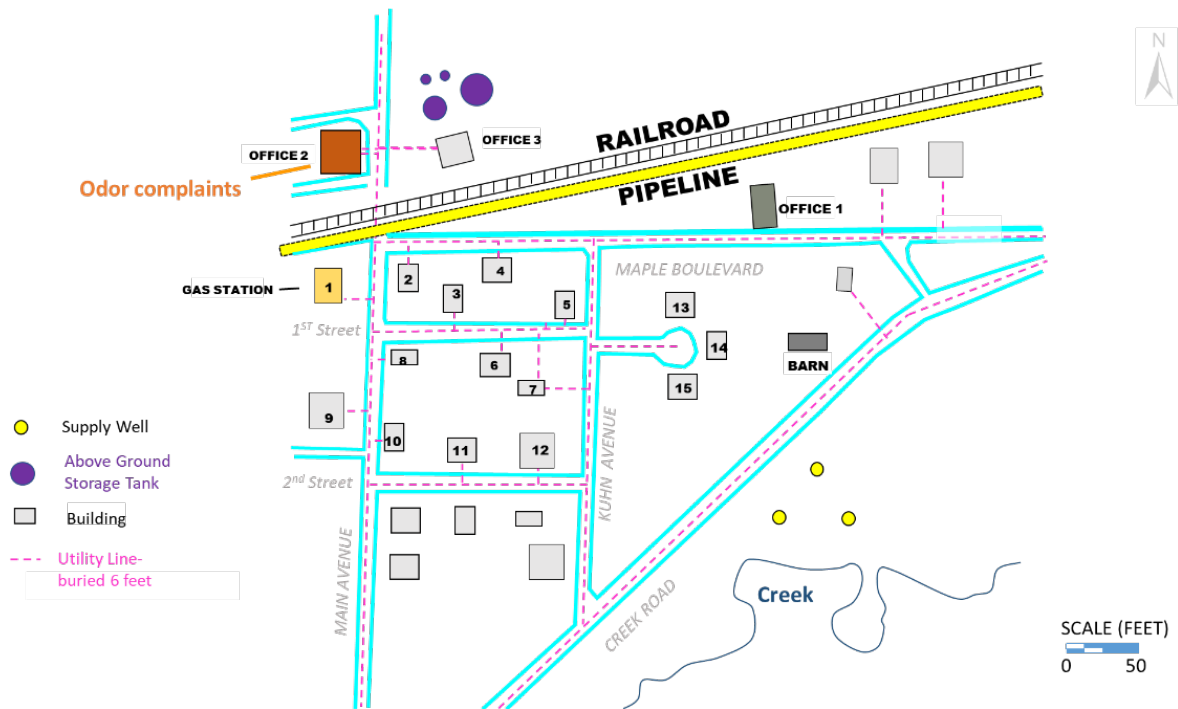
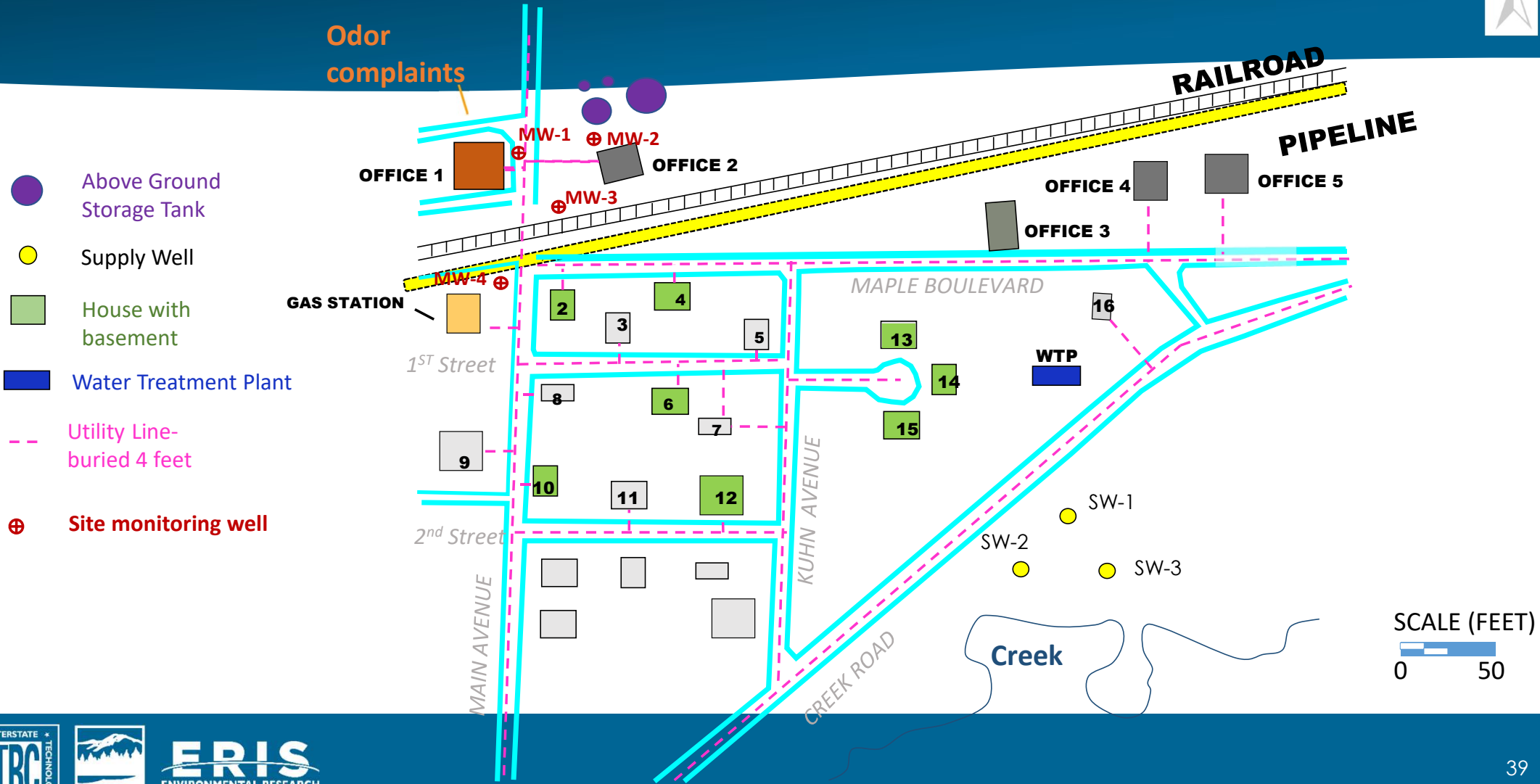




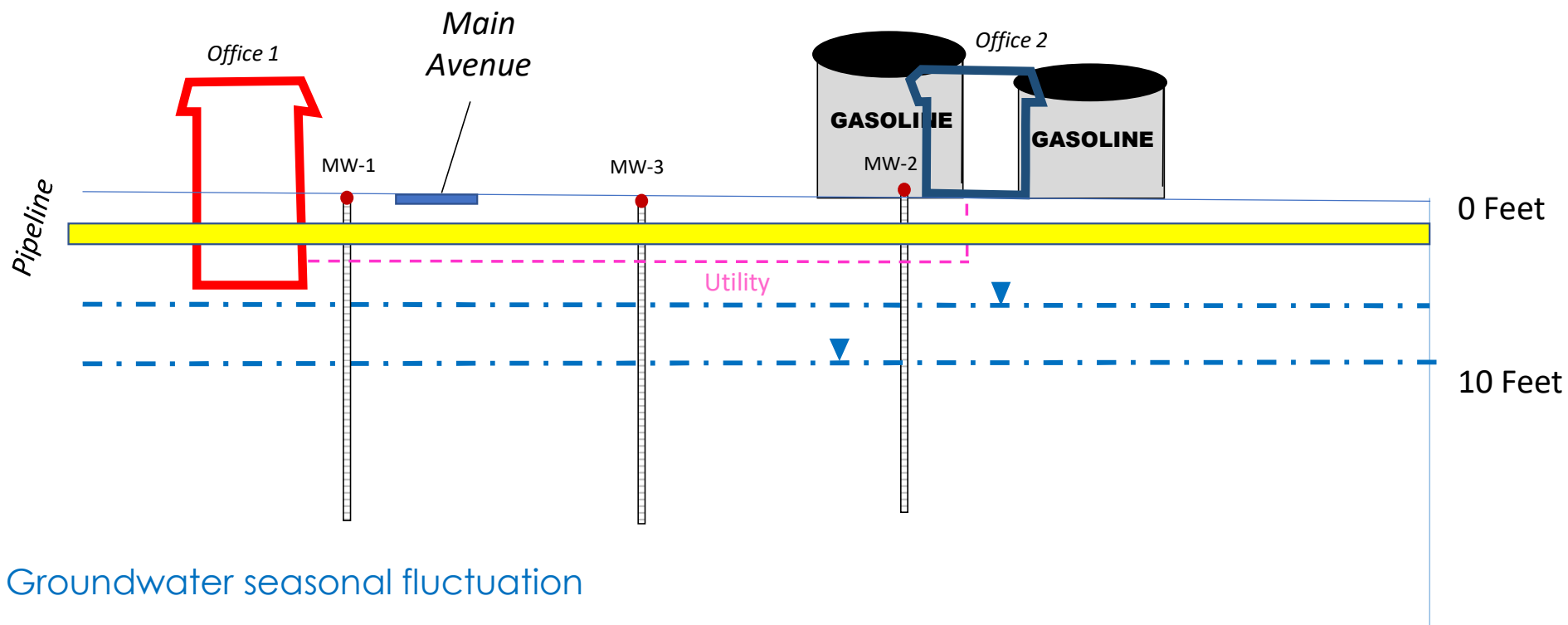
Glacial Fluvial Gasoline Scenario

Small town with mixed residential and commercial properties. Area is bounded by wet, low-lying areas and a creek to the south that runs from east to southwest. A railroad and a refined diesel pipeline run parallel through the site east-west. The town's municipal well field is in the south. Geology is a meandering stream within a terraced floodplain that contains fluvial-glacial sediments deposited over glacial till. Groundwater is unconfined 6 to 10 feet bgs with seasonal fluctuation and with general south-southeast flow towards the stream. An office has odor complaints with indoor air sampling indicating petroleum vapor intrusion problems. Potential sources in the area are a bulk fuel facility with above ground storage tanks, a diesel pipeline, and a gas station. Potential impacts include vapor intrusion, soil, and groundwater contamination.

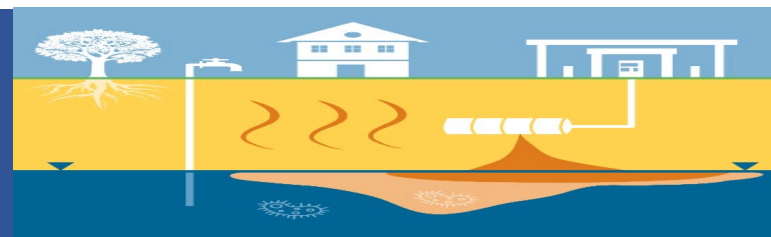




Cross Section View



Scenario Screening Levels (for exercise purposes only)



Contaminant	Resident Soil (mg/kg)	Industrial Soil (mg/kg)	Resident Air (ug/m ³)	Resident Soil Vapor (ug/m ³)	Industrial Soil Vapor (ug/m ³)	Groundwater (ug/L)	C _{sat} (mg/kg)
<i>Volatile Organic Compounds:</i>							
Benzene	1.2	5.1	0.36	12	1.8	5	1,820
Toluene	4,900	47,000	5,200	173,000	2,200	1,000	818
Ethylbenzene	5.8	25	1.1	37	5.5	700	480
Xylenes	580	2,500	100	3,300	44	10,000	260
<i>Lead scavengers:</i>							
Dibromoethane, 1,2- (EDB)	0.04	0.16	0.005	0.16	0.022	0.05	1,340
Dichloroethane, 1,2- (DCA)	0.46	2	0.11	3.7	0.520	5	2,980
<i>Polynuclear Aromatic Hydrocarbons:</i>							
Naphthalene	2	8.6	0.08	2.8	0.4	0.12	NA
<i>Total Petroleum Hydrocarbons:</i>							
TPH-GRO (C6-C12)	1,600	3,900	210	290	NA	100	7,000
TPH-DRO (>C12-C28)	2,399	12,000	210	290	NA	100	7,000
TPH-ORO (>C28-C35)	2,300	12,000	210	290	NA	100	7,000
Total Petroleum Hydrocarbons (Aliphatic Low)	520	2,200	630	21,000	2,600	1300	141
Total Petroleum Hydrocarbons (Aliphatic Medium)	96	440	100	3,300	440	100	6.86
Total Petroleum Hydrocarbons (Aliphatic High)	230,000	3,500,000	NA	NA	NA	60,000	0.34
Total Petroleum Hydrocarbons (Aromatic Low)	82	420	31	1,000	130	33	1,820
Total Petroleum Hydrocarbons (Aromatic Medium)	97	560	3.1	100	13	6	NA
Total Petroleum Hydrocarbons (Aromatic High)	2,400	30,000	NA	NA	NA	800	NA

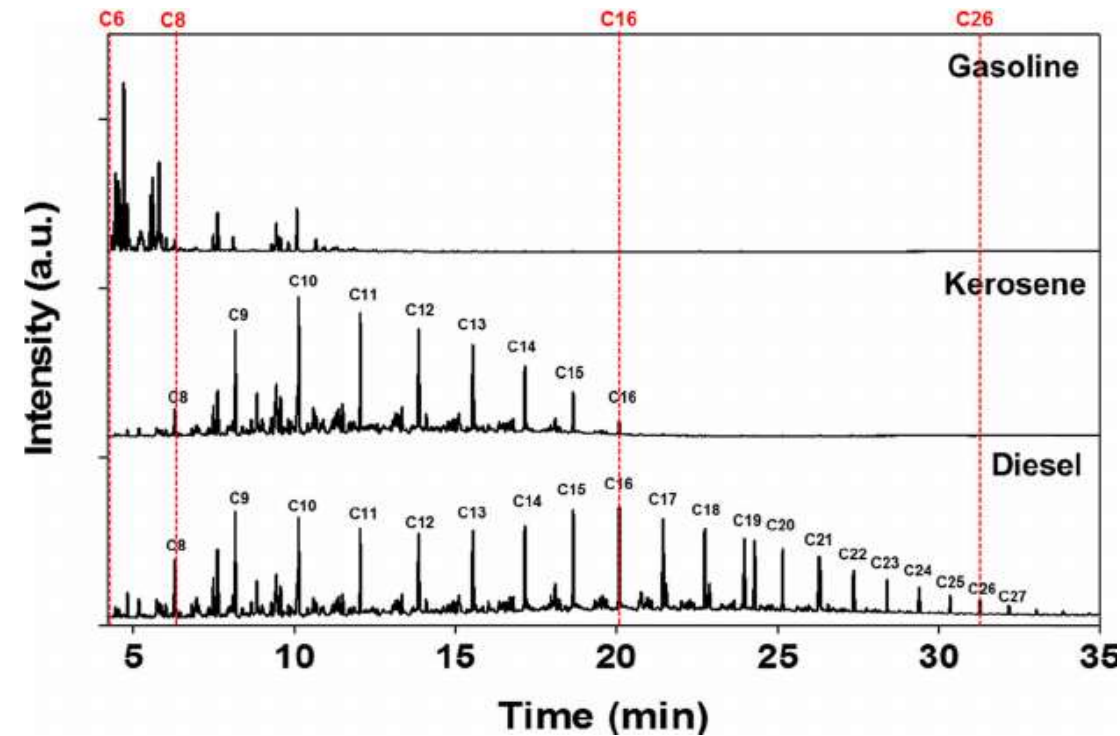
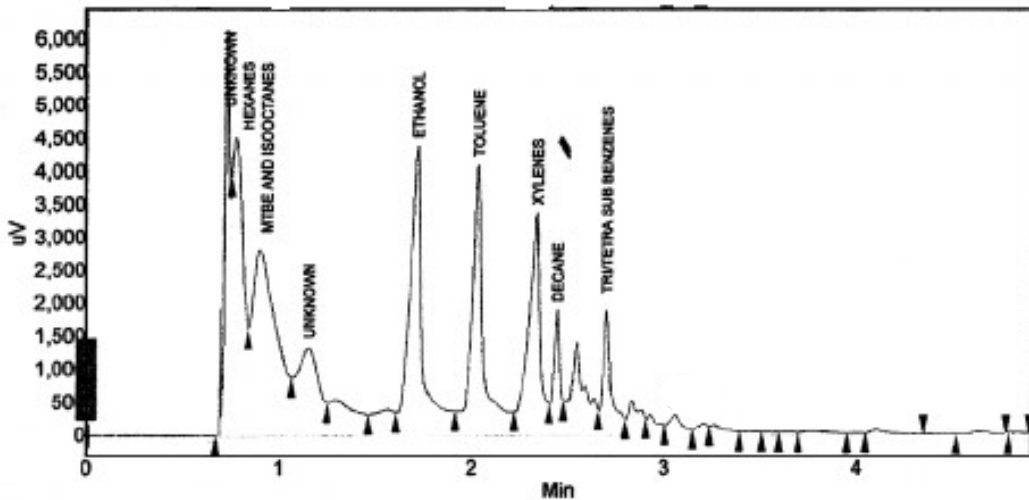
mg/kg = milligram per kilogram
 ug/L = microgram per liter

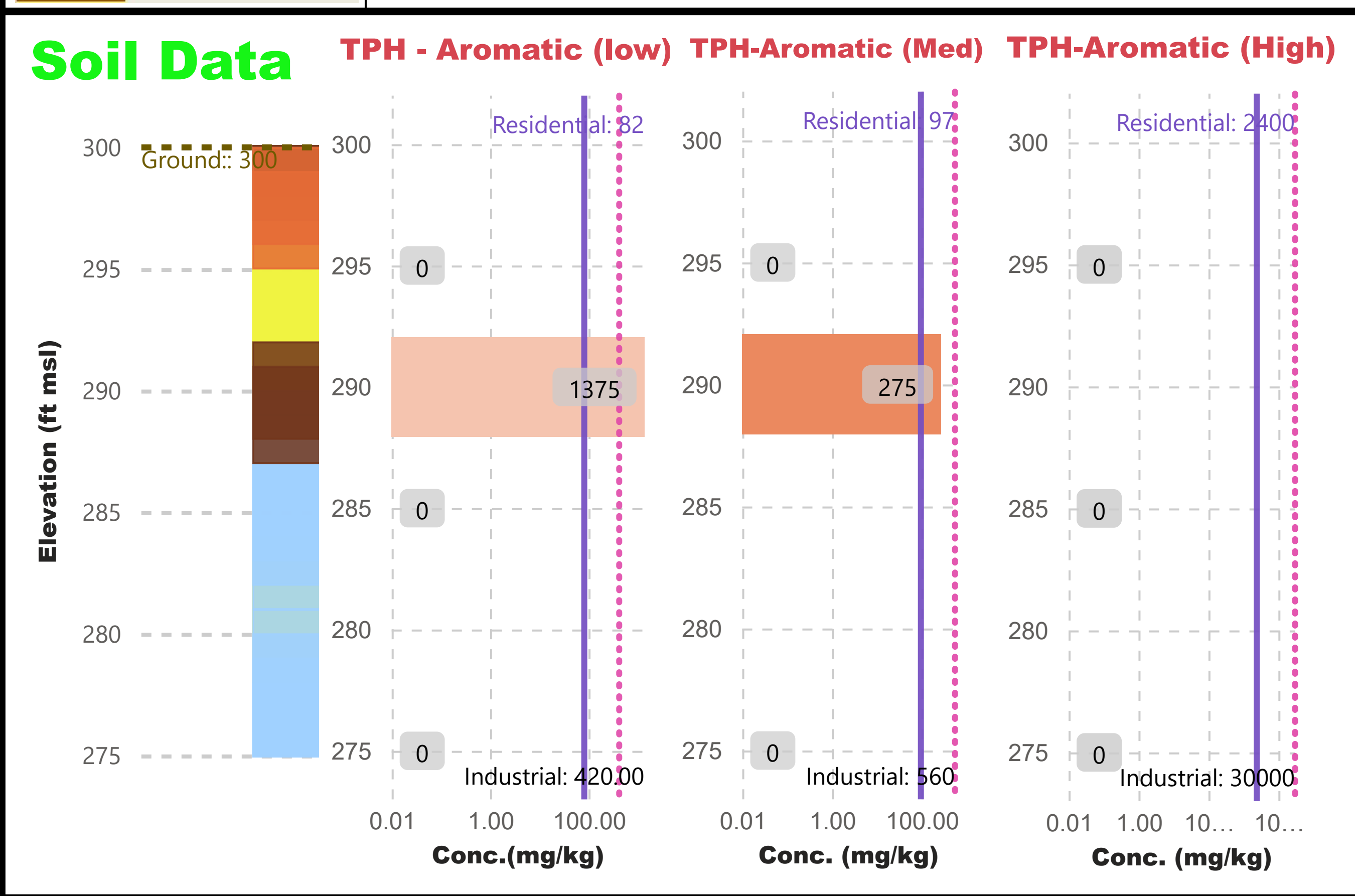
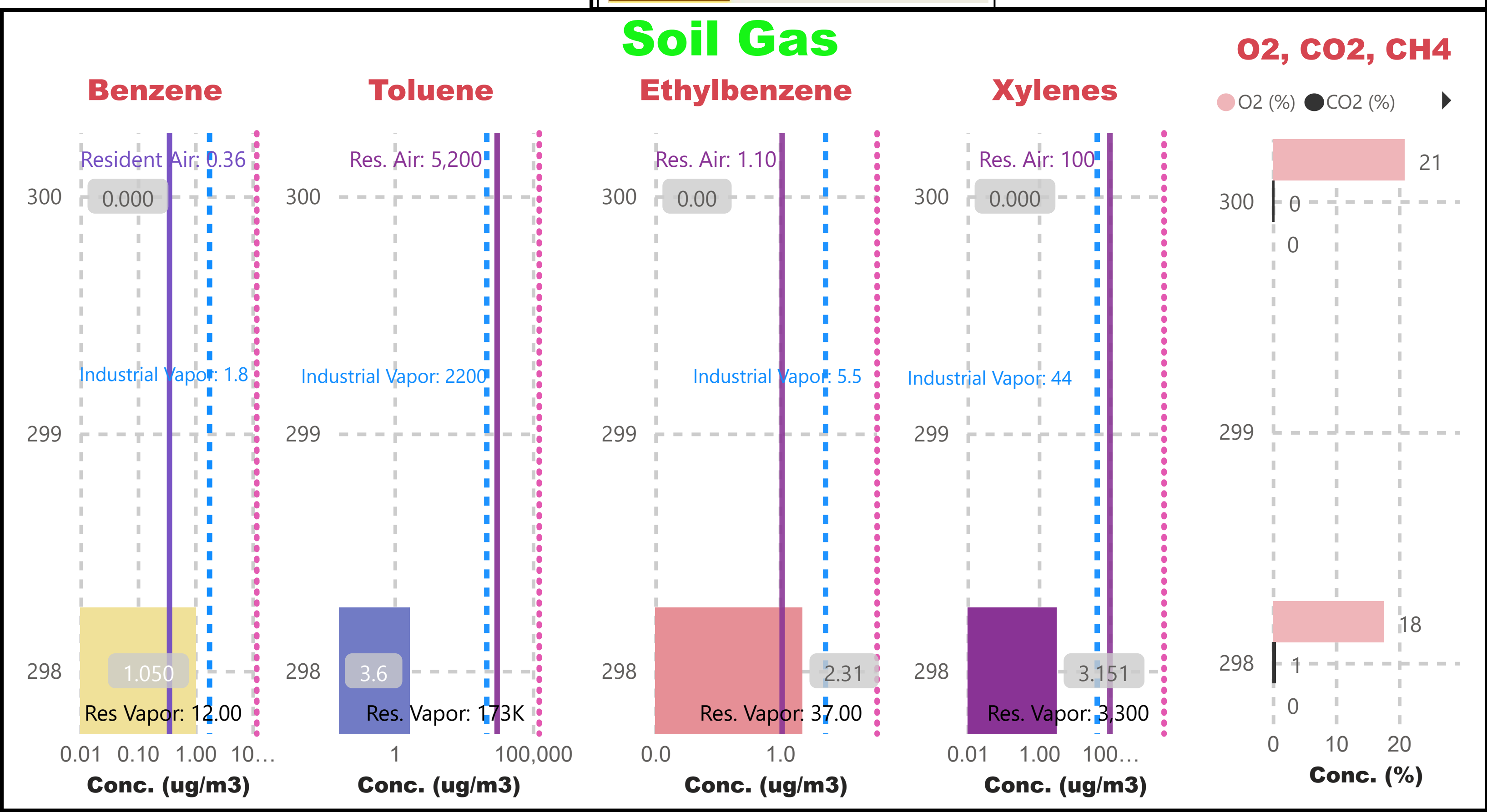
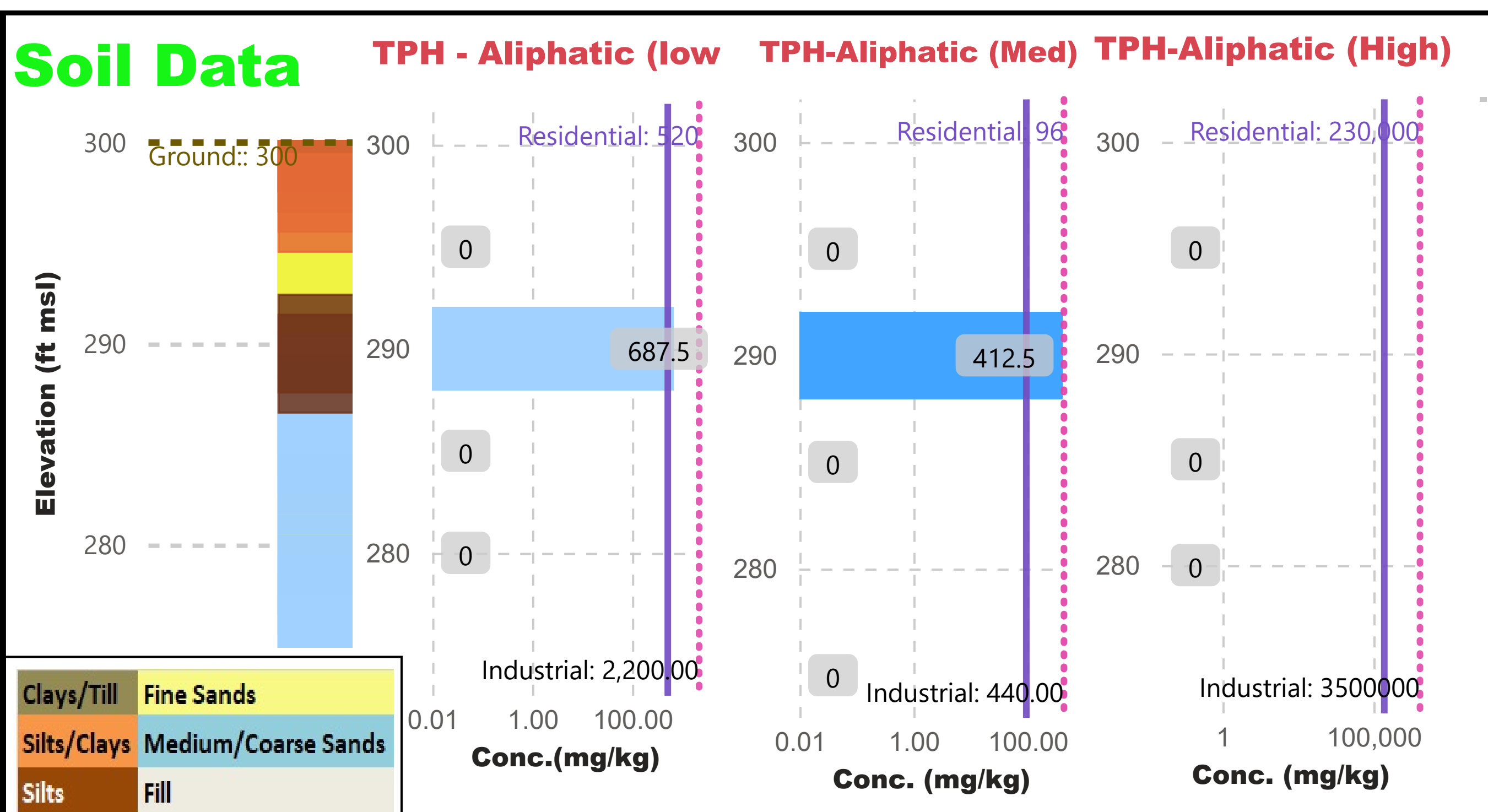
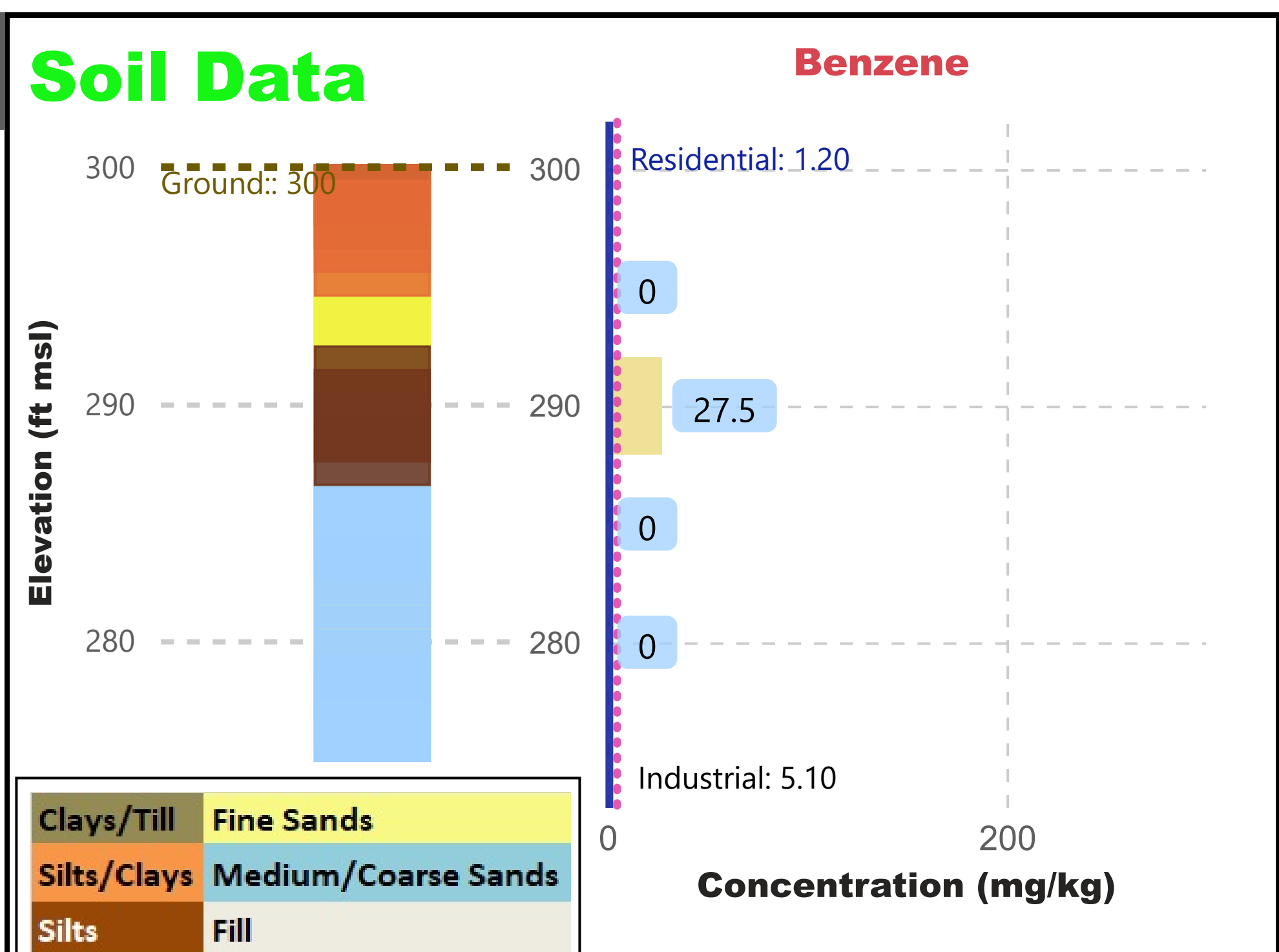
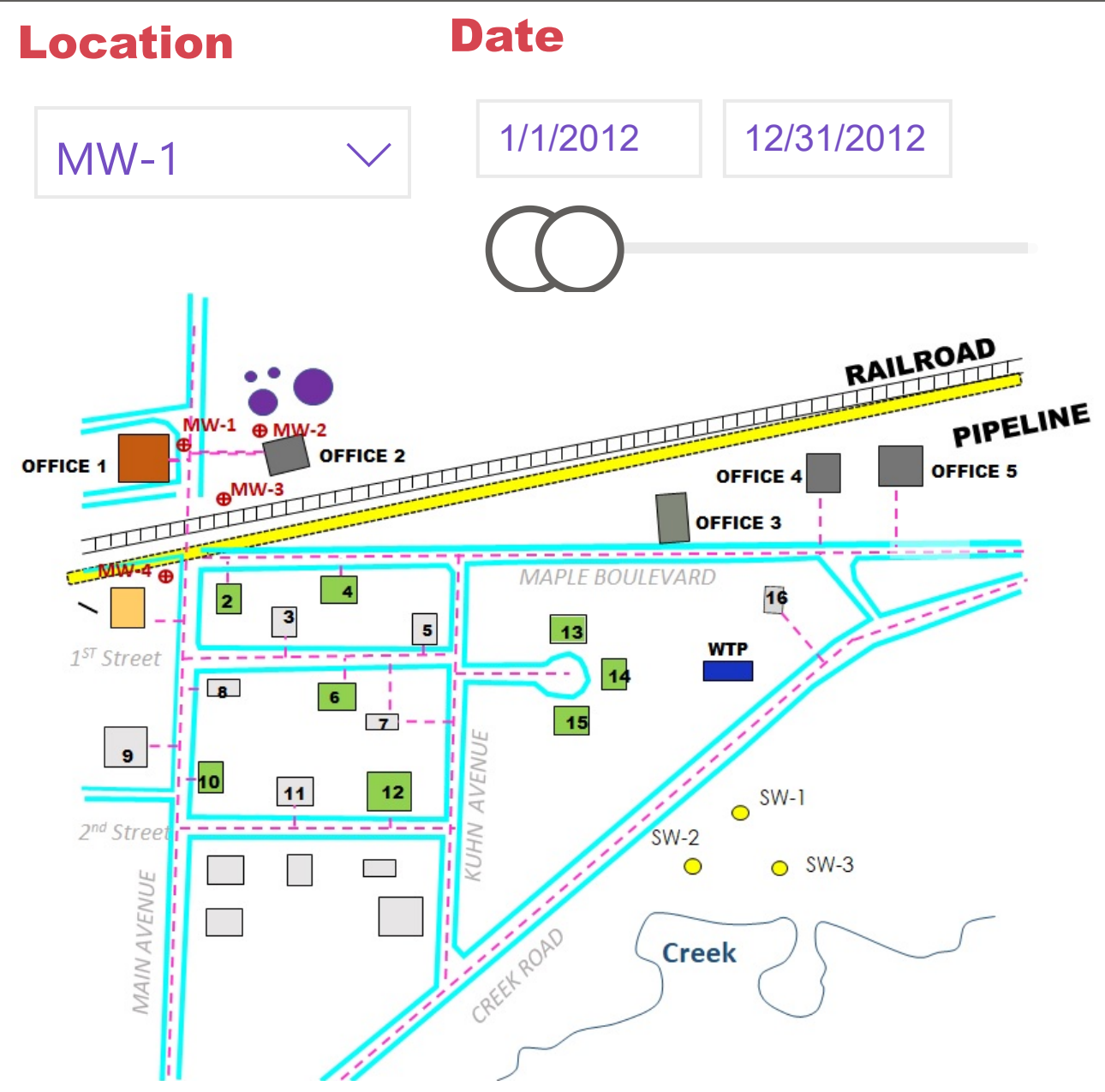
ug/m³ = microgram per cubic meter
 NA = value not available

C_{sat} = soil saturation limit

Gas Chromatography Mass Spec (GCMS) Soil Analysis from MW-2

Example Ranges of Common Hydrocarbons





MW-1 Soil and Soil Gas Summary

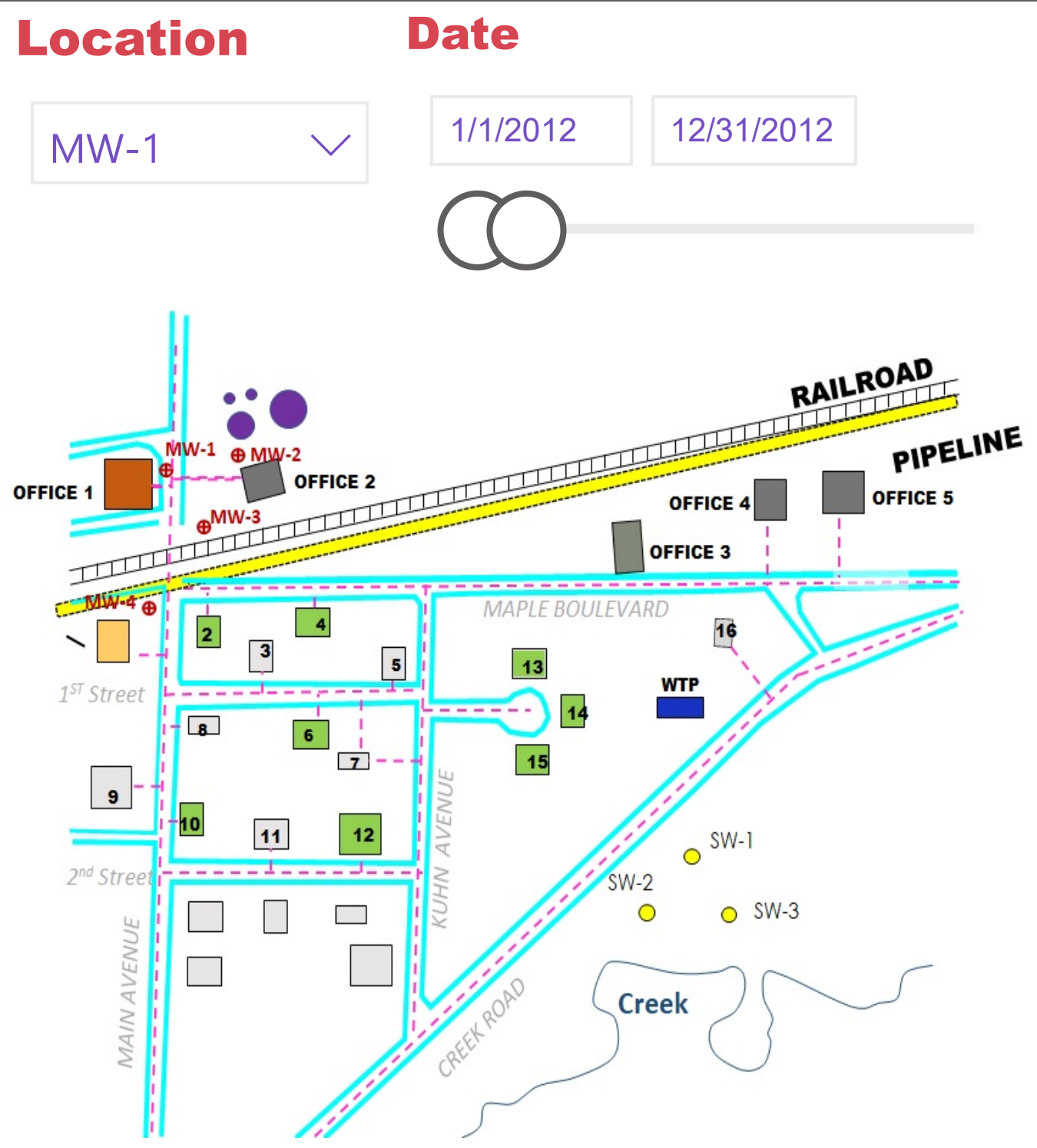
Clays/Till	Fine Sands
Silts/Clays	Medium/Coarse Sands
Silts	Fill

EC5-6	EC6-8	EC9-12	EC12-16	EC16-21	EC21-35
EC7	EC8	EC9-12	EC12-16	EC16-21	EC21-35
EC10-12	EC10-12	EC10-12	EC12-16	EC16-21	EC21-35

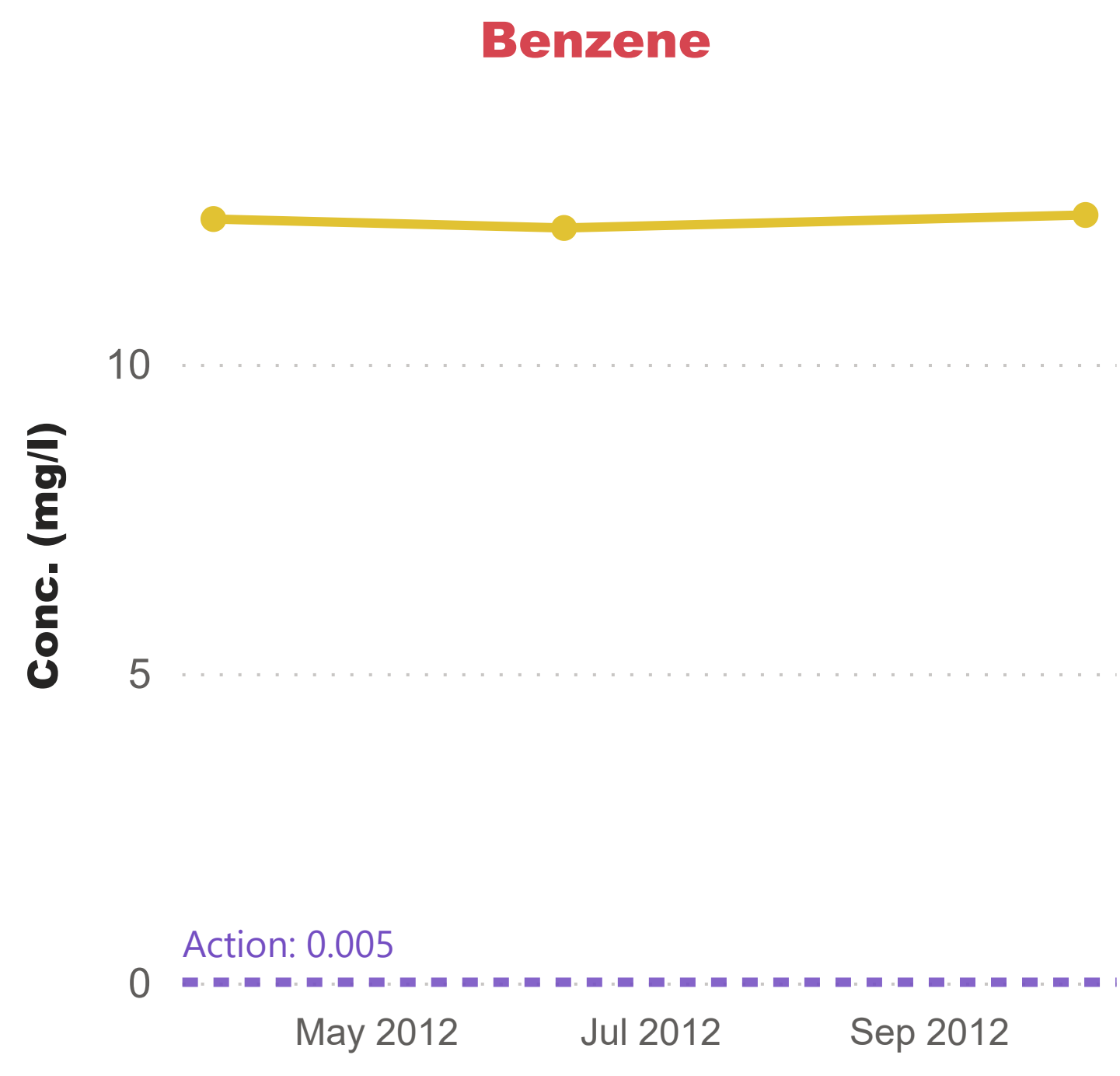
TPH Criteria Working Group 13 Transport Fractions

EC5-8	EC8-16	EC16-35
Low	Medium	High
EC6-9	EC9-22	EC22-35
Low	Medium	High

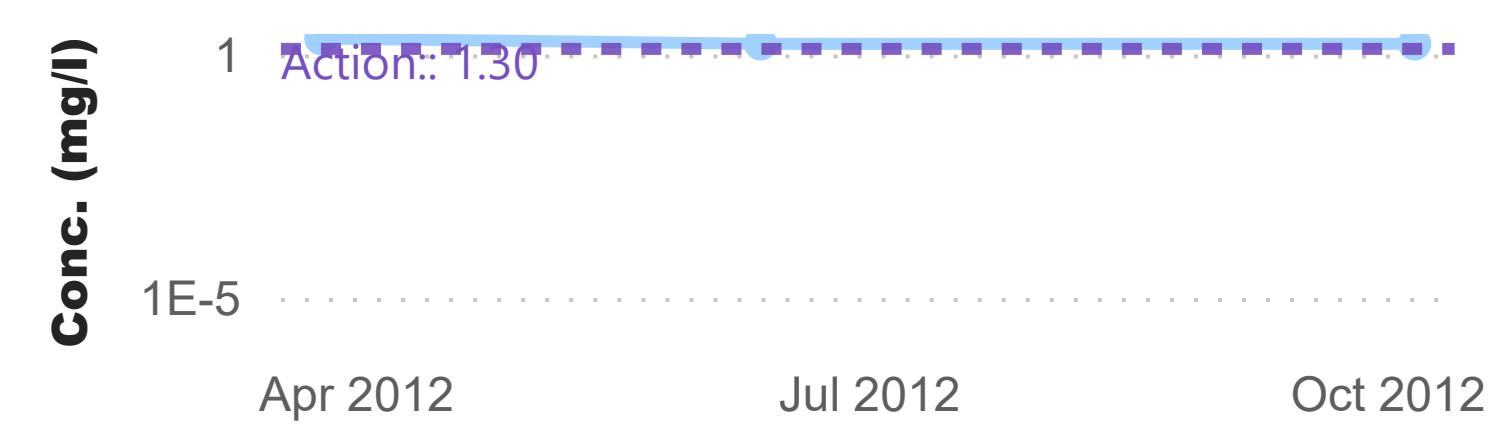
EPA 6 Toxicity Fractions



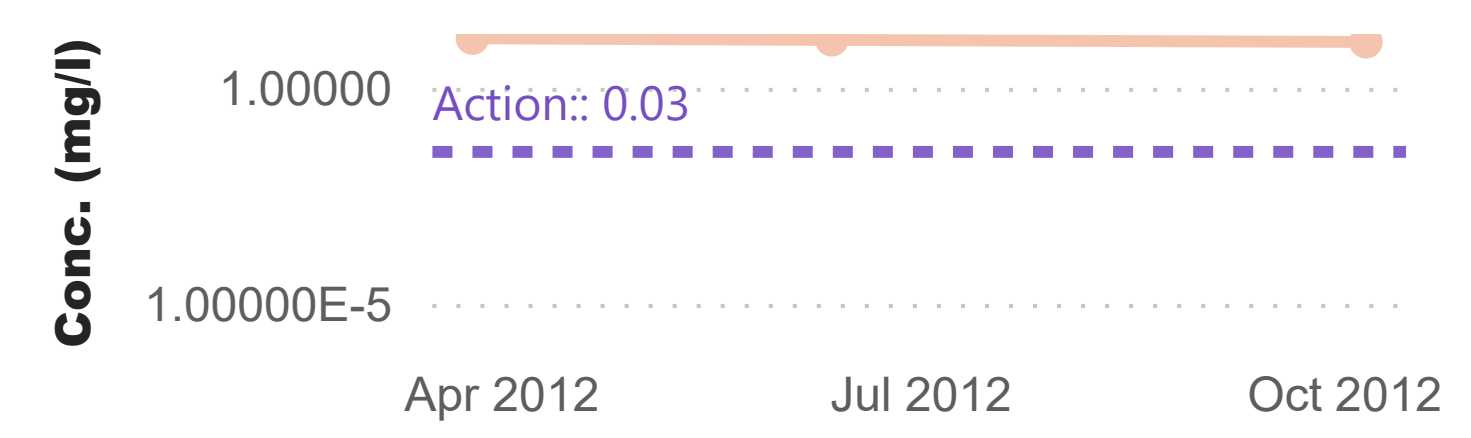
Dissolved Phase



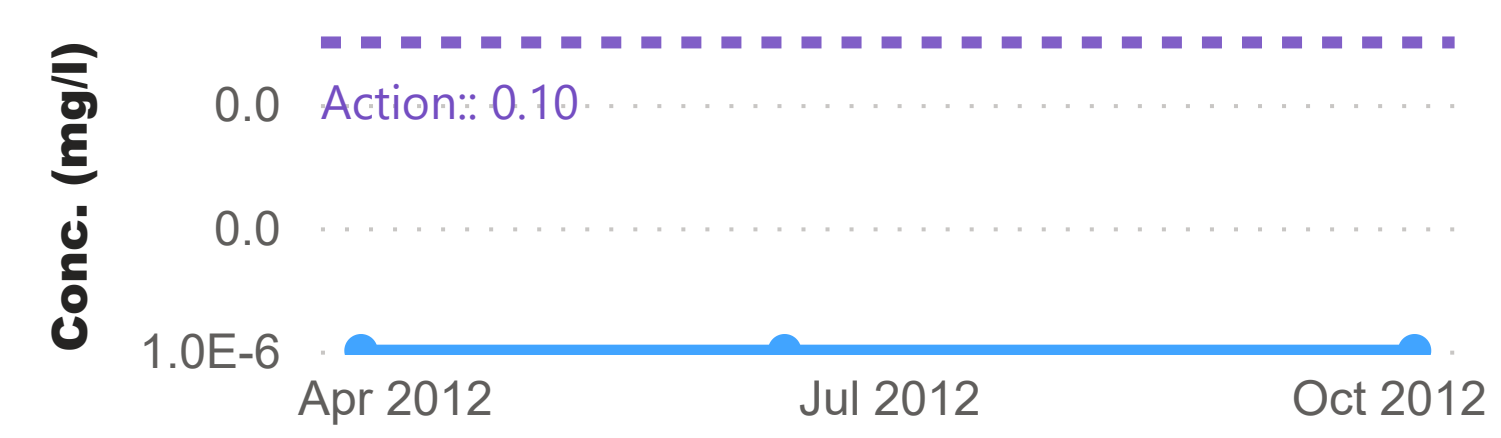
TPH-Aliphatic (Low)



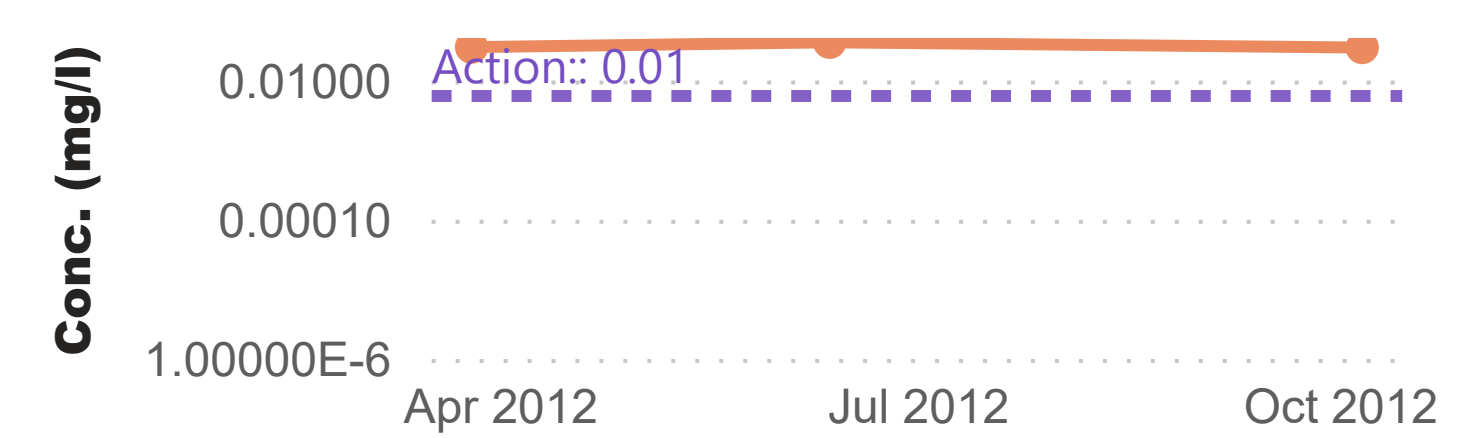
TPH-Aromatic (Low)



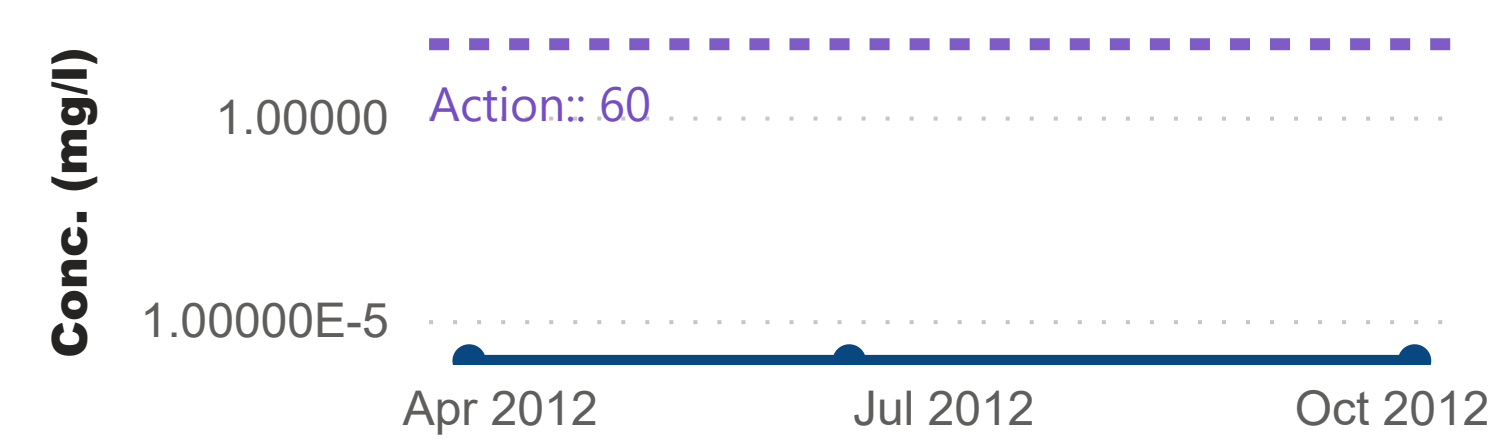
TPH-Aliphatic (Medium)



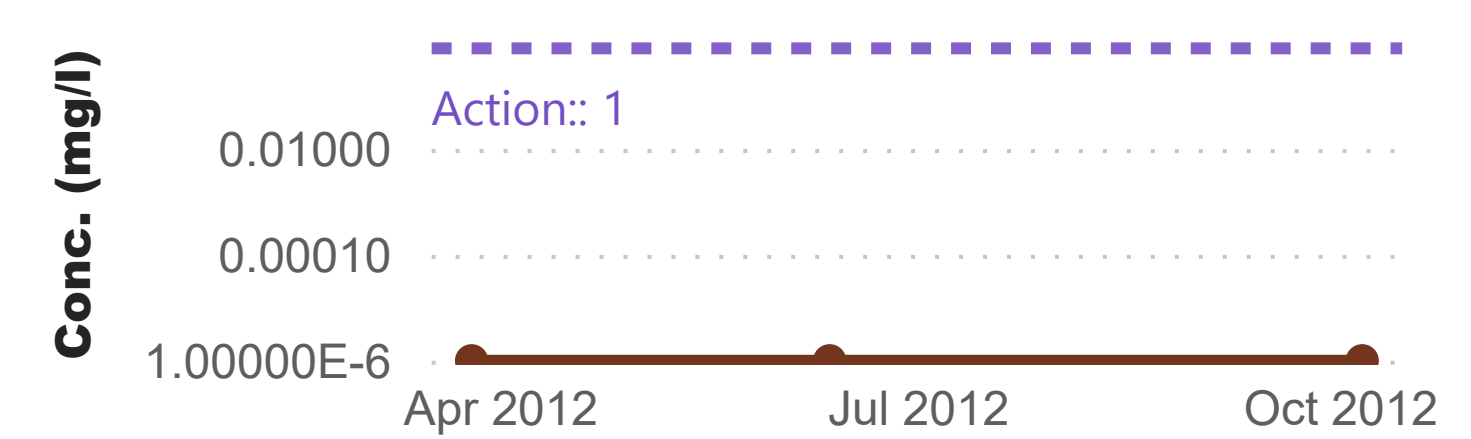
TPH-Aromatic (Medium)



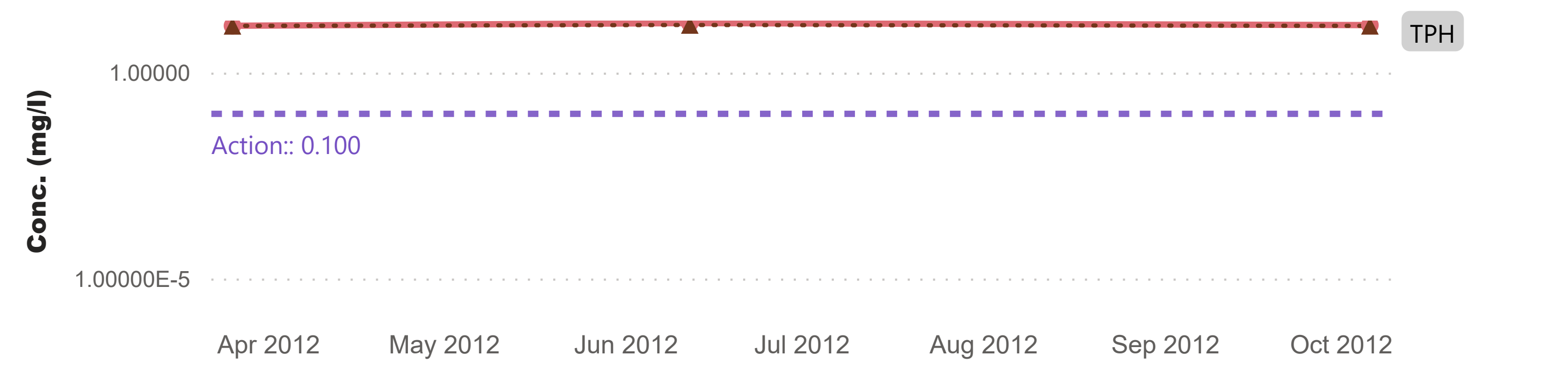
TPH-Aliphatic (High)



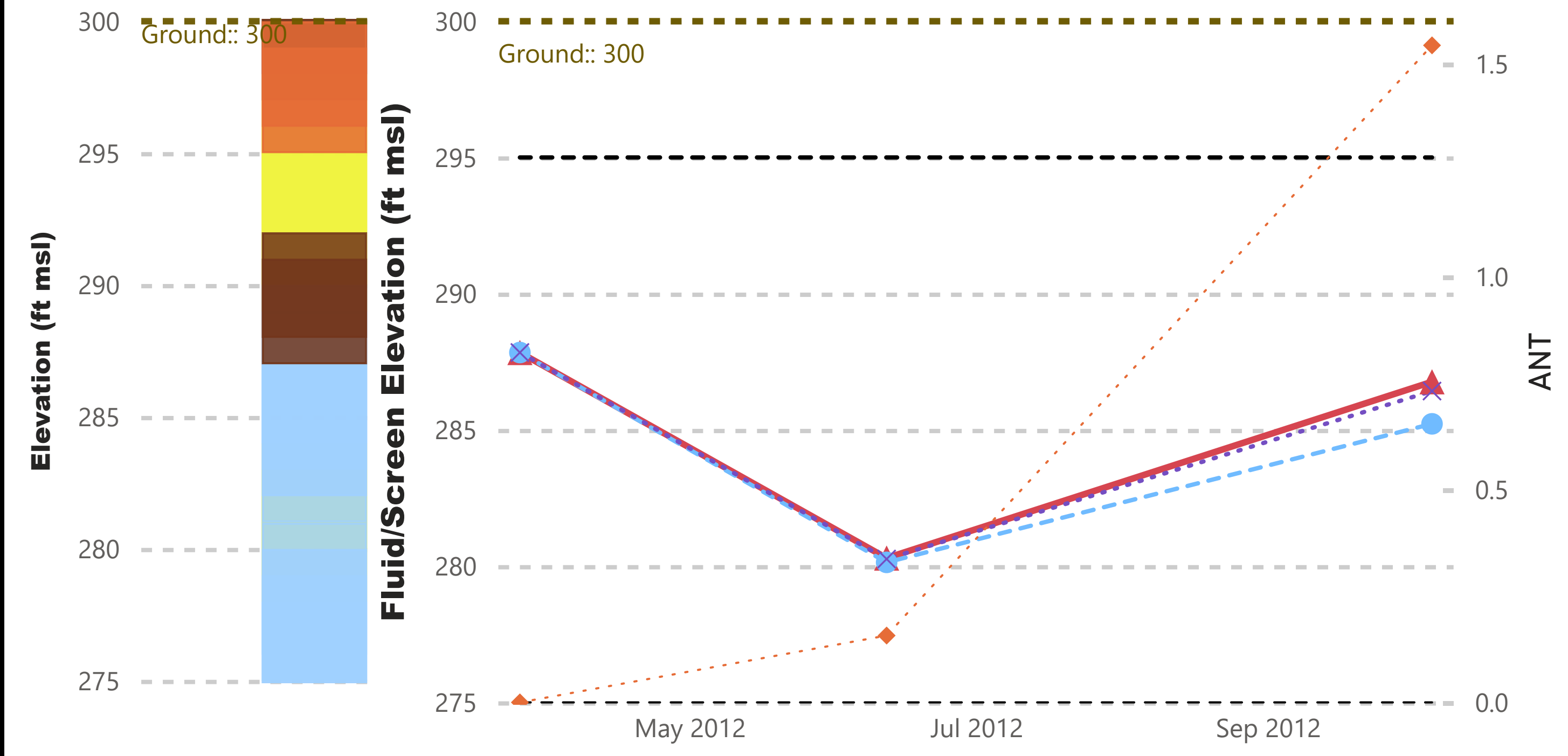
TPH-Aromatic (High)



TPH (with/without Silica Gel Cleanup)



Hydrograph



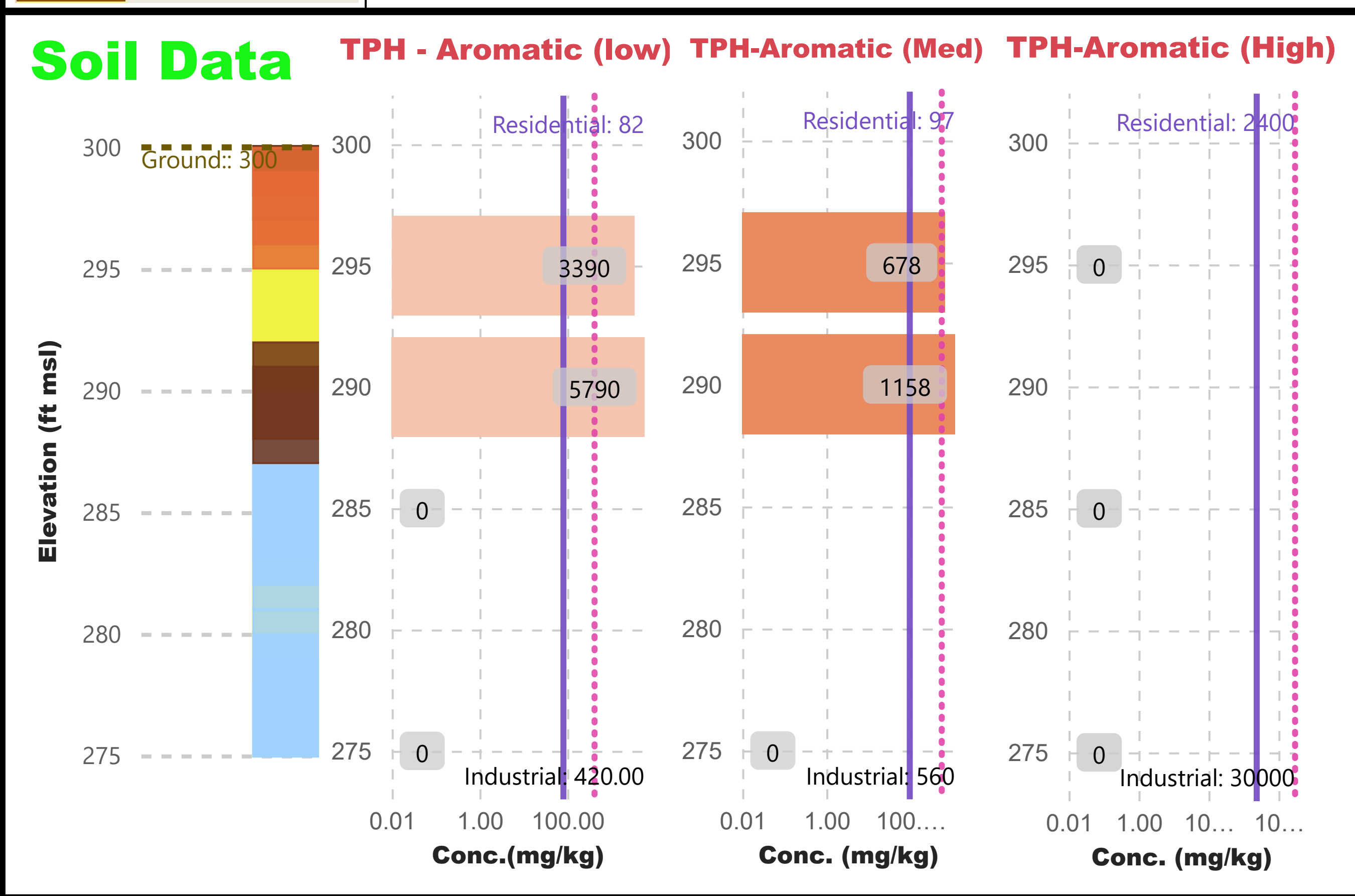
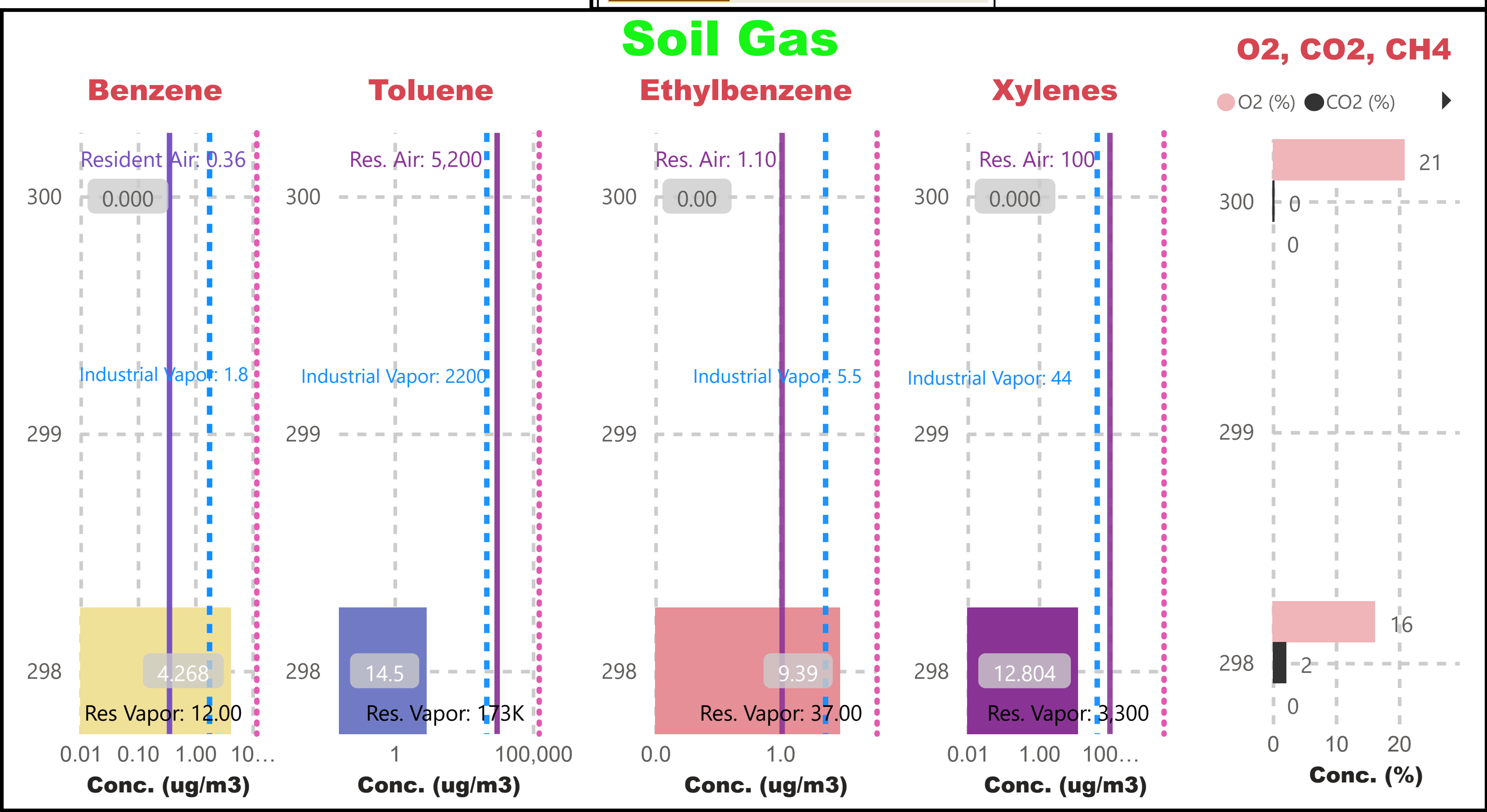
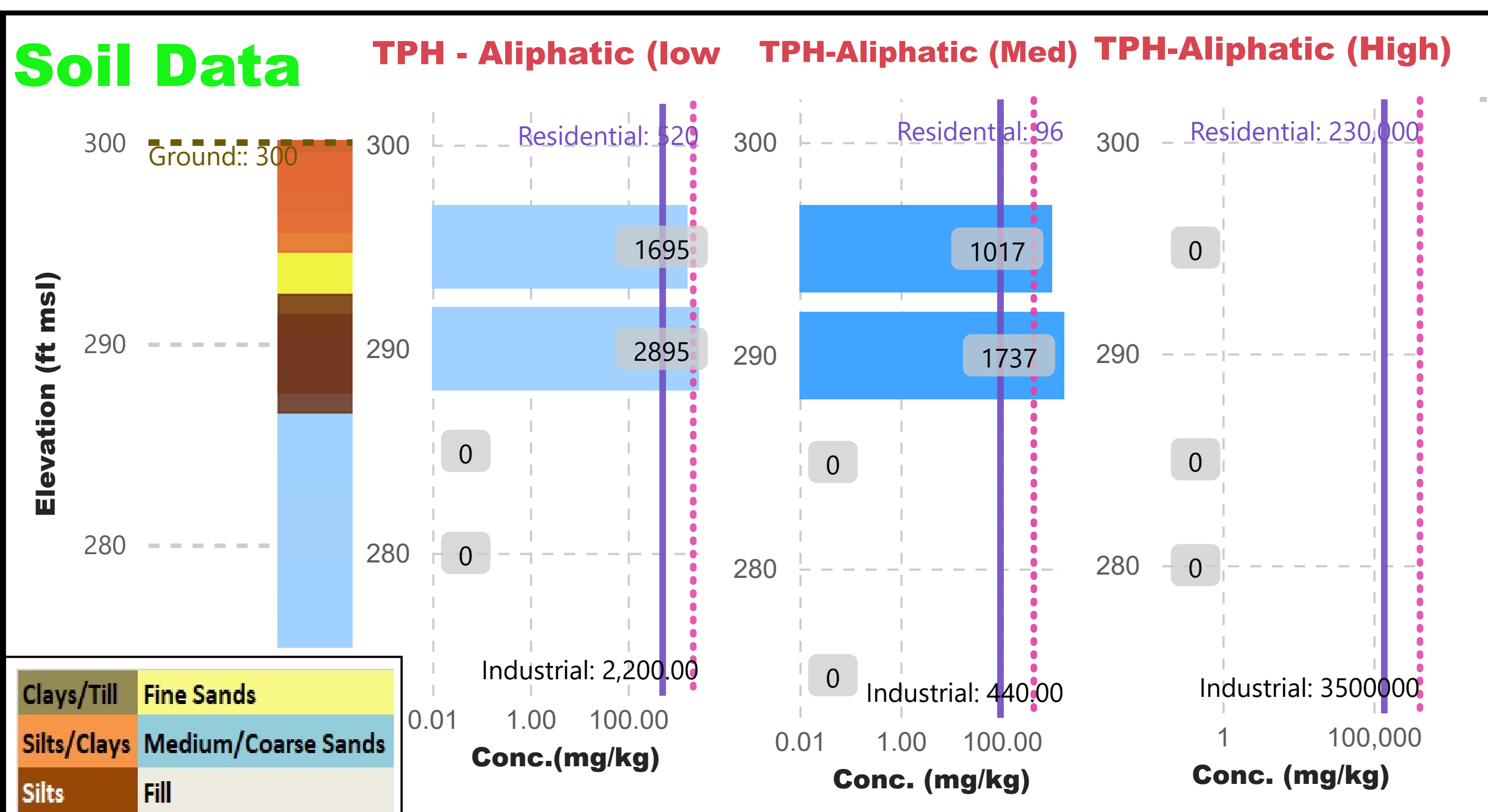
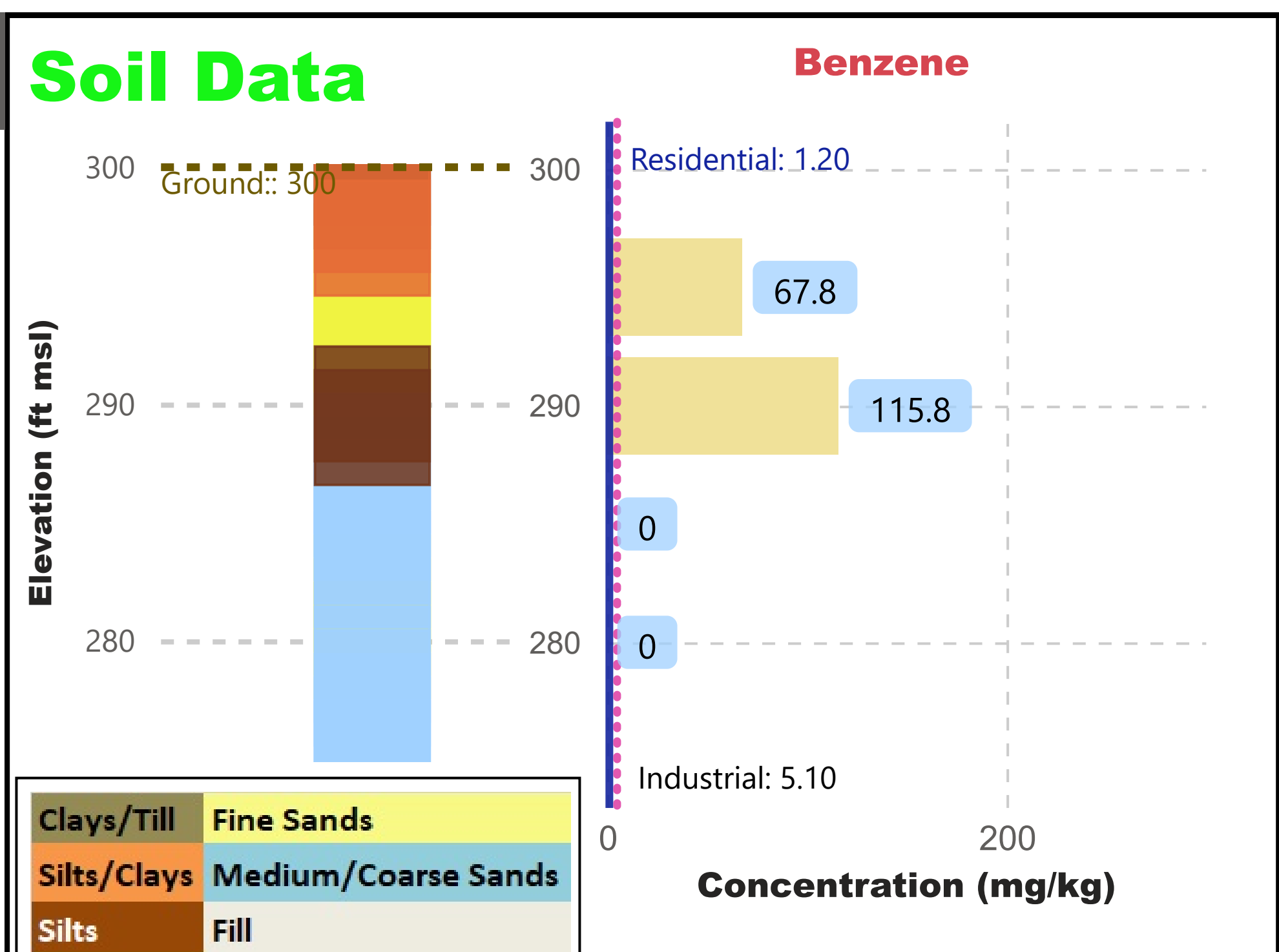
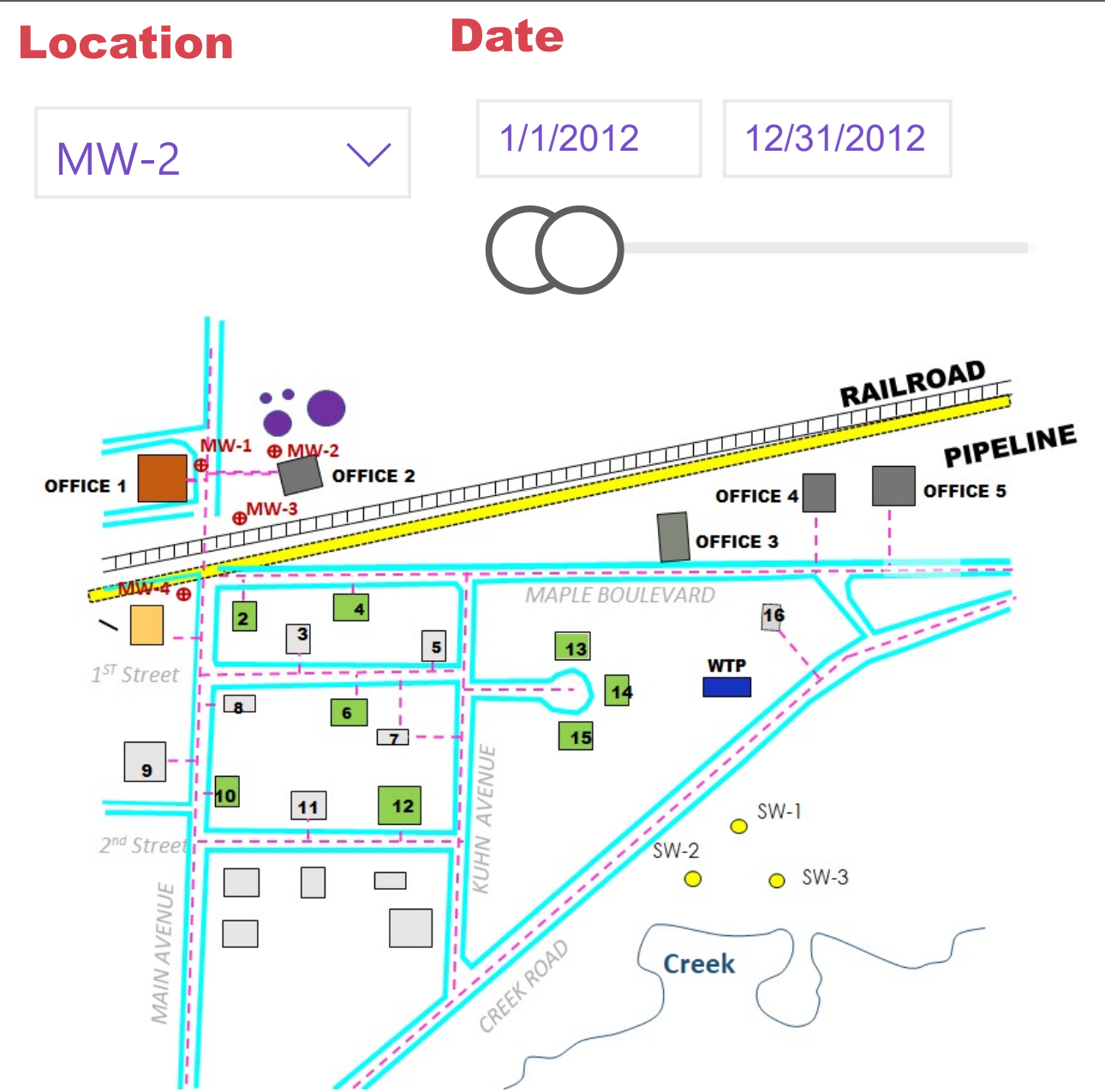
The Silica Gel Cleanup for TPH is a method used by the laboratory to "clean up" the sample extract before it is analyzed for TPH so that the extract contains primarily hydrocarbons (non-polar) compared to non-hydrocarbons like metabolites, natural organic matter, chlorinated solvents etc.

Molecular Structure	Aliphatic	Aromatic	Working Group	13 Transport Fractions	EPA 6 Toxicity Fractions
Aliphatic	EC5-6	EC7-10	Low	EC5-6	Low
Aliphatic	EC8-10	EC11-12	Medium	EC8-9	Medium
Aliphatic	EC12-16	EC16-21	High	EC12-16	High
Aliphatic	EC21-35	(same properties as EC16-21) -- not considered a transport fraction--	High	EC21-35	High

Increasing Equivalent Carbon (EC) Number →

Clays/Till	Fine Sands	--- Screen	TOS/BOS	X Corrected Groundwater Surface CGWS
Silts/Clays	Medium/Coarse Sands	▲ Air/NAPL Interface	ANI	◆ Apparent NAPL Thickness ANT
Silts	Fill	● NAPL/Water Interface	NWI	

MW-1 Hydrograph & Dissolved Summary

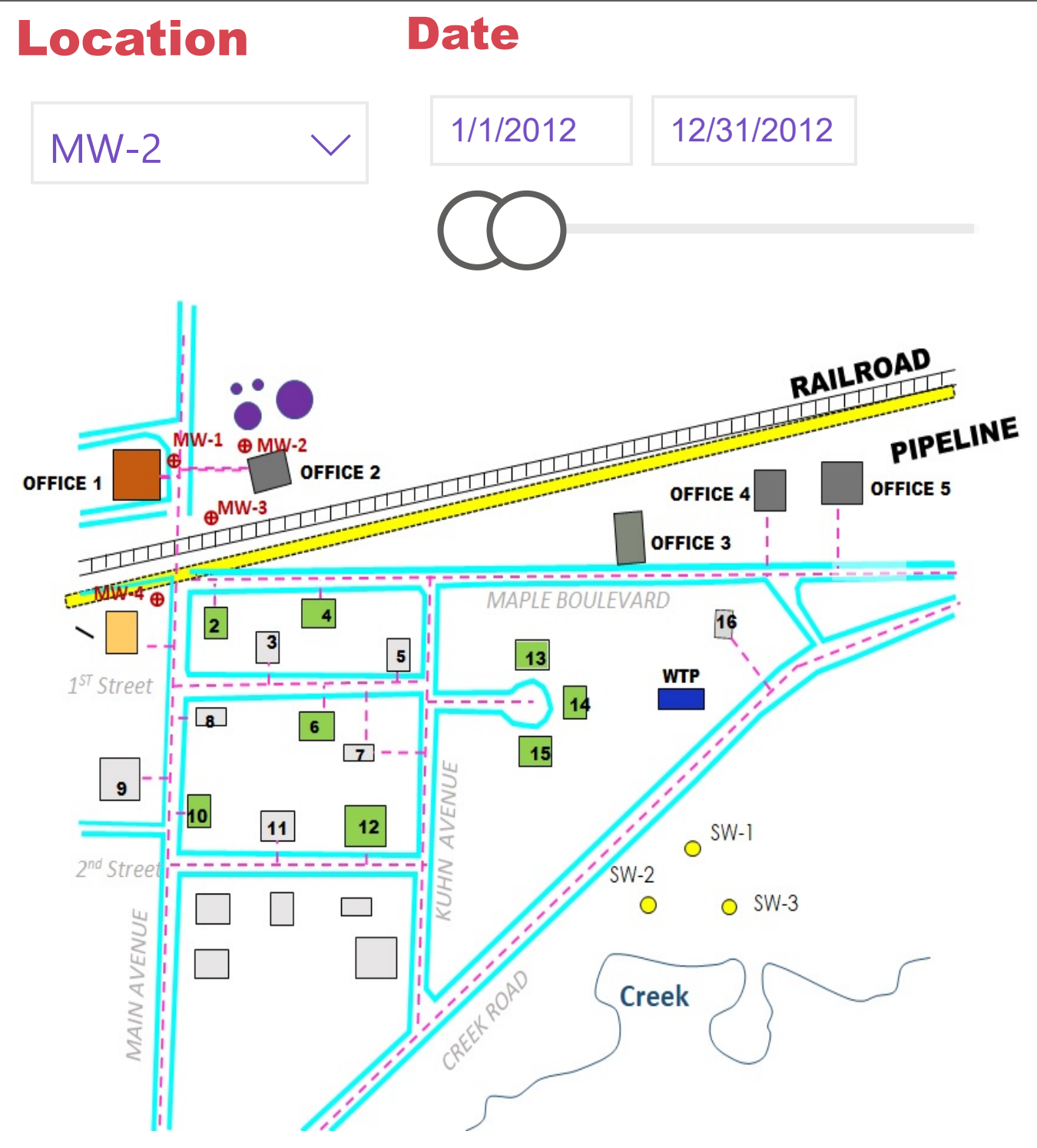


MW-2 Soil and Soil Gas Summary

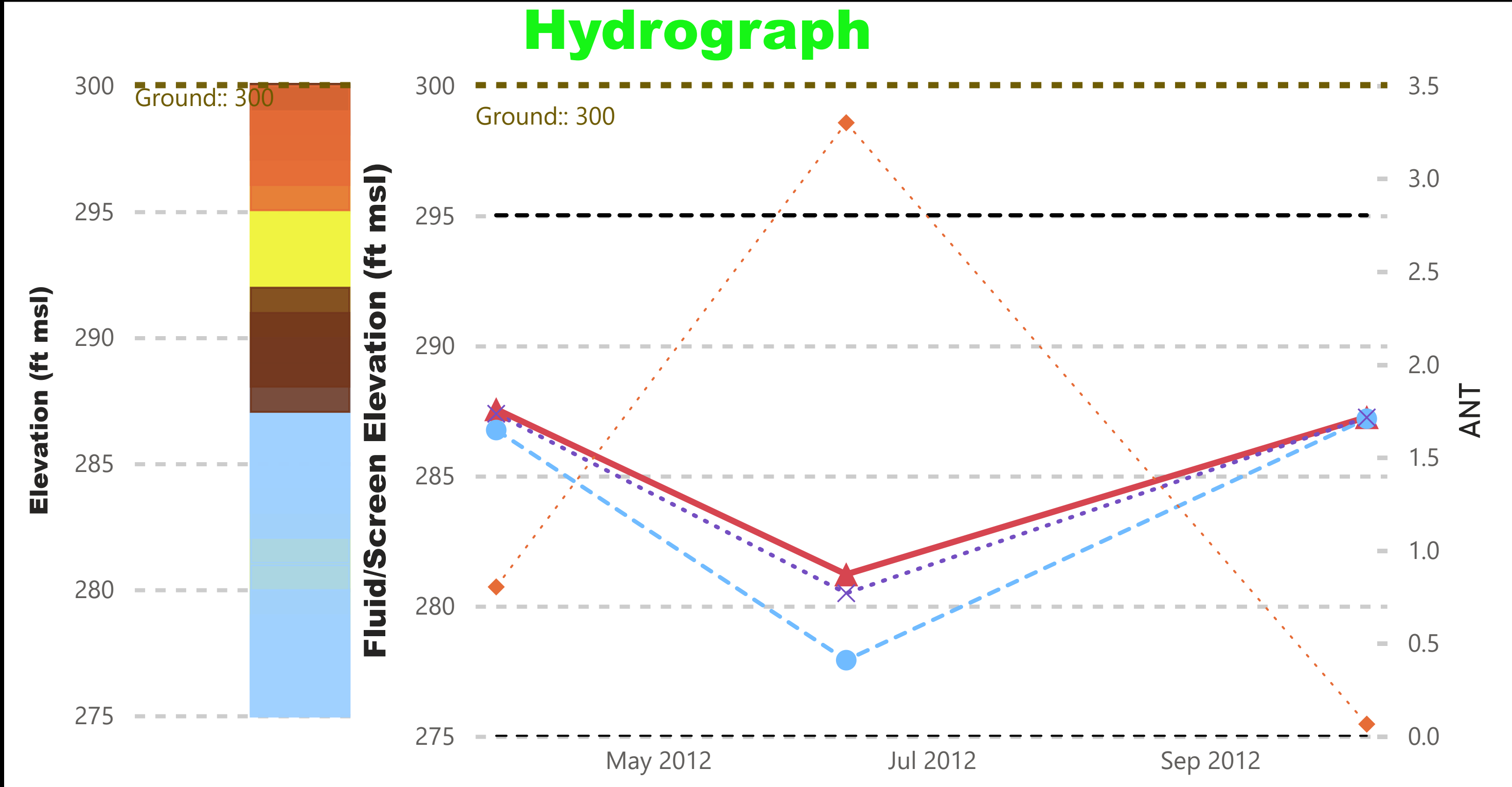
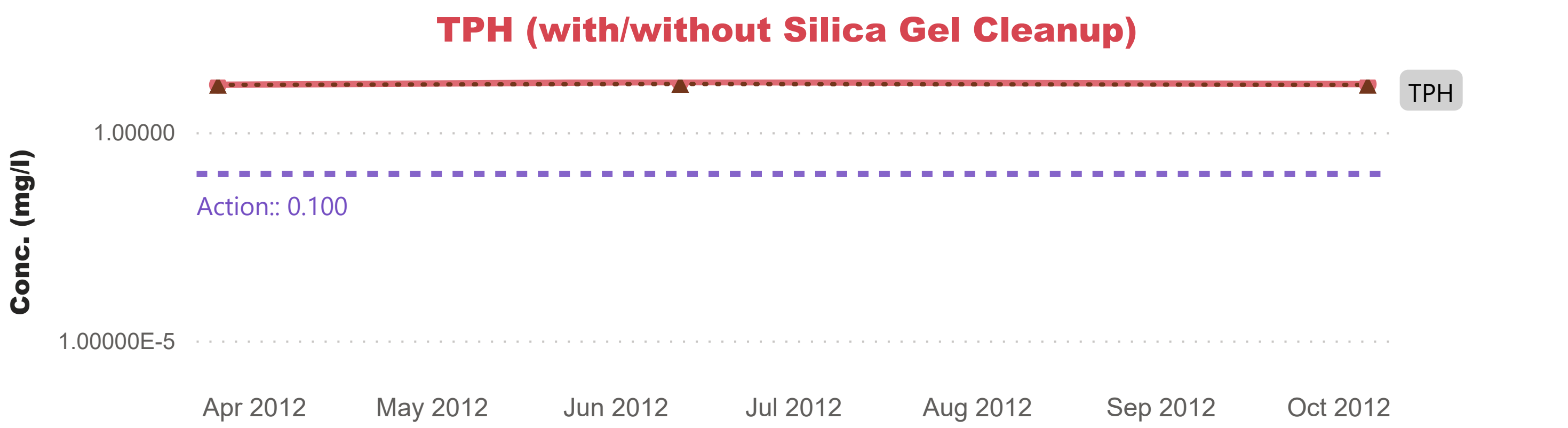
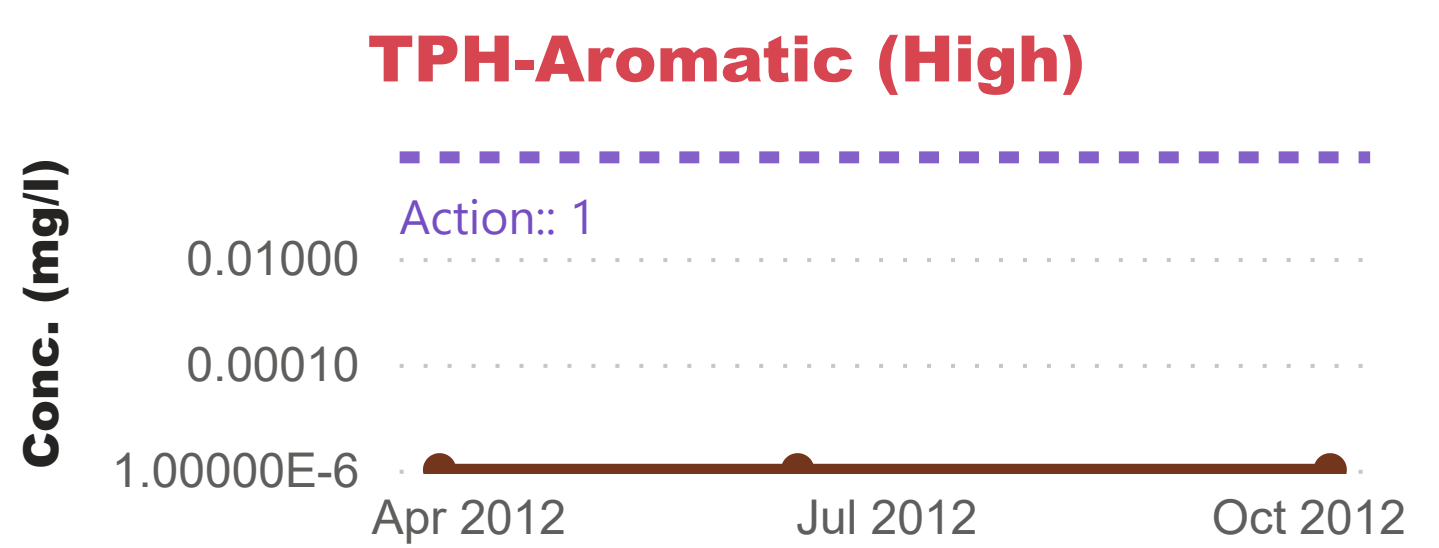
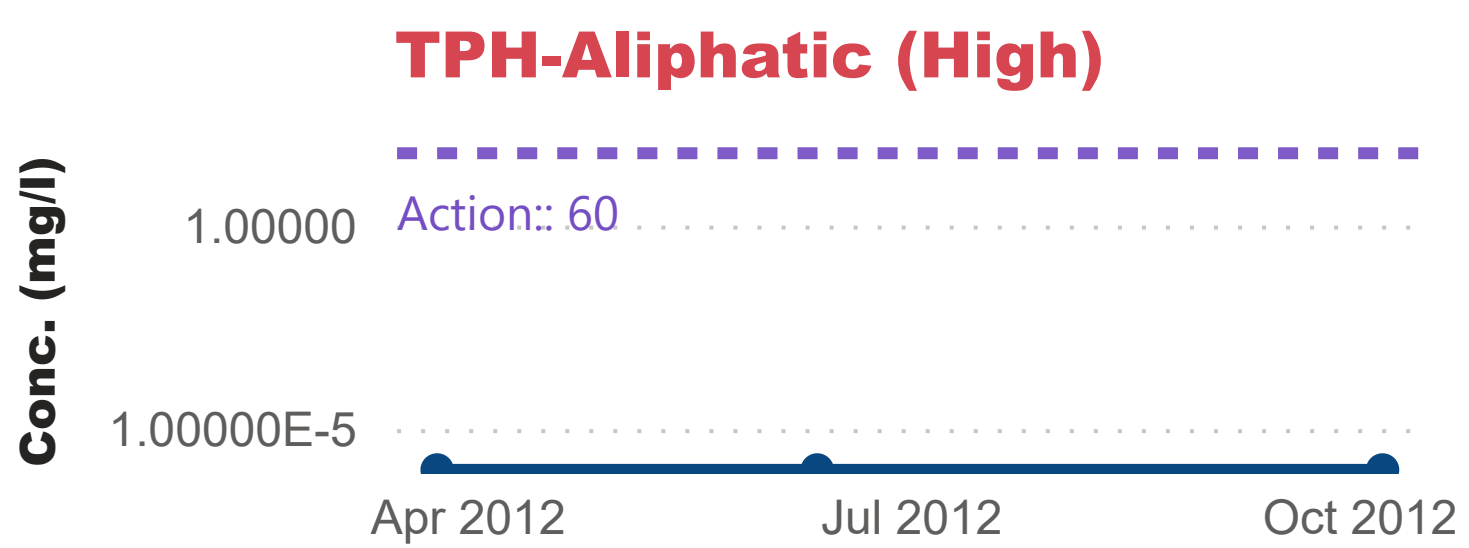
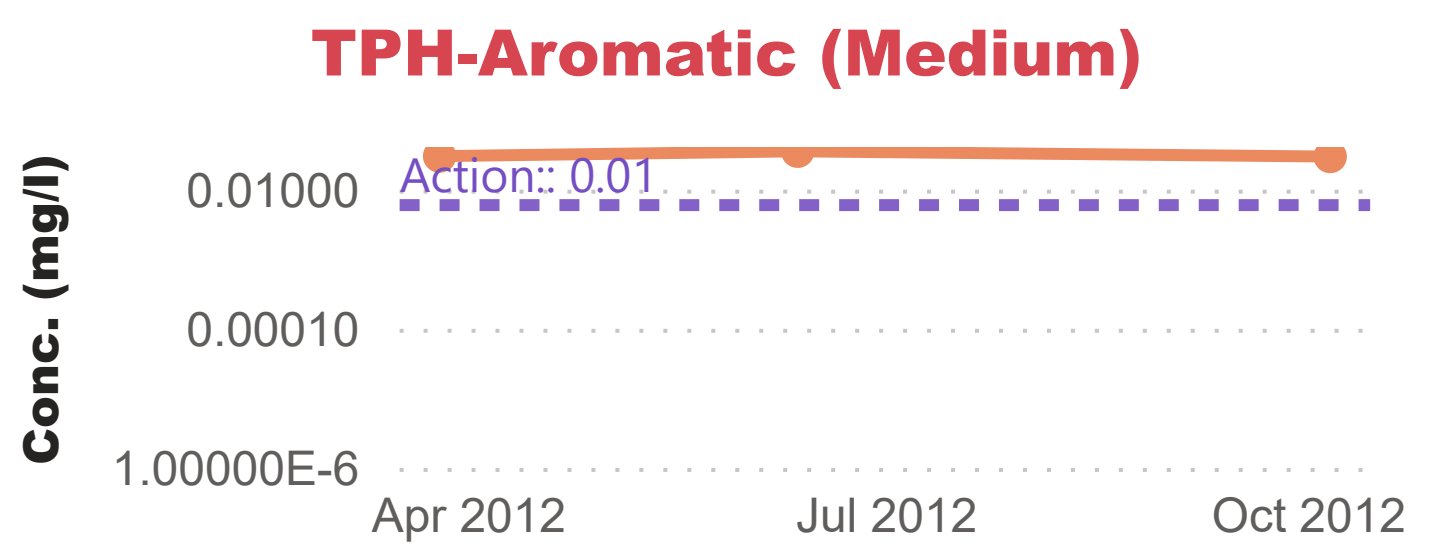
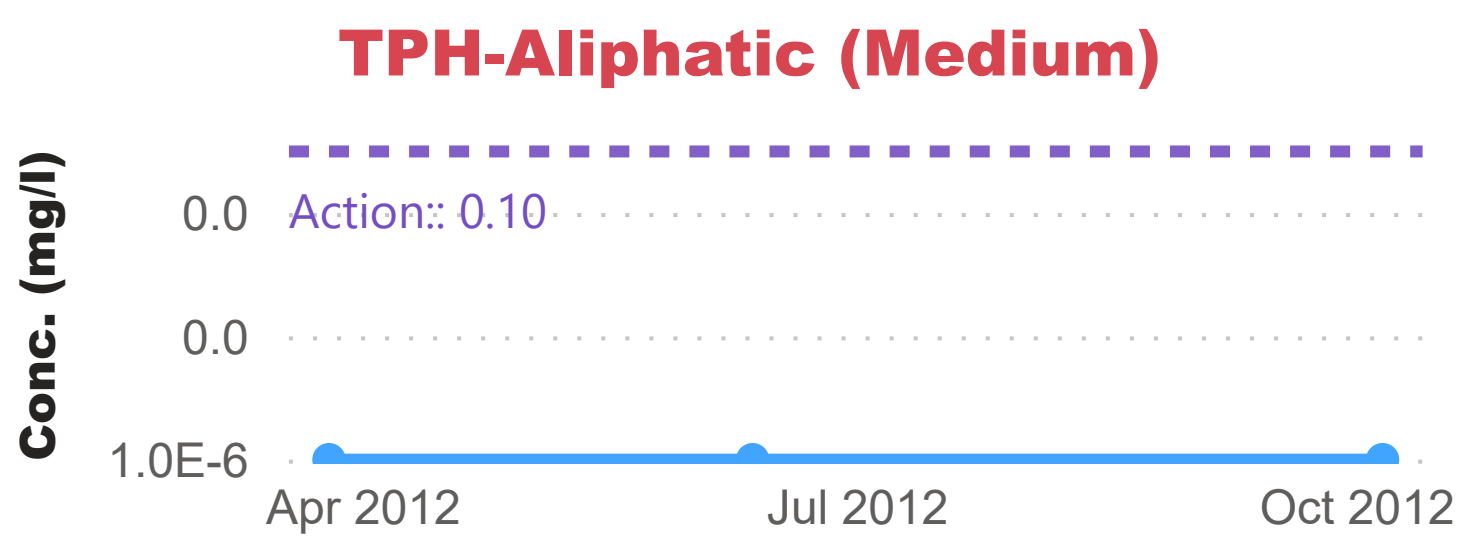
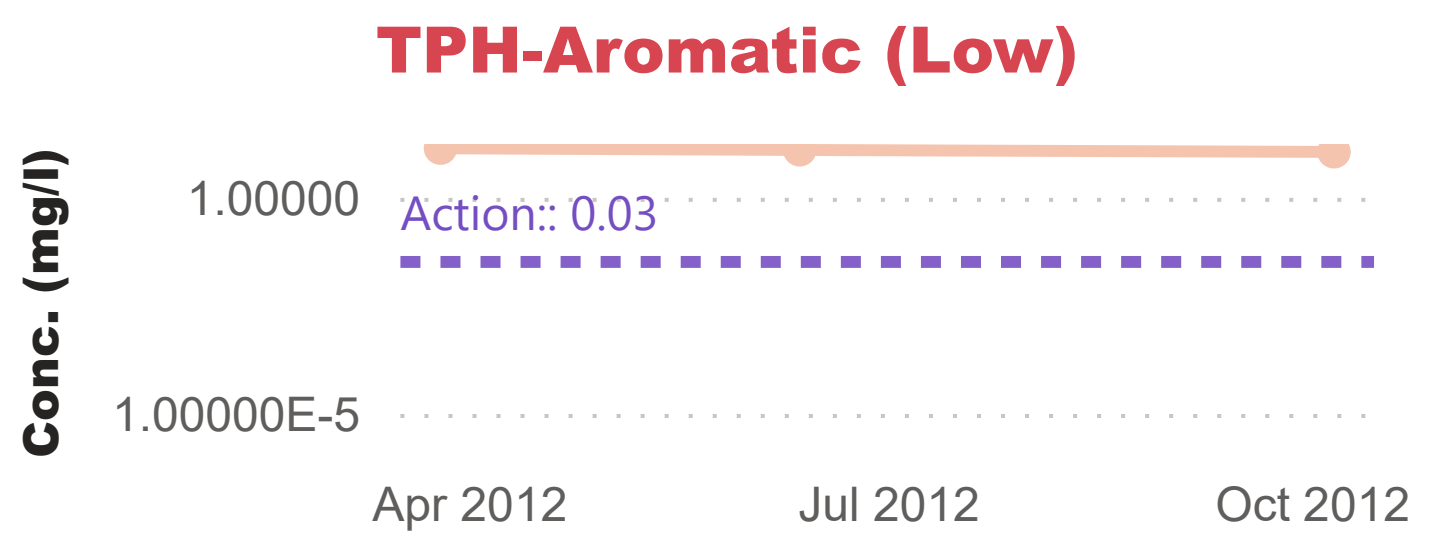
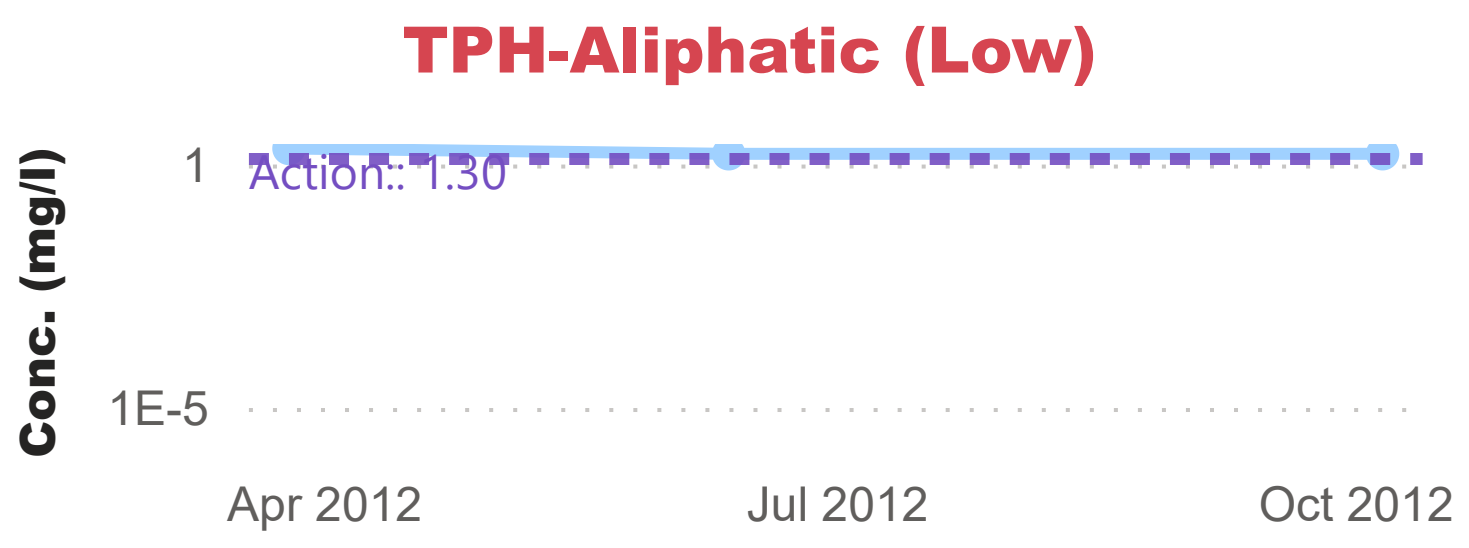
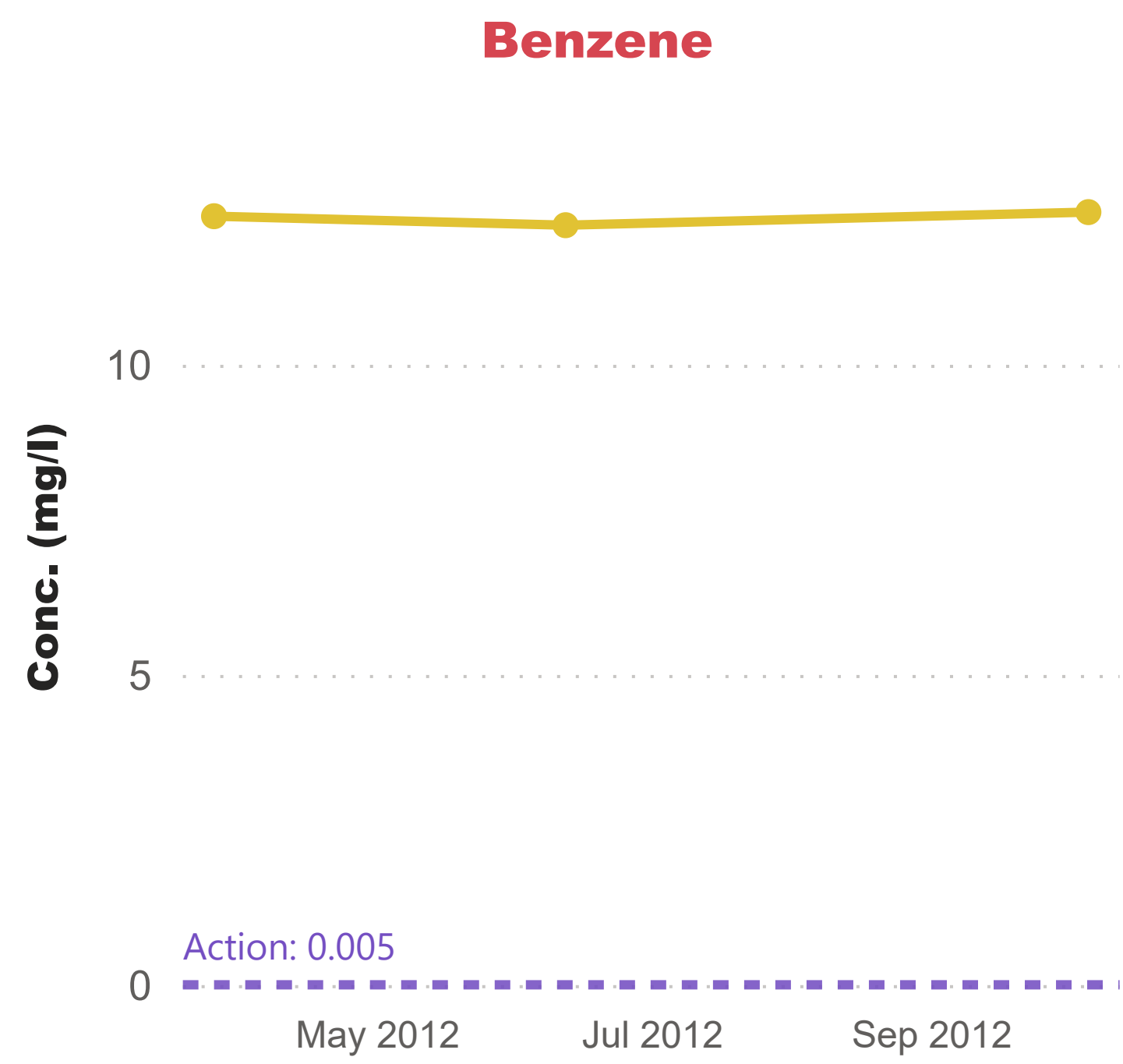
Clays/Till	Fine Sands
Silts/Clays	Medium/Coarse Sands
Silts	Fill

Molecular Structure	Aliphatic	Aromatic	TPH Criteria Working Group 13 Transport Fractions	EPA 6 Toxicity Fractions
EC5-6	EC5-6	EC5-6	EC5-6	EC5-6 Low
EC6-8	EC6-8	EC6-8	EC6-8	EC6-8 Med
EC9-12	EC9-12	EC9-12	EC9-12	EC9-12 High
EC12-16	EC12-16	EC12-16	EC12-16	EC12-16 High
EC16-21	EC16-21	EC16-21	EC16-21	EC16-21 High
EC21-35	EC21-35	EC21-35	EC21-35	EC21-35 High

Increasing Equivalent Carbon (EC) Number →



Dissolved Phase

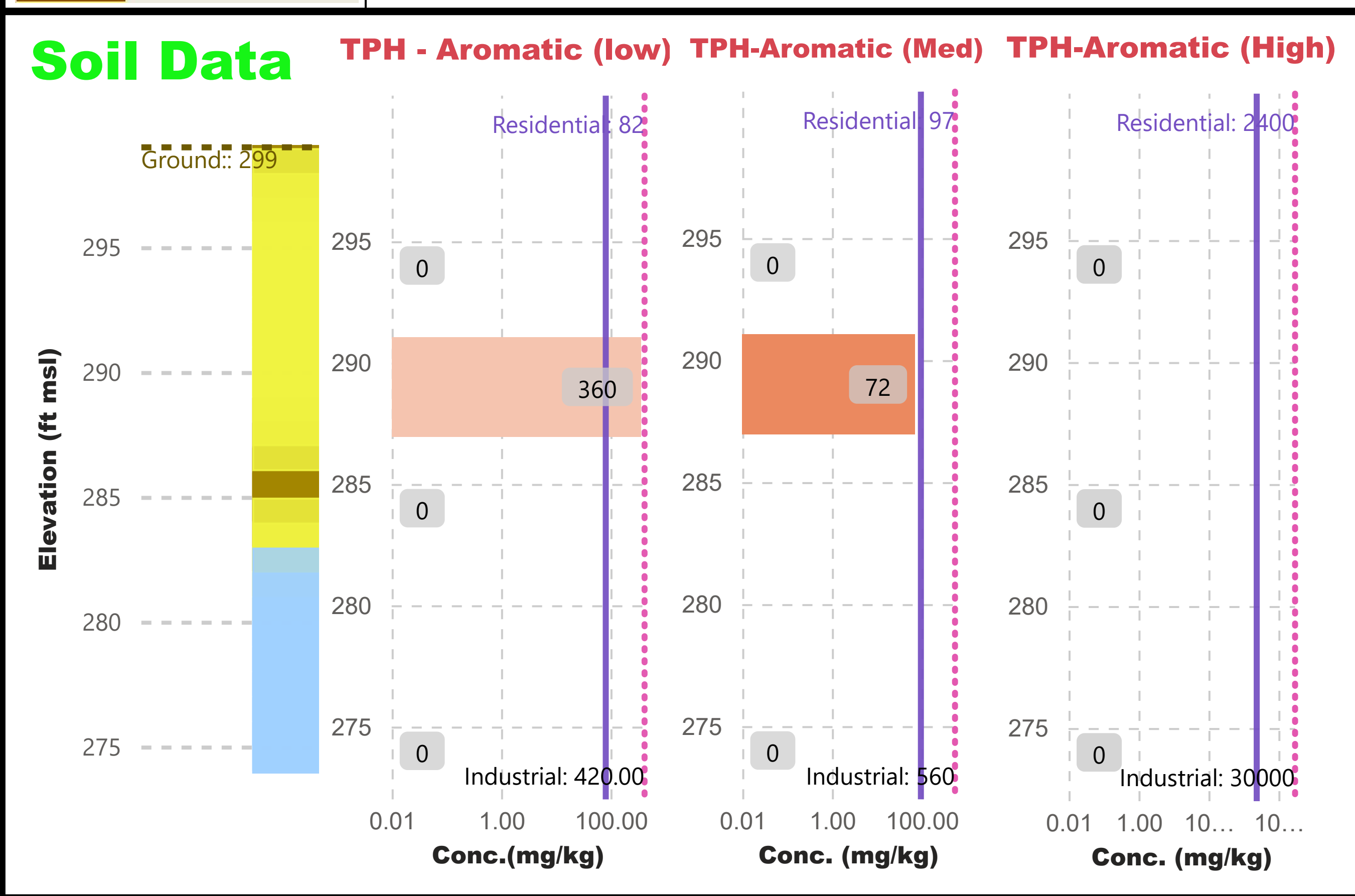
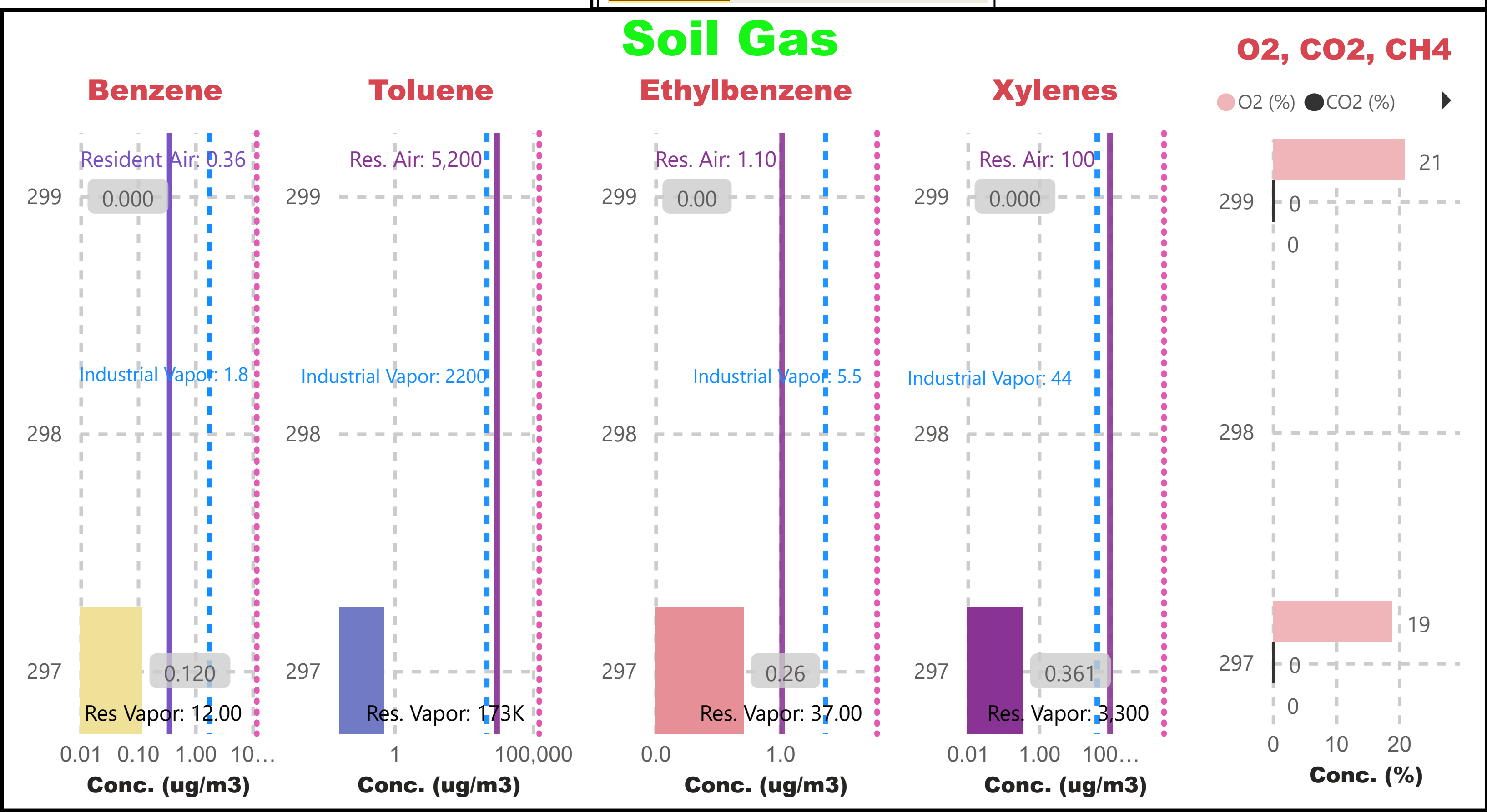
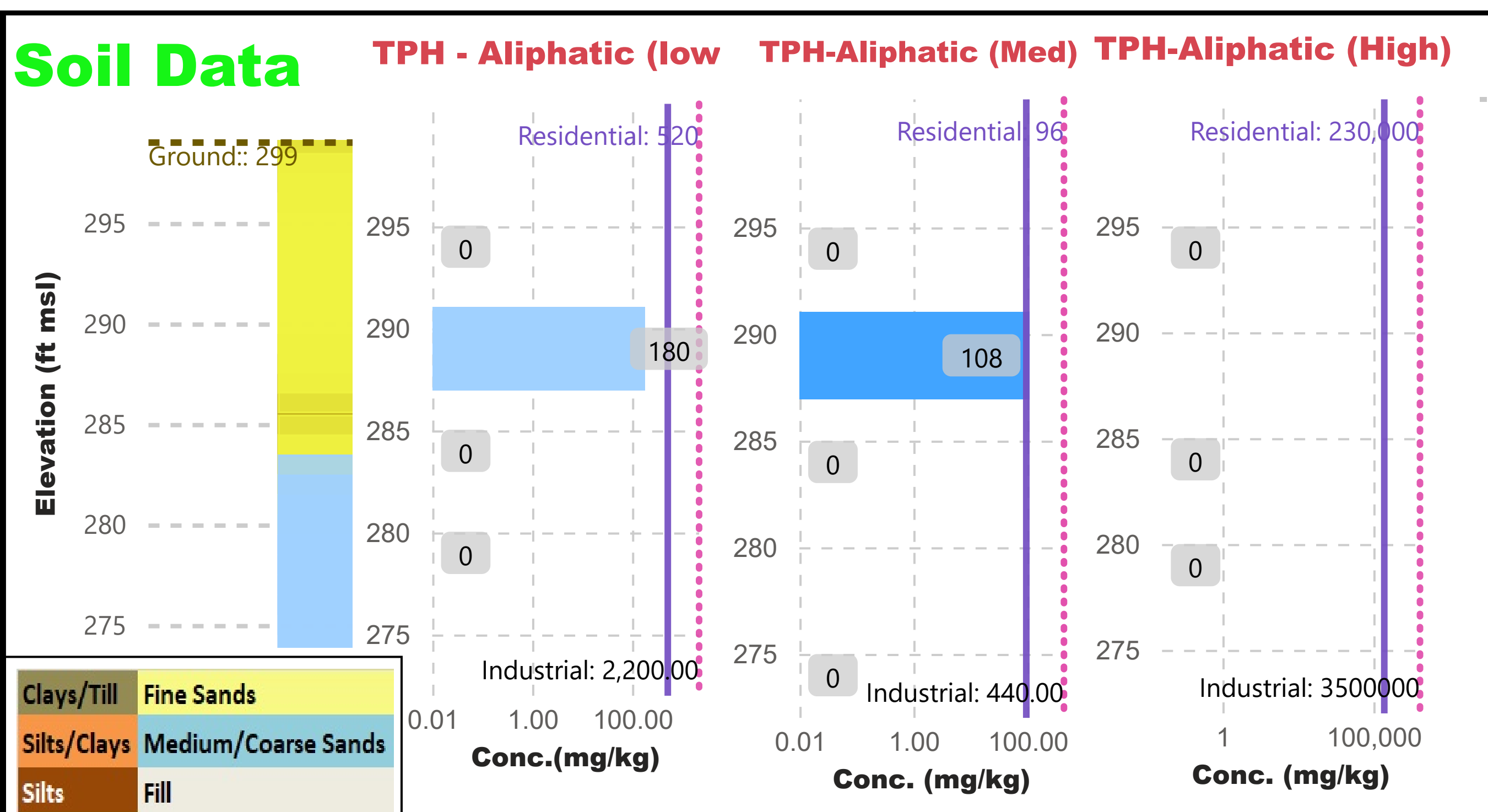
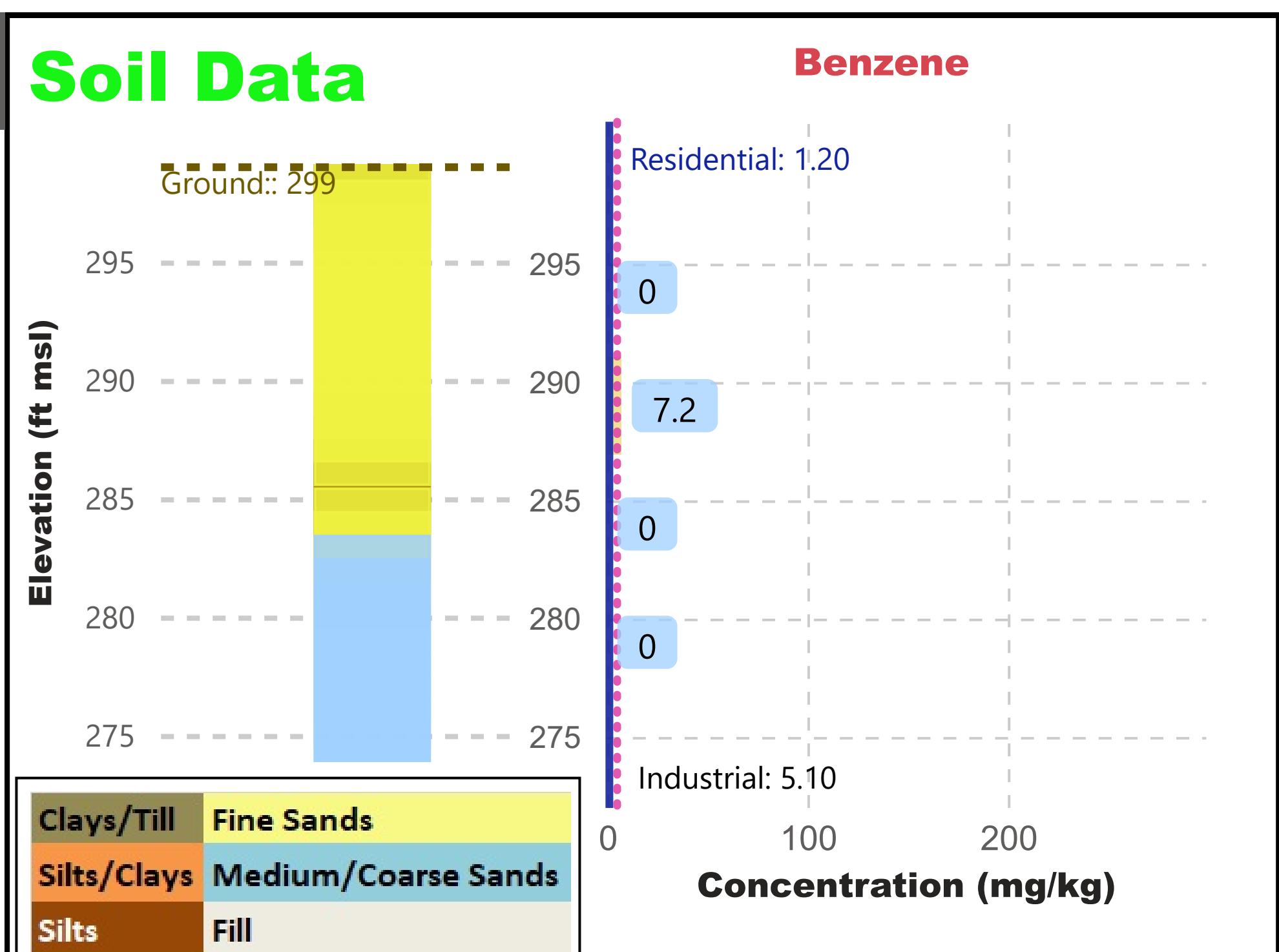
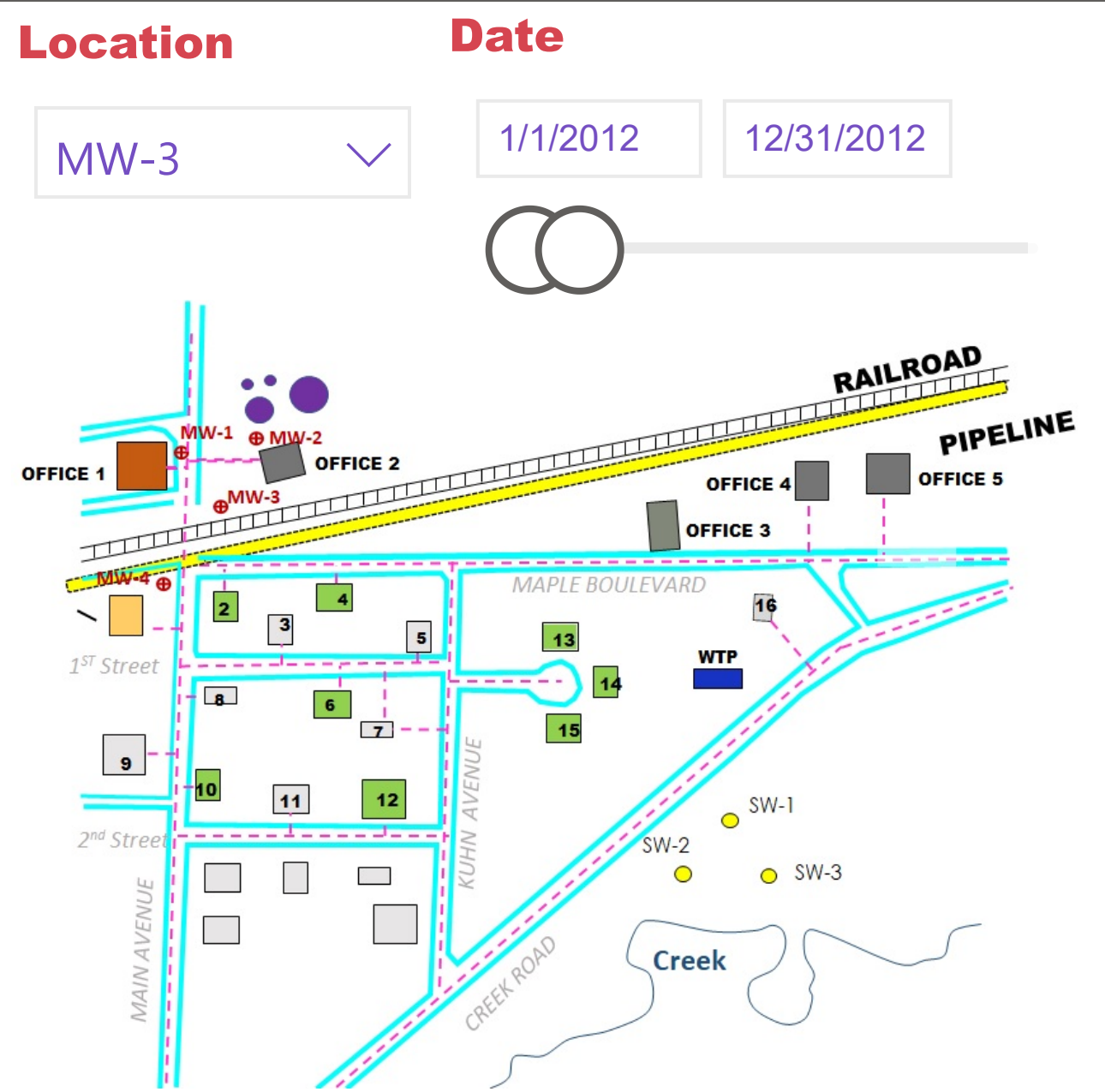


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Molecular Structure	Aliphatic	Aromatic	Working Group	13 Transport Fractions	EPA 6 Toxicity Fractions
EC5-6	Low	EC5-6	Low	EC5-6	Low
EC7-8	Low	EC7-8	Low	EC7-8	Low
EC9-10	Low	EC9-10	Low	EC9-10	Low
EC11-12	Low	EC11-12	Low	EC11-12	Low
EC13-14	Low	EC13-14	Low	EC13-14	Low
EC15-16	Low	EC15-16	Low	EC15-16	Low
EC17-18	Low	EC17-18	Low	EC17-18	Low
EC19-20	Low	EC19-20	Low	EC19-20	Low
EC21-22	Low	EC21-22	Low	EC21-22	Low
EC23-24	Low	EC23-24	Low	EC23-24	Low
EC25-26	Low	EC25-26	Low	EC25-26	Low
EC27-28	Low	EC27-28	Low	EC27-28	Low
EC29-30	Low	EC29-30	Low	EC29-30	Low
EC31-32	Low	EC31-32	Low	EC31-32	Low
EC33-34	Low	EC33-34	Low	EC33-34	Low
EC35	Low	EC35	Low	EC35	Low
EC36	Low	EC36	Low	EC36	Low
EC37	Low	EC37	Low	EC37	Low
EC38	Low	EC38	Low	EC38	Low
EC39	Low	EC39	Low	EC39	Low
EC40	Low	EC40	Low	EC40	Low
EC41	Low	EC41	Low	EC41	Low
EC42	Low	EC42	Low	EC42	Low
EC43	Low	EC43	Low	EC43	Low
EC44	Low	EC44	Low	EC44	Low
EC45	Low	EC45	Low	EC45	Low
EC46	Low	EC46	Low	EC46	Low
EC47	Low	EC47	Low	EC47	Low
EC48	Low	EC48	Low	EC48	Low
EC49	Low	EC49	Low	EC49	Low
EC50	Low	EC50	Low	EC50	Low
EC51	Low	EC51	Low	EC51	Low
EC52	Low	EC52	Low	EC52	Low
EC53	Low	EC53	Low	EC53	Low
EC54	Low	EC54	Low	EC54	Low
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EC57	Low	EC57	Low	EC57	Low
EC58	Low	EC58	Low	EC58	Low
EC59	Low	EC59	Low	EC59	Low
EC60	Low	EC60	Low	EC60	Low
EC61	Low	EC61	Low	EC61	Low
EC62	Low	EC62	Low	EC62	Low
EC63	Low	EC63	Low	EC63	Low
EC64	Low	EC64	Low	EC64	Low
EC65	Low	EC65	Low	EC65	Low
EC66	Low	EC66	Low	EC66	Low
EC67	Low	EC67	Low	EC67	Low
EC68	Low	EC68	Low	EC68	Low
EC69	Low	EC69	Low	EC69	Low
EC70	Low	EC70	Low	EC70	Low
EC71	Low	EC71	Low	EC71	Low
EC72	Low	EC72	Low	EC72	Low
EC73	Low	EC73	Low	EC73	Low
EC74	Low	EC74	Low	EC74	Low
EC75	Low	EC75	Low	EC75	Low
EC76	Low	EC76	Low	EC76	Low
EC77	Low	EC77	Low	EC77	Low
EC78	Low	EC78	Low	EC78	Low
EC79	Low	EC79	Low	EC79	Low
EC80	Low	EC80	Low	EC80	Low
EC81	Low	EC81	Low	EC81	Low
EC82	Low	EC82	Low	EC82	Low
EC83	Low	EC83	Low	EC83	Low
EC84	Low	EC84	Low	EC84	Low
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EC86	Low	EC86	Low	EC86	Low
EC87	Low	EC87	Low	EC87	Low
EC88	Low	EC88	Low	EC88	Low
EC89	Low	EC89	Low	EC89	Low
EC90	Low	EC90	Low	EC90	Low
EC91	Low	EC91	Low	EC91	Low
EC92	Low	EC92	Low	EC92	Low
EC93	Low	EC93	Low	EC93	Low
EC94	Low	EC94	Low	EC94	Low
EC95	Low	EC95	Low	EC95	Low
EC96	Low	EC96	Low	EC96	Low
EC97	Low	EC97	Low	EC97	Low
EC98	Low	EC98	Low	EC98	Low
EC99	Low	EC99	Low	EC99	Low
EC100	Low	EC100	Low	EC100	Low

Clays/Till	Fine Sands	--- Screen	TOS/BOS	X Corrected Groundwater Surface CGWS
Silts/Clays	Medium/Coarse Sands	▲ Air/NAPL Interface	ANI	◆ Apparent NAPL Thickness ANT
Silts	Fill	● NAPL/Water Interface	NWI	

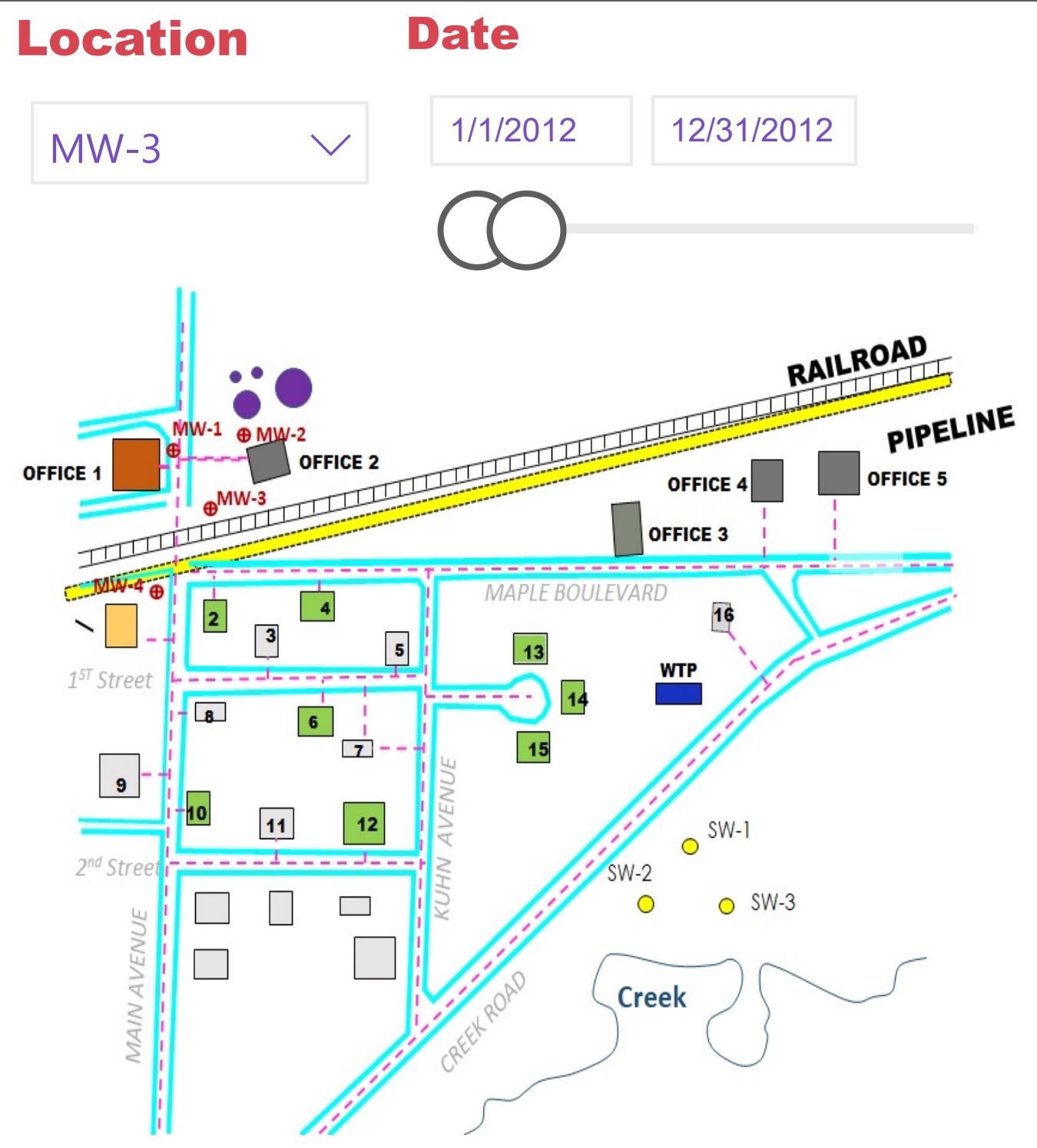
MW-2 Hydrograph & Dissolved Summary



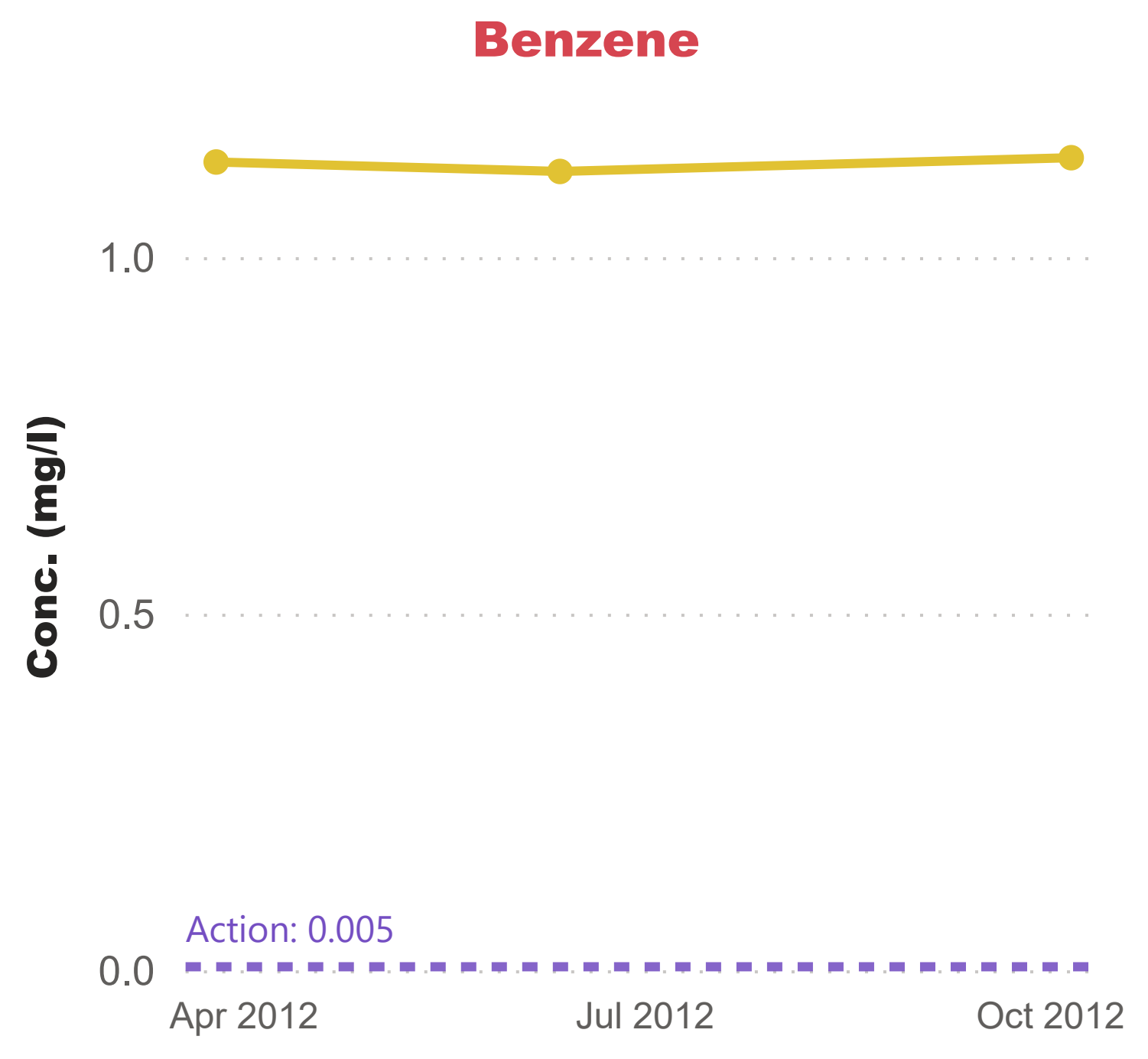
MW-3 Soil and Soil Gas Summary

Clays/Till	Fine Sands
Silts/Clays	Medium/Coarse Sands
Silts	Fill

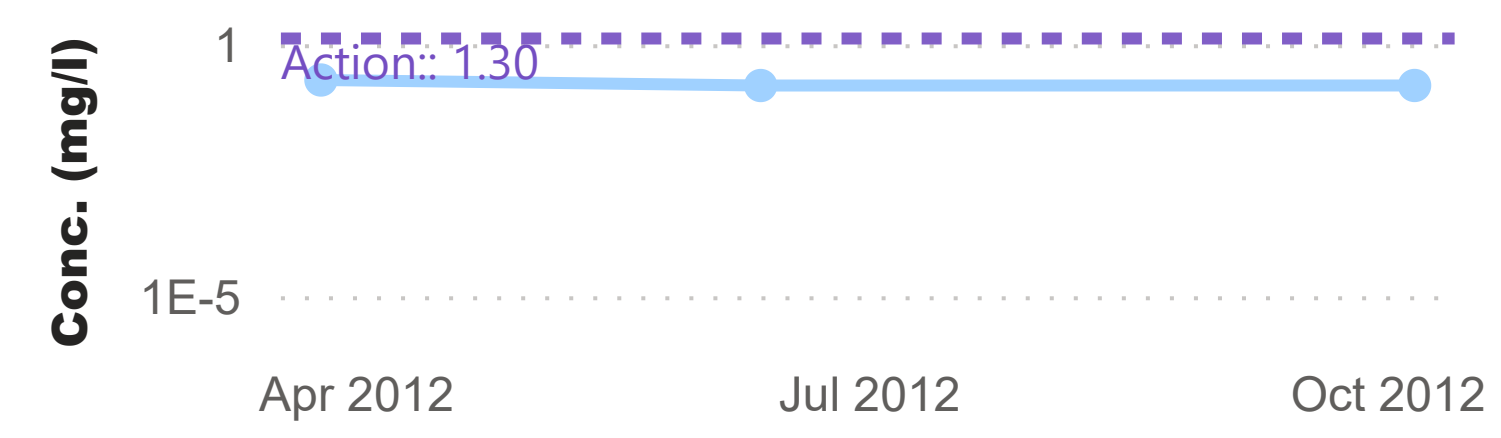
Molecular Structure	Aliphatic	Aromatic	TPH Criteria Working Group 13 Transport Fractions	EPA 6 Toxicity Fractions
EC5-6	EC5-6	EC5-6	EC5-6	EC5-6
EC7-8	EC7-8	EC7-8	EC7-8	EC7-8
EC9-10	EC9-10	EC9-10	EC9-10	EC9-10
EC11-12	EC11-12	EC11-12	EC11-12	EC11-12
EC12-16	EC12-16	EC12-16	EC12-16	EC12-16
EC16-21	EC16-21	EC16-21	EC16-21	EC16-21
EC21-35	EC21-35	EC21-35	EC21-35	EC21-35
EC35-40	EC35-40	EC35-40	EC35-40	EC35-40



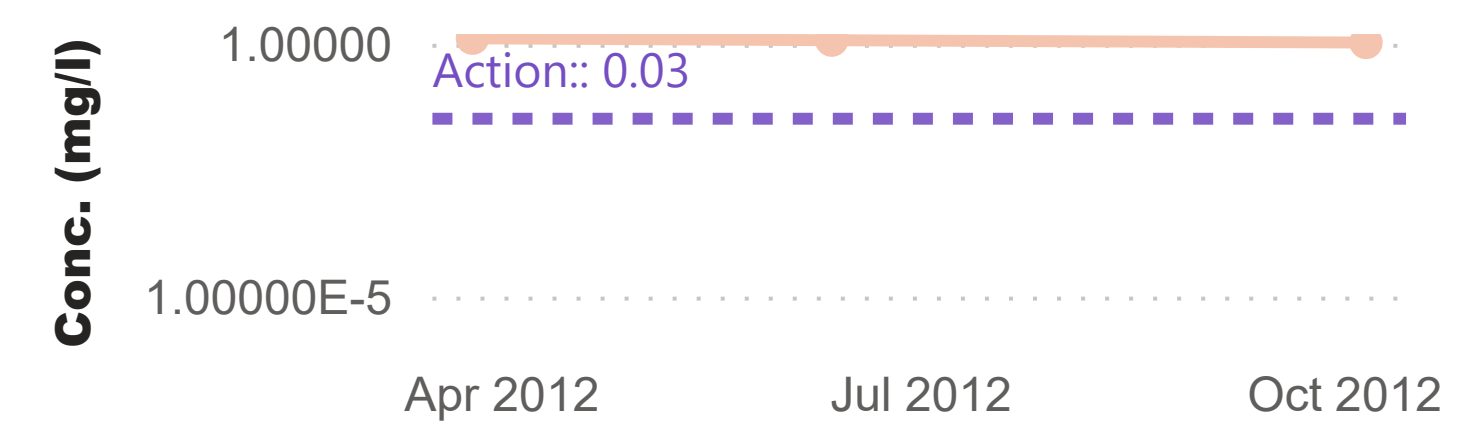
Dissolved Phase



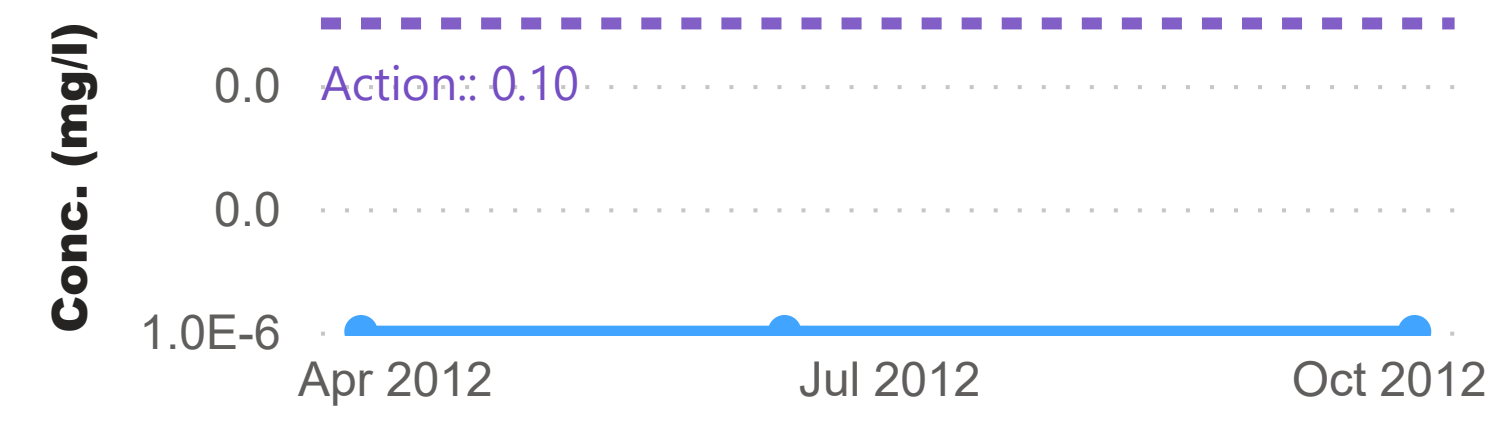
TPH-Aliphatic (Low)



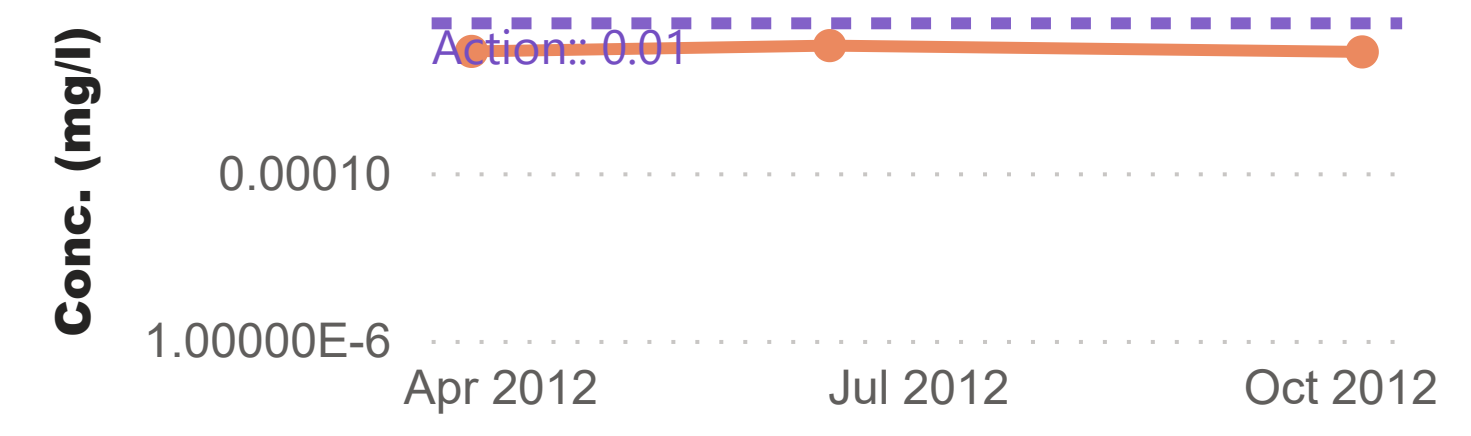
TPH-Aromatic (Low)



TPH-Aliphatic (Medium)



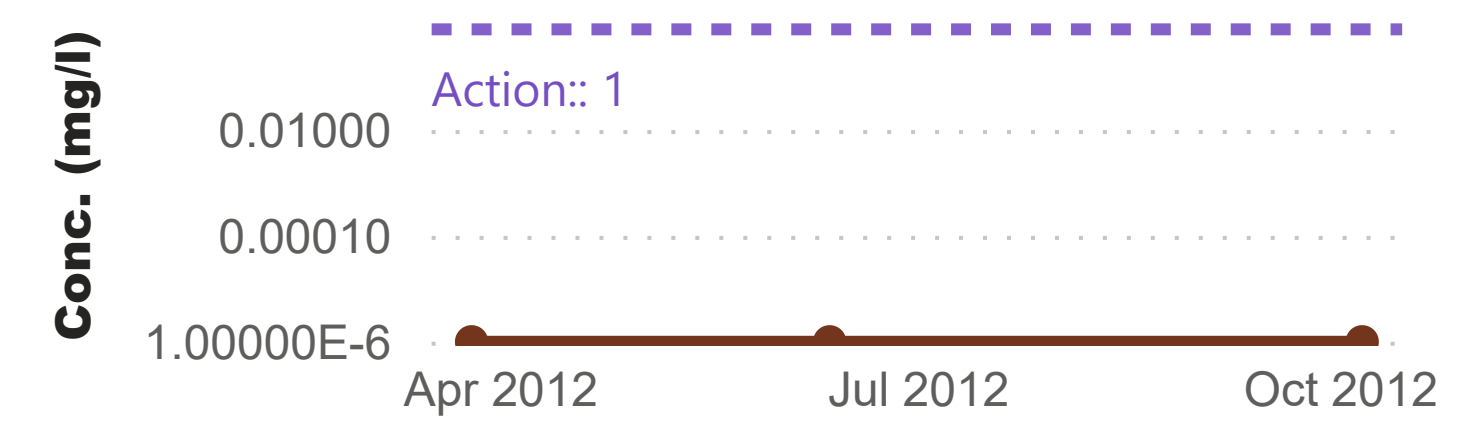
TPH-Aromatic (Medium)



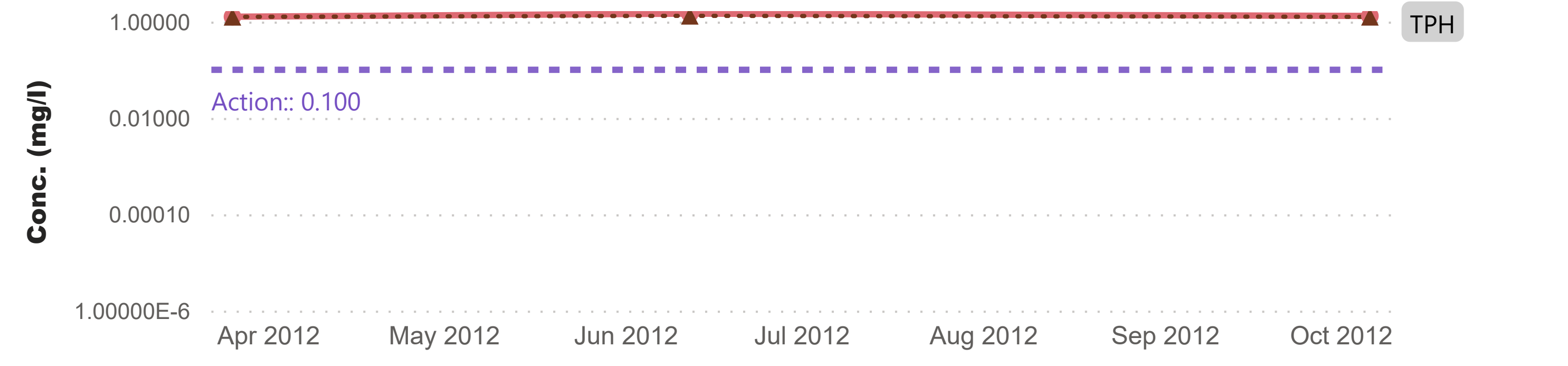
TPH-Aliphatic (High)



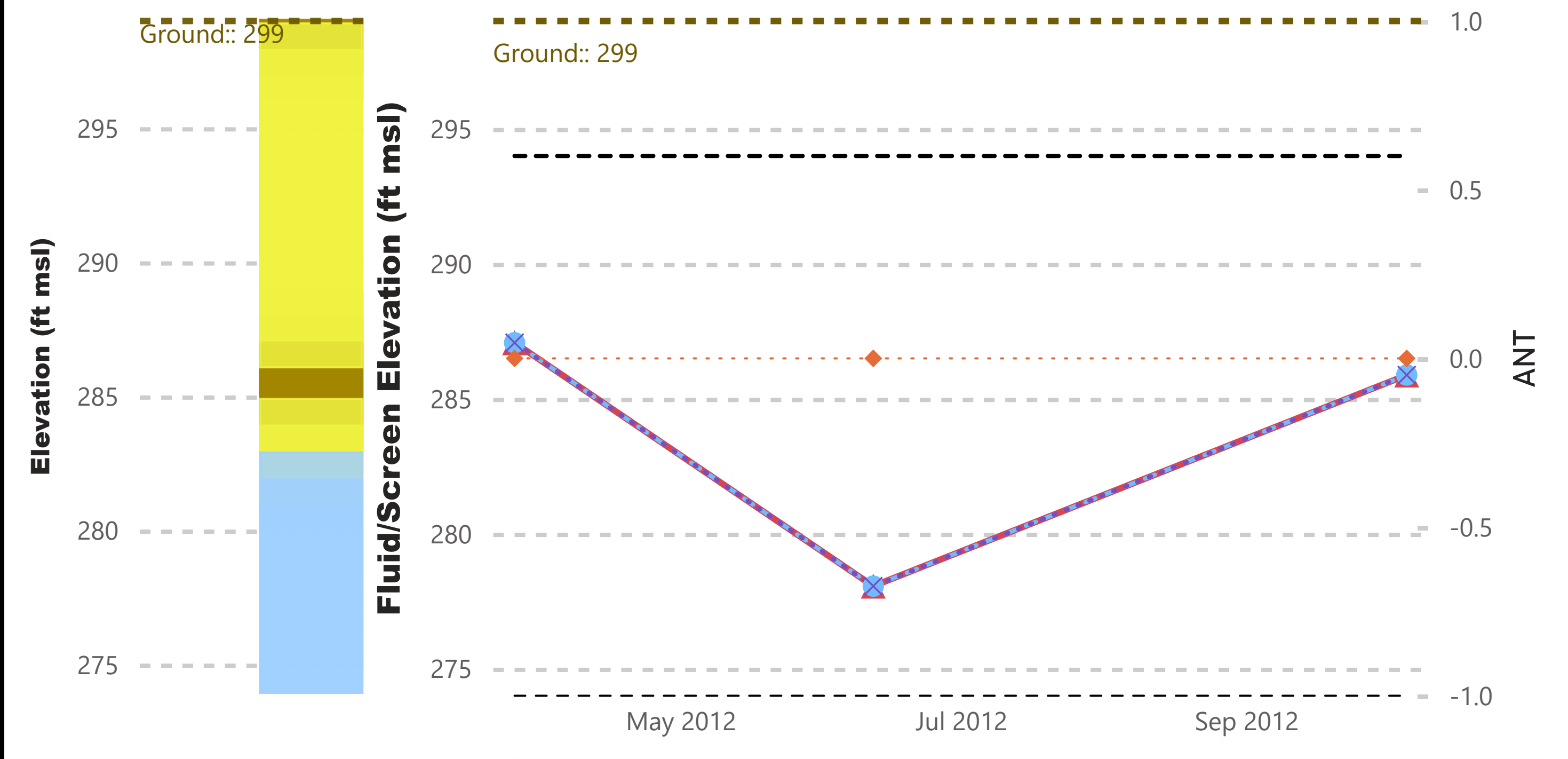
TPH-Aromatic (High)



TPH (with/without Silica Gel Cleanup)



Hydrograph



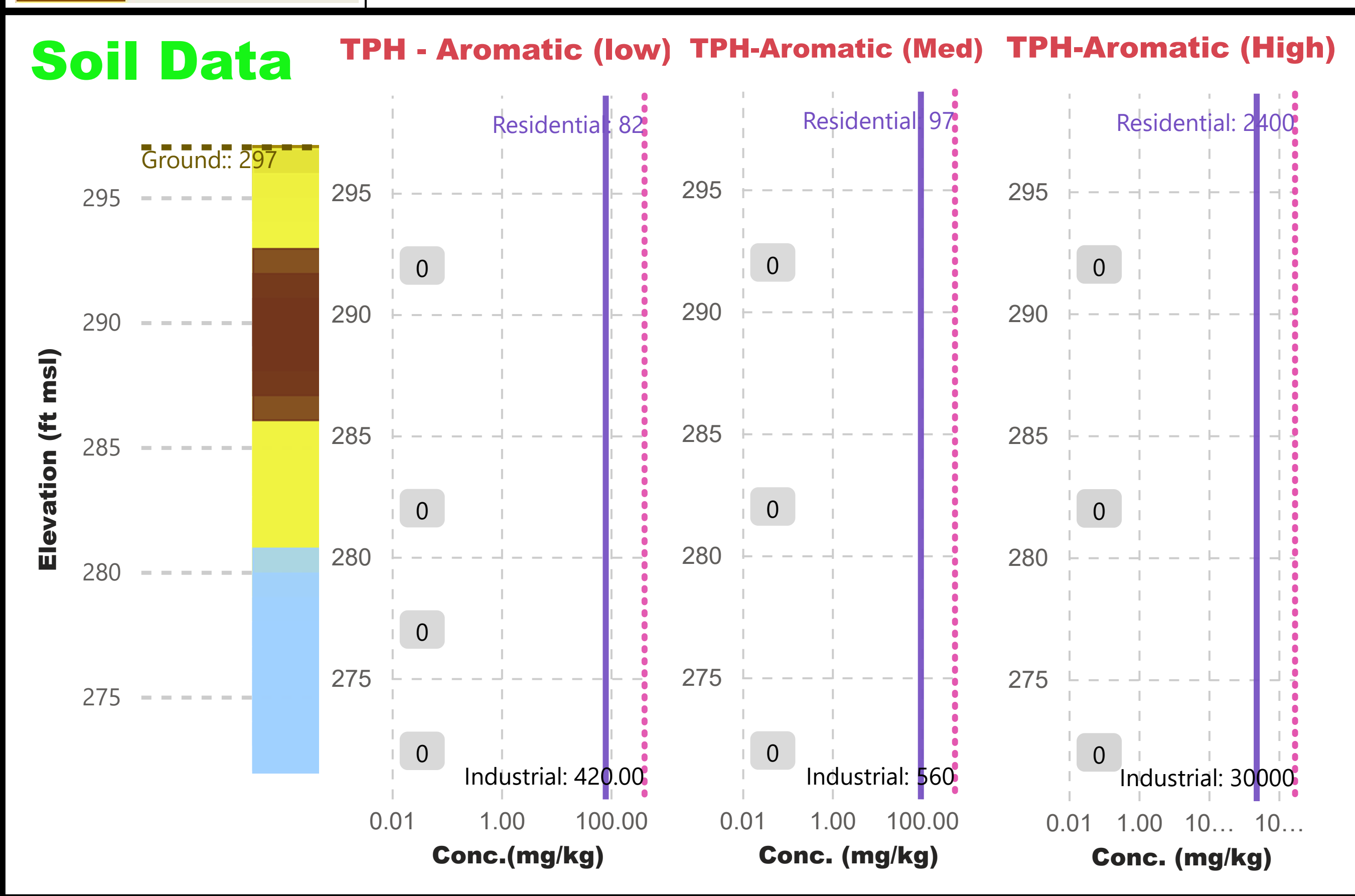
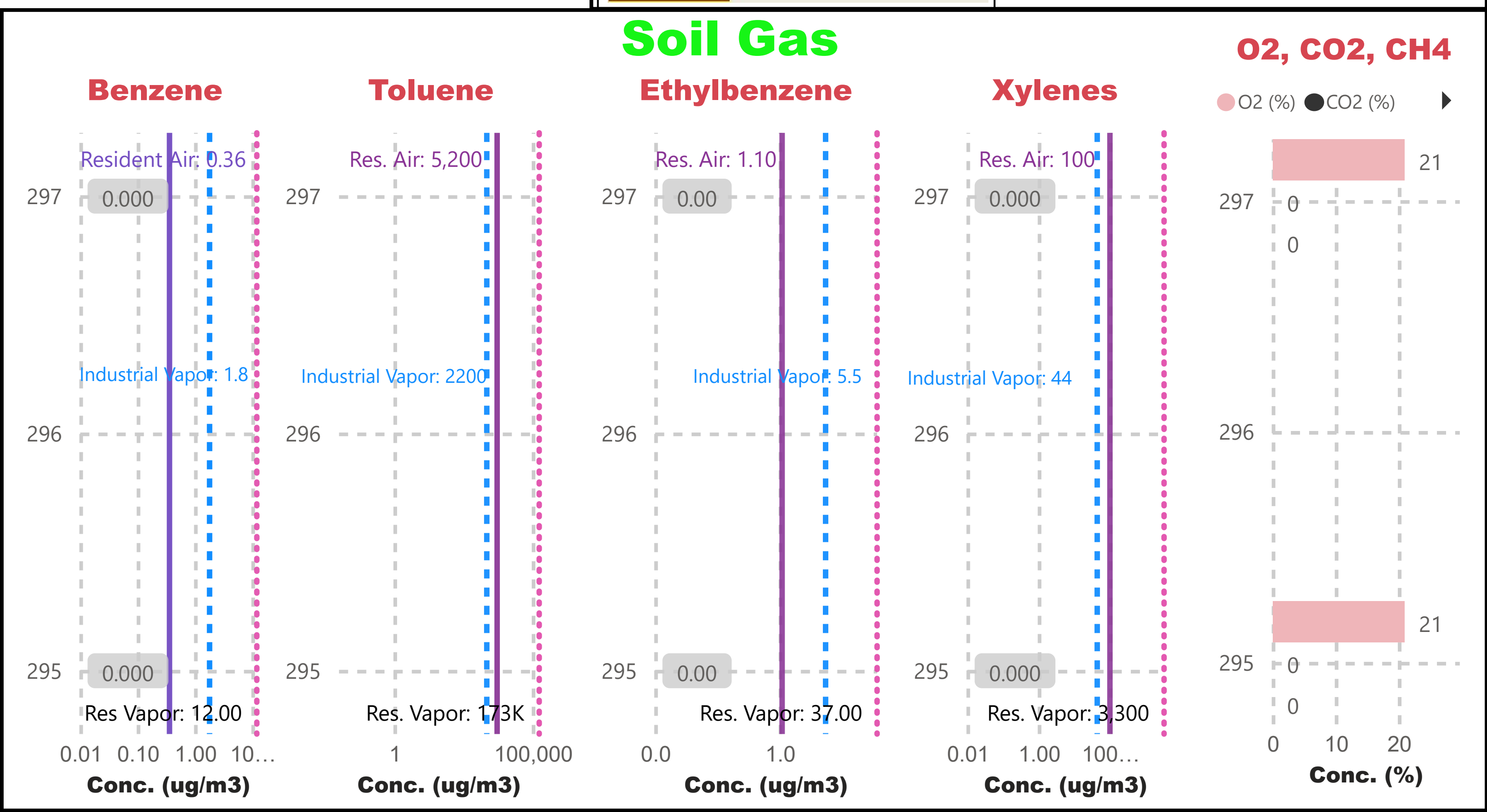
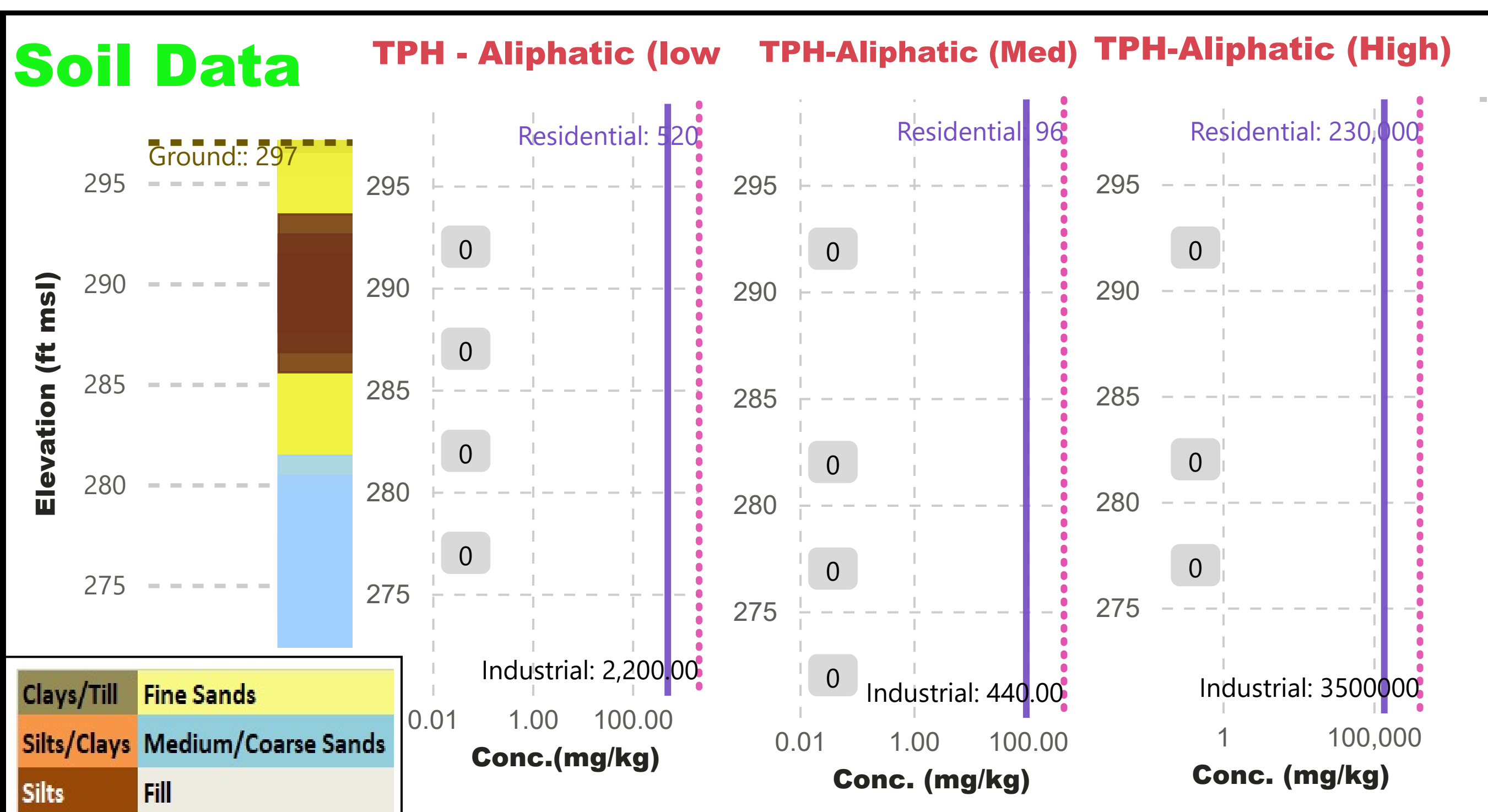
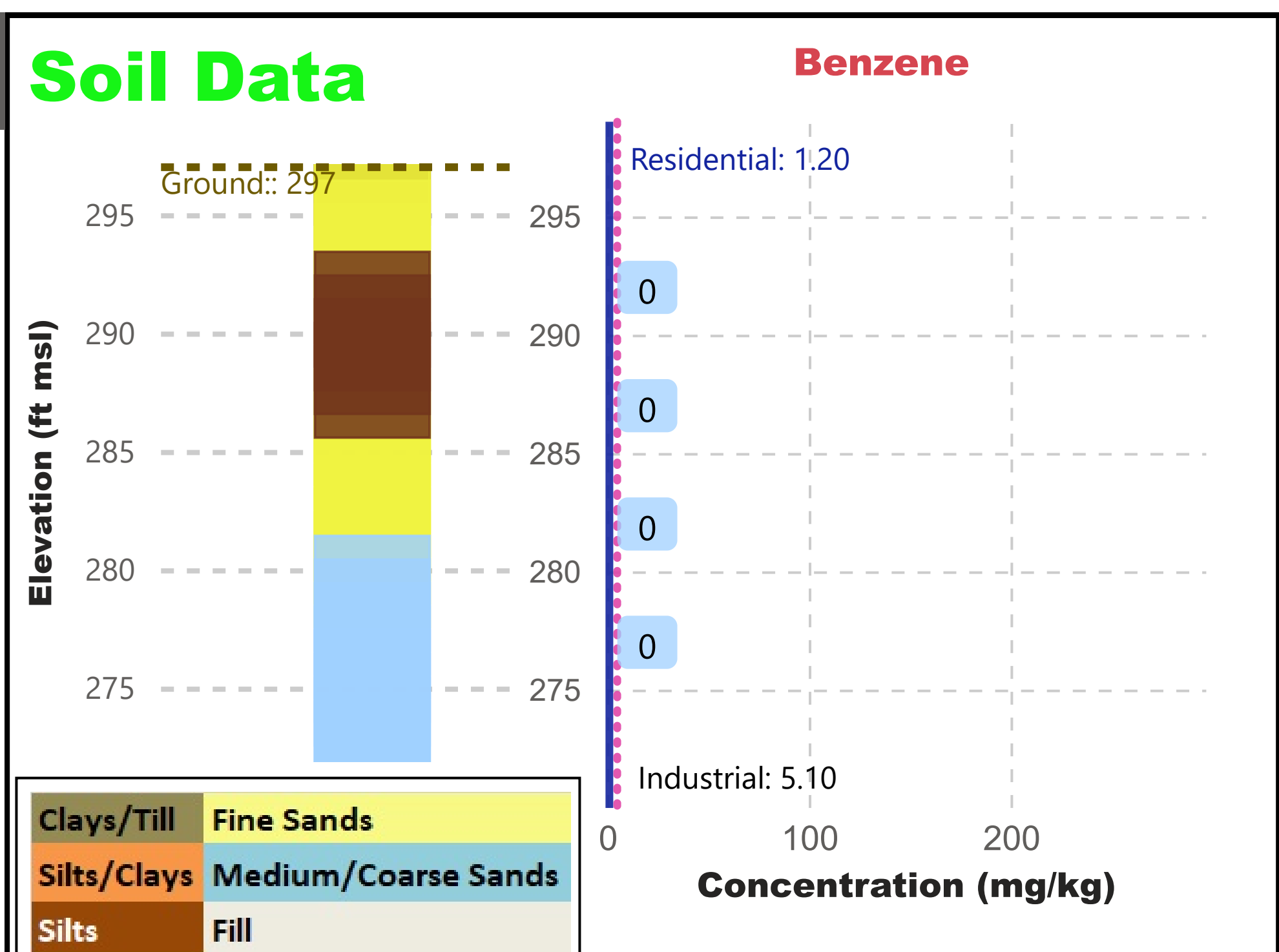
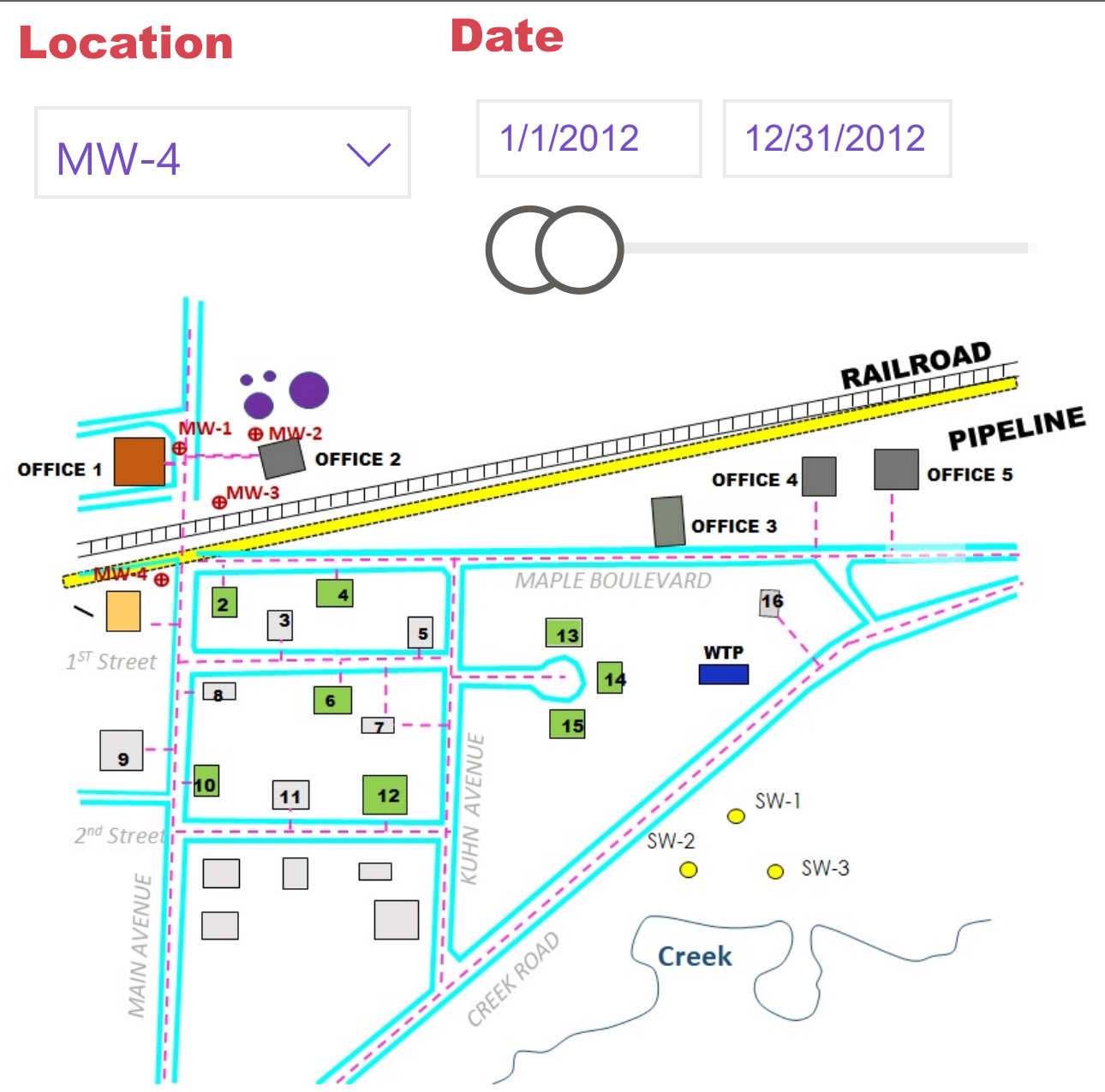
The Silica Gel Cleanup for TPH is a method used by the laboratory to "clean up" the sample extract before it is analyzed for TPH so that the extract contains primarily hydrocarbons (non-polar) compared to non-hydrocarbons like metabolites, natural organic matter, chlorinated solvents etc.

Molecular Structure	Aliphatic	Aromatic	Working Group	13 Transport Fractions	EPA 6 Toxicity Fractions
Aliphatic	EC5-6	EC7-10	Low	EC5-6	Low
Aliphatic	EC8-10	EC11-12	Medium	EC8-10	Medium
Aliphatic	EC12-16	EC16-21	High	EC12-16	High
Aliphatic	EC21-35	(same properties as EC16-21) -- not considered a transport fraction--	High	EC21-35	High

Increasing Equivalent Carbon (EC) Number →

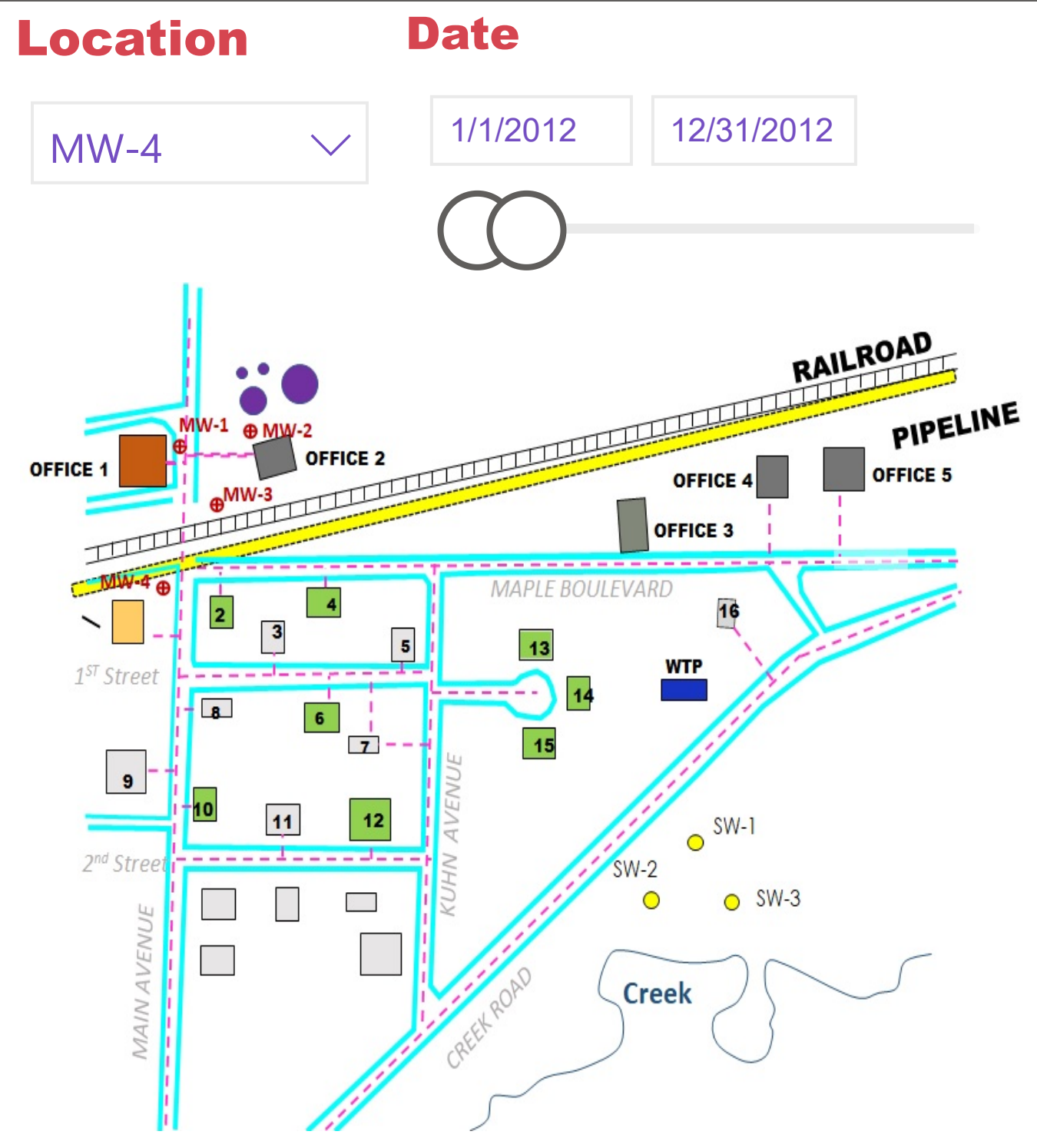
Clays/Till	Fine Sands	--- Screen	TOS/BOS	X Corrected Groundwater Surface CGWS
Silts/Clays	Medium/Coarse Sands	▲ Air/NAPL Interface	ANI	◆ Apparent NAPL Thickness ANT
Silts	Fill	● NAPL/Water Interface	NWI	

MW-3 Hydrograph & Dissolved Summary



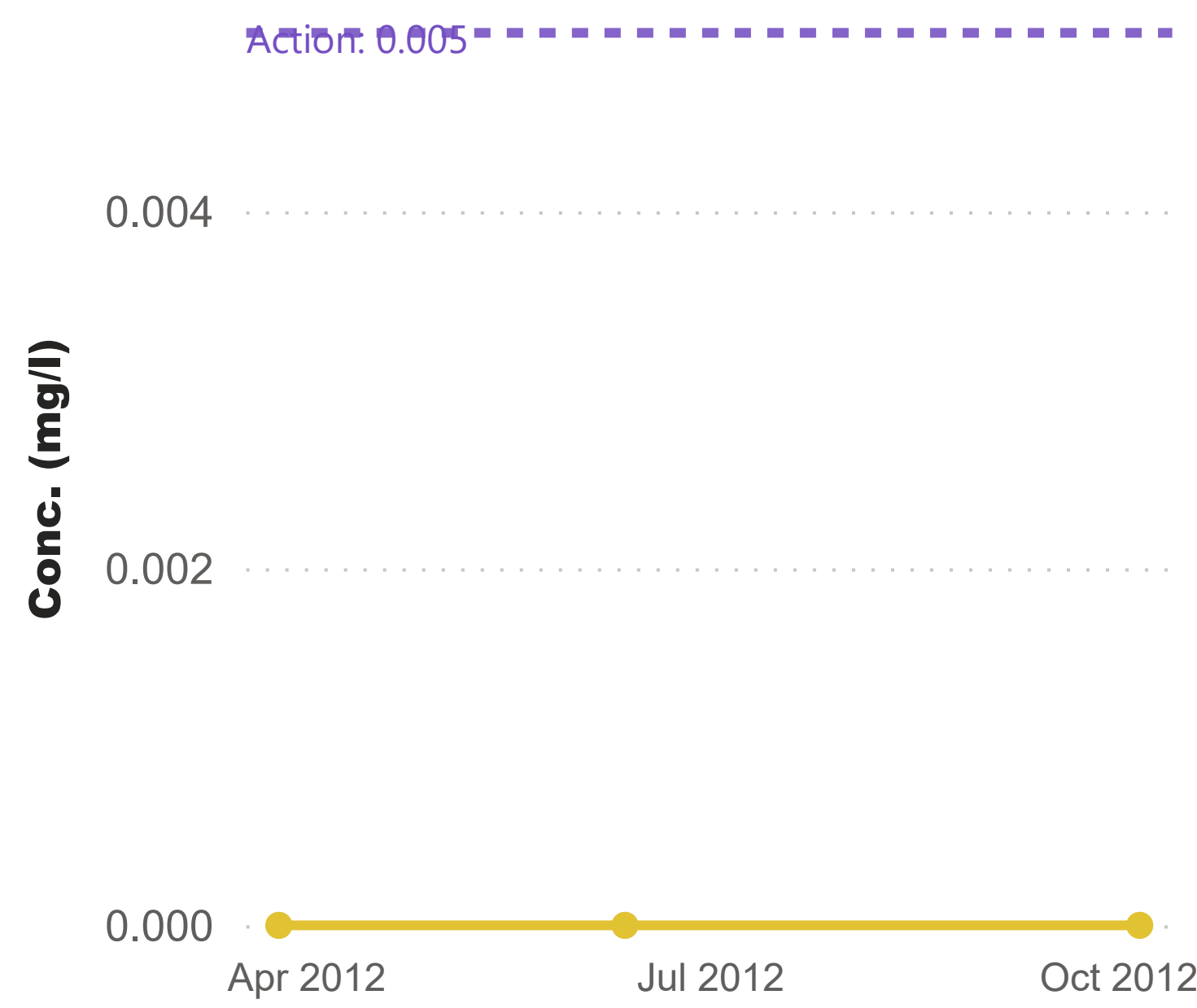
MW-4 Soil and Soil Gas Summary

Clays/Till	Fine Sands	
Silts/Clays	Medium/Coarse Sands	
Silts	Fill	

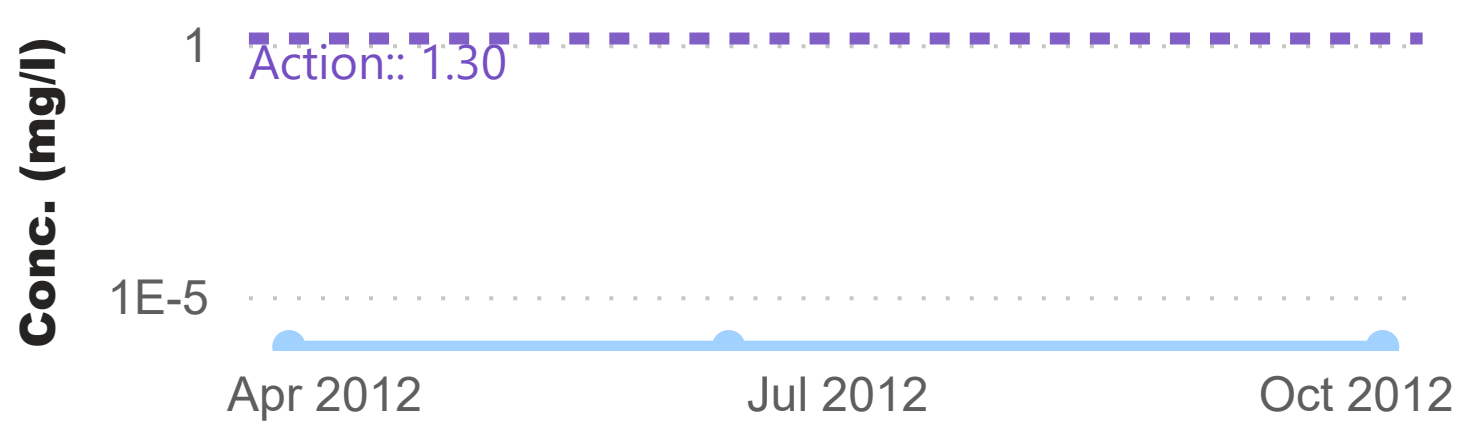


Dissolved Phase

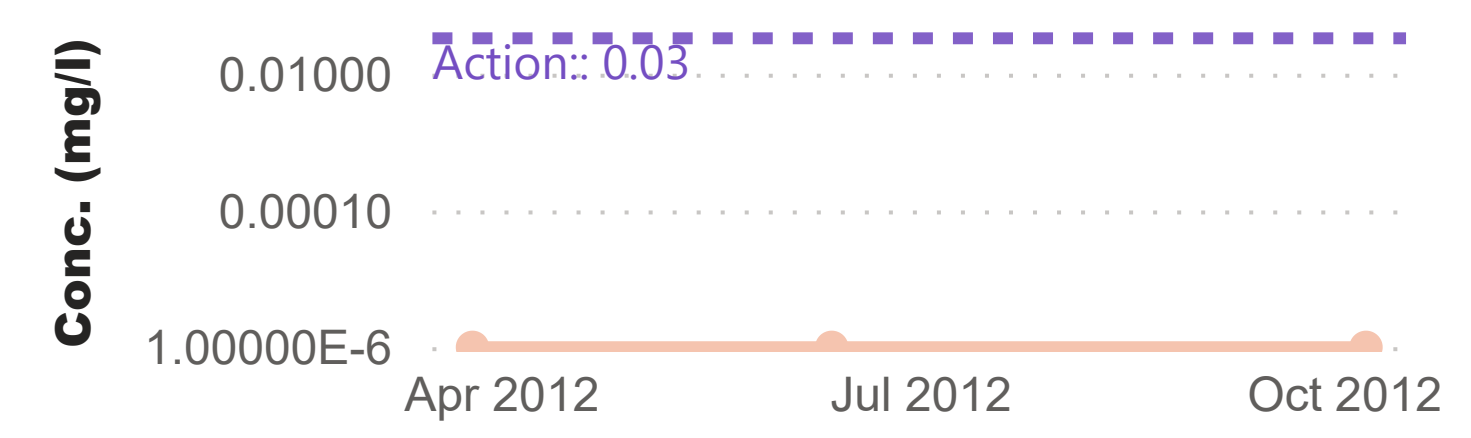
Benzene



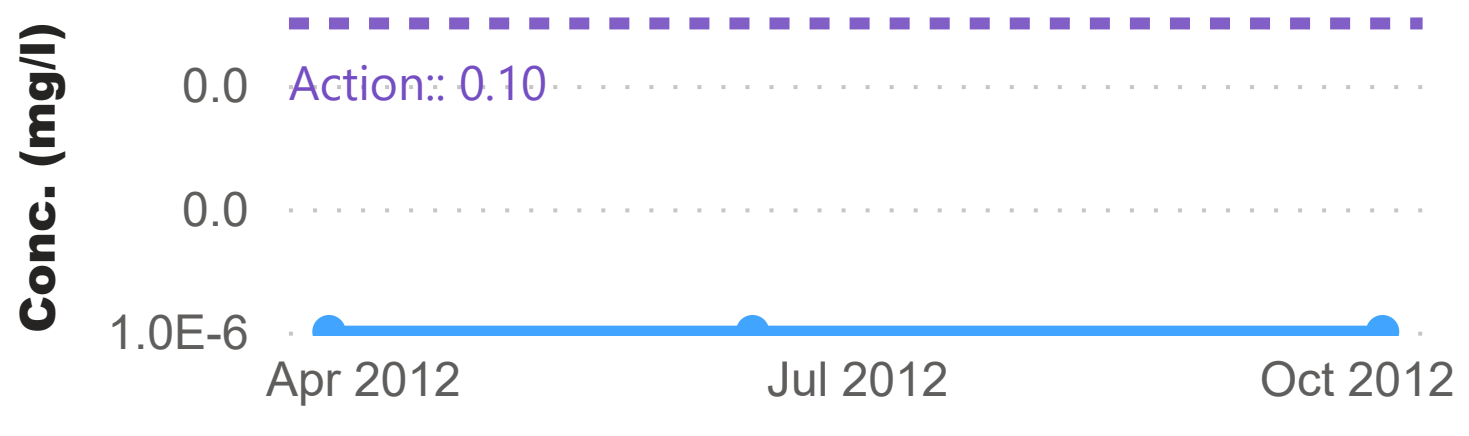
TPH-Aliphatic (Low)



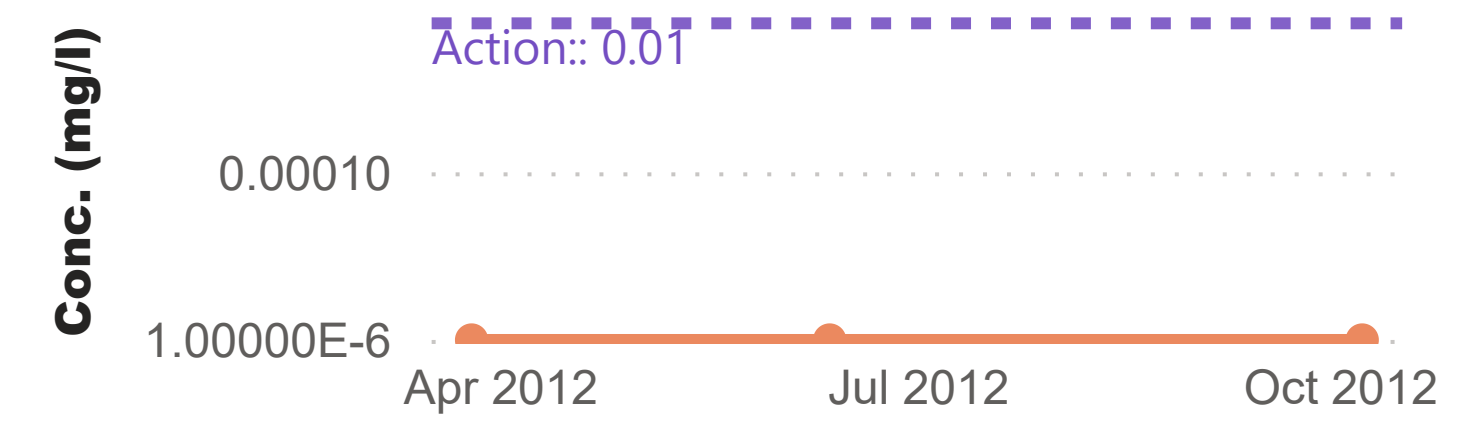
TPH-Aromatic (Low)



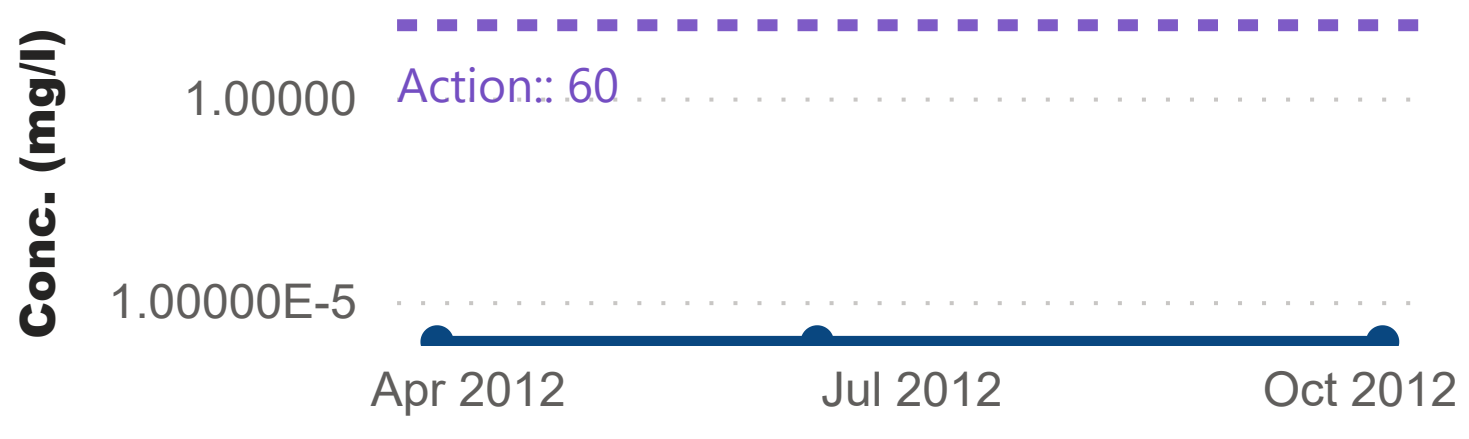
TPH-Aliphatic (Medium)



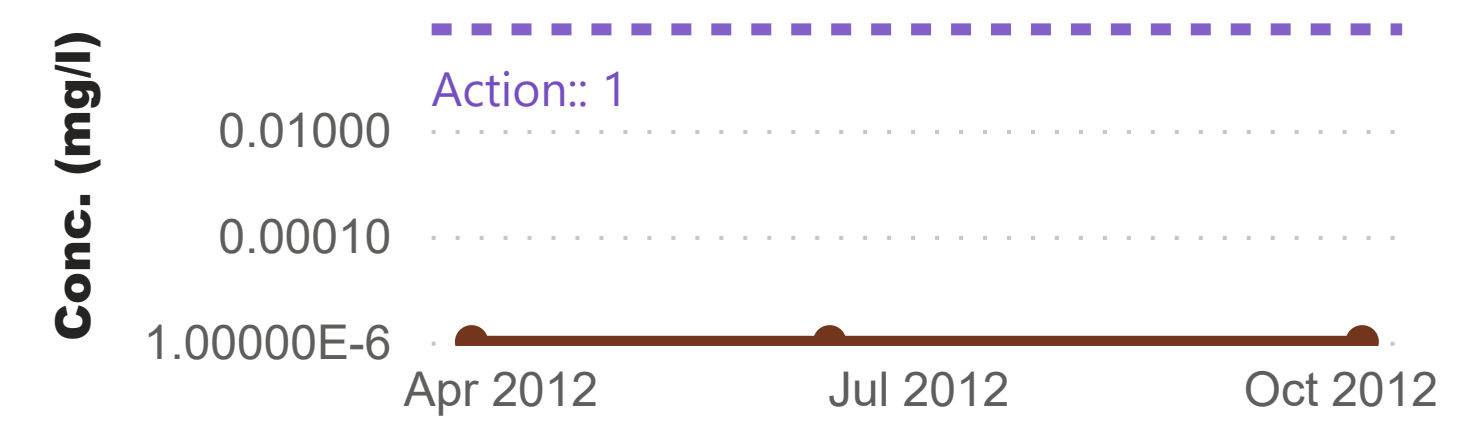
TPH-Aromatic (Medium)



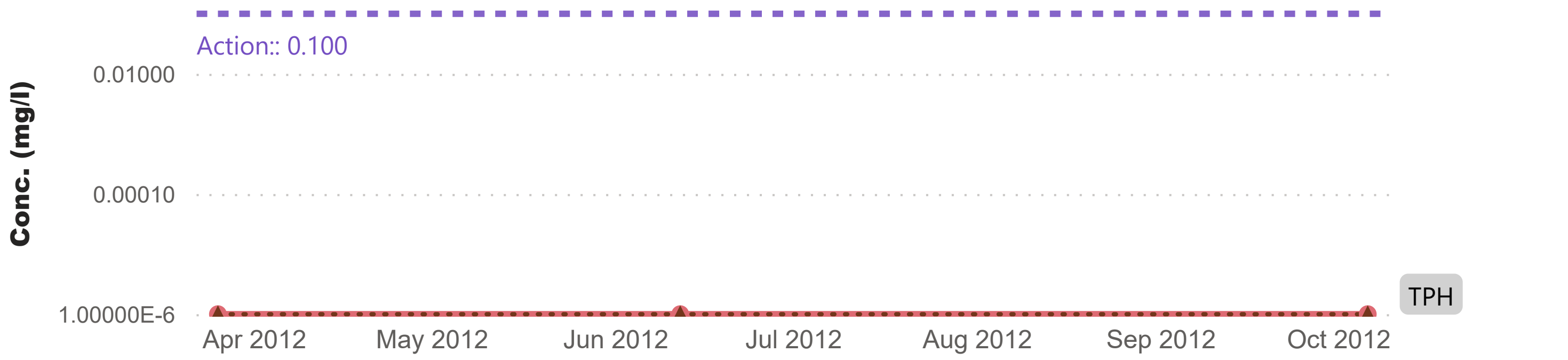
TPH-Aliphatic (High)



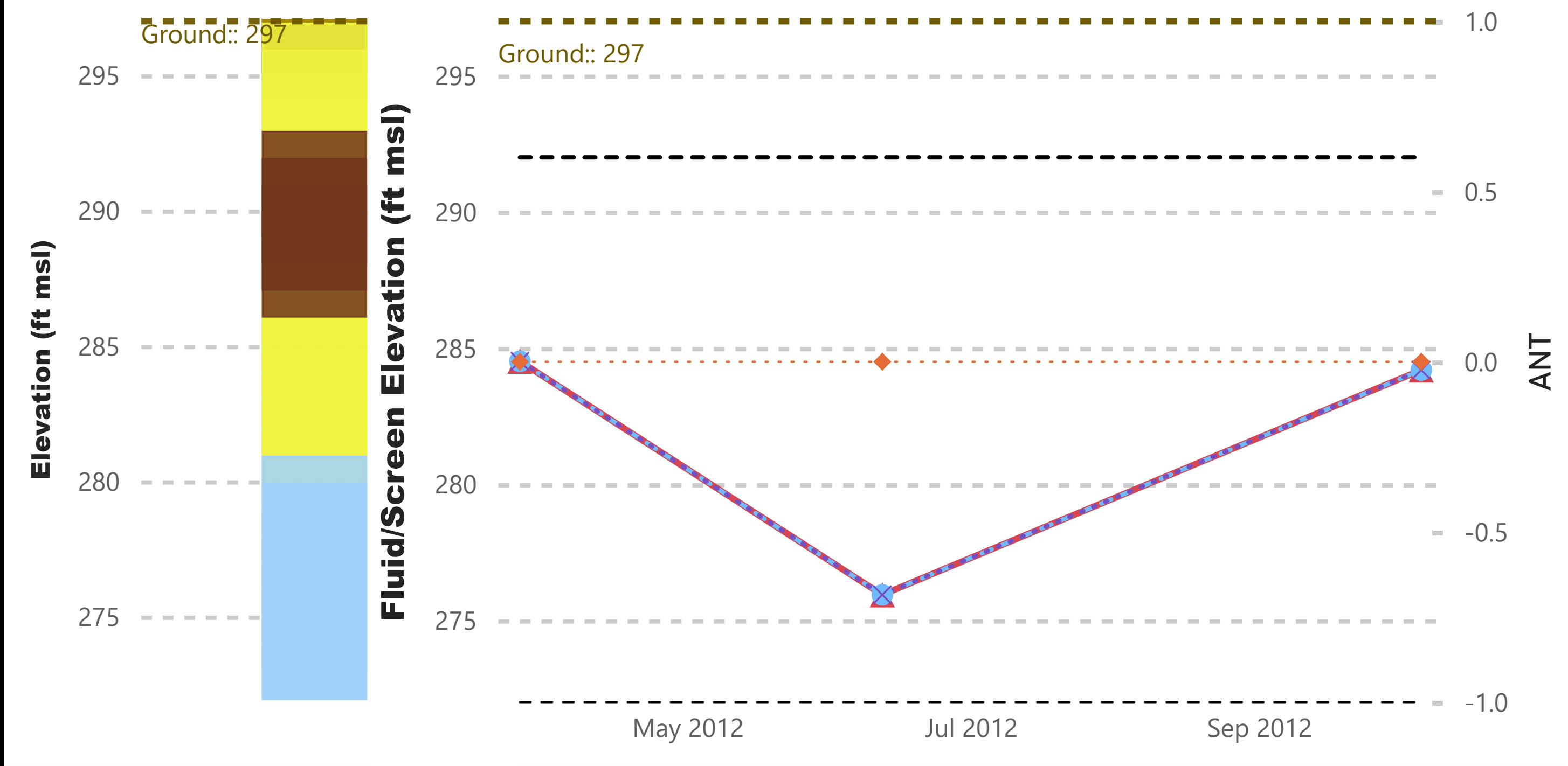
TPH-Aromatic (High)



TPH (with/without Silica Gel Cleanup)



Hydrograph



The Silica Gel Cleanup for TPH is a method used by the laboratory to "clean up" the sample extract before it is analyzed for TPH so that the extract contains primarily hydrocarbons (non-polar) compared to non-hydrocarbons like metabolites, natural organic matter, chlorinated solvents etc.

Molecular Structure	Aliphatic	Aromatic	Working Group	13 Transport Fractions	EPA 6 Toxicity Fractions
Aliphatic	ECS-6	ECS-7	Low	EC8-16	Low
Aromatic	ECS-8	ECS-9	Low	EC9-22	Low
Aliphatic	ECS-10	ECS-11	Medium	EC12-16	Medium
Aromatic	ECS-12	ECS-13	Medium	EC12-16	Medium
Aliphatic	ECS-14	ECS-15	High	EC16-21	High
Aromatic	ECS-16	ECS-17	High	EC16-21	High
Aliphatic	ECS-18	ECS-19	High	EC21-35	High
Aromatic	ECS-20	ECS-21	High	EC21-35	High

Clays/Till	Fine Sands	---	Screen	TOS/BOS	X	Corrected Groundwater Surface CGWS
Silts/Clays	Medium/Coarse Sands	▲	Air/NAPL Interface	ANI	◆	Apparent NAPL Thickness ANT
Silts	Fill	●	NAPL/Water Interface	NWI		

MW-4

Hydrograph & Dissolved Summary