1 and 2 stream (POE#1)

Contaminant	Leachate source concentrations (mg/L)	Predicted groundwater concentration at the Valley 1 and 2 stream confluence (POE#1) (mg/L)	ANZECC trigger levels for the protection of 95% of species (mg/L)
Arsenic	0.34	0.0000008	0.024
Barium	6.40	0.00001	-
Cadmium	0.01	0.00000001	0.0002
Chromium (III) (total chromium)	1.40	0.000002	0.0033
Lead (inorganic)	0.18	0.0000004	0.0034
Mercury	0.01	0.00000001	0.0006
Selenium	0.04	0.0000001	0.011
Silver	0.0011	0.000000002	0.00005
Cyanide	0.098	0.0000002	0.007
Benzene	0.02	-	0.95
Cresol, m-	0.03	-	0.1
Cresol, o-	0.28	-	0.1
Cresol, p-	4.20	-	0.1
Chlordane, gamma	0.03	-	0.00008
Chlordane, cis-(alpha chlordane)	0.03	0.00000007	0.00008
Endrin	0.025	0.00000006	0.00002
Heptachlor	0.025	-	0.00009
Methoxychlor	10.00	-	0.000005
Pentachlorophenol	0.01	-	0.01
Toxaphene	0.50	0.0000012	0.0002
Dichlorophenoxyacetic acid, 2,4-	10.00	-	0.28
Trichlorophenoxyacetic acid, 2,4,5-	1.00	-	0.036
Dinitrotoluene, 2,4-	0.025	-	0.065
Nitrobenzene	0.01	-	0.55
Methylethyl ketone	58.40	-	1
Pyridine	5.00	-	1

Contaminant	Leachate source concentrations (mg/L)	Predicted groundwater concentration at the Valley 1 and 2 stream confluence (POE#1) (mg/L)	ANZECC trigger levels for the protection of 95% of species (mg/L)
Carbon tetrachloride	0.02	-	0.24
Chloroform	0.025	-	0.37
Tetrachloroethylene	0.002	-	1
Trichloroethylene	0.015	-	1
Dichloroethane, 1,2-	0.0018	-	1.9
Dichloroethylene, 1,1-	0.025	-	0.7
Vinyl chloride	0.084	-	1
Chlorobenzene	0.006	-	1
Dichlorobenzene, 1,4-	0.0143	-	0.06
Hexachlorobutadiene	0.025	0.000000058	1
Hexachlorobenzene	0.0068	-	0.00005
Hexachloroethane	0.025	-	0.36
Polychlorinated biphenyls (liquid)	0.003	0.000000007	1
Trichlorophenol, 2,4,5-	0.005	-	0.0005
Trichlorophenol, 2,4,6-	0.0029	-	0.02

Notes:

Bold values represent waste acceptance criteria TCLP concentrations in the absence of Redvale leachate data for the analyte.

- indicates predicted concentration more than 10 orders of magnitude lower than the ANZECC trigger levels and so have not been reported.

Appendix N Table 7 details the predicted POE#2 and #3 concentrations in the regional groundwater prior to entering the Hōteō River.

Appendix N Table 7: Predicted concentrations in the regional groundwater at the Hōteō River (POE#2 and POE#3)

Contaminant	Leachate source Concentration (mg/L)	Predicted groundwater concentration at the Hōteō River (POE#2 and POE#3) (mg/L)	ANZECC trigger levels for the protection of 95% of species (mg/L)	ANZECC recreational guideline values (mg/L)
Arsenic	0.34	0.00000006	0.024	0.05
Barium	6.40	0.000001	-	1
Cadmium	0.01	0.0000000006	0.0002	0.005
Chromium (III) (total chromium)	1.40	0.0000001	0.0033	0.05
Lead (inorganic)	0.18	0.00000003	0.0034	0.05
Mercury	0.01	0.0000000005	0.0006	0.001

Contaminant	Leachate source Concentration (mg/L)	Predicted groundwater concentration at the Hôteo River (POE#2 and POE#3) (mg/L)	ANZECC trigger levels for the protection of 95% of species (mg/L)	ANZECC recreational guideline values (mg/L)
Selenium	0.04	0.000000009	0.011	0.01
Silver	0.0011	0.000000001	0.00005	0.05
Cyanide	0.098	0.000000002	0.007	0.1
Benzene	0.02	-	0.95	0.01
Cresol, m-	0.03	-	0.1	-
Cresol, o-	0.28	-	0.1	-
Cresol, p-	4.20	-	0.1	-
Chlordane, gamma	0.03	-	0.00008	0.006
Chlordane, cis-(alpha chlordane)	0.03	0.000000005	0.00008	0.006
Endrin	0.025	0.000000004	0.00002	0.001
Heptachlor	0.025	-	0.00009	0.003
Methoxychlor	10.00	-	0.000005	-
Pentachlorophenol	0.01	-	0.01	0.01
Toxaphene	0.50	0.000000009	0.0002	-
Dichlorophenoxyacetic acid, 2,4-	10.00	-	0.28	-
Trichlorophenoxyacetic acid, 2,4,5-	1.00	-	0.036	-
Dinitrotoluene, 2,4-	0.025	-	0.065	-
Nitrobenzene	0.01	-	0.55	-
Methylethyl ketone	58.40	-	1	-
Pyridine	5.00	-	1	-
Carbon tetrachloride	0.02	-	0.24	0.003
Chloroform	0.025	-	0.37	-
Tetrachloroethylene	0.002	-	1	0.01
Trichloroethylene	0.015	-	1	0.03
Dichloroethane, 1,2-	0.0018	-	1.9	0.01
Dichloroethylene, 1,1-	0.025	-	0.7	0.0003
Vinyl chloride	0.084	-	1	-
Chlorobenzene	0.006	-	1	-
Dichlorobenzene, 1,4-	0.0143	-	0.06	-
Hexachlorobutadiene	0.025	0.000000004	1	-
Hexachlorobenzene	0.0068	-	0.00005	-
Hexachloroethane	0.025	-	0.36	-
Polychlorinated biphenyls (liquid)	0.003	0.000000005	1	-

Contaminant	Leachate source Concentration (mg/L)	Predicted groundwater concentration at the Hōteō River (POE#2 and POE#3) (mg/L)	ANZECC trigger levels for the protection of 95% of species (mg/L)	ANZECC recreational guideline values (mg/L)
Trichlorophenol, 2,4,5-	0.005	-	0.0005	0.001
Trichlorophenol, 2,4,6-	0.0029	-	0.02	0.01

Notes:

Bold values represent waste acceptance criteria TCLP concentrations in the absence of Redvale leachate data for the analyte.

- indicates predicted concentration more than 10 orders of magnitude lower than the ANZECC trigger levels and so have not been reported.

Appendix N Table 8 details the predicted POE#4 and POE#5 concentrations in the regional groundwater prior to entering the farm bore.

Appendix N Table 8: Predicted concentrations in the regional groundwater at the farm bore (POE#4 and POE#5)

Contaminant	Leachate source Concentration (mg/L)	Predicted concentration at the farm bore (POE#4 and POE#5) (mg/L)	ANZECC livestock drinking water guidelines (mg/L)	Drinking water standards for New Zealand 2005 (revised 2018) (mg/L)
Arsenic	0.34	0.00000007	0.5	0.01
Barium	6.40	0.000001	-	0.7
Cadmium	0.01	0.000000001	0.01	0.004
Chromium (III) (total chromium)	1.40	0.0000001	1	0.05
Lead (inorganic)	0.18	0.00000004	0.1	0.01
Mercury	0.01	0.000000001	0.002	0.007
Selenium	0.04	0.00000001	0.02	0.01
Cyanide	0.098	0.00000002	-	0.6
Benzene	0.02	-	-	0.01
Chlordane, gamma	0.03	-	0.0002	0.0002
Chlordane, cis-(alpha chlordane)	0.03	0.000000006	0.0002	0.0002
Endrin	0.025	0.000000005	0.001	0.001
Methoxychlor	10.00	-	0.02	0.02
Pentachlorophenol	0.01	-	0.009	0.009
Dichlorophenoxyacetic acid, 2,4-	10.00	-	-	0.04
Trichlorophenoxyacetic acid, 2,4,5-	1.00	-	-	0.01
Carbon tetrachloride	0.02	-	0.005	0.005
Chloroform	0.025	-	0.4	0.4

Contaminant	Leachate source Concentration (mg/L)	Predicted concentration at the farm bore (POE#4 and POE#5) (mg/L)	ANZECC livestock drinking water guidelines (mg/L)	Drinking water standards for New Zealand 2005 (revised 2018) (mg/L)
Tetrachloroethylene	0.002	-	0.05	0.05
Trichloroethylene	0.015	-	0.02	0.02
Dichloroethane, 1,2-	0.0018	-	0.03	0.03
Vinyl chloride	0.084	-	0.0003	0.0003
Dichlorobenzene, 1,4-	0.0143	-	0.4	0.0003
Hexachlorobutadiene	0.025	0.000000005	0.0007	0.0007
Trichlorophenol, 2,4,6-	0.0029	-	0.2	0.2

Notes:

Bold values represent waste acceptance criteria TCLP concentrations in the absence of Redvale leachate data for the analyte.
- indicates predicted concentration more than 10 orders of magnitude lower than the ANZECC trigger levels and so have not been reported.

Appendix N Table 7 details the predicted POE#6 concentrations in the regional groundwater prior to entering the Waiteraire Stream.

Appendix N Table 9: Predicted concentrations in the regional groundwater at the Waiteraire Stream (POE#6)

Contaminant	Leachate source Concentration (mg/L)	Predicted groundwater concentration at the Waiteraire River (POE#6) (mg/L)	ANZECC trigger levels for the protection of 95% of species (mg/L)
Arsenic	0.34	0.0000003	0.024
Barium	6.40	0.000005	-
Cadmium	0.01	0.000000003	0.0002
Chromium (III) (total chromium)	1.40	0.0000006	0.0033
Lead (inorganic)	0.18	0.0000002	0.0034
Mercury	0.01	0.000000002	0.0006
Selenium	0.04	0.00000005	0.011
Silver	0.0011	0.0000000007	0.00005
Cyanide	0.098	0.00000009	0.007
Benzene	0.02	-	0.95
Cresol, m-	0.03	-	0.1
Cresol, o-	0.28	-	0.1
Cresol, p-	4.20	-	0.1
Chlordane, gamma	0.03	-	0.00008
Chlordane, cis-(alpha chlordane)	0.03	0.00000003	0.00008
Endrin	0.025	0.00000002	0.00002

Contaminant	Leachate source Concentration (mg/L)	Predicted groundwater concentration at the Waiteraire River (POE#6) (mg/L)	ANZECC trigger levels for the protection of 95% of species (mg/L)
Heptachlor	0.025	-	0.00009
Methoxychlor	10.00	-	0.000005
Pentachlorophenol	0.01	-	0.01
Toxaphene	0.50	0.0000005	0.0002
Dichlorophenoxyacetic acid, 2,4-	10.00	-	0.28
Trichlorophenoxyacetic acid, 2,4,5-	1.00	-	0.036
Dinitrotoluene, 2,4-	0.025	-	0.065
Nitrobenzene	0.01	-	0.55
Methylethyl ketone	58.40	-	1
Pyridine	5.00	-	1
Carbon tetrachloride	0.02	-	0.24
Chloroform	0.025	-	0.37
Tetrachloroethylene	0.002	-	1
Trichloroethylene	0.015	-	1
Dichloroethane, 1,2-	0.0018	-	1.9
Dichloroethylene, 1,1-	0.025	-	0.7
Vinyl chloride	0.084	-	1
Chlorobenzene	0.006	-	1
Dichlorobenzene, 1,4-	0.0143	-	0.06
Hexachlorobutadiene	0.025	0.00000002	1
Hexachlorobenzene	0.0068	-	0.00005
Hexachloroethane	0.025	-	0.36
Polychlorinated biphenyls (liquid)	0.003	0.000000003	1
Trichlorophenol, 2,4,5-	0.005	-	0.0005
Trichlorophenol, 2,4,6-	0.0029	-	0.02

Notes:

Bold values represent waste acceptance criteria TCLP concentrations in the absence of Redvale leachate data for the analyte.

- indicates predicted concentration greater than 10 orders of magnitude lower than the ANZECC trigger levels and so have not been reported.

N4 Mass conservation calculations

This section considers the potential subsoil drain capture of shallow or Upper Pakiri groundwater potentially affected by seepage through the lining system, which cannot effectively be assessed by RBCA modelling.

Section 8.2 indicates that the low hydraulic conductivity of the GCL and compacted clay layer would effectively slow the rate of seepage through the lining system to between 6 and 20 years before reaching a subsoil drain. In addition, the transport of contaminants in leachate will be further attenuated as they travel through the GCL and compacted clay by processes such as adsorption and biodegradation.

The Engineering Report (Technical Report N, Volume 2) indicates that the operation of Phases 1 to 3 is expected to be complete within around seven years, on the lower end of the seepage estimate through the lining system. Phases 1 to 3 will be constructed at the base of Valley 1 and the subsoil drains beneath these phases will probably receive the greatest volume of groundwater flow.

When the subsoil drains are grouted and sealed after operation and considering the other design aspects (i.e. trench dams), the preferential pathway created by the drains will be severed. The estimate of travel time through the GCL and compacted clay layer suggests that leachate seepage is highly unlikely to reach the subsoil drains before they are sealed.

In the unlikely event that leachate seepage does reach the subsoil drains, a straightforward mass conservation calculation has been used to assess potential effects on ecological receptors of the stream near the Valley 1 and 2 confluence. The mass conservation calculation considers the relationship between the leachate concentration, volume of leachate seepage, the background concentration in groundwater and the volume of groundwater flow through the subsoil drains. The calculation is expressed as:

$$C_{total} = ((CL \times VL) + (CD \times VD)) / V_{total}, \text{ where}$$

CL = concentration in leachate.

VL = volume of leachate seepage.

CD = background concentration in groundwater.

VD = volume of groundwater flow through subsoil drains.

$$V_{total} = VL + VD.$$

The mass conservation calculation indicates that leachate contaminants would not be detected in the stormwater pond at concentrations above the ANZECC 2000 trigger levels (refer to Appendix N Table 10). The only exception is for chromium which is naturally above the ANZECC 2000 trigger level in groundwater at the site.

Appendix N Table 10: Summary mass conservation results

Contaminant	Concentration in leachate (mg/L)	Background concentration in groundwater (mg/L) ¹	Total concentration (mg/L)	ANZECC trigger levels for protection of 95% of species (mg/L)
Arsenic	0.34	0.0028	0.0028	0.024
Barium	6.40	-	-	-
Cadmium	0.01	0.0001	0.0001	0.0002
Chromium (III) (total chromium)	1.40	0.0077	0.0077	0.0033
Lead (inorganic)	0.18	0.00076	0.0008	0.0034
Mercury	0.01	0.0001	0.0001	0.0006
Selenium	0.04	0.001	0.001	0.011

Contaminant	Concentration in leachate (mg/L)	Background concentration in groundwater (mg/L) ¹	Total concentration (mg/L)	ANZECC trigger levels for protection of 95% of species (mg/L)
Silver	0.0011	-	-	0.00005
Cyanide	0.098	0.002	0.002	0.007
Benzene	0.02	0	0.0000002	0.95
Cresol, m-	0.03	0	0.0000002	0.1
Cresol, o-	0.28	0	0.0000002	0.1
Cresol, p-	4.20	0	0.00003	0.1
Chlordane, gamma	0.03	0	0.0000002	0.00008
Chlordane, cis- (alpha chlordane)	0.03	0	0.0000002	0.00008
Endrin	0.025	0	0.0000002	0.00002
Heptachlor	0.025	0	0.0000002	0.00009
Methoxychlor	0.10 ²	0	7.65E-07	0.000005
Pentachlorophenol	0.01	0	0.00000004	0.01
Toxaphene	0.50	0	0.000004	0.0002
Dichlorophenoxyacetic acid, 2,4-	10.00	0	0.00008	0.28
Trichlorophenoxyacetic acid, 2,4,5-	1.00	0	0.000008	0.036
Dinitrotoluene, 2,4-	0.025	0	0.00000019	0.065
Nitrobenzene	0.01	0	0.000000069	0.55
Methyl ethyl ketone	58.40	0	0.00045	1
Pyridine	5.00	0	0.000038	1
Carbon tetrachloride	0.02	0	0.00000015	0.24
Chloroform	0.025	0	0.00000019	0.37
Tetrachloroethylene	0.002	0	0.000000015	1
Trichloroethylene	0.015	0	0.00000011	1
Dichloroethane, 1,2-	0.0018	0	0.000000014	1.9
Dichloroethylene, 1,1-	0.025	0	0.00000019	0.7
Vinyl chloride	0.084	0	0.00000064	1
Chlorobenzene	0.006	0	0.000000046	1
Dichlorobenzene, 1,4-	0.0143	0	0.000000109	0.06
Hexachlorobutadiene	0.025	0	0.00000019	1
Hexachlorobenzene	0.0068	0	0.00000005	0.00005
Hexachloroethane	0.025	0	0.00000019	0.36
Polychlorinated biphenyls (liquid)	0.003	0	0.00000002	1
Trichlorophenol, 2,4,5-	0.005	0	0.00000004	0.0005
Trichlorophenol, 2,4,6-	0.0029	0	0.00000002	0.02

Contaminant	Concentration in leachate (mg/L)	Background concentration in groundwater (mg/L) ¹	Total concentration (mg/L)	ANZECC trigger levels for protection of 95% of species (mg/L)
-------------	----------------------------------	---	----------------------------	---

Notes:

1. Based on either groundwater quality data, laboratory limits of detection or for organic contaminants, zero.
2. Methoxychlor concentration adjusted from the WAC TCLP by a factor of 100 to conservatively account for 1 tonne of methoxychlor in every 100 tonnes of waste deposited. We note that methoxychlor is no longer in circulation.

Appendix O: RBCA input and output sheets

Main Screen

RBCA Tool Kit for Chemical Releases
Version 2.5 © 2009 GSI Environmental Inc.

1. Project Information

Site Name:


Location:

Completed By:

Date: Job ID:


2. Which Type of RBCA Analysis?

Tier



Risk-Based Screening Levels

Tier 2/3



Site-Specific Target Levels

3. Calculation Options

Affects which input data are required

- Baseline Risks (Forward mode)**
- RBCA Cleanup Levels (Backward mode)**
- Individual Constituent Risk Goals Only
- Individual and Cumulative Risk Goals
- Apply Source Depletion Algorithm
Time to Future Exposure (yr)

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? = yes = no

Exposure Pathways

↓

Constituents of Concern (COCs)

↓

Transport Models

↓

Soil Parameters

↓

GW Parameters

↓

Air Parameters

Review Output

Exposure Flowchart

↓

COC Chem. Parameters

↓

Input Data Summary

↓

User-Spec. COC Data...

↓

Transient Domenico Analysis..

↓

Baseline Risks..

↓

Cleanup Levels..

5. Commands and Options

New Site

Load Data...

Save Data

User Chemical Database

Set Units

Print Sheet

Print Report

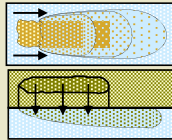
Help

Quit

Exposure Pathway Identification

1. Groundwater Exposure

Groundwater Ingestion/ Surface Water Impact



Receptor: None ▼ None ▼ S.W. ▼
 On-site Off-site1 Off-site2
 Distance: 0 2500 360 (m)

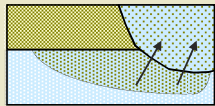
Source Media:

- Affected Groundwater
- Affected Soils Leaching to Groundwater

Option:

- Apply MCL value as ingestion RBEL (backward mode only)

GW Discharge to Surface Water Exposure

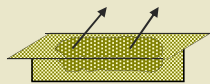


- Swimming
- Fish Consumption
- Specified Water Quality Criteria

Enter Criteria

2. Surface Soil Exposure

Combined Exposure



Receptor: None ▼
 On-site
 Construction Worker
 Source Media:
 Direct Ingestion
 Dermal Contact
 Inhalation (vol+part)
 Vegetable Ingestion

Option:

- Apply UK (CLEA) SGV as soil concentration limit

Veg Options

Site Name: Polaris_Stream Confluence POE1_Redvale Leachate

Location: Wayby Valley

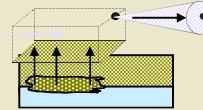
Compl. By: Leon Pemberton

Job ID: 1005069.113

Date: 30-Apr-19

3. Air Exposure

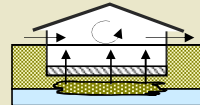
Volatilization and Particulates to Outdoor Air Inhalation



Receptor: None ▼ None ▼ None ▼
 On-site Off-site1 Off-site2
 Distance: 0 0 0 (m)

Source Media:

- Construction worker
- Affected Soils--Volatilization to Ambient Outdoor Air
- Affected Groundwater--Volatilization to Ambient Outdoor Air
- Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor: None ▼ None ▼ None ▼
 On-site Off-site1 Off-site2
 Distance: 0 0 0 (m)

Source Media:

- Affected Soils--Volatilization to Enclosed Space
- Affected Soils Leaching to GW--Volatilization to Enclosed Space
- Affected Groundwater--Volatilization to Enclosed Space

Bldg Options

4. Commands and Options

Main Screen

Print Sheet

Set Units

Help

Exposure Factors & Target Risks

Exposure Flowchart

Site Name: Polaris_Stream Confluence POE1_Redvale Leachz
 Location: Wayby Valley
 Compl. By: Leon Pemberton

Job ID: 1005069.113
 Date: 30-Apr-19

Commands and Options

Main Screen

Print Sheet

Help

Source Media Constituents of Concern (COCs)

Apply Raoult's Law ?

Selected COCs ?

COC Select: Sort List:

Arsenic
Barium
Cadmium
Chromium (III) (total chromium)
Lead (inorganic)
Mercury
Selenium
Silver
Cyanide
Benzene
Cresol, m-
Cresol, o-
Cresol, p-
Chlordane, gamma
Chlordane, cis- (alpha chlordane)
Endrin
Heptachlor
Methoxychlor
Pentachlorophenol
Toxaphene
Dichlorophenoxyacetic acid, 2,4-
Trichlorophenoxyacetic acid, 2,4,5-
Dinitrotoluene, 2,4-
Nitrobenzene
Methyl ethyl ketone

Representative COC Concentration ?

Groundwater Source Zone

Enter Directly Enter Site Data

(mg/L)	note
5.00E+0	WAC
1.00E+2	WAC
1.00E+0	WAC
5.00E+0	WAC
5.00E+0	WAC
2.00E-1	WAC
1.00E+0	WAC
5.00E+0	WAC
5.00E+1	WAC
5.00E-1	WAC
2.00E+2	WAC
2.00E+2	WAC
2.00E+2	WAC
3.00E-2	WAC
3.00E-2	WAC
2.00E-2	WAC
8.00E-4	WAC
1.00E+1	WAC
1.00E+2	WAC
5.00E-1	WAC
1.00E+1	WAC
1.00E+0	WAC
1.30E-1	WAC
2.00E+0	WAC
2.00E+2	WAC

Soil Source Zone

Enter Directly Enter Site Data

(mg/kg)	note
1.0E+1	
2.7E+2	
1.5E+0	
3.4E+6	
1.8E+0	
4.8E-1	
1.7E-1	
2.8E-2	
9.9E-1	
2.1E-2	
2.9E-2	
3.3E-1	
4.2E+0	
1.2E+2	
2.1E+3	
2.3E+0	
2.9E+0	
7.8E+3	
2.1E-2	
4.8E+2	
9.1E+1	
7.2E-1	
1.8E-2	
1.4E-2	
1.2E+1	

Mole Fraction in Source Material (-)

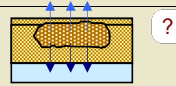
View Chemical Parameters

RBCA Tool Kit for Chemical Releases, Version 2.5

Pyridine	5.00E+0	WAC	1.3E+0	
Carbon tetrachloride	5.00E-1	WAC	4.2E-2	
Chloroform	6.00E+0	WAC	1.7E-2	
Tetrachloroethylene	7.00E-1	WAC	3.6E-3	
Trichloroethylene	7.00E-1	WAC	1.7E-2	
Dichloroethane, 1,2-	5.00E-1	WAC	6.7E-4	
Dichloroethylene, 1,1-	7.00E-1	WAC	2.2E-2	
Vinyl chloride	2.00E-1	WAC	3.9E-2	
Chlorobenzene	1.00E+2	WAC	1.4E-2	
Dichlorobenzene, 1,4-	7.50E+0	WAC	9.5E-2	
Hexachlorobutadiene	5.00E-1	WAC	1.7E+0	
Hexachlorobenzene	1.30E-1	WAC	1.9E+0	
Hexachloroethane	3.00E+0	WAC	4.6E-1	
Polychlorinated biphenyls (liquid)	5.00E+1	WAC	1.6E+1	
Trichlorophenol, 2,4,5-	4.00E+2	WAC	1.6E-2	
Trichlorophenol, 2,4,6-	2.00E+0	WAC	4.4E-3	

Transport Modeling Options

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors

- Surface soil volatilization model only ASTM Model
- Combination surface soil/Johnson & Ettinger models
- Thickness of surface soil zone (m)
- User-specified VF from other model Enter VF Values

Indoor Air Volatilization Factors

- Johnson & Ettinger model for soil and groundwater volatilization
- Johnson & Ettinger for soil, Mass Flux model for groundwater
- User-specified VF from other model Enter VF Values

Soil-to-Groundwater Leaching Factor

- ASTM Model
 - Apply Soil Attenuation Model (SAM) Enter Decay Rates
 - Allow first-order biodecay Enter LF Values
- User-specified LF from other model

Modeling Options

- Disable Mass Balance Limit
- Apply Dual Equilibrium Desorption Model

2. Lateral Air Dispersion Factor

- 3-D Gaussian dispersion model Off-site 1 Off-site 2
- User-Specified ADF (-)

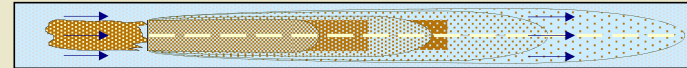
Site Name: Polaris_Stream Confluence POE1_Redvale Leachate ID: 1005069.113

Location: Wayby Valley

Date: 30-Apr-19

Compl. By: Leon Pemberton

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model

- Domenico equation with dispersion only (no biodegradation)
- Domenico equation first-order decay Enter Decay Rates
- Modified Domenico equation using electron acceptor superposition Enter Site Data

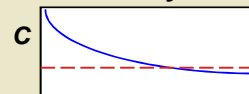
Calculate Biodegradation Capacity (mg/L)

— or —

User-Specified DAF Values

- DAF values from other model or site data Enter DAF Values

4. Chemical Decay and Source Depletion



Enter Decay Rates

Enter Source Mass

5. Commands and Options

Main Screen

Print Sheet

Help

Site Name: Polaris_Stream Confluence POE1_Redvale IL 61805
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

Commands and Options

Return Print Sheet
 Paste Default Values Help

Constituent Decay Rates

Constituent	Saturated Zone		Unsaturated Zone	
	Half-Life	First-Order Decay Coefficient	Half-Life	First-Order Decay Coefficient
	(day)	(1/day)	(day)	(1/day)
Arsenic	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Barium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cadmium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Chromium (III) (total chromium)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Lead (inorganic)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Mercury	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Selenium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Silver	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cyanide	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Benzene	7.2E+2	9.6E-4	7.2E+2	9.6E-4
Cresol, m-	4.9E+1	1.4E-2	4.9E+1	1.4E-2
Cresol, o-	1.4E+1	5.0E-2	1.4E+1	5.0E-2
Cresol, p-	2.8E+1	2.5E-2	2.8E+1	2.5E-2
Chlordane, gamma	2.8E+3	2.5E-4	2.8E+3	2.5E-4
Chlordane, cis- (alpha chlordane)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Endrin	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Heptachlor	5.0E+0	1.4E-1	5.0E+0	1.4E-1
Methoxychlor	3.7E+2	1.9E-3	3.7E+2	1.9E-3
Pentachlorophenol	1.5E+3	4.6E-4	1.5E+3	4.6E-4
Toxaphene	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Dichlorophenoxyacetic acid, 2,4-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Trichlorophenoxyacetic acid, 2,4,5-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Dinitrotoluene, 2,4-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Nitrobenzene	3.9E+2	1.8E-3	3.9E+2	1.8E-3
Methyl ethyl ketone	1.4E+1	5.0E-2	1.4E+1	5.0E-2

Site-Specific Soil Parameters

1. Soil Source Zone Characteristics

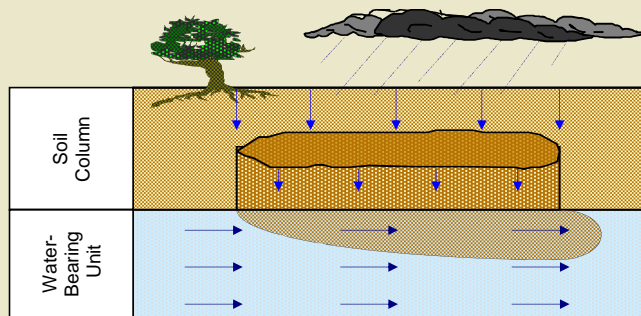
Hydrogeology

Depth to water-bearing unit	95	(m)
Capillary zone thickness	0.05	(m)
Soil column thickness	94.95	(m)

Affected Soil Zone

Depth to top of affected soils	1	(m)
Depth to base of affected soils	94	(m)
Length of affected soil parallel to assumed GW flow direction	1400	(m)

	Res/Com	Construction	
Affected soil area	2025		(m ²)
Length of affected soil parallel to assumed wind direction	45	45	(m)



Site Name: Polaris_Stream Confluence POE1_Redvale Leachate Job ID: 1005069.113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

2. Surface Soil Column

Predominant USCS Soil Type

SW/SP: Sand

Calculate

	Vadose Zone	Capillary Fringe	
Volumetric water content	0.08	0.369	(-)
Volumetric air content	0.33	0.041	(-)
Total porosity	0.41		(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	864		(cm/d)
Vapor permeability	1.00E-12		(m ²)
Capillary zone thickness	0.05		(m)

Net Rainfall Infiltration

Net infiltration estimate	0.00	(cm/yr)
or	Enter Directly	
Average annual precipitation	0	(cm/yr)

Partitioning Parameters

Fraction organic carbon - entire soil column	0.01	(-)
Fraction organic carbon - root zone	0.01	(-)
Soil/water pH	7.5	(-)

3. Commands and Options

Main Screen

Use/Set Default Values

Print Sheet

Set Units

Help

Site-Specific Groundwater Parameters

1. Water-Bearing Unit ?

Hydrogeology

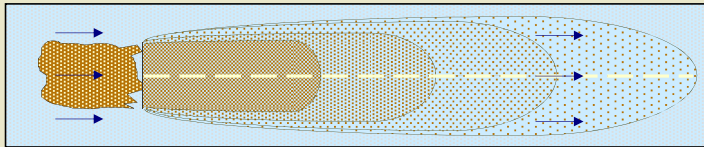
Groundwater Darcy velocity (cm/d)
 Groundwater seepage velocity (cm/d)
 or or
 Hydraulic conductivity (cm/d)
 Hydraulic gradient (-)
 Effective porosity (-)

Sorption

Fraction organic carbon--saturated zone (-)
 Groundwater pH (-)

2. Groundwater Source Zone ?

Groundwater plume width at source (m)
 Plume (mixing zone) thickness at source (m)
 or
 Saturated thickness (m)
 Length of source zone (m)



Site Name: Polaris_Stream Confluence POE1_Redvale Leachate Job ID: 1005069.113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

3. Groundwater Dispersion ?

Model:

	GW Ingestion		GW to Indoor Air	
	Off-site 1	Off-site 2	Off-site 1	Off-site 2
Distance to GW receptors	<input type="text" value="2500"/>	<input type="text" value="360"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Longitudinal dispersivity	<input type="text" value="250"/>	<input type="text" value="36"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Transverse dispersivity	<input type="text" value="82.5"/>	<input type="text" value="11.88"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Vertical dispersivity	<input type="text" value="12.5"/>	<input type="text" value="1.8"/>	<input type="text" value="0"/>	<input type="text" value="0"/>

4. Groundwater Discharge to Surface Water ?

Distance to GW/SW discharge point (m) Off-site 2
 Plume width at GW/SW discharge (m)
 Plume thickness at GW/SW discharge (m)
 Surface water flowrate at GW/SW discharge (m³/s)

5. Commands and Options

[Main Screen](#)

[Use/Set Default Values](#)

[Print Sheet](#)

[Set Units](#)

[Help](#)

RBCA SITE ASSESSMENT	Tier 2 Domenico Groundwater Modeling Summary
-----------------------------	---

Site Name: Polaris_Stream Confluent Site Location: Wayby Valley Completed By: Leon Pemberton Date Completed: 30-Apr-19 1 OF 2

DOMENICO GROUNDWATER MODELING SUMMARY

OFF-SITE GROUNDWATER EXPOSURE PATHWAYS (CHECKED IF PATHWAY IS ACTIVE)

SOILS LEACHING TO GROUNDWATER:

Constituents of Concern	1) Source Medium	2) Steady-state Exposure Concentration Groundwater: POE Conc. (mg/L)		3) POE Concentration Limit Groundwater: POE Conc. (mg/L)		4) Time to Reach POE Conc. Limit Conc. limit reached? ("n" if yes) ; Time (yr)	
	Soil Conc. (mg/kg)	Off-site 1 (2500 m) None	Off-site 2 (360 m) Surf. Water	Off-site 1 (2500 m) None	Off-site 2 (360 m) Surf. Water	Off-site 1 (2500 m) None	Off-site 2 (360 m) Surf. Water
Arsenic	1.0E+1		7.7E-7		2.7E+1	NA	○ NA
Barium	2.7E+2		1.3E-5		2.7E+1	NA	○ NA
Cadmium	1.5E+0		8.3E-9		2.2E-1	NA	○ NA
Chromium (III) (total chromium)	3.4E+6		1.6E-6		3.7E+0	NA	○ NA
Lead (inorganic)	1.8E+0		4.2E-7		3.8E+0	NA	○ NA
Mercury	4.8E-1		6.2E-9		6.7E-1	NA	○ NA
Selenium	1.7E-1		1.3E-7		1.2E+1	NA	○ NA
Silver	2.8E-2		1.8E-9		5.6E-2	NA	○ NA
Cyanide	9.9E-1		2.3E-7		7.8E+0	NA	○ NA
Benzene	2.1E-2		0.0E+0		1.1E+3	NA	○ NA
Cresol, m-	2.9E-2		0.0E+0		1.1E+2	NA	○ NA
Cresol, o-	3.3E-1		0.0E+0		1.1E+2	NA	○ NA
Cresol, p-	4.2E+0		0.0E+0		1.1E+2	NA	○ NA
Chlordane, gamma	1.2E+2		0.0E+0		8.9E-2	NA	○ NA
Chlordane, cis- (alpha chlordane)	2.1E+3		7.0E-8		8.9E-2	NA	○ NA
Endrin	2.3E+0		5.8E-8		2.2E-2	NA	○ NA
Heptachlor	2.9E+0		0.0E+0		1.0E-1	NA	○ NA
Methoxychlor	7.8E+3		0.0E+0		5.6E-3	NA	○ NA
Pentachlorophenol	2.1E-2		0.0E+0		1.1E+1	NA	○ NA
Toxaphene	4.8E+2		1.2E-6		2.2E-1	NA	○ NA
Dichlorophenoxyacetic acid, 2,4-	9.1E+1		0.0E+0		3.1E+2	NA	○ NA
Trichlorophenoxyacetic acid, 2,4,5-	7.2E-1		0.0E+0		4.0E+1	NA	○ NA
Dinitrotoluene, 2,4-	1.8E-2		0.0E+0		7.2E+1	NA	○ NA
Nitrobenzene	1.4E-2		0.0E+0		6.1E+2	NA	○ NA
Methyl ethyl ketone	1.2E+1		0.0E+0		1.1E+3	NA	○ NA
Pyridine	1.3E+0		0.0E+0		1.1E+3	NA	○ NA

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Carbon tetrachloride	4.2E-2		0.0E+0		2.7E+2	NA	○	NA
Chloroform	1.7E-2		0.0E+0		4.1E+2	NA	○	NA
Tetrachloroethylene	3.6E-3		0.0E+0		1.1E+3	NA	○	NA
Trichloroethylene	1.7E-2		0.0E+0		1.1E+3	NA	○	NA
Dichloroethane, 1,2-	6.7E-4		0.0E+0		2.1E+3	NA	○	NA
Dichloroethylene, 1,1-	2.2E-2		0.0E+0		7.8E+2	NA	○	NA
Vinyl chloride	3.9E-2		0.0E+0		1.1E+3	NA	○	NA
Chlorobenzene	1.4E-2		0.0E+0		1.1E+3	NA	○	NA
Dichlorobenzene, 1,4-	9.5E-2		0.0E+0		6.7E+1	NA	○	NA
Hexachlorobutadiene	1.7E+0		5.8E-8		1.1E+3	NA	○	NA
Hexachlorobenzene	1.9E+0		0.0E+0		5.6E-2	NA	○	NA
Hexachloroethane	4.6E-1		0.0E+0		4.0E+2	NA	○	NA
Polychlorinated biphenyls (liquid)	1.6E+1		7.0E-9		1.1E+3	NA	○	NA
Trichlorophenol, 2,4,5-	1.6E-2		0.0E+0		5.6E-1	NA	○	NA
Trichlorophenol, 2,4,6-	4.4E-3		0.0E+0		2.2E+1	NA	○	NA

NOTE: POE = Point of exposure

RBCA Tool Kit for Chemical Releases
 Version 2.5 © 2009 GSI Environmental Inc.

Main Screen

1. Project Information


Site Name:

Location:

Completed By:


Date: Job ID:

2. Which Type of RBCA Analysis?



Tier

Risk-Based
Screening
Levels



Tier 2/3

Site-Specific
Target Levels

3. Calculation Options

Affects which input data are required

- Baseline Risks (Forward mode)**
- RBCA Cleanup Levels (Backward mode)**
- Individual Constituent Risk Goals Only
- Individual and Cumulative Risk Goals
- Apply Source Depletion Algorithm
Time to Future Exposure (yr)

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? = yes = no

- Exposure Pathways
- ↓
- Constituents of Concern (COCs)
- ↓
- Transport Models
- ↓
- Soil Parameters
- ↓
- GW Parameters
- ↓
- Air Parameters

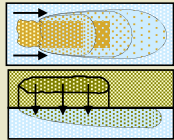
Review Output

- Exposure Flowchart
- COC Chem. Parameters
- Input Data Summary
- User-Spec. COC Data...
- Transient Domenico Analysis..
- Baseline Risks..
- Cleanup Levels..

5. Commands and Options

Exposure Pathway Identification

1. Groundwater Exposure



Groundwater Ingestion/ Surface Water Impact

Receptor: None None S.W.

Distance: On-site Off-site1 Off-site2

Distance: 0 2500 2100 (m)

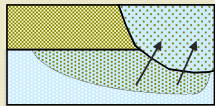
Source Media:

- Affected Groundwater
- Affected Soils Leaching to Groundwater

Option:

- Apply MCL value as ingestion RBEL (backward mode only)

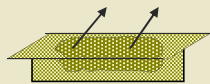
GW Discharge to Surface Water Exposure



- Swimming
- Fish Consumption
- Specified Water Quality Criteria

Enter Criteria

2. Surface Soil Exposure



Combined Exposure

Receptor: None

Distance: On-site

Source Media:

- Direct Ingestion
- Dermal Contact
- Inhalation (vol+part)
- Vegetable Ingestion

Construction Worker

Option:

- Apply UK (CLEA) SGV as soil concentration limit

Veg Options

Site Name: Polaris_Hoteo River_Regional_Ecology_Redvale TCV

Location: Wayby Valley

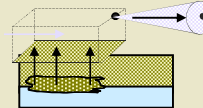
Compl. By: Leon Pemberton

Job ID: 1005069.113

Date: 30-Apr-19

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation



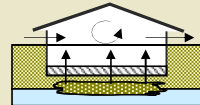
Receptor: None None None

Distance: On-site Off-site1 Off-site2

Distance: 0 0 0 (m)

Source Media:

- Construction worker
- Affected Soils--Volatilization to Ambient Outdoor Air
- Affected Groundwater--Volatilization to Ambient Outdoor Air
- Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor: None None None

Distance: On-site Off-site1 Off-site2

Distance: 0 0 0 (m)

Source Media:

- Affected Soils--Volatilization to Enclosed Space
- Affected Soils Leaching to GW--Volatilization to Enclosed Space
- Affected Groundwater--Volatilization to Enclosed Space

Bldg Options

4. Commands and Options

Exposure Factors & Target Risks

Site Name: Polaris_Hoteo River_Regional_Ecology_Redvale Tl Location: Wayby Valley Compl. By: Leon Pemberton	Job ID: 1005069.113 Date: 30-Apr-19	Commands and Options <input type="button" value="Main Screen"/> <input type="button" value="Print Sheet"/> <input type="button" value="Help"/>
---	--	--

Source Media Constituents of Concern (COCs) ? Apply Raoult's Law

Selected COCs ?

COC Select: ▼	Sort List:
<input type="button" value="Add/Insert"/> <input type="button" value="Delete"/>	<input type="button" value="Top"/> <input type="button" value="Bottom"/> <input type="button" value="MoveUp"/> <input type="button" value="MoveDown"/>
Arsenic Barium Cadmium Chromium (III) (total chromium) Lead (inorganic) Mercury Selenium Silver Cyanide Benzene Cresol, m- Cresol, o- Cresol, p- Chlordane, gamma Chlordane, cis- (alpha chlordane) Endrin Heptachlor Methoxychlor Pentachlorophenol Toxaphene Dichlorophenoxyacetic acid, 2,4- Trichlorophenoxyacetic acid, 2,4,5- Dinitrotoluene, 2,4- Nitrobenzene Methyl ethyl ketone	

Representative COC Concentration ?

Groundwater Source Zone		Soil Source Zone		Mole Fraction in Source Material
Enter Directly ▼	Enter Site Data	Enter Directly ▼	Enter Site Data	
(mg/L)	note	(mg/kg)	note	
5.00E+0	WAC	1.0E+1		(-)
1.00E+2	WAC	2.7E+2		
1.00E+0	WAC	1.5E+0		
5.00E+0	WAC	3.4E+6		
5.00E+0	WAC	1.8E+0		
2.00E-1	WAC	4.8E-1		
1.00E+0	WAC	1.7E-1		
5.00E+0	WAC	2.8E-2		
5.00E+1	WAC	9.9E-1		
5.00E-1	WAC	2.1E-2		
2.00E+2	WAC	2.9E-2		
2.00E+2	WAC	3.3E-1		
2.00E+2	WAC	4.2E+0		
3.00E-2	WAC	1.2E+2		
3.00E-2	WAC	2.1E+3		
2.00E-2	WAC	2.3E+0		
8.00E-4	WAC	2.9E+0		
1.00E+1	WAC	7.8E+3		
1.00E+2	WAC	2.1E-2		
5.00E-1	WAC	4.8E+2		
1.00E+1	WAC	9.1E+1		
1.00E+0	WAC	7.2E-1		
1.30E-1	WAC	1.8E-2		
2.00E+0	WAC	1.4E-2		
2.00E+2	WAC	1.2E+1		

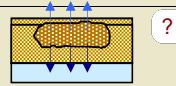
RBCA Tool Kit for Chemical Releases, Version 2.5

Pyridine	5.00E+0	WAC	1.3E+0	
Carbon tetrachloride	5.00E-1	WAC	4.2E-2	
Chloroform	6.00E+0	WAC	1.7E-2	
Tetrachloroethylene	7.00E-1	WAC	3.6E-3	
Trichloroethylene	7.00E-1	WAC	1.7E-2	
Dichloroethane, 1,2-	5.00E-1	WAC	6.7E-4	
Dichloroethylene, 1,1-	7.00E-1	WAC	2.2E-2	
Vinyl chloride	2.00E-1	WAC	3.9E-2	
Chlorobenzene	1.00E+2	WAC	1.4E-2	
Dichlorobenzene, 1,4-	7.50E+0	WAC	9.5E-2	
Hexachlorobutadiene	5.00E-1	WAC	1.7E+0	
Hexachlorobenzene	1.30E-1	WAC	1.9E+0	
Hexachloroethane	3.00E+0	WAC	4.6E-1	
Polychlorinated biphenyls (liquid)	5.00E+1	WAC	1.6E+1	
Trichlorophenol, 2,4,5-	4.00E+2	WAC	1.6E-2	
Trichlorophenol, 2,4,6-	2.00E+0	WAC	4.4E-3	

[View Chemical Parameters](#)

Transport Modeling Options

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors

- Surface soil volatilization model only ASTM Model
- Combination surface soil/Johnson & Ettinger models
- Thickness of surface soil zone (m)
- User-specified VF from other model Enter VF Values

Indoor Air Volatilization Factors

- Johnson & Ettinger model for soil and groundwater volatilization
- Johnson & Ettinger for soil, Mass Flux model for groundwater
- User-specified VF from other model Enter VF Values

Soil-to-Groundwater Leaching Factor

- ASTM Model
 - Apply Soil Attenuation Model (SAM) Enter Decay Rates
 - Allow first-order biodecay Enter LF Values
- User-specified LF from other model

Modeling Options

- Disable Mass Balance Limit
- Apply Dual Equilibrium Desorption Model

2. Lateral Air Dispersion Factor

- 3-D Gaussian dispersion model Off-site 1 Off-site 2
- User-Specified ADF (-)

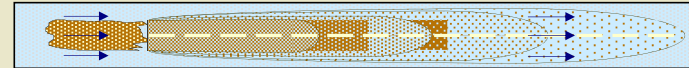
Site Name: Polaris_Hotoe River_Regional_Ecology_Redvale T00 ID: 1005069.113

Location: Wayby Valley

Date: 30-Apr-19

Compl. By: Leon Pemberton

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model

- Domenico equation with dispersion only (no biodegradation)
- Domenico equation first-order decay Enter Decay Rates
- Modified Domenico equation using electron acceptor superposition Enter Site Data

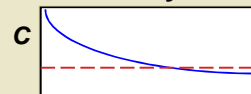
Calculate Biodegradation Capacity (mg/L)

— or —

User-Specified DAF Values

- DAF values from other model or site data Enter DAF Values

4. Chemical Decay and Source Depletion



Enter Decay Rates

Enter Source Mass

5. Commands and Options

Main Screen

Print Sheet

Help

Site Name: Polaris_Hotoe River_Regional_Ecology_Restoration
 Location: Wayby Valley
 Compl. By: Leon Pemberton

Commands and Options

Date: 30-Apr-19

Return Print Sheet

Paste Default Values Help

Constituent Decay Rates

Constituent	Saturated Zone		Unsaturated Zone	
	First-Order Decay		First-Order Decay	
	Half-Life (day)	Coefficient (1/day)	Half-Life (day)	Coefficient (1/day)
Arsenic	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Barium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cadmium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Chromium (III) (total chromium)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Lead (inorganic)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Mercury	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Selenium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Silver	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cyanide	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Benzene	7.2E+2	9.6E-4	7.2E+2	9.6E-4
Cresol, m-	4.9E+1	1.4E-2	4.9E+1	1.4E-2
Cresol, o-	1.4E+1	5.0E-2	1.4E+1	5.0E-2
Cresol, p-	2.8E+1	2.5E-2	2.8E+1	2.5E-2
Chlordane, gamma	2.8E+3	2.5E-4	2.8E+3	2.5E-4
Chlordane, cis- (alpha chlordane)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Endrin	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Heptachlor	5.0E+0	1.4E-1	5.0E+0	1.4E-1
Methoxychlor	3.7E+2	1.9E-3	3.7E+2	1.9E-3
Pentachlorophenol	1.5E+3	4.6E-4	1.5E+3	4.6E-4
Toxaphene	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Dichlorophenoxyacetic acid, 2,4-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Trichlorophenoxyacetic acid, 2,4,5-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Dinitrotoluene, 2,4-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Nitrobenzene	3.9E+2	1.8E-3	3.9E+2	1.8E-3
Methyl ethyl ketone	1.4E+1	5.0E-2	1.4E+1	5.0E-2

RBCA Tool Kit for Chemical Releases, Version 2.5

Pyridine	1.4E+1	5.0E-2	1.4E+1	5.0E-2
Carbon tetrachloride	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Chloroform	1.8E+3	3.9E-4	1.8E+3	3.9E-4
Tetrachloroethylene	7.2E+2	9.6E-4	7.2E+2	9.6E-4
Trichloroethylene	1.7E+3	4.2E-4	1.7E+3	4.2E-4
Dichloroethane, 1,2-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Dichloroethylene, 1,1-	1.3E+2	5.3E-3	1.3E+2	5.3E-3
Vinyl chloride	2.9E+3	2.4E-4	2.9E+3	2.4E-4
Chlorobenzene	3.0E+2	2.3E-3	3.0E+2	2.3E-3
Dichlorobenzene, 1,4-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Hexachlorobutadiene	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Hexachlorobenzene	4.2E+3	1.7E-4	4.2E+3	1.7E-4
Hexachloroethane	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Polychlorinated biphenyls (liquid)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Trichlorophenol, 2,4,5-	1.8E+3	3.8E-4	1.8E+3	3.8E-4
Trichlorophenol, 2,4,6-	1.8E+3	3.8E-4	1.8E+3	3.8E-4

Site-Specific Soil Parameters

1. Soil Source Zone Characteristics

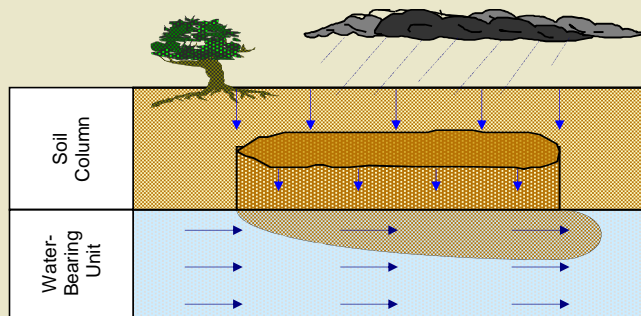
Hydrogeology

Depth to water-bearing unit	130	(m)
Capillary zone thickness	0.05	(m)
Soil column thickness	129.95	(m)

Affected Soil Zone

Depth to top of affected soils	1	(m)
Depth to base of affected soils	94	(m)
Length of affected soil parallel to assumed GW flow direction	560	(m)

	Res/Com	Construction	
Affected soil area	2025		(m ²)
Length of affected soil parallel to assumed wind direction	45	45	(m)



Site Name: Polaris_Hotoe River_Regional_Ecology_Redvale TCV Job ID: 1005069.113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

2. Surface Soil Column

Predominant USCS Soil Type

SW/SP: Sand

Calculate

	Vadose Zone	Capillary Fringe	
Volumetric water content	0.08	0.369	(-)
Volumetric air content	0.33	0.041	(-)
Total porosity	0.41		(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	864		(cm/d)
Vapor permeability	1.00E-12		(m ²)
Capillary zone thickness	0.05		(m)

Net Rainfall Infiltration

Net infiltration estimate	0.00	(cm/yr)
or	Enter Directly	
Average annual precipitation	0	(cm/yr)

Partitioning Parameters

Fraction organic carbon - entire soil column	0.01	(-)
Fraction organic carbon - root zone	0.01	(-)
Soil/water pH	7.5	(-)

3. Commands and Options

Main Screen

Use/Set Default Values

Print Sheet

Set Units

Help

Site-Specific Groundwater Parameters

1. Water-Bearing Unit ?

Hydrogeology

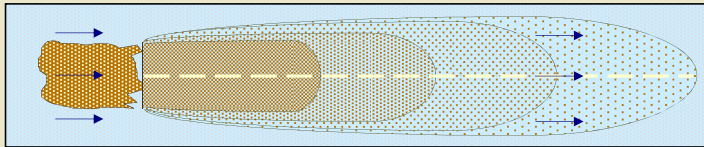
Groundwater Darcy velocity (cm/d)
 Groundwater seepage velocity (cm/d)
 or ↑ or
 Hydraulic conductivity (cm/d)
 Hydraulic gradient (-)
 Effective porosity (-)

Sorption

Fraction organic carbon--saturated zone (-)
 Groundwater pH (-)

2. Groundwater Source Zone ?

Groundwater plume width at source (m)
 Plume (mixing zone) thickness at source (m)
 or
 Saturated thickness (m)
 Length of source zone (m)



Site Name: Polaris_Hotoe River_Regional_Ecology_Redvale TCV Job ID: 1005069.113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

3. Groundwater Dispersion ?

Model:

	GW Ingestion		GW to Indoor Air	
	Off-site 1	Off-site 2	Off-site 1	Off-site 2
Distance to GW receptors	<input type="text" value="2500"/>	<input type="text" value="2100"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Longitudinal dispersivity	<input type="text" value="250"/>	<input type="text" value="210"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Transverse dispersivity	<input type="text" value="82.5"/>	<input type="text" value="69.3"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Vertical dispersivity	<input type="text" value="12.5"/>	<input type="text" value="10.5"/>	<input type="text" value="0"/>	<input type="text" value="0"/>

4. Groundwater Discharge to Surface Water ?

Distance to GW/SW discharge point (m) Off-site 2
 Plume width at GW/SW discharge (m)
 Plume thickness at GW/SW discharge (m)
 Surface water flowrate at GW/SW discharge (m³/s)

5. Commands and Options

[Main Screen](#)

[Use/Set Default Values](#)

[Print Sheet](#)

[Set Units](#)

[Help](#)

RBCA SITE ASSESSMENT	Tier 2 Domenico Groundwater Modeling Summary
-----------------------------	---

Site Name: Polaris_Hotoe River_Reg Site Location: Wayby Valley Completed By: Leon Pemberton Date Completed: 30-Apr-19 1 OF 2

DOMENICO GROUNDWATER MODELING SUMMARY

OFF-SITE GROUNDWATER EXPOSURE PATHWAYS (CHECKED IF PATHWAY IS ACTIVE)

SOILS LEACHING TO GROUNDWATER:

Constituents of Concern	1) Source Medium	2) Steady-state Exposure Concentration Groundwater: POE Conc. (mg/L)		3) POE Concentration Limit Groundwater: POE Conc. (mg/L)		4) Time to Reach POE Conc. Limit Conc. limit reached? ("n" if yes) ; Time (yr)	
	Soil Conc. (mg/kg)	Off-site 1 (2500 m) None	Off-site 2 (2100 m) Surf. Water	Off-site 1 (2500 m) None	Off-site 2 (2100 m) Surf. Water	Off-site 1 (2500 m) None	Off-site 2 (2100 m) Surf. Water
Arsenic	1.0E+1		5.6E-8		1.2E+5	NA	○ NA
Barium	2.7E+2		9.9E-7		1.2E+5	NA	○ NA
Cadmium	1.5E+0		6.1E-10		1.0E+3	NA	○ NA
Chromium (III) (total chromium)	3.4E+6		1.2E-7		1.7E+4	NA	○ NA
Lead (inorganic)	1.8E+0		3.1E-8		1.8E+4	NA	○ NA
Mercury	4.8E-1		4.6E-10		3.1E+3	NA	○ NA
Selenium	1.7E-1		9.4E-9		5.7E+4	NA	○ NA
Silver	2.8E-2		1.3E-10		2.6E+2	NA	○ NA
Cyanide	9.9E-1		1.7E-8		3.6E+4	NA	○ NA
Benzene	2.1E-2		0.0E+0		4.9E+6	NA	○ NA
Cresol, m-	2.9E-2		0.0E+0		5.2E+5	NA	○ NA
Cresol, o-	3.3E-1		0.0E+0		5.2E+5	NA	○ NA
Cresol, p-	4.2E+0		0.0E+0		5.2E+5	NA	○ NA
Chlordane, gamma	1.2E+2		0.0E+0		4.1E+2	NA	○ NA
Chlordane, cis- (alpha chlordane)	2.1E+3		5.1E-9		4.1E+2	NA	○ NA
Endrin	2.3E+0		4.3E-9		1.0E+2	NA	○ NA
Heptachlor	2.9E+0		0.0E+0		4.7E+2	NA	○ NA
Methoxychlor	7.8E+3		0.0E+0		2.6E+1	NA	○ NA
Pentachlorophenol	2.1E-2		0.0E+0		5.2E+4	NA	○ NA
Toxaphene	4.8E+2		8.6E-8		1.0E+3	NA	○ NA
Dichlorophenoxyacetic acid, 2,4-	9.1E+1		0.0E+0		1.5E+6	NA	○ NA
Trichlorophenoxyacetic acid, 2,4,5-	7.2E-1		0.0E+0		1.9E+5	NA	○ NA
Dinitrotoluene, 2,4-	1.8E-2		0.0E+0		3.4E+5	NA	○ NA
Nitrobenzene	1.4E-2		0.0E+0		2.9E+6	NA	○ NA
Methyl ethyl ketone	1.2E+1		0.0E+0		5.2E+6	NA	○ NA
Pyridine	1.3E+0		0.0E+0		5.2E+6	NA	○ NA

RBCA Tool Kit for Chemical Releases, Version 2.5 (BETA)

Carbon tetrachloride	4.2E-2		0.0E+0		1.2E+6	NA	○	NA
Chloroform	1.7E-2		0.0E+0		1.9E+6	NA	○	NA
Tetrachloroethylene	3.6E-3		0.0E+0		5.2E+6	NA	○	NA
Trichloroethylene	1.7E-2		0.0E+0		5.2E+6	NA	○	NA
Dichloroethane, 1,2-	6.7E-4		0.0E+0		9.8E+6	NA	○	NA
Dichloroethylene, 1,1-	2.2E-2		0.0E+0		3.6E+6	NA	○	NA
Vinyl chloride	3.9E-2		0.0E+0		5.2E+6	NA	○	NA
Chlorobenzene	1.4E-2		0.0E+0		5.2E+6	NA	○	NA
Dichlorobenzene, 1,4-	9.5E-2		0.0E+0		3.1E+5	NA	○	NA
Hexachlorobutadiene	1.7E+0		4.3E-9		5.2E+6	NA	○	NA
Hexachlorobenzene	1.9E+0		0.0E+0		2.6E+2	NA	○	NA
Hexachloroethane	4.6E-1		0.0E+0		1.9E+6	NA	○	NA
Polychlorinated biphenyls (liquid)	1.6E+1		5.1E-10		5.2E+6	NA	○	NA
Trichlorophenol, 2,4,5-	1.6E-2		0.0E+0		2.6E+3	NA	○	NA
Trichlorophenol, 2,4,6-	4.4E-3		0.0E+0		1.0E+5	NA	○	NA

NOTE: POE = Point of exposure

Main Screen

RBCA Tool Kit for Chemical Releases
Version 2.5 © 2009 GSI Environmental Inc.

1. Project Information

Site Name:


Location:

Completed By:

Date: Job ID:


2. Which Type of RBCA Analysis?

Tier



Risk-Based
Screening
Levels

Tier 2/3



Site-Specific
Target Levels

3. Calculation Options

Affects which input data are required

- Baseline Risks (Forward mode)**
- RBCA Cleanup Levels (Backward mode)**
- Individual Constituent Risk Goals Only
- Individual and Cumulative Risk Goals
- Apply Source Depletion Algorithm
Time to Future Exposure (yr)

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? = yes = no

Exposure Pathways

↓

Constituents of Concern (COCs)

↓

Transport Models

↓

Soil Parameters

↓

GW Parameters

↓

Air Parameters

Review Output

Exposure Flowchart

↓

COC Chem. Parameters

↓

Input Data Summary

↓

User-Spec. COC Data...

↓

Transient Domenico Analysis..

↓

Baseline Risks..

↓

Cleanup Levels..

5. Commands and Options

New Site

Load Data...

Save Data

User Chemical Database

Set Units

Print Sheet

Print Report

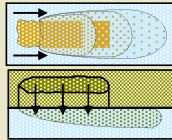
Help

Quit

Exposure Pathway Identification

1. Groundwater Exposure

Groundwater Ingestion/ Surface Water Impact



Receptor: None ▼ None ▼ S.W. ▼
 On-site Off-site1 Off-site2
 Distance: 0 2500 1900 (m)

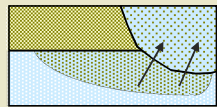
Source Media:

- Affected Groundwater
- Affected Soils Leaching to Groundwater

Option:

- Apply MCL value as ingestion RBEL (backward mode only)

GW Discharge to Surface Water Exposure

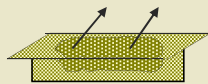


- Swimming
- Fish Consumption
- Specified Water Quality Criteria

Enter Criteria

2. Surface Soil Exposure

Combined Exposure



Receptor: None ▼
 On-site
 Construction Worker

Source Media:

- Direct Ingestion
- Dermal Contact
- Inhalation (vol+part)
- Vegetable Ingestion

Option:

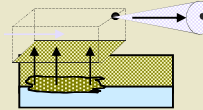
- Apply UK (CLEA) SGV as soil concentration limit

Veg Options

Site Name: Polaris_Hoteo River_POE4 drinking water_Regional_Farm bore_Redvale TC
 Location: Wayby Valley
 Compl. By: Leon Pemberton
 Job ID: 1005069.113 Date: 30-Apr-19

3. Air Exposure

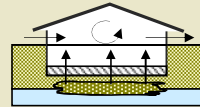
Volatilization and Particulates to Outdoor Air Inhalation



Receptor: None ▼ None ▼ None ▼
 On-site Off-site1 Off-site2
 Distance: 0 0 0 (m)

Source Media:

- Construction worker
- Affected Soils--Volatilization to Ambient Outdoor Air
- Affected Groundwater--Volatilization to Ambient Outdoor Air
- Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor: None ▼ None ▼ None ▼
 On-site Off-site1 Off-site2
 Distance: 0 0 0 (m)

Source Media:

- Affected Soils--Volatilization to Enclosed Space
- Affected Soils Leaching to GW--Volatilization to Enclosed Space
- Affected Groundwater--Volatilization to Enclosed Space

Bldg Options

4. Commands and Options

Main Screen

Print Sheet

Set Units

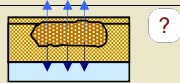
Help

Exposure Factors & Target Risks

Exposure Flowchart

Transport Modeling Options

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors

- Surface soil volatilization model only ASTM Model
- Combination surface soil/Johnson & Ettinger models
- Thickness of surface soil zone (m)
- User-specified VF from other model Enter VF Values

Indoor Air Volatilization Factors

- Johnson & Ettinger model for soil and groundwater volatilization
- Johnson & Ettinger for soil, Mass Flux model for groundwater
- User-specified VF from other model Enter VF Values

Soil-to-Groundwater Leaching Factor

- ASTM Model
 - Apply Soil Attenuation Model (SAM) Enter Decay Rates
 - Allow first-order biodecay Enter LF Values
- User-specified LF from other model

Modeling Options

- Disable Mass Balance Limit
- Apply Dual Equilibrium Desorption Model

2. Lateral Air Dispersion Factor

- 3-D Gaussian dispersion model Off-site 1 Off-site 2
- User-Specified ADF (-)

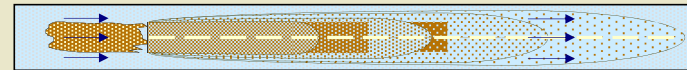
Site Name: Polaris_Hotoe River_POE4 drinking water_Regionalbldr 1005069.113

Location: Wayby Valley

Date: 30-Apr-19

Compl. By: Leon Pemberton

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model

- Domenico equation with dispersion only (no biodegradation) Enter Decay Rates
- Domenico equation first-order decay Enter Site Data
- Modified Domenico equation using electron acceptor superposition

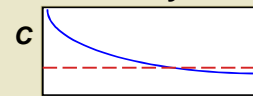
Calculate Biodegradation Capacity (mg/L)

— or —

User-Specified DAF Values

- DAF values from other model or site data Enter DAF Values

4. Chemical Decay and Source Depletion



Enter Decay Rates

Enter Source Mass

5. Commands and Options

Main Screen

Print Sheet

Help

Site Name: Polaris_Hoteo River_POE4 drinking water Regional 0509113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

Commands and Options

Return Print Sheet
 Paste Default Values Help

Constituent Decay Rates

Constituent	Saturated Zone		Unsaturated Zone	
	Half-Life	First-Order Decay Coefficient	Half-Life	First-Order Decay Coefficient
	(day)	(1/day)	(day)	(1/day)
Arsenic	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Barium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cadmium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Chromium (III) (total chromium)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Lead (inorganic)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Mercury	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Selenium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cyanide	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Benzene	7.2E+2	9.6E-4	7.2E+2	9.6E-4
Chlordane, gamma	2.8E+3	2.5E-4	2.8E+3	2.5E-4
Chlordane, cis- (alpha chlordane)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Endrin	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Methoxychlor	3.7E+2	1.9E-3	3.7E+2	1.9E-3
Pentachlorophenol	1.5E+3	4.6E-4	1.5E+3	4.6E-4
Dichlorophenoxyacetic acid, 2,4-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Trichlorophenoxyacetic acid, 2,4,5-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Carbon tetrachloride	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Chloroform	1.8E+3	3.9E-4	1.8E+3	3.9E-4
Tetrachloroethylene	7.2E+2	9.6E-4	7.2E+2	9.6E-4
Trichloroethylene	1.7E+3	4.2E-4	1.7E+3	4.2E-4
Dichloroethane, 1,2-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Vinyl chloride	2.9E+3	2.4E-4	2.9E+3	2.4E-4
Dichlorobenzene, 1,4-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Hexachlorobutadiene	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Trichlorophenol, 2,4,6-	1.8E+3	3.8E-4	1.8E+3	3.8E-4

Site-Specific Soil Parameters

1. Soil Source Zone Characteristics

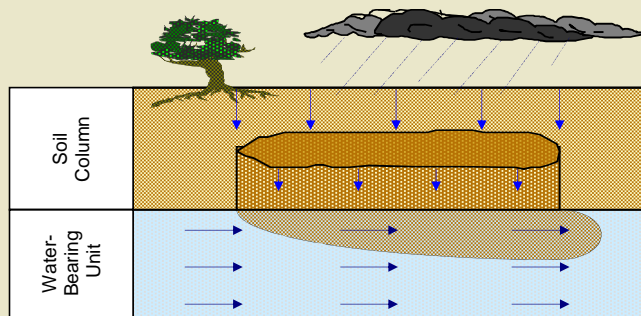
Hydrogeology

Depth to water-bearing unit	130	(m)
Capillary zone thickness	0.05	(m)
Soil column thickness	129.95	(m)

Affected Soil Zone

Depth to top of affected soils	1	(m)
Depth to base of affected soils	94	(m)
Length of affected soil parallel to assumed GW flow direction	560	(m)

	Res/Com	Construction	
Affected soil area	2025		(m ²)
Length of affected soil parallel to assumed wind direction	45	45	(m)



Site Name: Polaris_Hotoe River_POE4 drinking water_Regional_Farm Road1005069.113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

2. Surface Soil Column

Predominant USCS Soil Type

SW/SP: Sand

Calculate

	Vadose Zone	Capillary Fringe	
Volumetric water content	0.08	0.369	(-)
Volumetric air content	0.33	0.041	(-)
Total porosity	0.41		(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	864		(cm/d)
Vapor permeability	1.00E-12		(m ²)
Capillary zone thickness	0.05		(m)

Net Rainfall Infiltration

Net infiltration estimate	0.00	(cm/yr)
or	Enter Directly	
Average annual precipitation	0	(cm/yr)

Partitioning Parameters

Fraction organic carbon - entire soil column	0.01	(-)
Fraction organic carbon - root zone	0.01	(-)
Soil/water pH	7.5	(-)

3. Commands and Options

Main Screen

Use/Set Default Values

Print Sheet

Set Units

Help

Site-Specific Groundwater Parameters

1. Water-Bearing Unit ?

Hydrogeology

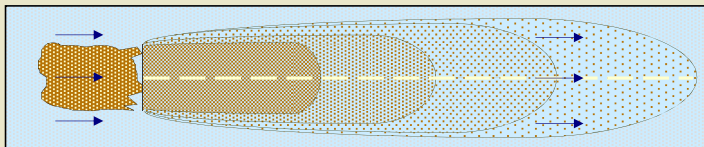
Groundwater Darcy velocity (cm/d)
 Groundwater seepage velocity (cm/d)
 or or
 Hydraulic conductivity (cm/d)
 Hydraulic gradient (-)
 Effective porosity (-)

Sorption

Fraction organic carbon--saturated zone (-)
 Groundwater pH (-)

2. Groundwater Source Zone ?

Groundwater plume width at source (m)
 Plume (mixing zone) thickness at source (m)
 or or
 Saturated thickness (m)
 Length of source zone (m)



Site Name: Polaris_Hotoe River_POE4 drinking water_Regional_Farm boreholes 105069.113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

3. Groundwater Dispersion ?

Model:

	GW Ingestion		GW to Indoor Air	
	Off-site 1	Off-site 2	Off-site 1	Off-site 2
Distance to GW receptors <input type="text" value="Calculate"/> <input type="button" value="▼"/>	<input type="text" value="2500"/>	<input type="text" value="1900"/>	<input type="text" value="0"/>	<input type="text" value="0"/> (m)
	↓	↓	↓	↓
Longitudinal dispersivity	<input type="text" value="250"/>	<input type="text" value="190"/>	<input type="text" value="0"/>	<input type="text" value="0"/> (m)
Transverse dispersivity	<input type="text" value="82.5"/>	<input type="text" value="62.7"/>	<input type="text" value="0"/>	<input type="text" value="0"/> (m)
Vertical dispersivity	<input type="text" value="12.5"/>	<input type="text" value="9.5"/>	<input type="text" value="0"/>	<input type="text" value="0"/> (m)

4. Groundwater Discharge to Surface Water ?

Distance to GW/SW discharge point (m) Off-site 2

Plume width at GW/SW discharge (m)

Plume thickness at GW/SW discharge (m)

Surface water flowrate at GW/SW discharge (m³/s)

5. Commands and Options

RBCA SITE ASSESSMENT	Tier 2 Domenico Groundwater Modeling Summary
-----------------------------	---

Site Name: Polaris_Hotoe River_POE Site Location: Wayby Valley Completed By: Leon Pemberton Date Completed: 30-Apr-19 1 OF 2

DOMENICO GROUNDWATER MODELING SUMMARY

OFF-SITE GROUNDWATER EXPOSURE PATHWAYS (CHECKED IF PATHWAY IS ACTIVE)

SOILS LEACHING TO GROUNDWATER:

Constituents of Concern	1) Source Medium		2) Steady-state Exposure Concentration Groundwater: POE Conc. (mg/L)		3) POE Concentration Limit Groundwater: POE Conc. (mg/L)		4) Time to Reach POE Conc. Limit Conc. limit reached? ("n" if yes) ; Time (yr)	
	Soil Conc. (mg/kg)	None	Off-site 1 (2500 m)	Off-site 2 (1900 m)	Off-site 1 (2500 m)	Off-site 2 (1900 m)	Off-site 1 (2500 m)	Off-site 2 (1900 m)
			None	Surf. Water	None	Surf. Water	None	Surf. Water
Arsenic	1.0E+1			6.9E-8		1.0E-2	NA	○ NA
Barium	2.7E+2			1.2E-6		7.0E-1	NA	○ NA
Cadmium	1.5E+0			7.5E-10		4.0E-3	NA	○ NA
Chromium (III) (total chromium)	3.4E+6			1.5E-7		5.0E-2	NA	○ NA
Lead (inorganic)	1.8E+0			3.8E-8		1.0E-2	NA	○ NA
Mercury	4.8E-1			5.6E-10		7.0E-3	NA	○ NA
Selenium	1.7E-1			1.1E-8		1.0E-2	NA	○ NA
Cyanide	9.9E-1			2.1E-8		6.0E-1	NA	○ NA
Benzene	2.1E-2			0.0E+0		1.0E-2	NA	○ NA
Chlordane, gamma	1.2E+2			0.0E+0		2.0E-4	NA	○ NA
Chlordane, cis- (alpha chlordane)	2.1E+3			6.3E-9		2.0E-4	NA	○ NA
Endrin	2.3E+0			5.2E-9		1.0E-3	NA	○ NA
Methoxychlor	7.8E+3			0.0E+0		2.0E-2	NA	○ NA
Pentachlorophenol	2.1E-2			0.0E+0		9.0E-3	NA	○ NA
Dichlorophenoxyacetic acid, 2,4-	9.1E+1			0.0E+0		4.0E-2	NA	○ NA
Trichlorophenoxyacetic acid, 2,4,5-	7.2E-1			0.0E+0		1.0E-2	NA	○ NA
Carbon tetrachloride	4.2E-2			0.0E+0		5.0E-3	NA	○ NA
Chloroform	1.7E-2			0.0E+0		4.0E-1	NA	○ NA
Tetrachloroethylene	3.6E-3			0.0E+0		5.0E-2	NA	○ NA
Trichloroethylene	1.7E-2			0.0E+0		2.0E-2	NA	○ NA
Dichloroethane, 1,2-	6.7E-4			0.0E+0		3.0E-2	NA	○ NA
Vinyl chloride	3.9E-2			0.0E+0		3.0E-4	NA	○ NA
Dichlorobenzene, 1,4-	9.5E-2			0.0E+0		3.0E-4	NA	○ NA
Hexachlorobutadiene	1.7E+0			5.2E-9		7.0E-4	NA	○ NA
Trichlorophenol, 2,4,6-	4.4E-3			0.0E+0		2.0E-1	NA	○ NA

Main Screen

RBCA Tool Kit for Chemical Releases
Version 2.5 © 2009 GSI Environmental Inc.

1. Project Information

Site Name:


Location:

Completed By:

Date: Job ID:


2. Which Type of RBCA Analysis?

Tier



Risk-Based Screening Levels

Tier 2/3



Site-Specific Target Levels

3. Calculation Options

Affects which input data are required

- Baseline Risks (Forward mode)**
- RBCA Cleanup Levels (Backward mode)**
- Individual Constituent Risk Goals Only
- Individual and Cumulative Risk Goals
- Apply Source Depletion Algorithm

Time to Future Exposure (yr)

4. RBCA Evaluation Process

Prepare Input Data

Data Complete? = yes = no

Exposure Pathways

↓

Constituents of Concern (COCs)

↓

Transport Models

↓

Soil Parameters

↓

GW Parameters

↓

Air Parameters

Review Output

Exposure Flowchart

↓

COC Chem. Parameters

↓

Input Data Summary

↓

User-Spec. COC Data...

↓

Transient Domenico Analysis..

↓

Baseline Risks..

↓

Cleanup Levels..

5. Commands and Options

New Site

Load Data...

Save Data

User Chemical Database

Set Units

Print Sheet

Print Report

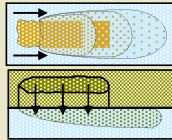
Help

Quit

Exposure Pathway Identification

1. Groundwater Exposure

Groundwater Ingestion/ Surface Water Impact



Receptor: None None S.W.

Distance: On-site Off-site1 Off-site2

Distance: 0 2500 1000 (m)

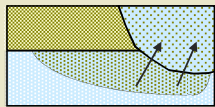
Source Media:

- Affected Groundwater
- Affected Soils Leaching to Groundwater

Option:

- Apply MCL value as ingestion RBEL (backward mode only)

GW Discharge to Surface Water Exposure

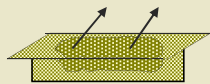


- Swimming
- Fish Consumption
- Specified Water Quality Criteria

Enter Criteria

2. Surface Soil Exposure

Combined Exposure



Receptor: None

Distance: On-site

Source Media:

- Direct Ingestion
- Dermal Contact
- Inhalation (vol+part)
- Vegetable Ingestion

Construction Worker

Option:

- Apply UK (CLEA) SGV as soil concentration limit

Veg Options

Site Name: Polaris_Waiteraire Stream_Regional_Ecology_Redvale TCV

Location: Wayby Valley

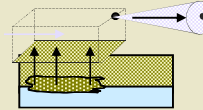
Compl. By: Leon Pemberton

Job ID: 1005069.113

Date: 30-Apr-19

3. Air Exposure

Volatilization and Particulates to Outdoor Air Inhalation



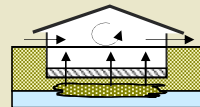
Receptor: None None None

Distance: On-site Off-site1 Off-site2

Distance: 0 0 0 (m)

Source Media:

- Construction worker
- Affected Soils--Volatilization to Ambient Outdoor Air
- Affected Groundwater--Volatilization to Ambient Outdoor Air
- Affected Surface Soils--Particulates to Ambient Outdoor Air



Volatilization to Indoor Air Inhalation

Receptor: None None None

Distance: On-site Off-site1 Off-site2

Distance: 0 0 0 (m)

Source Media:

- Affected Soils--Volatilization to Enclosed Space
- Affected Soils Leaching to GW--Volatilization to Enclosed Space
- Affected Groundwater--Volatilization to Enclosed Space

Bldg Options

4. Commands and Options

Main Screen

Print Sheet

Set Units

Help

Exposure Factors & Target Risks

Exposure Flowchart

Site Name: Polaris_Waiteraire Stream_Regional_Ecology_Red	Job ID: 1005069.113	Commands and Options
Location: Wayby Valley	Date: 30-Apr-19	<input type="button" value="Main Screen"/> <input type="button" value="Print Sheet"/> <input type="button" value="Help"/>
Compl. By: Leon Pemberton		

Source Media Constituents of Concern (COCs) ? Apply Raoult's Law

Selected COCs ?

COC Select: Sort List:																									
<input type="button" value="Add/Insert"/> <input type="button" value="Top"/> <input type="button" value="MoveUp"/>																									
<input type="button" value="Delete"/> <input type="button" value="Bottom"/> <input type="button" value="MoveDown"/>																									
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="padding: 2px;">Arsenic</td></tr> <tr><td style="padding: 2px;">Barium</td></tr> <tr><td style="padding: 2px;">Cadmium</td></tr> <tr><td style="padding: 2px;">Chromium (III) (total chromium)</td></tr> <tr><td style="padding: 2px;">Lead (inorganic)</td></tr> <tr><td style="padding: 2px;">Mercury</td></tr> <tr><td style="padding: 2px;">Selenium</td></tr> <tr><td style="padding: 2px;">Silver</td></tr> <tr><td style="padding: 2px;">Cyanide</td></tr> <tr><td style="padding: 2px;">Benzene</td></tr> <tr><td style="padding: 2px;">Cresol, m-</td></tr> <tr><td style="padding: 2px;">Cresol, o-</td></tr> <tr><td style="padding: 2px;">Cresol, p-</td></tr> <tr><td style="padding: 2px;">Chlordane, gamma</td></tr> <tr><td style="padding: 2px;">Chlordane, cis- (alpha chlordane)</td></tr> <tr><td style="padding: 2px;">Endrin</td></tr> <tr><td style="padding: 2px;">Heptachlor</td></tr> <tr><td style="padding: 2px;">Methoxychlor</td></tr> <tr><td style="padding: 2px;">Pentachlorophenol</td></tr> <tr><td style="padding: 2px;">Toxaphene</td></tr> <tr><td style="padding: 2px;">Dichlorophenoxyacetic acid, 2,4-</td></tr> <tr><td style="padding: 2px;">Trichlorophenoxyacetic acid, 2,4,5-</td></tr> <tr><td style="padding: 2px;">Dinitrotoluene, 2,4-</td></tr> <tr><td style="padding: 2px;">Nitrobenzene</td></tr> <tr><td style="padding: 2px;">Methyl ethyl ketone</td></tr> </table>	Arsenic	Barium	Cadmium	Chromium (III) (total chromium)	Lead (inorganic)	Mercury	Selenium	Silver	Cyanide	Benzene	Cresol, m-	Cresol, o-	Cresol, p-	Chlordane, gamma	Chlordane, cis- (alpha chlordane)	Endrin	Heptachlor	Methoxychlor	Pentachlorophenol	Toxaphene	Dichlorophenoxyacetic acid, 2,4-	Trichlorophenoxyacetic acid, 2,4,5-	Dinitrotoluene, 2,4-	Nitrobenzene	Methyl ethyl ketone
Arsenic																									
Barium																									
Cadmium																									
Chromium (III) (total chromium)																									
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Selenium																									
Silver																									
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Heptachlor																									
Methoxychlor																									
Pentachlorophenol																									
Toxaphene																									
Dichlorophenoxyacetic acid, 2,4-																									
Trichlorophenoxyacetic acid, 2,4,5-																									
Dinitrotoluene, 2,4-																									
Nitrobenzene																									
Methyl ethyl ketone																									

Representative COC Concentration ?

Groundwater Source Zone		Soil Source Zone		Mole Fraction in Source Material
(mg/L)	note	(mg/kg)	note	
5.00E+0	WAC	1.0E+1		(-)
1.00E+2	WAC	2.7E+2		
1.00E+0	WAC	1.5E+0		
5.00E+0	WAC	3.4E+6		
5.00E+0	WAC	1.8E+0		
2.00E-1	WAC	4.8E-1		
1.00E+0	WAC	1.7E-1		
5.00E+0	WAC	2.8E-2		
5.00E+1	WAC	9.9E-1		
5.00E-1	WAC	2.1E-2		
2.00E+2	WAC	2.9E-2		
2.00E+2	WAC	3.3E-1		
2.00E+2	WAC	4.2E+0		
3.00E-2	WAC	1.2E+2		
3.00E-2	WAC	2.1E+3		
2.00E-2	WAC	2.3E+0		
8.00E-4	WAC	2.9E+0		
1.00E+1	WAC	7.8E+3		
1.00E+2	WAC	2.1E-2		
5.00E-1	WAC	4.8E+2		
1.00E+1	WAC	9.1E+1		
1.00E+0	WAC	7.2E-1		
1.30E-1	WAC	1.8E-2		
2.00E+0	WAC	1.4E-2		
2.00E+2	WAC	1.2E+1		

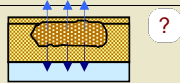
RBCA Tool Kit for Chemical Releases, Version 2.5

Pyridine	5.00E+0	WAC	1.3E+0	
Carbon tetrachloride	5.00E-1	WAC	4.2E-2	
Chloroform	6.00E+0	WAC	1.7E-2	
Tetrachloroethylene	7.00E-1	WAC	3.6E-3	
Trichloroethylene	7.00E-1	WAC	1.7E-2	
Dichloroethane, 1,2-	5.00E-1	WAC	6.7E-4	
Dichloroethylene, 1,1-	7.00E-1	WAC	2.2E-2	
Vinyl chloride	2.00E-1	WAC	3.9E-2	
Chlorobenzene	1.00E+2	WAC	1.4E-2	
Dichlorobenzene, 1,4-	7.50E+0	WAC	9.5E-2	
Hexachlorobutadiene	5.00E-1	WAC	1.7E+0	
Hexachlorobenzene	1.30E-1	WAC	1.9E+0	
Hexachloroethane	3.00E+0	WAC	4.6E-1	
Polychlorinated biphenyls (liquid)	5.00E+1	WAC	1.6E+1	
Trichlorophenol, 2,4,5-	4.00E+2	WAC	1.6E-2	
Trichlorophenol, 2,4,6-	2.00E+0	WAC	4.4E-3	

[View Chemical Parameters](#)

Transport Modeling Options

1. Vertical Transport, Surface Soil Column



Outdoor Air Volatilization Factors

- Surface soil volatilization model only ASTM Model
- Combination surface soil/Johnson & Ettinger models
- Thickness of surface soil zone (m)
- User-specified VF from other model Enter VF Values

Indoor Air Volatilization Factors

- Johnson & Ettinger model for soil and groundwater volatilization
- Johnson & Ettinger for soil, Mass Flux model for groundwater
- User-specified VF from other model Enter VF Values

Soil-to-Groundwater Leaching Factor

- ASTM Model
 - Apply Soil Attenuation Model (SAM) Enter Decay Rates
 - Allow first-order biodecay Enter LF Values
- User-specified LF from other model

Modeling Options

- Disable Mass Balance Limit
- Apply Dual Equilibrium Desorption Model

2. Lateral Air Dispersion Factor

- 3-D Gaussian dispersion model Off-site 1 Off-site 2
- User-Specified ADF (-)

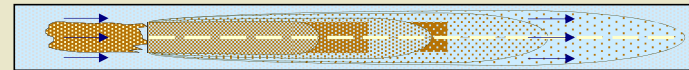
Site Name: Polaris_Waiteraire Stream_Regional_Ecology_Reduced 1005069.113

Location: Wayby Valley

Date: 30-Apr-19

Compl. By: Leon Pemberton

3. Groundwater Dilution Attenuation Factor



Calculate DAF using Domenico Model

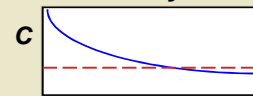
- Domenico equation with dispersion only (no biodegradation)
- Domenico equation first-order decay Enter Decay Rates
- Modified Domenico equation using electron acceptor superposition Enter Site Data

Calculate Biodegradation Capacity (mg/L)

User-Specified DAF Values

- DAF values from other model or site data Enter DAF Values

4. Chemical Decay and Source Depletion



Enter Decay Rates

Enter Source Mass

5. Commands and Options

Main Screen

Print Sheet

Help

Site Name: Polaris_Waiteraire Stream_Regional_Ecology DR10056CM3
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

Commands and Options

Return Print Sheet
 Paste Default Values Help

Constituent Decay Rates

Constituent	Saturated Zone		Unsaturated Zone	
	Half-Life	First-Order Decay Coefficient	Half-Life	First-Order Decay Coefficient
	(day)	(1/day)	(day)	(1/day)
Arsenic	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Barium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cadmium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Chromium (III) (total chromium)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Lead (inorganic)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Mercury	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Selenium	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Silver	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Cyanide	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Benzene	7.2E+2	9.6E-4	7.2E+2	9.6E-4
Cresol, m-	4.9E+1	1.4E-2	4.9E+1	1.4E-2
Cresol, o-	1.4E+1	5.0E-2	1.4E+1	5.0E-2
Cresol, p-	2.8E+1	2.5E-2	2.8E+1	2.5E-2
Chlordane, gamma	2.8E+3	2.5E-4	2.8E+3	2.5E-4
Chlordane, cis- (alpha chlordane)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Endrin	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Heptachlor	5.0E+0	1.4E-1	5.0E+0	1.4E-1
Methoxychlor	3.7E+2	1.9E-3	3.7E+2	1.9E-3
Pentachlorophenol	1.5E+3	4.6E-4	1.5E+3	4.6E-4
Toxaphene	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Dichlorophenoxyacetic acid, 2,4-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Trichlorophenoxyacetic acid, 2,4,5-	1.8E+2	3.9E-3	1.8E+2	3.9E-3
Dinitrotoluene, 2,4-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Nitrobenzene	3.9E+2	1.8E-3	3.9E+2	1.8E-3
Methyl ethyl ketone	1.4E+1	5.0E-2	1.4E+1	5.0E-2

RBCA Tool Kit for Chemical Releases, Version 2.5

Pyridine	1.4E+1	5.0E-2	1.4E+1	5.0E-2
Carbon tetrachloride	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Chloroform	1.8E+3	3.9E-4	1.8E+3	3.9E-4
Tetrachloroethylene	7.2E+2	9.6E-4	7.2E+2	9.6E-4
Trichloroethylene	1.7E+3	4.2E-4	1.7E+3	4.2E-4
Dichloroethane, 1,2-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Dichloroethylene, 1,1-	1.3E+2	5.3E-3	1.3E+2	5.3E-3
Vinyl chloride	2.9E+3	2.4E-4	2.9E+3	2.4E-4
Chlorobenzene	3.0E+2	2.3E-3	3.0E+2	2.3E-3
Dichlorobenzene, 1,4-	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Hexachlorobutadiene	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Hexachlorobenzene	4.2E+3	1.7E-4	4.2E+3	1.7E-4
Hexachloroethane	3.6E+2	1.9E-3	3.6E+2	1.9E-3
Polychlorinated biphenyls (liquid)	1.0E+24	6.9E-25	1.0E+24	6.9E-25
Trichlorophenol, 2,4,5-	1.8E+3	3.8E-4	1.8E+3	3.8E-4
Trichlorophenol, 2,4,6-	1.8E+3	3.8E-4	1.8E+3	3.8E-4

Site-Specific Soil Parameters

1. Soil Source Zone Characteristics

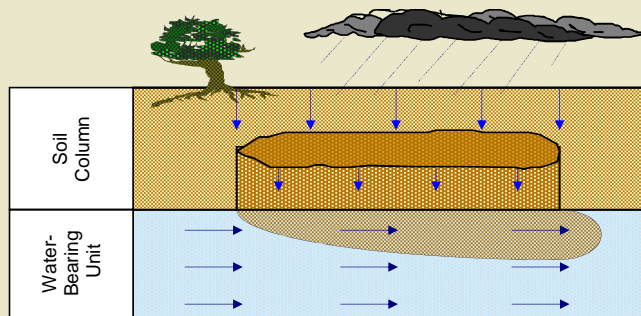
Hydrogeology

Depth to water-bearing unit	130	(m)
Capillary zone thickness	0.05	(m)
Soil column thickness	129.95	(m)

Affected Soil Zone

Depth to top of affected soils	1	(m)
Depth to base of affected soils	94	(m)
Length of affected soil parallel to assumed GW flow direction	560	(m)

	Res/Com	Construction	
Affected soil area	2025		(m ²)
Length of affected soil parallel to assumed wind direction	45	45	(m)



Site Name: Polaris_Waiteraire Stream_Regional_Ecology_RedvaleJ66VD: 1005069.113
 Location: Wayby Valley Date: 30-Apr-19
 Compl. By: Leon Pemberton

2. Surface Soil Column

Predominant USCS Soil Type

SW/SP: Sand

Calculate

	Vadose Zone	Capillary Fringe	
Volumetric water content	0.08	0.369	(-)
Volumetric air content	0.33	0.041	(-)
Total porosity	0.41		(-)
Dry bulk density	1.7		(kg/L)
Vertical hydraulic conductivity	864		(cm/d)
Vapor permeability	1.00E-12		(m ²)
Capillary zone thickness	0.05		(m)

Net Rainfall Infiltration

Net infiltration estimate	0.00	(cm/yr)
or	Enter Directly	
Average annual precipitation	0	(cm/yr)

Partitioning Parameters

Fraction organic carbon - entire soil column	0.01	(-)
Fraction organic carbon - root zone	0.01	(-)
Soil/water pH	7.5	(-)

3. Commands and Options

Main Screen

Use/Set Default Values

Print Sheet

Set Units

Help

Site-Specific Groundwater Parameters

1. Water-Bearing Unit ?

Hydrogeology

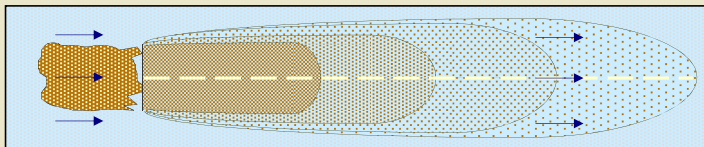
Groundwater Darcy velocity (cm/d)
 Groundwater seepage velocity (cm/d)
 or or
 Hydraulic conductivity (cm/d)
 Hydraulic gradient (-)
 Effective porosity (-)

Sorption

Fraction organic carbon--saturated zone (-)
 Groundwater pH (-)

2. Groundwater Source Zone ?

Groundwater plume width at source (m)
 Plume (mixing zone) thickness at source (m)
 or
 Saturated thickness (m)
 Length of source zone (m)



Site Name: Polaris_Waiteraire Stream_Regional_Ecology_Redvale TCV Job ID: 1005069.113

Location: Wayby Valley

Date: 30-Apr-19

Compl. By: Leon Pemberton

3. Groundwater Dispersion ?

Model:

	GW Ingestion		GW to Indoor Air	
	Off-site 1	Off-site 2	Off-site 1	Off-site 2
Distance to GW receptors	<input type="text" value="2500"/>	<input type="text" value="1000"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Longitudinal dispersivity	<input type="text" value="250"/>	<input type="text" value="100"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Transverse dispersivity	<input type="text" value="82.5"/>	<input type="text" value="33"/>	<input type="text" value="0"/>	<input type="text" value="0"/>
Vertical dispersivity	<input type="text" value="12.5"/>	<input type="text" value="5"/>	<input type="text" value="0"/>	<input type="text" value="0"/>

4. Groundwater Discharge to Surface Water ?

Distance to GW/SW discharge point (m) Off-site 2
 Plume width at GW/SW discharge (m)
 Plume thickness at GW/SW discharge (m)
 Surface water flowrate at GW/SW discharge (m³/s)

5. Commands and Options

[Main Screen](#)

[Use/Set Default Values](#)

[Print Sheet](#)

[Set Units](#)

[Help](#)

RBCA SITE ASSESSMENT	Tier 2 Domenico Groundwater Modeling Summary
-----------------------------	---

Site Name: Polaris Waiterair Stream Site Location: Wayby Valley

Completed By: Leon Pemberton

Date Completed: 30-Apr-19

1 OF 2

DOMENICO GROUNDWATER MODELING SUMMARY

OFF-SITE GROUNDWATER EXPOSURE PATHWAYS (CHECKED IF PATHWAY IS ACTIVE)

SOILS LEACHING TO GROUNDWATER:

Constituents of Concern	1) Source Medium	2) Steady-state Exposure Concentration Groundwater: POE Conc. (mg/L)		3) POE Concentration Limit Groundwater: POE Conc. (mg/L)		4) Time to Reach POE Conc. Limit Conc. limit reached? ("n" if yes) ; Time (yr)	
	Soil Conc. (mg/kg)	Off-site 1 (2500 m) None	Off-site 2 (1000 m) Surf. Water	Off-site 1 (2500 m) None	Off-site 2 (1000 m) Surf. Water	Off-site 1 (2500 m) None	Off-site 2 (1000 m) Surf. Water
Arsenic	1.0E+1		3.0E-7		1.5E+5	NA	○ NA
Barium	2.7E+2		5.2E-6		1.5E+5	NA	○ NA
Cadmium	1.5E+0		3.2E-9		1.2E+3	NA	○ NA
Chromium (III) (total chromium)	3.4E+6		6.4E-7		2.1E+4	NA	○ NA
Lead (inorganic)	1.8E+0		1.7E-7		2.1E+4	NA	○ NA
Mercury	4.8E-1		2.4E-9		3.7E+3	NA	○ NA
Selenium	1.7E-1		5.0E-8		6.8E+4	NA	○ NA
Silver	2.8E-2		6.9E-10		3.1E+2	NA	○ NA
Cyanide	9.9E-1		9.0E-8		4.4E+4	NA	○ NA
Benzene	2.1E-2		0.0E+0		5.9E+6	NA	○ NA
Cresol, m-	2.9E-2		0.0E+0		6.2E+5	NA	○ NA
Cresol, o-	3.3E-1		0.0E+0		6.2E+5	NA	○ NA
Cresol, p-	4.2E+0		0.0E+0		6.2E+5	NA	○ NA
Chlordane, gamma	1.2E+2		0.0E+0		5.0E+2	NA	○ NA
Chlordane, cis- (alpha chlordane)	2.1E+3		2.7E-8		5.0E+2	NA	○ NA
Endrin	2.3E+0		2.3E-8		1.2E+2	NA	○ NA
Heptachlor	2.9E+0		0.0E+0		5.6E+2	NA	○ NA
Methoxychlor	7.8E+3		0.0E+0		3.1E+1	NA	○ NA
Pentachlorophenol	2.1E-2		0.0E+0		6.2E+4	NA	○ NA
Toxaphene	4.8E+2		4.5E-7		1.2E+3	NA	○ NA
Dichlorophenoxyacetic acid, 2,4-	9.1E+1		0.0E+0		1.7E+6	NA	○ NA
Trichlorophenoxyacetic acid, 2,4,5-	7.2E-1		0.0E+0		2.2E+5	NA	○ NA
Dinitrotoluene, 2,4-	1.8E-2		0.0E+0		4.0E+5	NA	○ NA
Nitrobenzene	1.4E-2		0.0E+0		3.4E+6	NA	○ NA
Methyl ethyl ketone	1.2E+1		0.0E+0		6.2E+6	NA	○ NA
Pyridine	1.3E+0		0.0E+0		6.2E+6	NA	○ NA

RBCA Tool Kit for Chemical Releases, Version 2.5 (BETA)

Carbon tetrachloride	4.2E-2		0.0E+0		1.5E+6	NA	○	NA
Chloroform	1.7E-2		0.0E+0		2.3E+6	NA	○	NA
Tetrachloroethylene	3.6E-3		0.0E+0		6.2E+6	NA	○	NA
Trichloroethylene	1.7E-2		0.0E+0		6.2E+6	NA	○	NA
Dichloroethane, 1,2-	6.7E-4		0.0E+0		1.2E+7	NA	○	NA
Dichloroethylene, 1,1-	2.2E-2		0.0E+0		4.4E+6	NA	○	NA
Vinyl chloride	3.9E-2		0.0E+0		6.2E+6	NA	○	NA
Chlorobenzene	1.4E-2		0.0E+0		6.2E+6	NA	○	NA
Dichlorobenzene, 1,4-	9.5E-2		0.0E+0		3.7E+5	NA	○	NA
Hexachlorobutadiene	1.7E+0		2.3E-8		6.2E+6	NA	○	NA
Hexachlorobenzene	1.9E+0		0.0E+0		3.1E+2	NA	○	NA
Hexachloroethane	4.6E-1		0.0E+0		2.2E+6	NA	○	NA
Polychlorinated biphenyls (liquid)	1.6E+1		2.7E-9		6.2E+6	NA	○	NA
Trichlorophenol, 2,4,5-	1.6E-2		0.0E+0		3.1E+3	NA	○	NA
Trichlorophenol, 2,4,6-	4.4E-3		0.0E+0		1.2E+5	NA	○	NA

NOTE: POE = Point of exposure

Appendix P: Drawdown assessment

Time-drawdown calculations using Hantush-Jacob equation

Aquifer parameters		
T	7	m ² /d
S	0.0005	
B	650	m
Pumping rate		
Q	0.55	l/s

Radius (m)	50	1200	2200	Aquifer parameters		
Time (days)	Drawdown (m)	Drawdown (m)	Drawdown (m)	T	7	m ² /d
1	1.377	-	-	S	0.0005	
3	1.921	0.000	-	B	650	m
7	2.308	0.003	0.000	Pumping rate		
10	2.453	0.009	0.000	Q	0.55	l/s
15	2.599	0.027	0.000			
30	2.783	0.081	0.004			
40	2.832	0.104	0.008			
50	2.860	0.119	0.012			
90	2.895	0.143	0.021			
110	2.899	0.146	0.023			
120	2.900	0.147	0.023			
150	2.902	0.148	0.024			
365	2.902	0.149	0.024			

Distance-drawdown calculations using Hantush-Jacob equation

Time (days)	7	30	150	Aquifer parameters		
Radius (m)	Drawdown (m)	Drawdown (m)	Drawdown (m)	T	7	m ² /d
1	6.527	7.004	7.123	S	0.0005	
2	5.778	6.255	6.374	B	650	m
4	5.030	5.506	5.625	Pumping rate		
8	4.281	4.757	4.876	Q	0.55	l/s
16	3.533	4.009	4.128			
32	2.786	3.262	3.381			
64	2.046	2.519	2.638			
128	1.326	1.791	1.909			
256	0.669	1.102	1.218			
512	0.186	0.515	0.622			
1024	0.009	0.130	0.209			
2048	0.000	0.006	0.031			
4096	-	0.000	0.001			

