

607-1F VZCOMML© Contaminant Fate and Transport Modeling

ERD-EN-2019-0002

5/13/2019

EXECUTIVE SUMMARY

The fate and transport of contaminants associated with the 607-1F Sanitary Waste Treatment Unit was determined using the spreadsheet model VZCOMML[®]. A sampling event in 2018 found that the sludge at the bottom of the primary clarifying tank contained both heavy metals and semi-volatile organic compounds. VZCOMML[®] was used to determine if these contaminants pose a threat to groundwater underneath the facility after traveling through the vadose zone. Modeling revealed none of the contaminants exceeded action levels in groundwater within 1000 years. No contaminant migration constituents of concern were identified for 607-1F. Proposed grouting of the basin will immobilize the contaminants further reducing the limited potential for migration to groundwater.

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LIST OF ABBREVIATIONS AND ACRONYMS

bgs	below ground surface
CM	contaminant migration
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
ft	feet
kg	kilogram
L	liter
µg	microgram
m	meter
MCL	maximum contaminant level
mg	milligram
MLSSL	mass-limited soil screening limit
PCB	polychlorinated biphenyl
SRS	Savannah River Site
SSL	soil screening limit
SVOC	semi volatile organic compound
UTR	Upper Three Runs
USEPA	U. S. Environmental Protection Agency
VOC	volatile organic compound

1. Contaminant Fate and Transport

The purpose of this report is to determine the fate and transport of contaminants associated with the 607-1F Sanitary Waste Treatment Unit. A sampling event in 2018 revealed that the sludge at the bottom of the primary clarifying tank contained both heavy metals and low levels of organic compounds. As such, contaminant fate and transport modeling was performed to establish whether the sludge constituents pose a threat to groundwater which will aid in the selection of a facility decommissioning model.

Analysis was performed using the spreadsheet fate and transport model VZCOMML[®]^a, which accounts for decay processes, infiltration rate, soil properties, vadose zone thickness, and chemical behavior. Soil screening limits (SSLs) were calculated by the model and an exceedance of an SSL by a vadose zone constituent indicates that the maximum groundwater concentration has the potential to exceed the regulatory limits (e.g., maximum contaminant levels [MCLs]). The SSLs were then compared to current contaminant sludge concentrations to establish if any are contaminant migration (CM) constituents of potential concern (COPCs) that pose a threat to groundwater.

2. Contaminant Migration Model

a. Background

The 607-1F Sanitary Waste Treatment Unit is located southeast of the F-Area Tank farm (Attachment A). The unit resides on top of the Upper Three Runs Aquifer (UTRA), at an elevation of 281 ft above sea level (drawing W156164). The facility was initially used to treat wastewater from F Area and is currently inactive. Sometime after facility shut down, sludge contaminated with metals, organic compounds, and possibly radionuclides, was removed from a cooling tower basin (building 285-F) and placed in the 607-1F primary clarifying basin. A composite sample of this sludge (five sampling locations), still present at the bottom of the basin, taken in 2018 revealed elevated levels of metals, organics, and one detected polychlorinated biphenyl (PCB, Table 1). As such, VZCOMML[®] was used to identify constituents that may exceed groundwater action levels.

^a Vadose Zone Contaminant Migration Multi-Layered Model (VZCOMML[®]) Version 4.0, Copyright TXu 1-663-361, 2009, Savannah River Nuclear Services, LLC.

Table 1. Concentration of detected compounds in the basin sludge from the 2018 composite sample.

Analyte	Result (µg/kg)	Result (mg/kg)	Analyte	Result (µg/kg)	Result (mg/kg)
<u>Metals</u>			<u>PCBs</u>		
Aluminum	32800000	32800	Aroclor-1260	331	0.331
Antimony	19400	19.4	<u>Organics</u>		
Arsenic	2820000	2820	1,2-Dichloroethane	126	0.126
Barium	161000	161	Benzo(a)anthracene	346	0.346
Beryllium	27600	27.6	Benzo(a)pyrene	377	0.377
Cadmium	13200	13.2	Benzo(b)fluoranthene	651	0.651
Calcium	3310000	3310	Benzo(ghi)perylene	192	0.192
Chromium	1550000	1550	Benzo(k)fluoranthene	280	0.28
Cobalt	485000	485	Bis(2-ethylhexyl)phthalate	9630	9.63
Copper	4170000	4170	Butylbenzylphthalate	91.5	0.0915
Iron	139000000	139000	Chrysene	488	0.488
Lead	381000	381	Dibenzo(a,h)anthracene	59.7	0.0597
Magnesium	1390000	1390	Di-n-butylphthalate	98.2	0.0982
Manganese	1460000	1460	Fluoranthene	695	0.695
Mercury	2160	2.16	Indeno(1,2,3-cd)pyrene	240	0.24
Nickel	393000	393	Phenanthrene	198	0.198
Potassium	624000	624	Pyrene	508	0.508
Selenium	6410	6.41			
Sodium	59300	59.3			
Thallium	23600	23.6			
Vanadium	175000	175			
Zinc	7610000	7610			

b. Screening Methods

The identification of CM COPCs and CM COCs is facilitated by the spreadsheet model VZCOMML[®].

This CM evaluation follows the protocols and guidelines established in the *Environmental Compliance and Area Completion Projects Regulatory Document Handbook* (SRNS 2012). For the Tier I screening, the unit was modeled under the most conservative assumptions including maximum constituent concentrations at the maximum sample depth (i.e., shortest travel time distance in the vadose zone to water table). Constituents predicted by the model to impact groundwater at

concentrations exceeding action levels were retained as Tier I CM COPCs. A less conservative set of assumptions was used for the Tier II analysis to identify constituents impacting groundwater at concentrations exceeding action levels within the evaluation time of 1,000 years. The notable differences between the tiers are that Tier I analysis averages the contaminant mass over the all layers while the Tier II contaminant mass is confined to the source layer (s). Tier II analysis also includes biological and chemical degradation for organics.

Both the Tier I and Tier II screens include infinite source mass and limited source mass calculations. The consideration of an infinite source mass is not reasonable, so the mass-limited calculations (default mass-limited SSLs and SRS site-specific mass-limited SSLs [MLSSL]) $T_{1/2}^s$ consider the entire release of the source mass within a 70-year exposure period. This prevents a source mass balance error (i.e., releasing more contaminant mass than contained in the source) in the calculation, which is likely with the infinite source scenario.

VZCOMML[®] compares user-entered soil concentrations to SSLs and identifies constituents that are Tier I CM COPCs and Tier II CM COCs. Chemical properties of the contaminants (e.g., soil/water distribution coefficient, Henry's Law constant, etc.), hydraulic functions for different types of soil layers (e.g., source layer, soil layer, or engineered barrier layer) and texture classifications (e.g., sand, loamy sand, clay, concrete) are built in to the program. VZCOMML[®] calculates groundwater concentrations and migration times from input data and compares and evaluates user-entered concentrations to SSLs to identify constituents that are CM COPCs and CM COCs.

c. 607-1F Model Parameters

The vadose zone under 607-1F was modeled as a five-layer system based on soil lithology of the F-Area Retention Basin well FRB-1 approximately 500 ft from the unit (Attachment A), where:

- Layer 1 is the sludge source layer which was conservatively estimated to be 0.5 feet thick with a texture similar to silty clay. This layer begins 8 ft bgs as the basin floor is below grade.
- Layer 2 is concrete extending down from the sludge to 9.5 ft below ground surface (bgs). The basin slab is 12 in thick (drawing W156164).
- Layer 3 is a loamy sand soil, which extends from the base of Layer 2 to 22 ft bgs

- Layer 4 is silty loam soil which extends from layer 3 to 28 ft bgs
- Layer 5 is loamy sand soil which extends from layer 4 to the water table (66 ft bgs)
- The groundwater confining unit was the tan clay layer of the UTR aquifer. This layer is generally considered a leaky confining unit in that some groundwater still passes through. Using this layer as the confining unit decreases the thickness of the mixing layer, producing conservative groundwater concentrations and SSLs.

The concrete slab was assumed to be the limiting layer for infiltration in the vadose zone. These layers were used to develop a conceptual site model (CSM, Fig 1). The VZCOMML assigned parameters were used for each layer (see Attachment B). The depth to ground water, 66 ft, was determined using facility drawing (W156164) and potentiometric maps of the surrounding area (Attachment A), where the facility and water table are at elevations of 281 ft and 215 ft, respectively. The infiltration used rate was 5.62 inches per year, an ultra-conservative value based on an average estimated infiltration for concrete over a 1000-year period, which accounts for slab deterioration (SRNL, 2009). The source length was 24 ft, the length of the basin. The fraction organic content of the source layer was assumed to be low at 0.0001, which will have little effect on the migration of metals to the vadose zone and provides a high flux of organics from the source zone, leading to conservatively higher groundwater concentrations.

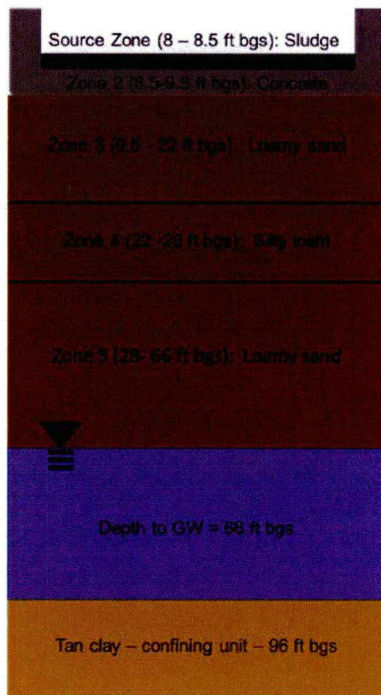


Figure 1. CSM for contaminant transport through the vadose zone under 607-1F

The composite concentrations of the detected constituent including metals, volatile organic compounds (VOCs), semi volatile organic compounds (SVOCs), and PCBs were used as the source zone concentrations. The properties of each constituent are provided in Attachment C. These parameters include organic carbon partitioning coefficient, soil-water partitioning coefficient, half-life (biological degradation for organics; radioactive decay for radionuclides), Henry’s Law constant, solubility, and regulatory action level. In addition to chemical parameters, several physical parameters are also employed in CM simulations.

3. RESULTS

a. Tier I Analysis

The Tier I analysis identified thirteen metals, six SVOCs, and one PCB as CM COPCs (Attachment D). The metals were arsenic, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel, thallium, vanadium, and zinc. The SVOCs were benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, bis(2-ethylhexyl)phthalate, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene. The PCB aroclor-1260 was also retained.

b. Tier II Analysis

The twenty constituents, which failed Tier I screening, were evaluated in a Tier II simulation (Attachment E). No constituents were identified as Tier II CM COCs. More specifically, the tier I retained metals exceeded the time frame in tier II analysis since the source zone is more accurately confined to the sludge layer. The retained organics, on the other hand, degraded before reaching concentrations that exceeded regulatory limits. As such, no contaminant migration constituents of concern were identified for 607-1F.

4. Conclusions

Contaminant migration analysis performed using VZCOMML[®] revealed no contaminants in the sludge have the potential to migrate to groundwater and exceed groundwater action levels within 1,000 years. The proposed grouting of the basin will immobilize the constituents in the sludge, further reducing the risk to groundwater.

5. References

Rucker, Gregory G., 2011. *Soil Contaminant Migration Screen Software Calculation Check (U) for VZCOMML[®] v.4.0*, Q-CLC-G-00089, Revision 0, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNL, 2009. *Material Property, Infiltration, and Saturation Estimates and Distributions for the Composite Analysis*, SRNL-STI-2009-00316, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

SRNS, 2012. *Environmental Compliance and Area Completion Projects Regulatory Document Handbook*, ERD-AG-003, Revision 17, Savannah River Nuclear Solutions, LLC, Savannah River Site, Aiken, SC

W156164, 1951. *ARRGT., Arch. & Concrete- Building 607-1F Sewage Treatment Plant Ground Floor & Sections*, Savannah River Plant, Aiken SC

6. ATTACHMENTS

Attachment A: Potentiometric map of the area surrounding 607-1F

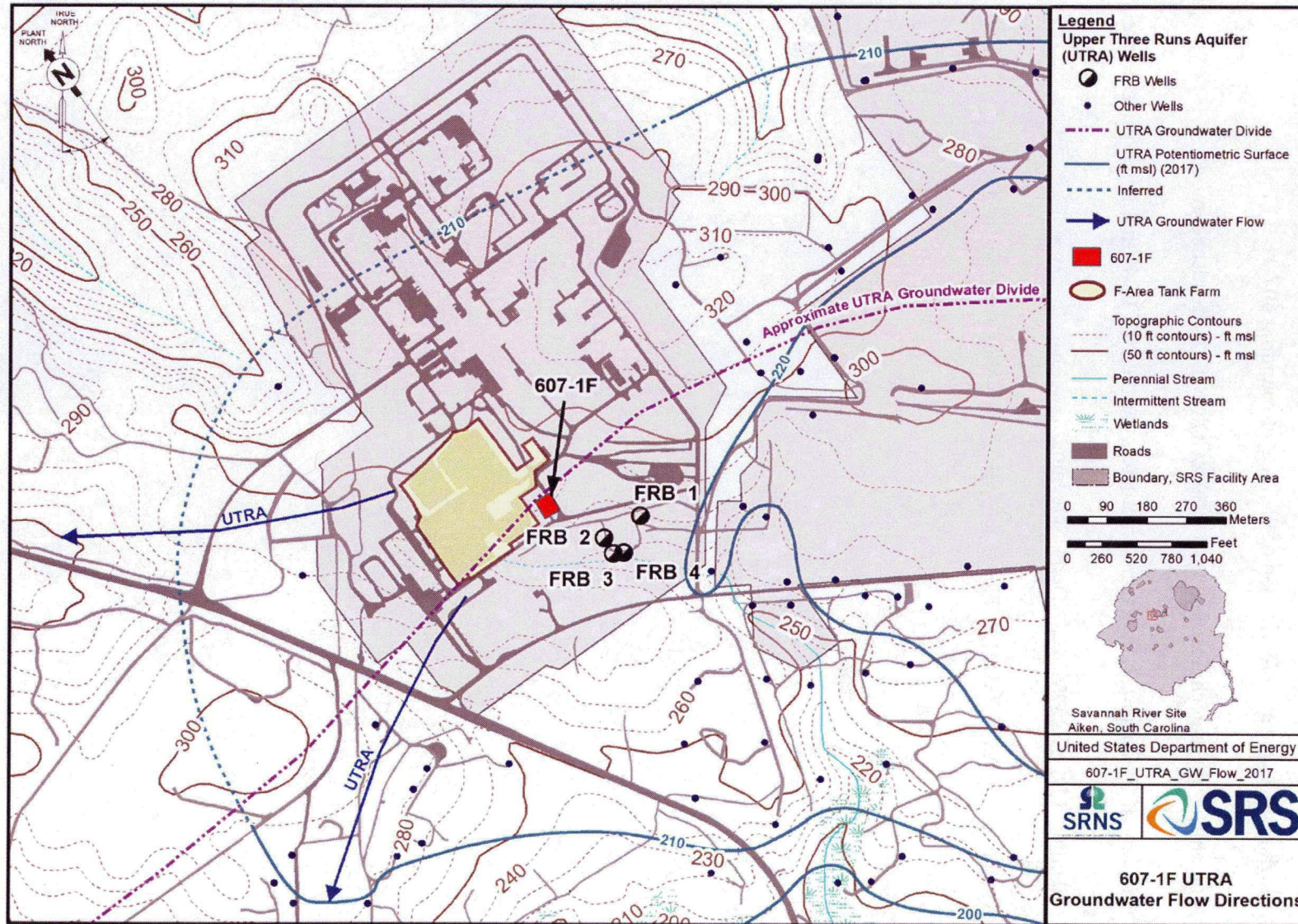
Attachment B: Geotechnical inputs to the VZCOMML© spreadsheet model

Attachment C: Chemical inputs and parameters for the VZCOMML© spreadsheet model.

Attachment D: VZCOMML© Tier 1 Screening

Attachment E: VZCOMML© Tier II screening (only those retained at Tier I)

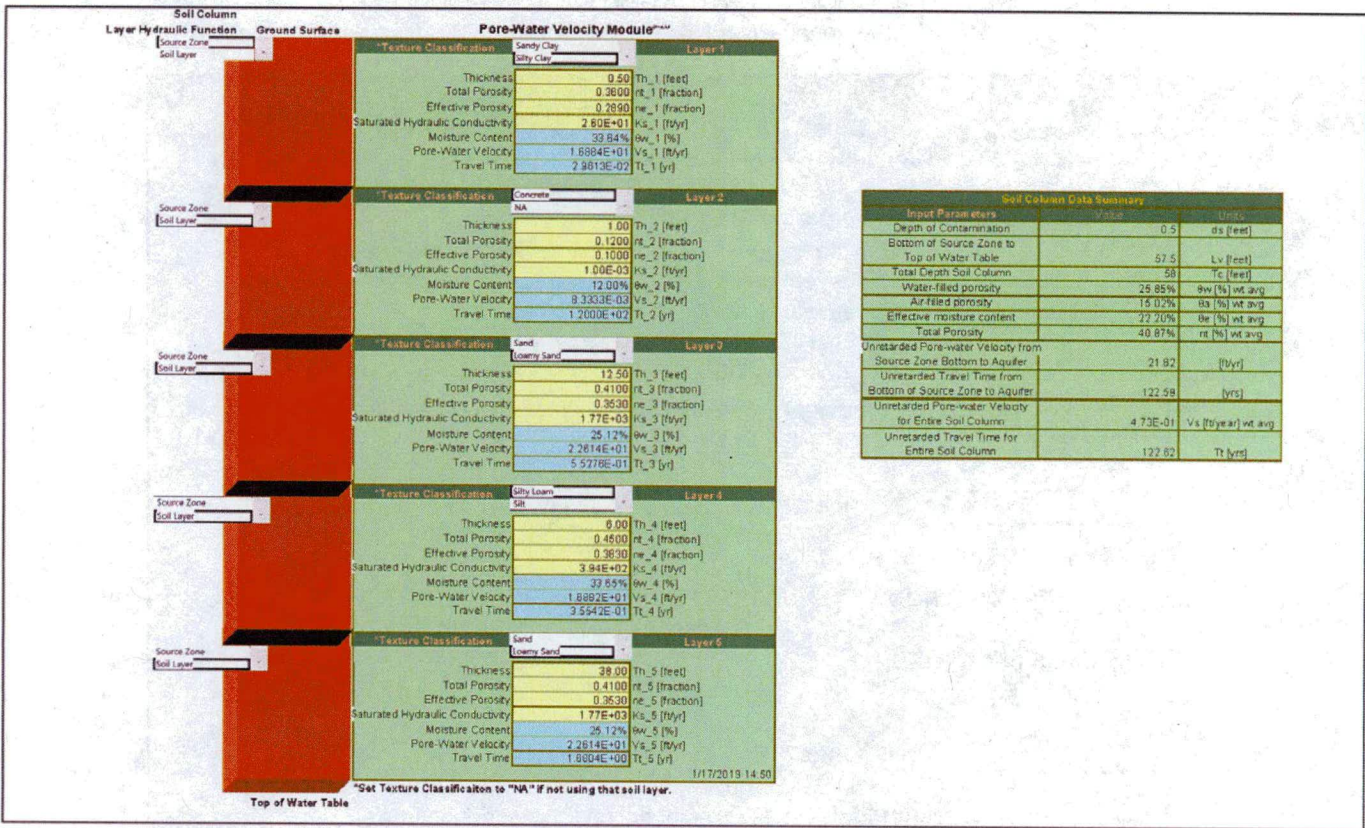
Attachment A: Potentiometric map of the area surrounding 607-1F



Attachment B: Geotechnical inputs to the VZCOMML© spreadsheet model

MIXING ZONE AND DILUTION ATTENUATION FACTOR MODULE
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ESTIMATION OF MIXING ZONE DEPTH			
PROJECT NAME:			
Calculation of Mixing Zone^{7, 8}			
Variable	Input Values	Units	Parameter
L=	24	feet	Source length parallel to groundwater flow
I=	5.68	feet/year	Infiltration rate through vadose zone
Ia=	Not Used	feet/year	Alternative infiltration rate through cover system (if used)
K _a =	1,772	feet/year	Aquifer saturated horizontal hydraulic conductivity
da=	30	feet	Aquifer thickness
i=	0.002	feet/feet	Horizontal hydraulic gradient in aquifer
d=	24.22	feet	Mixing Zone Depth
DILUTION ATTENUATION FACTOR (DAF)			
Calculation of DAF²			
Variable	Input Values	Units	Parameter
K=	1772	feet/year	Aquifer saturated horizontal hydraulic conductivity
i=	0.002	feet/feet	Horizontal hydraulic gradient in aquifer
mz=	24.22	feet	Mixing zone depth
L=	24	feet	Source length parallel to groundwater flow
DAF=	1.63		
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GEOTECHNICAL PARAMETERS MODULE
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Parameter	Variable	Value	Units
Depth to Bottom of Source	d_s	0.50	feet
Exposure Duration	ED	70.00	years
Bottom of Source Zone to Groundwater	L_v	57.50	feet
Evaluation Time	T_e	1,000.00	years
Bulk Density	ρ_b	1.70	kilograms/liter
Fraction Organic Carbon in Source Layer	f_{oc}	0.0001	fraction (decimal)

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Attachment C: Chemical inputs and parameters for the VZCOMML© spreadsheet model.

INPUT MODULE-VOCs
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Volatile Organic Analytes	K _{oc} (VOC) L/Kg	K _d ²¹ (VOC) L/Kg	T1/2 (VOC) Years	H' (VOC) Dimensionless	S (VOC) mg/L	C _t (VOC) mg/kg
1,2-Dichloroethane	3.80E+01	3.80E-03	5.00E-01	4.01E-02	8.52E+03	1.26E-01

INPUT MODULE-SVOCs

Semi-Volatile Analytes	K _{oc} (SVOC) L/Kg	K _d ²¹ (SVOC) L/Kg	T1/2 (SVOC) Years	H' (SVOC) Dimensionless	S (SVOC) mg/L	C _t (SVOC) mg/kg
Benzo(a)anthracene	3.58E+05	3.58E+01	1.86E+00	1.37E-04	9.40E-03	3.46E-01
Benzo(a)pyrene	9.69E+05	9.69E+01	1.45E+00	4.63E-05	1.62E-03	3.77E-01
Benzo(b)fluoranthene	1.23E+06	1.23E+02	1.67E+00	4.55E-03	1.50E-03	6.51E-01
Benzo(g,h,i)perylene	1.60E+06	1.60E+02	1.78E+00	5.13E-06	3.00E-04	1.92E-01
Benzo(k)fluoranthene	1.23E+06	1.23E+02	5.86E+00	3.40E-05	8.00E-04	2.80E-01
Bis(2-ethylhexyl) phthalate	1.11E+05	1.11E+01	6.30E-02	4.18E-06	3.40E-01	9.63E+00
Butylbenzyl phthalate	1.37E+04	1.37E+00	1.90E-02	5.17E-05	2.69E+00	9.15E-02
Chrysene	3.98E+05	3.98E+01	2.72E+00	3.88E-03	1.60E-03	4.88E-01
Dibenz(a,h)anthracene	1.79E+06	1.79E+02	2.58E+00	6.03E-07	2.49E-03	5.97E-02
Di-n-butyl phthalate	1.57E+03	1.57E-01	6.30E-02	3.85E-08	1.12E+01	9.82E-02
Fluoranthene	4.90E+04	4.90E+00	1.21E+00	6.60E-04	2.06E-01	6.95E-01
Indeno(1,2,3-c,d)pyrene	3.74E+06	3.74E+02	2.00E+00	6.56E-05	2.20E-05	2.40E-01
Phenanthrene	1.40E+04	1.40E+00	5.48E-01	1.60E-03	1.29E+00	1.98E-01
Pyrene	6.80E+04	6.80E+00	5.20E+00	4.51E-04	1.35E-01	5.08E-01

INPUT MODULE-PEST/PCBs
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Pesticides/PCBs	K _{oc} (PEST) L/Kg	K _d ²¹ (PEST) L/Kg	T1/2 (PEST) Years	H' (PEST) Dimensionless	S (PEST) mg/L	C _t (PEST) mg/kg
PCB 1260	3.09E+05	3.09E+01	3.42E+04	1.03E-02	1.44E-02	3.31E-01

INPUT MODULE-METALS
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Metal Analytes	Koc (Metal) L/Kg	Kd (METAL) L/Kg	T1/2 (METAL) Years	C _t (METAL) mg/kg
Aluminum	NA	1.50E+03	Infinite	3.28E+04
Antimony (metallic)	NA	4.00E+03	Infinite	1.94E+01
Arsenic, Inorganic	NA	3.90E+01	Infinite	2.82E+03
Barium	NA	4.10E+01	Infinite	1.61E+02
Beryllium and compounds	NA	7.90E+02	Infinite	2.76E+01
Cadmium	NA	7.50E+01	Infinite	1.32E+01
Calcium	NA	5.00E+00	Infinite	3.31E+03
Chromium, Total	NA	1.80E+06	Infinite	1.55E+03
Cobalt	NA	1.00E+01	Infinite	4.85E+02
Copper, Total	NA	2.50E+01	Infinite	4.17E+03
Iron	NA	2.20E+02	Infinite	1.39E+05
Lead and compounds	NA	2.70E+02	Infinite	3.81E+02
Magnesium	NA	No Kd available	Infinite	1.39E+03
Manganese	NA	5.00E+01	Infinite	1.46E+03
Mercury (elemental)	NA	5.20E+01	Infinite	2.16E+00
Nickel Soluble Salts	NA	6.50E+01	Infinite	3.93E+02
Potassium	NA	5.50E+01	Infinite	6.24E+02
Selenium	NA	5.50E+01	Infinite	6.41E+00
Sodium, total recoverable	NA	No Kd available	Infinite	5.93E+01
Thallium Soluble Salts	NA	7.10E+01	Infinite	2.36E+01
Vanadium, total recoverable	NA	1.00E+03	Infinite	1.75E+02
Zinc (metallic)	NA	6.20E+01	Infinite	7.61E+03

0.467 Henry's Law Constant for Mercury (H')

Attachment D: VZCOMML© Tier 1 Screening

SOIL SCREENING AND SOIL SATURATION LIMIT SCREENING MODULE
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ANALYTE	SOURCE ZONE CONCENTRATION Ct (mg/kg)	Tier I SOURCE-SPECIFIC SSL (mg/kg)	Tier I MASS LIMIT SSL (mg/kg)	ANALYTES >=SSL	SOIL SATURATION LIMIT (Csat) ³³ (mg/L)	ANALYTES >=Csat
1,2-Dichloroethane	1.26E-01	1.30E-03	3.81E+00		1.36E+03	

SOIL SCREENING AND SOIL SATURATION LIMIT SCREENING MODULE
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ANALYTE	SOURCE ZONE CONCENTRATION Ct (mg/kg)	Tier I SOURCE-SPECIFIC SSL (mg/kg)	Tier I MASS LIMIT SSL (mg/kg)	ANALYTES >=SSL	SOIL SATURATION LIMIT (Csat) ⁰⁰ (mg/L)	ANALYTES >=Csat
Benzo(a)anthracene	3.46E-01	1.76E-03	2.29E-02	Benzo(a)anthracene	3.38E-01	Benzo(a)anthracene
Benzo(a)pyrene	3.77E-01	3.16E-02	1.52E-01	Benzo(a)pyrene	1.57E-01	Benzo(a)pyrene
Benzo(b)fluoranthene	6.51E-01	5.02E-02	1.91E-01	Benzo(b)fluoranthene	1.85E-01	Benzo(b)fluoranthene
Benzo(g,h,i)perylene	1.92E-01	NA	NA		4.80E-02	NA
Benzo(k)fluoranthene	2.80E-01	5.02E-01	1.91E+00		9.85E-02	Benzo(k)fluoranthene
Bis(2-ethylhexyl) phthalate	9.63E+00	1.10E-01	4.57E+00	Bis(2-ethylhexyl) phthalate	3.83E+00	Bis(2-ethylhexyl) phthalate
Butylbenzyl phthalate	9.15E-02	3.97E-02	1.22E+01		4.09E+00	
Chrysene	4.88E-01	1.63E+00	1.91E+01		6.39E-02	Chrysene
Dibenz(a,h)anthracene	5.97E-02	7.30E-03	1.91E-02	Dibenz(a,h)anthracene	4.46E-01	
Di-n-butyl phthalate	9.82E-02	4.53E-01	6.86E+02		3.46E+00	
Fluoranthene	6.95E-01	6.59E+00	6.10E+02		1.04E+00	
Indeno(1,2,3-c,d)pyrene	2.40E-01	1.77E-02	2.21E-02	Indeno(1,2,3-c,d)pyrene	8.23E-03	Indeno(1,2,3-c,d)pyrene
Phenanthrene	1.99E-01	NA	NA		2.00E+00	NA
Pyrene	5.08E-01	1.38E+00	9.15E+01		9.39E-01	

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SOIL SCREENING AND SOIL SATURATION LIMIT SCREENING MODULE
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ANALYTE	SOURCE ZONE CONCENTRATION Ct (mg/kg)	Tier I SOURCE-SPECIFIC SSL (mg/kg)	Tier I MASS LIMIT SSL (mg/kg)	ANALYTES >=SSL	SOIL SATURATION LIMIT (C _{sat}) ³³ (mg/L)	ANALYTES >=C _{sat}
PCB 1260	3.31E-01	3.95E-04	5.95E-03	PCB 1260	4.47E-01	

SOIL SCREENING LIMITS MODULE
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ANALYTE	SOURCE ZONE CONCENTRATION Ct (mg/kg)	Tier I SOURCE-SPECIFIC SSL (mg/kg)	Tier I MASS LIMIT SSL (mg/kg)	ANALYTES >=SSL (mg/kg)
Aluminum	3.28E+04	4.89E+04	1.52E+04	
Antimony (metallic)	1.94E+01	3.91E+01	4.57E+00	
Arsenic, Inorganic	2.82E+03	6.38E-01	7.62E+00	Arsenic, Inorganic
Barium	1.61E+02	1.34E+02	1.52E+03	
Beryllium and compounds	2.76E+01	5.15E+00	3.05E+00	Beryllium and compounds
Cadmium	1.32E+01	6.12E-01	3.81E+00	Cadmium
Calcium	3.31E+03	NA	NA	NA
Chromium, Total	1.55E+03	2.93E+05	7.62E+01	
Cobalt	4.85E+02	9.93E-02	4.57E+00	Cobalt
Copper, Total	4.17E+03	5.33E+01	9.91E+02	Copper, Total
Iron	1.39E+05	5.02E+03	1.07E+04	Iron
Lead and compounds	3.81E+02	6.60E+00	1.14E+01	Lead and compounds
Magnesium	1.39E+03	NA	NA	NA
Manganese	1.46E+03	3.51E+01	3.28E+02	Manganese
Mercury (elemental)	2.16E+00	1.70E-01	1.52E+00	Mercury (elemental)
Nickel Soluble Salts	3.93E+02	4.14E+01	2.97E+02	Nickel Soluble Salts
Potassium	6.24E+02	NA	NA	NA
Selenium	6.41E+00	4.49E+00	3.81E+01	
Sodium, total recoverable	5.93E+01	NA	NA	NA
Thallium Soluble Salts	2.36E+01	2.32E-01	1.52E+00	Thallium Soluble Salts
Vanadium, total recoverable	1.75E+02	1.40E+02	6.56E+01	Vanadium, total recoverable
Zinc (metallic)	7.61E+03	6.08E+02	4.57E+03	Zinc (metallic)

Attachment E: VZCOMML© Tier II screening (only those retained at Tier I)

RESULTS MODULE FOR SVOCs
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Semi-Volatile Organic Analytes	Retardation ^d R (Unitless)	Mean Travel Time ^e T _{mean} (years)	Groundwater ^f Concentration C _{gw} in Aquifer (µg/L)	2018 Action Level MCL or SL (µg/L)	Analytes Greater Than MCL/SL/MLSSL and Less Than Evaluation Time (T _e)	Tier II ^g SSL _{T1/2} T1/2-SSL (mg/kg)	Tier II ^h MLSSL _{T1/2} T1/2-MLSSL (mg/kg)	Tier I ⁱ Default MLSSL (mg/kg)
Benzo(a)anthracene	2.75E+02	3.35E+04		3.00E-02		Infinite	Infinite	2.29E-02
Benzo(a)pyrene	7.43E+02	9.03E+04		2.00E-01		Infinite	Infinite	1.52E-01
Benzo(b)fluoranthene	9.43E+02	1.15E+05		2.50E-01		Infinite	Infinite	1.91E-01
Benzo(g,h,i)perylene	1.23E+03	1.49E+05		NA		NA	NA	NA
Dibenz(a,h)anthracene	1.37E+03	1.67E+05		2.50E-02		Infinite	Infinite	1.91E-02
Indeno(1,2,3-c,d)pyrene	2.87E+03	3.48E+05		2.90E-02		Infinite	Infinite	2.21E-02

Infinite indicates the analyte concentration has exceeded unity, e.g., >1x10E+9 ug/L, >1,000,000mg/kg, >1x10E+12 pCi/g, etc. Blanks indicate result is zero.
 PARAMETER indicates that a variable within the equation is not available.
 NA = Not Available; Red = MCL; Black = USEPA Regional Screening Table http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

RESULTS MODULE FOR PEST/PCBS
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Pesticide/PCB Organic Analytes	Retardation ^d R (Unitless)	Mean Travel Time ^e T _{mean} (years)	Groundwater ^f Concentration C _{gw} in Aquifer (µg/L)	2018 Action Level MCL or SL (µg/L)	Analytes Greater Than MCL/SL/MLSSL and Less Than Evaluation Time (T _e)	Tier II ^g SSL _{T1/2} T1/2-SSL (mg/kg)	Tier II ^h MLSSL _{T1/2} T1/2-MLSSL (mg/kg)	Tier I ⁱ Default MLSSL (mg/kg)	Tier I ^j Default SSL (mg/kg)
PCB 1260	2.38E+02	2.89E+04	3.14E-02	7.80E-03		8.22E-02	5.95E-03	5.95E-03	3.95E-04

Infinite indicates the analyte concentration has exceeded unity, e.g., >1x10E+9 ug/L, >1,000,000mg/kg, >1x10E+12 pCi/g, etc. Blanks indicate result is zero.
 PARAMETER indicates that a variable within the equation is not available.
 NA = Not Available; Red = MCL; Black = USEPA Regional Screening Table http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

RESULTS MODULE FOR METALS
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Metallic Inorganic Analytes	Retardation ⁴¹ R (Unitless)	Mean Travel Time ⁴² T _{Mean} (years)	Groundwater ⁴¹ Concentration C _{gw} in Aquifer (µg/L)	2018 Action Level MCL or SL (µg/L)	Analytes Greater Than MCL/SL/MLSSL and Less Than Evaluation Time (T _e)	Tier II ²⁹ SSL _{T1,2} SSL (mg/kg)	Tier I ²⁰ Default MLSSL (mg/kg)	Tier I ²³ Default SSL (mg/kg)
Arsenic, Inorganic	3.00E+02	3.64E+04	3.81E+02	1.00E+01		7.40E+01	7.62E+00	6.38E-01
Beryllium and compounds	6.05E+03	7.36E+05	1.85E-01	4.00E+00		5.97E+02	3.05E+00	5.15E+00
Cadmium	5.75E+02	6.99E+04	9.29E-01	5.00E+00		7.10E+01	3.81E+00	6.12E-01
Cobalt	7.76E+01	9.43E+03	2.53E+02	6.00E+00		1.15E+01	4.57E+00	9.93E-02
Copper, Total	1.92E+02	2.34E+04	8.77E+02	1.30E+03		6.18E+03	9.91E+02	5.33E+01
Iron	1.69E+03	2.05E+05	3.34E+03	1.40E+04		5.83E+05	1.07E+04	5.02E+03
Lead and compounds	2.07E+03	2.51E+05	7.46E+00	1.50E+01		7.66E+02	1.14E+01	6.60E+00
Manganese	3.84E+02	4.67E+04	1.54E+02	4.30E+02		4.08E+03	3.28E+02	3.51E+01
Mercury (elemental)	3.99E+02	4.85E+04	2.19E-01	2.00E+00		1.97E+01	1.52E+00	1.70E-01
Nickel Soluble Salts	4.99E+02	6.06E+04	3.19E+01	3.90E+02		4.80E+03	2.97E+02	4.14E+01
Thallium Soluble Salts	5.45E+02	6.62E+04	1.75E+00	2.00E+00		2.69E+01	1.52E+00	2.32E-01
Vanadium, total recoverable	7.66E+03	9.31E+05	9.26E-01	8.60E+01		1.63E+04	6.56E+01	1.40E+02
Zinc (metallic)	4.76E+02	5.78E+04	6.48E+02	6.00E+03		7.05E+04	4.57E+03	6.08E+02

Infinite indicates the analyte concentration has exceeded unity, e.g., >1x10E+9 µg/L, >1,000,000mg/kg, >1x10E+12 pCi/g, etc. Blanks indicate result is zero.

PARAMETER indicates that a variable within the equation is not available.

NA = Not Available; Red = MCL; Black = USEPA Regional Screening Table http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

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