Attachment C

Longevity Modeling Memo, Former Gordon Oil Refinery, Greybull, Wyoming

11/9/2020

This attachment describes the conversion of site TPH data to LNAPL saturation (as percentage of effective porosity), which is an input to the longevity model. This analysis was restricted to samples in excess of 250 mg/kg TPH on the rationale that the LNAPL saturation of the smear zone, or the source zone, is the relevant input to the model.

## Site TPH Data

The Site Data Quality Objectives (DQOs) specify criteria to determine whether or not the smear zone has been both horizontally and vertically delineated. One of these criteria was that Total Petroleum Hydrcarbons (TPH) concentrations, including both Diesel Range Organics (DRO) and Gasoline Range Organics (GRO) exceeding 250 mg/kg are considered indicative of the presence of LNAPL (see SCR Chapter 9). The following soil samples from the site meet this criteria:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Location.ID | Date.Sampled | DRO.GRO | X.Coordinate | Y.Coordinate |
| AOC2-TRCH1-N15 (5 ft) | 2004-09-27 | 311.40 | 1123020 | 1778437 |
| AOC2-TRCH1-N45 (12 ft) | 2004-09-27 | 3000.00 | 1123021 | 1778407 |
| AOC2-TRCH1-N75 (6 ft) | 2004-09-27 | 2745.00 | 1123022 | 1778376 |
| AOC2-TRCH2-W15 (13 ft) | 2004-09-27 | 1408.80 | 1123030 | 1778411 |
| AOC2-TRCH2-W17 (5 ft) | 2004-09-27 | 803.00 | 1123035 | 1778411 |
| AOC3-BH2 (10 ft) | 2004-10-16 | 733.00 | 1123138 | 1778403 |
| AOC4-BH2 (10 ft) | 2004-10-16 | 352.70 | 1123201 | 1778318 |
| AOC4-BH3 (10 ft) | 2004-10-17 | 2080.00 | 1123149 | 1778300 |
| AOC4-TP2 (1 ft) | 2004-09-23 | 1510.00 | 1123162 | 1778283 |
| AOC4-TP2 (6.5 ft) | 2004-09-23 | 1100.00 | 1123162 | 1778283 |
| AOC4-TP4 (5 ft) | 2004-09-23 | 1895.00 | 1123172 | 1778219 |
| AOC4-TRCH1-N10 (11 ft) | 2004-09-23 | 2250.00 | 1123149 | 1778381 |
| AOC4-TRCH1-S20 (11 ft) Dup | 2004-09-29 | 1510.00 | 1123150 | 1778343 |
| AOC4-TRCH2-S12 (9 ft) | 2004-09-29 | 1759.00 | 1123182 | 1778176 |
| AOC4-TRCH2-S12 (9 ft) Dup | 2004-09-29 | 1635.00 | 1123182 | 1778176 |
| AOC4-TRCH2-S95 (11 ft) | 2004-09-29 | 1320.00 | 1123192 | 1778259 |
| AOC5-BH4 (6-7 ft) | 2004-10-16 | 3230.00 | 1123037 | 1778077 |
| AOC5-MW11 (6-7 ft) | 2004-10-14 | 2512.00 | 1123131 | 1778083 |
| AOC5-TRCH1-S30 (4 ft) | 2004-09-22 | 5820.00 | 1122994 | 1778181 |
| AOC5-TRCH2-N69 (13 ft) | 2004-09-24 | 2700.00 | 1123072 | 1778154 |
| AOC5-TRCH2-S5 (5 ft) | 2004-09-24 | 620.25 | 1123039 | 1778067 |
| AOC5-TRCH3-E5 (6 ft) | 2004-09-28 | 3219.00 | 1123120 | 1778179 |
| AOC5-TRCH3-E7 (10.5 ft) | 2004-09-28 | 4017.00 | 1123120 | 1778179 |
| AOC5-TRCH4-W46 (12 ft) | 2004-09-29 | 1520.00 | 1123088 | 1778135 |
| AOC5-TRCH5-E26 (6 ft) | 2004-09-28 | 5140.00 | 1123071 | 1778098 |
| AOC5-TRCH5-E4 (12 ft) | 2004-09-28 | 7880.00 | 1123090 | 1778092 |
| AOC5-TRCH5-E4 (2 ft) | 2004-09-27 | 16280.00 | 1123090 | 1778092 |
| AOC5-TRCH5-W37 (11 ft) | 2004-09-28 | 986.00 | 1123048 | 1778107 |
| AOC5-TRCH6-NW23 (12 ft) | 2004-09-28 | 1606.10 | 1123188 | 1778095 |
| AOC5-TRCH6-SE25 (2.5 ft) | 2004-09-28 | 900.25 | 1123219 | 1778076 |
| AOC5-TRCH6-SE25 (4.5 ft) | 2004-09-28 | 23029.00 | 1123219 | 1778076 |
| AOC5-TRCH6-SE5 (10 ft) | 2004-09-28 | 6819.00 | 1123241 | 1778062 |
| AOC5-TRCH7-NE42 (3 ft) | 2004-09-29 | 84089.00 | 1123208 | 1778067 |
| F6-Subs (3.5-5 ft) | 2013-10-18 | 911.60 | 1123011 | 1778396 |
| F6-Subs (7.5-9 ft) | 2013-10-18 | 290.20 | 1123011 | 1778396 |
| F6-Surf (0-1 ft) | 2013-10-18 | 532.20 | 1123011 | 1778396 |
| F9(E)-Surf (0-1 ft) | 2013-10-19 | 522.00 | 1123005 | 1778129 |
| G8-Surf (0-1 ft) | 2013-10-01 | 458.30 | 1123075 | 1778227 |
| H10-Subs (3.5-6 ft) | 2013-10-17 | 645.00 | 1123163 | 1778044 |
| H10-Surf (0-1 ft) | 2013-10-17 | 1130.00 | 1123163 | 1778044 |
| H6-Subs (11-12.5 ft) | 2013-10-16 | 4900.00 | 1123192 | 1778420 |
| I10(W)-Surf (0-1 ft) | 2013-10-17 | 542.10 | 1123225 | 1778011 |
| I7-Surf (0-1 ft) | 2013-10-05 | 520.00 | 1123253 | 1778322 |
| J6-Surf (0-1 ft) | 2013-10-16 | 370.20 | 1123346 | 1778393 |
| MW-12 (5 ft) | 2004-10-13 | 4980.00 | 1123215 | 1778092 |
| MW-7 (10.5-11.5 ft) | 2004-10-13 | 7240.00 | 1123195 | 1778378 |
| SASB-4 (0-1 ft) | 2009-07-01 | 262.10 | 1123055 | 1778365 |
| SASB-4 (2-6 ft) | 2009-07-01 | 544.80 | 1123055 | 1778365 |
| SASB-4 (9-11 ft) | 2009-07-01 | 1823.00 | 1123055 | 1778365 |
| TP-1 (0-8 ft) | 2000-11-22 | 33000.00 | 1123107 | 1778185 |
| TP-2 (0-8 ft) | 2000-11-22 | 15000.00 | 1123095 | 1778168 |
| TP-3 (0-4 ft) | 2000-11-22 | 4000.00 | 1123077 | 1778141 |
| TP-8 (0-8 ft) | 2000-11-22 | 13000.00 | 1122990 | 1778180 |
| AOC1-BH2 (17-18 ft) | 2004-10-17 | 860.00 | 1122963 | 1778371 |
| AOC1-BH4 (16.5-17 ft) | 2005-10-11 | 540.00 | 1122930 | 1778274 |
| AOC2-BH1 (15-16 ft) | 2004-10-15 | 450.00 | 1123013 | 1778457 |
| AOC2-BH2 (16-17 ft) | 2004-10-15 | 1320.00 | 1123019 | 1778374 |
| AOC2-BH2 (25-25.5 ft) | 2004-10-15 | 770.00 | 1123019 | 1778374 |
| AOC2-BH3 (15 ft) | 2004-10-17 | 1100.00 | 1123079 | 1778334 |
| AOC2-BH4 (19.5-21.5 ft) | 2004-10-17 | 354.00 | 1123022 | 1778316 |
| AOC2-MW5 (15.5-16.5 ft) | 2004-10-12 | 1090.00 | 1123102 | 1778412 |
| AOC2-TRCH2-W20 (17 ft) | 2004-09-27 | 657.00 | 1123043 | 1778412 |
| AOC4-BH1 (15 ft) | 2004-10-17 | 2520.00 | 1123147 | 1778349 |
| AOC4-BH1 (15 ft) Dup | 2004-10-17 | 2700.00 | 1123147 | 1778349 |
| AOC4-TRCH1-N10 (13 ft) | 2004-09-23 | 2910.00 | 1123149 | 1778381 |
| AOC4-TRCH1-S20 (13 ft) Dup | 2004-09-23 | 320.00 | 1123150 | 1778343 |
| AOC5-BH3 (18-20 ft) | 2004-10-16 | 1240.00 | 1123066 | 1778139 |
| AOC5-BH5 (16.5-17 ft) | 2005-10-11 | 610.00 | 1123056 | 1777913 |
| AOC5-MW11 (20-21 ft) | 2004-10-14 | 1700.00 | 1123131 | 1778083 |
| AOC5-TRCH1-N13 (14 ft) | 2004-09-22 | 2190.00 | 1122988 | 1778205 |
| AOC5-TRCH1-S30 (16 ft) | 2004-09-22 | 11700.00 | 1122994 | 1778181 |
| AOC5-TRCH6-SE25 (16 ft) | 2004-09-28 | 11150.00 | 1123219 | 1778076 |
| MW-12 (20-20.5 ft) | 2004-10-13 | 11850.00 | 1123215 | 1778092 |
| MW-9 (18-18.5 ft) | 2004-10-14 | 286.00 | 1123230 | 1778199 |

The mean of the above values of DRO+GRO is:

## [1] 4618.5

## TPH to LNAPL Saturation Conversion

The conversion from TPH to LNAPL saturation uses the grain density based equation described in <http://naplansr.com/conversion-of-tph-to-napl-saturation-volume-2-issue-1-january-2012/>. This equation is:

where = porosity and = LNAPL density.

Using this equation and the following:  
\* TPH = 4618.5 (the value calculated from the data above)  
\* Grain Density = 2.65 g/cm3  
\* LNAPL Density = 0.8 g/cm3  
\* porosity = 0.348

LNAPL saturation is:

## [1] 0.02866323

This value (2.87%) is consistent with direct measurement of LNAPL saturation in site soil samples as reported in SECOR (2007) Appendix E. The average product saturation reported in SECOR (2007) Appendix E is 2.0%.