FluxTracer® Results: Darcy Velocity, Mass Flux, and Contaminant Concentrations

February 15, 2015

TO: Lori Riker
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FROM: Joshua Moreno, REGENESIS
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RE: Flux Tracer Results for Lori, Harrison Place Site

Scope of Work

FluxTracer® testing was conducted to assess groundwater velocity and contaminant mass flux within existing monitoring wells to aid in site characterization and remedial designs. REGENESIS received 2 set of 10' passive flux meter device from Roux Environmental Engineering and performed FluxTracer analysis to determine Darcy flux, mass flux, and flux derived contaminant concentration. The quantitative FluxTracer test measures the amount of alcohol tracers that desorbed from the activated carbon due to groundwater passively flowing through the cylinder cannisters. Concurrently, contaminants present in the plume will adsorb to the activated carbon during the deployed period after which will be extracted from the activated carbon to quantify mass flux and flux derived contaminant concentration.

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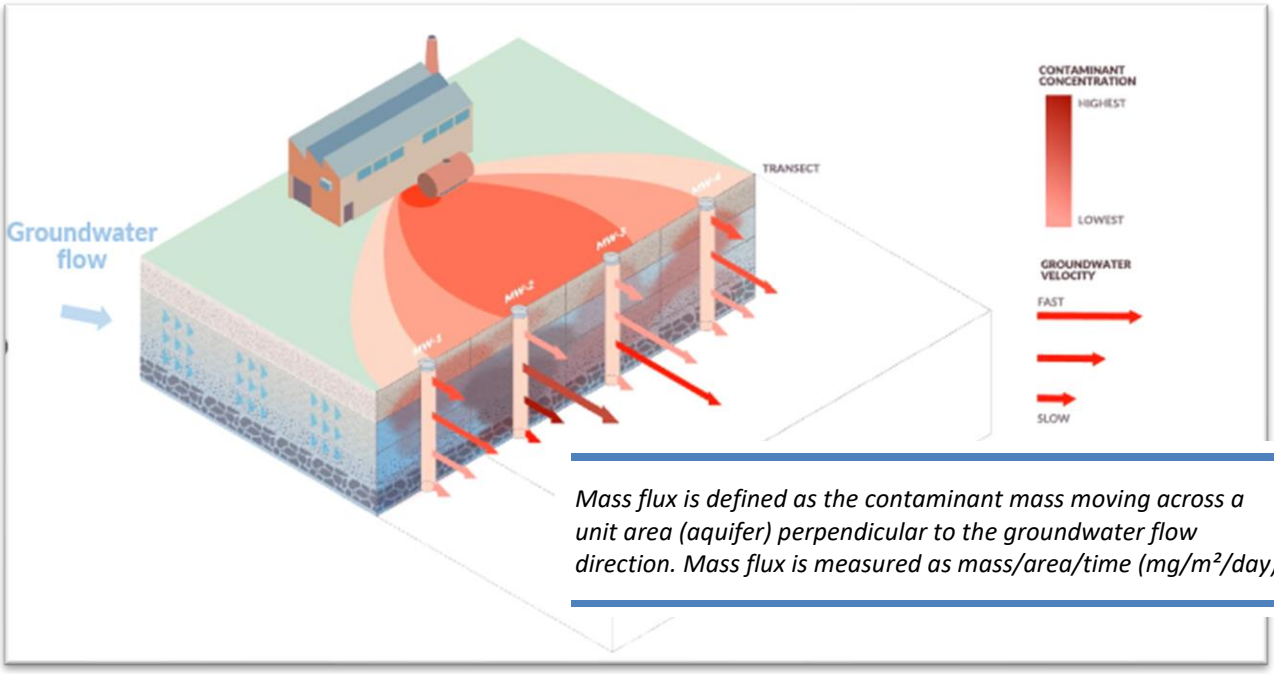
What is Mass Flux?



Mass flux is defined as the contaminant mass moving across a unit area (aquifer) perpendicular to the groundwater flow direction. Mass flux is measured as mass/area/time (mg/m²/day).

Conceptual site modeling overlaying hydraulic conductivity, groundwater velocity, and contaminant concentrations.

Mass flux refers to the movement of contaminant mass from one location to another, measured in units of mass per unit of time and area. Contaminant mass flux data is used in environmental remediation to identify the pathways through which contaminants are moving through the aquifer. This can involve the use of monitoring wells and various technologies to collect data on the flow of water and contaminants through the soil and rock formations. This information can help determine the locations of plumes and the direction of contaminant movement which is important for identifying the sources of contamination and designing remediation strategies.

Contaminant mass flux data can also be used to assess the potential risks to human and ecosystem health. By understanding the rate at which contaminants are moving through the groundwater and the concentrations at which they are present, it is possible to evaluate the potential impacts of environmental hazards on human and ecological receptors. Mass flux data can be used to prioritize remediation efforts and to develop risk management plans. For example, the use of permeable reactive barriers or in-situ bioremediation techniques may be more effective in certain locations based on contaminant mass flux data (ITRC, 2010). Contaminant mass flux data is an important tool in environmental remediation as it helps to understand and predict the movement of contaminants in the environment, assess potential risks to humans and ecosystems, and design effective remediation strategies.

ITRC. (2010). Use and Measurement of Mass Flux and Mass Discharge. www.itrcweb.org.

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Results

Table 1. SOB-1 Darcy velocity and mass flux data

Sample No.	Depth below top of well casing (ft)	Darcy velocity (cm/day)	PCE ($mg/m^2/day$)	TCE ($mg/m^2/day$)	cDCE ($mg/m^2/day$)
1	9.2	<2.0	<1	9	5
2	10.2	<2.0	<1	15	5
3	11.2	<2.0	<1	8	2
4	12.2	<2.0	<1	8	4
5	13.2	2.8	<1	18	8
6	14.2	<2.0	<1	12	3
7	15.2	<2.0	<1	9	4
8	16.2	<2.0	<1	8	4
9	17.2	<2.0	<1	9	3
10	18.2	2.1	<1	16	10

Table 2. SOB-1 Flux-derived concentration

Sample No.	Depth Below Casing (ft)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)
1	9.2	N/A	N/A	N/A
2	10.2	N/A	N/A	N/A
3	11.2	N/A	N/A	N/A
4	12.2	N/A	N/A	N/A
5	13.2	N/A	640	290
6	14.2	N/A	N/A	N/A
7	15.2	N/A	N/A	N/A
8	16.2	N/A	N/A	N/A
9	17.2	N/A	N/A	N/A
10	18.2	N/A	760	480

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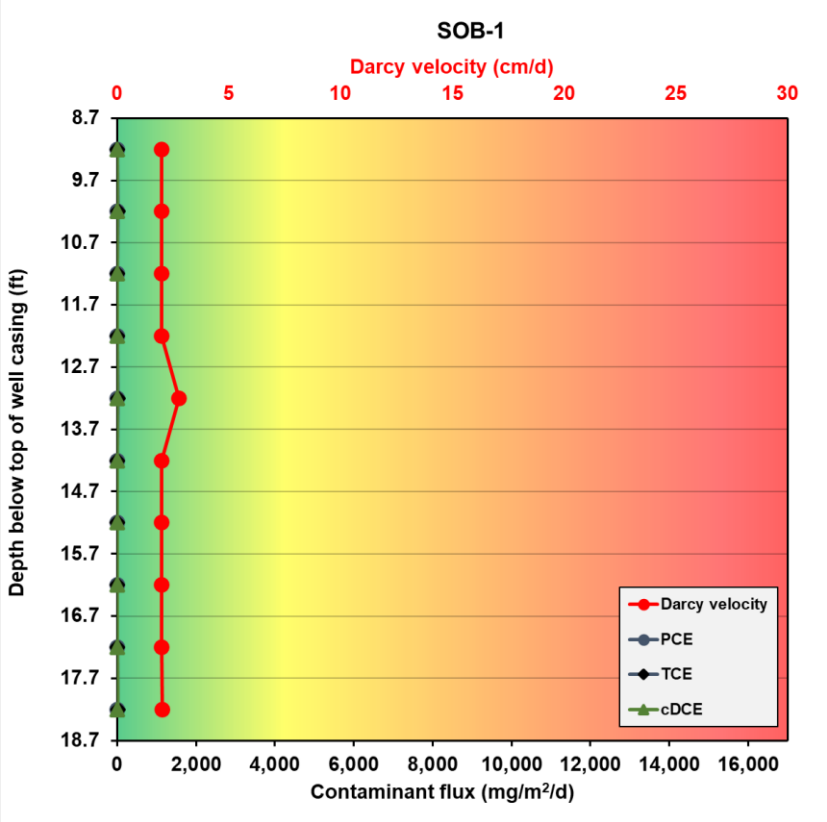

Figure 1. SOB-1 Contaminant flux (mg/m^2/d), Darcy velocity (cm/d), and depth below casing.

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Table 2. SOB-5 Darcy velocity and mass flux data

Sample No.	Depth below top of well casing (ft)	Darcy velocity (cm/day)	PCE ($mg/m^2/day$)	TCE ($mg/m^2/day$)	cDCE ($mg/m^2/day$)
1	16.7	2.2	<1	410.0	6.0
2	17.7	2.7	<1	4,200.0	57.0
3	18.7	4.2	3.0	15,000.0	260.0
4	19.7	4.4	3.0	13,000.0	240.0
5	20.7	4.3	3.0	8,900.0	73.0
6	21.7	5.4	2.0	7,500.0	47.0
7	22.7	10.0	<1	1,200.0	27.0
8	23.7	7.8	2.0	3,400.0	35.0
9	24.7	11.1	14.0	17,000.0	77.0
10	25.7	8.9	11.0	14,000.0	260.0

Table 3. SOB-5 Flux-derived concentration.

Sample No.	Depth Below Casing (ft)	PCE (µg/L)	TCE (µg/L)	cDCE (µg/L)
1	16.7	N/A	18,640	270
2	17.7	N/A	155,560	2,110
3	18.7	70	357,140	6,190
4	19.7	70	295,450	5,450
5	20.7	70	206,980	1,700
6	21.7	40	138,890	870
7	22.7	N/A	12,000	270
8	23.7	30	43,590	450
9	24.7	130	153,150	690
10	25.7	120	157,300	2,920

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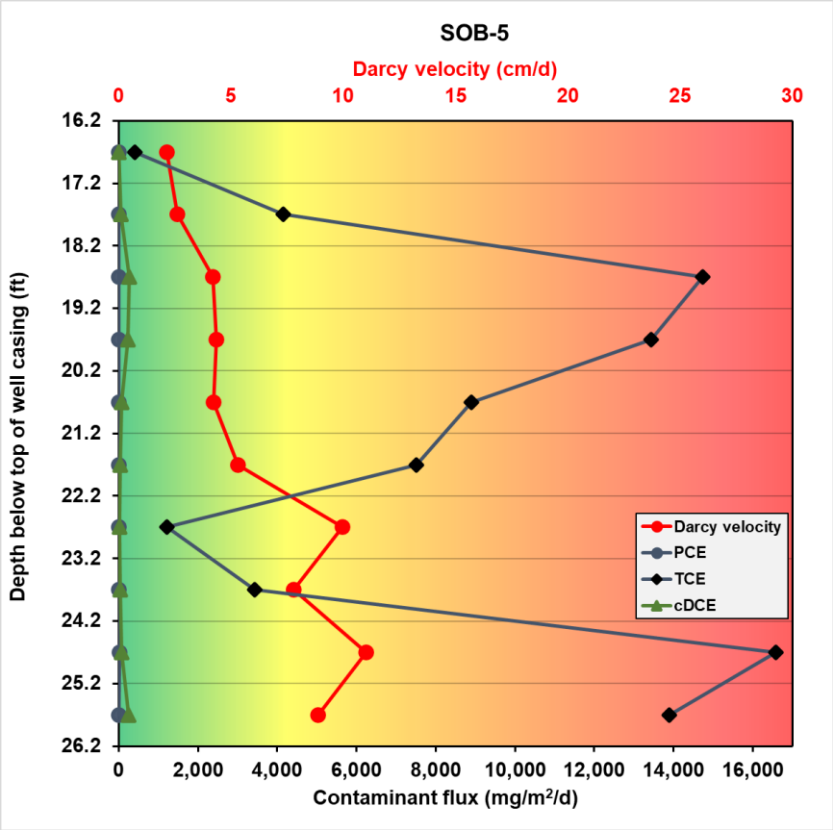

Figure 2. SOB-5 Contaminant flux (mg/m^2/d), Darcy velocity (cm/d), and depth below casing.

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Interpretation of Results:

The FluxTracer test provides contaminant flux and Darcy velocity at 1-foot intervals. Contaminant flux and Darcy velocity are then used to derive contaminant mass at 1-foot intervals.

Under these test conditions, the Darcy velocity and contaminant flux for the groundwater plume can be interpreted as follows:

Indicator	Qualitative Interpretation	Darcy Velocity (cm/day)	*Seepage Rate (ft/yr)	Contaminant Flux ($mg/m^2/day$)
Green to Yellow	Low	<2 - 5	<96 - 240	<10 - 300
Yellow to Orange	Medium	5 - 15	240 - 719	300 - 800
Orange to Red	High	15- >30	719 - 1437	800 - >2000

*Seepage rate assumes a 0.25 porosity

Flux derived concentration is derived using the following equation:

$$GW\ concentration\ (\mu g/L) = \frac{Mass\ flux\ (\mu g/m^2/d)}{Darcy(cm/d) * 10}$$

A non-applicable (N/A) is applied to the intervals where either the Darcy velocity, contaminant of concern, or both is less than the reporting limit.

A value of ND <X indicates that the analyte of concern is NOT detected above the method detection limit (MDL) or the method reporting limit (MRL).

A J-value indicates that the analyte of concern was detected and that the analyte concentration is an estimated value which is between the method detection limit (MDL) and the method reporting limit (MRL).

Description of Experimental Methods

A batch reactor is filled with 10 grams of sample from each 1-foot interval and is extracted for alcohol tracers followed by extraction of chlorinated volatile organic solvents (CVOCs) using of isobutanol and acetone-hexane, respectively. Batch reactors are then placed on a shaker for 24 hours. A 1 ml extract from each batch reactor is transferred to a liquid gas chromatography vial and each sample is analyzed by a GC-FID for alcohol tracers and GC-MS for CVOCs. Quantitation procedures of Darcy and mass flux can be found in, https://pubs.acs.org/doi/10.1021/es050074g.

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