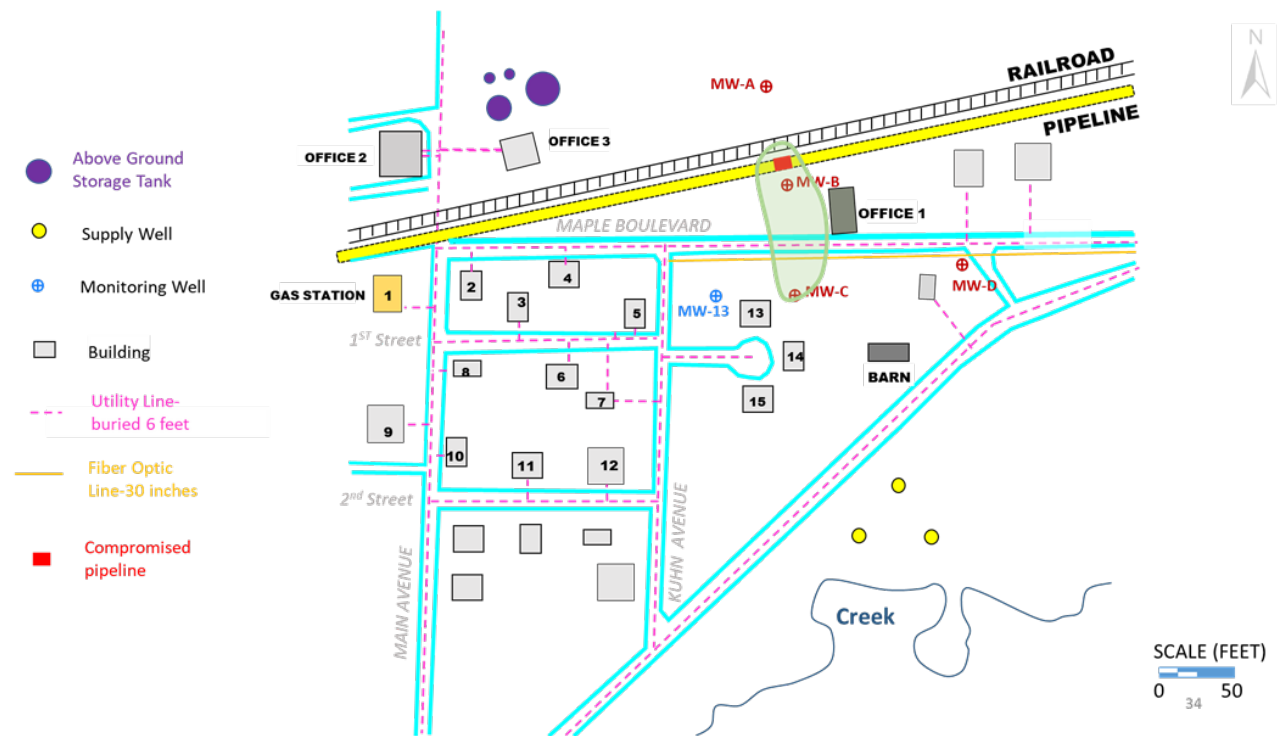


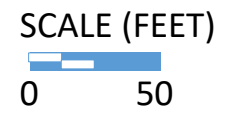
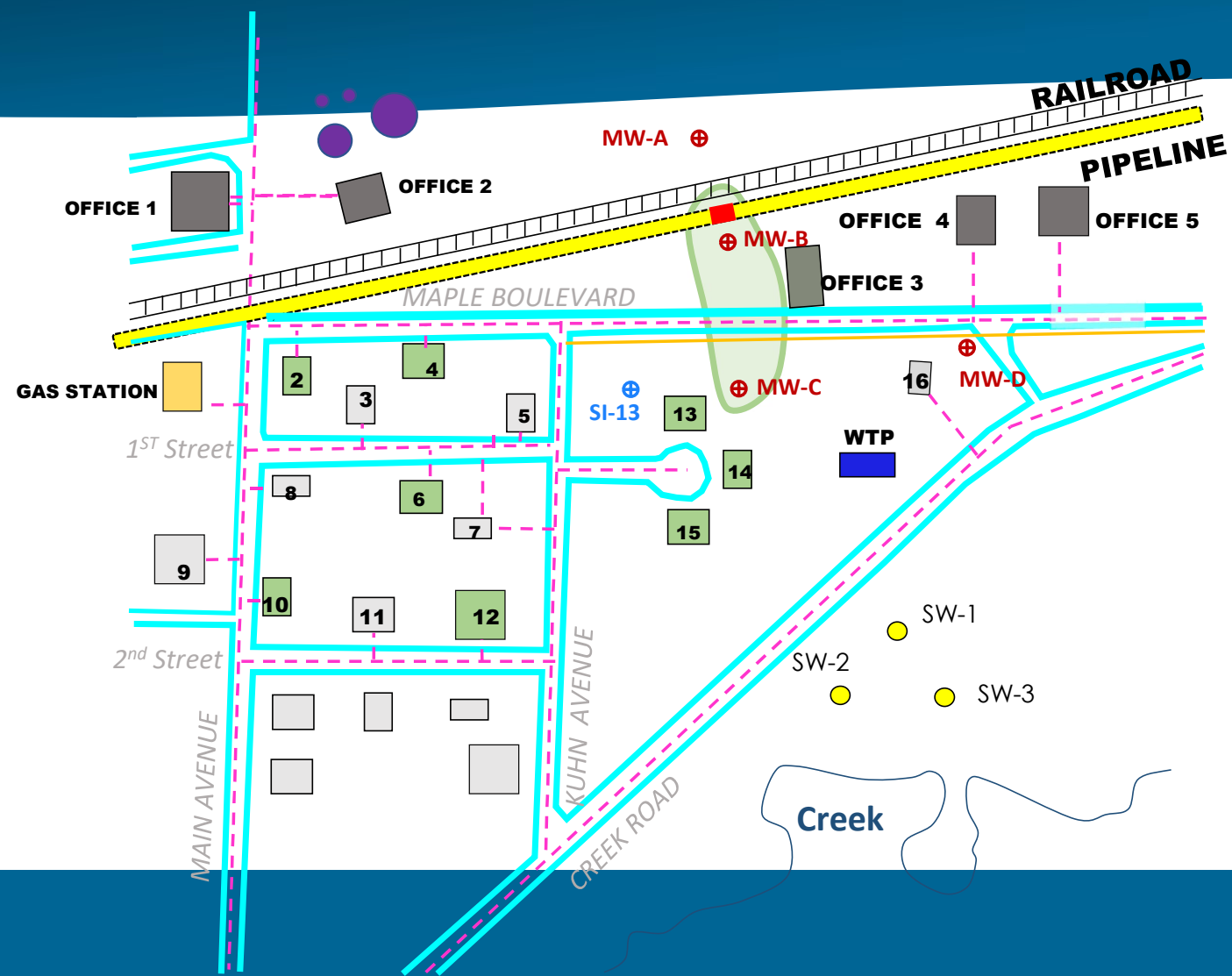
Glacial Fluvial Diesel Scenario

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. Workers digging in fiber optic along Maple Boulevard complain of petroleum odors. A previous investigation of a nearby gasoline release had indicated total petroleum hydrocarbon contamination with a diesel signature in monitoring well 13. Source identified as a small continuous leak from the diesel pipeline, the quantity and duration of the leak is unknown. Potential impacts include vapor intrusion, soil, and groundwater contamination.

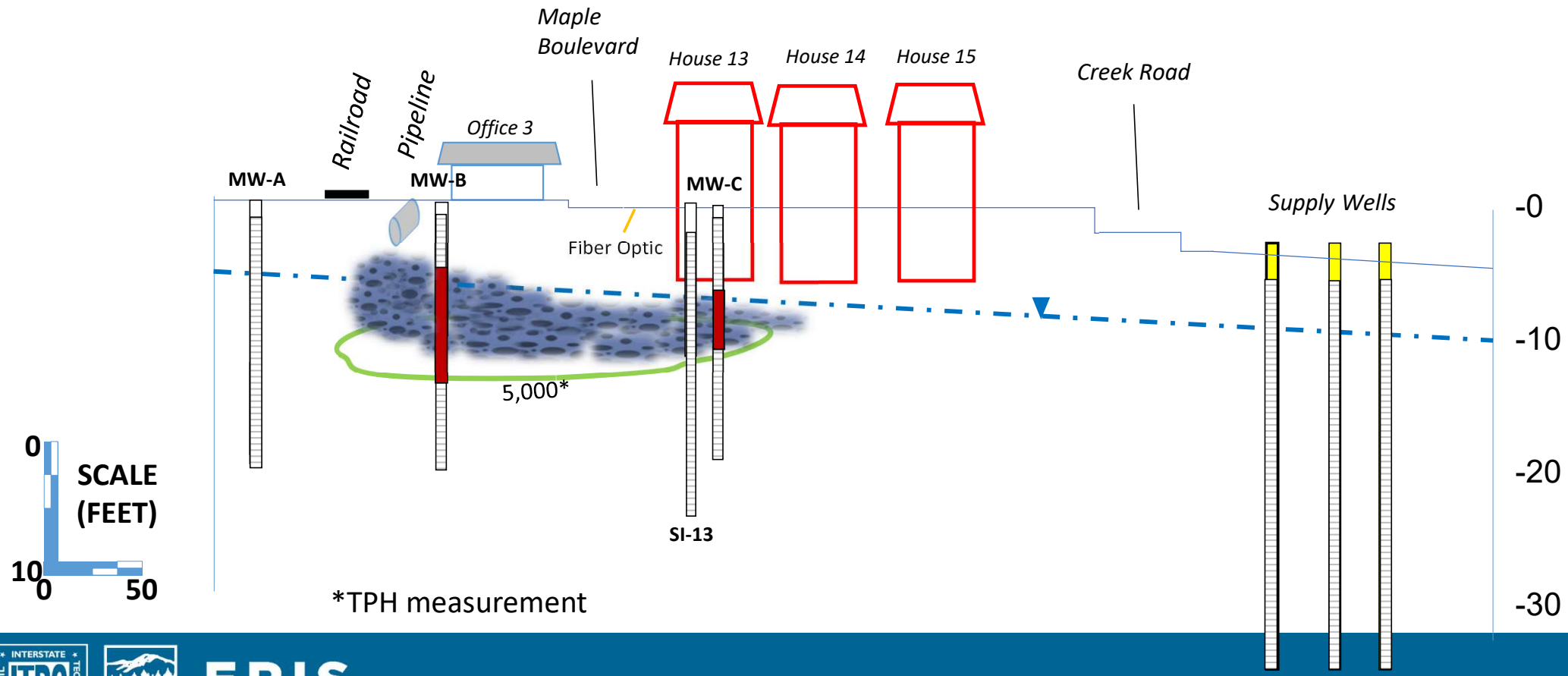




- Diesel
- Compromised pipeline
- Monitoring Well
- Previous Investigation Well
- Supply Well
- House with basement
- Water Treatment Plant
- Utility Line-buried 4 feet
- Fiber Optic Line-30 inches
- Above Ground Storage Tank



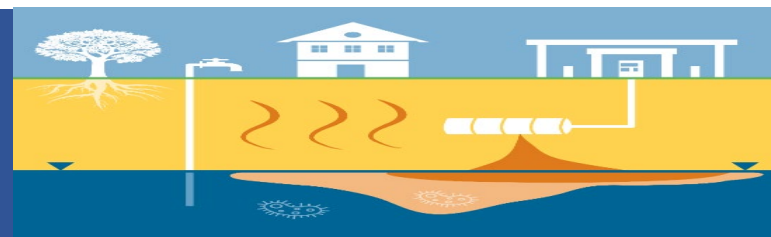
Cross Section View



*TPH measurement

Scenario Screening Levels

(for exercise purposes only)

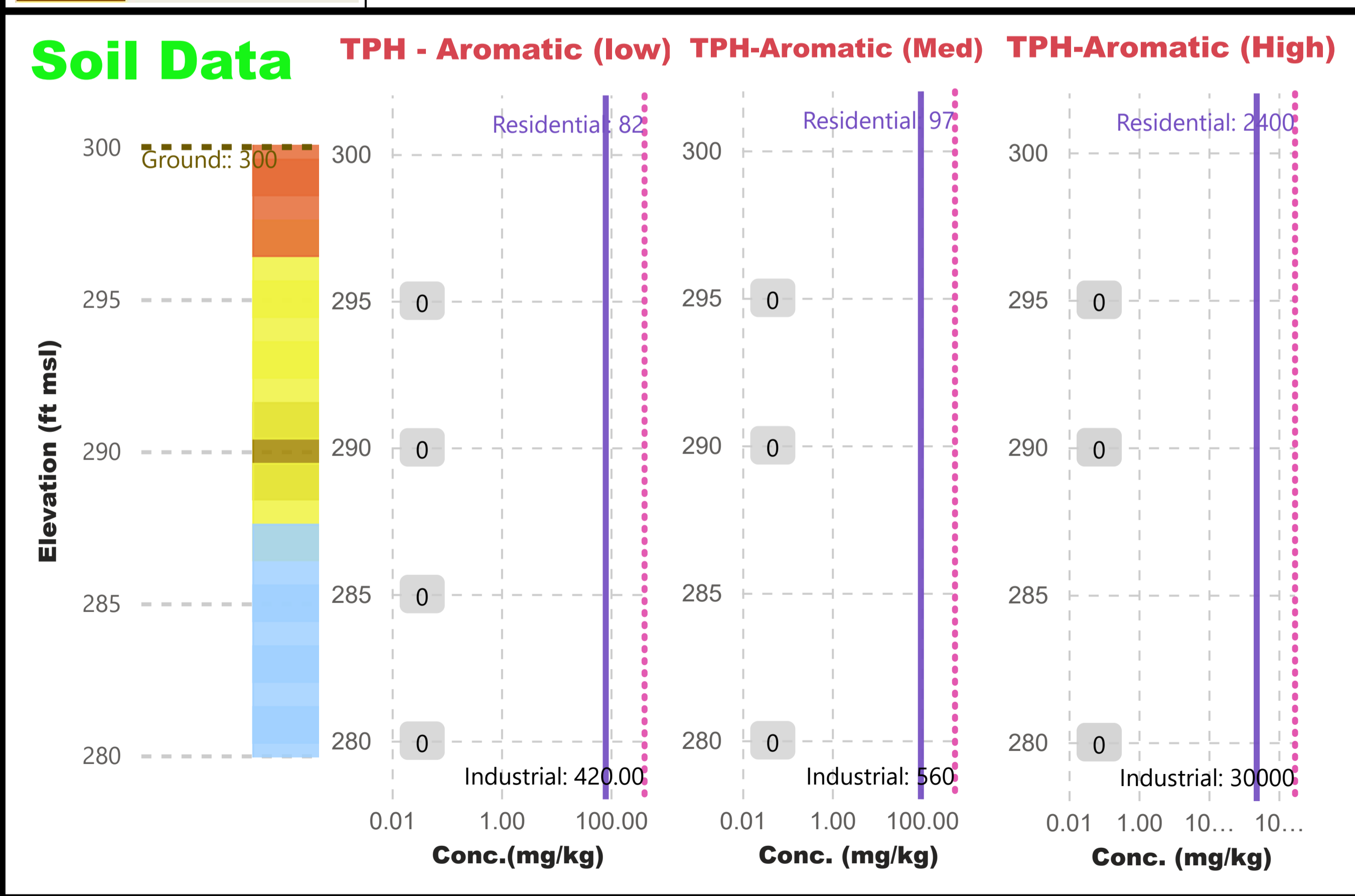
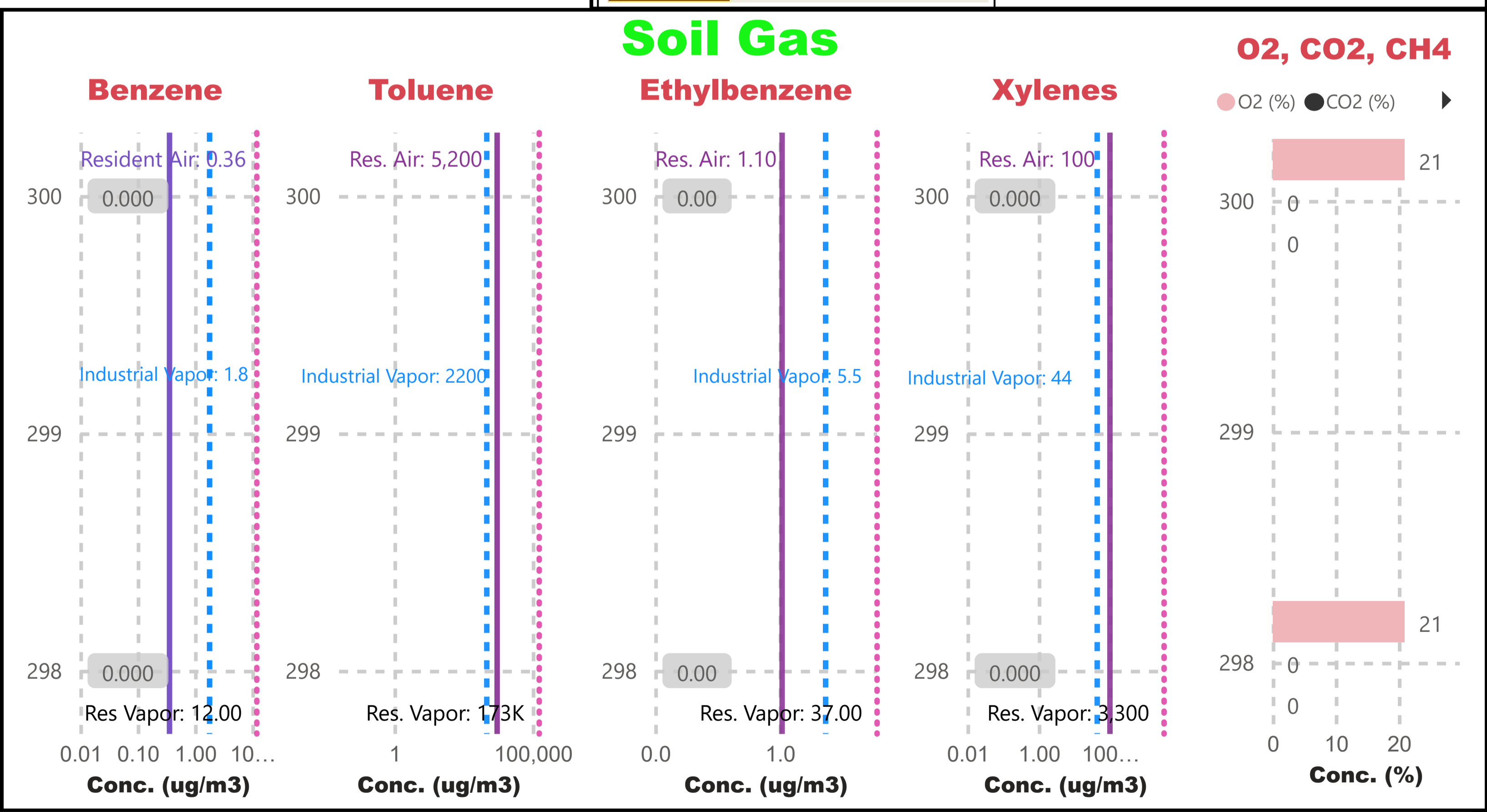
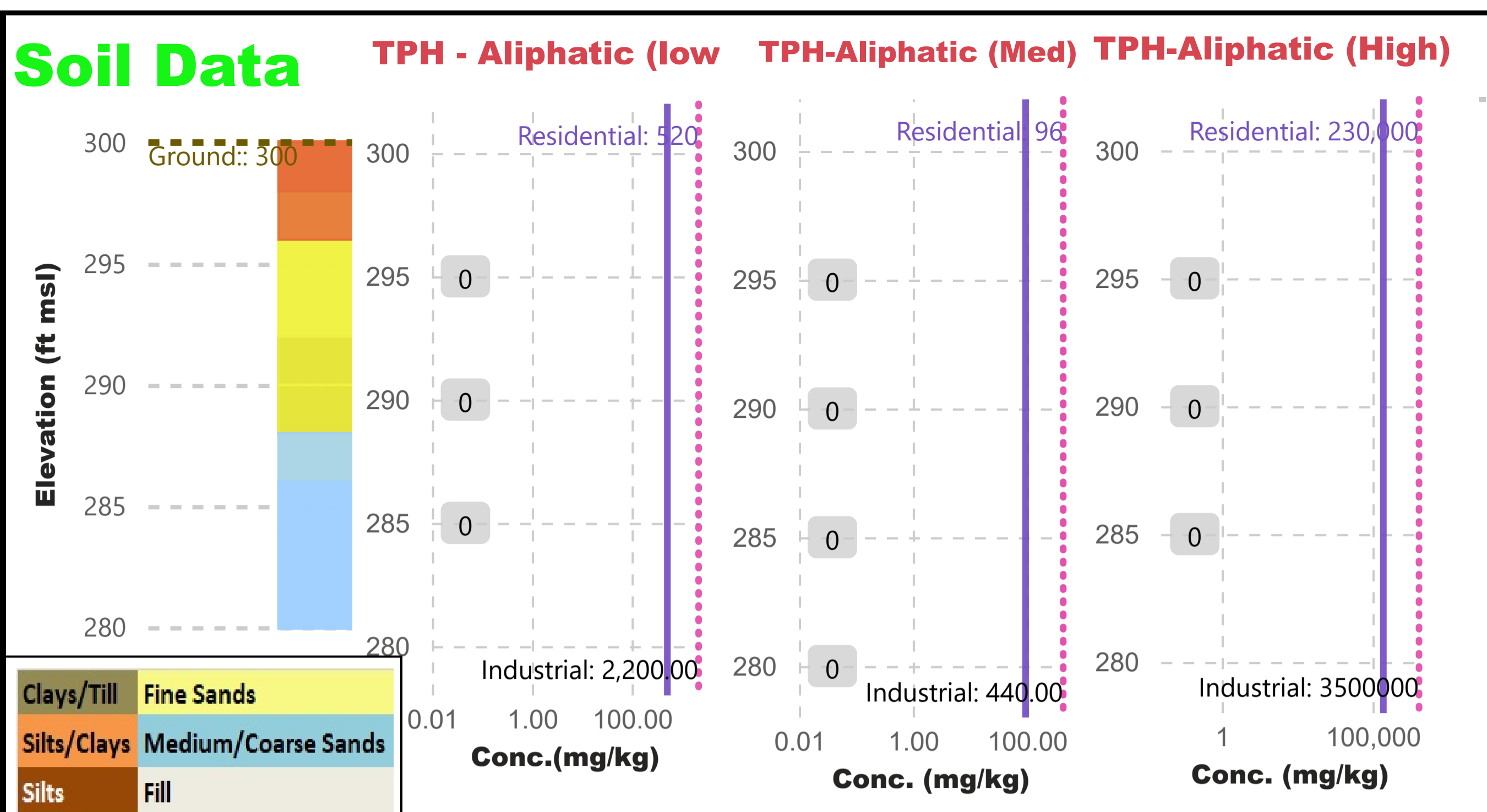
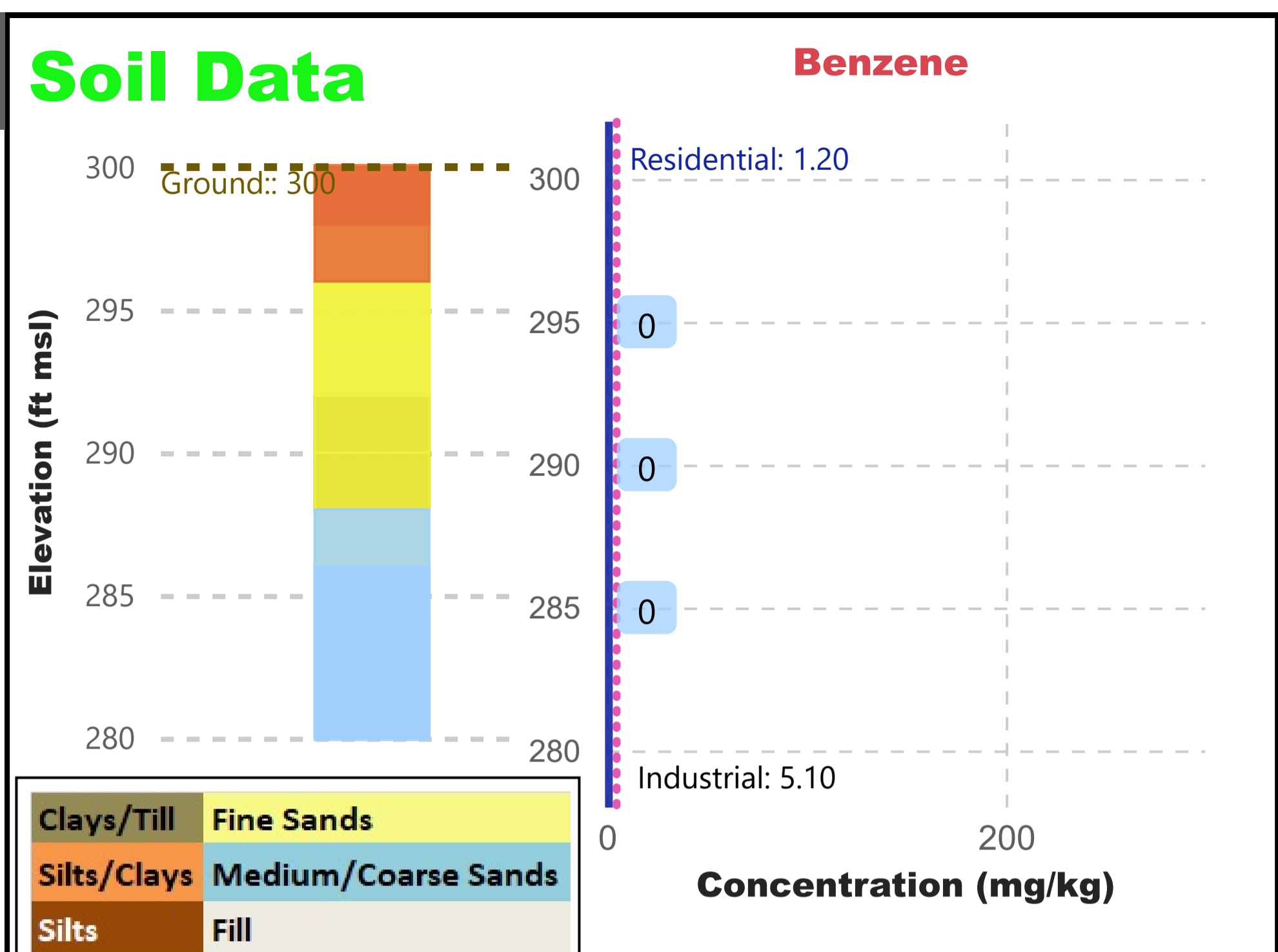
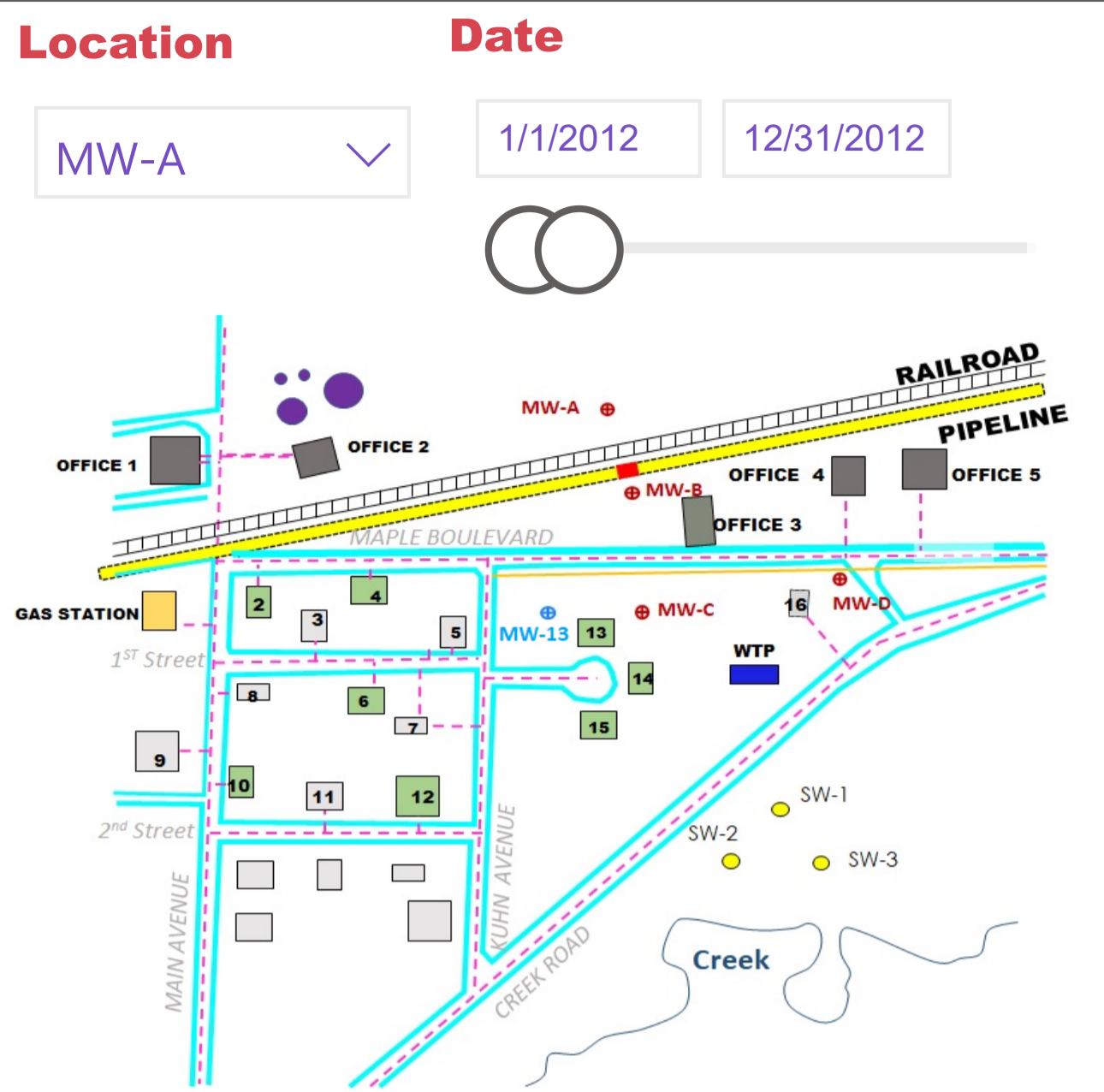


| Contaminant | Resident Soil (mg/kg) | Industrial Soil (mg/kg) | Resident Air (ug/m ³) | Resident Soil Vapor (ug/m ³) | Industrial Soil Vapor (ug/m ³) | Groundwater (ug/L) | C _{sat} (mg/kg) |
|---|-----------------------|-------------------------|-----------------------------------|--|--|--------------------|--------------------------|
| Volatile Organic Compounds: | | | | | | | |
| 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 |
| Lead scavengers: | | | | | | | |
| 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 |
| Polynuclear Aromatic Hydrocarbons: | | | | | | | |
| Naphthalene | 2 | 8.6 | 0.08 | 2.8 | 0.4 | 0.12 | NA |
| Total Petroleum Hydrocarbons: | | | | | | | |
| 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

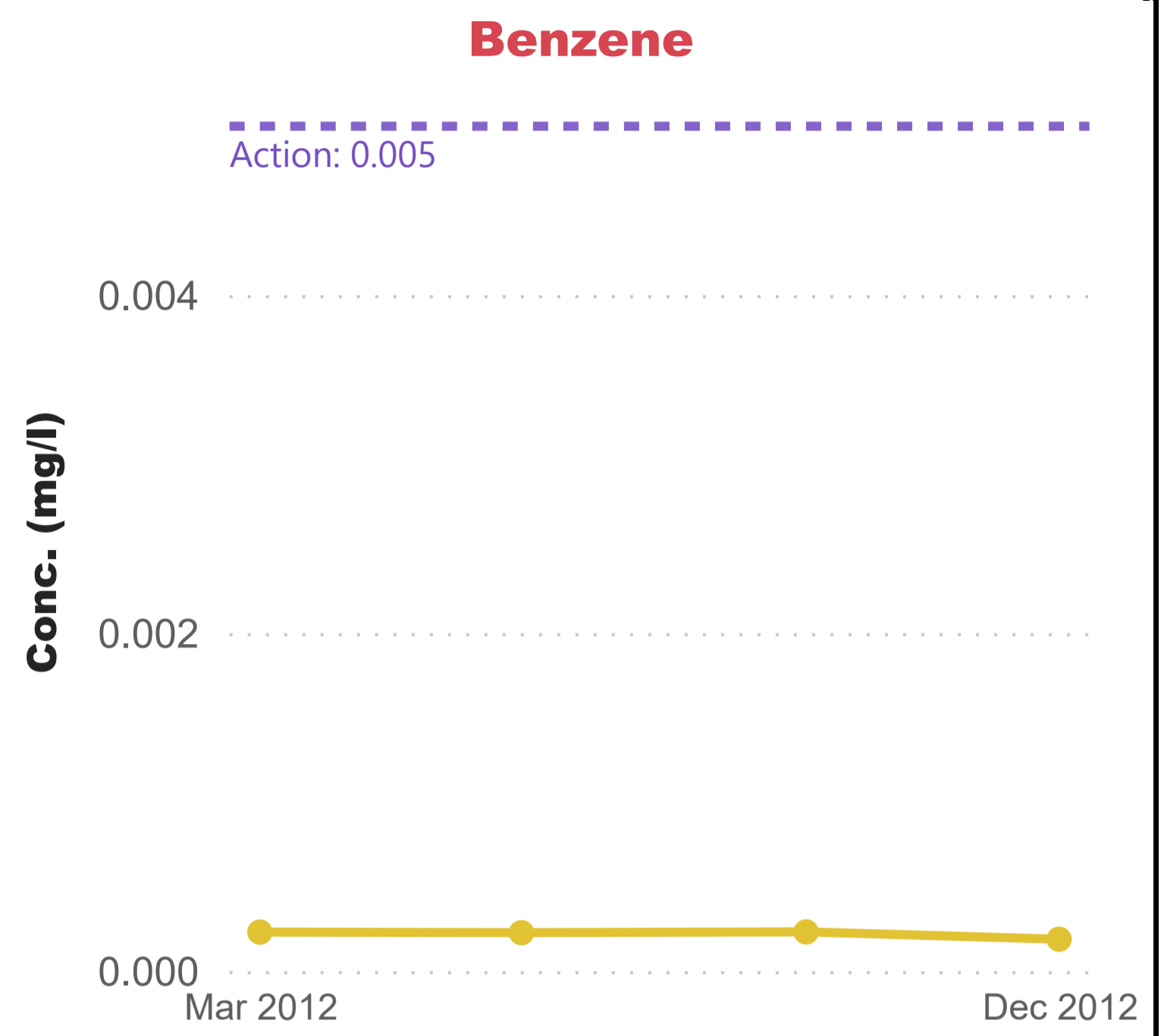


MW-A Soil and Soil Gas Summary

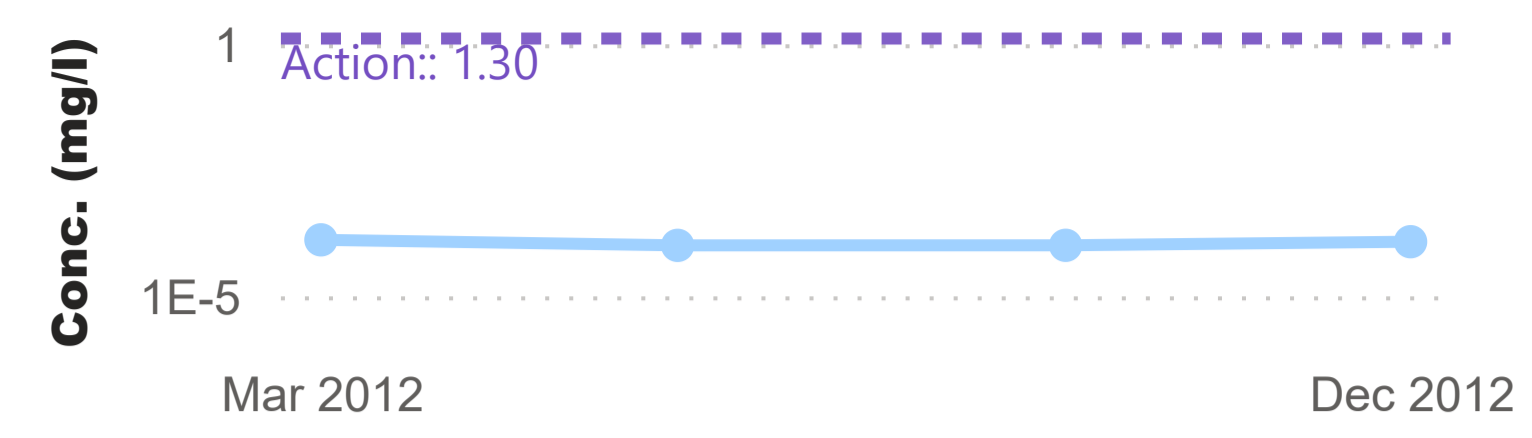
| | | | | | | |
|-------------|---------------------|--|--------------|------------------|-----------------|---------------------------------|
| Clays/Till | Fine Sands | <p>TPH Criteria Working Group 13 Transport Fractions</p> | EC5-8 Low | EC8-16 Medium | EC16-35 High | <p>EPA 6 Toxicity Fractions</p> |
| Silts/Clays | Medium/Coarse Sands | | EC6-9 Low | EC9-22 Medium | EC22-35 High | |
| Silts | Fill | | | | | |



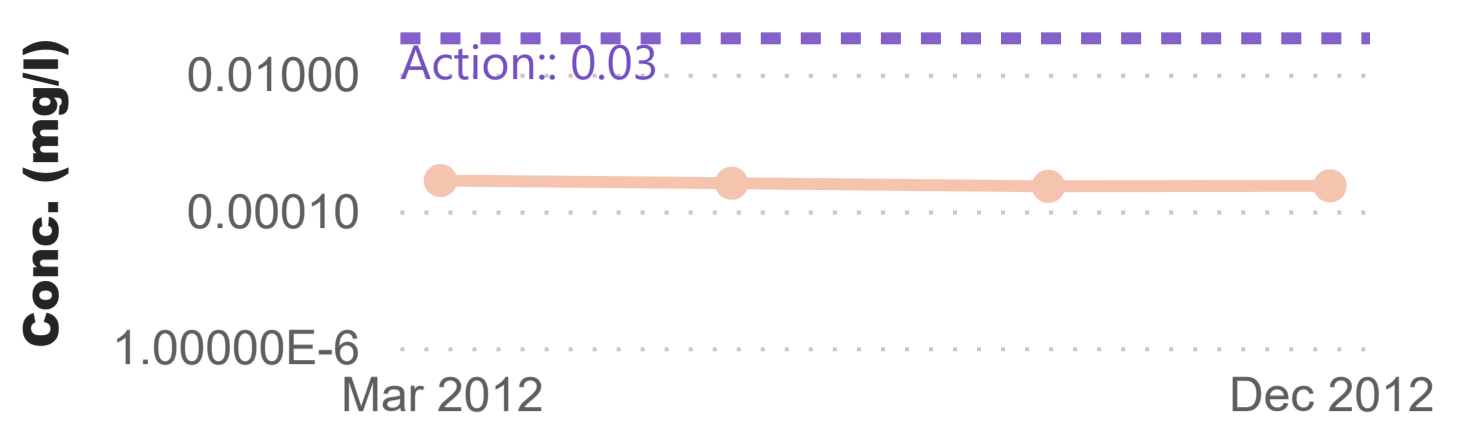
Dissolved Phase



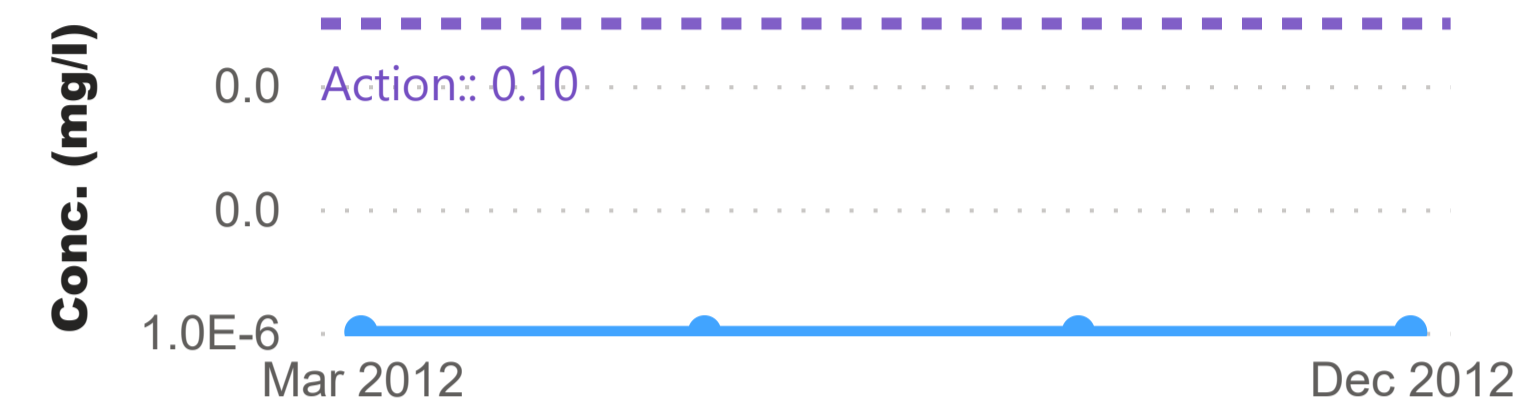
TPH-Aliphatic (Low)



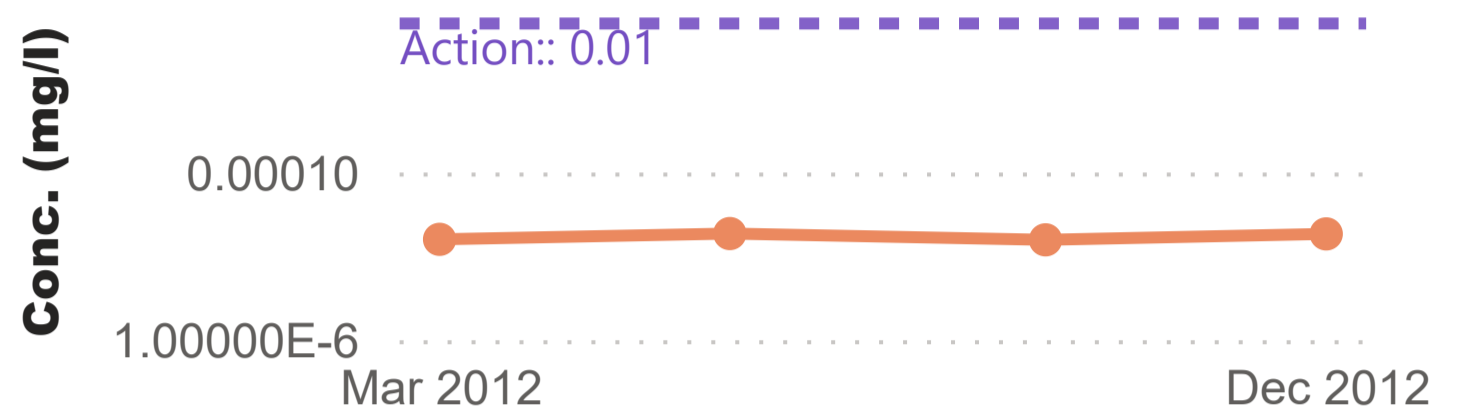
TPH-Aromatic (Low)



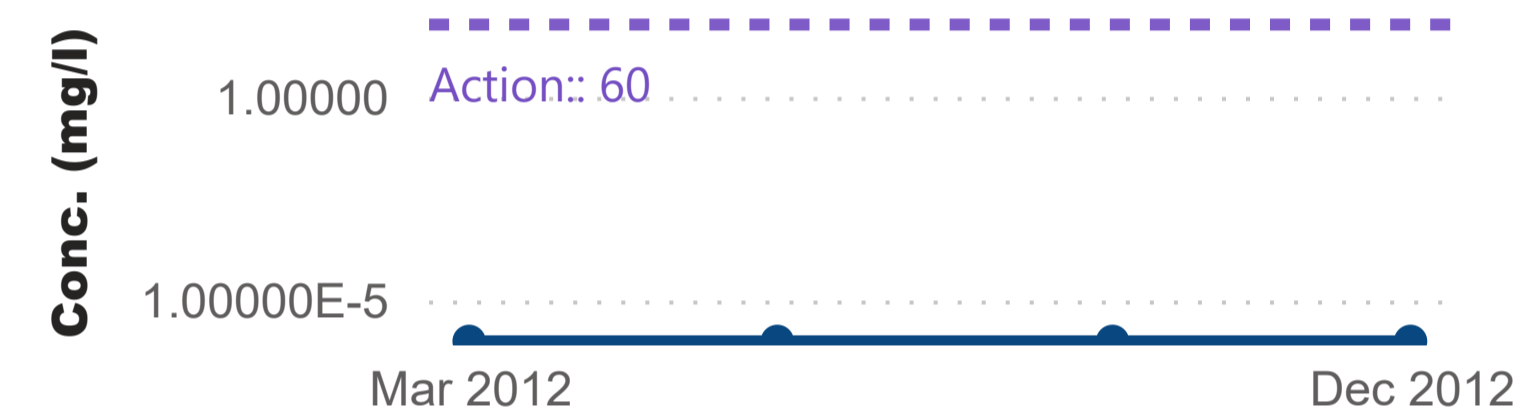
TPH-Aliphatic (Medium)



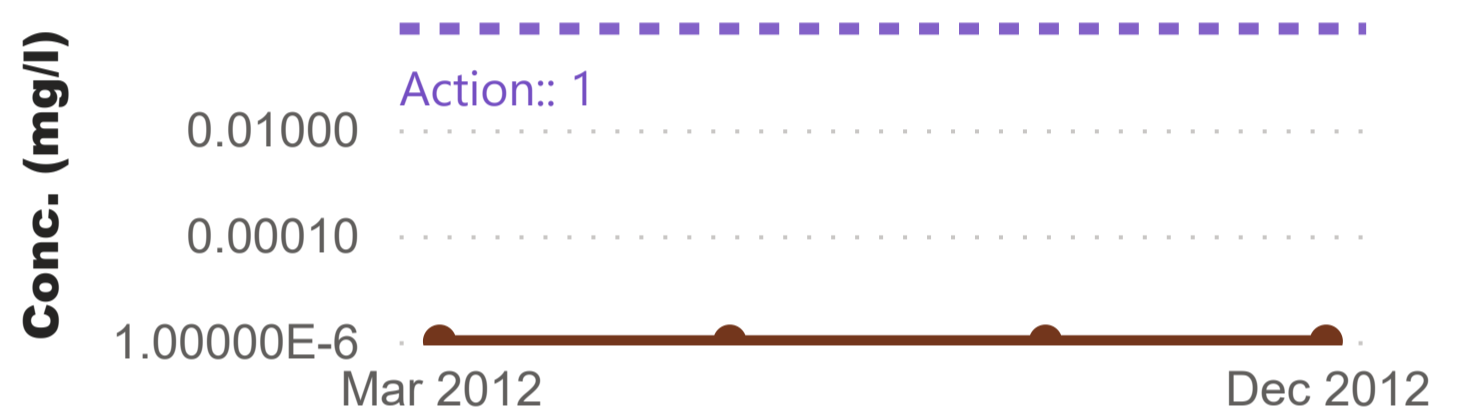
TPH-Aromatic (Medium)



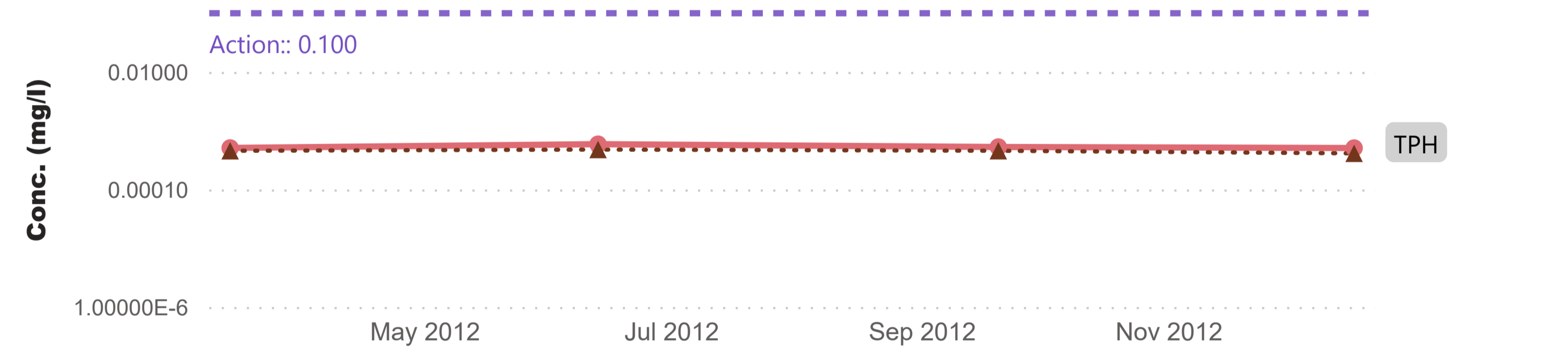
TPH-Aliphatic (High)



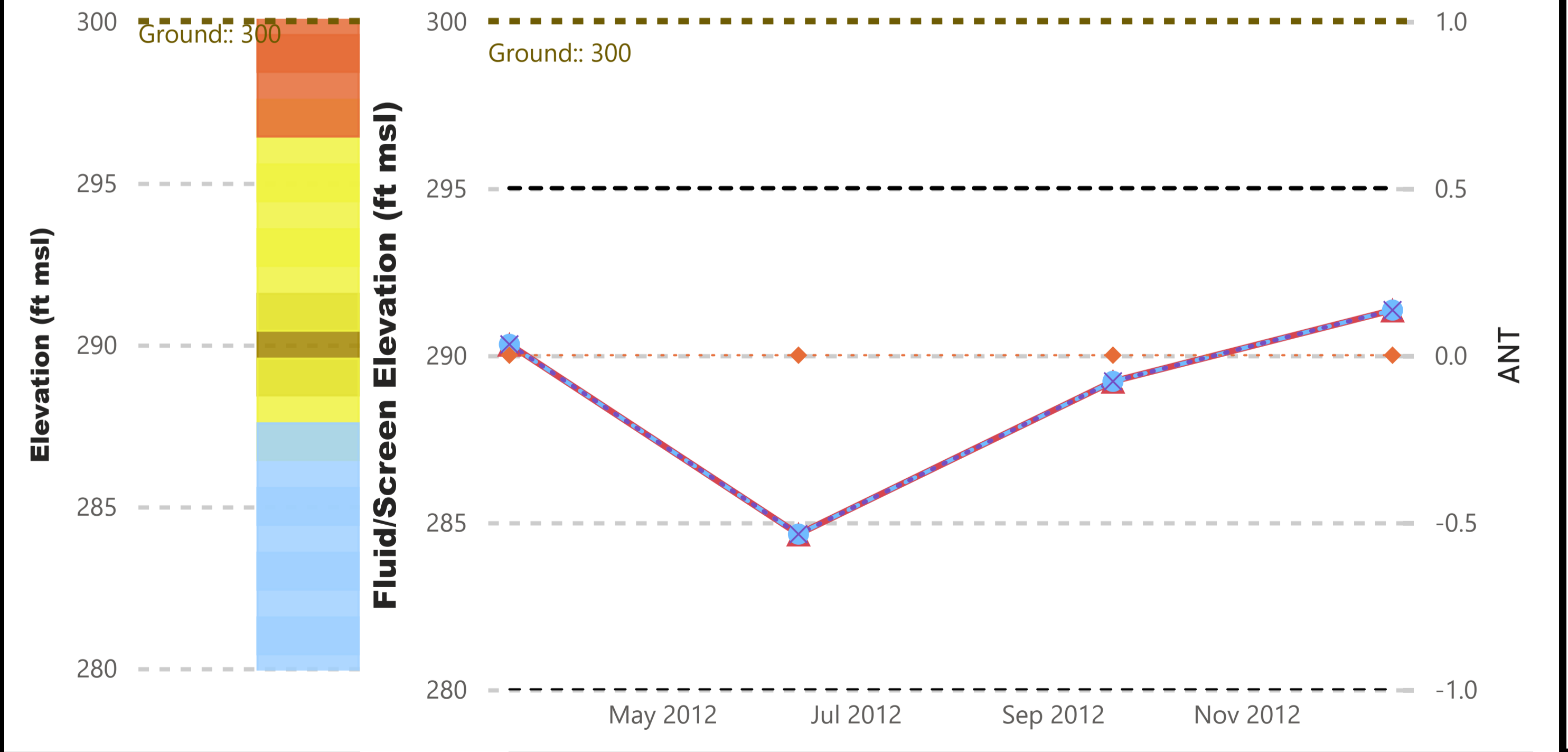
TPH-Aromatic (High)



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.

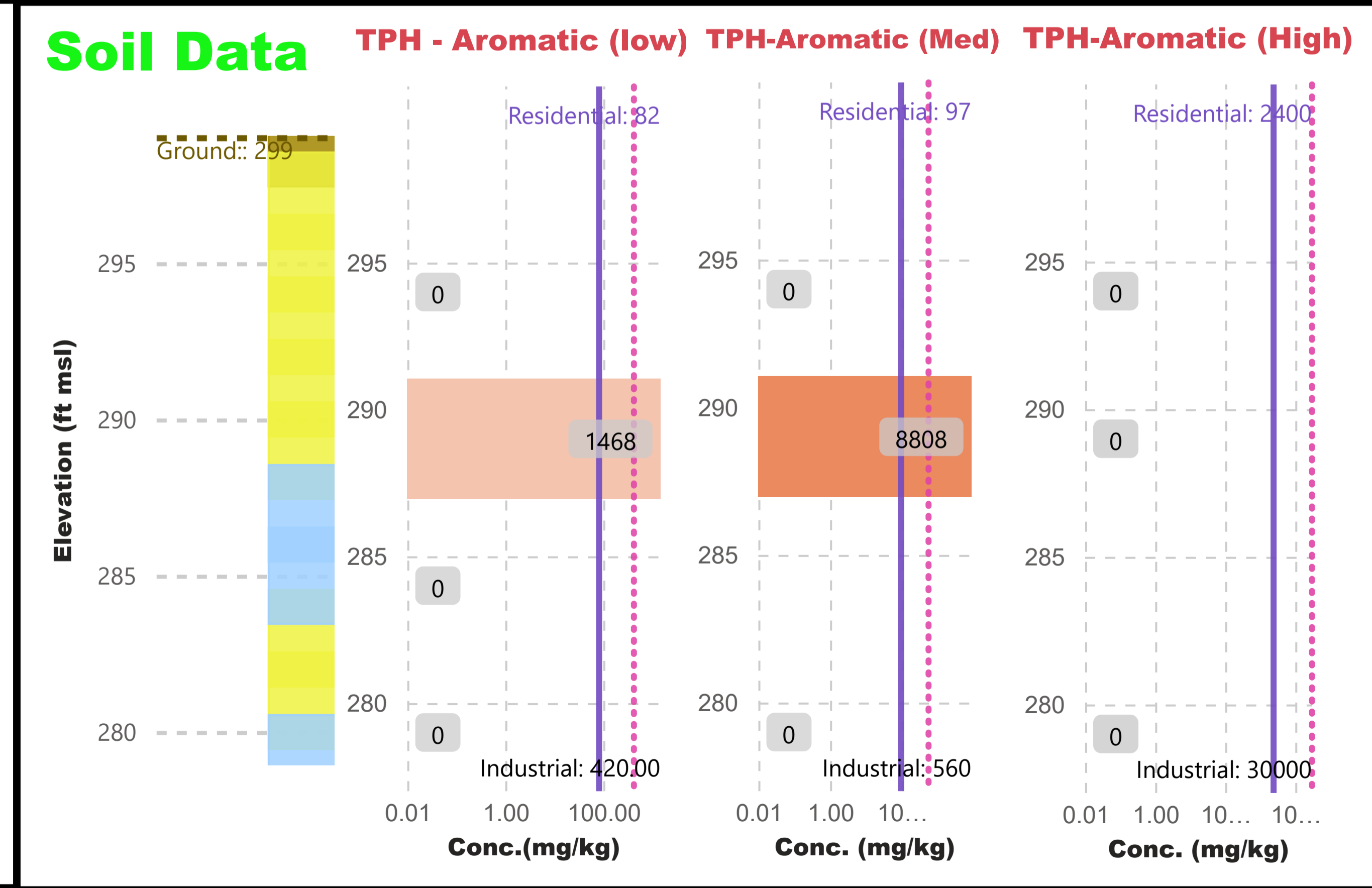
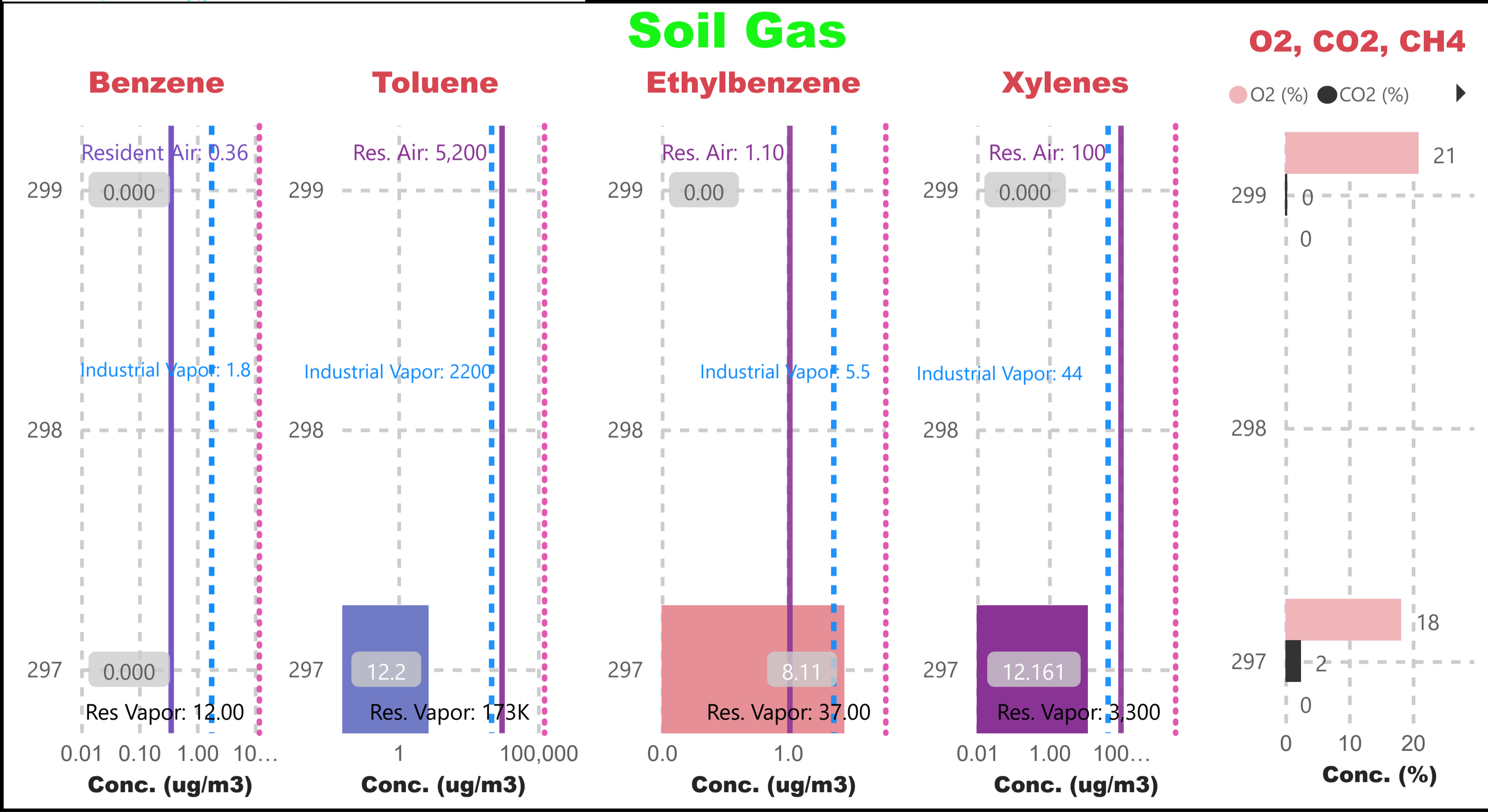
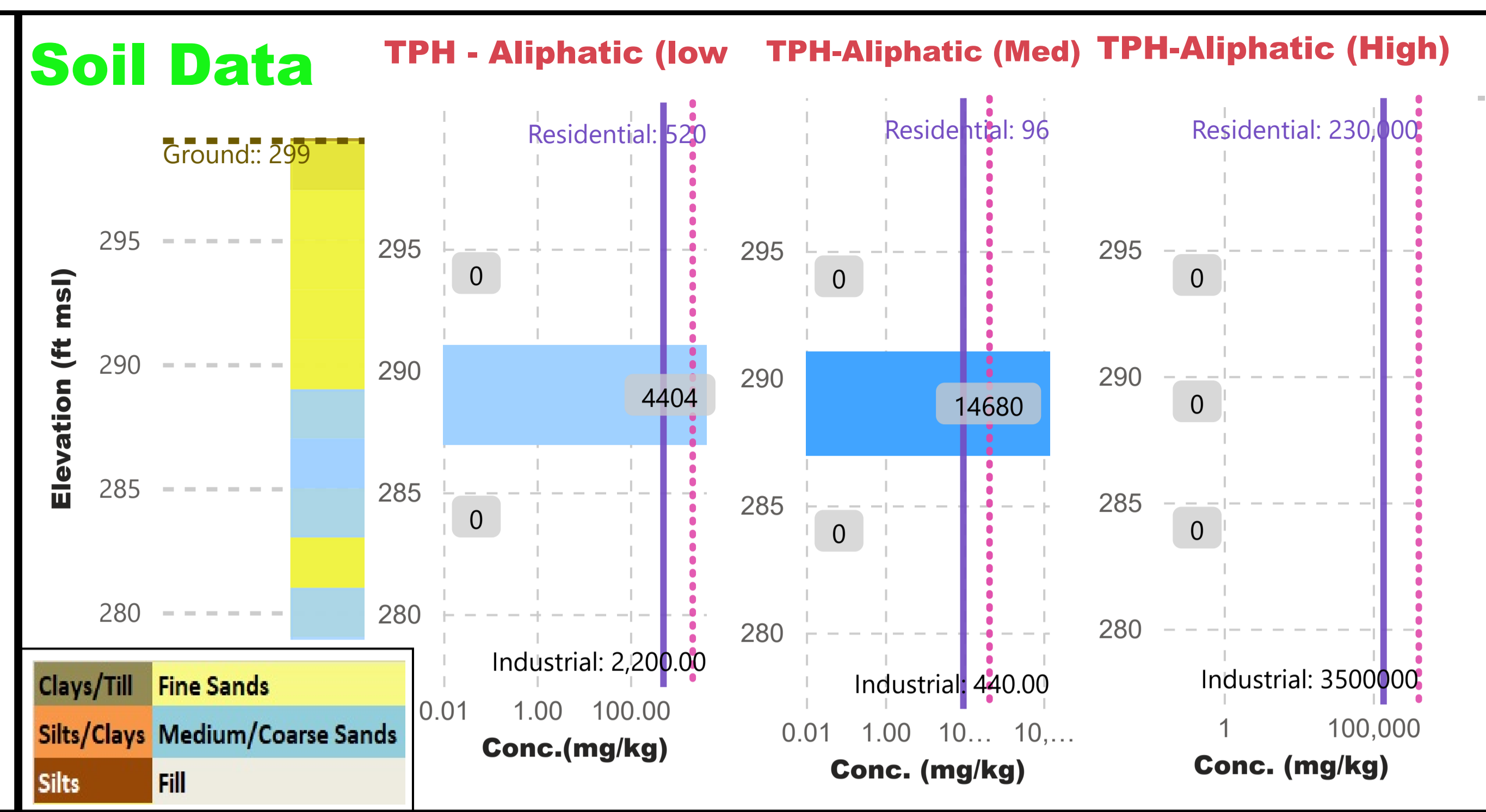
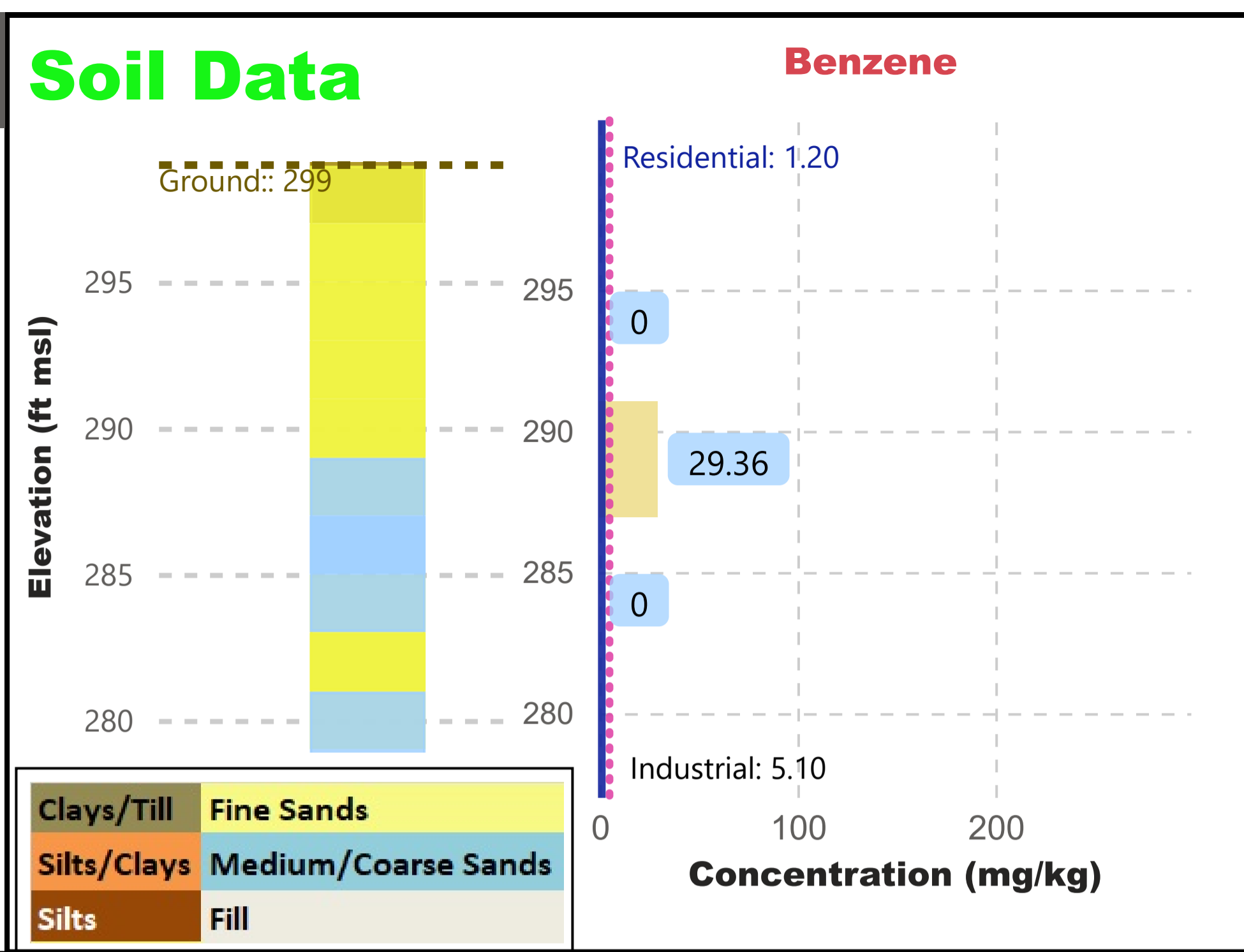
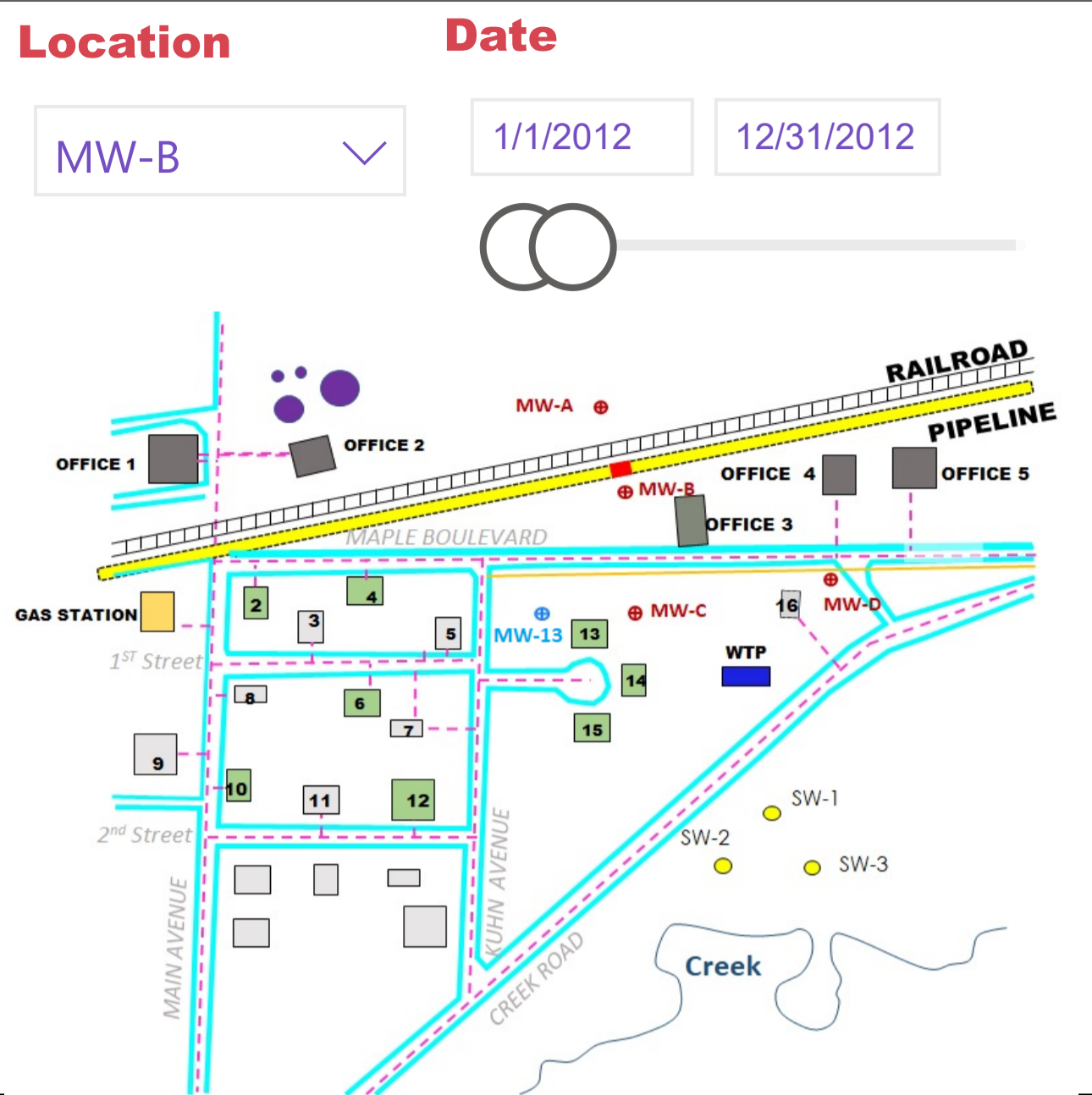
| Molecular Structure | Aliphatic | Aromatic | Working Group | 13 Transport Fractions | EPA 6 Toxicity Fractions |
|---------------------|-----------|----------|---------------|------------------------|--------------------------|
| Aliphatic | EC5-6 | EC8-16 | Low | EC16-35 | High |
| Aromatic | EC7-10 | EC9-22 | Low | EC22-35 | 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-A

Hydrograph & Dissolved Summary

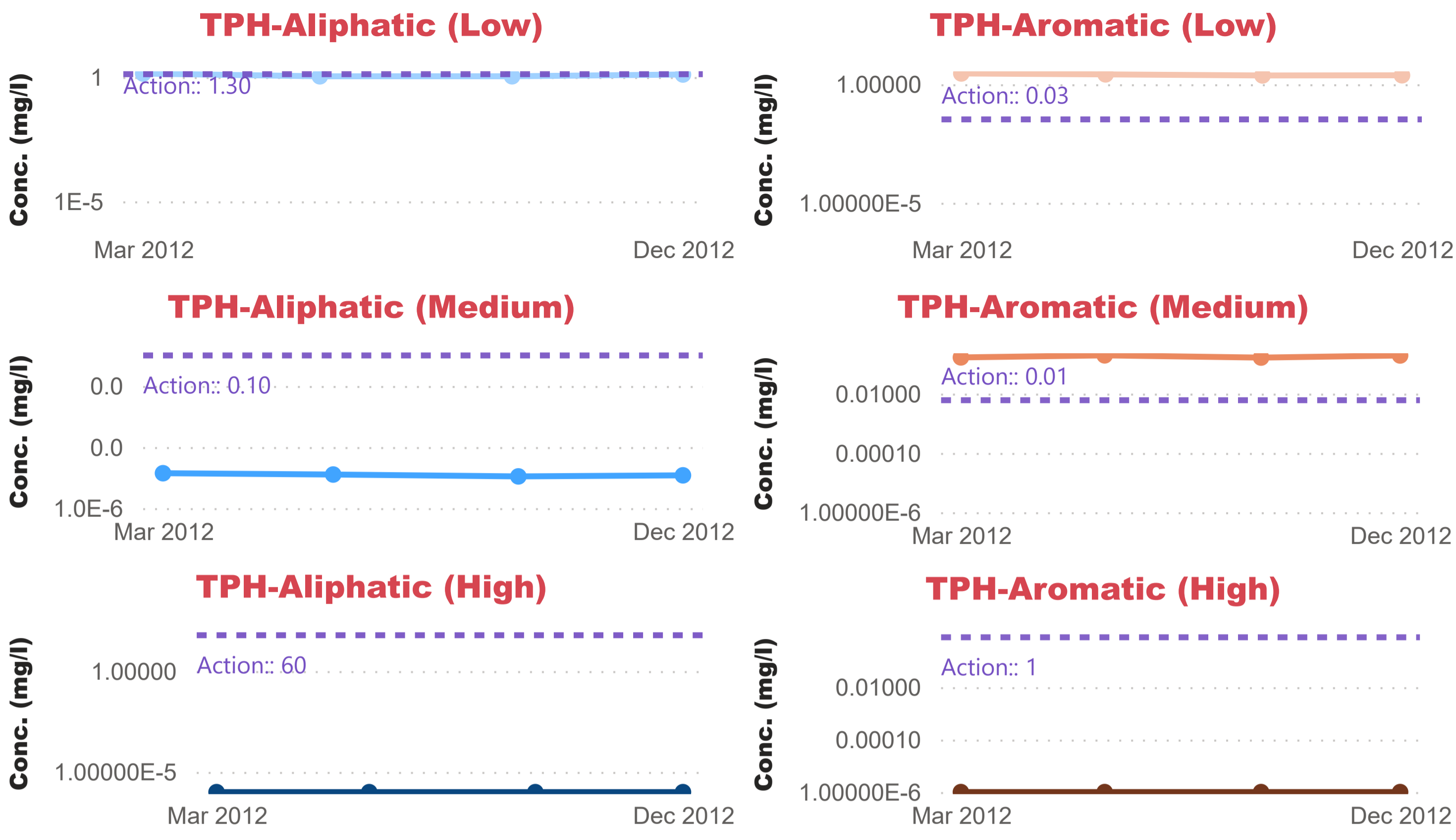
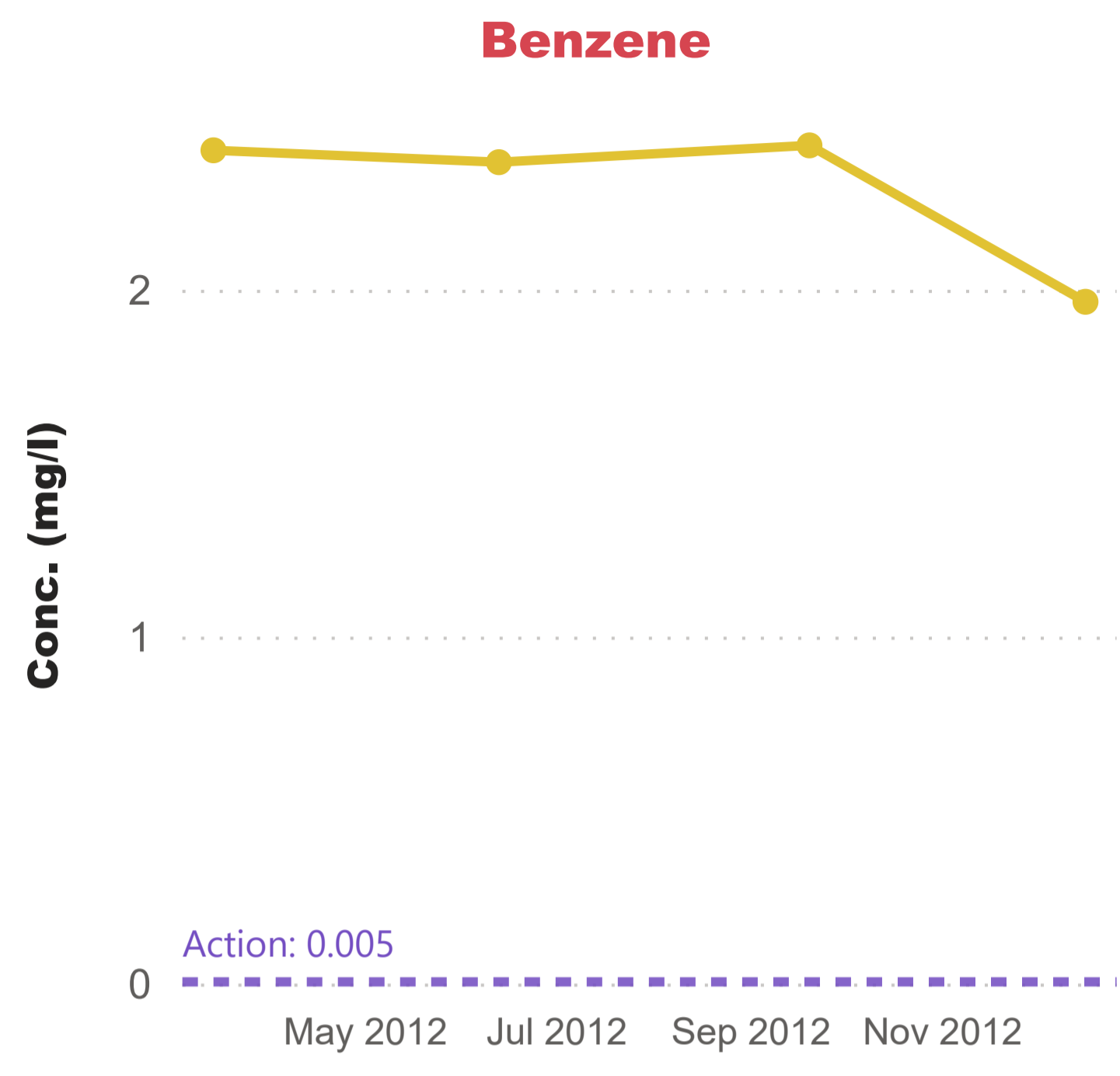


MW-B Soil and Soil Gas Summary

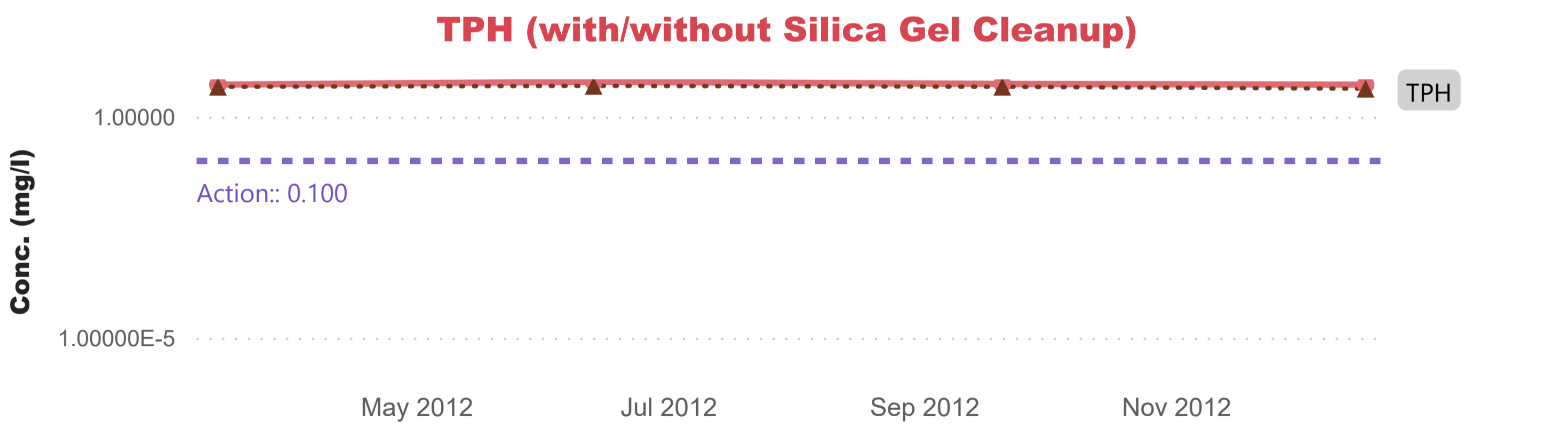
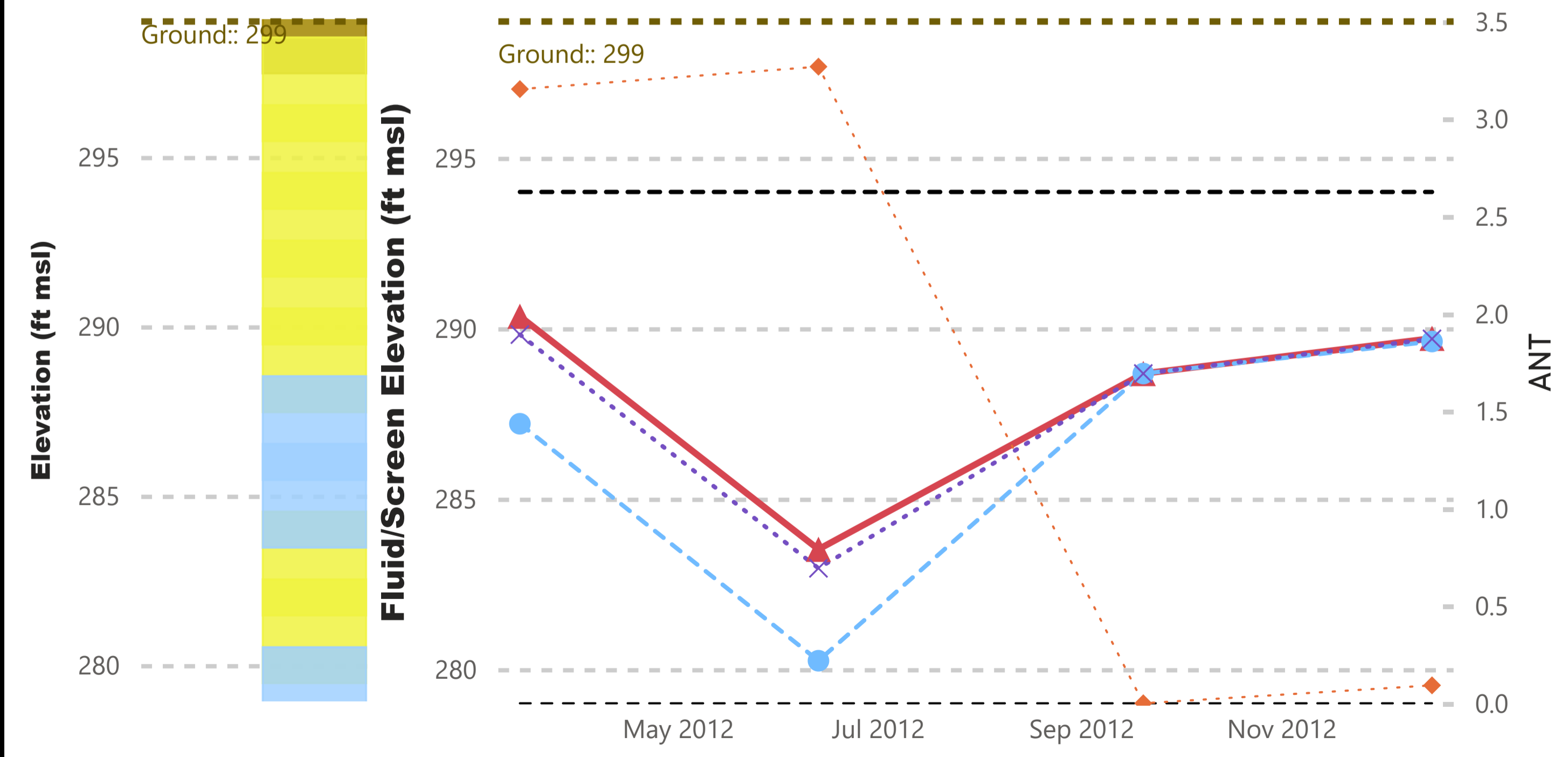
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------|------------|---|---------|-------|---------|---------|---------|-------|---------|---------|---------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--|-------|--------|---------|-----|--------|------|-------|--------|---------|-----|--------|------|--------------------------|
| Clays/Till | Fine Sands | <table border="1"> <tr><td>EC5-6</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC6-8</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC7-9</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC10-12</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC13-15</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC14-17</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC18-20</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> </table> | | EC5-6 | EC12-16 | EC16-21 | EC21-35 | EC6-8 | EC12-16 | EC16-21 | EC21-35 | EC7-9 | EC12-16 | EC16-21 | EC21-35 | EC10-12 | EC12-16 | EC16-21 | EC21-35 | EC13-15 | EC12-16 | EC16-21 | EC21-35 | EC14-17 | EC12-16 | EC16-21 | EC21-35 | EC18-20 | EC12-16 | EC16-21 | EC21-35 | <p>TPH Criteria Working Group 13 Transport Fractions</p> <table border="1"> <tr><td>EC5-8</td><td>EC8-16</td><td>EC16-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> <tr><td>EC6-9</td><td>EC9-22</td><td>EC22-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> </table> | EC5-8 | EC8-16 | EC16-35 | Low | Medium | High | EC6-9 | EC9-22 | EC22-35 | Low | Medium | High | EPA 6 Toxicity Fractions |
| EC5-6 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC6-8 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC7-9 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC10-12 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC13-15 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC14-17 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC18-20 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC5-8 | EC8-16 | EC16-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Low | Medium | High | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EC6-9 | EC9-22 | EC22-35 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Low | Medium | High | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |



Dissolved Phase



Hydrograph



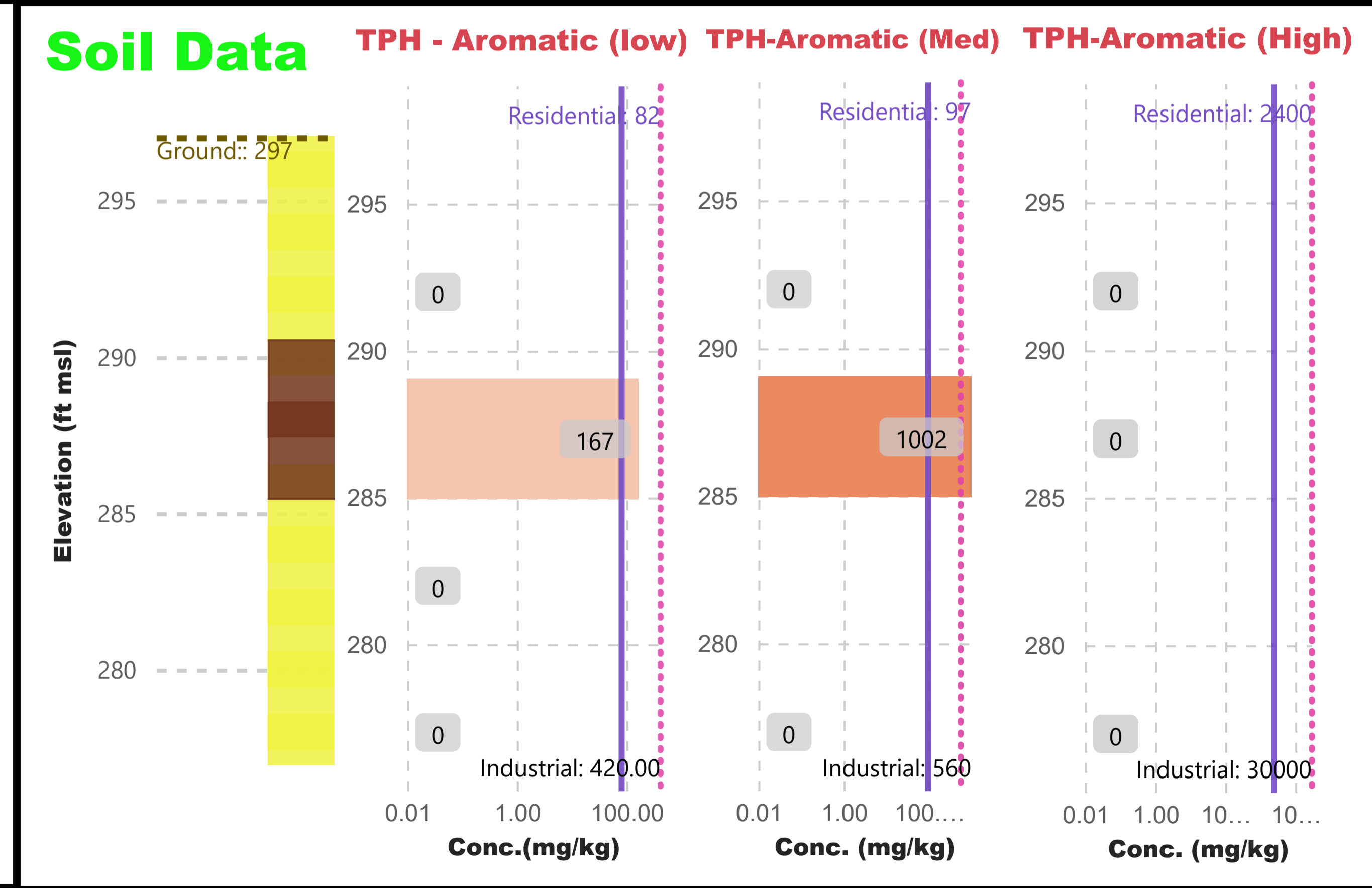
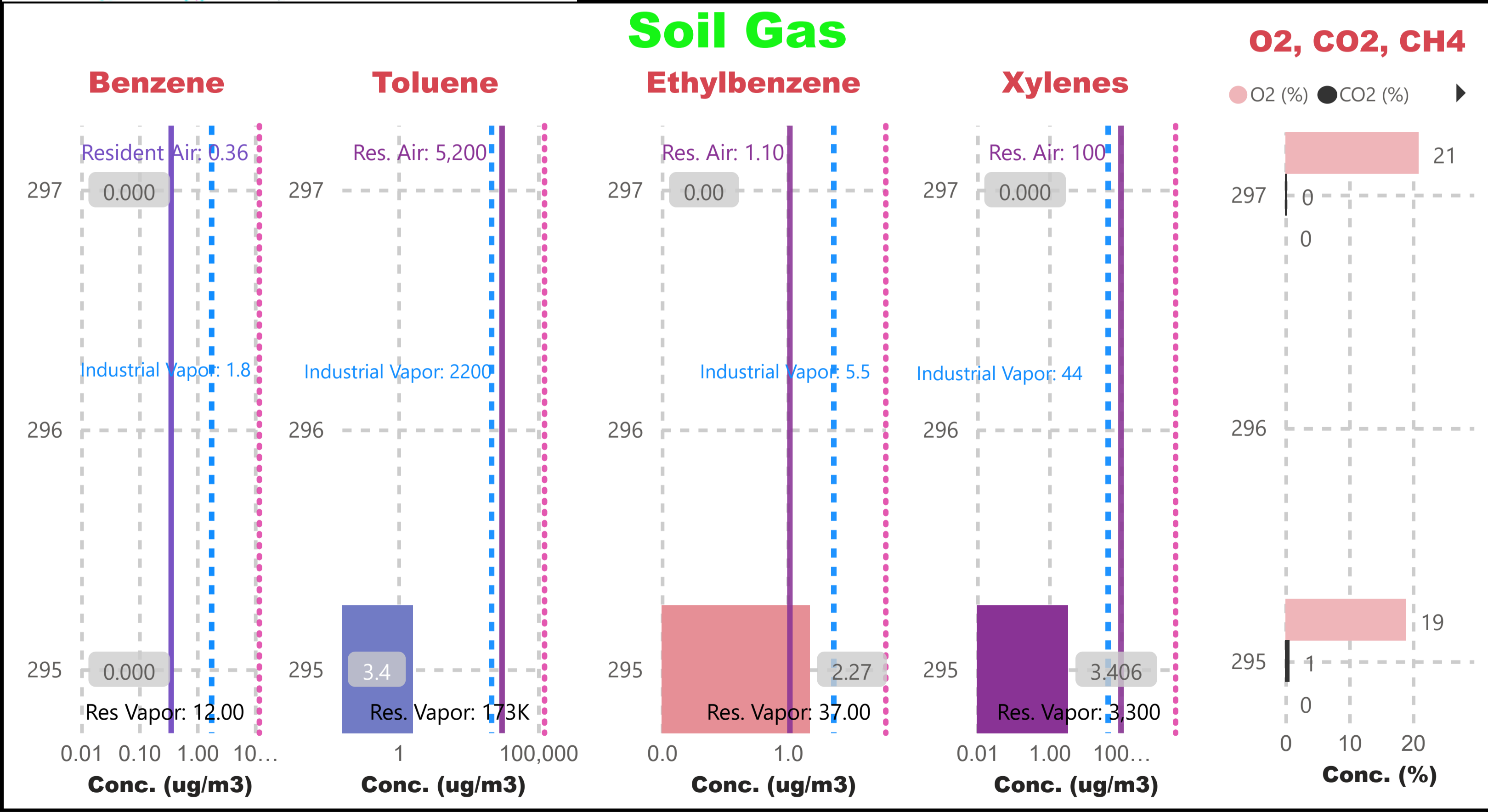
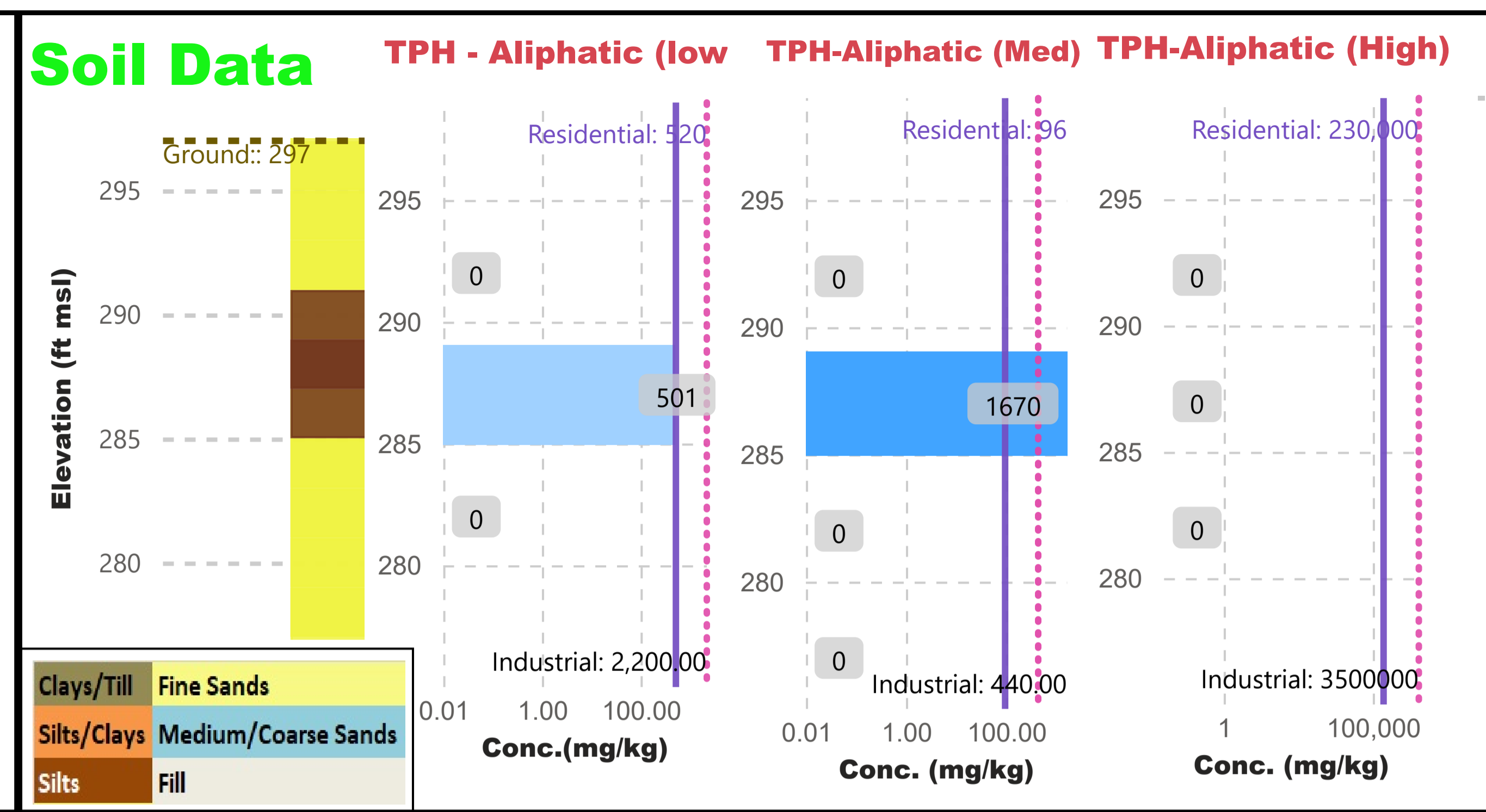
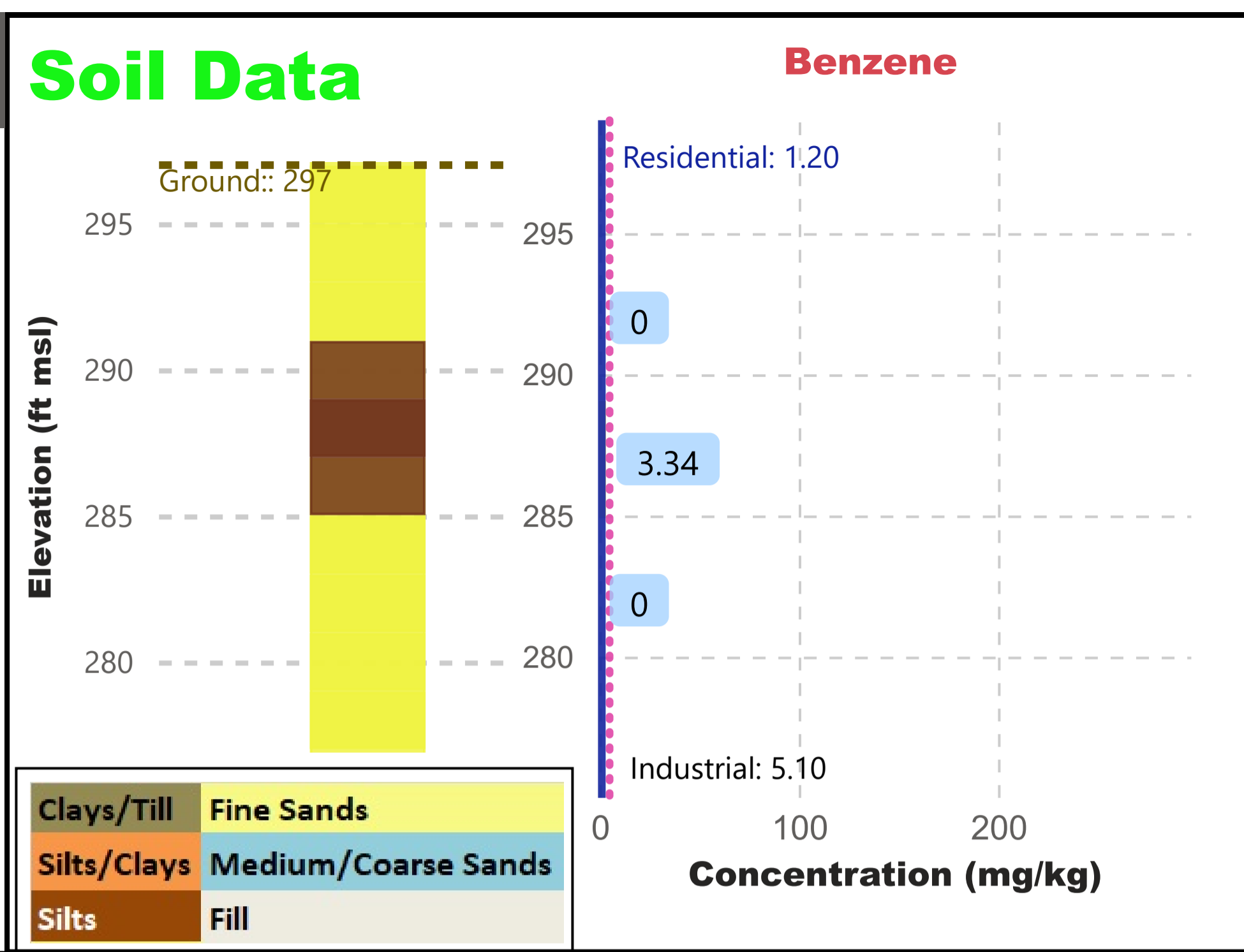
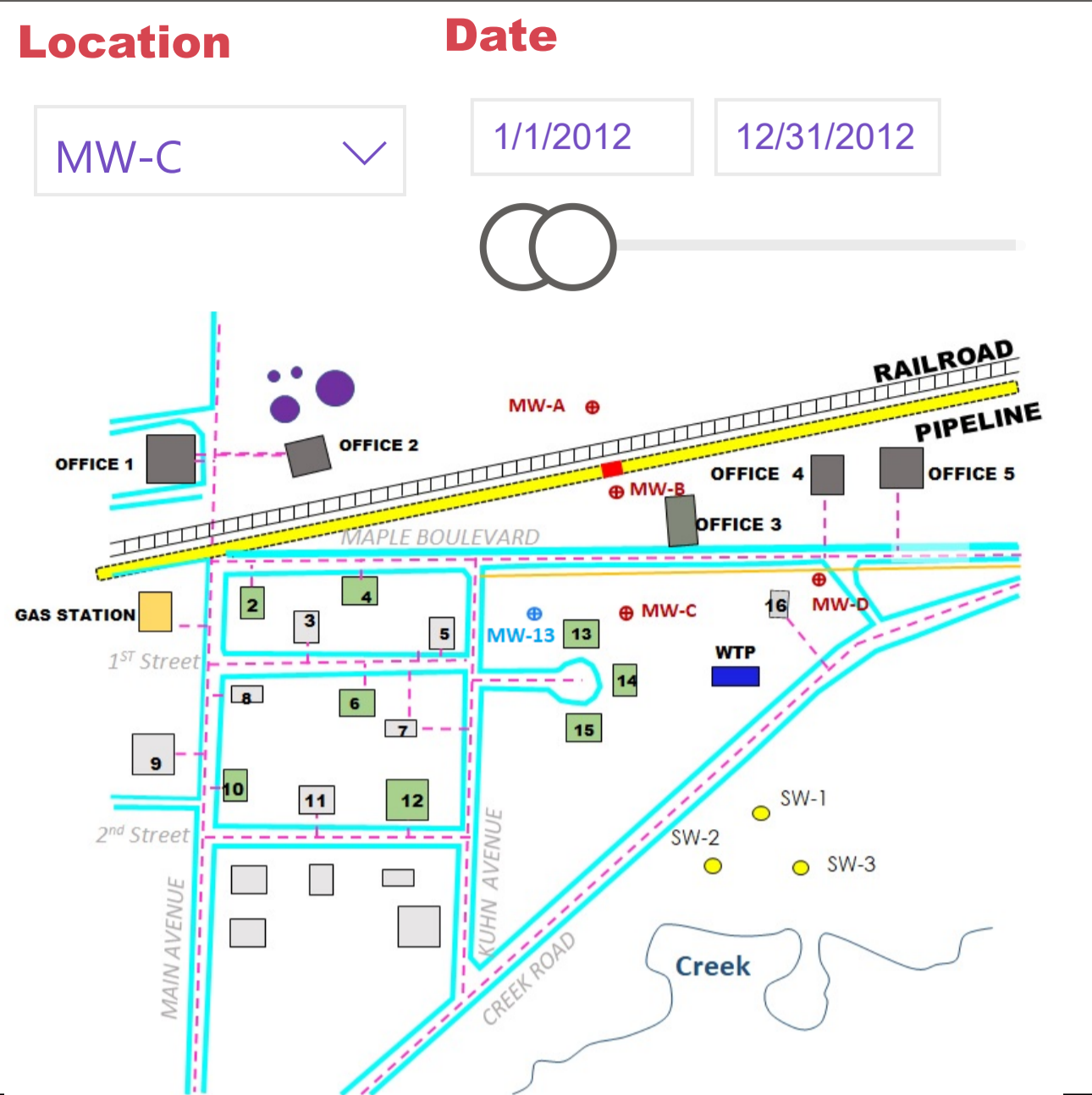
The Silica Gel Cleanup for TPH is a method used by the laboratory to "clean up" the sample extract before it is analyzed for TPH so that the extract contains primarily hydrocarbons (non-polar) compared to non-hydrocarbons like metabolites, natural organic matter, chlorinated solvents etc.

| Molecular Structure | Aliphatic | Aromatic | EPA 6 Toxicity Fractions |
|------------------------|-----------|----------|--------------------------|
| Working Group | EC5-8 | EC8-16 | EC16-35 |
| 13 Transport Fractions | EC5-7 | EC8-10 | EC16-21 |
| | EC9-12 | EC9-22 | EC22-35 |
| | EC12-16 | EC12-16 | EC16-21 |
| | EC16-21 | EC21-35 | EC21-35 |

Increasing Equivalent Carbon (EC) Number →

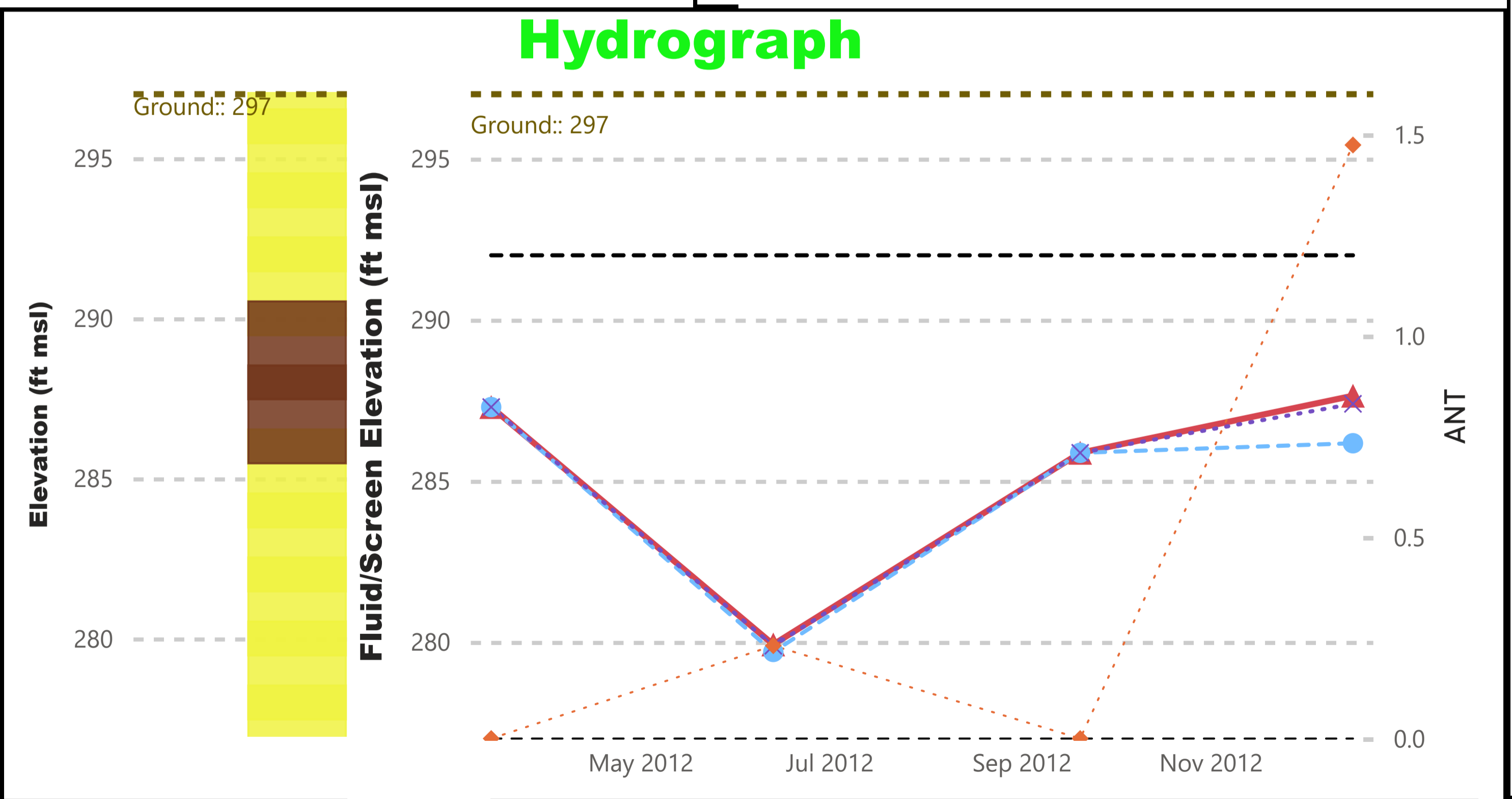
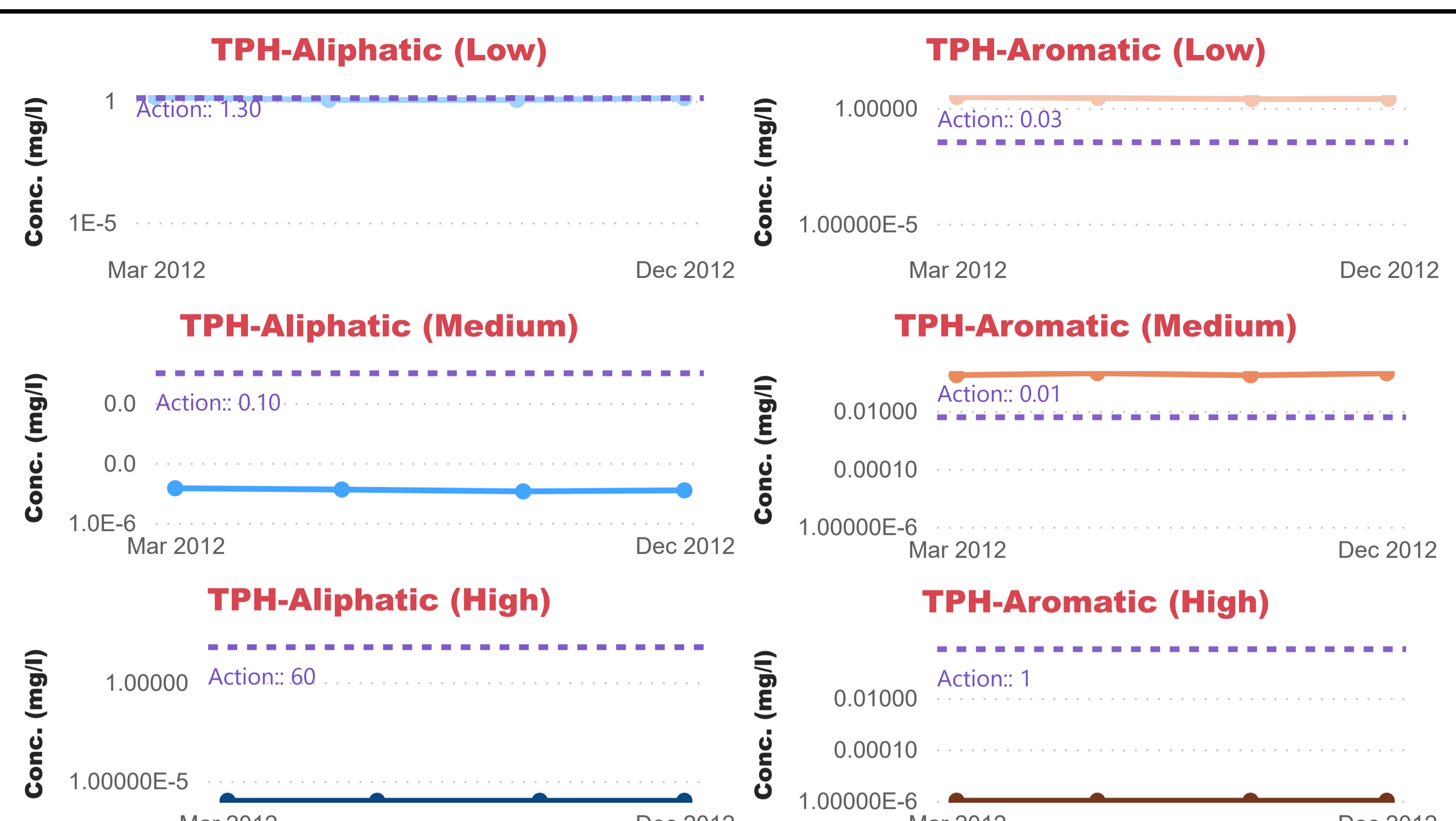
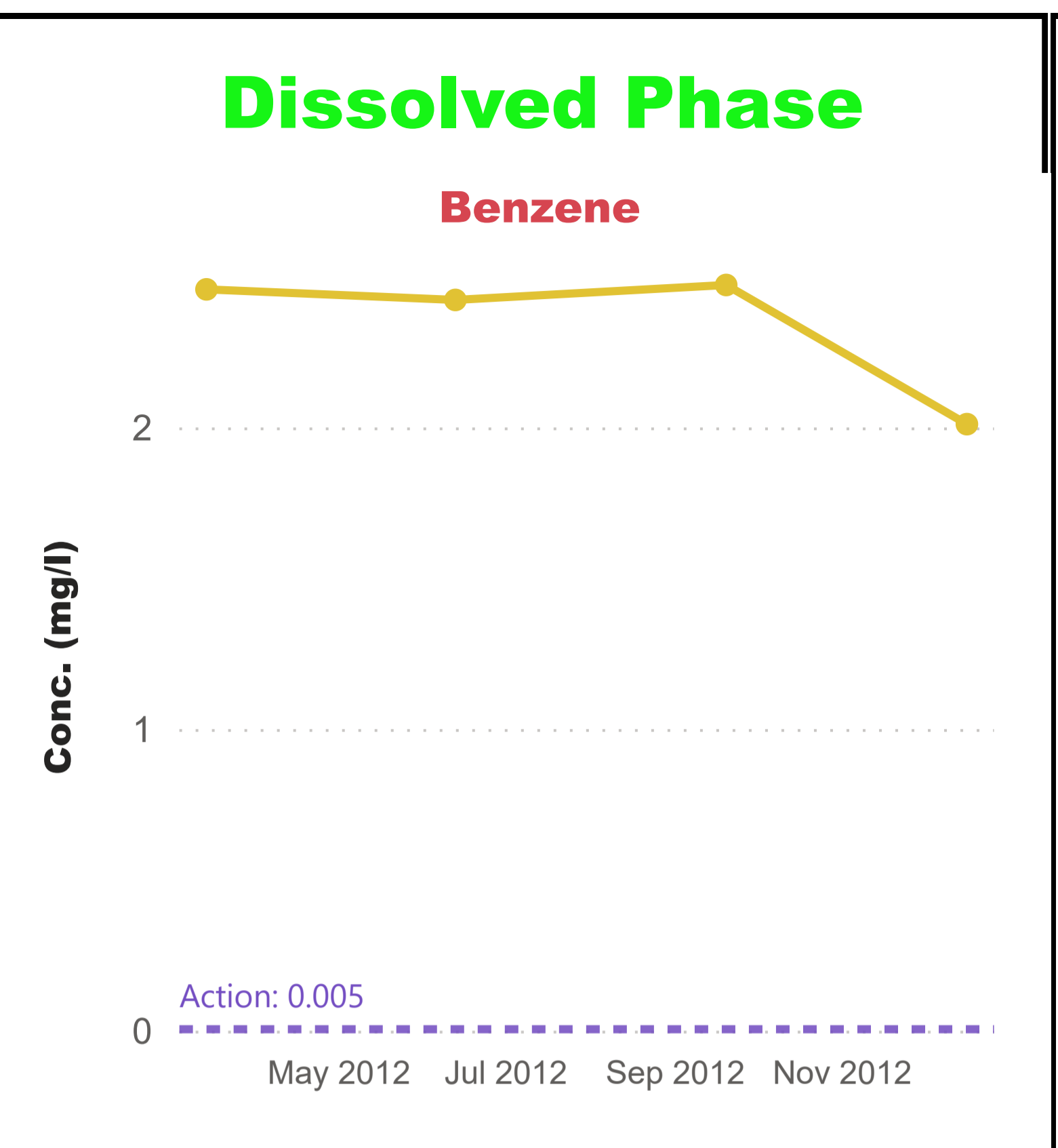
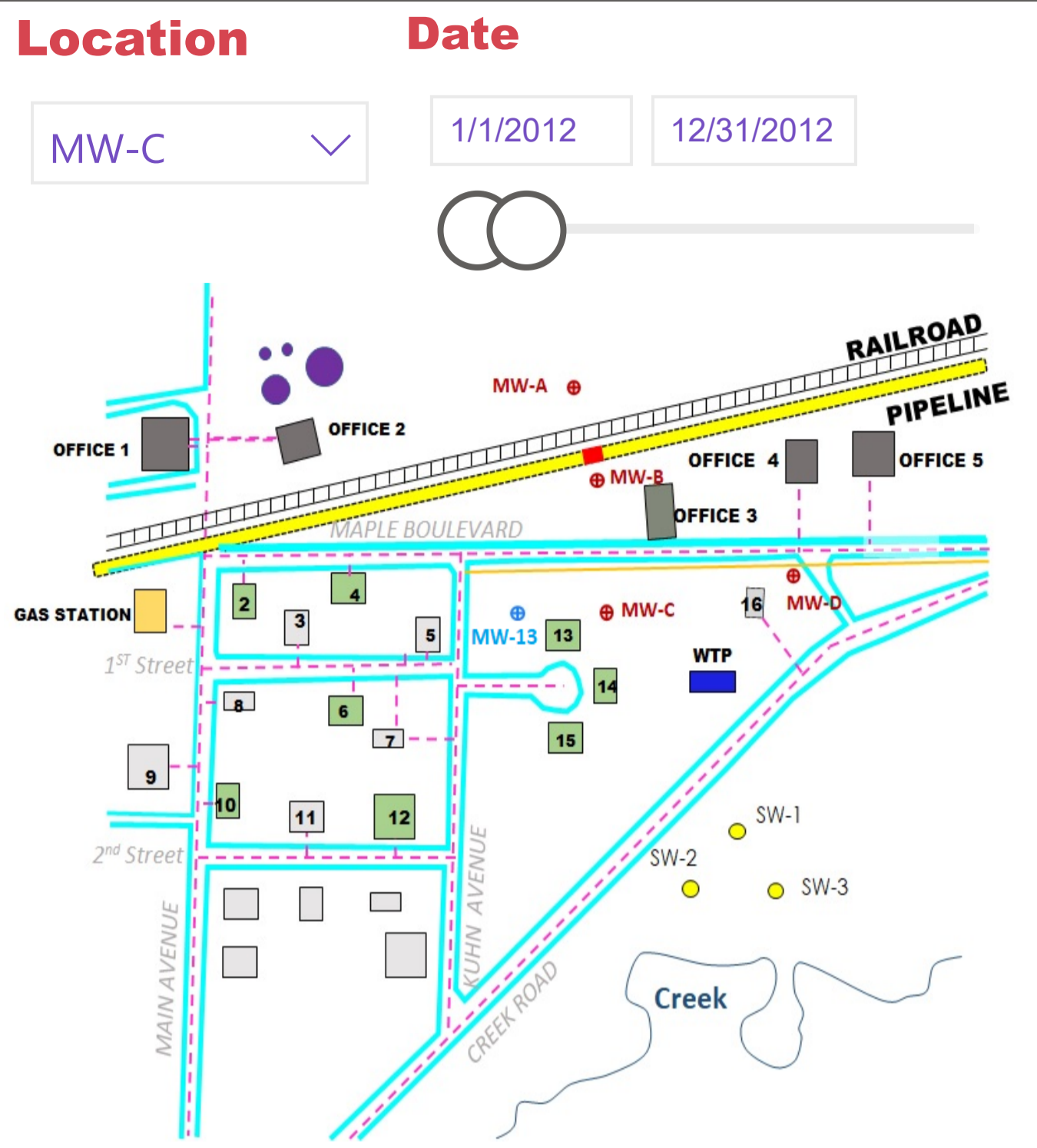
| | | | | |
|-------------|---------------------|------------------------|---------|--------------------------------------|
| Clays/Till | Fine Sands | --- Screen | TOS/BOS | X Corrected Groundwater Surface CGWS |
| Silts/Clays | Medium/Coarse Sands | ▲ Air/NAPL Interface | ANI | ◆ Apparent NAPL Thickness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

MW-B Hydrograph & Dissolved Summary



MW-C Soil and Soil Gas Summary

| | | | | | | | | | | |
|-------------|---------------------|---|--|---------|---------|---------|-----|--------|------|--|
| Clays/Till | Fine Sands | <table border="1"> <tr><td>EC5-6</td><td>EC8-16</td><td>EC16-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> </table> | | EC5-6 | EC8-16 | EC16-35 | Low | Medium | High | EPA 6 Toxicity Fractions Increasing Equivalent Carbon (EC) Number → |
| EC5-6 | EC8-16 | EC16-35 | | | | | | | | |
| Low | Medium | High | | | | | | | | |
| Silts/Clays | Medium/Coarse Sands | <table border="1"> <tr><td>EC7-15</td><td>EC9-22</td><td>EC22-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> </table> | | EC7-15 | EC9-22 | EC22-35 | Low | Medium | High | |
| EC7-15 | EC9-22 | EC22-35 | | | | | | | | |
| Low | Medium | High | | | | | | | | |
| Silts | Fill | <table border="1"> <tr><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> </table> | | EC12-16 | EC16-21 | EC21-35 | Low | Medium | High | |
| EC12-16 | EC16-21 | EC21-35 | | | | | | | | |
| Low | Medium | High | | | | | | | | |



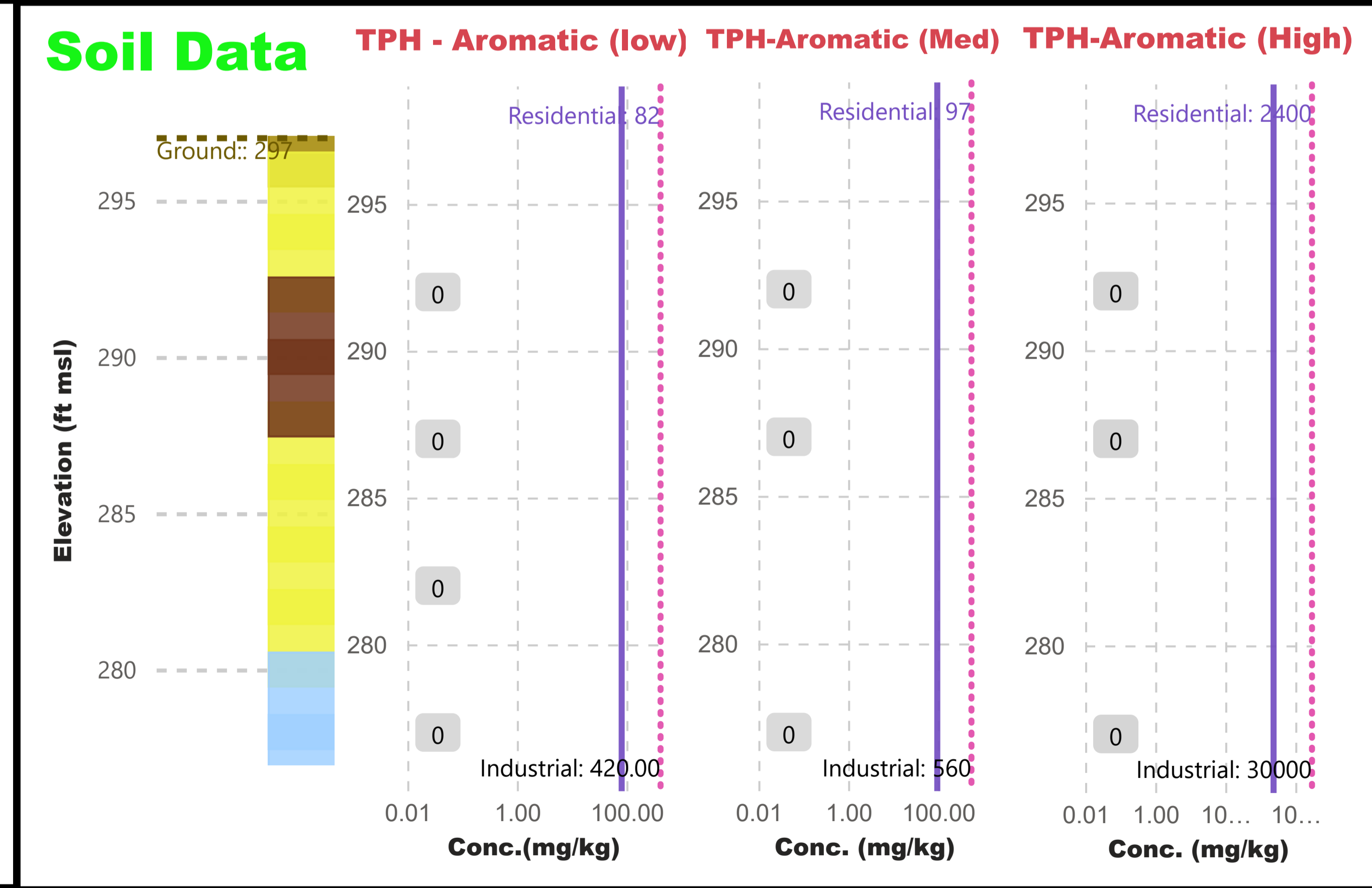
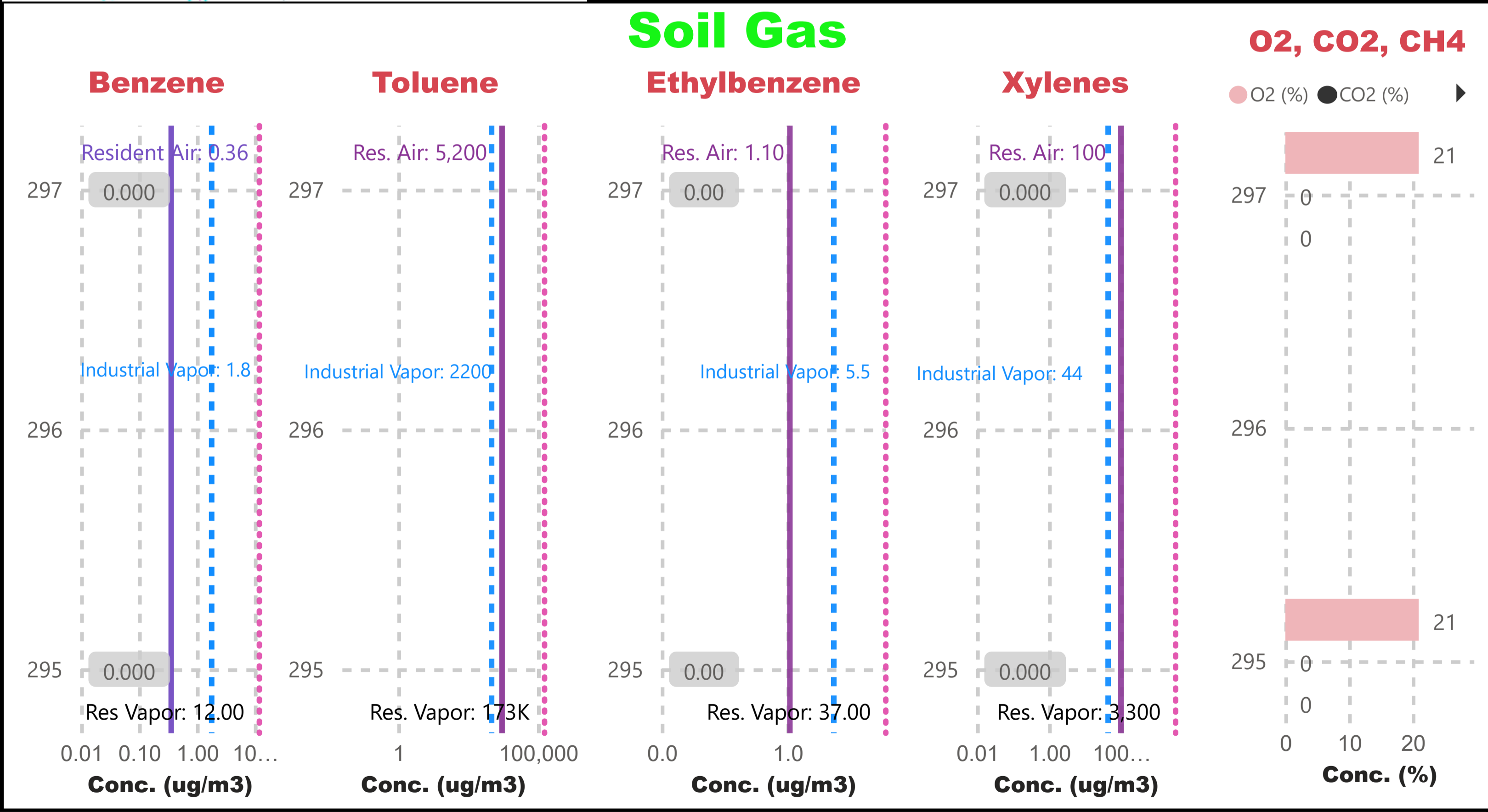
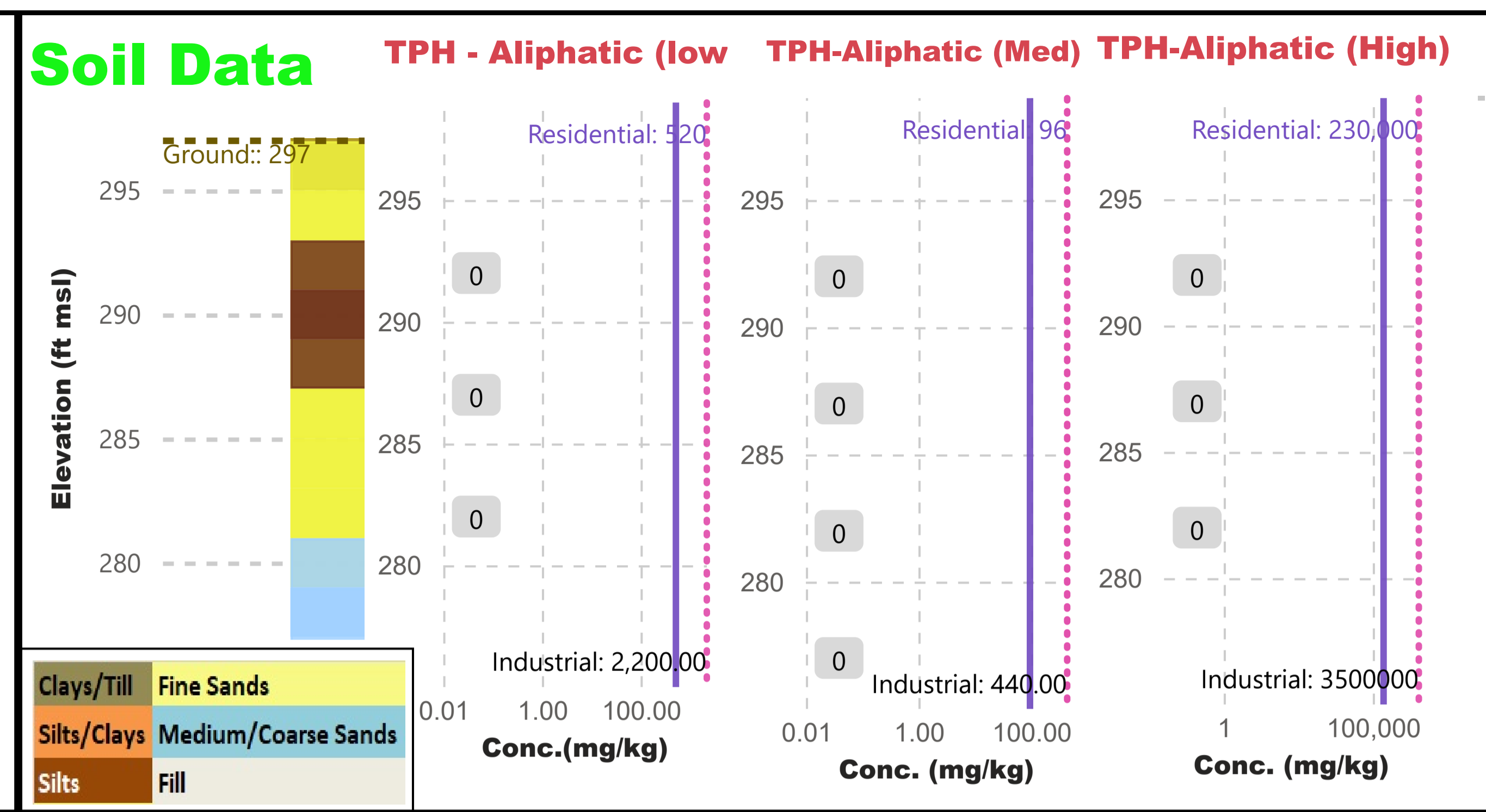
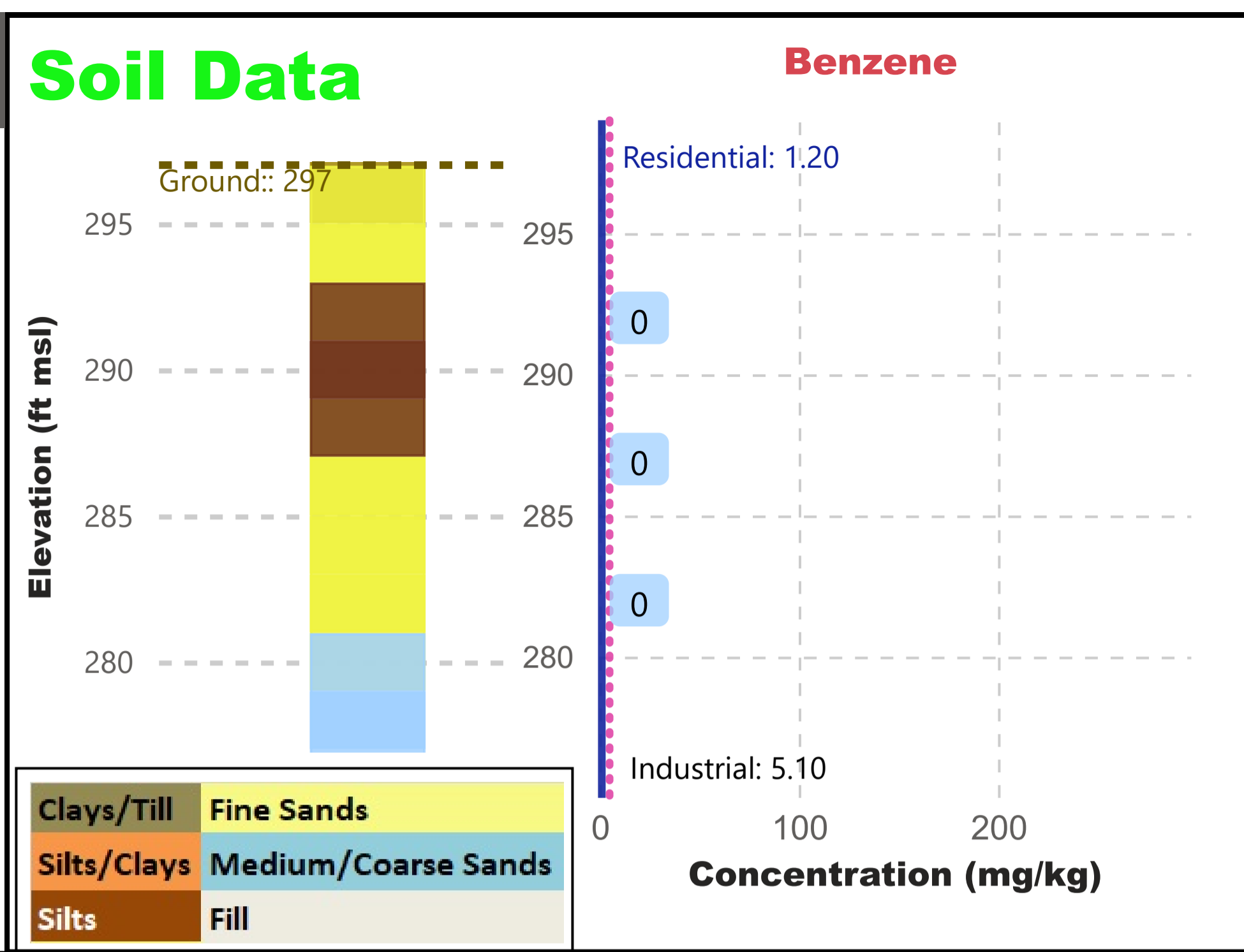
The Silica Gel Cleanup for TPH is a method used by the laboratory to "clean up" the sample extract before it is analyzed for TPH so that the extract contains primarily hydrocarbons (non-polar) compared to non-hydrocarbons like metabolites, natural organic matter, chlorinated solvents etc.

| Molecular Structure | Aliphatic | Aromatic | EPA 6 Toxicity Fractions |
|------------------------|-------------------------------|------------------|---|
| Working Group | EC5-6, EC6-8, EC8-10, EC10-12 | EC12-16, EC16-21 | EC21-35 (same properties as EC16-21) -- not considered a transport fraction-- |
| 13 Transport Fractions | EC5-7, EC7-9, EC9-10, EC10-12 | EC12-16, EC16-21 | EC21-35 |
| Working Group | EC5-8 (Low), EC8-16 (Medium) | EC16-35 (High) | EC21-35 (High) |
| 13 Transport Fractions | EC6-9 (Low), EC9-22 (Medium) | EC22-35 (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-C Hydrograph & Dissolved Summary

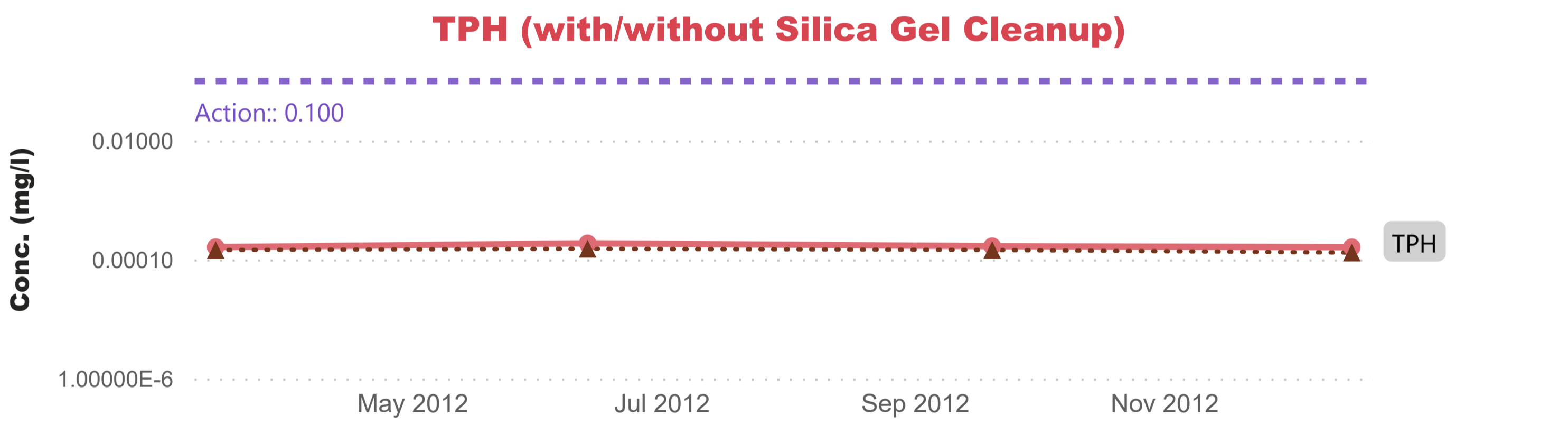
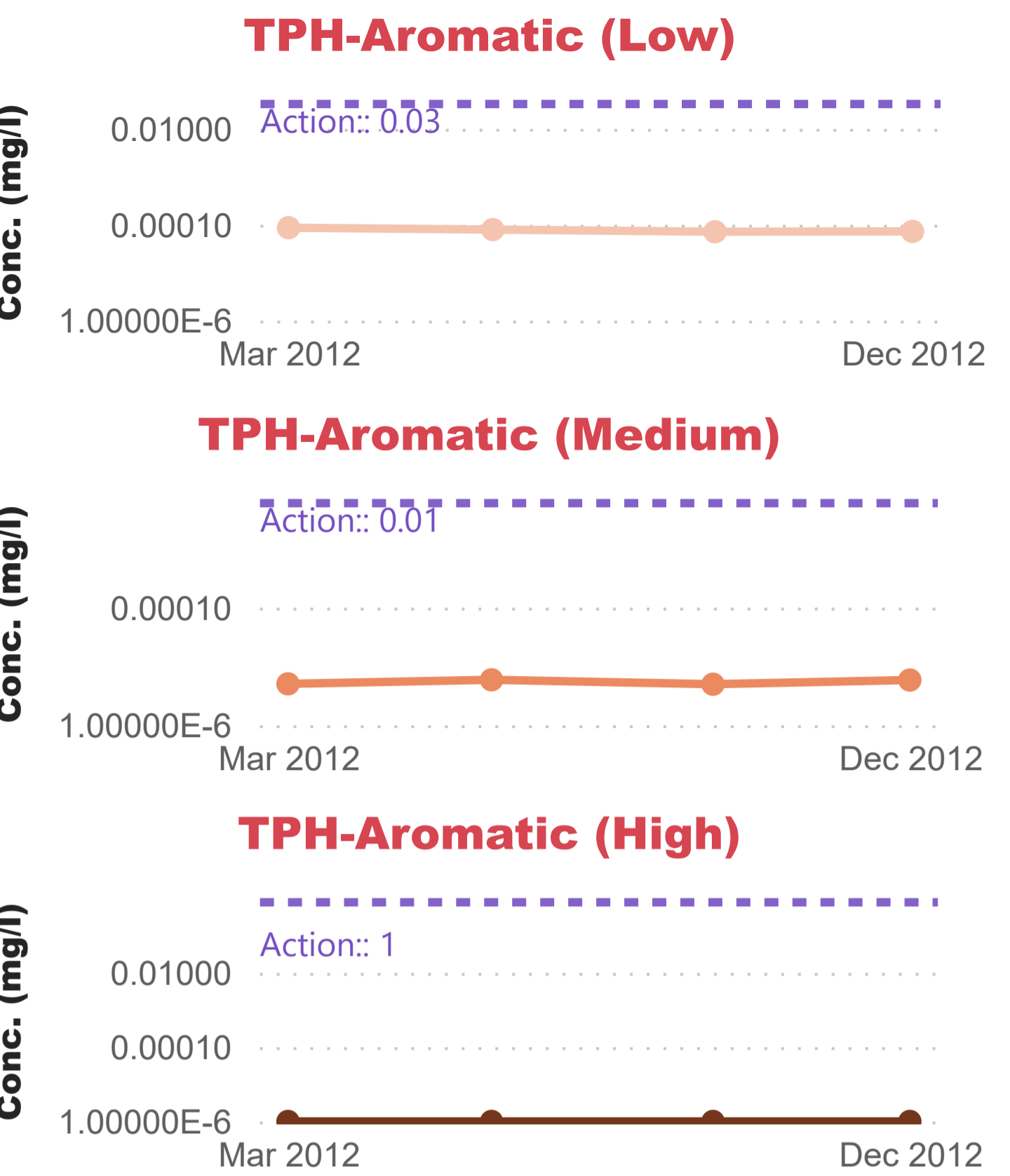
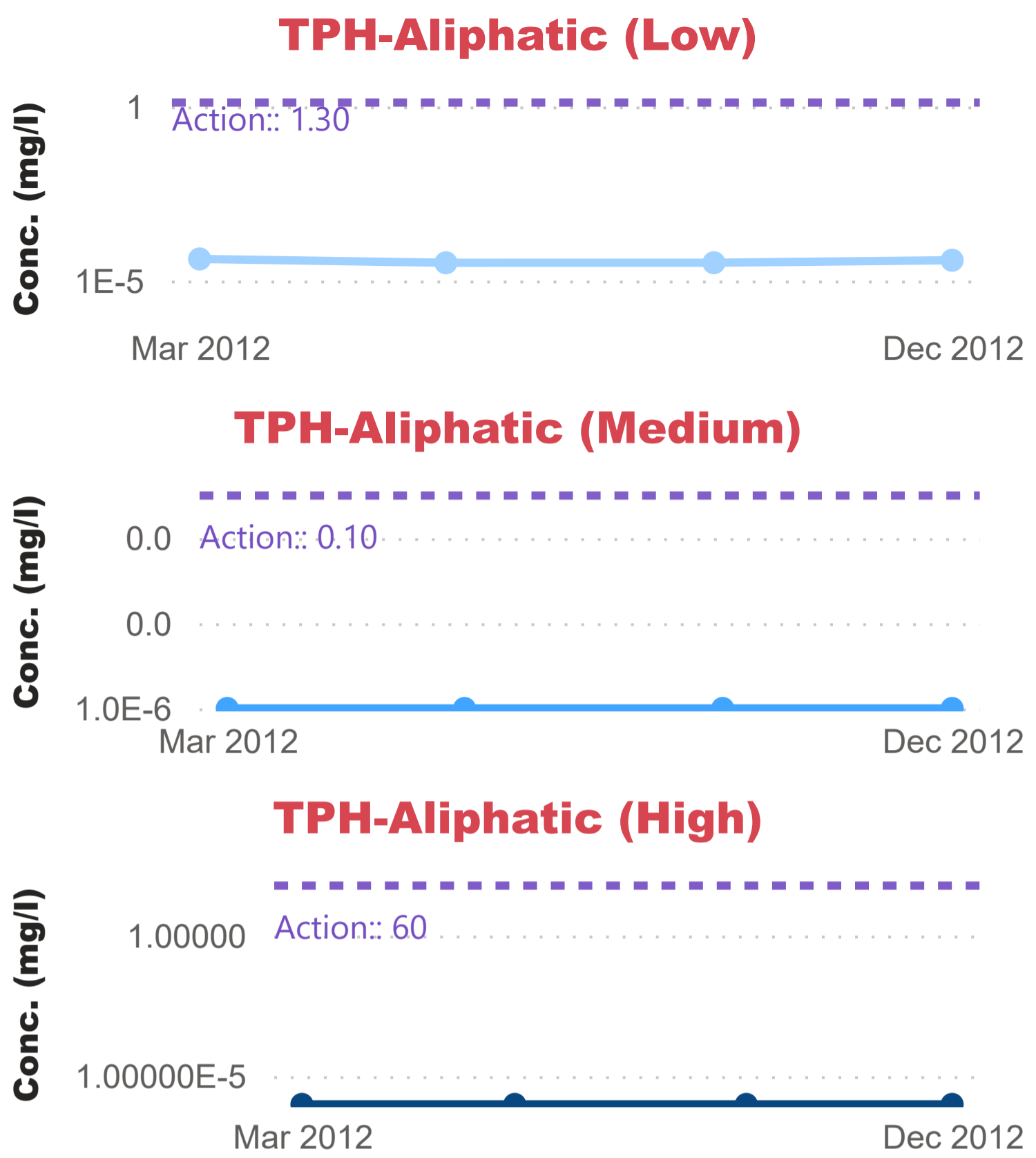
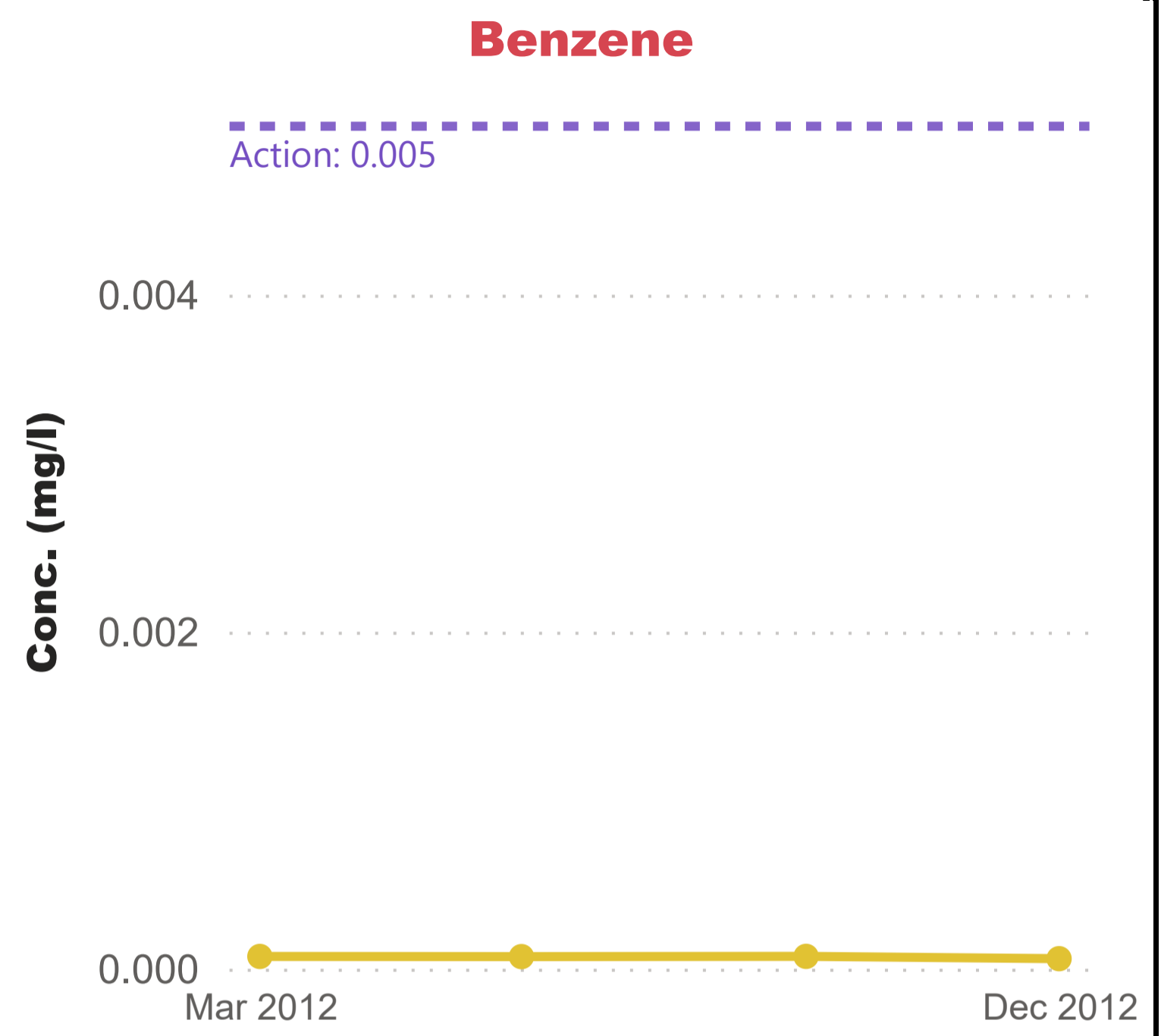


MW-D Soil and Soil Gas Summary

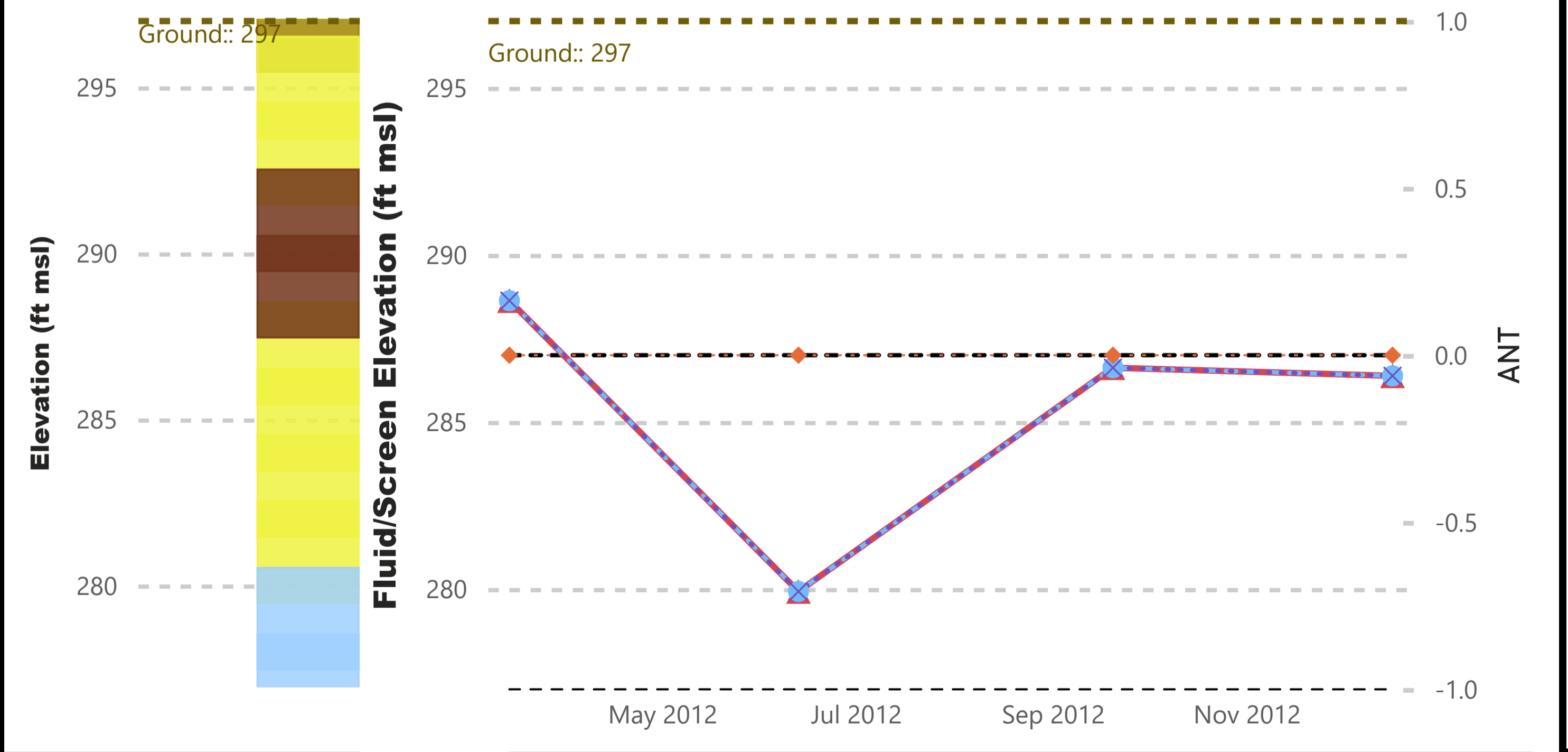
| | | | | | | | | | | |
|-------------|---------------------|---|--|---------|---------|---------|-----|--------|------|--|
| Clays/Till | Fine Sands | <table border="1"> <tr><td>EC5-6</td><td>EC8-16</td><td>EC16-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> </table> | | EC5-6 | EC8-16 | EC16-35 | Low | Medium | High | EPA 6 Toxicity Fractions Increasing Equivalent Carbon (EC) Number → |
| EC5-6 | EC8-16 | EC16-35 | | | | | | | | |
| Low | Medium | High | | | | | | | | |
| Silts/Clays | Medium/Coarse Sands | <table border="1"> <tr><td>EC7-11</td><td>EC12-16</td><td>EC21-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> </table> | | EC7-11 | EC12-16 | EC21-35 | Low | Medium | High | |
| EC7-11 | EC12-16 | EC21-35 | | | | | | | | |
| Low | Medium | High | | | | | | | | |
| Silts | Fill | <table border="1"> <tr><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>Low</td><td>Medium</td><td>High</td></tr> </table> | | EC12-16 | EC16-21 | EC21-35 | Low | Medium | High | |
| EC12-16 | EC16-21 | EC21-35 | | | | | | | | |
| Low | Medium | High | | | | | | | | |



Dissolved Phase



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.

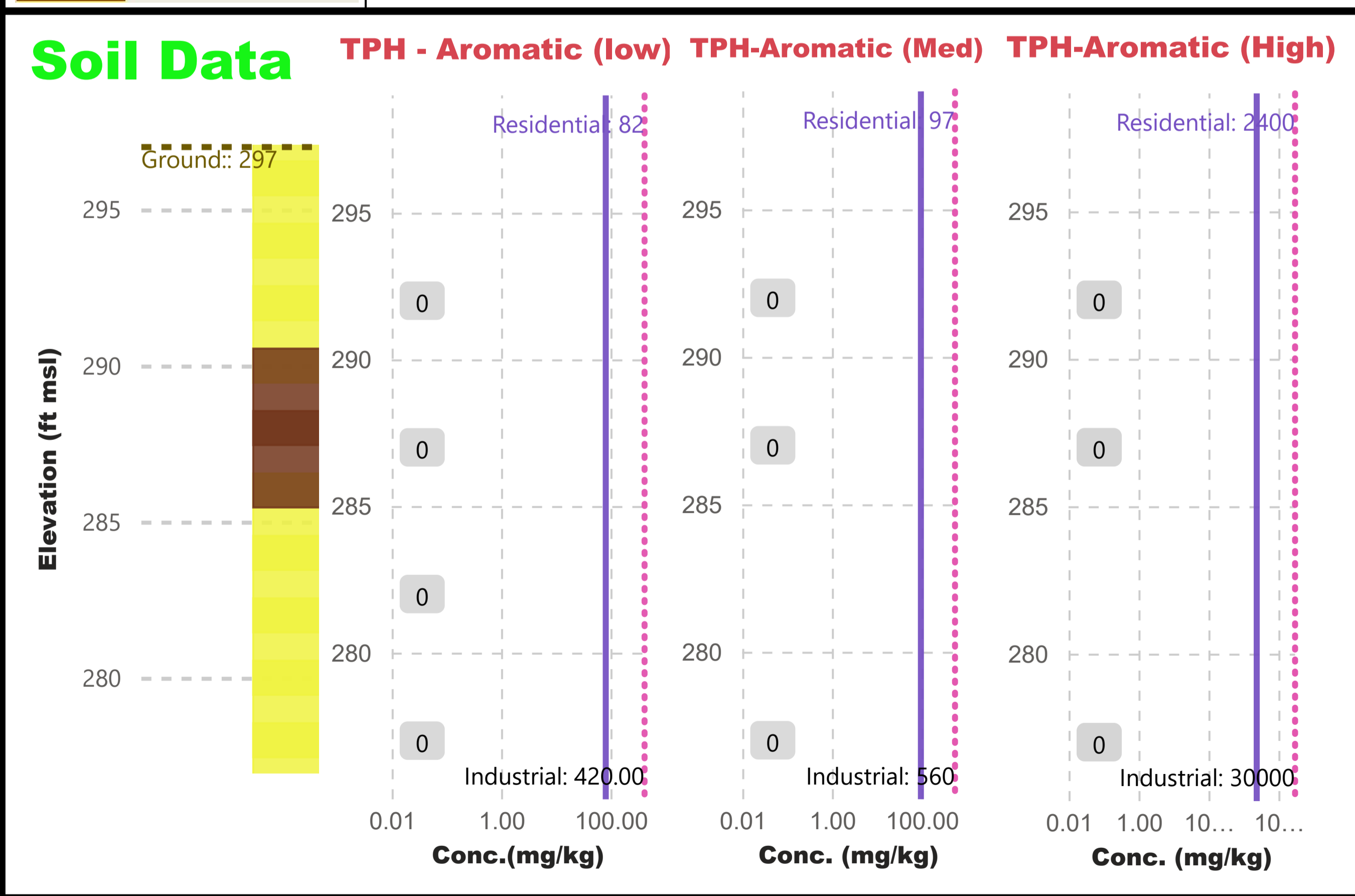
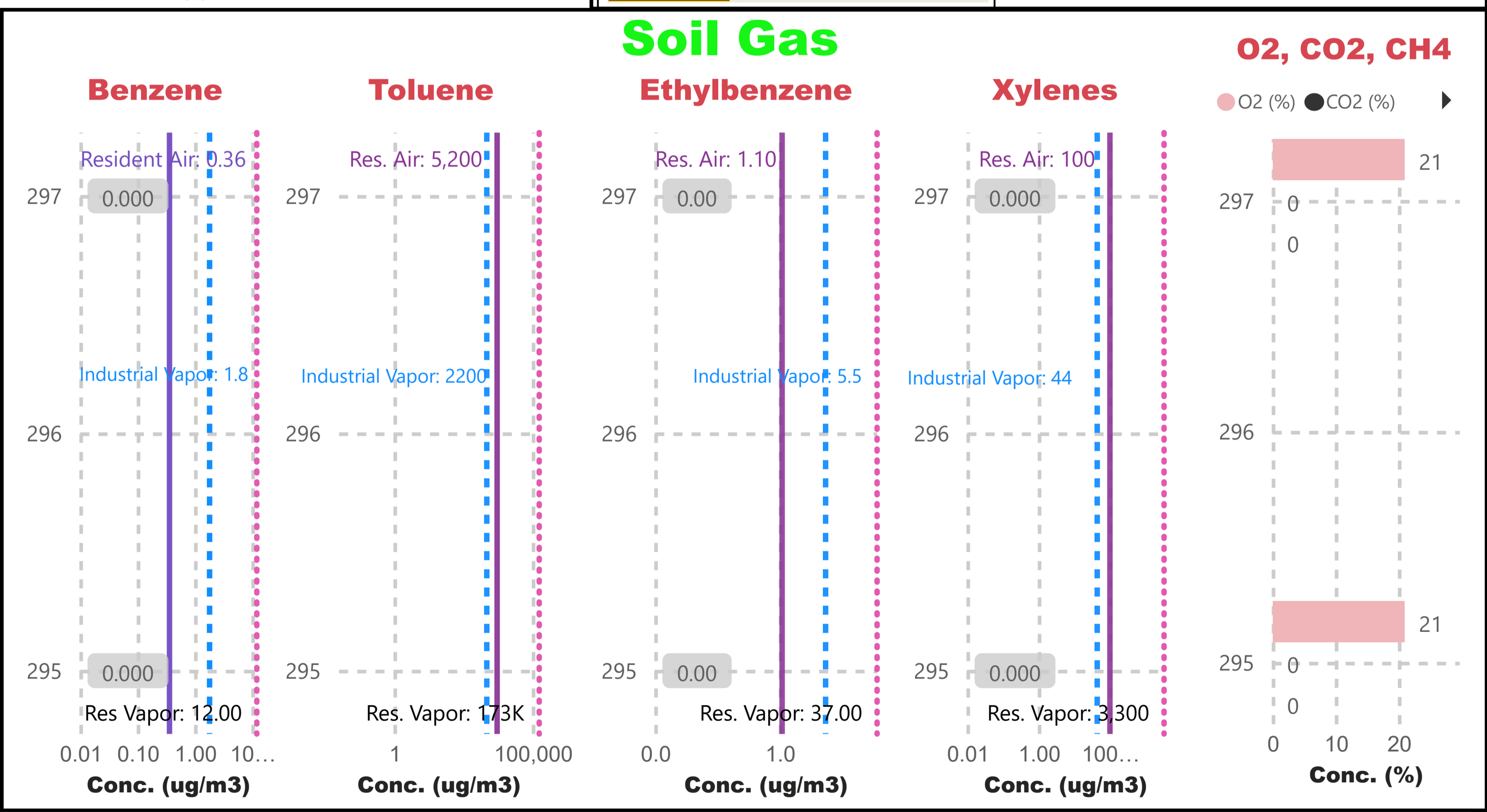
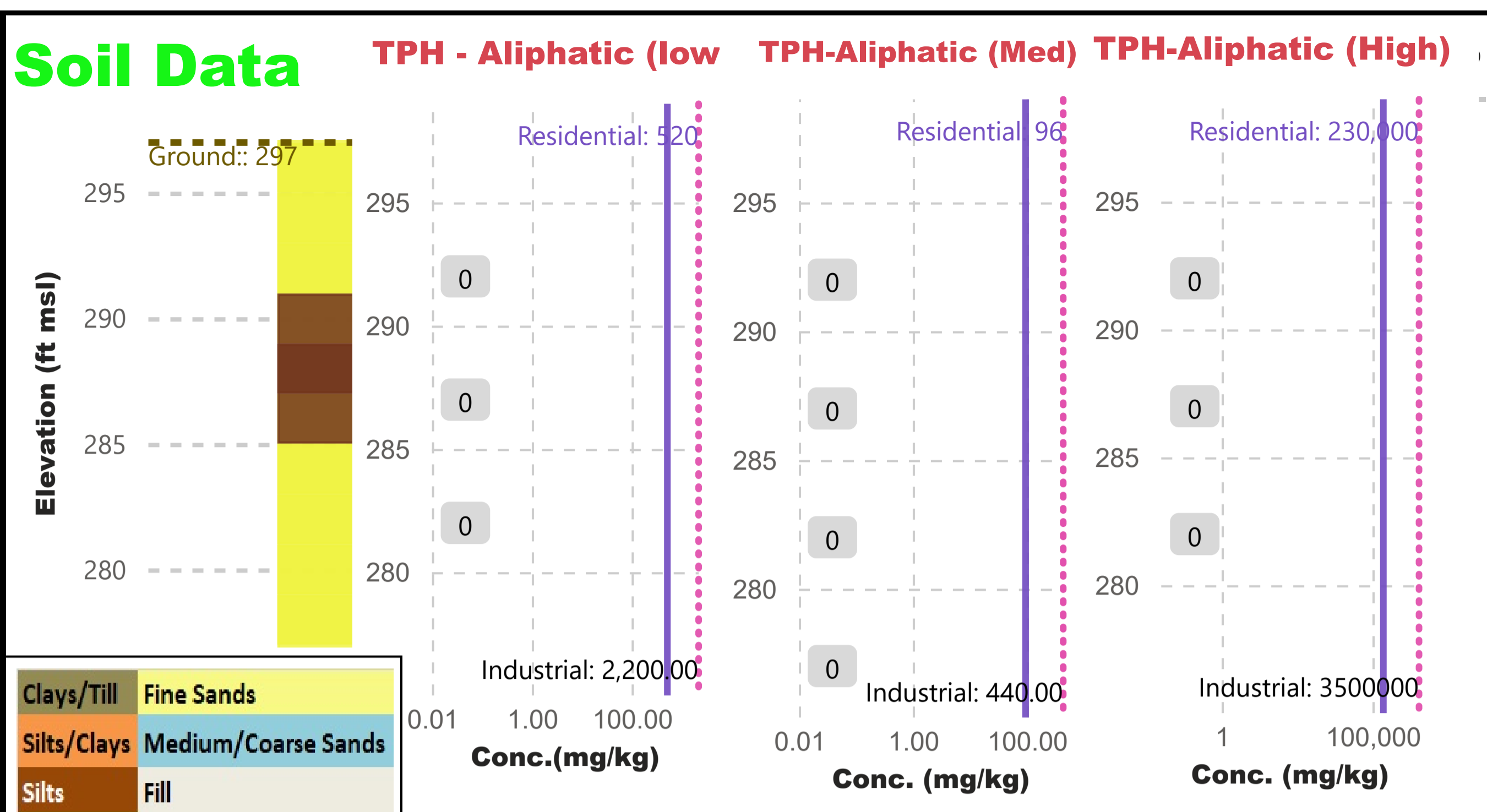
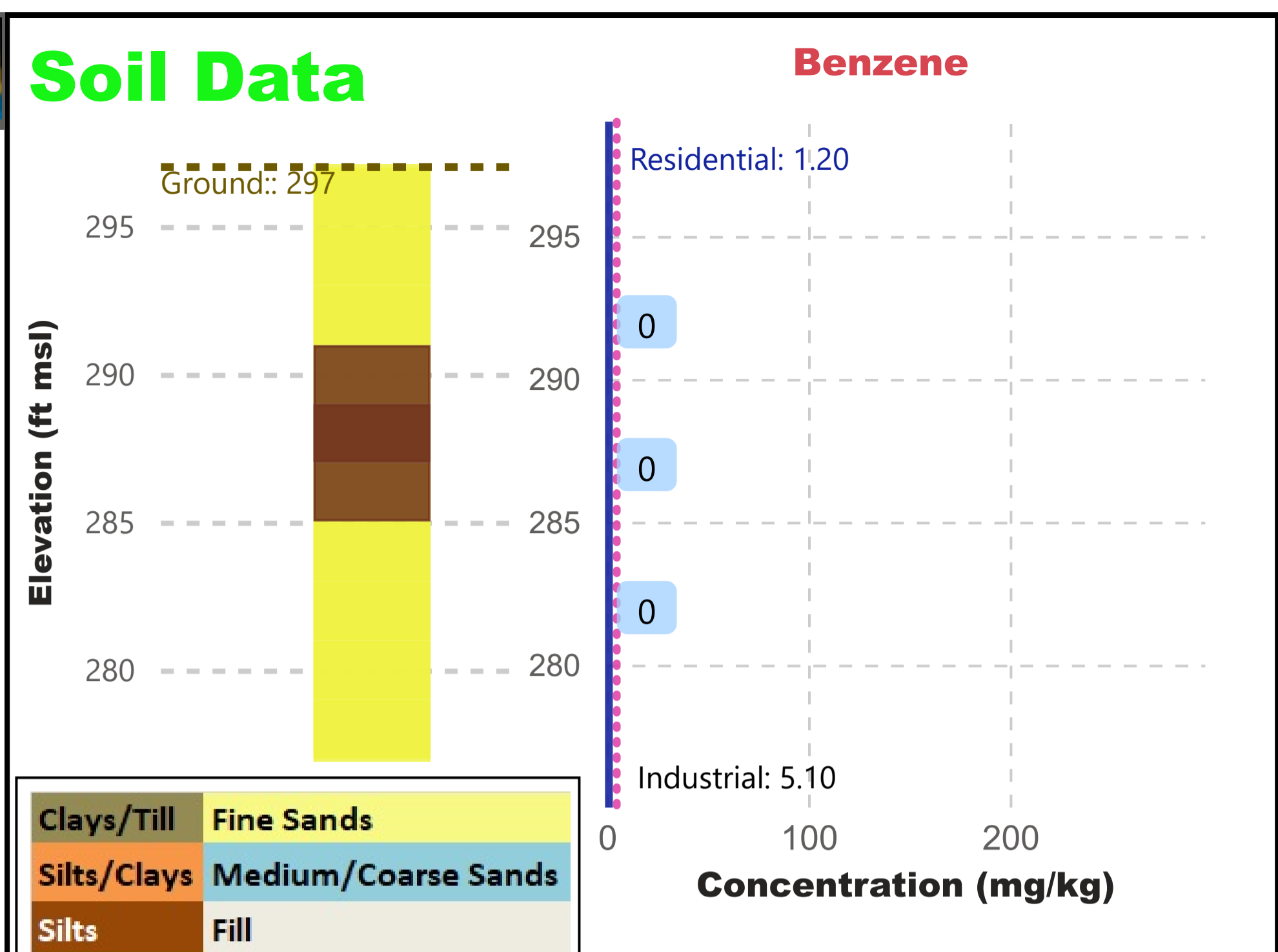
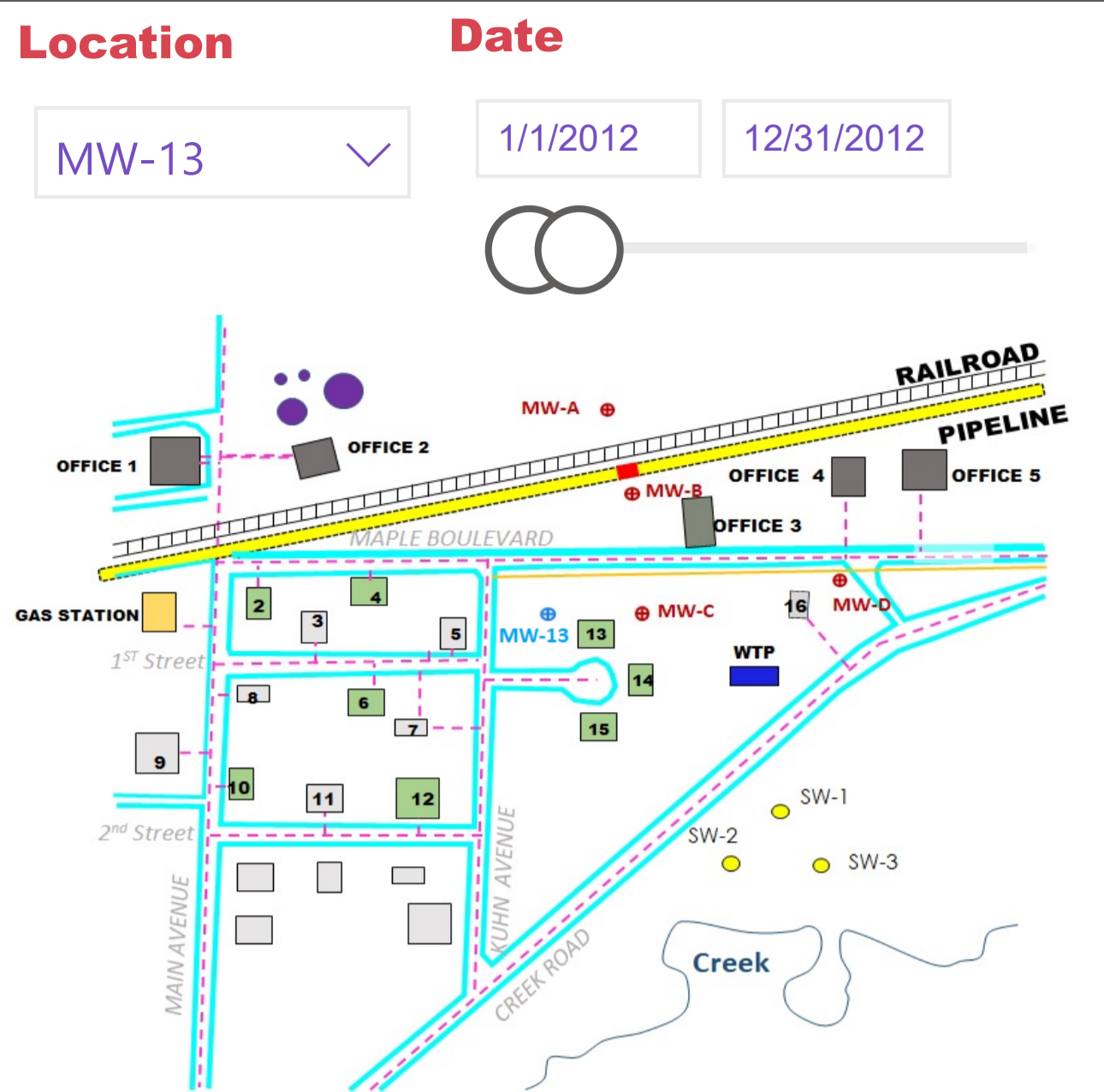
| Molecular Structure | Aliphatic | Aromatic | Working Group | 13 Transport Fractions | EPA 6 Toxicity Fractions |
|---------------------|-----------|----------|---------------|------------------------|--------------------------|
| EC5-7 | EC5-8 | EC9-11 | Low | EC9-22 | Low |
| EC8-10 | EC8-16 | EC12-14 | Medium | EC12-16 | Medium |
| EC10-12 | EC16-21 | EC16-21 | High | EC16-21 | High |
| EC12-16 | EC21-35 | EC21-35 | 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-D

Hydrograph & Dissolved Summary

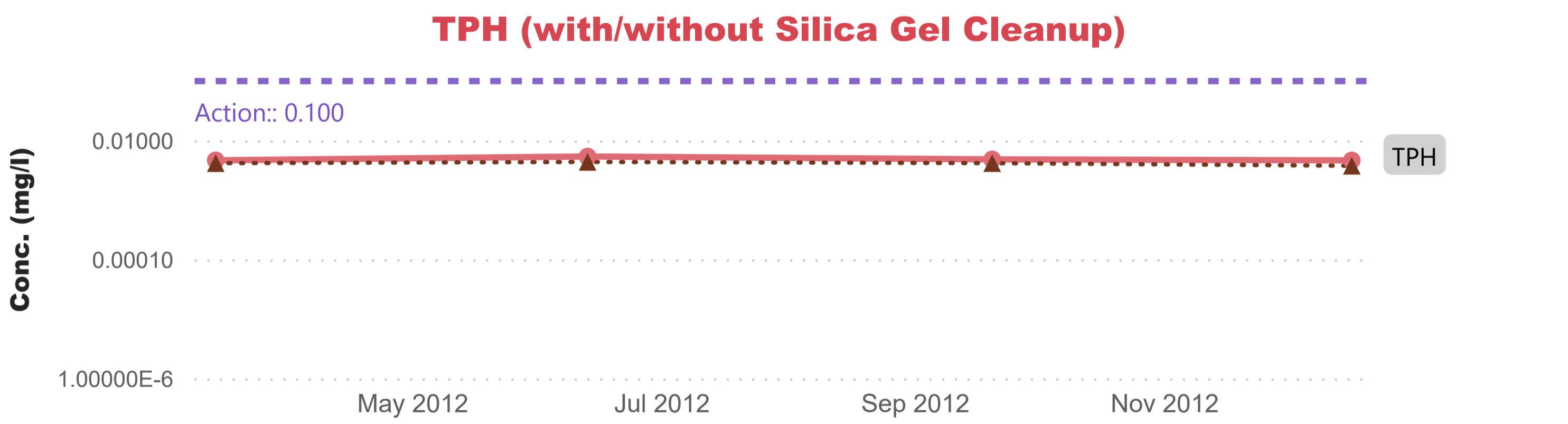
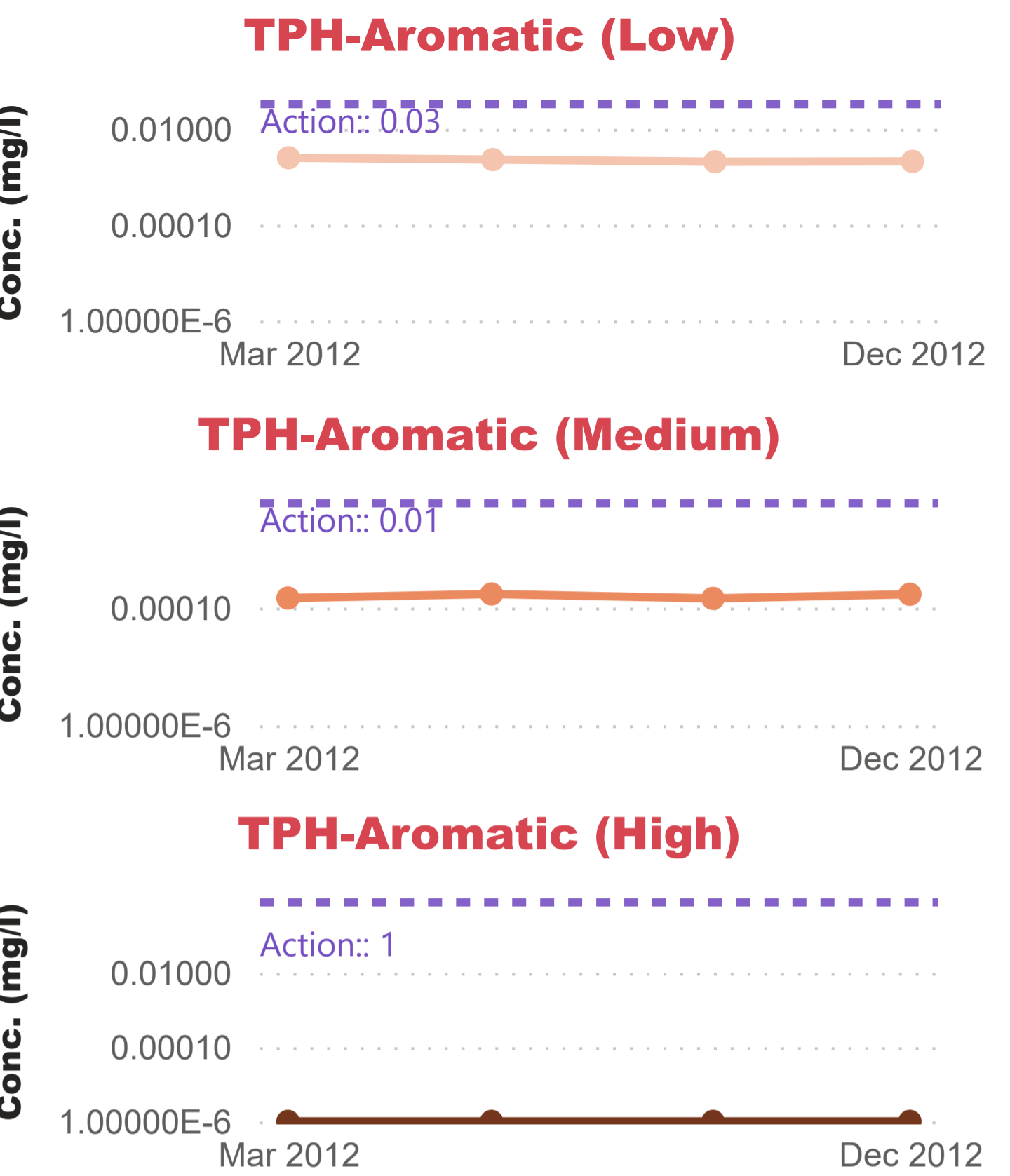
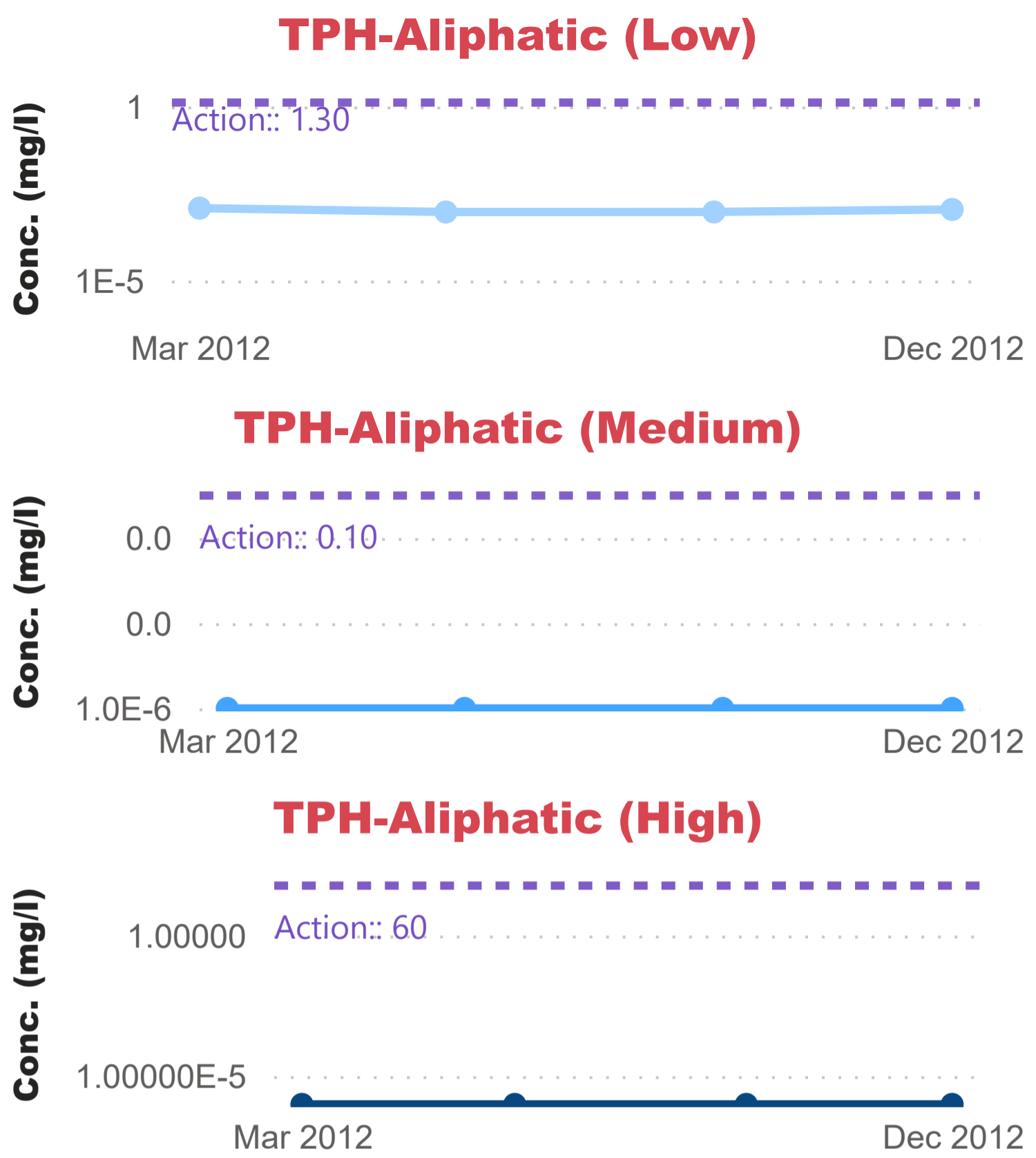
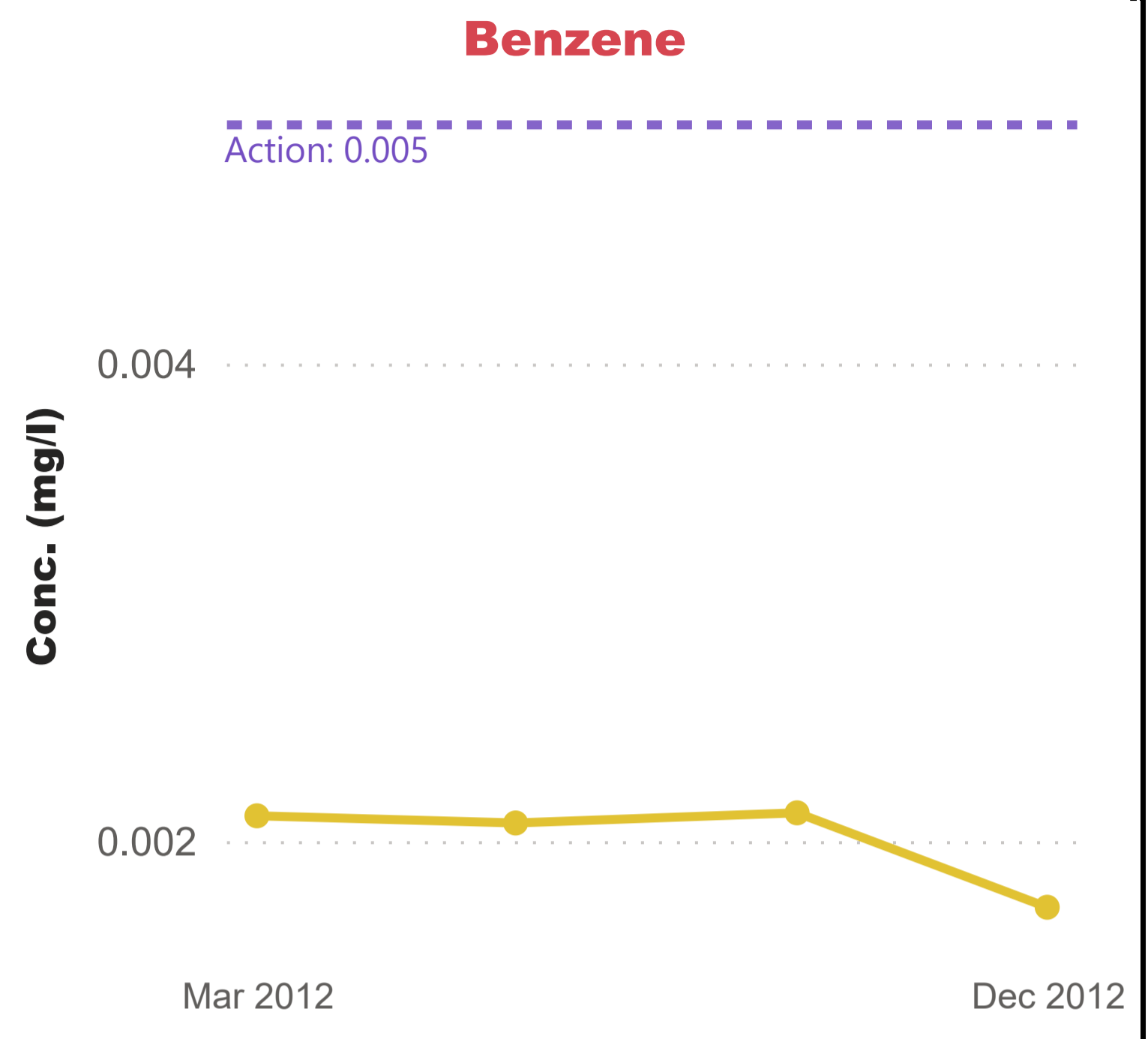


MW-13 Soil and Soil Gas Summary

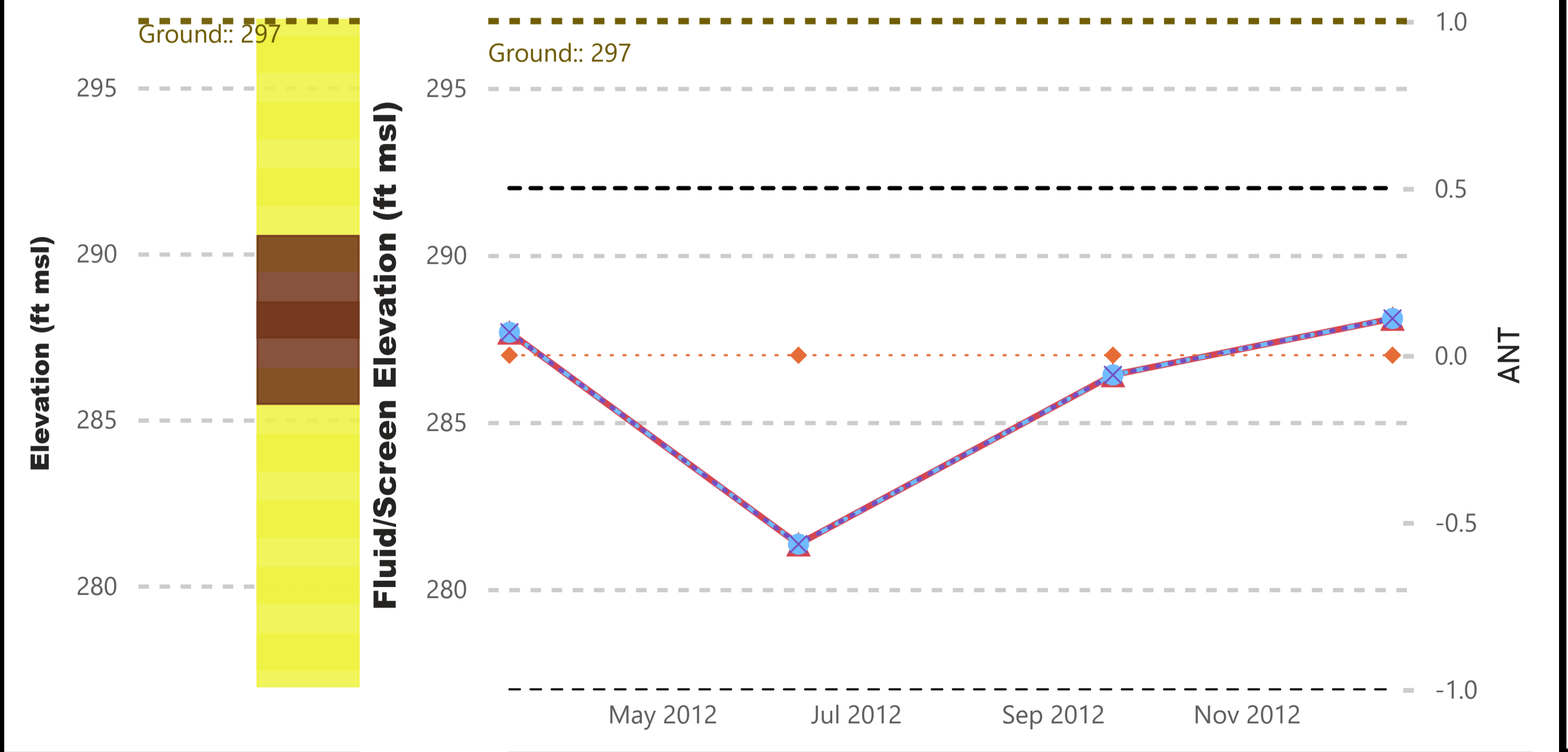
| | | | | | | | | | | | | |
|-------------|---------------------|---|---------|---------|---------|---------|---------|---------|---------|--|---------|---|
| Clays/Till | Fine Sands | <table border="1"> <tr><td>EC5-6</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC7-11</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> </table> | | EC5-6 | EC12-16 | EC16-21 | EC21-35 | EC7-11 | EC12-16 | EC16-21 | EC21-35 | TPH Criteria Working Group 13 Transport Fractions Increasing Equivalent Carbon (EC) Number → |
| EC5-6 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | |
| EC7-11 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | |
| Silts/Clays | Medium/Coarse Sands | <table border="1"> <tr><td>EC8-11</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC9-11</td><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> </table> | | EC8-11 | EC12-16 | EC16-21 | EC21-35 | EC9-11 | EC12-16 | EC16-21 | EC21-35 | |
| EC8-11 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | |
| EC9-11 | EC12-16 | EC16-21 | EC21-35 | | | | | | | | | |
| Silts | Fill | <table border="1"> <tr><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> <tr><td>EC12-16</td><td>EC16-21</td><td>EC21-35</td></tr> </table> | | EC12-16 | EC16-21 | EC21-35 | EC12-16 | EC16-21 | EC21-35 | EPA 6 Toxicity Fractions Increasing Equivalent Carbon (EC) Number → | | |
| EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | |
| EC12-16 | EC16-21 | EC21-35 | | | | | | | | | | |



Dissolved Phase



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 | EC8-16 | Low | EC16-35 | High |
| Aromatic | ECS-7 | EC9-22 | Low | EC22-35 | High |
| | EC8-10 | EC10-12 | Medium | | |
| | EC12-16 | EC16-21 | High | | |
| | EC12-16 | EC16-21 | High | | |
| | EC21-35 | (same properties as EC16-21) -- not considered a transport fraction-- | | | |

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-13 Hydrograph & Dissolved Summary