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Revision 0

Technical Memorandum: Reevaluation of Post-Record-of-Decision 100-F/IU Area Cleanup Verification Packages Incorporating Dimensional Consideration of Soil Screening Levels and Preliminary Remediation Goals

Document Type: ENV   Program/Project: EP&SP

W. E. Nichols
CH2M HILL Plateau Remediation Company

Date Published
May 2016

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

P.O. Box 1600
Richland, Washington 99352

100-FR-1
100-FR-2
100-IU-2
100-IU-6

APPROVED
By Janis Aardal at 12:47 pm, Jun 02, 2016

Release Approval   Date

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Plateau Remediation Company

TECHNICAL MEMORANDUM

Reevaluation of Post-Record-of-Decision 100-F/IU Area Cleanup Verification Packages Incorporating Dimensional Consideration of Soil Screening Levels and Preliminary Remediation Goals

Prepared for:	100-F/IU
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1. Introduction

A reevaluation of the comparison of exposure point concentrations (EPCs) originally evaluated in post-Record-of-Decision (ROD) cleanup verification packages (CVPs) with dimensional consideration incorporated was conducted. The CVPs under consideration compared EPCs against cleanup levels established in the ROD without dimensional consideration; that is, the values were evaluated as if the cleanup levels were dimensionless concentrations. However, the basis for these cleanup values makes them per-unit-length values that should be scaled by the representative length of the waste site decision unit in the general direction of groundwater flow. This technical memorandum documents that no cleanup verification sample EPCs (maximum values) in the CVPs of concern required reevaluation with scaling of cleanup values by waste site representative dimensions because none of the EPCs (maximum values) exceeded background levels.

A formal Environmental Calculation File (ECF) would have been prepared if a reevaluation had been necessary, but this was not the case.

2. Background

The model used to derive soil screening levels (SSLs) and preliminary remediation goals (PRGs) that form the basis for cleanup levels against which EPCs are evaluated CVPs are documented in ECF-HANFORD-12-0004, *STOMP 1-D Modeling for Determination of Soil Screening Levels and Preliminary Remediation Goals for 100 Area F and IU Source Areas*.

ECF-HANFORD-12-0004 presents a generalized model that evaluates initial contaminant concentrations assigned based on the 100:0 or 70:30 source configuration at the start of simulations. Transport in the vadose zone and portion of the aquifer were simulated with the STOMP code in which the model was implemented. The COPC concentrations in the groundwater exiting the model domain's downgradient boundary, corresponding to the top 5 m (16.4 ft) of the aquifer, were calculated over the 1,000 year simulation time frame. Using the upper 5 m of the aquifer is consistent with the requirements for aquifer mixing zone thickness in WAC 173-340-747[5][f][i]. The resulting time-varying groundwater concentration for each COPC was evaluated for the downgradient edge of the aquifer portion of the model, and the peak groundwater concentration and its year of occurrence were selected as the basis of calculating the SSL (assuming the irrigation recharge scenario) or PRG (assuming the native vegetation recharge scenario).

A simple calculation was then employed to compute unit-length SSL and PRG values by scaling the selected peak concentration value based on a unit-length source against the regulatory compliance criteria and the initial soil concentration. As a measure of allowable quantity of contaminant in the soil, SSLs and PRGs are expressed as contaminant mass per mass of soil for chemicals or as contaminant activity per mass of soil for radionuclides, per meter of waste site decision unit length in the direction parallel to groundwater flow.

The unit-length SSL for each COPC was computed as:

$$SSL_{unit-length} = C_I \frac{WQS}{CPK} \tag{1a}$$

where

$SSL_{unit-length}$ ≡ unit-length soil screening level $\left[\left(\frac{\text{mg}}{\text{kg}}\cdot\text{m}\right) \text{ or } \left(\frac{\text{pCi}}{\text{g}}\cdot\text{m}\right)\right]$

C_I ≡ initial concentration or activity $\left[\left(\frac{\text{mg}}{\text{kg}}\right) \text{ or } \left(\frac{\text{pCi}}{\text{g}}\right)\right]$

WQS ≡ water quality standard $\left[\left(\frac{\text{mg}}{\text{L}}\right) \text{ or } \left(\frac{\text{pCi}}{\text{L}}\right)\right]$

CPK ≡ peak groundwater concentration downgradient of soil column with unit-length in the direction of groundwater flow for the irrigation recharge scenario $\left[\left(\frac{\text{mg}}{\text{L}}\right) \text{ or } \left(\frac{\text{pCi}}{\text{L}}\right)\right]$

Similarly, the unit-length PRG for each COPC was computed as:

$$PRG_{unit-length} = C_I \frac{WQS}{CPK} \tag{1b}$$

where

$PRG_{unit-length}$ ≡ unit-length preliminary remediation goal $\left[\left(\frac{\text{mg}}{\text{kg}}\cdot\text{m}\right) \text{ or } \left(\frac{\text{pCi}}{\text{g}}\cdot\text{m}\right)\right]$

C_I ≡ initial soil mass or activity concentration $\left[\left(\frac{\text{mg}}{\text{kg}}\right) \text{ or } \left(\frac{\text{pCi}}{\text{g}}\right)\right]$

WQS ≡ water quality standard $\left[\left(\frac{\text{mg}}{\text{L}}\right) \text{ or } \left(\frac{\text{pCi}}{\text{L}}\right)\right]$

CPK ≡ peak groundwater concentration downgradient of soil column with unit-length in the direction of groundwater flow for the native vegetation recharge scenario $\left[\left(\frac{\text{mg}}{\text{L}}\right) \text{ or } \left(\frac{\text{pCi}}{\text{L}}\right)\right]$

The standard values used for *WQS* are the surface water quality standards for computing the SSLs and PRGs protective of surface water, whereas the groundwater quality standards are used to compute SSLs and PRGs protective of groundwater. For the 100-F/IU Area, the recharge scenario applied to develop SSL values was an irrigation recharge scenario, which was subsequently selected as the residential cleanup standard in the ROD (EPA and DOE 2013, *Record of Decision Hanford Site 100 Area Superfund Site 100-FR-1, 100-FR-2, 100FR-3, 100-IU-2, and 100-IU-6 Operable Units*). The PRG values were developed using a native vegetation recharge scenario.

COPC breakthrough was assumed not to occur if the simulated peak groundwater concentrations within the 1,000-year simulation timeframe did not exceed a value of 0.0001 µg/L for non-radionuclide COPCs or 0.0001 pCi/m^3 for radionuclide COPCs, in at least one of the representative stratigraphic columns simulated. In these instances, the results were below a level of numerical significance and were thus designated as non-representative.

The SSLs and PRGs for each COPC were calculated based on the assigned source distribution, K_d, recharge scenario and for each of the seven stratigraphic columns. The resulting SSL and PRG values were evaluated and adjusted based on the following provisions:

- If the calculated value was less than the estimated quantitation limit (EQL) concentration , as provided in DOE/RL-2009-40, *Sampling and Analysis Plan for the 100-DR-1 100-DR-2 100-HR-1 100-HR-2 and 100-HR-3 Operable Units Remedial Investigation Feasibility Study*), then the EQL was selected as the final SSL or PRG.
- Where simulated peak groundwater concentrations were very small, application of Equations 1a and 1b would yield physically unrealistic soil concentrations, e.g., 10 kg of aluminum per 1 kg of soil. Listing such unphysical protection levels is not meaningful, so an upper physical bound for SSL and PRG values was derived based on considering the extreme of total contaminant mass that can occupy the soil pore space within a unit mass (1.0 kg) of bulk soil. The maximum value was determined to be 384,000 mg per kg of soil (ECF-HANFORD-12-0004). Therefore, if the calculated SSL or PRG value exceeded this physical upper bound, the values was truncated at 384,000 mg/kg.
- The cleanup level for hexavalent chromium is set to 6.0 mg/kg based on the evaluation in ECF-Hanford-11-0165; this value is not dependent on waste site size.

For both protection to groundwater and surface water, a single SSL and a single PRG value was then selected for each COPC that corresponds to the minimum value calculated from a range of five representative stratigraphic columns simulated for derivation of 100-F/IU Area SSL and PRG values.

The unit-length SSL and PRG values obtained from the vadose zone models were intended to be scaled by a representative length in the direction of groundwater flow to obtain values for use in evaluating EPCs for a given waste site decision unit. This is required because the larger the waste site extends in the direction of groundwater flow, the more contamination that is contributed to groundwater. A simple example illustrates this concept. Figure 1(a) depicts the one-meter basis for the derivation of the SSL and PRG values in which soil is contaminated at initial concentration C_I, and the transport of this contaminant vertically downward in the vadose zone, then laterally in the aquifer, results in a peak groundwater concentration *CPK* (within 1000 years) at the downgradient edge of the waste site. The ratio of the resulting value of *CPK* to the applicable groundwater protection level is used to determine the maximum value of C_I (using Equation 1a or 1b above) that would not exceed the applicable protection level. Inherent to this construct is the dimension in the direction of groundwater flow (to which the model is intentionally aligned). The greater the length in this direction, the more contaminant mass arrives in groundwater from soil contaminated at level C_l, and the higher *CPK* becomes on the downgradient edge of the waste site. In Figure 1 (b), this is illustrated by considering a 5-m waste site. While the concentration of soil contamination is the same in both the 1-m and the 5-m wide cases, the total contaminant mass arriving in groundwater is five times greater in the 5-m wide case than in the 1-m case. This results in a *CPK* value five times greater in the 5-m case, which when scaled will result in a protection level (SSL or PRG value) five times smaller than in the 1-m case. Therefore, the SSL and PRG values derived from the model are provided on a unit-length basis so that these values can be readily scaled by the waste site representative length in the direction of groundwater flow for evaluation use. Scaling is accomplished by dividing the per-unit length SSL or PRG value by the representative length in the direction of groundwater flow. Scaled values then explicitly account for the total mass arrival in groundwater based on waste site size – and are appropriate to apply for evaluation of whether EPC values would potentially result in exceedance of protection levels. Of course, care must also be taken to ensure that the scaled SSL or PRG values are truncated at EQL and/or background levels before comparison, in case scaling reduces these values below those thresholds.

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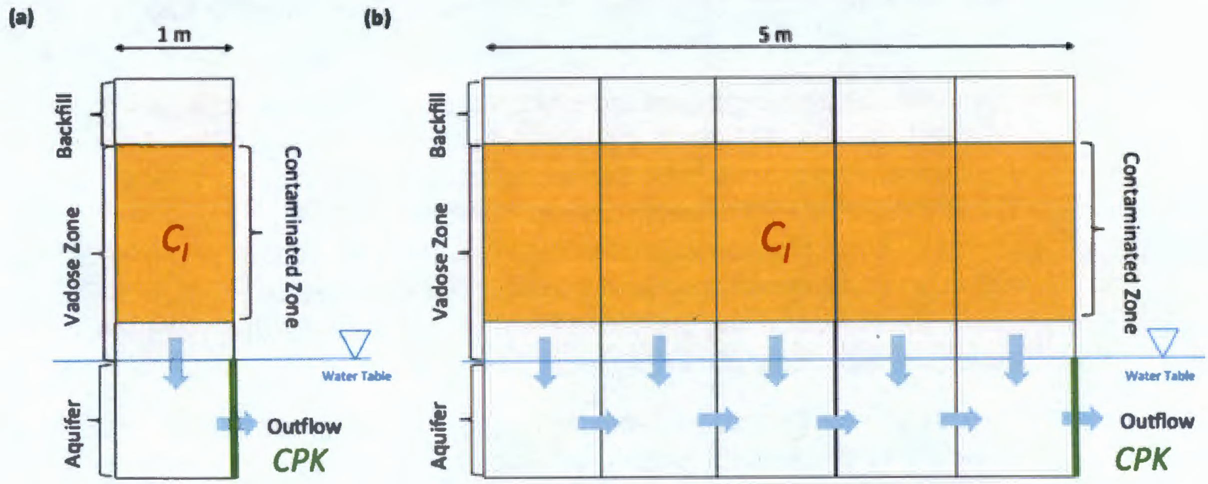

Figure 1. Illustration of Application of Unit-Length SSL and PRG Values

3. Result of Post-ROD Cleanup Verification Package Review

A review of CVPs provided by Washington Closure Hanford (WCH) for all waste sites evaluated post-ROD was conducted to identify all COPCs that exceeded background and require reevaluation with scaling of cleanup levels by waste site dimension.

All Post-ROD sites were included in Waste Site Reclassification Form 2015-073, and included the following sites/subsites:

1. 600-279, Vegetation-Free Area Between White Bluffs and 100-F
2. 600-293, White Bluffs Service Station #1
3. 600-294, White Bluffs Service Station #2

4. 600-298, Stained Soil and Surface Debris
5. 600-299, Surface Debris/Batteries
6. 600-3 75, Segment 4 Dry Cell Battery
7. 600-3 77, Segment 4 Oil Stain and Filter Area #2
8. 600-300 Miscellaneous Surface Debris
9. 600-301, White Bluffs Sanitary Sewer Pipelines Area
10. 600-303, Vertical Pipes
11. 600-316, Dry Cell Batteries
12. 600-318, Wet Cell Batteries Debris Area #1
13. 600-320, Oil Stains
14. 600-321 , Suspect ACM Sites
15. 600-328, Lead Slag
16. 600-356, Tar Deposit West of Susie Junction Generator Building Underground Fuel Storage tank
17. 600-368, Segment 4 Stained Soil #1
18. 600-369, Segment 4 Bare Ground and Crusted Soil Areas
19. 600-370, Segment 4 Debris Area #1
20. 600-371, Segment 4 Chalky Material Area
21. 600-372, Segment 4 Oil Stain and Filter Area #1
22. 600-373, Segment 4 Bare Ground and White Stain
23. 600-374, Segment 4 Drum Remnant Area
24. 600-376, Segment 4 Stained Soil Area #2
25. 600-378, 506 Telephone Exchange Emergency
26. 600-379, Segment 4 Burn Area #1

The review identified no COPCs that exceeded background and requiring reevaluation with scaling of cleanup levels by waste site dimension.

4. References

ECF-HANFORD-12-0004, *STOMP 1-D Modeling for Determination of Soil Screening Levels and Preliminary Remediation Goals for 100 Area F and IU Source Areas*, Rev. 3, CH2M Hill Plateau Remediation Company, Richland, Washington.

DOE/RL-2009-40, 2009, *Sampling and Analysis Plan for the 100-DR-1 100-DR-2 100-HR-1 100-HR-2 and 100-HR-3 Operable Units Remedial Investigation Feasibility Study*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0084375.

ECF-Hanford-11-0165, 2012, *Evaluation of Hexavalent Chromium Leach Test Data Conducted on Vadose Zone Sediment Samples from the 100 Area*, Rev. 1, CH2M Hill Plateau Remediation Company, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0086677.

EPA and DOE 2013, Record of Decision Hanford Site 100 Area Superfund Site 100-FR-1, 100-FR-2, 100FR-3, 100-IU-2, and 100-IU-6 Operable Units, U.S. Environmental Protection Agency and U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0082927H.